Miltiadis D. Lytras
John M. Carroll
Ernesto Damiani
Robert D. Tennyson (Eds.)

LNAI 5288

Emerging Technologies and Information Systems for the Knowledge Society

First World Summit on the Knowledge Society, WSKS 2008
Athens, Greece, September 2008
Proceedings

Springer

Lecture Notes in Artificial Intelligence 5288

Edited by R. Goebel, J. Siekmann, and W. Wahlster

Subseries of Lecture Notes in Computer Science

Miltiadis D. Lytras John M. Carroll
Ernesto Damiani Robert D. Tennyson (Eds.)

Emerging Technologies and Information Systems for the Knowledge Society

First World Summit on the Knowledge Society, WSKS 2008
Athens, Greece, September 24-26, 2008
Proceedings

Springer

Volume Editors

Miltiadis D. Lytras
Open Research Society, NGO, Gerakas Attikis, Greece
E-mail: lytras@open-knowledge-society.org

John M. Carroll
The Pennsylvania State University
College of Information Sciences and Technology
University Park, PA, USA
E-mail: jcarroll@ist.psu.edu

Ernesto Damiani
University of Milan, Department of Computer Technology
Crema (CR), Italy
E-mail: damiani@dti.unimi.it

Robert D. Tennyson
University of Minnesota
College of Education and Human Development
Minneapolis, MN, USA
E-mail: rtenny@umn.edu

Library of Congress Control Number: 2008935022

CR Subject Classification (1998): K.4, J.1, I.2, K.3, K.6

LNCS Sublibrary: SL 7 – Artificial Intelligence

ISSN 0302-9743
ISBN-10 3-540-87780-0 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-87780-6 Springer Berlin Heidelberg New York

Springer is a part of Springer Science+Business Media

springer.com

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 12529858 06/3180 5 4 3 2 1 0

Preface

It is a great pleasure to share with you the Springer LNCS proceedings of the First World Summit on the Knowledge Society - WSKS 2008 that was organized by the Open Research Society, NGO, http://www.open-knowledge-society.org, and took place in the American College of Greece, http://www.acg.gr, during September 24–27, 2008, in Athens, Greece.

The World Summit on the Knowledge Society Series is an international attempt to promote a dialogue on the main aspects of a knowledge society toward a better world for all based on knowledge and learning.

The WSKS Series brings together academics, people from industry, policy makers, politicians, government officers and active citizens to look at the impact of information technology, and the knowledge-based era it is creating, on key facets of today's world: the state, business, society and culture.

Six general pillars provide the constitutional elements of the WSKS series:

- Social and Humanistic Computing for the Knowledge Society—Emerging Technologies and Systems for the Society and Humanity
- Knowledge, Learning, Education, Learning Technologies and E-learning for the Knowledge Society
- Information Technologies—Knowledge Management Systems—E-business and Enterprise Information Systems for the Knowledge Society
- Culture and Cultural Heritage—Technology for Culture Management—Management of Tourism and Entertainment—Tourism Networks in the Knowledge Society
- Government and Democracy for the Knowledge Society
- Research and Sustainable Development in the Knowledge Society

The summit provides a distinct, unique forum for cross-disciplinary fertilization of research, favoring the dissemination of research that is relevant to international research agendas such as the EU FP7.

In the first event of the series, the Athens 2008 First World Summit on the Knowledge Society, five main tracks and four workshops were organized. LNCS/LNAI 5288 summarizes 64 full research articles that were selected after a double-blind review process from 286 submissions, contributed by 530 co-authors.

In this volume of LNCS you will find excellent quality research that summarizes sound propositions for advanced systems toward a knowledge society.

Figure 1 summarizes the context of the research presented at WSKS 2008.

I would like to thank the authors from 65 countries for their submissions; the Program Committee members and their subreviewers for the thoroughness of their reviews; and the colleagues at the American College of Greece for the great support they offered in the organization of the event on the Aghia Paraskevi Campus.

Fig. 1.

We are honored for the support and encouragement of the Editors-in-Chief of the ten ISI SCI/SSCI listed journals that agreed to publish special issues from extended versions of papers presented in the summit:

- Robert Tennyson, Editor-in-Chief of *Computers in Human Behaviour*
- Amit Sheth, Editor-in-Chief of *International Journal of Semantic Web and Information Systems*
- Witold Pedrycz, Editor-in-Chief of *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*
- Charles Crook, Editor-in-Chief, and Deputy Editor R. Joiner of the *Journal of Computer-Assisted Learning*
- Joseph Psotka and Bernard Scott, Editors-in-Chief of *Interactive Learning Environment*
- Keng Siau, Editor-in-Chief of the *Journal of Database Management (JDM)*
- Mohammed Dorgham, Editor-in-Chief of the *International Journal of Technology Management*
- Patricia Ordonez De Pablos, Editor-in-Chief of the *International Journal of Learning and Intellectual Capital.*

I am also honored that John Carroll, Robert Tennyson and my good friend Ambjorn Naeve supported the event with their keynotes. You can find more information at: http://www.open-knowledge-society.org/keynotes.htm

A great thank you also to Alfred Hofmann, Springer, and his staff for the excellent support in all the development phases of the proceedings of LNCS/LNAI 5288 and CCIS 19.

Our warmest appreciation, respect and thank you to the President of the American College of Greece, David G. Horner, and Lila Mordochae, Associate Dean, School of Business Administration, The American College of Greece, for their support and critical contribution to the success of WSKS 2008. A great thank you also to the Head of the CIS department at The American College of Greece, Jenny Vagianou and to all the members of the CIS Society for their efforts in making this event an unforgetable experience for all the participants.

Last but not least, a big thank you to the staff and members of the Open Research Society, for their great efforts during the summit organization and the joint vision to promote a better world for all based on knowledge and learning.

We need a better world. We can contribute with our sound voices to the various agendas, policies and actions. We invite you to join your voice with ours and all together to shape a new deal for our world: education, sustainable development, health, opportunities for well-being, culture, collaboration, peace, democracy, technology for all.

Looking forward to seeing you at the second event of the series, for which you can find more information at: http://www.open-knowledge-society.org/summit09.htm.

With 55 special issues already agreed for WSKS 2009, and 8 main tracks, we want to ask for your involvement and we would be happy to see you joining us. Give a hand!

On behalf of the Program and Organizing Committee, thank you – Efharisto Poli!

July 2008 Miltiadis D. Lytras

Organization

WSKS 2008 was organized by the Open Research Society, NGO, http://www.open-knowledge-society.org, and in cooperation with The American College of Greece, http://www.acg.gr

Executive Committee

General Chair of WSKS 2008

Miltiadis D. Lytras

President, Open Research Society, NGO

Miltiadis D. Lytras is the President and Founder of the Open Research Society, NGO. His research focuses on the Semantic Web, knowledge management and e-learning, with more than 100 publications in these areas. He has co-edited / co-edits, 25 special issues in international journals (e.g., *IEEE Transaction on Knowledge and Data Engineering*, *IEEE Internet Computing, IEEE Transactions on Education*, *Computers in Human Behaviour*, *Interactive Learning Environments*, *Journal of Knowledge Management*, *Journal of Computer-Assisted Learning*, etc.) and has authored/ ((co-)edited) 22 books (e.g., *Open Source for Knowledge and Learning Management*, *Ubiquitous and Pervasive Knowledge Management*, *Intelligent Learning Infrastructures for Knowledge-Intensive Organizations*, *Semantic Web-Based Information Systems*, *China Information Technology Handbook*, *Real-World Applications of Semantic Web and Ontologies*, *Web 2.0: The Business Model*, etc.) . He is the founder and officer of the Semantic Web and Information Systems Special Interest Group in the Association for Information Systems (http://www.sigsemis.org). He serves as the (Co) Editor-in-Chief of 12 international journals (e.g., *International Journal of Knowledge and Learning*, *International Journal of Technology-Enhanced Learning*, *International Journal on Social and Humanistic Computing*, *International Journal on Semantic Web and Information Systems*, *International Journal on Digital Culture and Electronic Tourism*, *International Journal of Electronic Democracy*, *International Journal of Electronic Banking*, *International Journal of Electronic Trade* etc.) while he is associate editor or editorial board member in seven more.

WSKS 2008 Co-chairs

David Avison

Distinguished Professor in Information Systems
President-Elect of the Association for Information Systems

David Avison is Distinguished Professor of Information Systems at ESSEC Business School, near Paris, France, after being Professor at the School of Management at

Southampton University for nine years. He has also held posts at Brunel and Aston Universities in the UK, and the University of Technology Sydney and University of New South Wales in Australia, and elsewhere. He is President-Elect of the Association of Information Systems (AIS). He is joint editor of Blackwell Science's *Information Systems Journal* now in its 18th volume, rated as a 'core' international journal. So far, 25 books are to his credit including the fourth edition of the well-used text *Information Systems Development: Methodologies, Techniques and Tools* (jointly authored with Guy Fitzgerald). He has published a large number of research papers in learned journals, edited texts and conference papers. He was Chair of the International Federation of Information Processing (IFIP) 8.2 group on the impact of IS/IT on organizations and society and is now Vice Chair of IFIP Technical Committee 8. He was past President of the UK Academy for Information Systems and also Chair of the UK Heads and Professors of IS and is presently a member of the IS Senior Scholars Forum. He was joint Program Chair of the International Conference in Information Systems (ICIS) in Las Vegas (previously also research Program Stream Chair at ICIS Atlanta), joint Program Chair of the IFIP TC8 conference at Santiago Chile, Program Chair of the IFIPWG8.2 conference in Amsterdam, Panels Chair for the European Conference in Information Systems at Copenhagen and Publicity Chair for the entity-relationship conference in Paris and Chair of several other UK and European conferences. He was joint Program Chair of the IFIP TC8 conference in Milan, Italy in 2008. He also acts as consultant and has most recently worked with a leading manufacturer developing their IT/IS strategy. He researches in the area of information systems development and more generally on information systems in their natural organizational setting, in particular using action research, although he has also used a number of other qualitative research approaches.

Ernesto Damiani

University of Milan, Italy

Ernesto Damiani is a professor at the Department of Information Technology, University of Milan, where he leads the Software Architectures Lab. Professor Damiani holds/has held visiting positions at several international institutions, including George Mason University (Fairfax, VA, USA) and LaTrobe University (Melbourne, Australia). He is an Adjunct Professor at the Sydney University of Technology (Australia). He has written several books and filed international patents; also, he has co-authored more than 200 research papers on advanced secure service-oriented architectures, open source software and business process design, software reuse and Web data semantics. Professor Damiani is the Vice Chair of IFIP WG 2.12 on Web Data Semantics and the secretary of IFIP WG 2.13 on Open Source Software Development. He coordinates several research projects funded by the Italian Ministry of Research and by private companies including Siemens Mobile, Cisco Systems, ST Microelectronics, BT Exact, Engineering, Telecom Italy and others.

Thomas Davenport

President's Chair in Information Technology and Management at Babson College

Voted the third-leading business-strategy analyst in *Optimize* magazine's October 2005 issue, Tom Davenport is a world-renowned thought leader who has helped hundreds of companies revitalize their management practices. An agile and prolific thinker, Davenport has written or co-authored 12 best-selling business books and has been a creator and early proponent of several key business ideas including: knowledge management, human approaches to information management, business process reengineering, and realizing the value of enterprise systems.With his vast storehouse of industry stories, research and data, and cutting-edge ideas, Davenport balances research-based business acumen with practical application. His areas of expertise include improving the productivity of knowledge workers, information and knowledge management, attention management, idea generation, innovation, competing on analytics, managing enterprise applications for business value, and business process reengineering.

John Davies

BT Exact, UK

Dr. John Davies leads the Next Generation Web research group at BT. Current interests center around the application of Semantic Web technology to knowledge management, information retrieval and service-oriented architectures. He is Industrial Chair of the Semantic Web Services Initiative, co-organizer of the European Semantic Web Conference series and Project Director of the SEKT EU integrated project. He has written and edited many papers and books in the areas of Web-based information management, knowledge management and the Semantic Web and has served on the Program Committee of many conferences in related areas. He is a Fellow of the British Computer Society and a Chartered Engineer. Earlier research at BT led to the development of a set of knowledge management tools which are the subject of a number of patents. These tools are now marketed through Exago Ltd. (www.exago.com), of which Dr. Davies is Chief Technology Officer.

Gottfried Vossen

University of Münster, Germany

Gottfried Vossen is Professor of Computer Science in the Department of Information Systems at the University of Münster in Germany. He is the European Editor-in-Chief of Elsevier's *Information Systems—An International Journal*, and a Director of the European Research Center for Information Systems (ERCIS) in Münster. His research interests include conceptual as well as application-oriented problems concerning databases, information systems, electronic learning, and the Web.

Program Chair

Patricia Ordonez De Pablos	University of Oviedo, Spain

Organizing Committee

Hosting Organization – The American College of Greece

David G. Horner	President, The American College of Greece
Lila Mordochae	Associate Dean, School of Business Administration, The American College of Greece
Jenny Vagianou	Head, CIS Department, The American College of Greece

Workshops and Tutorials Chairs

Ambjorn Naeve	Royal Institute of Technology, Sweden
Miguel Angel Sicilia	University of Alcala, Spain

Publicity Chair

Ekaterini Pitsa	Open Research Society, Greece

PhD Symposium Chair

John M. Carroll	The Pennsylvania State University, USA

Exhibition Chair

Efstathia Pitsa	University of Cambridge, UK

Sponsoring Organizations

Gold

Inderscience Publishers, http://www.inderscience.com

Program and Scientific Committee Members (Serving also as Reviewers)

Adrian Paschke	Technical University Dresden, Germany
Adriana Schiopoiu Burlea	University of Craiova, Romania
Agnes Kukulska-Hulme	The Open University, UK
Ahmad Syamil	Arkansas State University, USA
Aime' Lay-Ekuakille	University of Salento, Italy
Alan Chamberlain	University of Nottingham, UK

Alejandro Diaz-Morcillo	University of Cartagena, Spain
Algirdas Pakstas	London Metropolitan University, UK
Alok Mishra	Atilim University, Turkey
Alyson Gill	Arkansas State University, USA
Ambjörn Naeve	Royal Institute of Technology, Sweden
Ana B. Ríos Hilario	Universidad de Salamanca, Spain
Ana Isabel Jiménez-Zarco	Open University of Catalonia, Spain
Anas Tawileh	Cardiff University, UK
Anastasia Petrou	University of Peloponnese, Greece
Anastasios A. Economides	University of Macedonia, Greece
Andreas Holzinger	Medical University Graz, Austria
Andy Dearden	Sheffield Hallam University, UK
Ane Troger	Aston Business School, UK
Angela J. Daniels	Arkansas State University, USA
Anna Lisa Guido	University of Salento, Italy
Anna Maddalena	DISI, University of Genoa, Italy
Anna Maria Tammaro	University of Parma, Italy
Ansgar Scherp	OFFIS - Multimedia and Internet Information Services, Germany
Antonio Cartelli	University of Cassino, Italy
Antonio Tomeu	University of Cadiz, Spain
Riccardo Lancellotti	University of Modena and Reggio Emilia, Italy
Apostolos Gkamas	University of the Peloponnese, Greece
Arianna D'Ulizia	National Research Council, Italy
Aristomenis Macris	University of Piraeus, Greece
Athanassios Vozikis	University of Piraeus, Greece
Badr Al-Daihani	Cardiff University, UK
Beatriz Fariña	University of Valladolid, Spain
Belén Carro	University of Valladolid, Spain
Berardina Nadja De Carolis	University of Bari, Italy
Bob Folden	Texas A&M University-Commerce, USA
Bodil Nistrup Madsen	Copenhagen Business School, Denmark
Bonifacio Llamazares	Universidad de Valladolid, Spain
Bradley Moore	University of West Alabama, USA
Campbell R. Harvey	Duke University, USA
Carla Limongelli	Università "Roma Tre", Italy
Carlos Bobed	University of Zaragoza, Spain
Carlos Ferran	Penn State Great Valley University, USA
Carmen Costilla	Technical University of Madrid, Spain
Carolina Lopez Nicolas	University of Murcia, Spain
Charles A. Morrissey	Pepperdine University, USA
Chengbo Wang	Glasgow Caledonian University, UK
Chengcui Zhang	University of Alabama at Birmingham, USA
Christian Wagner	City University of Hong Kong, Hong Kong (China)
Christos Bouras	University of Patras, Greece
Christos K. Georgiadis	University of Macedonia, Greece

Chunzhao Liu	Chinese Academy of Sciences, China
Claire Dormann	Carleton University, Canada
Claus Pahl	Dublin City University, Ireland
Constantinos T. Artikis	University of Bradford, UK
Cui Tao	Brigham Young University, USA
Damaris Fuentes-Lorenzo	IMDEA Networks, Spain
Daniel R. Fesenmaier	Temple University, USA
Daniel Tse	City University of Hong Kong, Hong Kong (China)
Daniela Leal Musa	Federal University of Sao Paulo, Brazil
Daniela Tsaneva	Cardiff School of Computer Science, UK
Darijus Strasunskas	Norwegian University of Science and Technology (NTNU), Norway
David O'Donnell	Intellectual Capital Research Institute of Ireland, Ireland
David R. Harding	Jr. Arkansas State University, USA
Dawn Jutla	Saint Mary's University, Canada
Denis Gillet	Swiss Federal Institute of Technology in Lausanne (EPFL), Switzerland
Diane H. Sonnenwald	Director, Göteborg University and University College of Borås, Sweden
Dimitri Konstantas	University of Geneva, Switzerland
Dimitris N. Chryssochoou	University of Crete, Greece
Douglas L. Micklich	Illinois State University, USA
Duncan Shaw	Aston University, UK
Dusica Novakovic	London Metropolitan University, USA
Edward Dieterle	Harvard Graduate School of Education, USA
Ejub Kajan	High School of Applied Studies, Serbia
Elena García-Barriocanal	University of Alcalá, Spain
Elena Verdú Pérez	University of Valladolid, Spain
Emma O'Brien	University of Limerick, Ireland
Eric Tsui	The Hong Kong Polytechnic University, Hong Kong (China)
Eva Rimbau-Gilabert	Open University of Catalonia, Spain
Evanegelia Karagiannopoulou	University of Ioannina, Greece
Evangelos Sakkopoulos	University of Patras, Greece
Evripidis Korres	OPEN RESEARCH SOCIETY, Greece
F.F. Cai	London Metropolitan University, UK
Fernanda Lima	Universidade Catolica de Brasilia, Brazil
Filippo Sciarrone	Università "Roma Tre", Italy
Francesc Burrull	Polytechnic University of Cartagena, Spain
Francesca Lonetti	ISTI - Area della Ricerca CNR, Italy
Francisco Palomo Lozano	University of Cádiz, Spain
Gang Wu	Tsinghua University, China
Gary D. Robinson	Chair, Capella University, USA
Gavin McArdle	University College Dublin, Ireland
George A. Jacinto	Arkansas State University, USA

Georgios Skoulas	University of Macedonia, Greece
Gianluca Elia	University of Salento, Italy
Gianluigi Viscusi	University of Milano-Bicocca, Italy
Giovanni Vincenti	D.Sc. Gruppo Vincenti, S.r.l. Rome, Italy
Giuseppe Pirrò	University of Calabria, Italy
Giuseppe Vendramin	University of Salento, Italy
Vincenza Pelillo	University of Salento, Italy
Gregg, Janie	University of West Alabama, USA
Grigorios N. Beligiannis	University of Ioannina, Greece
Guillermo Ibañez	Universidad de Alcalá, Spain
Hai Jiang	Arkansas State University, USA
Haim Kilov	Stevens Institute of Technology, USA
Hajah Gy Hashim	University Technology Mara (UiTM), Malaysia
Hamidah Ibrahim	Department of Computer Science, Universiti Putra Malaysia, Malaysia
Hanh H. Hoang	Hue University, Vietnam
Hanne Erdman Thomsen	Copenhagen Business School, Denmark
Hanno Schauer	Universität Duisburg-Essen, Germany
Heinz V. Dreher	Curtin University of Technology, Australia
Helena Corrales Herrero	University of Valladolid, Spain
Helena Villarejo	University of Valladolid, Spain
Hui Yang	San Francisco State University, USA
Hyggo Almeida	University of Campina Grande, Brazil
Ian Taylor	LSU, USA
Inma Rodríguez-Ardura	Open University of Catalonia, Spain
Ino Martínez León	Universidad Politécnica de Cartagena, Spain
Ioan Marius Bilasco	Laboratoire Informatique de Grenoble (LIG), France
Ioanna Constantiou	Copenhagen Business School, Denmark
Ioannis Papadakis	Ionian University, Greece
Ioannis Stamelos	AUTH, Greece
Irene Daskalopoulou	University of the Peloponnese, Greece
Isabel Ramos	University of Minho, Portugal
James Braman	Towson University, USA
Jan-Willem Strijbos	Leiden University, The Netherlands
Javier De Andrés	University of Oviedo, Spain
Javier Fabra	University of Zaragoza, Spain
Jeanne D. Maes	University of South Alabama, USA
Jeannette K. Jones	American InterContinental University (AIU), USA
Jens O. Meissner	Lucerne School of Business, Switzerland
Jerome Darmont	University of Lyon (ERIC Lyon 2), France
Jesus Contreras	ISOCO, Spain
Jesús Ibáñez	University Pompeu Fabra, Spain
Jianhan Zhu	The Open University, UK
Johann Gamper	Free University of Bozen-Bolzano, Italy
Jon A. Preston	Clayton State University
Jorge Gracia	University of Zaragoza, Spain
Jose Jesus García Rueda	Carlos III University of Madrid, Spain

José Luis García-Lapresta	Universidad de Valladolid, Spain
Jose Luis Isla Montes	University of Cadiz, Spain
Jose M. Hernandez-Munoz	Universidad Carlos III de Madrid, and TELEFONICA I+D, Spain
Josemaria Maalgosa Sanahuja	Polytechnic University of Cartagena, Spain
Joseph C. Paradi	University of Toronto, Canada
Joseph Feller	University College Cork, Ireland
Joseph Hardin	University of Michigan, USA
Joze Gricar	University of Maribor, Slovenia
Juan Gabriel Cegarra Navarro	Universidad Politécnica de Cartagena, Spain
Juan Manuel Dodero	University of Cádiz, Spain
Juan Miguel Gómez Berbís	Univesidad Carlos III de Madrid, Spain
Juan Pablo de Castro Fernández	University of Valladolid, Spain
Juan Vicente Perdiz	University of Valladolid, Spain
Juan Ye	University College Dublin, Ireland
Julià Minguillón	Universitat Oberta de Catalunya (UOC), Spain
Jyotishman Pathak	Mayo Clinic College of Medicine, USA
Karim Mohammed Rezaul	University of Wales, UK
Karl-Heinz Pognmer	Copenhagen Business School, Denmark
Katerina Pastra	Institute for Language and Speech Processing, Greece
Ken Fisher	London Metropolitan University, UK
Kleanthis Thramboulidis	University of Patras, Greece
Konstantinos Kotis	University of the Aegean, Greece
Konstantinos Tarabanis	University of Macedonia, Greece
Kylie Hsu	California State University at Los Angeles, USA
Lambros Skarlas	University of Patras, Greece
Laura Papaleo	DISI, Italy
Laura Sanchez Garcia	Universidade Federal do Parana, Brazil
Laurel D. Riek	Cambridge University, UK
Lazar Rusu	Royal Institute of Technology (KTH), Sweden
Leonel Morgado	University of Trás-os-Montes e Alto Douro, Portugal
Leyla Zhuhadar	Western Kentucky University, USA
Lily Diaz-Kommonen	University of Art and Design Helsinki, Finland
Linda A. Jackson	Michigan State University, USA
Liqiong Deng	University of West Georgia, USA
Lori L. Scarlatos	Stony Brook University, USA
Lubomir Stanchev	Indiana University - Purdue University Fort Wayne, USA
Luis Angel Galindo Sanchez	Universidad Carlos III de Madrid, Spain
Luis Iribarne	Departamento de Lenguajes y Computacion, Universidad de Almeria, Spain
Luke Tredinnick	London Metropolitan University, UK
Lynne Nikolychuk	King's College London, UK
M. Carmen de Castro	Universidad de Cádiz, Spain
M. Latif	Manchester Metropolitan University, UK
Mahmoud Youssef	Arab Academy for Science and Technology, Egypt

Maiga Chang	Athabasca University , Canada
Manolis Vavalis	University of Thessaly, Greece
Manuel Rubio-Sanchez	Rey Juan Carlos University, Spain
Marco Temperini	Universita La Sapienza, Italy
Marcos Castilho	Departamento de Informática da Universidade Federal Paraná, Brazil
Marcos Martin-Fernandez	Associate Valladolid University, Spain
Maria Chiara Caschera	IRPPS-CNR, Rome, Italy
Maria Grazia Gnoni	University of Salento, Lecce, Italy
Maria de Lourdes Machado-Taylor	CIPES- Center for Research in Higher Education Policies, Portugal
Maria Helena Braz	Technical University of Lisbon, Portugal
Maria Jesús Martinez-Argüelles	Open University of Catalonia, Spain
María Jesús Segovia Vargas	Universidad Complutense de Madrid, Spain
María Jesús Verdú Pérez	University of Valladolid, Spain
Maria Joao Ferreira	Universidade Portucalense, Portugal
Maria Papadaki	University of Ioannina, Greece
Maria Pavli-Korres	University of Alcala de Henares, Spain
Marianna Sigala	University of Aegean, Greece
Marie-Hélène Abel	Université de Technologie de Compiègne, France
Mariel Alejandra Ale	Universidad Tecnológica Nacional (UTN), Argentina
Markus Rohde	University of Siegen, Germany
Martijn Kagie	Erasmus University Rotterdam, The Netherlands
Martin Beer	Sheffield Hallam University, UK
Martin Dzbor	The Open University, UK
Martin J. Eppler	University of Lugano, Switzerland
Martin Wolpers,	Fraunhofer FIT.ICON, Germany
Mary Meldrum	Manchester Metropolitan University Business School, UK
Maurizio Vincini	Università di Modena e Reggio Emilia, Italy
Meir Russ	University of Wisconsin, Green Bay, USA
Mercedes Ruiz	University of Cádiz, Spain
Mey (Ongech) Brenda	Ludwig Maximilian University of Munich, Germany
Michael Derntl	University of Vienna, Austria
Michael O'Grady	University College Dublin, Ireland
Michael Veith	University of Siegen, Germany
Miguel L. Bote-Lorenzo	University of Valladolid, Spain
Miguel-Angel Sicilia	University of Alcalá, Spain
Miha Škerlavaj	Univerza v Ljubljani, Slovenia
Mikael Collan	Institute for Advanced Management Systems Research, Finland
Mike Cushman	London School of Economics and Political Science, UK
Mohamed Amine Chatti	RWTH Aachen University, Germany
Monika Lanzenberger	Technische Universitaet Wien, Austria
Muhammad Shafique	International Islamic University, Pakistan
Nadia Pisanti	University of Pisa, Italy

Nancy Alonistioti	University of Piraeus, Greece
Nancy Hauserman Williams	University of Iowa, USA
Nancy Linwood	DuPont, USA
Luis Álvarez Sabucedo	University of Vigo, Spain
Nelson K.Y. Leung	University of Wollongong, Australia
Nick Higgett	De Montfort University, UK
Nicola Capuano	University of Salerno, Italy
Nilay Yajnik	NMIMS University, Mumbai, India
Nineta Polemi	University of Piraeus, Greece
Noah Kasraie	Arkansas State University, USA
Nuran Fraser	The Manchester Metropolitan University, UK
Nuria Hurtado Rodríguez	University of Cádiz, Spain
O.J. Ebohon	De Montfort University, UK
Omar Farooq	Loughborough University, UK
Paige Wimberley	Arkansas State University, USA
Panagiotis T. Artikis	University of Warwick, UK
Pancham Shukla	London Metropolitan University, UK
Pankaj Kamthan	Concordia University, Canada
Paola Di Maio	Content Wire, UK
Paola Mello	University of Bologna, Italy
Paolo Toth	University of Bologna, Italy
Patricia A. Walls	Arkansas State University, USA
Paul A. Kirschner	Open University of The Netherlands, The Netherlands
Paul G. Mezey	Memorial University, Canada
Pedro J. Muñoz Merino	Universidad Carlos III de Madrid, Spain
Pedro Soto-Acosta	University of Murcia, Spain
Peisheng Zhao	George Mason University, USA
Pekka Muukkonen	University of Turku, Finland
Per Anker Jensen	Copenhagen Business School, Denmark
Peter Gomber	Johann Wolfgang Goethe-Universität Frankfurt, Germany
Phil Fitzsimmons	University of Wollongong, Australia
Pierre Deransart	INRIA-Rocquencourt, France
Pilar Manzanares-Lopez	Technical University of Cartagena, Spain
Pirkko Walden	Abo Akademi University, Finland
Ralf Klamma	RWTH Aachen University, Germany
Ramon J. Duran Barroso	University of Valladolid, Spain
Raquel Hijón Neira	Universidad Rey Juan Carlos, Spain
Raymond Y.K. Lau	City University of Hong Kong, Hong Kong SAR
Razaq Raj	Leeds Metropolitan University, UK
Razvan Daniel Zota	Academy of Economic Studies Bucharest, Romania
Ricardo Colomo Palacios	Universidad Carlos III de Madrid, Spain
Ricardo Lopez-Ruiz	University of Zaragoza, Spain
Rob Potharst	Erasmus University, The Netherlands
Robert Fullér	Åbo Akademi University, Finland
Roberto García	Universitat de Lleida, Spain

Roberto Paiano	University of Salento, Italy
Roman Povalej	Institute AIFB University of Karlsruhe, Germany
Rushed Kanawati	LIPN – CNRS, France
Russel Pears	Auckland University of Technology, New Zealand
Ryan Robeson	Arkansas State University, USA
Sabine H. Hoffmann	Macquarie University, Australia
Sadat Shami	Cornell University, USA
Salam Abdallah	Abu Dhabi University, United Arab Emirates
Samiaji Sarosa	Atma Jaya Yogyakarta University, Indonesia
Sean Mehan	University of the Highlands and Islands, Scotland, UK
Sean Wolfgand M. Siqueira	Federal University of the State of Rio de Janeiro (UNIRIO), Brazil
Sebastian Matyas	Otto-Friedrich-Universität Bamberg, Germany
Seppo Virtanen	University of Turku, Finland
Sergio Ilarri	University of Zaragoza, Spain
Shantha Liyanage	Macquarie University, Australia
Shaoyi He	California State University, USA
She-I Chang	National Chung Cheng University, Taiwan (China)
Sherif Sakr	University of New South Wales, Australia
Sijung Hu	Loughborough University, UK
Silvia Rita Viola	Università Politecnica delle Marche - Ancona, Italy
Silvia Schiaffino	Univ. Nac. del Centro de la Pcia, Argentina
Sima Yazdani	Cisco Systems, USA
Sinuhe Arroyo	University of Alcalá de Henares, Spain
Sonia Berman	University of Cape Town, South Africa
Soror Sahri	Université Paris-Dauphine, France
Sotirios Goudos	Aristotle University of Thessaloniki, Greece
Sotiris Kotsiantis	University of the Peloponnese, Greece
Spyros D. Arsenis	University of Thessaly, Greece
Staffan Elgelid	Arizona State University, USA
Stefan Hrastinski	Uppsala University, Sweden
Stephan Lukosch	FernUniversität in Hagen, Germany
Steve Barker	King's College London, UK
Steve Creason	Metropolitan State University, USA
Stone Schmidt	Arkansas State University, USA
Suneeti Rekhari	University of Wollongong, Australia
Taha Osman	Nottingham Trent University, UK
Takaharu Kameoka	Mie Univeristy, Japan
Tarun Abhichandani	Claremont Graduate University, USA
Teck Yong Eng	University of London, UK
Terrill L. Frantz	Carnegie Mellon University, USA
Thanos C. Papadopoulos	The University of Warwick, UK
Tobias Ley	Know-Center, Austria
Toyohide Watanabe	Nagoya University, Japan
Universitat Libre de Bruxelles	Belgium
Upasana Singh	University of KwaZulu, South Africa

Vaclav Snasel	VSB-Technical University of Ostrava, Czech Republic
Vagan Terziyan	University of Jyvaskyla, Finland
Val Clulow	Monash University, Australia
Véronique Heiwy	IUT de Paris, France
Vincenzo Ciancia	University of Pisa, Italy
Violeta Damjanovic	Salzburg Research Forschungsgesellschaft, Austria
Virginie Sans	Université de Cergy-Pontoise, France
Vlasios Voudouris	London Metropolitan University, UK
Walt Scacchi	University of California, USA
Weili Wu	University of Texas at Dallas, USA
Xavier Calbet	EUMETSAT, Germany
Luisa M. Regueras	University of Valladolid, Spain
Xiaohua (Tony) Hu	Drexel University, Philadelphia, USA
Xihui (Paul) Zhang	University of Memphis, USA
Yang Li	British Telecom, UK
Yannis Charalabidis	National Technical University of Athens, Greece
Yihong Ding	Brigham Young University, USA
Ying Liu	Lecturer, The Hong Kong Polytechnic University, Hong Kong (China)
Yolaine Bourda	SUPELEC, France
Yuan An	Drexel University, USA
Yujian Fu	Alabama A&M University, USA
Yun Shen	University of Bristol, UK
Yvon Kermarrec	Institut Télécom / Télécom Bretagne, France
Zaiyong Tang	Salem State College, USA
Ziqi Liao	Hong Kong Baptist University, Hong Kong (China)
Zuleyka Diaz Martinez	Universidad Complutense de Madrid, Spain

Table of Contents

Track I: Social and Humanistic Computing for the Knowledge Society: Emerging Technologies and Systems for the Society and the Humanity

Track II: Knowledge, Learning, Education, Learning Technologies and E-learning for the Knowledge Society

Track III: Information Technologies for the Knowledge Society: Knowledge Management Systems – E-business – Enterprise Information Systems for the Knowledge Society

Track IV: Culture and Cultural Heritage – Technology for Culture Management – Management of Tourism and Entertainment – Tourism Networks in the Knowledge Society

Track V: Government and Democracy for the the Knowledge Society

Inclusive Social Tagging: A Paradigm for Tagging-Services in the Knowledge Society

Michael Derntl[1], Thorsten Hampel[2], Renate Motschnig-Pitrik[1], and Tomáš Pitner[3]

[1] Research Lab for Educational Technologies, University of Vienna, Austria
[2] University of Paderborn, Germany
[3] Faculty of Informatics, Masaryk University of Brno, Czech Republic
michael.derntl@univie.ac.at

Abstract. This paper investigates the Web 2.0 phenomenon of social tagging in the context of existing approaches to semantic data structuring. Social tagging is embedded into the space spanned by current structuring approaches like t axonomies, metadata, or ontologies in order to identify its semantic and pragmatic foundations. Thereby, we use the Inclusive Universal Access paradigm to assess social tagging with respect to socio-technical criteria for inclusive and barrier-free provision and usage of web services. From this analysis we propose criteria for a paradigm we chose to call "Inclusive Social Tagging." We subsequently use these criteria to assess the tagging functionality of popular Web 2.0 services.

1 Introduction

Tagging is one of the oldest concepts of structuring our daily world. For instance, tags are used to remember which sort of jam was filled into a particular jar – at least your grandma did so. You tag your luggage before check-in at the airport, some people tag buildings with graffiti, and others tag resources on the web. Tagging means to attach a specific set of information – some sort of personal metadata – to some object of our daily life. Grandma's jam tag may contain, in addition to the flavor (e.g. cherry, raspberry), also the date when it was cooked and maybe the name of the person who made it. There are no explicit standards on how to tag your jam jar, but obviously most people do it in a similar way; we will later see that tagging supports the development of a common vocabulary among the people who tag. As tags are fairly easy to attach to physical objects – you just need a post-it note and a pencil – they represent some kind of barrier-free service usage. Later in this paper we will propose this easiness of tagging web objects as a special criterion for barrier-free usage of semantic structuring. Particularly the advent of Web 2.0 with its desktop-like experience and focus on social applications helped tagging to be established as a concept worthy of being considered as one open, decentralized way of structuring and sharing information and meta-data in the knowledge society. Through tagging, social and community-like structures can emerge. Thomas Vander Wahl coined the term "folksonomy" for these phenomena. It may be compared to the effect that you get to know other people doing their special sort of jam when offering yours to friends and family members. Tagging

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 1–10, 2008.

helps to get to know people who tag similar resources and to support the decentralized emergence of shared vocabularies and structuring of resources.

In this paper we show why tagging is an essential element of the modern information and knowledge society. We investigate tagging in the light of criteria related to the inclusion and involvement of all potential users and the adaptability and usability of tagging services. The concept governing these criteria is called Inclusive Universal Access, and we adopt that concept and transfer it to the domain of tag-based knowledge structuring. The result is called *Inclusive Social Tagging*.

The paper is structured as follows. In section 2 we introduce the basic concepts underlying semantic data structuring. In section 3 we extend the current scope of structuring concepts by introducing Inclusive Social Tagging based on the principles of Inclusive Universal Access. In section 4 and in the conclusion we employ this concept for analysis and categorization of existing Web 2.0 services, and demonstrate that the proposed paradigm is capable of pushing the effectiveness and inclusiveness of informal information structuring in the knowledge society.

2 Basic Concepts

The open sharing and provision of distributed resources creates a huge, informally structured and – generally weakly systematic – pool of information and knowledge assets. Within such weakly structured spaces it is typically hard to efficiently retrieve desired objects. To bring order to this chaos the knowledge management community has developed a number of more or less formal mechanisms. Figure 1 shows a conceptual representation of constructs and mechanisms that might be subsumed under the heading "semantic knowledge organization." However, considering the constructivist perspective that information and data are not equivalent to knowledge we propose to refer to it as "semantic data organization."

Before going into details on concepts and terms used in Figure 1 it should be emphasized that the scientific community currently lacks consensus about characteristics and semantics of these concepts and terms. For instance, as [1] [2] point out, the term ontology refers to a whole spectrum of constructs beginning with weak semantics (e.g., a set of axioms about the intended meaning of some vocabulary) via taxonomies and thesauri to complex systems at the semantically rich end of the spectrum. Semantically rich ontologies typically define the categories and relationships among existing entities and their types. Examples of such ontologies include Wordnet [3] or SUMO (Suggested Upper Merged Ontology) [4]. In computer science an ontology is typically understood as a (meta-)data model that describes a set of concepts, their types and their relationships in a domain [5].

Along the dimensions of formality we differentiate informal mechanisms that assign tags or metadata in an uncoordinated, personal fashion, from formal metadata that are defined in elaborate specifications and standards. In-between we find, e.g., categories, labels, less formal metadata, or stereotypes. Generally, the term metadata refers to data ("tags") that characterize data. Note that tools and documents might use other terms like label or category instead of tag. Formal metadata is strictly defined and used according to given syntax and semantics. The metadata schema typically stems from some conceptual meta-model or semantically rich ontology defining the

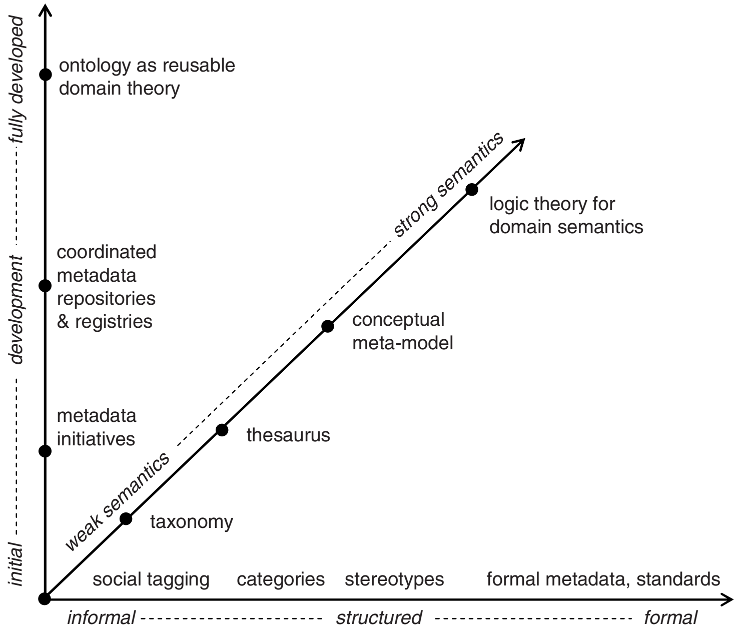


Fig. 1. Three dimensions of semantic data organization

descriptors or tags. For instance, those metadata can be expressed by using the Resource Description Framework (RDF) model [6].

The third dimension introduces a temporal view on development status: at the beginning we often find metadata initiatives, which might grow in coordination and elaboration. This process may lead to metadata repositories and public registries, which can be further developed into comprehensive and reusable ontologies.

In the context of the Web, *social tagging* is a promising informal and simple mechanism to collaboratively add (mostly incomplete) order to a wealth of data and resources. Compared to other mechanisms mentioned above, social tagging is the simplest, most flexible and versatile, even though results and order are not always reliable and/or efficient. One strong point of social tagging is the active participation of multiple users, which, for example in project management is known to produce higher acceptance of results and products.

3 Inclusive Social Tagging

Background. The concept of Inclusive Universal Access (IA) is based on the older concept of universal access. The latter demands the inclusion of all potential users in the provision and use of a product or service, regardless of his/her characteristics, capabilities and disabilities [7]. It is not constrained to services and products of the IT domain; it is a philosophy that puts users into the center of development, extension, provision and use of any type of system or service [8] [9] [10].

The concept of universal access was recently extended to *Inclusive Universal Access* (IA) [11]. The explicit introduction of the term inclusion is justified through the central meaning of inclusion for universal access, particularly when transcending the borders of technology: IA not only intends to include all potential users, but also to be inclusive of the whole person, i.e., his intellect, skills, meanings, and personality. This kind of vertical inclusion cements the crucial role of universal access as an essential paradigm for the provision of products and services in the knowledge society. Four IA dimensions were originally identified [11] [12]; for our purposes we collate them into three main dimensions:

- *Inclusion*: this dimension represents the access of all potential users to the usage of a product. Moreover, the design and provision of a product should consider all levels of human functioning related to the product offered; these might include motor skills, but also expectations, technical premises, personality traits, skills, etc. This dimension also addresses the inclusion of users and stakeholders in all stages of system analysis, requirements elicitation, design, development and evaluation. As an example consider the extensive beta testing phase of Google Mail, where potential users were involved from the beginning.
- *Adaptability*: This dimension addresses the capability of a product to be adaptable to particular user characteristics, needs and behavior. It also addresses important non-functional requirements like extensibility or the integration of a service into another service (e.g., tagging service in a calendar application)
- *Usability*: A product should comply with relevant usability guidelines (e.g., the Web Accessibility Initiative [13]) and be easy to use. The user experience should be intuitive also for non-expert users.

For example, popular torrent download portals or “warez” services violate requirements on the usability dimension, because for downloading the desired content users need special client applications, knowledge about networking issues (firewalls, etc.), and knowledge about pertinent terms used to identify quality (e.g., telesync, cam, DVDrip, screener, etc.) and availability (e.g., leechers, seeders, peers, etc.) of downloads. Therefore, these services are also non-inclusive and non-adaptable as they explicitly address a closed, specialized user community and do not offer any alternative means of access, respectively.

Social tagging vs. metadata. The main purpose of this paper is to exploit IA as a paradigm for explaining and shaping the social tagging phenomenon. First, we reveal the contrast between formal, strict mechanisms of data organization on the one hand, and social tagging as an informal mechanism on the other hand. From this we distill the unique characteristics of Inclusive Social Tagging (IST) and its essential principles. The discussion will show that the added value of the social component in social tagging can be attributed to a compliance with IA criteria.

Table 1 provides a comparison of metadata concepts with social tagging. It provides an analysis of compliance with the IA criteria regarding creation and usage of metadata and tags, respectively. The comparison shows that social tagging satisfies all IA criteria to a high degree. Much of this compliance can be attributed to the social, democratic, and decentral components that social tagging embodies in creation and usage of tags. This “advantage” is lost in centrally controlled developments within

Table 1. Comparison of metadata and tagging with respect to IA criteria in creation and usage

	Inclusiveness of creation	**Inclusiveness of usage**
Metadata	Creation of metadata specifications is usually restricted to a closed circle of persons, committees, and organizations. → *Not inclusive*	Usage of metadata by all potential users, typically underlying strict guidelines and rules. Often metadata are built upon assumptions about the target domain, requiring substantial effort by first-time users. → *Inclusive with entry barriers*
Social tagging	Creation of tags is one important use case for all users; usually there are no restrictions on number or meaning of tags, whatsoever. Therefore, important tags are created cooperatively through decentral user interactions. → *Highly inclusive*	Tagging services can be accessed by all users (most services require registration). → *Highly inclusive*
	Adaptability of creation	**Adaptability of usage**
Metadata	Metadata can be adapted to changing requirements; however, the effort required may be significant due to the bureaucratic control mechanisms. Also, existing application might be rendered unusable after changes in the metadata model. → *Adaptable with effort by provider*	Due to typically strict usage guidelines and requirements extension and adaptation of existing metadata might be possible through user-defined application profiles. However, this might require extensive research on extension mechanisms. → A*daptable with effort by user*
Social tagging	Adaptation and extension are core elements of social tagging. Typically no restricted dictionary, extension and adaptation are “natural” use cases. → *Easily adaptable*	Tags can be added, edited and retrieved easily (sometimes only the creator of the object is allowed to do so) → *Adaptable*
	Usability of creation	**Usability of usage**
Metadata	Typically many assumptions, rules and restrictions in the underlying domain model. → *Usability for experts*	Depends heavily on quality of tools and documentation provided. → *Usability conditional*
Social tagging	Creation of tags enabled through provided software service. Conceptually simple task, however dependent on software quality. → *Usability typically high*	Usage of tags is most important use case, so there is particular caution for usability in tagging services. Mostly implemented as Web 2.0 services resembling a “desktop experience.” → *High usability*

metadata initiatives. Another factor favoring social tagging is the congruence of creation and usage cases and the equal power of all participants.

Principles of Inclusive Social Tagging. Following these considerations, we are able to distill and describe essential principles of Inclusive Social Tagging:

1. *Decentral responsibility*: The simplicity of tagging allows users to access tagging features virtually without entry barriers. The responsibility to create added value as a community of users lies completely with each participating individual. Tag rankings or tag clouds, etc., are constructed without central control.

2. *Active participation*: is explicitly sought for all tagging use cases (creation, editing, searching, assigning metadata, linking, etc.) to activate the social component of IST.
3. *Interpersonal exchange*: Social networks and active participation foster personal exchange and creation of shared meaning among individuals in the spirit of a folksonomy.
4. *Person centeredness*: Equality of all users and unrestricted application of tags within the tagging service fosters personal openness and transparency; still, each user has the choice to contribute or not.
5. *Universal accessibility*: The classic universal access concept is widely supported through modern Web 2.0 tagging software.

4 Analysis of Web 2.0 Services

In our research we examined nine Web 2.0 services representing popular functionality currently found on the web. These include: *Adobe Sharing*, *Flickr* and *SlideShare* for *content sharing* of various media types; *Google Docs* allowing online *content creation*; *Blogger* as a *blog hosting service*; *Wikidot.com* providing advanced *wiki hosting*; and finally, *Backpack* which supports *teamwork* and *Gmail/GTalk* for both asynchronous and synchronous online *communication*. We tested their tag-related functionality and their performance regarding the Inclusive Social Tagging criteria of *inclusion*, *adaptability*, and *usability*, which will be evaluated separately.

Inclusion. The classical notion of inclusion prescribes that a product (service) should put no a-priori limitations on skills, age, origin, culture, or place of the client using it, and it should require only minimal technological preconditions – i.e., should allow various client devices to access the service. The extended concept of inclusion in social tagging further requires a simple user interface (UI), access for people with impairments, and overcoming cultural barriers.

The results are rather surprising. Although all services offer simple user interfaces often featuring RIA[1] characteristics, they all failed in declaring compliance with W3C's Web Content Accessibility Guidelines [14] or similar requirements for accessible web applications. We investigated the compatibility of the services using two mobile devices – a Windows Mobile PDA and a mobile phone equipped with the Opera Mini browser. Sometimes the tagging provided by a specific service was available on a mobile device, while the service core functionality such as document creation, video or slideshow sharing did not work there, making the tagging almost useless. Only a minority provides a view (layout) accustomed to limited mobile device capability. Services employing the Adobe Flex platform failed on the mobile devices du to lack of appropriate plug-ins. Details of the accessibility tests using different devices are given in Table 2.

[1] RIA = Rich Internet Application – web-based applications resembling desktop applications and featuring a similar user experience.

Table 2. Service accessibility tested with desktop PC, PDA, and mobile phone

Service	Access devices[2]
Adobe Share	Requires latest Adobe Flash Player, high screen resolution; Desktop only
Backpack	Desktop: OK; PDA and Phone: view only, no tag operations)
Blogger	Desktop: OK; PDA: bad page layouting, some controls invisible; Phone: errors in e.g. locale selection and login
Flickr	Desktop: OK; special view for PDA or Phone: OK for viewing but not editing or using tags
GMail + GTalk	Desktop: OK; special view for PDA and Phone: tags not supported
Google Docs	Desktop: OK; special view for PDA and Phone: tags supported via a simpler UI; no document editing
MySpace	Desktop: OK; with certain layout issues on PDA and Phone (tags working OK)
SlideShare	Desktop: OK; PDA: serious layout and functionality limitations; Phone: OK, tags working
Wikidot.com	Desktop: OK; PDA and Phone limited: reading OK, no editing possible

Adaptability. Adaptability means the capability to adapt to user requirements, extensibility, and being ready for integration. The same applies for services with tagging. The integration can be done in a primitive way by incorporating the service graphical UI (GUI) or via some published application programming interface (API). Table 3 summarizes how these characteristics are met by the services.

Some of the services do not offer an official API where the tagging functionality would be exposed. In such cases, incorporating their GUI into third party services, and automated access to the GUI, is the only integration option; it is legally forbidden in many services, though. The APIs are mostly based on web service standards, albeit REST principles [15] are more frequent than SOAP [16].

Table 3. Service integration, API and access to GUI

Service	Official API	Incorporating GUI + automated access to GUI
Adobe Share	REST	Incorporating forbidden, automated access unspecified
Backpack	XML over HTTP	Incorporating with permission, automated access unspecified
Blogger	GData	Incorporating forbidden, automated access unspecified
Flickr	REST, XML-RPC, SOAP	Incorporating with permission, automated access via provided interface only
GMail + GTalk	POP3/SMTP/IMAP, XMPP	Incorporating and automated access forbidden
Google Docs	GData	Incorporating with permission, automated access forbidden
MySpace	no	Incorporating with permission, automated access forbidden
SlideShare	REST	Incorporating forbidden, access by no "burdening" robots only
wikidot.com	no	Incorporating limited, automated access forbidden

[2] Devices used: (a) **Desktop PC** w. Windows 2000k or XP/MS IE, Firefox; (b) **PDA** E-TEN X800 Glofiish with Windows Mobile/MS IE, Opera Mini; (c) **Mobile phone** SonyEricsson K700i with Java, Opera Mini.

Usability. Usability means that any functionality offered by a service must be accompanied by an easy-to-use, intuitive user interface using clear and simple terminology not demanding specific previous knowledge. There are also other non-functional requirements affecting usability: security and privacy, as well as reliability and robustness. Table 4 shows the selected characteristics attributed to tagging offered by the respective services. The terminology and functionality columns show basic tagging concepts and, eventually, their extensions. The rightmost column describes security and privacy characteristics of the service as a whole, as well as options to make user content private.

The basic concepts of tagging do not only include *tag* or *label*; some services (Google Docs) employ *folders* that may be hierarchical, *categories* or *topics* that may (or must not) overlap. Tagging functionality ranges from simple add tag/delete tag/list tagged resources to fetching syndication feeds like RSS on tags, accessing via API, or even advanced Boolean querying (which is rather rare). The same applies to security and privacy: securing the communication (by SSL) is not a standard feature. On the contrary, sharing a resource within a certain user group or keep it private is typically an option. None of the considered services supports auto-completion when attaching tags to resources. However, there are such services, e.g., *Diigo* (see http://diigo.com) features auto-completion that supports creation of a common vocabulary. The tag sharing is thus postponed to the "consumption" phase – searching, filtering, or querying on tags.

Table 4. Services, tagging terminology, security and privacy

Service	Terminology	Extensions	Operations with tags (beyond basic ones)	Tagged resources – privacy and sharing	Security
Adobe Share	–	N/A	N/A	private or shared	–
Backpack	tag	–	–	sharing (except free version)	SSL support (except free version)
Blogger	label	rating: 0..5 stars, comment	advanced querying with tags (incl. boolean operators)	private, shared on invitation, or public blogs	SSL support
Flickr	tag	comment	Also mailed photos may have tags set	Private, shared, or public	no SSL
GMail + GTalk	label	star	Automated attaching of tags by message filters	Private, not shared even with G. Docs	login via SSL
Google Docs	folder	star	Using folders via API	Private, shared on invitation, or public	login via SSL
MySpace	tag	category, rating	–	Private or public	no SSL
SlideShare	tag, topic	annotation	Edit tags, get RSS feeds of tagged resources	Private, shared, or public	no SSL
wikidot.com	tag	category, comments optional	–	Private, shared, or public	no SSL

As active user involvement increases the added value of a service by strengthening the network effect (more users, higher value), it is important to see how the services foster fair but liberal licensing of the user-provided content allowing reuse. Some services where the resources are shared or public (Flickr, SlideShare, Wikidot), come with Creative Commons licenses or simply let the user have all rights reserved. None of the services specifically mention licensing of the tags, i.e., whether tags can be a subject of licensing in similar terms as the other content is.

5 Conclusions

Despite its broad acceptance and usage by web users, social tagging theory lags behind in providing and explaining underlying foundations and success factors. In this paper, we presented Inclusive Social Tagging (IST) as an initial attempt to foster understanding of features and media support in tagging systems. This leads to the identification of important socio-technical dimensions and criteria for IST, which are: decentralized responsibility; accessibility without entry barriers; active participation and contribution of all; interpersonal exchange as a social networking aspect; person centeredness and equality of all users; and finally, the classic concept of universal access as quality guideline for technological aspects of tagging in Web 2.0 applications.

The services that were presented and analyzed demonstrate the variety and “flavors” of tagging systems already available today. On the one hand, this is a clear indicator of success and universality of the concept. On the other hand, most of these services still offer many opportunities for further improvement, particularly regarding the cooperative and social features of tagging, namely tag sharing and advanced tag querying. The same applies to service security, which is mostly insufficient for any serious business use. Enterprise applications would also require better application integration support (e.g., through open APIs) in some services, and community features should be fostered by explicit liberal licensing of the user provided content.

Exploitation of tagging for cooperative management, structuring and creation of information and knowledge require a deep understanding of the persons involved and their individual and shared intentions. In that sense, Inclusive Social Tagging is proposed as a theoretical, basic concept of social tagging in Web 2.0 to make it amenable to analysis, evaluation, and evolution based on issues relevant to today’s knowledge society.

References

1. Höfferer, P.: Achieving Business Process Model Interoperability using Metamodels and Ontologies. In: Proc. 15th European Conference on Information Systems, St. Gallen, Switzerland (2007)
2. Obrst, L.: Ontologies for Semantically Interoparable Systems. In: Proc. ACM International Conference on Information and Knowledge Management, New Orleans, Luisiana (2003)
3. Fellbaum, C.: WordNet - An Electronic Lexical Database. MIT Press, Cambridge (1998)
4. Niles, I., Pease, A.: Towards a Standard Upper Ontology. In: Proc. 2nd International Conference on Formal Ontology in Information Systems, Ogunquit, Maine (2001)

5. Geroimenko, V.: Dictionary of XML technologies and the semantic web. Springer, London (2004)
6. Tauberer, J.: What is RDF (2006), http://www.xml.com/pub/a/2001/01/24/rdf.html
7. Yang, S.J.H., Chen, I.Y.L.: Universal Access and Content Adaptation in Mobile Learning. In: Proc. Sixth IEEE International Conference on Advanced Learning Technologies, Kerkrade, The Netherlands (2006)
8. Stephanidis, C., Savidis, A.: Universal Access in the Information Society: Methods, Tools, and Interaction Technologies. Universal Access in the Information Society 1, 40–55 (2001)
9. Adams, R.: Consilience in research methods for HCI and universal access. Universal Access in the Information Society 5, 251–252 (2006)
10. Oviatt, S.: Designing Robust Multimodal Systems for Universal Access. In: Proc. Workshop on Universal Accessibility of Ubiquitous Computing, Alcacer do Sal, Portugal (2001)
11. Derntl, M., Motschnig-Pitrik, R.: Inclusive Universal Access in Engineering Education. In: Proc. 37th ASEE/IEEE Frontiers in Education Conference, Milwaukee, WI (2007)
12. Pitner, T., Derntl, M., Hampel, T., Motschnig-Pitrik, R.: Web 2.0 as Platform for Inclusive Universal Access in Cooperative Learning and Knowledge Sharing. In: Proc. 7th International Conference on Knowledge Management, Graz, Austria (2007)
13. W3C: Web Accessibility Inititative (WAI) home page (2006), http://www.w3.org/WAI/
14. W3C: Web Content Accessibility Guidelines 1.0 (1999), http://www.w3.org/TR/1999/WAI-WEBCONTENT-19990505/
15. Fielding, R.T.: Architectural Styles and the Design of Network-based Software Architectures, University of Calfornia, Irvine, CA (2000)
16. W3C: SOAP Specifications (2004), http://www.w3.org/TR/soap

A Unifying Framework for Building Social Computing Applications

Renato A.C. Capuruço and Luiz F. Capretz

University of Western Ontario, Department of Electrical and Computer Engineering
London, Ontario, Canada, N6A 5B9
{r.capu,lfcapretz}@uwo.ca

Abstract. There have been a number of frameworks and models developed to support different aspects of social computing. Some were developed to deal with online interaction through the application of computer-mediated communications tools, whereas others such as social network analyses and reputation systems were more specific in their focus. While these methodologies are interrelated, current social computing research has dealt with them as separate aspects. This paper presents a comprehensive framework for social computing that aims at integrating all these three aspects into a unified model so that discovery and exploration of community members are not only made possible, but also optimized. The novelty of the proposed approach stems from: (1) integration of social interaction, social network analysis and social reputation domains; (2) incorporating many flexible and practical features such as individual- and group-level perceptions of trust in social relations for different social contexts; and (3) using path-related algorithms for selection and discovery of target community members. A description of the proposed model and its implementation are presented. This research is expected to assist online community members to make decisions that facilitate the discovery of people and their connections while promoting increased awareness of community structure and information exposure.

Keywords: Social Computing, Social Informatics, Reputation Systems, Online Interaction, Social Networks, Web 2.0.

1 Introduction

In recent years, social computing has received considerable attention in North America and worldwide. The proliferation of online social networking services, in which millions of members publicly articulate mutual "friendship" relations has given rise to many forms of online sociality. These tendencies to form online social groups or live in an online community have also powered the rise of social computing upon fundamentals such as computer-mediated communication tools, reputation systems and social network analyses. While online social interactions at these three levels are inter-related, social computing research has dealt with them as separate aspects; thus, may lead to neither being articulated in cooperation one to another to foster more compelling nor more effective social interactions.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 11–21, 2008.

Based on the theoretical constructs of sociology and mathematical foundations of graph theory, social network analysis offers a unique methodology for visualizing and investigating social structures and relations [1]. Social network analysis also produces an alternate view of complex sets of relationships between members of social systems at all scales, where the relationships and ties of an individual with others are more important than their personal attributes alone. From these analyses and mathematical models streams that are used to understand and analyze the social network data, several generalizations about the features of personal networks have emerged and a summary of the most relevant ones can be found in [2, 3, 4, 5, 6, 7 and 8]. Granovetter [2, 3] has revealed, emphasized and shown the importance of different kinds of ties (e.g., weak, strong) have on individual and communities accessing their network resources for a purpose, such as finding jobs. Blau [4] and Burt [5] have analyzed the importance of social exchanges in interpersonal relationships of multi-group affiliations to reveal the ultimate effects of ethnic, socioeconomic, and other aspects of population structures to achieve societal power, and large-scale domination (economic or political) of groups without personal contact. Moreno [6], for example, introduced the basis of ever-evolving quantitative methods for measuring social relationships, but it was Freeman [7] who showed that although over the years a great many measures of centrality – an indicator to identify a person's position in the network, who is capable of lower or higher network influence [8] – have been proposed, those are often only vaguely related to the intuitive ideas that support the index, and many are so complex that it is difficult or impossible to discover what, if anything, they are measuring. Despite of the increasing trends in developing theoretical studies on social networks [9] and latest developments in applied computer applications for social network analysis [10], existing research still has some drawbacks related to modeling complexity of relationship phenomena that enables an individual to achieve societal gains, which the present research is attempting to overcome.

Bringing physical communities to the virtual world is a complex issue. Several design principles for successfully establishing them in the later environment have been underlined. For example, Kollock [11] suggested that a flourishing online community has to (i) create the condition that two individuals will meet again in the future, (ii) create the condition that individuals must be able to identify each other, and (iii) create the condition that individuals must have information about how the other person has behaved in the past. In addition, Godwin [12] stresses the importance of promoting continuity in online groups and that online communities should provide institutional memory – durable records of the events and history of the group, and Rourke et al. [13] anticipated that the ability for community members to leave comments in an interactive format is an important element to support the cognitive and affective objectives of social interaction. Computer-mediated communication techniques such as blogs and chat rooms can help communities meet those challenges. They are found to be the most popular and accepted interaction tools to constituting and maintaining an online social presence [14], thus becoming a key ingredient in constructing online communities for the purpose of this research.

Kollock [15] has also stated that reputation and trust are the bedrock of community ongoing interaction and cooperation, and are a vital source of social information and control. In this regard, considerable amount of research that has focused on the development of trust and reputation models as the most accepted and popular methods to capture trustworthy in the online interaction process can be found in [16, 17, 18, 19, 20, 21, 22, 23 and 24]. There are two main streams of reputation systems: e-commerce and peer-to-peer applications. In Gupta et al. [16], peer-to-peer applications including KaZaA[1] are examined and a trust model is proposed where different parameters such as the average query-response message size, the ration of Mbytes uploaded, and the amount of content-shared are used for computing the reputation score associated with peers. On the other hand, Dellarocas et al. [21] is an example of research on reputation systems that are largely used only for online trading communities, such as e-Bay[2]. The reliability of participants in such environments is measured by calculating a score associated with one or more of a user's participation level (e.g., number of successful transactions), availability of physical identities (e.g. valid email), and feedback about interactions with each other.

However, incorporating reputation information into social networks formed from social interactions other than the ones derived from e-commerce- and peer-to-peer-based communities complicates and renders traditional methodologies as insufficient to deal with the distinct formulation involved. A new methodology is needed, which the present research is also attempting to overcome.

While existing social computing methodologies and models have dealt specifically with single aspects of social interaction, social reputation, and social networks, they still have some drawbacks that may hinder the practical discovery and exploration of community members in terms of social spaces, casual interactions, and meaningful exchanges, particularly when considering all three domains combined.

This paper presents a comprehensive and transparent model to assist online community members to make decisions that facilitate the discovery of people and their connections while promoting increased awareness of community structure and information exposure. This is achieved by integrating the social interaction, social network analysis and social reputation domains; by incorporating many flexible and practical features (e.g., social contexts, social priorities, social relations, and social intensities); and by incorporating path-related algorithms for selection and discovery of target members. The framework developments and its implementation on a prototype application are outlined. The output of the model is a set of search and guidance strategies based on individual and group perceptions of trust in social relations for different social contexts for the discovery and exploration of community members throughout the underlined social network.

2 Components of a Unified Social Computing Framework

The main components of the unifying social computing framework (SCF) that incorporates the three above-mentioned domains are as follows:

- Detailed SFC models (online social interaction tools, social network, and reputation-dependent perceptions of qualities or attributes)
- SFC Constraints (social context, social relation, social reputation, user defined constraints such as social relation intensity, priority etc.)

[1] www.kazaa.com
[2] www.ebay.com

- SFC Decision Support Module (user interface, community database, social relation assessment, reputable search, visualization)

2.1 Framework Models

At the core of a successful SCF are proper models for promoting interaction and capturing the relationship patterns of the individuals in the online community so that several interaction patterns can be estimated and the benefits of knowing those returned to the community itself.

Interaction Model
The SCF requires an online interaction model that supports online human interaction and information flow so that communities are formed for ongoing collaboration and exchange of information and knowledge among their members. In this regard, people form online communities by using a combination of one-to-one (e.g., instant messages, e-mails, chat rooms), one-to-many (e.g., web pages and blogging), and many-to-many (e.g., wikis) communication modes [25]. This model is the entry point in which personal networks are formed.

Social Network Model
The social network model represents the logical structure that embodies the patterns of the relationships between social actors (i.e., members or individuals with a particular role of an online community) at all scales and the possible statements that can drawn from those by using social network analyses-based techniques.

In this research, a combination of Laumann et al.'s [26] three generic approaches to decide on the set(s) of objects that lie within a social network and Scott's [27] definition of the principal types of data to be considered to fulfil those approaches was employed. As such, this model uses two types of data as the model's building blocks: attribute- and relational-based data. According to [27], Attribute data relates to the attitudes, opinions and behaviours of objects (i.e., actors) combined with their basic characteristics to define formal membership criteria. These data sets are regarded as the properties, qualities or characteristics that belong to them as individuals or groups. Relational data, on the other hand, are the contacts, ties, and connections, the group attachments and meetings, which relate one actor to another and so cannot be reduced to the properties of the actors, but of systems of actors; these relations connect pairs of actors into the larger relational system.

The two basic types of data are translated into the community members' profile and their connections features. While a set of socio-demographic characteristics such as age, gender, etc. is the most natural dataset candidate to be organized as attribute data, an assortment of opinions representing expressions of the experience when dealing with particular actors can be also structured as attribute data. The collection of relations connecting pairs of individuals such as "friend of whom", "has studied with", "has worked with", etc. emerges as specific community-generated content that can be mapped as relational data.

Social Reputation Model
In this paper, the reputation model is designed to take into account both individual and group perceptions for the person in which others are linked. Sabater et al. [28]

suggested that reputation is not just based on facts, but also based on other's beliefs about the subject of the reputation calculation.

Therefore, the perception of trust in this model can be divided into four parts: (i) the category the reputation information belongs to, (ii) the amount of reputation (i.e., rating) assign to a particular category, (iii) the feedback type used to collect those judgments, and finally (iv) the relative importance (i.e., weight) among the categories.

These perceptions of trust are aggregated into a numerical value, which synthesizes the social impressions of interaction quality and trust that not only a person has about another, but also perceptions the community as a whole has about an individual.

At the group level, candidate rating parameters such as *frequency of online participation*, *willingness to share private information*, and *being recommended by other members* allows the calculation of a Social Reputation score (Eq. 1) for each member of the community. The score can be automatically determined as a weighted sum of the reputation ratings of each of the categories, considering the respective category's intensity (weights), and dividing them by the sum of the weights. In the scope of this research, this score represents the total informed judgment on the trustworthiness of a member by the community he or she belongs to.

$$SRS_{group} = \frac{\sum (Reputation\ rating \times Intensity)}{\sum Intensities} \tag{1}$$

At the individual level, candidate rating parameters such as *cognitive*, *interactive*, and *affective* types of relations allows the calculation of a Social Relation score (Eq. 2) for the connection existing between each pair of individuals of the community. The score can be automatically determined as a weighted sum of the relation ratings of each of the relation types, considering the respective relation intensity (weights), and dividing them by the sum of the weights. This score represents the total intuitive judgment on the interaction of a pair of community members.

$$SRS_{individual} = \frac{\sum (Relation\ rating \times Intensity)}{\sum Intensities} \tag{2}$$

The idea behind the score weights is to allow the community members to reflect on their unique intuitive knowledge about what category matters the most, which can vary from one member's experience to another.

2.2 Framework Constraints

Several practical constraints should be taken into consideration for implementing social-aware applications. These constraints can be categorized as follows: *social context*, a specific and common relation environment among pair of people in which social interactions happen; *social relations*, the different types of interactions among pair of people; *social reputation*, the measure of judgments and perceptions about the character, stability, reliability, behaviour, etc. of people who interact in a given community; *relation intensity*, the measure of the relative strength, importance or "bond energy" among interactions; *relation priority*, the measure of importance of the relationship among pair of people; *user*, the ability of a community member to enforce his or her decision on the decided one; *privacy and security*, the governing policies that allow disclosure of personal information and access privileges to those. These are important aspects to be considered in the design of a general social computing system.

2.3 Framework Decision Support

The SCF decision support integrates both the SCF models and the SCF constraints to arrive at the social-aware application. The SCF decision support component comprises of a reputable search optimization model linked to the portfolio (database) of communities and to a social relation assessment model that applies all the SCF models to all components.

Community Database
The underlined physical structure of the community network that supports the social network model is a familiar database schema based on node-link representation, where nodes represent members of the community and links denote the articulated "social relationships" (e.g., interaction, ties) between them. Each node and link has attributes associated that allows users to calculate and store reputation information. Each link is associated with a particular social context, and a pair of nodes may have one or more links, thus representing different social contexts of interactions.

Based on the both profile and connection attributes, a relational database management system was designed and two main tables – nodes and links, respectively – were implemented to store, in real-time, the network objects and the associations between objects. This network model is the working data repository that becomes available for further processing by the decision support engine.

Social Relation Assessment
A social relation rating system had to be developed to perform the condition assessment of the social reputations and social relations in the network. The condition rating used in this methodology varies according to the reputation category and relation type. Generally, the rating uses a general scale from 1 to 5 for the reputation elements. This scale assumes that social reputations and relations are valued as the worst and the best, respectively. Condition ratings are used to describe the existing condition of trust and opinions among individuals in the social network. It is considered as the most important phase on which subsequent decisions are based.

The Social score calculation mechanism works as a function of the type of user feedback: when the online community is capable of storing complete and accurate information about the transactions they mediate (e.g., number of logins per member) to execute the calculation, this is aggregated automatically by batch routines, without user's direct participation. On the other hand, when explicit input from the rest of the community members is needed to express comments about interactions with each other, then the calculation is performed manually, upon user's request for participation (e.g., online voting).

Reputable Searchability using Path-related Algorithms
Having defined the present condition of a social network with the online interaction model and reputation model, the proposed SCF uses a Path-based optimization model

[29] to determine optimum priority list of members and their social relations conditions. *Reputable Searchability* is a newly coined term to define the class of social computing search engines that are capable of show a target member based on a desired level of individual- and/or group-based reputation. *Reputable Searchability* is very important to consider because a member of a community is not defined by its ethnographic attributes only; rather, he/she is characterized by a combination of those with his or her social ties [30]. The reputable search engine also optimally "guides" the searcher to its desired destination functioning as a means or medium for showing all linkages between two or more people. As such, the procedure searches for the path with lowest cost between a community member and every other member with respect to user defined constraints.

In order to develop a sound reputable search mechanism, a Social Relation Index as a combination of group- and individual-based perceptions was constructed to account for the social distance between a pair of members, as per Equation (3) below:

$$SRI = \frac{\left(SRS_{individual} \times Weight_i\right) + \left(SRS_{group} \times Weight_g\right)}{\sum Weights_{i,g}} \tag{3}$$

The Social Relation Index (SRI) is calculated as the weighted sum of the individual (i.e., Social Relation Score) and group (i.e., Social Reputation Score) scores, considering the relative importance between them (i.e., weight), and dividing the result by the sum of the weights. This index represents the total "social distance" between a pair of members. The "social distance" is the basis for the cost structure that had to be implemented, so that the path-related algorithm can function accordingly.

Implementing a graph search algorithm in the framework involves four main steps: (1) eliciting community members and their connections for a given social context; (2) setting the source and destination nodes; (3) deciding on the evaluation criteria, higher or lower SRIs; and (4) applying the relaxation principle to generate short paths. The cost structure is a function of the Social Relation Index and because lower scores mean worst case scenarios (e.g., lower affectivity, interactivity, etc.), the procedure had to be adapted to find the path with the highest cost as well (i.e., higher SRI), more specifically meaning paths with highest quality in terms of social relation (e.g., higher affectivity, interactivity, etc.).

After defining the cost structure, the constraints considered in the algorithm are:

1. Choose a Social Context – This will filter out members and/or connections;
2. Choose one or more Social Relations, assigning corresponding weights – This will affect the calculation of the Social Score at the individual level;
3. Choose "Group" or "Individual" reputation – This will affect not only the calculation of the Social Score at the group level, but it will also affect the calculation of the whole Social Index by including/excluding either or both levels;
4. Specify whether to use lower or higher scores – This will affect the selection of target members by the algorithm.

To evaluate a possible solution (list of members), the reputable search algorithm identifies, analyses and builds the cost structure by using the desired constraints and social context for a particular population (community). Once the target population of that community has been created, the social distance is calculated for each social interaction for all of their members. Then, beginning from the source node (member), paths from one node to another whose total cost is the least among all such paths is calculated until the target node is reached.

Visualization
A visualization model includes representation and presentation features suggested by Carpendale et al. [31]. The model also should support a range of basic exploratory search features by such methods such as panning, scrolling, zooming, etc., providing visualization of the rich profile and connection data characteristics as of traditional "Sociograms" [32].

3 Discussions

The framework model presented in this paper has been demonstrated to work effectively on the example application. Further experimentation was conducted on different combinations of personal networks with different properties, and the model proved to consistently produce expected results. The exploration and discovery of members of a community by using the proposed framework is a powerful feature that brings along the necessity to discuss its implications for the knowledge society as a whole.

In today's electronic age, raw data has become a valuable commodity and the protection of personal information has become increasingly important to our sense of privacy. New technologies such as the framework being proposed will certainly create challenges for the protection and use of personal information. Two core approaches could be used to help address this issue.

First, the model should be designed with privacy tools necessary to control how and with whom personal information is shared from one individual to another. This would give individuals the sense of safety of their information, making the improper collection or misuse of information more difficult to achieve.

Second, while this technology is not required for an invasion of privacy, the ability of techniques to amplify, routinize and sublimate surveillance to collect and use the health of personal data with the proposed model raises some even greater privacy concerns. For example, practices including the monitoring of telephone calls and computer use could be employed to collect non-disclosed personal data, which could be plugged into the framework to extract commercial and legal value from people's interaction in rich, powerful, and flexible ways.

In many respects, private sectors, government and citizens groups may have to work together towards effective legal safeguards and proper communication methods to the practical aspects of such technologies and techniques. This is an essential ingredient to promote the responsible development of such methodologies, while protecting information privacy and rights.

4 Conclusions

In this paper, literature related to online interaction tools, social network analyses, and reputation systems has been reviewed and a model is presented to integrate these three aspects into a unified social computing application framework.

The proposed framework incorporates a reputable search engine based on path-related algorithms to calculate the social relations conditions for members of an online community and optimally generate a list of members between any target and destination persons. The developed model is flexible and allows for several customizations for more effective searches. In addition to its expandable data structure, some of the flexible features of the proposed framework that make it an efficient model for building social applications include:

- Combination of three research venues (online social interaction, social network, and reputation systems) into a single methodology;
- Reputable Searchability process with optimization process that respects desirable social distance;
- Incorporate Social Relation Index as indicator to assess the social relation condition of the network;
- Consider two levels of reputation: group and individual;
- Consider variable types of relationships;
- Consider variable categories of social context, one at a time; and,

References

1. Wasserman, S., Faust, K.: Social Network Analysis: Methods and Applications. Cambridge University Press, New York (1994)
2. Granovetter, M.: The Strength of Weak Ties. American Journal of Sociology 78, 1360–1380 (1973)
3. Granovetter, M.: The Strength of Weak Ties: A Network Theory Revisited. Journal of Sociological Theory 1, 201–233 (1983)
4. Blau, P.: Macro Structural Concepts. In: Structural Contexts of Opportunities. University of Chicago Press, Chicago (1994)
5. Burt, S., Ronald: Structural Holes. Univ. Chicago Press, Chicago (1992)
6. Moreno, J.L.: Sociometry: Experimental Method and the Science of Society – An Approach to a New Political Orientation. Beacon House, Beacon (1951)
7. Freeman, L.C.: Centrality in Social Networks Conceptual Clarification. Journal of Social Networks 1, 215–239 (1978/1979)
8. Bavelas, A.: A mathematical model for group structures. Human Organization 7, 16–30 (1948)
9. Freeman, L.C.: The Development of Social Network Analysis: A study in the Sociology of Science. Empirical Press, Vancouver (2004)
10. Huisman, M., Van Duijn, M.A.J.: Software for Social Network Analysis. In: Carrington, P.J., Scott, J., Wasserman, S. (eds.) Models and Methods in Social Network Analysis, pp. 270–316. Cambridge University Press, New York (2005)
11. Kollock, P.: Design Principles for Online Communities. In: The internet and Society. Harvard Conference Proceedings. O'Reilly & Associates, Cambridge (1997)

12. Goodwin, M.: Nine Principles for Making Virtual Communities Work. Wired 2.06, 72–73 (1994)
13. Rourke, L., Anderson, T., Garrison, D.R., Archer, W.: Assessing Social Presence In Asynchronous Text-based Computer Conferencing. Journal of Distance Education/Revue de l'enseignement à distance (2001)
14. Boyd, D.M., Ellison, N.B.: Social network sites: Definition, history, and scholarship. Journal of Computer-Mediated Communication 13(1), article 11 (2007)
15. Kollock, P., Smith, M.: Managing the Virtual Commons: Cooperation and Conflict in Computer Communities. In: Herring, S. (ed.) Computer-Mediated Communication: Linguistic, Social, and Cross-Cultural Perspectives, pp. 109–128. John Benjamins, Amsterdam (1996)
16. Gupta, M., Judge, P., Ammar, M.: A reputation system for peer-to-peer networks. In: Proc. of the ACM 13th International Workshop on Network and Operating Systems Support for Digital Audio and Video, Monterey, California, USA (2003)
17. Damiani, E., De Capitani di Vimercati, S., Paraboschi, S., Pesenti, M., Samarati, P., Zara, S.: Fuzzy logic techniques for reputation management in anonymous peer-to-peer systems. In: Proc. of the Third International Conference in Fuzzy Logic and Technology, Zittau, Germany (2003)
18. Damiani, E., De Capitani di Vimercati, S., Paraboschi, S., Samarati, P., Violante, F.: A reputation-based approach for choosing reliable resources in peer-to-peer networks. In: Proc. of the 9th ACM Conference on Computer and Communications Security, Washington, DC, USA (2002)
19. Dellarocas, C.: Immunizing online reputation reporting systems against unfair ratings and discriminatory behavior. In: Proc. of the 2nd ACM Conference on Electronic Commerce, Minneapolis, MN, USA (2000)
20. Dingledine, R., Freedman, M.J., Hopwood, D., Molnar, D.: A reputation system to increase MIX-net reliability. In: Moskowitz, I.S. (ed.) IH 2001. LNCS, vol. 2137, p. 126+. Springer, Heidelberg (2001)
21. Dellarocas, C., Resnick, P.: Online Reputation Mechanisms: A Roadmap for Future Research. In: Summary report of the First Interdisciplinary Symposium on Online Reputation Mechanisms, April 26-27 (2003)
22. Rahman, A., Hailes, S.: Supporting trust in virtual communities. In: Proc. of the IEEE Hawaii International Conference on System Sciences, Maui, Hawaii (2000)
23. Yu, B., Singh, M.: A social mechanism for reputation management in electronic communities. In: Proc. of the 4th International Workshop on Cooperative Information Agents, Boston, USA (2000)
24. Zacharia, G., Moukas, A., Maes, P.: Collaborative reputation mechanisms in electronic marketplaces. In: Proc. of the 32nd Hawaii International Conference on System Sciences, Maui, Hawaii (1999)
25. Shirky, C.: A Group is Its Own Worst Enemy. In: 2nd Annual O'Reilly Emerging Technology Conference, Santa Clara, California, April 20-25 (2003), http://www.shirky.com/writings/group_enemy.html
26. Laumann, E.O., Marsden, P.V., Prensky, D.: The Boundary Specification Problem in Network Analysis. In: Freeman, L.C., White, D.R., Ronney, A.K. (eds.) Research Method in Social Network Analysis, pp. 61–87. George Mason University Press, VA (1989)
27. Scott, J.: Social Network Analysis: A Handbook, ch. 1-2, p. 2. Sage, London (1991)
28. Sabater, J., Sierra, C.: Review on computational trust and reputation models. Artificial Intelligence Review 24(1), 33–60 (2005)

29. Dijkstra, E.W.: A note on two problems in connexion with graphs. In: Numerische Mathematik, vol. 1, pp. 269–271 (1959)
30. Simmel, G.: The Number of Members as Determining the Sociological Form of the Group. American Journal of Sociology 8(1), 1–46; (2):158–196 (1902)
31. Carpendale, M.S.T., Montagnese, C.: A Framework for Unifying Presentation. In: Proceedings of ACM User Interface Software and Technology UIST 2001, pp. 82–92 (November 2001)
32. Freeman, L.C.: Visualizing Social Networks. Journal of Social Structure (2000)

Eye Knowledge Network: A Social Network for the Eye Care Community

Rudi Verago[1], Fabian Chatwin Cedrati[2], Fabio d'Alessi[1], and Arrigo Zanette[1]

[1] M31 S.p.A., Via Tommaseo 77, Padova, Italy
rudi.verago@m31.com, fabio.dalessi@m31.com, zanettea@gmail.com
http://www.m31.com
[2] CenterVue S.p.A. Via Tommaseo 77, Padova, Italy
fabian.cedrati@centervue.com
http://www.centervue.com

Abstract. Eye Knowledge Network (EKN) aims at creating a complete framework for collaboration and interaction between eye care professionals. EKN exploits resources and concepts of Web 2.0 to set up a continuously growing "virtual library" of multimedia data (images, videos, animations) and an interacting set of tools for supporting the discussion. Being the clinical case media the pinning point for the medical research and application, the social network is oriented to the creation of specific discussion threads and to develop connections based on similarity and analogies. All the media and the discussions are tagged by the system which incorporates an ontology specialized in medical and eye care field and that provides smart search and a recommendation system. An hybrid recommendation approach, both content-based and collaborative, builds a multicriteria ranking system of objects and users. The media upload to the library allows the flexibility to dynamically interact with the data representations pointing out regions and highlighting areas of interest.

Index terms: social network, eye care, tag, recommendation system, ontology, clinical diagnosis.

1 Introduction

In the field of medical science, it is of paramount importance to share and circulate information about clinical cases and methodologies in the shortest time, as well as to create historical databases made available for future reference and analysis within the whole technical community. The social network paradigm allows the construction of a virtual space where the user, be it medical staff, or an industrial partner, or even a private customer subscriber, can find answers and suggestions to their own information needs. These may range, with respect to the aforementioned user classes, from discussion on very technical topics and new available equipment, to investigation on market trends and niches for new applications, to more general understanding of diseases and reference of medical and research structures.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 22–30, 2008.

1.1 Goal

The ambition behind the whole EKN project is to assume the role of a reference meeting point within the eye care medical community, by representing a collector of knowledge and knowledgeableness on the field relying on powerful tools from the Web 2.0 philosophy (OReilly[7], 2005) for clinical discussions and interaction over the data evidence. Specifically EKN differentiates in many ways from standard generic oriented social networks that are becoming more and more popular on the Internet, while keeping though their distinctive characteristics. In this effort we face various issues dealing with doctors that want to interact about very technical topics: our social network gives the opportunity to discuss about clinical cases, submit media (images and videos) to the community to discuss on. These actions are obtained through either automatic or explicit tagging procedures that enhance and upgrade the information content input by single agents by creating the added value promised by the network theory (hybrid recommendation approach). As a consequence, the whole database is organized using multicriteria ranking of objects and users and the retrieval of the information is efficiently managed by a query engine. Remarkably, due to the delicacy of the subject, all these elements (users and data) are strictly managed according to privacy regulations and access profile rules. A fundamental aspect to improve data accessibility is the ability of suggesting to the user objects he might be interested in.

2 Tagged Element

With the collaboration of experienced eye care professionals we identified a vocabulary of terms related to ophthalmology, a *tag set*, and we built a specialized ontology over it. For each term we assigned an absolute weight (AW): five ranks between zero and one (0.2, 0.4, 0.6, 0.8, 1). The more a term is common into eye care discussions, the lower is the AW. "Retina", for instance, is a very common term and therefore it has an AW of 0.2, while "Cone dystrophy" is more specialized and its AW is 0.8, as shown in table 1.

2.1 Special Forum

The frame is similar to a classical web forum: there are threads composed by a topic and posts from different users. We call it *special* because the discussion is not only text based but users can also dynamically interact with the images attached to the thread by adding tags and landmarks, pointing out regions and highlighting areas of interest. The *richimage* is a key feature of the project. Any subscriber can upload images to his personal Media Library, both from the profile page or while posting to a discussion, images can be tagged by the author. When the user contributes with a post to a thread, he can choose to attach an image, which can be one of the images previously discussed in the specific thread, or any image in his personal Media Library. Once the image has been attached, it can be enriched by dragging on it the following features:

Table 1. Mini weighted ontology

Tag	AW	Synonym of	Similar to	Derivation
20/20	0.6	Ametropia, Visual acuity	Accomodation, PRK	Hyperphoria, Myopia, Presbyopia
Cone dystrophy	0.8	Rod cone, dystrophy	Cone rod degeneration	Color vision, RP, Visual Acuity
PRK	0.2	Photorefractive keratectomy	20/20, Astigmatism, LASIK	Myopia, Hyperopia, Presbyopia

- arrow/flag landmark, to highlight a feature
- resizable circle and rectangle, to highlight a region
- speech bubble feature, to allow free-text comment on a part of the image
- free-text caption, to comment the image and the landmarks/areas spotted

The original image is never modified: informations added in the above way is stored in the database, which takes care of every single contribution of every subscriber. The thread will show all the contributions aside of the post of the contributor. Text is *rich* too, since it may contain semantic tags and links: for instance a word in italic is more important than default formatting text. There are no rigid categories where to post a new thread; the system creates dynamic channels using tags as discriminating items and it create customized channels according to user profiles. Association with tags is computed with the Tag Extractor algorithms. Users can score each thread (one to five *stars*) and each post (*thumbs down* versus *thumbs up*). Each thread has a community manager, who can add a special flag "diagnosis assessed" to the discussion. The purpose is to raise the clinical value of a diagnosis determined in a discussion thread. If the discussion starts with a clinical question and gets to a point where a community manager recognizes a valid answer, he sets the *diagnosis assessed* flag. Threads with this flag set have special visibility in the search engine. This feature can be argued by not being community driven and anti-social, since creates power users in the community, but we must keep in mind that we are dealing with possible medical diagnoses, which need to have some sort of authority supervision. To accommodate both the target of keeping a healthy social network and a reliable collection of discussions that are clinically valid, the following approach is adopted:

- "diagnosis assessed" flag is balanced by an "argued" flag, which can be raised by the thread owner: the "argued" flag lowers the value of the assessment, adding a doubt in the community manager decision;
- a flagged thread is not closed, the community can discuss and even flame the community manager if it decides that the flag decision is wrong;
- a community manager receives a score by the subscribers. He is elected by the community: when his personal score exceeds a given value the user is elected

to be community manager and gains visibility. Community managers can lose score and their special visibility if the community decides so;

2.2 Media

Media are podcasts and screencasts produced by expert eye care doctors. During the upload procedure, the doctor tags media with a subset of our ontology and supplies a title, an abstract and a full description. Registered users can see/listen full length casts and they can give feedback posting comments. They can also score the media using a star score system similar to the one used by YouTube. We call *stream* a "media set" that can be interesting for a user.

2.3 Social Network

Each user has a set of tags given by his area of interest, his specialties and tags coming from activities such as forum posts. The system monitors user activities in order to suggest new objects. Users may have friends and neighbors (such as professionals with similar interests). Since the ambition of the EKN project is to assume the role of a reference meeting point for eye care professionals we give users the possibility to score other users and to signal inappropriate behaviors. At the beginning the community is open only to eye care doctor in U.S.A.

3 Algorithms and Technologies

The EKN engine includes three different algorithms: a *Tag-Extractor* that points at relevant information within the users/objects spaces; a *Score-Mechanism* with the ability to attribute votes to the users/objects spaces; an *Affinity-Recommendation-Engine* that computes neighborhood and affinity between users and objects. We use the open source web application framework Ruby on Rails over MySQL database, algorithms have been written using C++. We have developed client-side editors for text and images using AJAX technologies.

3.1 Tag Extractor

The Tag Extractor mainly extracts important terms from a thread, manages common words and tags association with thread. This algorithm runs every time a thread undergoes a change (as an instance after new post/image insertion and post modification). The main inputs of the algorithm are a single thread and the entire set of tags. A thread is composed by a topic (typically a title), a list of posts composed of *richtexts* and a list of *richimages*. EKN Tag Extractor takes these two inputs and it outputs the tags present into the thread, computing a weight for each tag. The weight is normalized and it indicates the importance of the term within a thread: the algorithm looks at the features of the text as bold, italic, font size. We call this weight TW. The result is a table called Main Thread Tags (MTT), from this table we compute another table called Total

Thread Tags (TTT) that contains all the elements into MTT plus tags related to Main Thread Tags using the ontology. Each tag into TTT has a weight given by the following formula:

$$WTT = TW \cdot RW \cdot AW \tag{1}$$

Total Thread Tags Weight (WTT) depends on text weight (TW), on ontology absolute weight (AW) and on a relative weight (RW). RW is given by the relation between tags into the ontology following these rules:

- if a tag belongs to MTT then it has $RW = 1$
- else (belongs only to TTT)
  - if it is a synonym of some tag into TTT then it has $RW = 0.9$
  - if it is a similar to some tag into TTT then it has $RW = 0.6$
  - if it is a derivation of some tag or it is derivated from some tag into TTT then it has $RW = 0.3$

Each tag into TTT but not into MTT has the same TW of the parent related tag into TTT. The weights are real numbers in *[0,1]*. For example in our database we have the tag "ABMD" (acronym for Anterior Basement Membrane Dystrophy) and the tag "dystrophy". $ABMD$ has an AW of 0.8 while dystrophy equals to 0.2. Suppose that tag extractor finds $ABMD$ into the thread with $TW = 0.9$, since $AMBD$ is a kind of dystrophy (relation "similar to" into ontology) we have that $AMDB$ has $RW = 1$ and dystrophy has $RW = 0.6$ and TW equals to the parent term into TTT so for dystrophy $TW = 0.9$. With this data we can compute WTT for each tag:

$$TWW(\text{AMDB}) = 0.9 \cdot 1.0 \cdot 0.8 = 0.72 \tag{2}$$

$$TWW(\text{dystrophy}) = 0.9 \cdot 0.6 \cdot 0.2 = 0.108 \tag{3}$$

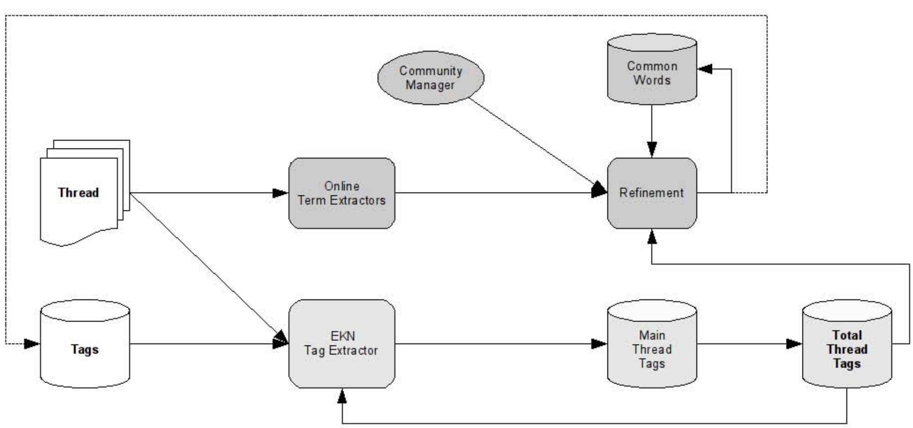


Fig. 1. Block diagram of EKN Extractor algorithm

This means that the thread talks about *AMDB* but it could be interesting also for the users that look for (in the search engine) dystrophy, or users that have dystrophy in their profile or that have a community activity related to dystrophy. A tag extraction algorithm computes the importance of the tag in our ontology inside a thread but it does not find any new tags. In order to resolve this issue there are two possible approaches: manual (by a person) or automatic, using term extractor (Sclano[4], 2007) or other algorithms (Eiken[2], 2006). We use a hybrid methodology. We extract relevant terms using two online services: Yahoo Term Extractor and TagThe. These are free web services that take as input a plain text and return a set of tags based on the specified textual content. From this initial set we remove tags and common terms which are present in out ontology; a community manager makes the last refinement by manually selecting reasonable and consistent terms. These terms, after community validation, become ontology tags.

3.2 Scoring

The scoring algorithm assigns a score to each object. Such score is the sum of components determinated mainly from user votes. Actions from users, like adding posts to the thread, visiting a discussion, contributing with an image, triggering a numeric value associated to a user or to a thread. This value contributes to the global score of that user (User Score, *US*) or thread (*TS*). *US* and *TS* are integers obtained adding various components, we call *TSN* (Thread Score Normalized) and *USN* (User Score Normalized). *US* and *TS* are incremental number with no limits. *USN* and *TSN* have been normalized under the assumption they have a Gaussian distribution. Normalized values are used also as weights to generate new scores: for instance adding a new post to a thread increases *TS* of that thread depending on personal *USN* of the user that is posting. Tables 2 and 3 list the triggers and associated values. The coefficents still have to prove their effectiveness and they will undergo a revision once the social network population increases.

3.3 Recommendations

A fundamental aspect to improve data accessibility is the ability of suggesting the user objects he might be interested in. Many kinds of *recommender systems* have been proposed in the literature (Adomavicious[1], 2005). They can be mainly classified into two classes: *content-based* and *collaborative*. The first one recommends objects similar to what the user liked in the past; while the second one suggests objects that similar users liked too. Both approaches have drawbacks. The first approach requires a good classification of contents in order to be able to measure objects similarities. Moreover suggestions would tend to overspecialize on what the user liked, preventing new interesting recommendations. The collaborative approach tries to overcome these problems measuring object-user neighborhood on the base of what other users liked. However, to provide valid recommendations this latter approach requires a certain amount

Table 2. TS components

Thread category	***TS* value**
One visit to the thread	1
One post to the thread	$10 \cdot USN$
One image in the thread	5
Thread global score (one to five stars)	$1 \rightarrow 20 \cdot USN$
	$2 \rightarrow 10 \cdot USN$
	$3 \rightarrow 0 \cdot USN$
	$4 \rightarrow$ -10 $\cdot USN$
	$5 \rightarrow$ -20 $\cdot USN$
One positive comment on thread post (thumbs up)	2
One negative comment on thread post (thumbs down)	-1

Table 3. US components

User category	***US* value**
Profile completeness	10 - 50
One post to the thread	$1 \cdot TSN$
One image posted in the thread	1
One positive comment on thread post (thumbs up)	$1 \cdot TSN \cdot USN$
One positive comment on thread post (thumbs down)	-1 $\cdot TSN \cdot USN$
Start a new thread	3

of users and users rates on objects. Trying to get the best from both approaches, we implemented a *hybrid* recommendation system. Every user or object i has a profile p_i in the tags space and comes with a neighborhood of objects that have similar profiles p_j. Similarities are measured using the Pearson correlation coefficient:

$$sim(p_i, p_j) = \frac{\sum_{t \in \text{Tags}} (p_i(t) - \bar{p_i})(p_j(t) - \bar{p_j})}{\sqrt{\sum_{t \in \text{Tags}} (p_i(t) - \bar{p_i})^2 \sum_{t \in \text{Tags}} (p_j(t) - \bar{p_j})^2}} \tag{4}$$

where $p_i(t)$ is the t component (tag) of vector p_i and $\bar{p_i}$ is the mean of the vector p_i over all possible components t. This tag-centric, content-based approach allows us to find similar users, or contents that might be of interest to the user, or contents related to what a user is viewing just by comparing vectors in the same tag space. However profiles typically tend to be sparser than they should be. To overcome this issue both ontological information on tags and collaborative filtering are used to fill in profile vectors. Semantic relationships between tags are a reason for profile sparsity when they are not appropriately taken into account. So in our application we use simple ontology to describe basic semantical relationships as, for example, synonimity, hyponymity, etc. These relationships are then used to check and correct collected ratings. As far as users are concerned, their profiles are often sparse or incomplete, especially right after their registration. We use collaborative filtering to remedy this problem,

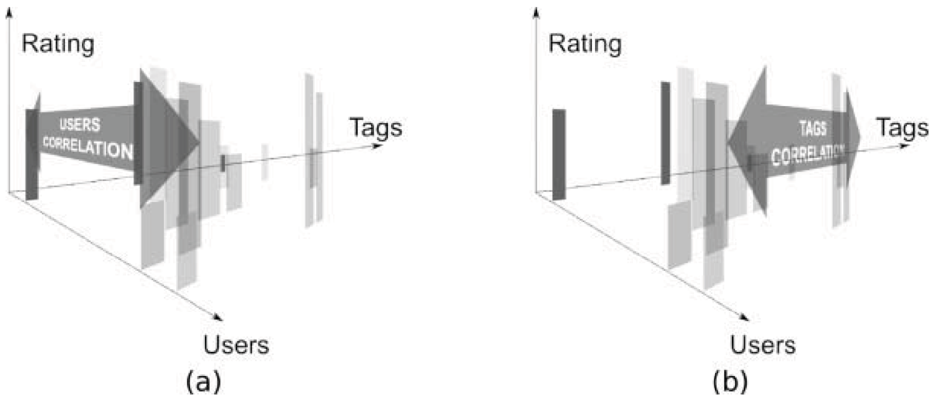


Fig. 2. (a) Correlation between users's profiles in the space of tags, used to recommend users to similar users. (b) correlation between tags in the space of users, used to refine users profiles.

correlating tags with each other, in much the same way we evaluate similarity between users:

$$corr(t_i, t_j) = \frac{\sum_{u \in \text{Users}} (p_u(t_i) - \bar{t_i})(p_u(t_j) - \bar{t_j})}{\sqrt{\sum_{u \in \text{Users}} (p_u(t_i) - \bar{t_i})^2 \sum_{u \in \text{Users}} (p_u(t_j) - \bar{t_j})^2}}$$

where $\bar{t_i}$ is the mean of the ratings of tag t_i over all users. The interpretation is that t_i and t_j are highly correlated ($corr(t_i, t_j)$ close to 1) if users rating high t_i, also rates high t_j (see Fig. 2). We use these tag-to-tag correlations to extrapolate new user ratings from existing ones.

The refined profiles are used to evaluate user-user, user-object and object-object affinities in terms of Pearson correlation coefficients. The computation is carried out off-line once a day on a dedicated machine and resulting data is stored in the database in terms of $top - N$ ($N = 100$) affinities between profiles, ready for fast online retrieval.

4 Conclusion and Future Works

EKN represents a novel approach to cooperative work and discussion focusing on a specific medical field and dealing with a community of professionals. Thanks to its Web 2.0 perspective and through the use of some elements of the so-called Web 3.0, EKN has its strengths in being extremely user and community friendly. Through extensive use of tagging, EKN frees the users from unneeded artificial barriers (such as separated channels grouping threads according to static criteria) and helps them finding what they are most interested in with the minimal effort, in a very efficient and practical way. Complex results (such as finding a user's favourite topics or interests) are done transparently, without the need of any complex operation on the user side. Rich media and information libraries, intuitive tools such as *richimage* editing coupled with good usability a good community strategies (manager election, scoring etc.) make EKN a healthy environment where medical experts find themselves at ease and where their time can be invested in discussing medical topics with maximum information outcome and advantage for the overall community. Future directions include revising and optimizing the algorithms and coefficients of our tagging system and the use of open online tagging systems. Other future works include different user classes (involving also patients) and the use of different open and online ontologies.

References

1. Adomavicious, G., Tuzhilin, A.: Towards the Next Generation of Recommender Systems: A Survey of the State-of-the-Art and Possible Extensions (June 2005)
2. Eiken, U.C., Liseth, A.T., Witschel, H.F., Richter, M., Biemann, C.: Ord i Dag: Mining Norwegian Daily Newswire (2006)
3. ODonovan, J., Smyth, B.: Trust in Recommender Systems (2005)
4. Sclano, F., Velardi, F.: TermExtractor: a Web Application to Learn the Shared Terminology of Emergent Web Communities (March 2007)
5. Amigo, E., Gonzalo, J., Peinado, V., Penas, A., Verdejo, F.: Using Syntactic Information to Extract Relevant Terms for Multi-Document Summarization (2001)
6. Even, F.: Corpus Analysis to Extract Information (2002)
7. O'Reilly, T.: What Is Web 2.0 Design Patterns and Business Models for the Next Generation of Software (September 2005), http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html
8. Copeland, M.: What's next for the Internet, http://money.cnn.com/magazines/business2/business2_archive/2007/07/01/100117068/index.htm

Human-Centric Design of Percipient Knowledge Distribution Service

Peter Géczy, Noriaki Izumi, Shotaro Akaho, and Kôiti Hasida

National Institute of Advanced Industrial Science and Technology (AIST)
Tokyo and Tsukuba, Japan

Abstract. We present a functional design of behaviorally centered percipient knowledge distribution service for organizational systems. The service transparently embeds explicit knowledge into the web content; enabling easy access by users while they perform their browsing tasks. The service functionality emphasizes proper nonintrusive presentation of knowledge objects, and suitable alignment with the web content as well as organizational policies. The design utilizes analytic findings of human browsing behavior on a large scale organizational intranet portal. The findings imply that knowledge objects should contain at least two information components. One should be rapidly processable within seconds, and the other within few minutes. The knowledge objects should be presented at the target pages of users' browsing tasks. Functionality of the service should be personalized to account for user diversity.

1 Introduction

Organizational knowledge is among the most valuable intangible assets. It is the central part of knowledge intensive organizations [1]. Management, effective and timely dissemination, and utilization of organizational knowledge are amid the most important tasks. Progressive and perspective organizations are paying utmost attention to these issues.

The internet and world wide web significantly contribute to the presentation and dissemination of knowledge and information. Organizations are investing extensive resources to establishing their global web presence and at the same time building their internal web based portals [2],[3]. Resources and services available at large organizational portals are, however, often underutilized [4]. Effective development of enterprise portals is a complex task that is essentially organization-specific. Several best practices and engineering frameworks have been proposed [5], [6]. Well-built organizational information systems should facilitate improved working and operational efficiency, and increased performance of knowledge workers [7]. Efficient and timely diffusion of organizational knowledge pertinently contributes to this goal.

Web based portals serve as a suitable distribution medium of knowledge and information. The enhanced organizational knowledge absorption demands human-centric rather than system-centric approach. We present a pioneering behaviorally oriented functional design of percipient knowledge distribution service utilizing findings from a large scale intranet portal.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 31–40, 2008.

2 System Concept

This section introduces the overall system concept together with its essential elements. It encompasses separability of data, processes, and interactions with users—effectively implementable by web services. The higher level concept is applicable to various organizational settings. However, the individual implementations should be aligned with the organizational specifics.

To provide an intuitive understanding of percipient knowledge distribution, consider the following example of user interactions with the organizational web portal. A manager accesses the internal web portal in order to arrange a business trip. The initial arrangements generally require identifying the intended time period in the attendance records as a business trip. (Provided data is checked against the calendar/schedule records for availability and/or conflicting higher priority events.) At the initial business trip arrangement page, the manager is shown a concise extract of the latest organizational policy concerning vacations, e.g. in the upper part of the page. While waiting for processing of a submitted form, he/she moves the mouse pointer over the area and a larger bubble with more details is displayed. During the reading time, the submitted form has been processed and the manager is shown the next page for specifying the travel and stay preferences, so the affiliated travel agency can arrange a suitable package. On this page, the former upper area contains a brief extract with managerial guidelines concerning vacation approval for subordinates. When moving the mouse pointer over the area, the manager is shown a bubble having more

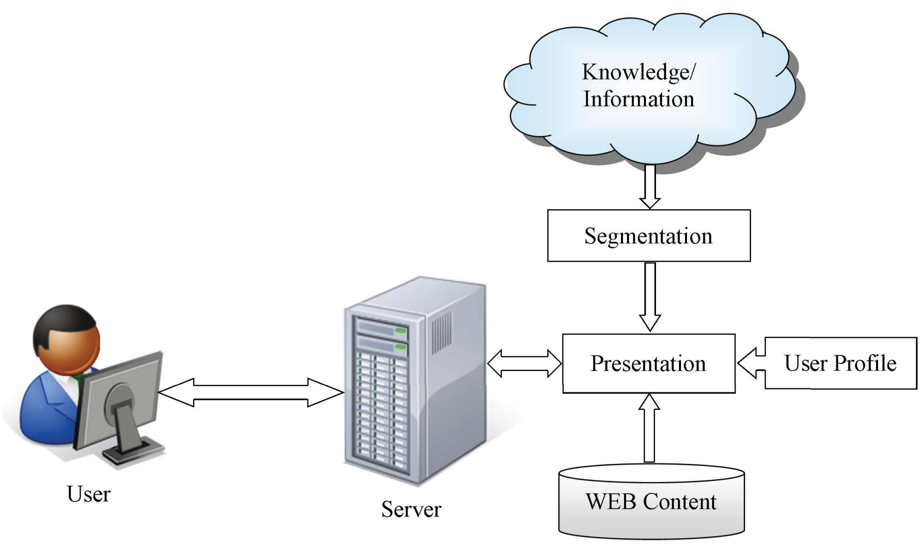


Fig. 1. Illustration of the system concept. Organizational information is presented to the users via web based interface. Larger information blocks are segmented into smaller units that are suitably embedded within the web content.

details. By the time he/she finishes reading it, the submitted data has been processed. The new page displays successful completion message, and the contact information of the assigned travel agent preparing the package.

In the former example, the web supported process of business trip arrangement has been complemented with the display of pertinent organizational information. The manager could familiarize himself/herself with the brief summary of the latest organizational vacation policy, and also the managerial guidelines concerning the vacation approval. The complementary information has been timely presented at proper pages and highlighted important organizational policies.

The percipient knowledge and information distribution aims at appropriately disseminating the explicit knowledge segments that are easily perceivable and processable. The distribution strategies should be suitably aligned with the organizational goals. The knowledge, or information, is presented along with the information content of business processes. The emphasized distribution medium in this study is a digital space, such as web based organizational information portal.

The system concept is illustrated in Figure 1. The knowledge and/or information from organizational knowledge base is segmented into smaller parts that are easier to comprehend in a relatively short time. These segments are suitably bundled with the information of the displayed web content. The presentation is personalized to individual users according to their characteristic profiles.

The substantive higher order components of the system perform the following functions:

– **Segmentation:** division of larger explicit knowledge and information into smaller parts according to the specific rules. The rules for segmentation are derived from analysis of users' behavior in organizational web based portals.
– **Presentation:** display of knowledge and/or information segments to user via web based interface. Apart from the graphical user interface aspects of the presentation, the additional important issue must be addressed: on which pages to present the segments?
– **Personalization:** adjustments of system functionality according to user preferences and browsing characteristics. User profiles should incorporate the essential web behavioral features extracted from observed interaction behavior.

The functionality of the components must reflect the essential characteristics of human interactions in electronic environments. Human web behavior analytics are pertinent in this context. Strategic determination of the proper functional constructs of the components relies on it. The following sections highlight how the observed human-web interactions on a large scale organizational intranet portal translate to actionable knowledge for the system design.

3 Behavior Analytics and Case Study Portal

Behavior Analytics Framework

Recent findings of temporal dynamics of human behavior in electronic environments exposed several significant attributes [8]. Temporal dynamics of human-web interactions exhibit bursts of activity followed by longer periods of inactivity [9]. Certain web tasks are executed rapidly, whereas others are carried out after a substantial delay. The execution timing is considered to be perceptually prioritized [10].

Accounting for the observed human temporal dynamics in digital environments, it is desirable to divide the interaction sequences of human browsing behavior into parts capturing the activity bursts. We consider two parts: sessions and subsequences. The sessions are temporally longer interaction segments. They are further divided into subsequences. An illustration of click stream segmentation is presented in Figure 2. The analytic framework has been detailed in [4]. We briefly recall the relevant constructs for this study.

Sessions delineate more complex interaction tasks that are divided into several sub-tasks represented by subsequences. The division is determined based on the observed delays d_i between page transitions. For instance: in a single session a user logins into intranet portal (subsequence 1), searches for a document (subsequence 2), downloads it (subsequence 3), and then pursues offline work. This session consists of three subsequences indicating distinct sub-tasks. Important navigation points of sessions and subsequences are their initial and terminal pages. The points where users initiate their actions are *starters*, and the targets of their actions are *attractors*.

Intranet Portal

The case study organizational information system is a large scale intranet portal of The National Institute of Advanced Industrial Science and Technology. The

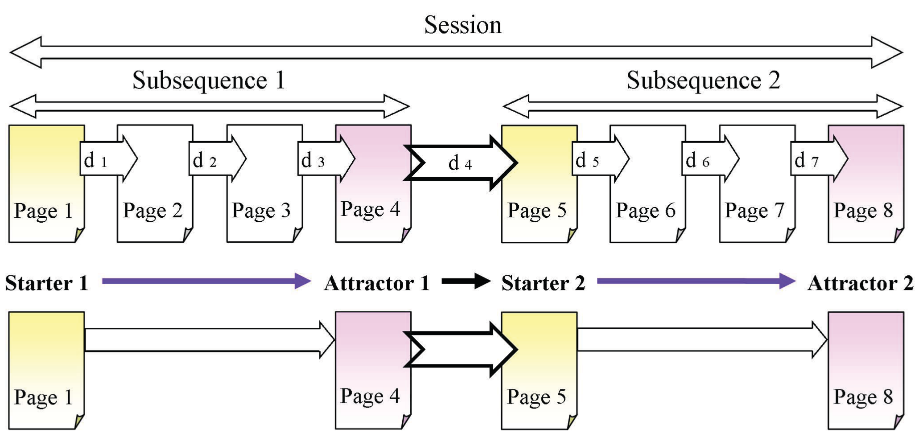


Fig. 2. Illustration of the navigational click stream segmentation

institute has a significantly large intranet portal. Its infrastructure consists of six web servers connected to the high-speed backbone in a load balanced configuration. The intranet services and resources are available to the users via channels ranging from optical to wireless connectivity, and support platforms extending to mobile devices.

The institution has a broad network of branches at various locations throughout the country; thus several services and resources are decentralized. The portal contains wide spectrum of resources, such as documents in various formats, downloadable software, multimedia, etc. There is also large number of services supporting organizational business processes, cooperation with industry, academia, and other institutes, resource localization; but also networking, blogging, etc. The visible web space exceeds 1 GB. The deep web space is considerably larger, but hard to estimate due to the distributed architecture and altering back-end data.

Table 1. Basic information about data used in the study

Web Log Data Volume	∼ 60 GB
Log Records	315 005 952
Resources	3 015 848
Sessions	3 454 243
Unique Sessions	2 704 067
Subsequences	7 335 577
Unique Subsequences	3 547 170
Valid Subsequences	3 156 310
Unique Valid Subsequences	1 644 848
Users (Knowledge Workers)	∼10 000

Intranet traffic is considerable and generates a rich pool of web log data (see Table 1). The data was, however, contaminated by machine generated traffic (from monitoring software and several other applications) and required extensive preprocessing, and cleaning. The data preparation, processing, filtering, and segmentation to sessions and subsequences are described in [4] and not addressed here. It is worth noting that the elimination of machine generated traffic substantially reduced the number of unique valid subsequences, by 53.6% (the primary investigation target is human interactivity with the system—hence the machine traffic elimination).

4 Behavior-Centric Design

The design of percipient knowledge distribution service for organizational information systems incorporates both the conventional design elements as well as the novel human behavior-centric constructs. The novel constructs are derived from the web behavior analytics of the portal users. They determine the core functionality of the system components. The following subsections expose the implications of human-web interaction findings on the strategic elements of the functional design.

4.1 Segmentation

Organizational knowledge base generally incorporates a vast amount of resources. The resources vary in length, detail, importance, and other factors. Facilitation of easy comprehension of complementary information requires efficient segmentation of larger knowledge resources into smaller relatively self-contained sections. The crucial question is: what are the web behaviormetric determinants for segmentation? To address this question necessitates observation of user temporal browsing characteristics together with segmentation of their browsing tasks into sub-tasks.

The presented knowledge objects should incorporate information processable both within few seconds and few minutes. The observed average subsequence duration in knowledge worker browsing sessions was 30.68 seconds. The peak subsequence duration, however, was in the interval between two and five seconds (see Figure 3). During the subsequence interval, the users navigated through two to five pages—as indicated from the peak subsequence length displayed in Figure 4. This suggests approximately one to six seconds time per page transition. If user is presented with the initial complementary information on a page, its mental processing should require less than six seconds.

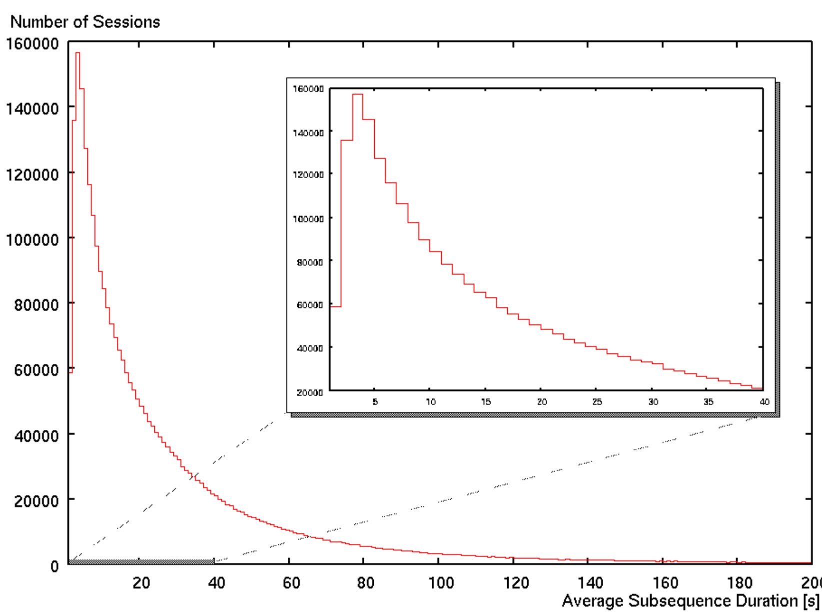


Fig. 3. Histogram of average subsequence durations in browsing sessions. The detailed view of the initial histogram part is displayed in sub-window.

The processing duration of the longer part of knowledge object implies from the average delay between subsequences. Detected average duration of knowledge worker browsing sessions was 48.5 minutes. This is approximately two times longer that the average session duration of students (approximately 25.5 minutes) reported in [11]. However, 48.5 minutes observation incorporated machine generated traffic. After filtering the machine generated subsequences, it has been discovered that the average delays between subsequences lasted approximately 6 minutes 28 seconds. This was the average time spent on the attractors of subsequences. Thus, if a user is provided with the longer information segment, its mental processing should not extend beyond this time on average.

Practical representation of knowledge in objects may vary depending on conveyed explicit knowledge or information. The shorter part of knowledge object could be, for instance, a title, catching headline, or picture. The longer part may be a summary paragraph. If the displayed title (or picture) catches user's attention, he/she can access the larger part.

4.2 Presentation

The segmented information from the organizational knowledge base should be appropriately presented to the users. It should efficiently complement the accessed web content, yet maintain nonintrusive character. Conventional approaches to resolution of these issues would focus mainly on two tasks: *1)* alignment of the accessed page content with the knowledge object content, and *2)* interface design. Both of these issues have been widely addressed by academics and practitioners. Behaviorally centered presentation functionality introduces an additional dimension: proper identification of the page on which the knowledge object should be presented.

The knowledge objects should be presented on the attractor pages. Analysis of knowledge worker navigation on the intranet portal revealed that the commonly used navigation pattern indicates knowledge of the starting point–starter, and familiarity with the navigational path to the desired target–attractor. Users' navigation habituates as they familiarize with the web environment. This leads to the rapid transitions.

The navigation dynamics described in the former subsection indicate that users navigate from page to page within second(s). Such fast paced dynamics suggest insufficient time for scanning the complete page content. Users know where the link to following page is located and proceed directly there. The rapid transitions repeat until the user reaches the attractor page. The attractor pages have been observed to be the navigation points where users spend the most time. If users do not pay sufficient attention to the content of the transitional pages between starter and attractor, it is inappropriate to present the knowledge objects there. They would be unnoticed, and such functionality would only waste resources. The knowledge objects, therefore, should be presented on the attractor pages.

Noticeable observation from the analysis of the studied portal was that knowledge workers utilized a relatively small spectrum of attractors. There were 288075

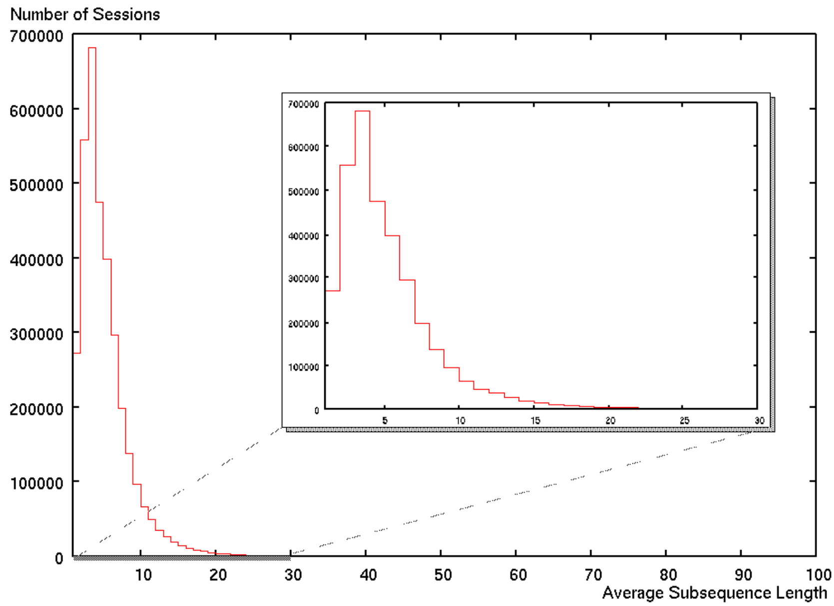


Fig. 4. Histogram of average subsequence lengths in browsing sessions. The detailed view of the initial histogram part is shown in sub-window.

unique attractors identified. Although the set of unique attractors was approximately three times larger than the set of starters, it is still relatively minor portion—approximately 9.55% of resources.

A small number of utilized attractors, in comparison to a number of available knowledge objects, causes complications for content based alignment techniques. The alignment algorithms must be able to manage mappings between a relatively small attractor content space and a larger knowledge object content space. If the attractor content space is insignificant (e.g. small portals), a simple priority based presentation is more efficient.

4.3 Personalization

There are significant differences among users in organizations. Different members have different access rights and priorities. Certain information is relevant to some members while irrelevant to others. Specific information is timely important to one user while marginally important to the other. The organizations maintain their own structural and departmental classification of their members. The information dissemination is generally managed with respect to it.

There are also web browsing and behavioral differences among users. Different users have different browsing styles and characteristics. Some users have longer or shorter sessions and subsequences than the others; some spend more time at certain attractors than the others; some are more exploratory than the others; etc. Different users have also different frequent starter and attractor sets.

Presentation of knowledge objects should be personalized. The conventional personalization approaches generally consider organizational classification of users, their browsing histories, and preferences. Behaviorally centered design emphasizes the behavioral and browsing characteristics in addition to the conventional methods. The presentation and segmentation of knowledge objects can be further adjusted with respect to the users' behavioral features on the web portal. This demands behaviormetric profiling of users.

Behaviormetric profiling encompasses the following three main categories of browsing and behavioral characteristics:

- **Temporal:** the essential time related specifics of human-web interactions.
- **Navigational:** the aspects of user interactions related to the individual navigational elements such as starters and attractors.
- **Abstractions:** patterns of starter–attractor pairs of individual subsequences and transitions to the consecutive subsequences (attractor of the previous subsequence in connection with starter of the next one).

The underlying temporal characteristics are reasonably represented by delays and durations. The analysis of the intranet portal revealed that the typical temporal characteristics for sessions and subsequence have Poissonian-like distributions. The essential temporal aspects of user behaviormetric profiles are thus suitably represented by minimum, maximum, and average diagnostics.

The navigational and abstract pattern characteristics target usability aspects. Useful pages and pattern abstractions are accessed or utilized more frequently than the less useful ones. It has been observed that these features of knowledge worker browsing behavior, on the studied intranet portal, indicate significant long tail distributions. The heads of the distributions are substantially smaller than their tails. The heads contain frequently used elements while the tails contain infrequently used elements. The long tailed features of human browsing behavior are sufficiently captured by means of frequencies, numbers of unique elements, and selected number of the most frequent elements.

5 Conclusions

The current study presents behaviorally centered functionality of the percipient knowledge distribution service for organizational information systems. The percipient knowledge distribution service aims at distributing the explicit knowledge or information to relevant users in a transparent manner while they are performing the web based tasks. The distributed information/knowledge is suitably embedded into the web content and easily accessible by users.

The system design requires efficient resolution of the following main issues: segmentation of explicit knowledge from organizational knowledge base into easily comprehensible parts, and appropriate presentation that accounts for individual user browsing and behavioral specifics. Behavior-centric approach to functional design utilizes analytics of users' web browsing. The analytics revealed that the knowledge objects should contain at least two elements: one comprehensible within seconds, and the other comprehensible within minutes. The quickly comprehensible information is suitably presented on the specific page. It links to the larger information element optionally invokable by users. The knowledge objects should be presented on the attractor pages, that is, where users pay the most attention to the content. The personalized presentation, accounting for behavioral diversity of users, is achievable by employing behaviormetric profiling.

References

1. Alvesson, M.: Knowledge Work and Knowledge-Intensive Firms. Oxford University Press, Oxford (2004)
2. Dewan, R.M., Freimer, M.L., Seidmann, A., Zhang, J.: Web portals: Evidence and analysis of media concentration. Journal of Management Information Systems 21(2), 181–199 (2004)
3. Collins, H.: Enterprise Knowledge Portals. Amacom, New York (2003)
4. Géczy, P., Akaho, S., Izumi, N., Hasida, K.: Knowledge worker intranet behaviour and usability. Int. J. Business Intelligence and Data Mining 2, 447–470 (2007)
5. Nikolaidou, M., Alexopoulou, N., Tsadimas, A., Dais, A., Anagnostopoulos, D.: A consistent framework for enterprise information system engineering. In: Proceedings of the International Conference on Enterprise Distributed Object Computing, Hong Kong, pp. 492–496 (2006)
6. Sullivan, D.: Proven Portals: Best Practices for Planning, Designing, and Developing Enterprise Portal. Addison-Wesley, Boston (2004)
7. Davenport, T.H.: Thinking for a Living - How to Get Better Performance and Results from Knowledge Workers. Harvard Business School Press, Boston (2005)
8. Barabasi, A.-L.: The origin of bursts and heavy tails in human dynamics. Nature 435, 207–211 (2005)
9. Dezso, Z., Almaas, E., Lukacs, A., Racz, B., Szakadat, I., Barabasi, A.-L.: Dynamics of information access on the web. Physical Review E73, 066132(6) (2006)
10. Vazquez, A., Oliveira, J.G., Dezso, Z., Goh, K.-I., Kondor, I., Barabasi, A.-L.: Modeling bursts and heavy tails in human dynamics. Physical Review E73, 036127(19) (2006)
11. Catledge, L., Pitkow, J.: Characterizing browsing strategies in the world wide web. Computer Networks and ISDN Systems 27, 1065–1073 (1995)

Towards a Community of Practice Toolkit Based on Semantically Marked Up Artifacts

Christine Müller and Michael Kohlhase

Computer Science, Jacobs University Bremen
{c.mueller,m.kohlhase}@jacobs-university.de

Abstract. Almost all aspects of scientific research and communication are now supported by software systems. Even though most of these systems allow the user to specify interaction preferences or even employ user modeling techniques, every system is an island with this respect. In particular, different systems cannot share user models or predict in the absence of prior interactions. We use ideas from the theory of Communities of Practice to arrive at declarative models that predict prior knowledge, preferences, and learning paths of scientists. Our models build on collections of semantically marked up artifacts (CoPfolios) that inscribe scientific practice. Our vision is to provide a toolkit that encapsulates CoPfolios allowing scientific applications to share user data.

1 Communities of Practice in Science

In the late 80s [LW91] coined the term *Communities of Practice (CoP)* to express the need for a new theory of learning. Nowadays, the concept is a well-known and widely accepted theory, which has a great impact on various disciplines: Meant to be useful for the debate on education, the concept has been applied to domains such as government, science, education, as well as industry and is of interest to both, researchers and practitioners.

[KW05] analyzed CoPs in the domain of science. We agree that the CoP theory is suited to describe scientific communities. In particular, the concept allows us to better understand the collaborative and emergent nature of science. Moreover, as CoPs act as "platforms for building a reputation" [Wen05], they support an important concern in science, i.e. to increase one's reputation and impact on the community.

We apply the theory of CoPs to the *Science, Technology, Engineering, and Mathematics (STEM)* disciplines. We view *STEMicians* as mathematical practitioners, who understand mathematics as the *language of science* and as the *basis for several disciplines*. The STEM community is very heterogeneous: Although outsiders may get the impression that mathematical practitioners form a homogeneous, unified community and share the same practices all over the world, they actually form various sub-communities that differ in their *preferred notations* [Caj93, SW06, Mül08b], *basic assumptions* [Rab08], and *motivating examples* [KK06].

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 41–50, 2008.

We observe that scientists *primarily interact via their artifacts*, including documents in a more traditional understanding such as conference proceedings, journal publications, and books as well as documents in a wider interpretation such as emails, forum postings, online reviews, and wiki entries. Artifacts also include mathematical concepts and foundations as well as software and libraries. We assume that scientific interactions, and more generally mathematical practices, are *inscribed* into artifacts and aim at extracting the *inscribed scientific practices* to *model* scientific communities and their participation. [KW05] follow a similar approach to adapt the principles for cultivating CoPs by [WMS02] for the *Computer Supported Collaborative Learning (CSCL)* community. Based on a *citation analysis* of the CSCL conference proceedings they model the participation of their scientific community. In contrast, we build on a *semantically marked up corpus* of artifacts, which facilitates to distinguish different types of artifacts and relations on distinct granular levels. Moreover, [KW05] compose design principles by analyzing and *describing the current situation* in CSCL, while we aim at modeling the STEM community in order to *predict* membership, interest, activities, and preferences.

2 Community Oriented Technologies for Science

[Wen01] emphasizes that the success of a CoP primarily depends on social, cultural, and organizational factors and secondly on technological features. Taking this into account, [Wen01] and [WWSR05] provide aspects of CoPs that can be supported by technology and point out implementations that are suited to support these areas. We have applied the discussion to the STEM community, in particular, to analyse tools that support interaction via scientific artifacts. From our survey, we conclude that STEMicians have been using technology for many years. Many specialized tools exist that support various scientific activities, but none of them supports all. We observed that in science an *all-embracing implementation seems impossible* since the requirements of scientists are very *diverse* and even *contrary*. In particular, the choice of tools often depends on the scientist's basic assumptions and foundations, which in turn depend on his "personal preferences and the character of the current problem" [Rab08]. Since scientists use various tools to accomplish different tasks, their repertoire of artifacts is scattered across various system-internal database and so is the repertoire of their CoPs. However, we need to consolidate artifacts and *integrate existing scientific tools* to facilitate scientists to *manage and share their data across systems* and, thus, to facilitate collaborations. Since the STEM community is very *document-centered*, we propose an integrative approach that pools scientific tools with various specialized functionality around *common corpora of artifacts* in a *common representation and markup format*. For the course of this paper we focus on systems that build on our XML-based Open Mathematical Document Format (OMDoc)[1] [Koh06].

[1] Please note that we are not restricted to the OMDoc format but emphasize on the OMDoc functionality. This approach can be applied to other powerful markup formats, such as sTEX [Koh05b] or CNXML [HG07].

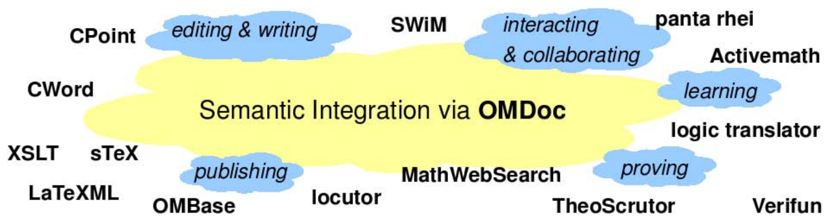


Fig. 1. The OMDoc universe: Integrating scientific tools via a common representation format

We view OMDoc as a semantic integration platform, which offers means to annotate the *structural semantics* of artifacts, that is to "identify the structure, the meaning of text fragments, and their relations to other knowledge" [Koh06]. This markup facilitates the automatic processing of scientific documents, while allowing authors to choose the level of formality of their documents.

Figure 1 illustrates scientific tools that have already been integrated via the OMDoc format and which support various scientific activities[2]. In particular, the OMDoc universe comprises the intelligent version database [OMB08], the management of chance system [loc07], the semantic wiki [Lan08], the discussion platform [pan08], the course management system [Act07], the automated prover [Ver08], the semantic search engine [Mat07], the theory-browser [NK07], the logic translator by [Rab08], and the invasive OMDoc editors in Microsoft PowerPoint and Word [Koh05a]. However, none of these systems provide an integration of user data and preference settings.

In the following sections, we build on the notion of *portfolios*, which integrate artifacts from several systems wrt. to a single scientist, in particular, his user data and preference settings. Based on these *single-owned portfolios*, we propose **CoPfolios**, which include *artifact collections of groups* and facilitate the portability of common preference settings across various systems (cf. Sect. 3). Moreover, portfolios and CoPfolios provide portable and (partially) public community and user views that help to contextualize the adaptation of information. In contrast to many other adaptive systems, we focus on semantically enriched artifacts. We believe that *semantic technologies* support the *reification* and *extraction* of *scientific practice* and discuss novel services based on the extracted information (cf. Sect. 4 and 5).

3 Towards Portable User and CoP Models

3.1 From Portfolios to CoPfolios

The term "*portfolio*" (lat. portare "carry" and folium "folio") refers to a collection of objects of a specific type that document an individual's activities and

[2] The figure is patterned after an overview in [WWSR05] on general CoP oriented technologies. Please note that we do not cover all relevant scientific tools in this paper, but focus on the OMDoc universe.

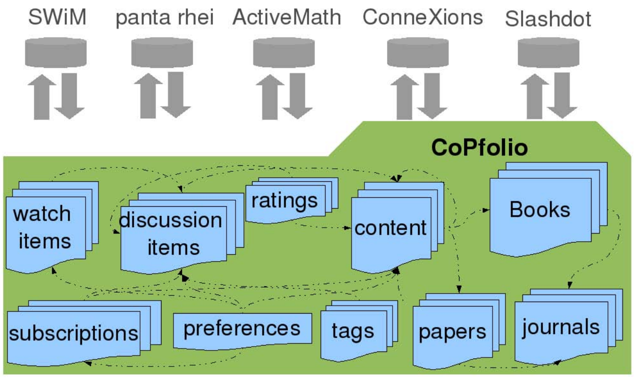


Fig. 2. Potential types of artifacts for CoPfolios. Several systems from the OMDoc universe, such as SWiM, *panta rhei*, and ActiveMath, as well as non-OMDoc systems, such as [CNX08] or [sla08], can initialize these types.

preferences [Wik08]. They include *artifacts* the individual created, as well as *self-evaluation*, *reflection*, *best practice*, and *methods*. Portfolios consists of private as well as public parts that allow others to get an impression of one's practices. Portfolios have been used in several domains, in particular, in *industry* (finance or project portfolios), *education* (learner portfolios), and *human resource management* (career portfolios) to support *life-long learning* and to *track personal or community developments*. We view portfolios as platform-independent collections of *interrelated semi-structured* artifacts an individual creates, shares, discusses, or uses as well as *metadata* on these artifacts that express the individual's self-reflexion, interest, and views.

Building on the portfolio idea of *single-owned* collections of artifacts, we propose CoPfolios, which are artifact collections shared by a CoP of scientists and are interpreted as *representations of CoPs*. Note, as portfolios are special cases of CoPfolios for *singleton CoPs*, we only refer to CoPfolios in the further course of this paper.

3.2 Maintenance of CoPfolios

We propose `CoPit`[3], a community of practice toolkit, for managing CoPfolios. As illustrated in Fig. 2, CoPfolios include several *interrelated* types of artifacts such as *papers*, *preprints*, *discussion items*, *preference settings*, *ratings*, *tags*, or *subscriptions*. Moreover, they include profile data, such as email, fullname, address, and messenger IDs, as well as preference settings, e.g. with respect to general subscription preferences or notation systems. These types of artifacts are initialized by system-specific data provided by various systems, whereas the CoPfolios are maintained by `CoPit`. Each system provides an export to and import from `CoPit`. For more information on `CoPit` see [Mül08a].

[3] Please note that the following illustrations are visionary and experimental. We are in the progress of implementing a proof-of-concept prototype, with which we will evaluate and refine our approach.

4 Services Based on CoPfolios

The immediate benefit of CoPfolios for individual scientists is the consolidation of their user data across systems. Accordingly, the immediate advantage of CoPfolios for CoPs of scientists is the platform-independent management of a CoP's repertoire. The machine-processable collection of semantically marked up artifacts also facilitate *CoP services*, i.e. services based on the sharing of information with CoP members and the access to other scientists' repertoires.

4.1 Views and Lenses

The preference settings in CoPfolios can be interpreted by systems to provide *views* or *lenses* on artifact collections, particularly, wrt. their *presentation*, *structure*, and *selection*. For example, a group of scientists may prefer a particular *notation system*. Their *notation preferences* (or notation lens) are stored in the group's CoPfolio and can be reused by other scientists to view artifacts through the *CoP's lens*. Vice versa, instead of learning the CoP's notation system, a scientist could also use his *own lens* to make sense of the repertoire in the CoPfolio.

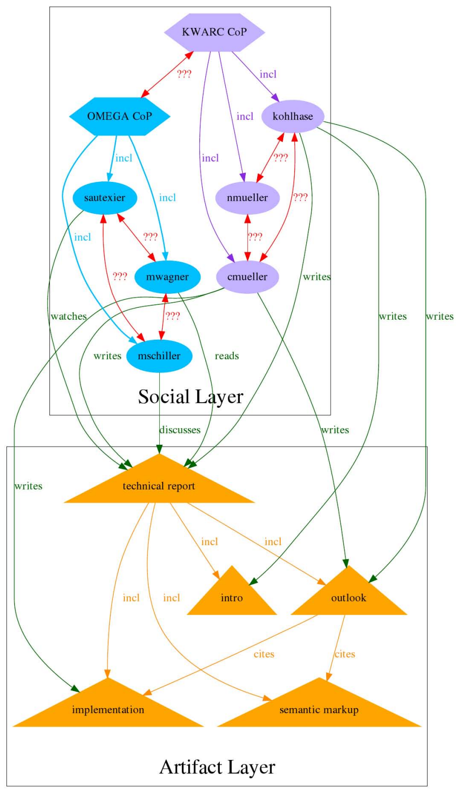


Fig. 3. Artifact & Social layer

4.2 Visualizing and Browsing

We can visualize the semantic interrelations within and across CoPfolios to e.g. facilitate the search for related work and potential collaborations across systems. Based on an interactive visualization, we can facilitate the semantic browsing along these relations extending existing approaches such as citation-based browsings.

Fig. 3 illustrates semantic interrelations on the *artifact layer*, i.e. relations such as *includes*, *cites*, and *refutes*, and the *social layer*, i.e. relations such as *knows*, *trusts*, or *collaborates with*. The relations between social layer and artifact layer, such as *writes*, *reads*, *implements*, *watches*, or *subscribes to*, allow the *bidirectional propagation of dependencies* between the layers, that is *bottom up* and *top down*: By analysing the content, structure, presentation, and metadata of an artifact, we can identify similarities that eventually propagate to the social layer: For example, the artifacts interrelation can be used to *construct social* *networks* or to *predict similarities between users*. In contrast, a top down approach allows to use the information on users and their social relation to *define* the adaptation, selection, and structuring of artifacts.

4.3 CoP Spawning and Browsing

We propose the interpretation of semantically marked up artifacts to compute the *differences* between user (or rather between the user's artifacts and their interrelations) to eventually build *parametrized clusters* of similar users, henceforth referred to as *virtual CoPs*. The parameters define different *dimensions* for the clustering, e.g. the common *basic assumptions* or *background*, the common *choice of examples*, or the common *notation preferences*. We do not claim that the computed clusters (or virtual CoPs), are CoPs wrt. to [LW91] as they only consider selected dimensions. However, they provide initial means for other users to cope with information without prior interactions.

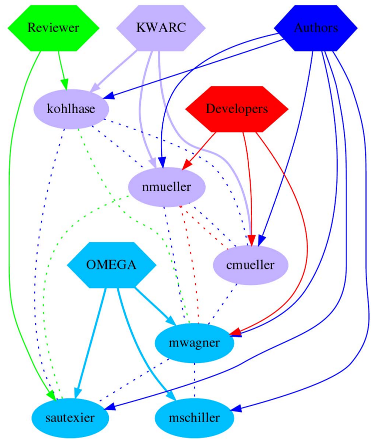


Fig. 4. Virtual CoPs

For example, based on the interrelated repertoire of the KWARC and ΩMEGA group in Fig. 4, subcommunities within and across both CoPs can be identified. Potentially, these *virtual CoPs* help to identify *similarities* and relations among the members of both CoPs, on which basis new CoPs (or collaborations) can be established. For example in Fig. 5, the virtual *Developer CoP*, with the members nmueller, mwagner, and cmueller, as well as the CoP's *implementation repertoire*, including mmlkit [MMK08], the *locutor* system, and PlatΩ [pla07], are displayed. The scientists nmueller and cmueller relate via their collaborative development of `mmlkit`. mwagner implements PlatΩ and watches the development of the *locutor* systems, which eventually allows to infer his relation to nmueller or the relation between his implementation and the *locutor* system.

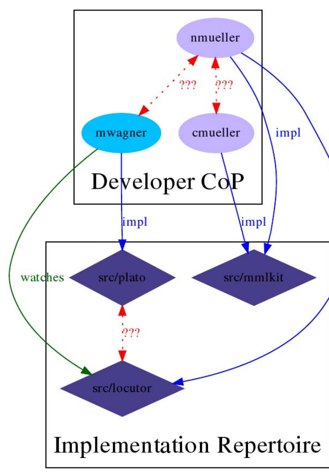


Fig. 5. Developer CoP and its repertoire

5 CoPit Case Study

As CoPit supports the sharing of user-specific data across systems and among other users, we need to take the authentication and rights management into account. We will use the *decentralised identity service* [Ope08] via URL-based identities to uniquely identify scientists across systems. Systems can adapt their authentication process to these open identities or rely on their own user management.

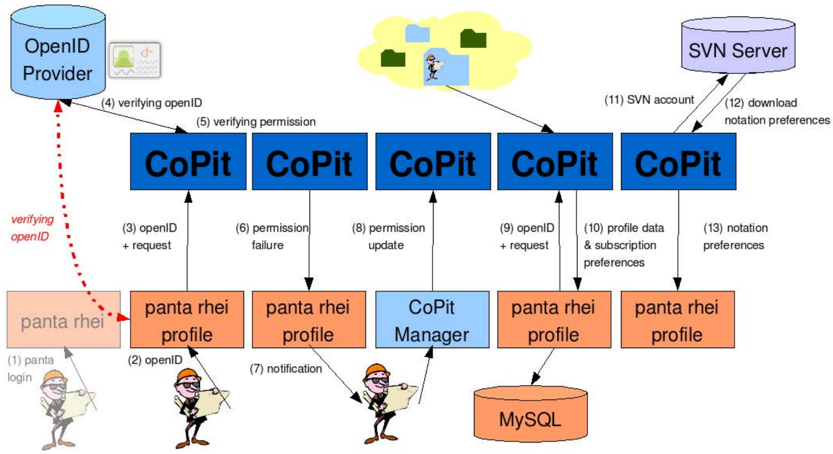


Fig. 6. Authentication and Rights Management based on OpenIDs

Figure 6 illustrates a potential OpenID-based scenario. The user *kohlhase* logs into the panta rhei system (for the first time) using his panta rhei account (1)[4]. He access his profile page in the system, provides his openID, e.g. http://copit.kwarc.info/kohlhase, and assigns panta rhei to display his profile data from his CoPit CoPfolio (2). panta rhei prompts CoPit, provides the openID, and request the profile data of kohlhase. CoPit prompts an OpenID Provider, e.g. http://copit.kwarc.info/, to verify the openID (4). It then verifies the access rights for the panta rhei system on the kohlhase CoPfolio (5). Since panta rhei has no access, the request fails (6). Panta rhei prompts the user to grant the required permissions (7). kohlhase uses the CoPit manager to grant panta rhei read access on his profile and preference data (8). panta rhei re-initializes its request (9). This time the system has access to the respective parts in the kohlhase CoPfolio, receives profile data, and initializes its internal profile page (10). Since panta rhei provides email notifications, the system can interpret the subscription preferences in the user's CoPfolio (10). Being a notation aware system, panta rhei can also interpret the user's notation preferences. However, the

[4] Alternatively, panta rhei could directly be based on openID. Instead of verifying the system-internal user account the system would prompt an OpenID provider to verify the openID.

notation preferences are stored in the kohlhase SVN repository. Consequently, panta rhei only receives pointers and needs to prompt the SVN server for the actual files. However, the system is not permitted to access the respective SVN directories yet. It thus needs to notify the user to modify the respective SVN permissions. Alternatively, `CoPit` provides an abstraction to the storage of the notation preference files in SVN `CoPit` stores the SVN account of kohlhase, which is now used to access SVN (11), to download the requested files (12), and to finally pass them to panta rhei (13).

6 Related Work

Our approach of pointer-based CoPfolios is analogous to the user modeling [Mel01] in the ActiveMath [Act07] system, an eLearning system based on an OMDoc corpus of course material, which provides the generation of user-specific courses and exercises. The generation is based on *learner models* consisting of concepts, technically pointers to the OMDoc repertoire, as well as competencies of the users. The model focuses on the representation of a learner's knowledge and preferences wrt. layout and notation preferences. CoP models or the portability of models across systems is not considered.

The emerging standard FOAF [FOA08] (an acronym for *friend-of-a-friend*) is an machine-readable ontology describing persons, their activities, and relations to other persons and objects. Users can use the RDF [LS99] extension to describe themselves and publish their user data. Several systems provide imports and exports of these FOAF files to initialize their user models. However, the FOAF format is restricted to individuals and does not support to represent all relevant user data such as specialized preference settings.

7 Conclusion and Outlook

An important aspect of the Knowledge Society is the challenge of digital knowledge management (KM). We believe that KM requires the digitalization of knowledge and its social context to provide sophisticated (automated) interactions. As interaction is practice, we make use of the theory of communities of practice to reify practices and represent interaction.

In our previous work we have discuss the reification of several practices as preference settings [KMR08, KMM07a, KMM07b]. In this paper, we focused on a natural place to collect, store, and manage these preferences to facilitate the sharing of user and CoP data. We made use of the notion of *portfolios* to consolidate artifacts and context (represented as preference settings) of scientists across systems (of the OMDoc universe) and extended portfolios towards collections of CoP artifacts, i.e. CoPfolios. These are maintained by `CoPit`, which facilitates the sharing of user and CoP data across systems. To motivate our approach, we presented several CoP services and a case study, which we want to implement in the *panta rhei* system. We plan to integrate functionality of the *`locutor`* system to extract semantic dependencies for the browsing of artifacts as well as computation of *virtual CoPs*. For the implementation of views and lenses, we will integrate the `mmlkit` [MMK08] system, which facilitates the adaptation of artifacts wrt. to different notation preference.

Acknowledgments. We would like to thank the KWARC group for their valuable feedback and discussion on our work. Special thanks go to Normen Müller, Christoph Lange, and Andrea Kohlhase. This work was supported by JEM-Thematic-Network ECP-038208.

References

[Act07] ACTIVEMATH (February 2007), http://www.activemath.org/

[Caj93] Cajori, F.: A History of Mathematical Notations. Courier Dover Publications (published, 1929)

[CNX08] CONNEXIONS (June 2008), http://cnx.org

[FOA08] Friend of a Friend (FOAF) project (June 2008), http://www.foaf-project.org/

[HG07] Hendricks, B., Galvan, A.: The Connexions Markup Language (CNXML) (June 2007), http://cnx.org/aboutus/technology/cnxml/

[KK06] Kohlhase, A., Kohlhase, M.: Communities of Practice in MKM: An Extensional Model. In: Borwein, J.M., Farmer, W.M. (eds.) MKM 2006. LNCS (LNAI), vol. 4108, pp. 179–193. Springer, Heidelberg (2006)

[KMM07a] Kohlhase, M., Mahnke, A., Müller, C.: Managing Variants in Document Content and Narrative Structures, pp. 324–329 (2007)

[KMM07b] Kohlhase, M., Müller, C., Müller, N.: Documents with exible notation contexts as interfaces to mathematical knowledge. In: Libbrecht, P. (ed.) Mathematical User Interfaces Workshop 2007 (2007)

[KMR08] Kohlhase, M., Müller, C., Rabe, F.: Notations for Living Mathematical Documents. In: Mathematical Knowledge Management, MKM 2008. LNCS (LNAI). Springer, Heidelberg (in press, 2008)

[Koh05a] Kohlhase, A.: Cpoint (2005), http://kwarc.info/projects/CPoint/

[Koh05b] Kohlhase, M.: Semantic markup for TEX/LATEX (manuscript, 2005), http://kwarc.info/software/stex

[Koh06] Kohlhase, M.: OMDoc – An Open Markup Format for Mathematical Documents [version 1.2]. LNCS (LNAI), vol. 4180. Springer, Heidelberg (2006)

[KW05] Kienle, A., Wessner, M.: Principles for Cultivating Scientic Communities of Practice. In: van den Besselaar, P., de Michelis, G., Preece, J., Simone, C. (eds.) Communities and Technologies, pp. 283–299. Springer, Heidelberg (2005)

[Lan08] Lange, C.: SWiM: A semantic wiki for mathematical knowledge management (February 2008), http://kwarc.info/projects/swim/

[loc07] locutor: An Ontology-Driven Management of Change (June 2007), http://www.kwarc.info/projects/locutor/

[LS99] Lassila, O., Swick, R.R.: Resource Description Framework (RDF) Model and Syntax Specification. W3C recommendation, World Wide Web Consortium (W3C) (1999), http://www.w3.org/TR/1999/REC-rdf-syntax

[LW91] Lave, J., Wenger, E.: Situated Learning: Legitimate Peripheral Participation (Learning in Doing: Social, Cognitive and Computational Perspectives S.). Cambridge University Press, Cambridge (1991)
[LWA08] Wissens- und Erfahrungsmanagement LWA (Lernen, Wissensentdeckung und Adaptivität) Conference Proceedings (2008)
[Mat07] Math Web Search (June 2007), http://kwarc.info/projects/mws/
[Mel01] Melis, E.: User model description. DFKI Report, DFKI (2001)
[MMK08] Müller, N., Müller, C., Kohlhase, M.: The math markup language toolkit (mmlkit) (June 2008), http://kwarc.info/projects/mmlkit
[Mül08a] Müller, C. (ed.): 2nd Workshop on Scientific Communities of Practice (SCooP-2008) (2008)
[Mül08b] Müller, C.: A Survey on Mathematical Notations (2008), http://kwarc.info/publications/papers/kw1_notationSurvey.pdf
[NK07] Normann, I., Kohlhase, M.: Extended formula normalization for ϵ-retrieval and sharing of mathematical knowledge. In: Kauers, M., Kerber, M., Miner, R., Windsteiger, W. (eds.) MKM/CALCULEMUS 2007. LNCS (LNAI), vol. 4573, pp. 266–279. Springer, Heidelberg (2007)
[OMB08] OMBase Project (April 2008), http://kwarc.info/projects/ombase/
[Ope08] OpenID: Shared Identity Service (June 2008)
[pan08] The panta rhei Project (2008), http://kwarc.info/projects/panta-rhei/
[pla07] PLATO: Interactive Mathematical Authoring (August 2007), http://www.ags.uni-sb.de/plato/bin/view.pl
[Rab08] Rabe, F.: Representing Logics and Logic Translations. PhD thesis, Jacobs University Bremen (to appear, 2008)
[sla08] slashdot (July 2008), http://slashdot.org/
[SW06] Smirnova, E., Watt, S.M.: Notation Selection in Mathematical Computing Environments. In: Proceddings Transgressive Computing 2006: A conference in honor of Jean Della Dora (TC 2006), Granada, Spain, pp. 339–355 (2006)
[Ver08] VeriFun, A.: verifier for functional programs (February 2008), http://www.verifun.de/
[Wen01] Wenger, E.: Supporting Communities of Practice: A Survey of Community-oriented Technologies, Report to the Council of CIOs of the US Federal Government (2001), http://www.ewenger.com/tech/
[Wen05] Wenger, E.: Communities of Practice in 21st-century organization (2005)
[Wik08] Wikipedia: Portfolio (aus Wikipedia, der freien Enzyklopädie) (2008), http://de.wikipedia.org/w/index.php?title=Portfolio&oldid=47657869
[WMS02] Wenger, E., McDermott, R.A., Snyder, W.: Cultivating of Communities of Practice. Harvard Business School Press (2002)
[WWSR05] Wenger, E., White, N., Smith, J.D., Rowe, K.: Technology for Communities (2005)

An Annotation-Based Access Control Model and Tools for Collaborative Information Spaces

Peyman Nasirifard, Vassilios Peristeras, and Stefan Decker

Digital Enterprise Research Institute, National University of Ireland, Galway, IDA Business Park, Lower Dangan, Galway, Ireland
firstname.lastname@deri.org

Abstract. We present an Annotation-Based Access Control model supported by a Collaboration Vocabulary (CoVoc) as a more flexible and user-centric access control approach in social platforms and shared workspaces. We present also briefly two SOA-based tools for enabling our approach: Uncle-Share is a gadget that provides annotation-based access control for bookmarks and uses CoVoc for annotating collaborative relationships. Who-With-Whom uses also CoVoc and visualizes extended social networks in order to help users to select the appropriate contacts to grant access to resources.

Keywords: Annotation, Access Control, Social Computing, Collaboration Vocabulary.

1 Introduction and Overview

In our real-life, we share the resources we own based on social acquaintances or credits that we give to people, with whom we communicate. As an example, we may share the keys of our apartments with our parents, but not with our friends, as we give more credits to our parents rather than friends. Access Control emerges almost together with the concept of sharing. In brief, Access Control defines Who can access What [1].

"Sharing" is a key concept for collaborative information spaces like Web 2.0 platforms (e.g. Flickr, YouTube, del.icio.us) and/or Collaborative Work Environments (CWE). These platforms and applications provide the infrastructure and services for different types of users to collaborate together and share resources which may vary from songs and photos to documents and calendars. In these Web-based environments of massive-scale sharing, access control takes interesting characteristics as poses additional requirements.

Our analysis and also some other works like [2] show that current access control mechanism within Web 2.0 platforms and shared workspaces suffer from fine-granularity. As an example, users are able to share a resource with some colleagues, but additional restrictions such as temporal, spatial, etc. can not be expressed. This shortcoming undermines the utility of shared workspaces and brings privacy-related issues in Web 2.0 platforms.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 51–60, 2008.

In this paper, we propose an annotation-based model to address access control requirements in social and collaborative platforms and implement our approach using Semantic Web [3] technologies (e.g. RDF) and social computing (annotations, social networks analysis, gadgets), two prominent paradigms in Web-based information systems development. More specifically, we present here:

- A model for access control which is applicable both in Web 2.0 platforms and shared workspaces.
- A vocabulary for annotating collaborative relationships amongst people.
- Software tools that implement this approach.

2 Background and Related Work

There are many different approaches and mechanisms for controlling access, e.g. role-based access control (RBAC) [4, 5], attribute-based access control [6], etc. Each approach has its own advantages, disadvantages and feasibility scope. Some researchers have tried to combine different access control mechanisms to build more powerful models.

The study of access control mechanisms in Cooperative Systems is not new and was in existence since the birth of e-Collaboration tools in 1980s. Shen et al. [7] studied access control mechanisms in a simple collaborative environment, i.e. a simple collaborative text editing environment. Zhao [8] provides an overview and comparison of three main access control mechanisms in collaborative environments. Tolone et al. [9] have published a comprehensive study on access control mechanisms in collaborative systems and compare different mechanisms based on multiple criteria, e.g. complexity, understandability, ease of use. Jaeger et al. [10] present basic requirements for role-based access control within collaborative systems. Gutierrez Vela et al. [11] try to model an organization in a formal way that considers the necessary elements to represent the authorization and access control policies. Kern et al. [12] provide an architecture for role-based access control to use different rules to extract dynamic roles. Alotaiby et al. [13] present a team-based access control which is built upon role-based access control. Periorellis et al. [14] introduce another extension to role-based access control which is called task-based access control. They discuss task-based access control as a mechanism for dynamic virtual organisation scenarios. Toninelli et al. [15] present an approach towards combining rule-based and ontology-based policies in pervasive environments. Demchenko et al. [16] propose an access control model and mechanism for grid-based collaborative applications. Massa et al. [17] use the dataset from Epinions.com to do computational experiments on employing global versus local trust metrics. They study the implications of controversial users in product rating community.

Social networks and their analysis have lots of potential in various domains, from learning [18] to knowledge management [19] and access control [20]. Social computing (the use of wikis, blogs, networking sites, collaborative filtering, and so on) helped to the birth of a new broad phase in knowledge management [21, 22]. In [23] a theoretical notion of virtual community is developed that is based on the idea of dynamic, self-organizing social systems. [24] investigates some studies of the concept of social networks through several different areas of interests, including the World Wide

Web and human and biological sciences in the economic arena. [25] discuss also the economic impact of social networks by studying a test bed from Google Answers, a fee-based knowledge market which was fully closed by late December 2006.

In the area of social acquaintances between people, various vocabularies have been proposed so far, like RELATIONSHIP [26] and REL-X [27]. We have used some concepts from RELATIONSHIP in our work however, these vocabularies have been mainly developed to be of general purpose and do not capture the specific relationships that exist in a collaborative working environment.

3 Annotation-Based Access Control

Annotation is a common mechanism which is used nowadays by social platforms for annotating shared informational resources and is based on mechanisms that allow users to describe resources with “tags”. In this way, users are allowed to attach metadata in commonly shared resources (social tagging). These tags later facilitate browsing and discovery of relevant resources. Annotation and tags are important mechanisms of what has been called Web 2.0 or Social Web.

Our access control model is based on annotations, too. End users are able to annotate their contacts (social network) and define policies for granting access to their resources based on these annotations. In this context, only those contacts that fulfill the required policies get access to specific resources. Annotation-based access control is very close to how we share resources in our real-life. We may share our credit card details with our parents, but not with our friends. Based on this simple scenario, in annotation-based access control, both our parents and friends are parts of our social network, but our parents have been tagged as *parent* and our friends have been tagged as *friend* and our credit card details are resources with a policy to be shared only with *parent*.

Our current access control model composes of three main entities and two main concepts: *Person*, *Resource*, and *Policy* are the three entities; *Annotation* and *Distance* are the two main concepts. A Person is an entity with the RDF type *Person*. A Person is connected to zero or more other Persons. A Person owns zero or more Resources. A Person defines zero or more Policies. An Annotation is a term or a set of terms that are connected together and aims to describe the Person. Each connection between Persons can be annotated with zero or more Annotations. A Resource is an entity with the RDF type *Resource* and is owned by (isOwnedBy) one or more Persons. Resources are in the form of URIs and/or short messages. A Resource can be either private or public. A private Resource has zero or more Policies, whereas a public resource has one or more Policies. A Policy is an entity with the RDF type *Policy*. A Policy is defined by (isDefinedBy) one Person and belongs to (belongsTo) one Resource. A Policy has one Annotation and one Distance. Again an Annotation is a term or a set of terms that are connected together and aims to describe the Person that the Resource should be shared with. A Distance is a numerical value which determines the *depth* that the Policy is valid. The depth is actually the shortest path among two Persons with consideration of Annotations.

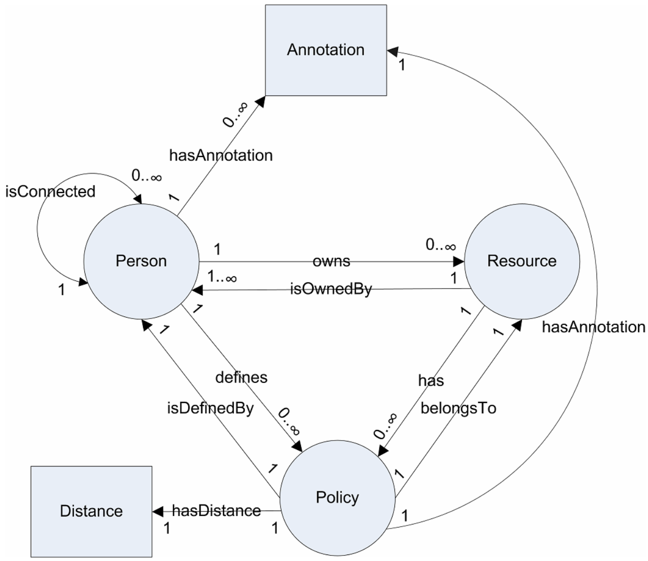


Fig. 1. Main elements in access control mechanism and their relationships

Fig. 1 demonstrates the elements and relationships of our access control model. The model becomes clearer with the use case scenario in the next part.

A Person acquires access to a Resource, if and only if (iff) s/he meets *all* policies that have been defined by Resource owner for that Resource. It means that the Person has been already annotated with the Annotations which are already defined in Policies and s/he is also in the scope of the Policies (i.e. Distance criteria).

3.1 Use Case Scenario

In order to clarify the concepts and make our model more understandable, we present a simple scenario. In our scenario, we have four users: Alice, Bob, Mary, and Tom. They perform the following actions:

Alice adds Bob to her contacts and annotates him with *collaborateWith* and *doResearchWith*. Alice adds also Mary to her contacts and annotates her as *director*. Alice owns three resources: *www.resource1.com*, *www.resource2.com* and *I_need_to_talk_to_you_please*. The latter resource is actually a short message but still remains a resource owned by Alice. Alice defines the following three policies:

- *policy1: collaborateWith:1* and *doResearchWith:1* for *www.resource1.com*;
- *policy2: collaborateWith:2* and *doResearchWith:2* for *www.resource2.com;*
- *policy3: director:1* for *I_need_to_talk_to_you_please* resource.

The numerical value which comes in policies after the annotation is the distance, i.e. the depth that the policy will be valid.

Bob adds Tom to his contacts and annotates him as *collaborateWith* and *doResearchWith*. He also adds Alice and annotates her as *student*. Bob owns also two resources: *www.resource4.com* and *www.resource5.com*. He defines the following policies for his resources:

- *policy4: collaborateWith:1* and *doResearchWith:1* for *www.resource4.com;*
- *policy5: student:1* for *www.resource5.com.*

Tom and Mary do not add any contacts or resources.

In this case, we have granted access to the followings persons/resources.

- Alice has access to her three resources and *www.resource5.com* via Bob, because *www.resource5.com* is accessible to the Bob's contacts that have been annotated as *student* and have maximum distance one to Bob and Alice fulfils this policy (see *policy5*).
- Bob has access to his two resources and also two of Alice's resources: *www.resource1.com* (see *policy1*) and *www.resource2.com* (see *policy2*).
- Tom has access to *www.resource4.com* which was shared via Bob to him (see *policy4*) and also *www.resource2.com* which was shared via Alice to him (see *policy2*).
- Mary will see the short message from Alice: *I_need_to_talk_to_you_please* (see *policy3*).

4 CoVoc: Suggesting Social Annotations

For annotating people and also defining policies, we like to create a tool to recommend/suggest terms to the users. These suggestions should come from a vocabulary. We developed the Collaboration Vocabulary (CoVoc) for this purpose.

In brief, CoVoc is a set of terms that covers various collaborative relationships and social acquaintances that exist between individuals (collaborative users) in a collaborative environment. For developing CoVoc we studied more than forty ontologies from SchemaWeb[1], as they appear relevant to collaboration. We also looked at detailed Curriculum Vitae (CV) of around thirty researchers, Ph.D. and M.Sc. students to determine what they perform together with other people in their professional (research) lives. The researchers came from different computer science areas.

The terms included in the current version of CoVoc follow on two broad categories:

- Terms which are directly related to relationships between persons. These are terms that describe actual relationships between two persons that collaborate (e.g. writeDocumentWith).
- Terms which are related to personal characteristics that acquire interest for the users in a collaborative context (e.g. supervisor). In other words, these are attributes of the entities that somehow influence the relationship of the entity with other external entities.

This latter category ideally should not be part of a Collaboration Vocabulary, as it covers personal characteristics that exist at the user profile and not at the relationship layer. These characteristics should have been stored and thus become available through formal user profiles (e.g. FOAF extensions that cover additional

[1] http://www.schemaweb.info/

collaboration-related personal characteristics). But due to the lack of such profiles, we have included these terms in CoVoc in order to allow users to annotate their relationships using them. We developed a RDF Schema for CoVoc. Due to the space limitation, we do not present the details here. The CoVoc terms and its schema are accessible online[2].

5 Tools and Implementation Issues

To enable and evaluate the above access control model, we have developed some tools that are presented in this part. Both tools (Uncle-Share and Who-With-Whom) and their documentation are accessible online[2].

5.1 Uncle-Share: Annotation-Based Access Control Tool

To enable annotation-based access control, we have developed Uncle-Share. Uncle-Share has been developed as a gadget. Having this application as a gadget enables end users to use Uncle-Share together with other applications something that increases the tool's usability, as users don't have to launch a new application or browse a new Web page to utilize Uncle-Share. In particular, we decided to use iGoogle for developing our gadget, as Google provides sufficient documentation and support for developing gadgets; however, our gadget can be embedded into any other widget/gadget platform or Web site. The only client-side requirement is that the browser should support

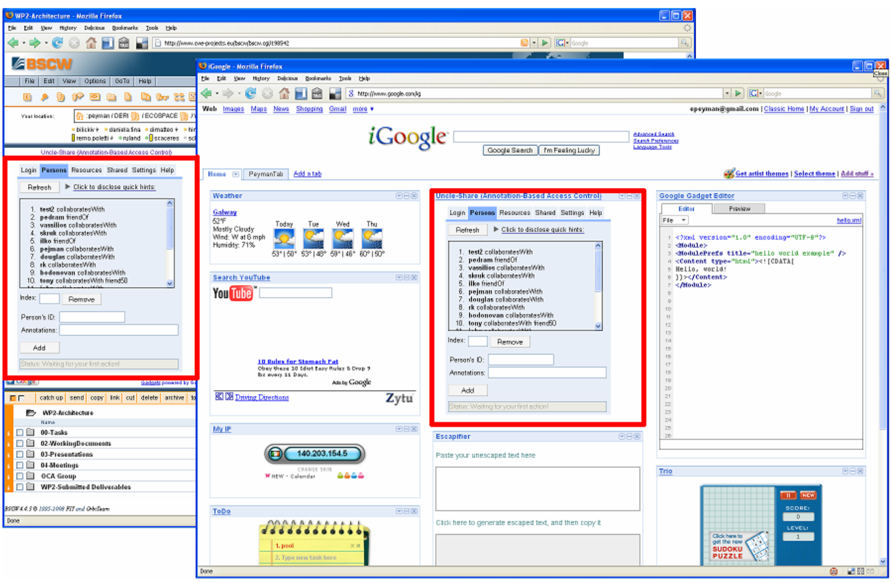


Fig. 2. Embedding Uncle-Share into iGoogle and BSCW shared workspace

[2] http://purl.oclc.org/projects/phd

JavaScript. The tool fully supports scenarios like the one described in previous sections and successfully executes all the policies defined there. Figure 2 demonstrates the embedded Uncle-Share within iGoogle and BSCW shared workspace.

We have developed Uncle-Share as a Service-Oriented Architecture (SOA) application. All functionalities of Uncle-Share (registration, changing password, adding persons and resources, fetching shared resources, etc.) are wrapped as services. This approach enables developers to utilize all Uncle-Share's functionalities within their own separate applications, ensuring reusability and interoperability with various platforms.

We used Sesame[3] 2.0 as RDF repository to store the generated RDF triples. The SOA backbone is based on Apache CXF[4] which eases the development of Web services. For building the AJAX-based gadget, we used Google Web Toolkit[5].

5.2 Who-with-Whom: Visualizing Social Networks

Who-With-Whom is a simple prototype that visualizes the annotated social networks based on CoVoc terms. The visualization is a means that helps users to choose/come up with the appropriate persons that should be granted access to resources. We used *Graph Gear*[6] for visualizing the graphs which is based on Adobe Flash. Who-With-Whom uses Sesame RDF store as input. It fetches the RDF triples that are related to a specific CoVoc term and transforms them into the appropriate input which feeds Graph Gear. If the users' photos were already stored in the repository, it will be shown in the graph as well. Figure 3 demonstrates a snapshot of Who-With-Whom.

6 Discussions and Comparisons

The main difference between RBAC [4, 5] and our approach is that in RBAC, the roles are already defined by a role engineer, but in our approach, we have decentralized concepts (i.e. annotations) which are not necessary roles (from the semantics point of view). It is the user that defines his/her own annotations and assigns them to his/her contacts which is more user-centric. From the RBAC perspective, our model can be seen as an extension to RBAC through assigning user-centric roles (i.e. annotations) to a person's contacts. The other main difference is the concept of Distance which increases or decreases the scope of policies in sharing resources, as the people are connected together in a graph-like manner (rather than hierarchy-like manner). Where RBAC can be very useful in large and well-structured organizations, our approach fits well for defining access control policies for personal data.

In our model, all relationships are private, as there is no need to publicly announce the relationships between people. End users can freely publish their own relationships, if this is needed. While fixed vocabulary are used in approaches like [28], in our model and tools, fixed terms are just suggested to end users, as we do not really force users to exclusively use them. They are allowed to use their own terms as well as

[3] http://www.openrdf.org/
[4] http://incubator.apache.org/cxf/
[5] http://code.google.com/webtoolkit/
[6] http://www.creativesynthesis.net/blog/projects/graph-gear/

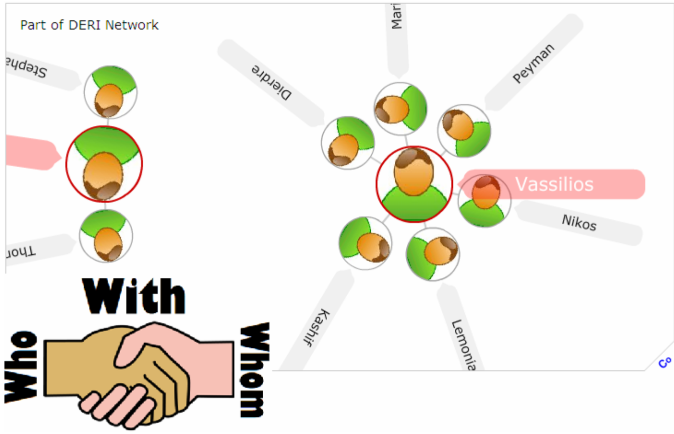


Fig. 3. A snapshot of Who-With-Whom

fixed terms for annotations. This open vocabulary approach enables end users to express the trust level in a more natural way as well. As an example, instead of using percentage for expressing the trust level (e.g. *friend 80%*) like in [20], end users can express degrees of friendship in a more natural way with an annotation like *closeFriendOf*. The model becomes in this way more realistic, as we don't really label our friends in real-life with numerical values. Moreover, we calculate the distance between two persons taking into account the annotation value. For example, if person A is connected to person B and this connection has the annotation *student*, the distance from person A to B (directional) with the consideration of *student* is one. The distance from person A to B (directional) with the consideration of any other annotations (e.g. friendOf) is infinity. The distance from person B to A (directional) is also infinity, because person B has no outgoing link to person A.

7 Conclusion and Future Work

In this paper, we presented an annotation-based access control model, a vocabulary for annotating collaborative users and tools to define and visualize access policies for information resources we own. This approach is applicable in multiple Web-based collaborative information spaces like Web 2.0 social platforms (e.g. Flickr, YouTube, del.icio.us) and/or Collaborative Work Environments (CWE). Our model can be seen as an extension of role-based access control, where people are able to define their own roles and assign them to others in a user-centric model.

We plan to extend our work in several directions: The current access control model that we propose here is not context-aware as it lacks context characteristics. We want to extend the model in order to include context information. For this, we plan to build a simple mashup to fetch context information of users from their Micro-blogs like Twitter . This can be done via defining a fixed set of terms for context or via natural language processing.

Another interesting extension is to use Open Social API to embed the tools into social networking sites like MySpace and Orkut. Open Social follows the idea of *Write once, run anywhere* and enables developers to develop cross-platform applications among social Web sites.

More advanced user models, suggestions/recommendations for access policies, and access policy prioritization are additional possible future improvements.

Acknowledgements

This work is partially supported by the Ecospace project: FP6-IST-5–35208 and the Lion project supported by Science Foundation Ireland under Grant No. SFI/02/CE1/I131.

References

1. Russell, D., Gangemi Sr., G.T.: Computer Security Basics. O'Reilly and Associates, Sebastopol (1991)
2. Hart, M., Johnson, R., Stent, A.: More Content - Less Control: Access Control in the Web 2.0. in Web 2.0 security and privacy issues. In: IEEE Symposium on Security and Privacy (2007)
3. Berners-Lee, T., Hendler, J., Lassila, O.: The Semantic Web, A new form of Web content that is meaningful to computers will unleash a revolution of new possibilities. Scientific American (2001)
4. Ferraiolo, D.F., Kuhn, D.R.: Role Based Access Control. In: 15th National Computer Security Conference (1992)
5. Sandhu, R.S., Coyne, E.J., Feinstein, H.L., Youman, C.E.: Role-Based Access Control Models. IEEE Computer 29(2), 38–47 (1996)
6. Kolter, J., Schillinger, R., Pernul, G.: A Privacy-Enhanced Attribute-Based Access Control System. In: DBSec. 2007. Springer, Heidelberg (2007)
7. Shen, H., Dewan, P.: Access Control for Collaborative Environments. In: Computer-Supported Cooperative Work Conference. ACM Press, New York (1992)
8. Zhao, B.: Collaborative Access Control. In: Seminar on Network Security (2001)
9. Tolone, W., Ahn, G., Pai, T., Hong, S.: Access control in collaborative systems. ACM Computing Surveys 37, 29–41 (2005)
10. Jaeger, T., Prakash, A.: Requirements of role-based access control for collaborative systems. In: 1st ACM Workshop on Role-based access control. ACM Press, New York (1996)
11. Gutierrez Vela, F.L., Isla Montes, J.L., Paderewski, P., Sanchez, M.: Organization Modelling to Support Access Control for Collaborative Systems. In: Software Engineering Research and Practice (2006)
12. Kern, A., Walhorn, C.: Rule support for role-based access control. In: 10th ACM symposium on Access Control Models and Technologies. ACM Press, New York (2005)
13. Alotaiby, F.T., Chen, J.X.: A Model for Team-based Access Control. In: International Conference on Information Technology: Coding and Computing. IEEE Computer Society, Los Alamitos (2004)
14. Periorellis, P., Parastatidis, S.: Task-Based Access Control for Virtual Organizations. In: Scientific Engineering of Distributed Java Applications (2005)

15. Toninelli, A., Bradshaw, J., Kagal, L., Montanari, R.: Rule-based and Ontology-based Policies: Toward a Hybrid Approach to Control Agents in Pervasive Environments. In: Semantic Web and Policy Workshop (2005)
16. Demchenko, Y., Gommans, L., Tokmakoff, A., van Buuren, R.: Policy Based Access Control in Dynamic Grid-based Collaborative Environment. In: International Symposium on Collaborative Technologies and Systems. IEEE Computer Society, Los Alamitos (2006)
17. Massa, P., Avesani, P.: Trust Metrics on Controversial Users: Balancing Between Tyranny of the Majority and Echo Chambers. International Journal on Semantic Web & Information Systems 3(1), 39–64 (2007)
18. Hoogenboom, T., Kloos, M., Bouman, W., Jansen, R.: Sociality and learning in social software. International Journal of Knowledge and Learning 3(4-5), 501–514 (2007)
19. Chatti, M.A., Jarke, M., Frosch-Wilke, D.: The future of e-learning: a shift to knowledge networking and social software. International Journal of Knowledge and Learning 3(4-5), 404–420 (2007)
20. Kruk, S.R., Grzonkowski, S., Gzella, A., Woroniecki, T., Choi, H.C.: D-FOAF: Distributed Identity Management with Access Rights Delegation. In: Asian Semantic Web Conference (2006)
21. Liu, H., Maes, P.: Introduction to the Semantics of People & Culture. International Journal on Semantic Web and Information Systems, Special Issue on Semantics of People and Culture 3(1), i–ix (2007)
22. Davies, J., Lytras, M., Sheth, A.P.: Guest Editors' Introduction: Semantic-Web-Based Knowledge Management. IEEE Internet Computing 11(5), 14–16 (2007)
23. Fuchs, C.: Towards a dynamic theory of virtual communities. International Journal of Knowledge and Learning 3(4-5), 372–403 (2007)
24. Ehrlich, D.M.: Social network survey paper. International Journal of Learning and Intellectual Capital 3(2), 167–177 (2006)
25. Rafaeli, S., Raban, D.R., Ravid, G.: How social motivation enhances economic activity and incentives in the Google Answers knowledge sharing market. International Journal of Knowledge and Learning 3(1), 1–11 (2007)
26. Davis, I., Vitiello Jr., E.: RELATIONSHIP: A vocabulary for describing relationships between people (2005), `http://vocab.org/relationship/`
27. Carminati, B., Ferrari, E., Perego, A.: The REL-X vocabulary. OWL Vocabulary (2006), `http://www.dicom.uninsubria.it/~andrea.perego/vocs/relx.owl`
28. Carminati, B., Ferrari, E., Perego, A.: Private Relationships in Social Networks. In: ICDE Workshops (2007)

Attributions of Human-Avatar Relationship Closeness in a Virtual Community

Yi Zhao and Weiquan Wang

Department of Information Systems, City University of Hong Kong
83 Tat Chee Avenue, Kowloon, Hong Kong
{yizhao,weiquan}@cityu.edu.hk

Abstract. As avatars have become increasingly used in virtual communities (VCs) to provide users with a more natural and favorable online experience, promoting a close human-avatar relationship has been a necessity to the sustainable development of VCs. In this study, we intend to explore users' attributions of human-avatar relationship closeness in VCs. We conceptualize human-avatar relationship closeness as composed of activity diversity, interaction frequency, and relational influence, and identify its antecedents (i.e., perceived needs fulfillment, irreplaceableness, resource investment) by extending theories in an interpersonal domain into a human-artifact interaction domain. The hypothesized model is empirically tested through an online survey in the specific context of Second Life (SL), a popular virtual community (VC), and we find that people's perceived needs fulfillment has positive effects on relational influence, perceived relationship irreplaceableness has positive effects on activity diversity and relational influence, while perceived resource investment positively associates with all three dimensions of human-avatar relationship closeness.

Keywords: virtual community; Second Life; human-avatar relationship; relationship closeness; human-computer interaction.

1 Introduction

Avatars have become increasingly used in virtual communities (VCs) to provide users with a more natural and favorable online experience. When interacting with avatars, people treat avatars as social actors rather than tools that mediate the human-human interaction; rules guiding interpersonal interaction are also applicable to the human-avatar interaction [1]. Therefore, in VCs using avatars, the traditional human-human interaction mode has been replaced by the *human-avatar* interaction through which people form relationships with avatars. Parallel to the importance of a close interpersonal relationship in the real world, a close human-avatar relationship is vital to a VC's success. Although the attributions of interpersonal relationship closeness have been widely studied [2], few prior studies have explored the attributions of human-avatar relationship closeness. Whether findings in the interpersonal relationship closeness domain are also applicable to the relatively new context of human-avatar interaction remains a question. Thus, this research aims to explore the factors that

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 61–69, 2008.

influence the closeness of people's relationships with avatars in a VC by borrowing theories in an interpersonal domain and taking the specific features of human-avatar interaction into account. The research topic is important because it will shed light on how to design a VC to promote close human-avatar relationships, which contributes to the development of social networks in the VC.

The context of this research is Second Life (SL), a 3D VC established in 2003. The population in SL is composed of more than *13000000* unique avatars [3], and every real person is represented by an avatar, an artifact created and controlled by the real person. SL is an independent social system in which you will see residents, estates, currency, shopping malls, schools, etc. In April, 2008, 19083327 transactions were made and 56930 users earned revenue through SL [3]. People form relationships with different avatars, which are the basis of this virtual social system. With the aid of these relationships, individuals are able to achieve a wonderful experience in the VC, while firms are provided with valuable opportunities to do businesses and create revenues. Therefore, the fulfillment of these goals depends, to a large extent, on the establishment of close human-avatar relationships.

In this study, attributions of human-avatar relationship closeness were identified by extending Rusbult et al's investment model in the interpersonal domain [2]. The significance of these attributions together with the closeness of human-avatar relationships was assessed with Likert-type scales. Furthermore, a structural equation modeling technique was adopted to analyze the causal strengths of these attributions. Findings of this research are expected to enrich the theories on relationship closeness and provide guidelines for practitioners to design effective human-computer interactions and comfortable user experiences in VCs.

2 Literature Review and Hypotheses Development

Relationship closeness is quite complex [4]. It is proposed that a close relationship should have four characteristics: (1) the relationship partners have frequent impact on each other; (2) the degree of the impact should be strong; (3) the impact should involve a variety of activities; and (4) the above three characteristics should exist for a long period [5]. Based on this conceptualization, scholars have identified three dimensions of relationship closeness: interaction frequency, activity diversity, and relational strength [4]. Frequency means the time relationship partners use to interact with each other during a fixed period. Diversity refers to the number of activity domains relationship partners engage in. Strength indicates the extent to which the relationship partners influence each other's daily behavior, decisions, life, etc. In this research, we adapted this three-dimensional model and contended that the closeness of a human-avatar relationship comprises three dimensions: interaction frequency, activity diversity, and relational influence.[1]

Generally, a relationship needs maintaining and is gradually getting closer and closer with its continuity and improvement. People's actions to continue and improve their current relationships are mainly determined by their *intentions* to do so [6],

[1] In this research, the term "influence" is used instead of strength. Because the original term "strength" actually deals with the influence of the relationship, the term "influence" is more straightforward and pertinent to its underlying meaning.

which is identical to the definition of interpersonal relationship commitment [7]. Based on this logic, human-avatar relationship closeness is mainly determined by people's relationship *commitment* with the avatar. Many prior studies have examined the antecedents of interpersonal relationship commitment [2, 8-10], and after a review of these studies, we found that the investment model of interpersonal relationship commitment is the most comprehensive and integrates all the antecedents identified before [2]. This model has also been empirically supported [11]. The model includes satisfaction level, quality of alternatives and investment size as the three determinants of interpersonal relationship commitment. Satisfaction is an overall evaluation of one's experience in a relationship; alternatives refer to options of relationships with other entities that can replace the current relationship with an entity; investment means the resources people invest in that relationship. In this study, we adapted the investment model in the context of human-avatar relationship and contended that people's perceived needs fulfillment, perceived relationship irreplaceableness, and perceived resource investment contribute collaboratively to the human-avatar relationship closeness.

Perceived needs fulfillment is defined as the extent to which a person perceives that his or her needs are satisfied in the interaction with an avatar.[2] This determinant is judged on the individual's former interaction experience with the avatar and is an overall evaluation of the experience. People interact and form relationships with others for different purposes, among which, to acquire a sense of inclusion, sense of control, and sense of affection are the three most fundamental needs of people involved in an interpersonal relationship [8, 9]. In the human-avatar domain, people interact with avatars as if they were real people, especially in SL where the real community is sophisticatedly simulated, and treat the human-avatar relationships as interpersonal relationships unconsciously [12]. Thus, people seek to acquire a sense of being included in the relationship with other avatars (sense of inclusion), a sense of having control over others in the interaction (sense of control), and a sense of getting affection from others (sense of affection).

Relationship formation is a dynamic process [7], which emerges from people's interaction with an avatar. During this process, people evaluate the outcomes of the interaction, that is, whether their needs have been well met, and gradually form an impression on the relationship. The more positive the impression, the more willing people will continue to sustain and enhance the relationship and the more committed the human-avatar relationship will be. The human-avatar relationship commitment further contributes to human-avatar relationship closeness which contains three dimensions: frequency, diversity, and influence.

Since people are prone to make decisions based on their prior experience, if a person's needs are well met in the relationship with a certain avatar, he or she is likely to resort to the avatar when encountering the same needs. When engaging in new activities, the person may also believe that the avatar has the comparable capabilities to satisfy his or her new needs. Also, in this case, people will heavily rely on the avatar, which imposes an influence on them. So, it is proposed that:

---

[2] In this research, the term "perceived needs fulfillment" is used instead of "satisfaction level" in the investment model, because the original term "satisfaction level" actually deals with the fulfillment of people's needs in the relationship.

H1a: Perceived needs fulfillment has a positive effect on the activity diversity of human-avatar relationship.

H1b: Perceived needs fulfillment has a positive effect on the interaction frequency of human-avatar relationship.

H1c: Perceived needs fulfillment has a positive effect on the relational influence of human-avatar relationship.

Perceived Relationship Irreplaceableness refers to the extent to which a person feels that his or her relationship with a certain avatar can be replaced by those with other avatars. When people believe that alternatives to their relationship with the avatar are easy to find elsewhere in a VC, they will probably not cherish it or take efforts to maintain it; when people feel that the relationship cannot be easily replaced, they may be forced to stay in it reluctantly even if their needs are not fully satisfied. Thus, we contend that perceived relationship irreplaceableness will promote relationship commitment which further contributes to human-avatar relationship closeness. When a certain human-avatar relationship is perceived to be irreplaceable, people will more cherish it and be eager to sustain it. Interacting more frequently and involving in more diverse activities are two ways to sustain the relationship. Also, under this circumstance, people will be locked in that relationship due to the lack of alternatives, which will influence their lives and decision makings. So, we propose that:

H2a: Perceived relationship irreplaceableness has a positive effect on the activity diversity of human-avatar relationship.

H2b: Perceived relationship irreplaceableness has a positive effect on the interaction frequency of human-avatar relationship.

H2c: Perceived relationship irreplaceableness has a positive effect on the relational influence of human-avatar relationship.

Perceived Resource Investment refers to the degree to which an individual thinks that he or she has put many resources in the relationship with a certain avatar. If an individual has put considerable resources in the relationship with an avatar, the potential loss cannot be ignored when deciding to quit the relationship, which constraints people from leaving the relationship and prevents the human-avatar relationship commitment from declining [10]. When people have put many resources in the relationship with a certain avatar, they are likely to expect a high return. In order to obtain the return, they have to sustain the relationship first, which can be achieved by interacting with the avatar more frequently and engaging in more diverse activities. Moreover, when people invest more resources in certain relationships, they will values these relationships more. As a result, people's decision making will be more influenced by such relationships. Therefore, we propose that:

H3a: Perceived resource investment has a positive effect on the activity diversity of human-avatar relationship.

H3b: Perceived resource investment has a positive effect on the interaction frequency of human-avatar relationship.

H3c: Perceived resource investment has a positive effect on the relational influence of human-avatar relationship.

3 Methodology

3.1 Procedures

In order to test the hypotheses, an online survey was conducted. Survey invitations were posted at several online SL forums and distributed through a few SL mailing lists. Subjects were required to think of an avatar that they had contact with recently and still wanted to maintain a relationship with. The questionnaire included statements about the closeness of the relationship and subjects should indicate their levels of agreement, it also included specific reasons for relationship closeness and subjects should indicate the salience of each reason. The data collected were analyzed using partial least squares (PLS), implemented in PLS 13.0.

3.2 Measures

In this study, we needed to measure the three constructs of human-avatar relationship closeness and their three hypothesized antecedents. However, no suitable measurement scales were available for our research context; thus, we developed items for all six constructs. After an initial items pool was created, all the items went through two rounds of card sorting for further adjustments [13]. After the two rounds of sorting, 26 items were finalized for all six constructs. All the constructs were measured by reflective items except perceived needs fulfillment. Because each of the three basic needs describes only one aspect of people's relationship needs, perceived needs fulfillment was measured by formative indicators as a second order construct, which consists of three first order subconstructs (sense of inclusion, affection, and control) evaluated by reflective items [14].

4 Results

A total of 171 complete responses were received during a period of two months. Three responses were excluded due to the duplication of IP addresses, while another 17 responses were also deleted due to these subjects' obviously not taking the questionnaire seriously, i.e. the response time was too short or too long. Therefore, 151 answers remained as valid responses for data analyses.

4.1 Measurement Model

Since both reflective and formative indicators were adopted, we used different evaluation criteria for these two kinds of measures. For constructs using reflective items, we assessed them by internal consistency, discriminant validity, and individual item reliability [15]. Internal consistency was evaluated by the composite reliability of each latent variable, and composite reliabilities of all the constructs were above the 0.70 threshold (Table 1) [15]. Discriminant validity was verified by two criteria. First, the square root of average variance extracted (AVE) for each construct is larger than its correlations with all the other constructs (Table 1). Second, the loading of each item on its target construct is larger than its cross-loadings on other constructs (Table 2). Individual item reliability was checked by examining the factor loading of each item on their respective latent variables, and loadings of all the items were above the rule of thumb, 0.707 (Table 2) [15]. Thus, all the scales using reflective indicators were reliable and valid.

For perceived needs fulfillment which was a second order construct and utilized formative indicators, we based the assessment of this construct on Diamantopoulos and Winklhofer's procedures [14]. Actually, content specification and indicator specification had already been checked during the initial items pool generation and sorting procedures to make sure that the scope of the construct was clear and the indicators covered the full range of the construct. Variance inflation factor (VIF) of each indicator in this construct was calculated as a measurement of multi-collinearity. The VIF for all the items were in the range, 1.409 to 2.662, all below the widely used cut-off value of 10 [14].

Table 1. Composite reliabilities and correlations of constructs. (*square root of average variance extracted (AVE)).

Constructs	Composite Reliability	Diversity (DVS)	Frequency (FRQ)	Influence (IFL)	Perceived Relationship Irreplaceableness (IRP)	Perceived Resource Investment(IVS)
DVS	0.874	0.796*				
FRQ	0.942	0.483	0.897*			
IFL	0.908	0.483	0.565	0.876*		
IRP	0.936	0.458	0.424	0.590	0.843*	
IVS	0.880	0.491	0.639	0.660	0.692	0.912*

Table 2. Loadings and cross loadings of measures

Items	DVS	FRQ	IFL	IRP	IVS
DVS1: The type of activities I took part in with this avatar is diverse.	**0.825**	0.500	0.464	0.395	0.496
DVS2: When I interact with this avatar, we usually engage in different activities.	**0.827**	0.361	0.357	0.422	0.438
DVS3: Normally, I interact with this avatar in only one activity.	**0.792**	0.377	0.401	0.366	0.313
DVS4: When I interact with this avatar, we usually engage in the same activity.	**0.738**	0.229	0.276	0.214	0.228
FRQ1: I often interact with this avatar.	0.498	**0.956**	0.557	0.440	0.621
FRQ2: I interact with this avatar many times per week.	0.421	**0.899**	0.529	0.375	0.583
FRQ3: I interact with this avatar frequently.	0.490	**0.963**	0.540	0.418	0.617
FRQ4: I seldom interact with this avatar.	0.292	**0.752**	0.380	0.266	0.451
INFL1: This avatar has significant influence on my life.	0.508	0.525	**0.924**	0.567	0.643
INFL2: This avatar influences the way I handle my work or life.	0.429	0.467	**0.885**	0.504	0.532
INFL3: My life will not be influenced if my relationship with this avatar is suspended.	0.319	0.491	**0.815**	0.482	0.556
IRP1: Currently, there is no other avatar that can replace this avatar in my relationship network in Second Life.	0.424	0.427	0.547	**0.903**	0.645
IRP2: I cannot find a new avatar as an alternative to this avatar.	0.373	0.265	0.434	**0.814**	0.513
IRP3: For me, this avatar is unique and is difficult to find elsewhere.	0.358	0.362	0.509	**0.809**	0.582
IVS1: I have put much time in the relationship with this avatar.	0.419	0.561	0.617	0.676	**0.898**
IVS2: I have put much effort in the relationship with this avatar.	0.442	0.620	0.614	0.606	**0.912**
IVS3: I have taken great effort to establish and maintain the relationship with this avatar.	0.482	0.563	0.579	0.612	**0.924**

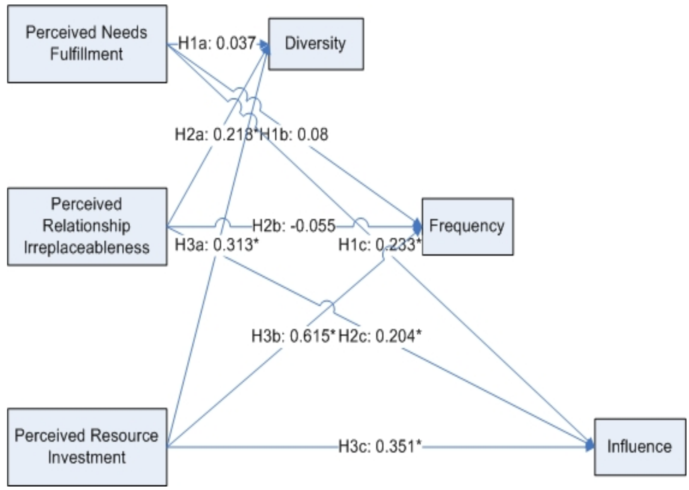


Fig. 1. Structural model results. (*significance level: $p < 0.05$).

4.2 Structural Model

The path coefficient for each hypothesized path and its significance level are reported in Fig. 1. H1c, H2a, H2c, H3a, H3b, and H3c are all supported, while H1a, H1b, and H2c are not. Perceived needs fulfillment has a positive effect on the influence of human-avatar relationship, while it does not exert any significant influence on diversity or frequency; perceived relationship irreplaceableness has a positive impact on diversity and influence, while it does not have a significant influence on frequency; perceived resource investment has a positive effect on all three human-avatar relationship dimensions.

5 Discussion

5.1 Discussion of Findings

This study investigated users' attributions of *human-avatar* relationship closeness. Based on the theory of social response [12], we extended findings in interpersonal relationship closeness into the domain of *human-avatar* relationship. As was theoretically predicted, empirical evidence confirmed that human-avatar relationship closeness, which involves the activity diversity, interaction frequency, and relational influence, can be largely attributed to people's perceived needs fulfillment, relationship irreplaceableness, and resource investment. Nevertheless, differences between our expectations and the empirical results are that (1) the association between diversity and perceived needs fulfillment does not exist and (2) interaction frequency can be attributed to neither perceived needs fulfillment nor perceived relationship irreplaceableness. One possible explanation is the special context of the VC. Although SL utilizes many advanced virtual reality technologies to simulate the real community and provides numerous facilities for people to act as in real life, a great discrepancy still exists between a real community and a VC. In a VC, however perfectly it is designed and implemented in terms of simulation technology, people's activities in it are still quite limited compared with those in a real community. For instance, people may have dinners and enjoy delicious food with friends in real life, but in a VC, people are not able to do so. Since these two worlds can never be exactly the same, even if an individual's needs are highly satisfied and he or she is extremely willing to engage in more diverse activities with the avatar, he or she may not be able to do so due to the limitations of the VC. Moreover, today's real life is full of competition and pressure, and people are always very busy, especially for the mid-aged which is the majority of our sample (54.30%). As a result, people may not have enough time to completely enjoy their lives in the VC. Therefore, even if people really intend to or have to interact with an avatar more frequently, they may fail to spare enough time from their challenging real life activities to do so.

5.2 Implications

Theoretically, the successful identification of the three attributions of human-avatar relationship closeness enriched the theories on relationship closeness. Prior theories always focused on interpersonal interaction, while this research extended those interpersonal-oriented findings into the context of *human-computer interaction*. When interacting with avatars, people form relationships with them, and these relationships are direct and social in nature [12]. Our study not only further demonstrated it, but also found something unique for human-computer interaction. Unlike the situation in interpersonal interaction, the activity diversity and interaction frequency of a human-avatar relationship cannot be so easily induced as relational influence probably due to the limitations of the VC and the fast pace of modern society.

Practically, findings of this research provided some guidelines for designing effective human-computer interactions and comfortable user experience in VCs. Some useful strategies were indicated to promote a close human-avatar relationship, especially for those who intend to conduct e-businesses in a VC with the aid of avatars. A close human-avatar relationship can be acquired by satisfying people's needs including the sense of control, affection, and inclusion, making the avatar unique so that it cannot be easily replaced or encouraging people to invest more resources in the relationship. Management can decide their marketing strategies based on these three aspects. Additionally, by evaluating and monitoring the levels of these three antecedents, practitioners are able to predict people's relationship closeness with the avatar, and thus, adjustments can be made dynamically and immediately in order to achieve a close human-avatar relationship which is helpful in enhancing customer involvement and loyalty in e-businesses.

5.3 Limitations and Future Research

A few limitations were involved in this research. First, the conclusions in this research were drawn in the specific context of SL. However, other types of VCs, such as online discussion forums and weblogs, and other VCs of the same type, such as There and Active Words also exist. Whether our findings in this study are applicable in these VCs still remains a question. Actually, SL is a sophisticated VC that simulates the real community, but others such as online discussion forums are not so sophisticated. Hence, further research is encouraged to generalize our findings to other contexts. Second, in VC, there are many types of human-avatar relationships, such as romantic relationships and seller-buyer relationships. People are likely to make different attributions of relationship closeness for different types of relationships due to their distinct natures. However, in this study, we just investigated the human-avatar relationship as a whole and did not differentiate between diverse types of relationships. Whether the attributions drawn from this research can be applied to all specific kinds of human-avatar relationships needs further exploration.

References

1. Wang, W., Benbasat, I.: Attributions of Trust in Decision Support Technologies: A Study of Recommendation Agents for E-Commerce. Journal of Management Information Systems 24, 249–273 (2008)
2. Rusbult, C.E., Wieselquist, J., Foster, C.A., Witches, B.S.: Commitment and Trust in Close Relationships: An Interdependence Analysis. In: Adams, J.M., Jones, W.H. (eds.) Handbook of Interpersonal Commitment and Relationship Stability. Kluwer Academic / Plenum Publishers, New York (1999)
3. Linden Research Inc., `http://secondlife.com/whatis/economy_stats.php`
4. Berscheid, E., Snyder, M., Omoto, A.M.: The Relationship Closeness Inventory: Assessing the Closeness of Interpersonal Relationships. Journal of Personality and Social Psychology 57, 792–807 (1989)
5. Kelley, H.H., Berscheid, E., Christensen, A., Harvey, J.H., Huston, T.L., Levinger, G., Mcciintock, E., Peplau, L.A., Peterson, D.R.: Close Relationships. W.H. Freeman, New York (1983)
6. Ajzen, I.: The Theory of Planned Behavior. Organizational Behavior and Human Decision Procedures 50, 179–211 (1991)
7. Ballard-Reisch, D.S., Weigel, D.J.: Communication Process in Marital Commitment. In: Adams, J.M., Jones, W.H. (eds.) Handbook of Interpersonal Commitment and Relationship Stability. Kluwer Academic / Plenum Publishers, New York (1999)
8. Schutz, W.: The Interpersonal Underworld. Science & Behavior Books, Palo Alto (1966)
9. Corrigan, M.W.: Social Exchange Theory, Interpersonal Communication Motives, and Volunteerism: Identifying Motivation to Volunteer and the Rewards and Costs Associated. Department of Communication Studies, 67 pages. West Virginia University, Morgantown (2001)
10. Bendapudi, N., Berry, L.L.: Customers' Motivations for Maintaining Relationships with Service Providers. Journal of Retailing 73, 15–37 (1997)
11. Le, B., Agnew, C.R.: Commitment and Its Theorized Determinants: A Meta-Analysis of the Investment Model. Personal Relationships 10, 37–57 (2003)
12. Reeves, B., Nass, C.I.: The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places. CSLI Publications, Stanford (1996)
13. Moore, G.C., Benbasat, I.: Development of an Instrument to Measure the Perception of Adoption an Information Technology Innovation. Information Systems Research 2, 192–222 (1991)
14. Diamantopoulos, A., Winklhofer, H.M.: Index Construction with Formative Indicators: An Alternative to Scale Development. Journal of Marketing Research 38, 269–277 (2001)
15. Barclay, D., Higgins, C., Thompson, R.: The Partial Least Square (Pls) Approach to Casual Modeling: Personal Computer Adoption and Use as an Illustration. Technology Studies 2, 285–309 (1995)

Modelling an Environmental Knowledge-Representation System

Nicolas Padilla[1], Luis Iribarne[1], Jose A. Asensio[1], Francisco J. Muñoz[1], and Rosa Ayala[2]

[1] Applied Computing Group, University of Almeria, Spain
[2] Computers and Environmental Group, University of Almeria, Spain

Abstract. *Environmental Management Systems* (EMS) are social-technical systems with a variety of final users and actors that cooperate with each other and interact with the system for decision-making, problems resolution, etc. The modelling of these systems using formal methods provides mechanisms and tools that guarantee the users a correct deployment and use of it. In this paper we showing environmental knowledge modelling accomplished in the SOL-ERES project, a spatio-temporal information system for environmental management, a cooperative system based on multi-agent architectures and intelligent agents. The system modelling uses UML for knowledge representation, and *Model-Driven Engineering* (MDE) perspective —based on the OMG classical *Model-driven Architecture* (MDA)— to create OWL/XML ontology automatically.

Keywords: Ontology, Knowledge modelling, Environmental Management Systems, OWL, UML.

1 Introduction

Environmental Management Systems (EMS) —used for specific behaviors of soil or planning management of natural resources— are social-technical systems with a variety of final users (i.e., politicians, technicians, administrators, etc.) that cooperate with each other and interact with the system for decision-making, problems resolution, etc. The systems specification for support to the groups needs a different orientation that when we specify systems for individual use, given the social fragility that sustains them and the organization of the work that takes place. Therefore, if we want to guarantee the success of their users everyday activities, the systems design must be developed using computational models that allow specifying correctly these new requirements.

System modelling using formal methods provides mechanisms and tools that guarantee the users a correct deployment and use of it. Using open computer techniques has the potential to reduce costs, have less dependence on owner solutions, shorter development times, better-tested products, increase of portability and of stable technologies. Moreover, the fact of using standards make the systems (modelled with these standards) more adaptable to technological advances and to the endless market changes.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 70–78, 2008.

There is a group of IT materials and methods for an environmental management system (EMS) modelling, supported by W3C, OMG, ISO, among others. For instance: the ISO 14000 family guarantees an appropriate environmental management system [7] [23]; the ISO 9000 family guarantees quality features. W3C and OMG support other techniques of system modelling such as UML, XML, OCL, CIM, PIM, OWL, among others [8] [11] [21].

In our case, we are applying some of these techniques in the R&D SOLERES project, a spatio-temporal information system for environmental management. This system is supported by the application, integration and development (extension) of multidisciplinary works in satellite images, neural networks, cooperative systems based on multi-agent architectures and intelligent agents and software systems with commercial components.

The general idea of the R&D project is the study of a framework that favours the integration of the aforesaid disciplines using the "*Environment*" as the application domain, specifically ecology and landscape connectivity.

In this paper we will focus on describing partially the SOLERES-KRS, the part of the SOLERES system that models the environmental information meta-data. This information is used by users (i.e. actors) for cooperating and making decision through the SOLERES-HCI subsystem, a framework of the information system implementing the paradigm of *Computer Supported Cooperative Work* (CSCW) by using innovative technology of intelligent agents and multi-agent architectures. Both the SOLERES-KRS and SOLERES-HCI use a trading agent [1]. This software agent identity, locate and register objects in order to get the best solutions when the final users accomplish consults on ecological maps.

We use UML [4], since it is the most accepted software engineering standard, for knowledge modelling. The use of UML for developing ontologies is well known [16] [9]. We use UML class diagrams for development of ontology taxonomy and relations between ontological concepts and next, using the *Model-Driven Engineering* (MDE) perspective —based on the OMG classical *Model-driven Architecture* (MDA)— we create an OWL/XML ontology automatically.

The rest of the paper is structured as follows. In Section 2 we describe some environmental information systems that use ontologies for knowledge representation. Section 3 describes our partial SOLERES-KRS modelling. Finally, in Section 4 we complete the paper explaining some conclusions and future work.

2 Environmental Knowledge-Representation with Ontologies

In the context of computer and information systems, an *Ontology* allows us to model a domain of knowledge, typically in term of classes, attributes and relationships. There exist different languages that allow us to model the knowledge's domain, emphasizing DAM-OIL [18] and OWL [3], being the latter the most recent and used at present. Web Ontology Language (OWL) was designed to be used in applications that need to try the content of the information instead of being only in use for representing the information. These contents can be new or to be related with another ones. In this way, an ontology can use terms that are included in other ontologies and change them, creating an open and distributed system [17].

Ontologies have been used for representing knowledge in the *environmental* area. So, in [6] is presented an environmental decision-support system, called *OntoWEDSS*, for wastewater management. In this system, the ontology is used to model the wastewater treatment process, to provide a shared and common vocabulary, and an explicit conceptualization that describes the semantics of the data. Other example is in [10], an air quality monitoring system, that uses an ontology for to define messages and communication acts with a concise meaning and without ambiguity. [5], in the other hand, presents *Ecolingua*, an ontology for representing ecological quantitative data, provided by the *EngMath* family of ontologies.

These examples show the use of ontologies to get models that describe the entities in the given domain and characterises the relationships and constraints associated with these entities.

3 Modelling SOLERES-KRS

Figure 1 shows the partial architecture of the SOLERES system. At the user layer side (top side), the system is designed in order to be used for environmental decision making tasks and in cooperation among different people or actors (system's users with different roles). This human-computer interaction and human-human interaction is guided by a cooperative system supported by a multi-agent architecture (next layer). There is a *UI agent* mediating between the user and:

(a) The rest of the system's users (who have their own *UI agent*),
(b) The search information system (next layer) directly, or
(c) An environmental software agent (*EMS agent*), i.e., a virtual consultant that cooperates with other agents to facilitate the tasks of information exploitation, that interacts with the search information system and that filters the irrelevant information.

Given the magnitude of the information available in the information system, and due to the fact that this information may be provided by different sources, at different times or even by different people, the environmental information may be distributed and consulted, and geographically located in different places or *Environmental Process Units* (EPUs). So, the system is formed by a cooperative group of EPUs based on knowledge. This group operates individually by using an intelligent agent in order to get the best solutions (consults on ecological maps). We bring up the distributed cooperation of these EPUs through the development of a trading agent. A trader [13] [14] [15] is used as a middleware solution to identify, locate and register objects in an open and distributed system.

In our case, the trading agent mediates between HCI requests and EPU services, and it manages a templates repository of the environmental information meta-data. The modelling of this environmental information is part of SOLERES-KRS and has carried out in 2 phases. Firstly, UML has been used for expressing the concepts, attributes associated with these as well as the existing relations between the above mentioned concepts. Next, the model obtained is automatically mapped to ontology in OWL. Later, we are going to describe both phases.

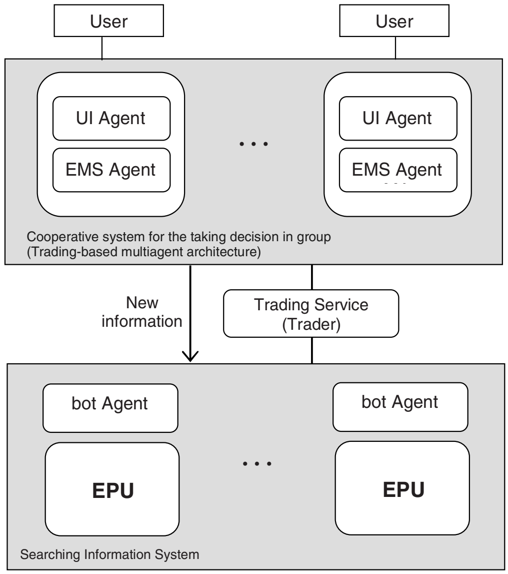


Fig. 1. Partial SOLERES architecture

3.1 Using UML for Knowledge Modelling

As previously indicated, SOLERES-KRS is the part of the SOLERES project that models environmental information meta-data. Modelled environmental information is linked to a hierarchical ecological classification. An ecological classification involves the synthetic representation of the most significant ecological relationships among the elements of a territory. Starting from a territory map, we represent an area split into subsystems or environmental units internally homogeneous [24]. Inside them there are associations between biological and abiotic variables. The integration of these two variables can be charted to different spatial scales [2], which imply their classification in different heterogeneity levels or hierarchies [19].

Figure 2 shows the UML partial class diagram of a hierarchical ecological classification modelling. The concepts are basically grouped into 2 parts: (a) the concepts that identify the cartographic information (*Cartography* class) and; (b) the concepts that identify the process of a hierarchical ecological classification (*Ecological_classification* class).

The cartographic information comprises the geographical information (*Geography* class) and the ecological cartographic maps (*Layer* class). Geographical information includes the identification data of the area where the classification will be carried out. On the other hand, each cartographic map is formed by at least an ecological variable (*Variable* class) (for instance, rainfall) and it is stored in files (*Resource* class).

There are different kinds of files, each one storing different pieces of information for the ecological classification process. For space reasons, we have not included in the figure the part of the files modelling.

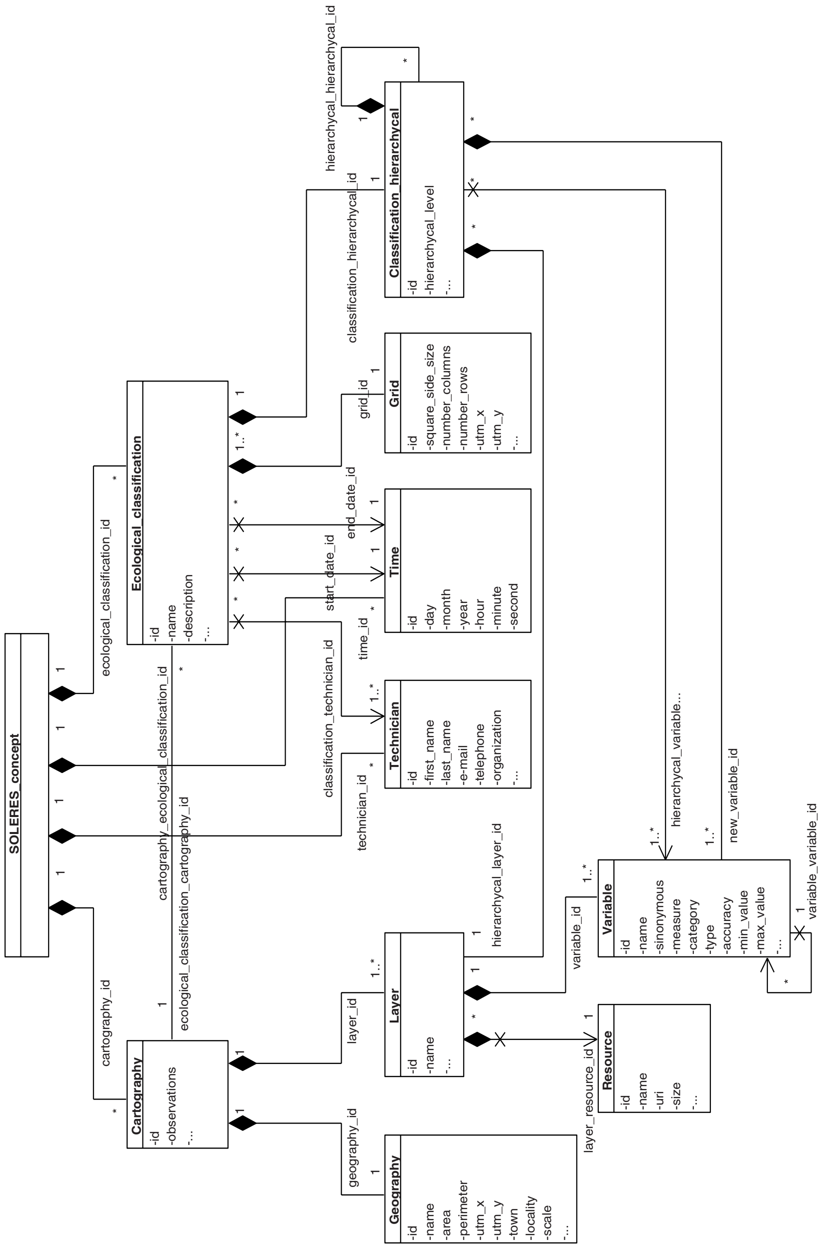


Fig. 2. UML partial classes diagram of a hierarchical ecological classification

On the other hand, we represent the concepts that are associated with the information of a hierarchical ecological classification, grouped into the *Ecological_classification* class. A hierarchical ecological classification is made by some technicians (*Technician* class) in some specific time (*Time* class) and based on the grids generation for data management. This procedure for data management adds the dimensions supplied in a vectorial way. In its spatial projection, it represents the direction and dimension of data on a map in UTM format.

The ecological classification of a territory used in the project is carried out following a procedure of integrated hierarchical description. It is based on the ecological concept of the hierarchical organization of natural systems. This hierarchical organization can create new ecological maps and new variables starting from the existing ones. This piece of information is identified in the *Classification_hierarchycal* class and the existing relationships between the aforesaid class and the *Layer* and *Variable* classes.

3.2 Mapping the UML Model to the SOLERES Ontology

The ontology has been created in OWL/XML from the UML class diagram automatically. Figure 3 shows the UML to OWL/XML transformation schema. We have used the Model-Driven Engineering (MDE) perspective based on the OMG classical Model-driven Architecture (MDA). To achieve the process we have used 3 models: the UML model, the OWL model and the OWL/XML model. The first one is used for representing the hierarchical ecological classification class diagram. The second one is generated temporarily to be able to carry out the transformation. The last one represents the OWL ontology obtained in XML format.

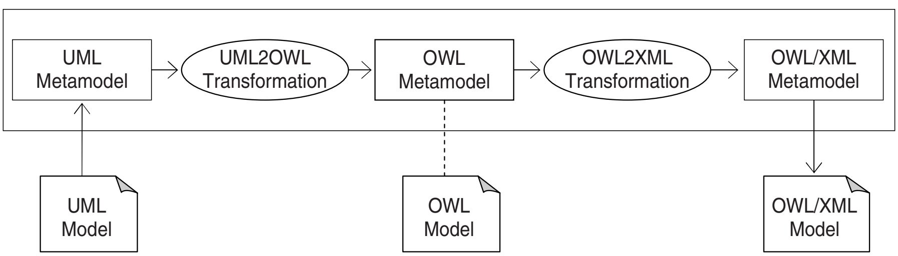


Fig. 3. UML to OWL/XML transformation schema

The model-transformation is realized automatically in two steps:

(a) First step, we have used the UML2OWL ATL transformation [22] to obtain an OWL model for the ontology by using the model of the UML class diagram.
(b) Second step, with the model obtained and using the OWL2XML ATL transformation, we obtain the XML final representation of our OWL ontology. Figure 4 shows a piece of the OWL/XML model obtained as result of the mapping process.

```
      ...
<owl:Class rdf:ID = 'Ecological_classification'>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource = '#Ecological_classification.id'/>
      <owl:cardinality rdf:datatype = 'http://www.w3.org/2001/XMLSchema#integer'>1
      </owl:cardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource = '#Ecological_classification.name'/>
      <owl:cardinality rdf:datatype = 'http://www.w3.org/2001/XMLSchema#integer'>1
      </owl:cardinality >
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource = '#Ecological_classification.description'/>
      <owl:cardinality rdf:datatype = 'http://www.w3.org/2001/XMLSchema#integer'>1
      </owl:cardinality >
    </owl:Restriction>
  </rdfs:subClassOf>
        ...
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource =
      '#Ecological_classification.ecological_classification_cartography_id'/>
      <owl:cardinality rdf:datatype = 'http://www.w3.org/2001/XMLSchema#integer'>1
      </owl:cardinality >
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource = '#Ecological_classification.grid_id'/>
      <owl:cardinality rdf:datatype = 'http://www.w3.org/2001/XMLSchema#integer'>1
      </owl:cardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource =
      '#Ecological_classification.classification_technician_id'/>
      <owl:minCardinality rdf:datatype= 'http://www.w3.org/2001/XMLSchema#integer'>1
      </owl:minCardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:label>Ecological_classification</rdfs:label>
</owl:Class>
        ...
```

Fig. 4. A piece of the SOLERES OWL/XML Ontology

The use of the MDE perspective provides (as the main benefit) the automatic-generation of ontology from UML class diagrams. This is particularly significant when modifications are made and /or extensions of the ontology.

4 Conclusions and Future Work

In this paper, we have partially described SOLERES-KRS (SOLERES Knowledge Representation System). This part of the system models hierarchical ecological classification information. An ecological classification is used for the synthetic representation of the most significant ecological relationships among the elements of a territory. In concrete, we model ecological classification meta-data. This information is used by users (final, technician, and politician users) for cooperating and making decision using a cooperative human-computer interaction system (SOLERES-HCI).

Meta-data are used for a trading agent to identity, locate and register objects in order to get the best solutions when the final users accomplish consults on ecological maps. We have used UML class diagrams for modelling ontology taxonomy and relations between ontological concepts. Using model-transformation techniques (UML2OWL and OWL2XML transformations), we have automatically created OWL ontology from UML class diagrams in XML format.

As a future work, there are specific objectives that we want to address. On the one hand, we want to extend our ontology to accommodate ecological and geographical notations by using the standards EML [12] and GML [20], respectively. This kind of information is very important to complete the main knowledge representation due to the purposes of application of the SOLERES project (http://www.ual.es/acg/soleres).

The data model only represents cartographical information and semantic, but the satellite image information is also important to manage in EMS. Therefore, we want to extend the ontology to accommodate satellite image issues. Again, this kind of information is a project's requirement.

Finally, we are interested in solve the gap between the presentation and data logic in EMS. As we have advanced in the introduction, the data modelling presented in this paper is a part of the SOLERES project (an EMS). SOLERES concerns with two main purposes: (a) the data modelling with semantical representations (ontologies; the aim of this paper), and (b) intelligent, cooperative and adaptive user interactions (human-computer interaction approaches). To connect the presentation logic (HCI) and data logic (ontology) we want to develop advanced searching mechanisms based on *softcomputing* issues.

The reader will find more information about the knowledge implementation and other details of the SOLERES project at http://www.ual.es/acg/soleres/skrs.

Acknowledgments. This work has been partially supported by the EU (FEDER) and the Spanish MEC under grant of the project TIN2007-61497 "*SOLERES. A Spatio-Temporal Environmental Management System based on Neural-Networks, Agents and Software Components*".

References

1. Asensio, J.A., Iribarne, L., Padilla, N., Ayala, R.: Implementing trading agents for adaptable and evolutive COTS components architectures. In: Proc. of the International Conference on e-Business, Porto, Portugal, July 26-29 (in press, 2008), `http://www.ual.es/acg/soleres`
2. Bailey, R.G.: The factor of scale in ecosystem mapping. Environmental Management 9(4), 271–276 (1985)
3. Bechhofer, S., van Harmelen, F., Hendler, J., Horrocks, I., McGuinness, D.L., Patel-Schneider, P.F., Stein, L.A.: OWL Web Ontology Language Reference. W3C Recommendation (2004)

4. Booch, G., Jacobson, I., Rumbaugh, J.: The Unified Modelling Language User Guide. Addison-Wesley, Reading (1998)
5. Brilhante, V.: An Ontology for Quantities in Ecology. In: Bazzan, A.L.C., Labidi, S. (eds.) SBIA 2004. LNCS (LNAI), vol. 3171, pp. 144–153. Springer, Heidelberg (2004)
6. Ceccaroni, L., Cortés, U., Sànchez-Marrè, M.: OntoWEDSS: augmenting environmental decision-support systems with ontologies. Environmental Modelling & Software 19, 785–797 (2004)
7. Corbett, C., Russo, M.: ISO 14001: Irrelevant or invaluable? ISO Management Systems, 23–29 (2001)
8. Cranefield, S., Purvis, M.: Integrating environmental information: incorporating metadata in a distributed information system's architecture. Advances in Environmental Research 5(4), 319–325 (2001)
9. Cranefield, S., Purvis, M.: UML as an Ontology Modelling Language. In: Proceedings of the Workshop on Intelligent Information Integration, 16th International Joint Conference on Artificial Intelligence (IJCAI 1999) (1999)
10. Di Lecce, V., Pasquale, C., Piuri, V.: A Basic Ontology for Multi Agent System Communication in an Environmental Monitoring System. In: International Conference on Computational Intelligence for Measurement Systems and Applications (CIMSA 2004), Boston, USA (2004)
11. Dupmeier, C., Geiger, W.: Theme park environment as an example of environmental information systems for the public. Environmental Modelling and Software 21(11), 1528–1535 (2006)
12. Ecoinformatics, Ecological Metadata Language. Knowledge Network for Biocomplexity (KNB) (2004), `http://knb.ecoinformatics.org/software/eml/`
13. Iribarne, L., Troya, J., Vallecillo, A.: A trading service for COTS components. Computer Journal 4(3), 342–357 (2004)
14. Iribarne, L., Troya, J., Vallecillo, A.: Trading for COTS Components to Fulfil Architectural Requirements. The Development of Component-Based Information Systems. M.E. Sharpe, Inc. (2005)
15. ISO, Information Technology – Open Distributed Processing – Trading Function: Specification. ISO/IEC 13235-1, ITU-T X.950 (1997)
16. Kogut, P., Cranefield, S., Hart, L., Dutra, M., Baclawski, K., Kokar, M., Smith, J.: UML for ontology development. Knowledge Engineering Review 17(1), 61–64 (2002)
17. Lytras, M.: Semantic Web and Information Systems: An Agenda Based on Discourse with Community Leaders. International Journal onSemantic Web and Information Systems (IJSWIS) 1(1), i–xii (2005)
18. McGuinness, D.L., Fikes, R., Hendler, J., Stein, L.A.: DAM+OIL: An Ontology Language for the Semantic Web. IEEE Intelligent Systems 17(5) (2002)
19. O'Neill, R.V., Gardner, R.H.y., Turner, M.G.: A hierarchical neutral model for landscape analysis. Landscape Ecology 7(1), 55–61 (1992)
20. OpenGIS, Geography Markup Language, R.3.2, Open Geospatial Consortium Inc. (2007), `http://www.opengeospatial.org/`
21. Pinet, F., Duboisset, M., Soulignac, V.: Using UML and OCL to maintain the consistency of spatial data in environmental information systems. Environmental Modelling and Software 22, 1217–1220 (2007)
22. SIDo Group, L3I lab in La Rochelle. ATL Use Case - ODM Implementation (Bridging UML and OWL) (2007)
23. Stapleton, P.: ISO 14004 revision will promote use of environmental management systems by the EMS. ISO Management Systems, pp. 21–25 (2002)
24. Zonneveld, I.S.: The land unit – A fundamental concept in landscape ecology, and its applications. Landscape Ecology 3(2), 67–86 (1989)

Combining OpenEHR Archetype Definitions with SWRL Rules – A Translation Approach

Leonardo Lezcano[1], Miguel-Angel Sicilia[1], and Pablo Serrano-Balazote[2]

[1] Information Engineering Research Unit
Computer Science Dept., University of Alcalá
Ctra. Barcelona km. 33.6 – 28871 Alcalá de Henares (Madrid), Spain
{leonardo.lezcano,msicilia}@uah.es
[2] Medical Director, Fuenlabrada Hospital
Cº del Molino, nº2, 28942, Fuenlabrada, Madrid, Spain
pserrano.hflr@salud.madrid.org

Abstract. The interoperability of electronic healthcare information systems is critical for a more effective healthcare management. Several specifications and standards have been created for facilitating such interoperability at different levels. Among them, the OpenEHR initiative emphasizes the sharing of flexible specifications of healthcare information pieces in the form of *archetypes*. However, the OpenEHR ADL language does not provide support for rules and inference which are important pieces of clinical knowledge. This paper reports on an approach to convert ADL definitions to OWL and then attach rules to the semantic version of the archetypes. This allows for an automated means to reuse knowledge expressed in the form of rules which is also flexible and follows the same philosophy of sharing archetypes.

Keywords: Electronic healthcare records, clinical archetypes, ontologies, OWL, SWRL.

1 Introduction

Clinical practice can be represented as an iterative, care delivery process that starts with *observations* of the status of the patient. Such observations lead to informed *opinions* on the part of a health care professional, including assessment of the current situation, goals for a future situation and plans for achieving the goals. Then those plans become into detailed *instructions* for clinical practice that eventually trigger the appropriate *actions*. At this stage, we may need to repeat the whole iteration until the problem is solved (Elstein et al., 1987). These four kinds of information are the breakpoints where communication between independent systems is frequently lost because of data ambiguity and incompatibility. Several specifications and standards have been created for facilitating such interoperability at different levels. Among them, the OpenEHR[1] model proposes their modular definition in the form of *archetypes* that restrict their format and describe their possible values, as Qamar and Rector (2007) explained. Observation concepts like blood pressure, evaluations like pregnancy, and instructions like intravenous fluid administration are quite known

[1] http://www.openehr.org/

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 79–87, 2008.

clinical statements that have already been specified as archetypes. Archetypes are mainly targeted to data interoperability among heterogeneous systems.

The OpenEHR *Archetype Definition Language* (ADL), provides an open constraint-based data interchange model. However, it does support neither formal rules nor any kind of specifications for automated inference.

This paper reports on an approach to combine ontology and rule languages with archetype definitions as a way to seamlessly integrate rules and reasoning in open, modular clinical information models. Concretely, ADL archetypes are translated to the Web Ontology Language (OWL[2]) and rules expressed in SWRL can be attached to specific concepts in the archetype definition. By merging SWRL rules with OWL ontologies, parts of the decision making process can be specified formally and executed automatically. SWRL is a W3C submission developed to improve semantic limitations of OWL which is already a W3C recommendation. In combination, they add considerable expressive power to the Semantic Web.

The rest of this paper is structured as follows. Section 2 describes the approach to translate ADL archetypes to OWL. Then, Section 3 describes how clinical data can be fetched into the ontology created. The paper continues with Section 4, where the process of using SWRL rules to obtain inferred alerts is elucidated. Section 5 finishes the article with a conclusions and further work explanation.

2 Translating ADL to OWL

Bicer et al. (2005) described an approach in which archetypes are translated to OWL in order to achieve interoperability of Web Service messages exchanged in the health care domain. The approach presented here is based on similar translation principles.

Our point of departure has been the mapping of the OpenEHR *Reference Model* (RM)[3] which defines a logical EHR information architecture for the interoperability of EHR compatible systems. The RM ontology contains classes whose instances represent neither constraints nor archetypes but samples of real data.

That mapping was developed by Román et al. (2006) according to openEHR specifications. Maps are split into five ontologies which are: DataTypes, DataStructures, Demographic Model, Common and EHR Information Model. They have been defined using the Protégé-OWL editor.

The translation merges an OpenEHR archetype definition with abovementioned ontologies to create a new OWL file[4] that reuses them as parents of new (child) concepts.

Archetype definitions start with an `Entry` subtype like `EVALUATION`, `INSTRUCTION`, `ACTION` or `OBSERVATION`. Essentially, an archetype restricts the instances of such categories, so a main translation principle is having those `Entry` categories as classes and each archetype definition becoming a subclass depending on the subtype.

From now on this section will take as example the translation process of the `Intravascular Pressure` archetype[5]. It's an `OBSERVATION` to get the pressure in a

[2] http://www.w3.org/TR/owl-guide/
[3] http://www.openehr.org/releases/1.0.1/architecture/overview.pdf
[4] The code of the translator is available under open source license at http://code.google.com/p/ehr2ont/
[5] http://www.openehr.org/svn/knowledge/archetypes/dev/html/en/openEHR-EHR-OBSERVATION.intravascular_pressure.v1.html

specific location, blood vessel or heart cavity, at a specific phase of the heart or an average over the heart cycle. `OBSERVATIONs` are distinguished from `ACTIONs` in that `ACTIONs` are interventions whereas `OBSERVATIONs` record only information relating to the situation of the patient, not what is done to him/her.

The code fragments depicted in Figure 1 and 2 illustrate the mapping from the archetype root definition into the `Intravascular_pressure` OWL class that inherits all `OBSERVATION` features.

```
definition
   OBSERVATION[at0000] matches {
     data matches { … }

ontology
   term_definitions = <
     ["en"] = <
         items = <
            ["at0000"] = <
               description = <"The pressure in a specific location … ">
               text = <"Intravascular pressure">
             >
```

Fig. 1. Definition fragment (*ADL*)

```
<owl:Class rdf:ID="Intravascular_pressure">
  <NodeID rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >at0000</NodeID>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:allValuesFrom>
        <owl:Class rdf:ID="history"/>
      </owl:allValuesFrom>
      <owl:onProperty rdf:resource="http://.../EHR/EHR_RM.owl#data"/>
    </owl:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="http://.../EHR/EHR_RM.owl#OBSERVATION"/>
```

Fig. 2. Root class (*OWL*)

Because archetypes have a tree like structure (created from the RM) we repeat the above step for each level until the whole hierarchy is mapped. By translating ADL relations into OWL Object Properties we can guarantee that defined classes perfectly simulate the archetype configuration. Figure 3 illustrates how OWL class `Intravascular pressure` have a restriction on its `data` property that forces class instances to be related only to `history` instances, which is another archetype definition. (note that `history` specializes RM's `EVENT_SERIES` class).

At the ADL's bottommost level we may find several types of data-valued constraints. This kind of information should be translated to OWL customized Datatypes. At the present time OWL has serious limitations on supporting user-defined datatypes so, until a standard emerges, there is a couple of approaches addressing this issue. One is described by Pan et al. (2005) and the other by Knublauch (2005). In our blood

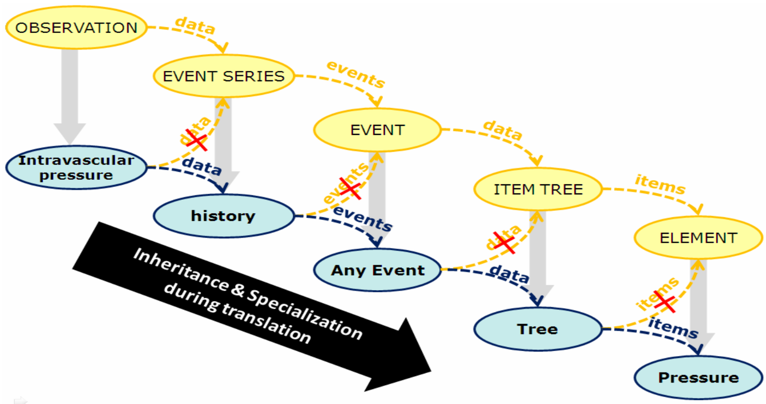


Fig. 3. Inherited properties are replaced to guarantee OWL and ADL structure compatibility

pressure example we confine a couple of OWL Datatype Properties, named `magnitude` and `precision`, to customized datatypes that fulfill `Pressure ELEMENT` requirements. Figure 5 depicts the application of Knublauch approach to abovementioned properties.

```
ELEMENT[at0005] occurrences matches {0..1} matches {-- Pressure
     value matches {
        C_DV_QUANTITY <
          property = <[openehr::125]>
          list = <
             ["1"] = <
                units = <"mm[Hg]">
                magnitude = <|>=0.0|>
                precision = <|2|>
             >
```

Fig. 4. Pressure ELEMENT (*ADL*)

3 Mapping Data to OWL Instances

Concrete clinical data may come from a variety of sources, e.g. relational databases or flat files. In any case, there must be a way of mapping concrete data formats to instances in the ontologies generated by the translator. Here we describe the general approach of translating scalar data from comma separated value (CSV) files into ontology instances.

Archetype instantiation involves the creation of a set of OWL individuals that conforms the archetype hierarchy. Because upper level instances cannot a priori establish which lower level instances will be supplied, the latter ones should be created first in order to properly fulfill the properties between levels. Thus, instantiation process performs a bottom-up traverse of the archetype.

```
<owl:Class rdf:about="#Pressure_DV_QUANTITY">
 <owl:intersectionOf rdf:parseType="Collection">
  <owl:Restriction>
   <owl:allValuesFrom>
    <rdfs:Datatype>
     <xsp:base rdf:resource="http://www.w3.org/2001/XMLSchema#double"/>
      <xsp:minInclusive rdf:datatype=http://www.w3.org/2001/XMLSchema#double
      >0.0</xsp:minInclusive>
    </rdfs:Datatype>
   </owl:allValuesFrom>
  <owl:onProperty rdf:resource="http://... /EHR/Data_Types_RM.owl#magnitude"/>
  </owl:Restriction>
  <owl:Restriction>
   <owl:allValuesFrom>
    <rdfs:Datatype>
     <xsp:maxInclusive rdf:datatype="http://www.w3.org/2001/XMLSchema#int"
     >2</xsp:maxInclusive>
     <xsp:base rdf:resource="http://www.w3.org/2001/XMLSchema#int"/>
     <xsp:minInclusive rdf:datatype="http://www.w3.org/2001/XMLSchema#int"
     >2</xsp:minInclusive>
    </rdfs:Datatype>
   </owl:allValuesFrom>
  <owl:onProperty rdf:resource="http://.../EHR/Data_Types_RM.owl#precision"/>
 </owl:Restriction>
</owl:intersectionOf>
```

Fig. 5. Pressure_DV_QUANTITY fragment (*OWL*)

Leaf nodes instances are concrete clinical values, originally stored outside the boundaries of OWL domain, for example, in a CSV file. For that reason, a mapping between those values and their archetype slots should be provided. Once the source values are transformed into OWL customized Datatypes, they are linked to `ELEMENTs` instances, which are organized by an `ITEM_STRUCTURE` instance and so on, until the archetype's root instance is created.

The following CSV chunk contains an extract of clinical measures required to instantiate the `Intravascular Pressure` archetype. Each row will be transformed into a set of OWL individuals with an `Intravascular Pressure` instance at the top.

```
Patient_ID | Date | Pressure | Relative | Location | Phase of heart cycle
846385 | 09-03-2008 | 3 | lowered | Left Transverse Sinus | Systolic
973589 | 20-10-2007 | 8 | markedly increased |Left Sigmoid Sinus | Diastolic
123453 | 12-02-2008 | 5 | normal | Right Transverse Sinus| Diastolic
745385 | 15-05-2008 | 2 | lowered | Right Sigmoid Sinus| Pre-systolic
984647 | 03-01-2008 | 1 | markedly reduced | Left Transverse Sinus | Systolic
```

Fig. 6. CSV file including `Intravascular Pressure` data. Fields are pipe delimited

Mappings are node IDs of the current archetype ordered the same way as CSV fields:

```
| | at0005 | at0015 | at0006 | at0007
```

Fig. 7. Mappings between `Intravascular Pressure` nodes and CSV file

Neither `Patient_ID` nor `Date` fields have mappings to the archetype because such information is not described as a part of *Intravascular Pressure* concept. Actually, it is administrative information that should be captured by other archetypes.

Assuming that CSV attributes notation is compatible with archetype slots, the above procedure can be generalized to any kind of archetype.

4 Adding Rules and Inference Execution

Many health care processes, such as computer aided decision making or disease diagnosis and treatment, are often best modeled using a declarative approach, leading to a very active interest in rule-based systems. However, interoperability among the multitude of current rule-based systems is limited.

The SWRL language has appeared as a first step solution to increase rule-based systems interoperability from the Semantic Web perspective. It's based on a combination of the OWL Web Ontology Language with the Rule Markup Language[6]. In common with many other rule languages, SWRL rules are written as antecedent/consequent pair. In the clinical environment, several kinds of rules can be expressed with this logic. For example, *standard-rules* allow for chaining ontologies properties as well as *mapping-rules* between ontologies contribute to data integration and navigability, (Golbreich et al., 2003).

Following the above example, we are going to attach it some rules that aid intraoperative monitoring on Transverse Sinus Ligation during Large Petroclival Meningioma Surgery. The transverse sinuses are two areas, beneath the brain, which allow blood veins to span the area, from the back of the head towards the nose. According to Hwang guidelines (Hwang et al., 2004), if intravascular pressure increases too much after temporary occlusion testing, the sinus should be kept intact. Rules intention is to formally reflect the risk assessment using SWRL language.

Required data access is made through an OWL `COMPOSITION` class named `Sinus Ligation Measures`. It includes a couple of sections (`Prior to test occlusion` and `After test occlusion`) that contain instances of previous translated `Intravascular pressure` archetype.

As an example implementation, here we discuss an inference process based on the Jess-Java bridge provided with the Protégé ontology editor. As a first step, SWRL rules must be defined. Figure 8 shows one of the sentences that captures Hwang guidelines.

```
Patient(?x) ∧
has_BeforeTOMeassure(?x, ?bt_value) ∧
has_AfterTOMeassure(?x, ?at_value) ∧
swrlb:subtract(?result, ?at_value, ?bt_value) ∧
swrlb:greaterThan(?result, 10)
    → has_LigationAssessment(?x, "inadequate")
```

Fig. 8. Monitoring Rule 1 (*SWRL*)

[6] http://www.w3.org/Submission/SWRL/

For the knowledge base to be accessible, we need to integrate both OWL ontology and SWRL rules. Fortunately, Protégé SWRL editor supports almost all language features outlined in the current SWRL Specification. Rules are stored as OWL individuals described by the SWRL Ontology (O'Connor, 2005).

As pointed out in (Horrocks, 2005), the integration of OWL and SWRL offers several advantages and goes beyond that of either OWL DL or Horn rules alone. The code fragment in Figure 9 expresses the above rule, now using OWL XML syntax:

```
<swrl:Imp rdf:ID="MonitoringRule1">
   …
   <swrl:propertyPredicate rdf:resource="#has_LigationAssessment"/>
    <swrl:argument2 rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
      >inadequate</swrl:argument2>
       …
      <swrl:BuiltinAtom>
       <swrl:builtin rdf:resource="http://www.w3.org/2003/11/swrlb#subtract"/>
        …
         <rdf:first rdf:resource="#at_value"/>
         …
         <swrl:Variable rdf:ID="bt_value"/>
        …
      <swrl:BuiltinAtom>
       <swrl:builtin rdf:resource="http://www.w3.org/.../swrlb#greaterThan"/>
        …
         <rdf:first rdf:resource="#result"/>
         …
         <rdf:first rdf:datatype="http://www.w3.org/2001/XMLSchema#int"
         >10</rdf:first>
        …
```

Fig. 9. Monitoring Rule 1 fragments (XML syntax)

Having procedural and descriptive knowledge merged under the same syntactic structure provides means for the interoperability of rule systems. For example, Argüello and Des (2008) explain how encoding OWL domain ontology fragments and SWRL rule fragments as the inputs and outputs of Web Services looks like a huge step towards dynamic discovery, composition, and invocation without user intervention.

Sooner or later rules should be invoked so, as said before, we delegate Jess to accomplish the inference job. Jess engine is a production rule system with forward chaining to achieve inferred results. Mei and Bontas (2005) have demonstrated that mappings between SWRL and Jess are possible.

The communication between OWL and Jess is based on the `SWRLJessBridge`[7]. Once the bridge has been created, the inference process can be broken down into the following stages:

i. Clear all knowledge from the rule engine.
ii. Import all SWRL rules and relevant OWL knowledge from the OWL model into the bridge.
iii. Invoke the rule engine.
iv. Transfer any information asserted by a rule engine, like property values, to the OWL model.

[7] http://smi-protege.stanford.edu/svn/swrl-jess-bridge

The resulting OWL ontology, enriched with inferred knowledge, has many possible uses. For example it could be directly delivered to the end user through a compatible interface or it could be stored in a repository. In the clinical environment, these results provide means for automatically improve decision making and monitoring tasks.

5 Conclusions and Future Work

Given that interoperability is one of the medicine primary goals and also that ADL definitions do not support for rules, this paper presented an approach on how OpenEHR archetypes can be automatically translated into OWL models by constraining a mapping of OpenEHR schemas. Then, data coming from any kind of source can be represented as instances of the obtained ontology. Finally, attaching SWRL rules to the semantic version of the archetypes allows for any compatible reasoner to execute the inference.

For the automatic ADL to OWL translation to perform a correct parsing and comprehension of any kind of archetype, the implementation should cover the entire set of RM types and all their possible combinations. In order to avoid the maintenance problems that this approach could provoke, the process design should follow the same hierarchical principles of the RM. This way, we encourage for the reusability and scalability of the implementation.

Another fact that may attempt against the standardization of current approach, affecting the inference stage, is that developing complex archetype rules will require the use of mathematical functions that are not currently supported in the SWRL. An example can be the implementation of fractal functions or exponential sums, which are quite useful in medical fields like genetic, biochemistry and neuroscience. SWRL do not provide the tools to cope with these scenarios. It includes some mathematical built-ins to perform simple operations such as the subtraction used in the *Sinus Ligation* example. However, it is not designed to work with complex formulas.

In spite of above inconveniences, the availability of rule-based systems oriented to the Semantic Web and the need for semantic interoperability, ascribe great advantages to this approach. Expressing archetypes as OWL ontologies allows for improving semantic activities such as classification, selection and navigation. Besides, data correctness and consistency can be guaranteed more efficiently.

Future work will focus on the evaluation and assessment of this technique by gathering results from a real clinical environment. In addition, further steps in the translation development include not only the OpenEHR full coverage but also the CEN standard compatibility in order to increase the implementation scope.

Acknowledgements

This work has been supported by project the project "*Historia Clínica Inteligente para la seguridad del Paciente/Intelligent Clinical Records for Patient Safety*" (CISEP), code FIT-350301-2007-18, funded by the Spanish Ministry of Science and Technology.

References

Argüello, M., Des, J.J.: Clinical practice guidelines: A case study of combining OWL-S, OWL, and SWRL. Knowledge-Based Systems 21(3), 247–255 (2008)

Bicer, V., Kilic, O., Dogac, A., Laleci, G.B.: Archetype-Based Semantic Interoperability of Web Service Messages in the Health Care Domain. Journal on Semantic Web & Information Systems 1(4), 1–23 (2005)

Elstein, A.S., Shulman, L.S., Sprafka, S.A.: Medical problem solving: an analysis of clinical reasoning. Harvard University Press, Cambridge (1987)

Golbreich, C., Dameron, O., Gibaud, B., Burgun, A.: Web ontology language requirements w.r.t expressiveness of taxonomy and axioms in medicine. In: Fensel, D., Sycara, K.P., Mylopoulos, J. (eds.) ISWC 2003. LNCS, vol. 2870, pp. 180–194. Springer, Heidelberg (2003)

Horrocks, I., Patel-Schneider, P.F., Bechhofer, S., Tsarkov, D.: OWL rules: A proposal and prototype implementation. Web Semantics: Science, Services and Agents on the World Wide Web 3(1), 23–40 (2005)

Hwang, S., Gwak, H., Paek, S., Kim, D., Jung, H.: Guidelines for the Ligation of the Sigmoid or Transverse Sinus during Large Petroclival Meningioma Surgery. Skull Base 14(1), 21–28 (2004)

Knublauch, H.: User-defined datatypes in protégé-owl (retrieved) (2005) (June 20, 2008), `http://protege.stanford.edu/plugins/owl/xsp.html`

Mei, J., Bontas, E.P.: Reasoning Paradigms for SWRL-Enabled Ontologies. In: Protégé With Rules Workshop: 8th International Protégé Conference, Madrid, Spain (2005)

O'Connor, M., Knublauch, H., Tu, S., Grosof, B., Dean, M., Grosso, W., Musen, M.: Supporting Rule System Interoperability on the Semantic Web with SWRL. In: Proceedings of the 4th International semantic web conference, Galway, Ireland, November 6. Springer, Berlin (2005)

Pan, J.Z., Horrocks, I.: OWL-Eu: Adding customised datatypes into OWL. Web Semantics: Science, Services and Agents on the World Wide Web 4(1), 29–39 (2005)

Qamar, R., Rector, A.: Semantic Issues in Integrating Data from Different Models to Achieve Data Interoperability. In: Kuhn, K., et al. (eds.) Proceedings of MedInfo 2007, pp. 674–678. IOS publishing (2007)

Román, I., Roa, L.M., Reina-Tosina, J., Madinabeitia, G.: Demographic management in a federated healthcare environment. International Journal of Medical Informatics 75(9), 671–682 (2006)

Psychology in the ICT Era: Electronic Psychology

Athanasios Drigas, Leyteris Koukianakis, and Yannis Papagerasimou

NCSR 'Demokritos',
Institute of Informatics and Telecommunications,
Net Media Lab,
Agia Paraskevi, 153 10, Athens, Greece
{dr,kouk,ypapa}@imm.demokritos.gr

Abstract. Cognitive science is the scientific domain which studies, analyses, simulates and infers for various aspects, functions and procedures of human mentality such as, thinking, logic, language, knowledge, memory, learning, perception and the ability to solve problems. E-psychology is in a close relation with the cognitive science domain, but expands beyond it, as e-psychology is the efficient convergence of Psychology and Information and Communication Technologies (ICTs). E-psychology offers a number of services such as supporting, diagnosis, assessment, therapy, counseling, intervention and tests through an effective exploitation of ICTs. This article presents a user-friendly, flexible and adaptive electronic platform, which supports both synchronous and asynchronous e-psychology activities through the use of informative and communicative tools and services, which can be adapted to support various methods of e-psychology activities. It is important to underline that e-psychology is not an alternative psychology field, but a resource to enhance the conventional psychology process.

Keywords: E-psychology, ICTs, cognitive science.

1 Introduction

The rapid advance of ICTs and the Internet over the course of the last fifteen years has affected a significant number of aspects of contemporary life including education. Nowadays, educational e-content can be found anywhere, anytime and to anyone who can connect to the Internet. Hence, it was only natural for universities and academic institutions to use this development to their advantage by providing on-demand web based education and training through course delivery platforms such as the Ariadne Web based learning environment and electronic textbooks through the use of authoring tools such as InterBook [1], [2].

A large number of sciences including Psychology have taken advantage and have exploited the numerous capabilities of the Internet to their benefit. More particularly, psychology uses the Internet in order to create programs for psychological intervention, assessment, orientation, and specialized counseling, as a means of prevention. The Internet not only constitutes a new communicative medium between patient and therapist but is also the future of psychology [4], [5], [6], [7], [8], [9], [10], [11]. This new virtual environment uses such tools as e-mail, chat rooms, discussion forums and

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 88–95, 2008.

audio and video conference for the communication and interaction of the therapist with the patient, tools which are also used for educational purposes in e-learning environments [12], [13].

It is common knowledge that the Internet is packed with information of uncertain quality and prestige. Taking this fact into account, it becomes more than apparent that it is absolutely essential to know how and where to extract useful and qualitative information from, regarding the object of ones interest. This becomes even more important and more vital when the object of interest regards health issues [14], [15], [16], [17]. According to a recent study, real patients and supported individuals were found to trust entirely and resort to prominent and well-known websites in order to gather information regarding their health issue, without prior guidance by neither their therapists nor even by Internet experts. That is, they visited websites of major hospitals, health organizations as well as of government organizations in order to acquire information [3]. Quality information with substantial validity and weight can have a positive psychological effect on patients. Hence, it becomes crucial that psychologists embed this new and innovative means of psychology in their practice and view it as a means to enhance the entire psychology process [18], [19].

Based on the aforementioned framework, an e-psychology platform was developed which was also based on the following principles. Firstly, it was decided that since the e-psychology platform is partially but principally addressed to supported individuals, which is a very sensitive social group, it was essential that the design was as user-friendly and user-centered as possible and according to the user needs. Secondly, it was decided that the electronic content and the tools of the platform should be modular and flexible. With this modularity and flexibility of both the e-content and the tools, the administrator has the capability to provide environments and services of different types. This is done, in order for the platform to support different target groups, various categories of supported individuals (depending on the type of support they are receiving) and different categories of scientists (psychologists training, staff training) on the one hand and on the other, to support different psychological procedures. For instance, reusability can support a procedure that is based on behavioral psychological principles or it can organize an environment that is based on and embeds the diagnostic principles and tools of cognitive psychology. Finally, the instructional methods that are embedded within the developed web-based platform use most of the available modern multimedia and communicative technologies of the Internet and offer various modes for the delivery and presentation of the electronic content.

2 E-Psychology: An Overview

2.1 Modelling Psychology Procedures

The first step that is required in order to develop and design an e-psychology environment is to model the operations and procedures of the psychology cycle (Fig. 1). The most important step in the procedure of psychological services provision is diagnosis. Diagnosis, as it is presented below is based on the one hand on the diagnostic criteria, which are associated with DSM-IV and ICD-10, while on the other hand it utilizes and is based on diagnostic instruments such as interview, psychometric tests and observation. The result of the above is the production of the assessment report.

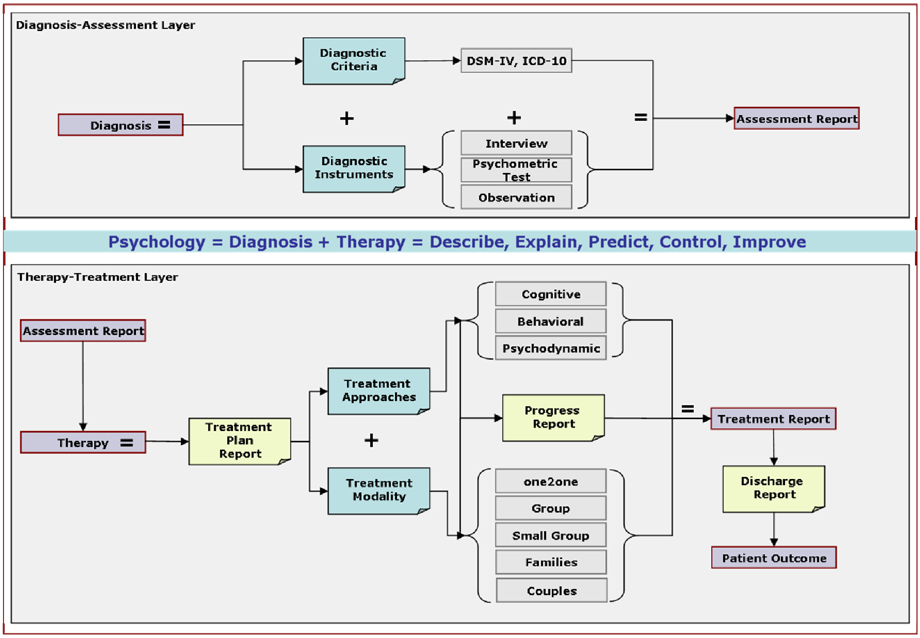


Fig. 1. Psychology model diagram

It is obvious that these distinguished steps of the diagnosis procedure are the main structural ingredients with which it is possible to create an embedded system in an e-psychology environment, which performs the operations of diagnosis support (e-diagnosis).

Following the modeling of diagnosis, it is very important to underline the importance of modeling the stages and the procedures of therapy - treatment to the process of designing and realizing an e-psychology environment.

Based on the assessment report that was derived through the diagnosis process, the therapy - treatment process follows the stages that are depicted above. The basis for the development of these stages for this process is the treatment plan report, which consists of the treatment approaches and the treatment modality. With the term treatment approaches we refer to the various therapeutic and theoretical approaches of psychology such as cognitive, behavioral, psychodynamic and existential. On the other hand, with the term treatment modality we refer to the various means of intervention such as one to one, small group, family and couples.

Finally, at the last stage of the modeled therapeutic process, the treatment report is produced as well as the discharge report and finally the patient outcome.

2.2 E-Psychology Process Cycle

Following the discussion about modeling psychology procedures, this chapter presents the e-psychology process cycle (Fig. 2), which is realized in our platform and which was the basis for the development of the e-psychology environment.

The Supported Person (SP) has access through a registration form over a Secure Socket Layer (SSL) to the registration department and his/her application becomes accepted after the necessary validation process. Following this, a temporary supported person page is created and through certain electronic procedures such as psychometric tests and interviews the assessment report is produced.

Furthermore, through the creation of the supported person's history folder and the appropriate review, the supported person's personal information is inserted in the appropriate virtual clinic department where suitable treatment modalities are chosen and applied through suitably designed treatment plans. At this stage, the informative tools that support and realize the aforementioned procedures are the Supported Person calendar, health files, personal information, psychologist, health library and forum.

At the end of the e-psychology process cycle there is the patient e-outcome provided that all the necessary conditions of the treatment plan report, progress report and discharge report are met successfully.

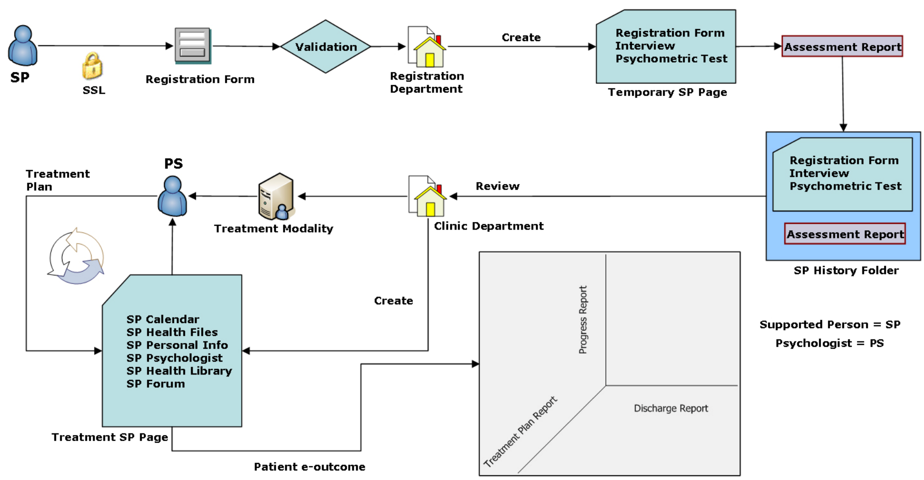


Fig. 2. E-psychology process cycle diagram

2.3 E-Psychology and E-Learning Tools

The presented e-psychology process cycle is realized through special information and communication technologies tools and services. These are divided into two categories: the informative and the communicative tools and services. The latter are divided into two subcategories: the synchronous (real-time) and the asynchronous (non real-time) tools and services, which determine the terms synchronous and asynchronous environments. These tools and services were used for the development of the e-psychology platform imprinting the traditional learning and psychology processes with synchronous and asynchronous learning and psychology tools in the platform.

In addition, the user levels and user interfaces of the e-psychology platform comprise the administrator, the therapist - psychologist, the patient - supported person and finally the visitor who support similar actions with the e-learning user levels namely, administrator, instructor, student and user. Finally, the seminars, classes, courses and educational material from the e-learning circle, are supported by the same tools in similar procedures with the therapeutic entities, small groups, therapeutic process, and supporting material, from the e-psychology circle.

The specifications of the user levels, the e-content and the e-tools in an e-psychology platform can be easily implemented through a simple correspondence of the psychology ontologies to the generic e-learning ontologies.

E-psychology and e-learning have a very close relationship. It is obvious that the roles of the ‘‘instructor’’ and the ‘‘student’’ are transformed into the roles of the ‘‘psychologist’’ and the ‘‘supported individual’’ respectively. The ‘‘classes’’ are transformed into ‘‘small therapy groups’’ and the ‘‘courses’’ into ‘‘supporting material’’. The ‘‘consulting material’’ (examples, exercises, multiple choice tests) correspond respectively to diagnosis, educational exercise for treatment and diagnostic tests. Finally, all the tools (web directory, glossary, references, video and audio lectures, events calendar, news, announcements, mailing lists, e-library, message box, e-mail, video and audio conference, discussion forums, instant messaging, chat, and telephony) can be easily applied to both platforms.

3 E-Psychology Platform Presentation

3.1 E-Psychology Platform Structure and User Levels

Based on the discussion in chapter 2, we have developed an e-psychology platform which is abstractly depicted in (Fig. 3). The environment supports the operations of e-diagnosis and e-therapy that lead to the successful coverage of the aims that were set according to the followed psychological approach, in order to finally reach the e-outcome (provided that the aims are met successfully).

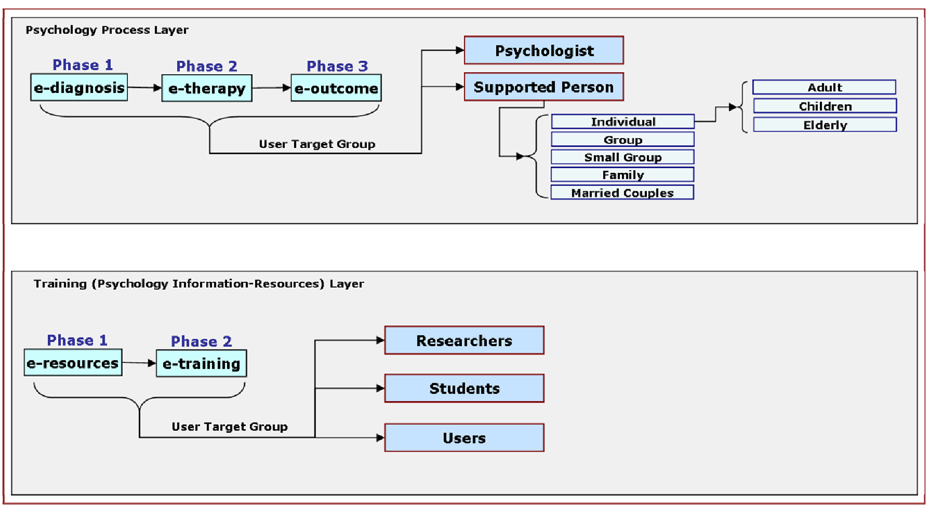


Fig. 3. Abstract presentation of the e-psychology platform structure

These operations support and refer to the user target groups. These comprise the supported persons on the one hand and on the other the therapists, who receive support through the e-psychology environment in order to execute their task in the best possible way. The supported persons comprise individuals, groups, small groups, families and couples while the individuals can be either adults, children or elderly.

The module that refers to training plays a very important role in the structure of the e-psychology platform. Training is a very important tool in the e-psychology field as it is used not only in the various fields of psychology for the support of the supported persons, but also for the support and constant upgrade of the cognitive skills of the therapists and the formation of the way that they treat both the supported persons as well as the various procedures within the e-psychology environment.

Beyond the therapists and supported persons, the training module of the e-psychology platform constitutes a very powerful tool for the training of researchers and students who are given permission to access the e-psychology platform. Finally, the importance of the training modules' role in the training of the common user (mean citizen) should not be overlooked as it informs and trains him/her on various interesting subjects regarding everyday psychological health such as stress control, possible perception or even behavioral deflections in children, memory issues with adults and the elderly and finally, substances abuse etc.

The e-psychology platform comprises four different user levels namely administrator, psychologist - therapist, patient - supported individual and visitor. Each of these user levels has a different role and different permission levels to both informative and communicative tools and services of the platform.

The role of the administrator is to manage the e-platform using the administrative tools of the system. These tools give the administrator the power to hand permission to the other users of the platform to access the various tools and services, depending on their needs. Finally, the administrator is in constant communication with the therapist - psychologist regarding their sessions with patients and their progress.

Moreover, the role of the therapist - psychologist is to create and organize the e-content of the platform in terms of its delivery to the patients - supported individuals as well as to anyone who is interested in viewing it. In particular, general information regarding psychological issues is uploaded to the system but more importantly, the electronic content of the sessions that the therapist engages in with a patient. The scope of this is to enable the patients to revise the session in their own time and have a better perception of it. Finally, there is also the online communication, which aims at the further interaction of the two parts and the reply of questions that may rise.

Furthermore, the role of the patients - supported individuals is that of the regulator of the e-platform. That is to say that it is the patients that view the e-content, engage in the online sessions with the therapists and hence it is up to them to determine whether the platform is worth while or not. Additionally, the patients have full access to all the information and the services provided by this e-psychology platform.

Finally, the visitor (common citizen) has the unique opportunity to access the e-content of the e-psychology platform. This means access to consulting material, general sessions and discussion forums where the visitor can go through discussions between therapists and patients for purely informative and educational purposes. This innovation is in accord with the principle 'information for all' which conforms to the knowledge society strategies. It must be noted that these discussions are generic and non confidential. It is obvious that visitors do not have the ability to access the e-content that has to do with confidential sessions and discussions between therapists and patients. This personal information is protected and can only be accessed by the other three user levels who are authorized to do so.

4 Conclusions

The incorporation of ICTs as well as of Internet technologies within the traditional psychology process results in what is commonly known as e-psychology, which was the topic of this article. Although e-psychology is an innovation and a step forward for traditional psychology, it was underlined from the start that under no circumstances does it substitute, replace or undermine the traditional psychology process but acts more as a means to enhance it and to complement it.

E-psychology in its broad sense enables the therapists - psychologists as well as the patients - supported individuals to use and incorporate technology in their sessions bringing the latter to a whole new level. While carrying on their traditional sessions both parts have the opportunity to experiment simultaneously with this new electronic process in order to deduce useful conclusions and to make the whole experience of a virtual session more appealing and beneficiary for both parts.

This e-psychology platform was based on modern informative and communicative tools and services as is the case in many modern e-learning platforms. More particularly, it was designed and developed very meticulously in an effort to provide an innovative platform that was user-centered, user-friendly, modular and flexible. In addition, the aim was to exploit in full all the capabilities of contemporary Internet technologies for the benefit of both therapists and patients but mostly in an effort to primarily cover as much as possible the psychological needs (regardless of the field) of the aforementioned users of the platform.

References

1. Brusilovski, P., Eklund, J., Schwarz, E.: Web-Based Education for All: A Tool For Development Adaptive Courseware. In: 7th International WWW Conference, pp. 291–300. Elsevier, Amsterdam (1998)
2. Durm, R., Duval, E., Verhoeven, B., Cardinaels, K., Olivie, H.: Extending the ARIADNE Web-Based Learning Environment. In: World Conference on Educational Multimedia, Hypermedia and Telecommunications, pp. 1932–1937 (2001)
3. García, V., Ahumada, L., Hinkelman, J., Muñoz, R., Quezada, J.: Psychology over the Internet: On-Line Experiences. In: 29th InterAmerican Congress of Psychology, pp. 29–33 (2004)
4. Plant, R., Howes, A., Hammond, N., Trapp, A.: A Virtual Psychology Lab: A Look Back Over the Last Three Years. In: Computers in Psychology Conference (2000)
5. Marks, I., Shaw, S., Parkin, R.: Computer-Aided Treatments of Mental Health Problems. In: Clinical Psychology: Science and Practice, pp. 151–170 (1998)
6. Kenwright, M.: Computer-Aided Self-Treatment for Phobias. In: Computers in Psychology Conference (2000)

7. Riva, G., Molinari, E., Vincelli, F.: Interaction and Presence in the Clinical Relationship: Virtual Reality (VR) as a Communicative Medium between Patient and Therapist. In: IEEE Transactions on Information Technology in Biomedicine, pp. 198–205 (2002)
8. Vincelli, F.: From Imagination to Virtual Reality: The Future of Clinical Psychology. In: CyberPsychology and Behavior, pp. 241–248 (1999)
9. Vincelli, F., Riva, G.: Virtual Reality: A New Tool for Panic Disorder Therapy. In: Expert Review of Neurotherapeutics, pp. 377–383 (2002)
10. Gonzalez, G.: Bilingual Telephone-Assisted Computerized Speech Recognition Interviewing: Automated Screening of Depression Symptoms. In: Computers in Psychology Conference (2000)
11. Richter, T., Naumann, G.: Computer-Based Assessment of Reading Skills. In: Computers in Psychology Conference (2000)
12. MacRae, A.: Multimedia Statistics Course on CD: The First Year's Experience. In: Computers in Psychology Conference (2000)
13. Morris, E., Scanlon, E., Joiner, R.: Evaluating Multimedia Resources for Teaching Statistics to Psychology Undergraduates. In: Computers in Psychology Conference (2000)
14. Gomella, L.: The Wild, Wild Web: Resources for Counseling Patients with Prostate Cancer in the Information Age. In: Semin Urologic Oncol, pp. 167–171 (2000)
15. Eysenbach, G., Powell, J., Kuss, O.: Empirical Studies Assessing the Quality of Health Information for Consumers on the World Wide Web: A Systematic Review. JAMA 287, 2691–2700 (2002)
16. Matthews, S., Camacho, A., Mills, P., et al.: The Internet for Medical Information About Cancer: Help or Hindrance? Psychosomatics 44, 100–103 (2003)
17. Fogel, J., Albert, S., Schnabel, F.: Quality of Health Information on the Internet. JAMA 286, 2093–2095 (2001)
18. Fogel, J.: Internet Breast Health Information: Use and Coping Among Women with Breast Cancer. CyberPsychology & Behavior 7, 59–63 (2004)
19. Carlson, N., Buskist, W.: Psychology: The Science of Behavior. Allyn and Bacon, Inc. (1997)

Towards an Ontology for Describing Emotions

Juan Miguel López[1], Rosa Gil[1], Roberto García[1], Idoia Cearreta[2], and Nestor Garay[2]

[1] GRIHO Research Group
Universitat de Lleida, Lleida, Spain
{juanmi,rgil,rgarcia}@diei.udl.cat
[2] Laboratory of Human-Computer Interaction for Special Needs,
University of the Basque Country, Donostia-San Sebastian, Spain
{idoia.cearreta,nestor.garay}@ehu.es

Abstract. The study of emotion in human beings has traditionally been a research interest area in disciplines such as psychology and sociology. The appearance of affective computing paradigm has made it possible to include findings from these disciplines in the development of affective interfaces. Still, there is a lack of applications that take emotion related aspects into account. This situation is mainly due to the great amount of proposed theoretical models and the complexity of human emotions. Besides, the importance that mobile computing area is acquiring has made necessary to bear context related aspects in mind. The proposal presented in this paper is based on a generic ontology for describing emotions and their detection and expression systems taking contextual and multimodal elements into account. The ontology is proposed as a way to develop a formal model that can be easily computerized. Moreover, it is based on a standard, the Web Ontology Language (OWL), which also makes ontologies easily shareable and extensible. Once formalized as an ontology, the knowledge about emotions is used in order to make computers more accessible, personalised and adapted to user needs.

1 Introduction

Human beings are eminently emotional, as their social interaction is based on the ability to communicate their emotions and to perceive the emotional states of others. Consequently, emotions must be taken into account when implementing information systems in order to enable a more social and humanistic computing for our knowledge society. A new paradigm called affective computing works on the detection and response to user's emotions [1]. There is a great variety of theoretical models of emotions which can frame the design of affective applications, and there are different technologies that can be used for their implementation. In addition, although there are many common properties, emotions are not universal. They are differently expressed in different cultures and languages, while many emotional properties are individual. There is rarely a one-size-fits-all solution for the growing variety of computer users and interactions [1]. Therefore, emotion-aware applications should be designed in a flexible way if they are wanted to be used with a wider class of users. In this

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 96–104, 2008.

way, personalisation is necessary for more efficient interaction, and better tuning and acceptation of developed systems.

However, computer systems cannot be only user-centred. The rapid development of mobile computing implies that studying context is relevant in order to analyse user interaction with computer systems. In this sense, the great extent of situations involved in mobile computing has made context a critical factor to take into account when designing computer systems. In order to cope with elements that have influence in affective interactions between people and computers, several models have been developed. Some of them have been presented as ontologies. In any case, their main aim is to be computationally affordable.

It must be highlighted that there is a broad terminology related to affective states in human beings. There is a tendency to use the term "emotion" in a broad sense, especially in technological contexts [2]. Scherer [3] proposed a number of taxonomies for these affective states. This list was modified and defined in Douglas-Cowie et al. (2006).

This paper is focused specifically on Emergent emotion, instead of a global taxonomy of Affective states. This is made to reduce the complexity of proposed domain, due to space limitations in the paper. In [4], Emergent emotion (full-blown) is defined as "states where the person's whole system is caught up in the way they react to a particular person or situation – which may be in reality or in their mind". Besides, for the same reason, focus is mainly devoted to emotion detection and expression systems instead of modelling internal emotion processing in humans.

With the aim of solving presented problems and bearing proposed limitations in mind, we propose a generic approach to defining context-aware emotions taking different theoretical models into account. This approach can serve as a guide for flexible design of multimodal affective applications with independence of the starting model and the final way of implementation.

Next section of this paper presents several theories and concepts relevant for describing emotions. Afterwards, several topics related to ontologies and emotions are explained. Then, our conceptual model is highlighted before describing the ontology itself. Finally, some conclusions are shown and future works suggested.

2 Theories and Relevant Aspects for Describing Emotion

Emotion is a complex aspect and findings of different areas, such as anthropology, psychology, and biology, are included in its wide-ranging discussion. In the field of psychology, definitions of emotion have been proposed with different theoretical orientations. In this sense, theories of emotions proposed by cognitive psychology are a useful starting point in order to describe emotion. Although several cognitive models of emotions exist, the most commonly ones used in affective computing area are the categorical [5], dimensional [6] and appraisal [7].

Lang [6] also proposed analysing of emotions according to three systems involved in the expressions of emotions: Subjective or verbal information (i.e. reports about perceived emotions described by users), Behavioural (i.e. facial and postural expressions, speech paralinguistic parameters), and Psychophysiological answers (such as heart rate, galvanic skin response –GSR–, and electroencephalographic response).

The emotional memory arisen from the experience of the individual and the cultural surroundings (also called socialized emotion) also has an influence on affective states in humans as well. Sociology of emotions has typically examined how affect arises, linking emotions to particular types of interactions [8]. Besides, as the emotional answer is often socialized, it does not necessarily correspond to a pure emotional answer and it can mask real affective states.

It is noteworthy that, generally speaking, research has paid little attention to context in affective computing area [9]. Context is inescapably linked to modality, and emotion is strongly multimodal as emotional cues may appear in various different channels. However, not all types of emotional cues tend to be available together, as context can affect relevant or accessible emotional cues. For instance, [10] explained that emotional behaviour models require representing multiple levels involved in emotional processes: the emotional context, the emotion itself and associated multimodal behaviours. In that work, some appraisal descriptors derived from the appraisal model [7] such as time-of-event were added in the context part of the proposed scheme. On the other hand, [11] proposed that context aware systems [12] are systems that adapt their behaviour according to context and that this context (location, time, activity, devices and person) includes also the user's affective state.

3 Ontologies and Emotions

Ontology has been a field of philosophy since Aristotle and from its beginnings, it has been characterised as a study of existence, a compendium of all there is in the world. Nowadays, it has evolved in great measure in the computer science and artificial intelligence fields. Currently, ontologies are viewed as a shared and common understanding of a domain that can be communicated between people and heterogeneous and distributed application systems. A detailed description is presented in Fig. 1.

Several ontologies for modelling affect have been proposed in literature. For instance, in text analysis area, Mathieu [13] presented a semantic lexicon in the field of feelings and emotions. This lexicon is described with an ontology. Words in the lexicon are emotionally labelled as positive, negative and neutral. Emotional annotation has also been used in WordNet ontology, thanks to the work performed in its WordNetAffect extension [14]. With the support of ontology technologies, users can retrieve information in a semantic manner [15]. A primary course of ontology building

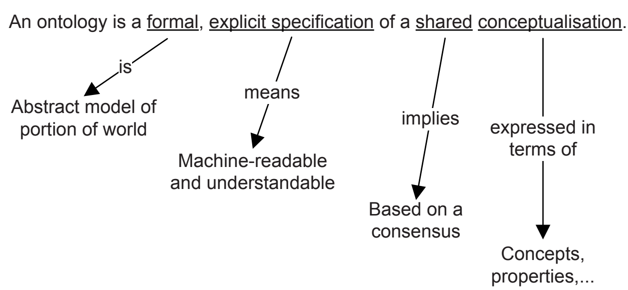


Fig. 1. Ontology definition [18]

is related to concept development. Focusing on speech, Galunov et al. [16] present an ontology for speech signal recognition and synthesis where emotion is taken into account. On the other hand, focusing on the context, Benta et al. [17] present an ontology based representation of the affective states for context aware applications which allows expressing the complex relations that are among the affective states and between these and the other context elements.

Although these kinds of unimodal approaches have relevance in their respective fields, they lack properly expressing the multimodal nature of human emotions. In this sense, multimodal ontologies for describing emotion have been proposed. For instance, Obrenovic et al. [19] describe an ontology based on emotional cues that uses media properties from different sources to model emotion. Apart from multimodality and user adaptation issues, technological evolution in mobile computing area has made necessary taking context into account in human-computer interaction situations. In this sense, Cearreta et al. [20] models user context by dividing it into several parts and focusing on emotion-related aspects in each part.

4 Conceptual Model

Our model has been created with independence of the psychological theory used. When expressing emotions, the three systems proposed by Lang [6] are used. Besides, it is considered that senses are used by humans and sensors by computers in order to receive affective information. Multimodality of emotions is related to sensors and expression systems.

As it is mentioned before, emotion has a strong dependence on contextual elements. Therefore, it is necessary to define the model taking the whole context that surrounds the user into account. It includes the personal part of the user and his/her affective state, which are also considered as parts of the context. Moreover, the model also includes environmental data, such as topics related to the place where user is. Finally, social aspects related to personal context are also described.

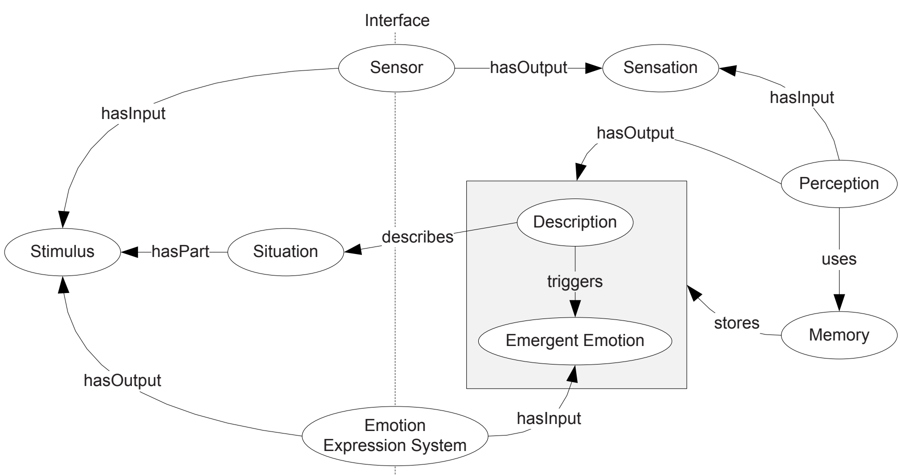


Fig. 2. Emergent emotion relationships with human information processing systems

We start our model from emergent emotions because they are easier to detect and can serve as a basis to understand what it is involved in human affectivity. Then, we generalise our model in order to treat emergent emotions, as it can be seen in Fig. 2.

Two main parts can be identified in Fig. 2, which are defined by the Interface line. This line groups the Sensor and Emotion Expression systems, which interface between the “physical world” on the left and the “mental world” on the right. In the physical world the model identifies arrangements called Situations that are constituted by a set of Stimuli. Stimuli are the input for Sensors, which have Sensations as output in the mental world. Sensations are the input for the Perception process, which uses memory in order to give meaning to Sensations and produces Descriptions, the mental representations for the Situations that describe them. Descriptions are associated to Emergent Emotions as they trigger them and both are stored in the Memory, from where they might influence the operation of future perceptions. Finally, Emergent Emotions constitute the output for the Emotion Expression System that reflects emotions in the real world by generating new Stimuli. In our model, we detail involved affective processes. The model is not trying to interpret emotions, because this depends on the used affective theory. In the same way, the "trigger" process in Fig. 2 is not detailed, because describing and interpreting emergent emotions also depends on affective theories. This model is detailed in the next section, formalised as an ontology. A detailed description of sensors and emotion expression systems is also provided.

5 Ontology for Describing Emotions

From the previous generic model, and following a classical ontology engineering methodology [21], a formalisation as an emotions ontology is developed. The ontology follows the modelling principles of the previous section and tries to be as emotions theory agnostic as possible. The objective is to develop an ontology flexible enough to accommodate existing emotions theories, like the ones presented in the literature review.

The first step has been to formalise the emotion model presented in the previous section. Semantic Web tools [22] have been chosen, more concretely the Web Ontology Language (OWL) [23]. OWL makes it possible to attain a great level of expressivity while producing a web ontology that can be easily shared through the web and thus be opened to third party extensions.

The different parts of the model have been modelled using the primitives provided by OWL. The main building blocks are classes, which represent concepts in the model, and properties, which represent the relations among the concepts. The first step has been to model all the ovals in Fig. 2 as OWL classes. Therefore, there are classes such as *EmergentEmotion*, *Description*, *Memory*, *Perception*, *Sensor*, etc. For the relations among these concepts in the model, OWL object properties have been generated, i.e. *hasInput*, *hasOutput*, *triggers*, etc.

The ontology is completed with some axioms that restrict the kind of things that these properties can link. In OWL, these axioms are called OWL restrictions and, in the context of a class, they specify to objects of what class does that property link to when applied to objects of the source class. For instance, the ontology contains a restriction that specifies that the *triggers* property when applied to the class *Description* points to objects of type *EmergentEmotion*. The full specification of the Emotions Ontology in OWL format is available on-line[1].

5.1 Rooting the Model on Upper Ontologies

The previous formalisation of the emergent emotion model helps building an ontology that facilitates computerised emotions management. However, it provides little semantics apart from those explicitly present in the model. For instance, the ontology provides little information about what a *Sensor* is. In order to enrich the ontology, we have taken existing upper ontologies into account.

Upper ontologies are very generic ontologies, about concepts like object or process, that settle down the ontological foundations about what is there in the world. Consequently, they provide very basic and fundamental semantics about the kind of things that a more specialised ontology, like the Emotions Ontology, can deal with. Building an upper ontology is a very complex process and thus it is recommended to reuse existing upper ontologies instead of elaborating a full conceptualisation for the concepts in a specialised ontology.

We have chosen DOLCE [24], that stands for Descriptive Ontology for Linguistic and Cognitive Engineering, because it fits really well with the underlying cognitive aspects that we have considered in order to build the conceptual model. In fact, the *Description* and *Situation* concepts in the Emotions Ontology have been reused from DOLCE.

These concepts provide a framework for representing contexts. *Situation* stands for a unitarian entity out of a “state of affairs”. The unity criterion is provided by a *Description*, an entity that partly represents it and that can be “conceived” by an agent: either human, collective, social or artificial.

Apart from these two concepts, DOLCE provides many other generic concepts that have been used in order to contextualise those in the Emotions Ontology. First of all, there is *Event* that generalises all occurring thing in our model. There are some concretisations, i.e. *Process*, an event considered in its evolution, and *Action*, an event with at least one agent that participates in it.

On the other hand, there are objects. *PhysicalObject* has been used in order to contextualise concepts like *Sensor*, which we have detailed further in the Emotions Ontology with artificial and biological sensors, and more specifically with human-like senses. *SocialObject* is the generalisation for *Description* and *Situation*, but also for *Verbal*, a kind of *EmotionExpressionSystem* together with *Behavioural* systems that have been specified as *Action*s.

All these relationships among Emotions Ontology and DOLCE concepts are shown in Fig. 3, where DOLCE concepts are coloured in grey. Moreover, the figure also shows additional concepts, apart from those shown in the model, that concretise concepts like *EmotionExpressionSystem* or *Sensor*. Additionally, the ontology also includes the different kinds of Context identified during the conceptualisation process. *SocialContext* and *EnvironmentalContext* are modelled using *Situation*. On the other hand, *PersonalContext* is based on the *Interface* concept that includes both the *EmotionExpressionSystem* and the Sensor concepts.

[1] Emotions Ontology, http://rhizomik.net/ontologies/2008/05/emotionsonto.owl

Although DOLCE provides the building block for modelling context, i.e. Description and Situation, concrete means that allow modelling the descriptions for the situations that trigger and are associated with emotions are necessary. However, to develop an ontology capable of dealing with the enormous range of situations that might be associated with emotions is out of the scope of an Emotions Ontology. Consequently, we have selected an existing ontology that provides such a wide scope called FrameNet [25].

We have selected FrameNet because it is better suited for modelling context as situations. FrameNet is based on the frame modelling paradigm. A frame is a schematic representation of a typical situation (e.g. eating, spying, removing, classifying, etc.) together with a list of the kinds of participants, properties and other conceptual roles that are seen as components of that situation[2]. Moreover, it is already connected with DOLCE, as it can be noted in Fig.3, where the concept *Frame* appears as a subclass of *Description*. Consequently, we can accomplish a smooth integration among the Emotions Ontology, DOLCE and FrameNet.

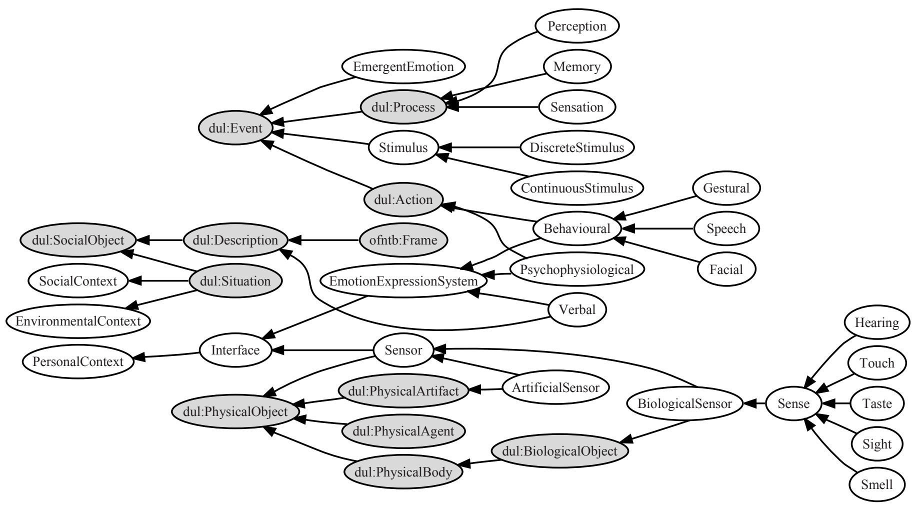


Fig. 3. The emotions ontology core in the context of the DOLCE upper ontology

For instance, in order to model the situation "Torres scored a winning goal in the last minute" using FrameNet, it is possible to use the "score.v" lexical unit, which belongs to the "Getting" frame. This frame defines a set of Frame Elements (FEs) and some of them might be used in order to model the participants and properties of this situation. The Frame Element "Recipient" is associated with "Torres", the FE "Theme" is linked to "goal", "Result" is filled with "winning" and "Time" points to "in the last minute".

6 Conclusions and Future Work

In this paper we present a generic model for describing emotions and their detection and expression systems taking contextual and multimodal elements into account. The model is formalised as an ontology that can be easily computerised.

[2] FrameNet. Retrieved June 4th 2008 from http://framenet.icsi.berkeley.edu

It is remarkable that context has received little attention regarding emotion-aware application development. This work takes this concept into consideration as a necessary component for modelling emotion. In this sense, proposed ontology is based on the definition of relevant contextual elements.

The ontology is based on the Web Ontology Language (OWL) standard, which makes ontologies easily shareable and extensible. This approach makes possible to reuse parts of DOLCE and FrameNet, two generic ontologies that help modelling descriptions and situations (D&S). D&S correspond to the only theoretical commitment that has been incorporated into the ontology, based on a cognitive interpretation of emotions. Apart from this, the ontology is totally agnostic regarding emotion theories. Existing semantic web technologies have proven to be valid and provide an adequate environment for modelling aspects related to human emotion.

The ontology can be used to develop applications that make computers more accessible, personalised and adapted to user needs. For instance, the ontology is being applied in an emotion-aware application based on Tangible User Interfaces (TUI) [26]. These TUIs are geared towards emotions-based human-computer interaction. The ontology structures and contextualizes the knowledge managed by the application, so it is been extended in order to deal with this concrete scenario.

Other interesting future work lays on extending the ontology beyond emergent emotion. The first extension considered is to model affective states in humans in order to make the ontology capable of modelling more complex aspects of human affectivity. This will make possible to model users bearing abovementioned affective states in mind. These enriched user models enable including aspects related with users disabilities and developing applications more adapted to their needs. Finally, the inclusion of social context in the ontology allows exploring emotion in computerised social environments such as social networks.

References

1. Picard, R.: Perceptual user interfaces: affective perception. Communications of the ACM 43(3), 50–51 (2000)
2. W3C Emotion Incubator Group (EmoXG). Report (July 10, 2007), `http://www.w3.org/2005/Incubator/emotion/XGR-emotion-20070710`
3. Scherer, K.R.: Psychological models of emotion. In: Borod, J.C. (ed.) The Neuropsychology of Emotion, pp. 137–162. Oxford University Press, Oxford (2000)
4. Douglas-Cowie, E., et al.: HUMAINE deliverable D5g: Mid Term Report on Database Exemplar Progress. HUMAINE Netowork of Excellence (2006), `http://emotion-research.net/deliverables/D5g%20final.pdf`
5. Ekman, P.: Expression and nature of emotion. In: Scherer, K., Ekman, P. (eds.) Approaches to emotion. Erlbaum, Mahwah (1984)
6. Lang, P.J.: A bio-informational theory of emotional imagery. Psychophysiology 16, 495–512 (1979)
7. Scherer, K.R.: Appraisal theory. In: Dalgleish, T., Power, M.J. (eds.) Handbook of cognition and emotion, pp. 637–663. Wiley, New York (1999)
8. Goffman, E.: Embarrassment and Social Organization. American Journal of Sociology 62, 264–274 (1956)

9. Cowie, R., Douglas-Cowie, E., Cox, C.: Beyond emotion archetypes: databases for emotion modelling using neural networks. Neural Networks 18, 371–388 (2005)
10. Devillers, L., Abrilian, S., Martin, J.: Representing real life emotions in audiovisual data with non basic emotional patterns and context features. In: Tao, J., Tan, T., Picard, R.W. (eds.) ACII 2005. LNCS, vol. 3784, pp. 519–526. Springer, Heidelberg (2005)
11. Baldauf, M., Dustdar, S., Rosenberg, F.: A Survey on Context-Aware systems. International Journal of Ad Hoc and Ubiquitous Computing 2(4), 263–277 (2007)
12. Collazos, C., García, R.: Semantics-Supported Cooperative Learning for Enhanced Awareness. International Journal of Knowledge and Learning 3(2/3), 59–66 (2007)
13. Mathieu, Y.: Annotation of Emotions and Feelings in Texts. In: Tao, J., Tan, T., Picard, R.W. (eds.) ACII 2005. LNCS, vol. 3784, pp. 350–357. Springer, Heidelberg (2005)
14. Strapparava, C., Valitutti, A.: WordNet-Affect: an affective extension of WordNet. In: Proceedings of 4th International Conference on Language Resources and Evaluation (LREC 2004), Lisbon, pp. 1083–1086 (2004)
15. Chi, Y.-L., Peng, S.-Y., Yang, C.-C.: Creating Kansei Engineering-Based Ontology for Annotating and Archiving Photos Database. In: Jacko, J.A. (ed.) HCI 2007. LNCS, vol. 4550, pp. 701–710. Springer, Heidelberg (2007)
16. Galunov, V.I., Lobanov, B.M., Zagoruiko, N.G.: Ontology of the Subject Domain. In: Speech Signals Recognition and Synthesis SPECOM 2004, 9th Conference Speech and Computer Saint-Petersburg, Russia (2004)
17. Benta, K.L., Rarău, A., Cremene, M.: Ontology Based Affective Context Representation. In: Proceedings of the 2007 Euro American conference on Telematics and information systems (EATIS 2007), Faro, Portugal (2007)
18. Studer, R., Benjamins, R., Fensel, D.: Knowledge engineering: principles and methods. Data and knowledge engineering 25, 161–197 (1998)
19. Obrenovic, Z., Garay, N., López, J.M., Fajardo, I., Cearreta, I.: An ontology for description of emotional cues. In: Tao, J., Tan, T., Picard, R.W. (eds.) ACII 2005. LNCS, vol. 3784, pp. 505–512. Springer, Heidelberg (2005)
20. Cearreta, I., López, J.M., Garay, N.: Modelling multimodal context-aware affective interaction. In: Paiva, A.C.R., Prada, R., Picard, R.W. (eds.) ACII 2007. LNCS, vol. 4738, pp. 57–64. Springer, Heidelberg (2007)
21. García, R.: Methodology. In: A Semantic Web Approach to Digital Rights Management, pp. 116–120. PhD Thesis, Universitat Pompeu Fabra, Spain (2006), `http://rhizomik.net/~roberto/thesis/html/Methodology.htm`
22. Lytras, M., García, R.: Semantic Web Applications: A framework for industry and business exploitation - What is needed for the adoption of the Semantic Web from the market and industry. Int. Journal of Knowledge and Learning 4(1) (in press, 2008)
23. Lacy, L.W.: OWL: Representing Information Using the Web Ontology Language. Trafford Publishing (2005)
24. Gangemi, A., Guarino, N., Masolo, C., Oltramari, A., Schneider, L.: Sweetening Ontologies with DOLCE. In: Gómez-Pérez, A., Benjamins, V.R. (eds.) EKAW 2002. LNCS (LNAI), vol. 2473, pp. 166–181. Springer, Heidelberg (2002)
25. Scheffczyk, J., Baker, C.F., Narayanan, S.: Ontology-Based Reasoning about Lexical Resources. In: Calzolari, N., Gangemi, A., Lenci, A., Oltramari, A., Prévot, L. (eds.) Ontologies and Lexical Resources for Natural Language Processing. Cambridge University Press, Cambridge (2008)
26. Neyem, A., Aracena, C., Collazos, C., Alarcón, R.: Designing Emotional Awareness Devices: What One Sees Is What One Feels. Ingeniare 15(3), 227–235 (2007)

Strategic IT Alignment in Swedish Public Healthcare System

Lazar Rusu[1], Yu Huang [2], and Ali Turab Rizvi[3]

[1] Department of Computer and Systems Sciences, Stockholm University/
Royal Institute of Technology Stockholm, Sweden
lrusu@dsv.su.se
[2] eBuilder, Stockholm Sweden
yu.huang@ebuilder.se
[3] Royal Institute of Technology Stockholm, Sweden
alitr@kth.se

Abstract. Information and communication technology (ICT) is not only beneficial for the business sector but has a lot to offer for the public sector as well. In fact, the public sector can benefit the most by the advancement of ICT that it offers numerous potential benefits in terms of improvements for patients, health and elderly care professionals and decision makers. In this context this research paper has studied the healthcare sector in Stockholm and has analyzed if their IT strategy is aligned with the government strategy. During this analysis we have found a lot of models developed for the alignment of business and IT strategy but we haven't found any model for the alignment of IT with the government strategy. Therefore in the analysis we have done in this paper we have proposed an integrated model and used the Swedish healthcare system as a case study in order to see if their IT strategy is aligned with their government's strategy.

1 Introduction

Although alignment is a top management concern, no comprehensive model of the construct is commonly used. A number of models of strategic business/IT alignment have been proposed till now from which the most well known are of Henderson and Venkatraman (1993) and Luftman (2000). The alignment of business and IT strategies has been utilized by organizations to create and improve efficiencies, reduce costs, create barriers to entry, improve customer and buyer/supplier relationships, and to create new products and business solutions. In the research of Weiss and Anderson (2004) concerning the alignment of business and IT strategies, they have found that there were at least four common themes, which were repeated by respondents of a survey of the companies who were more aligned at all levels of IT/business strategy: Clear direction, Commitment, Communication and Cross-functional Integration. These themes are called "The four C's," and the alignment results are in cross-functional integration. If an organization wants to succeed in IT/business strategy alignment, the boundaries between functions must be intentionally blurred and their

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 105–113, 2008.

employees must be encouraged to investigate the utilization of information technology to create value and accomplish the business strategy. Furthermore in order to investigate the evidence of alignment between business and IT, another alignment model was introduced by Huang and Hu (2005). Therefore in our case study research approach we have anchored our research on the model of Weiss and Anderson (2004) by using "The 4 C's" and the model introduced by Huang and Hu (2005). In this way, we have combined these two models to form a new alignment model that is an attempt to transform the concept of alignment into a practical method, incorporating both management and design components. In line with Tallon et al (2000), the organization on which we have mainly focused in our case study (Carelink) is operational-focused with regard to its IT use in seeking operational efficiency. Moreover like Hirschheim and Sabherwal (2001) have mentioned in their research we have noticed that the others actors involved in the Swedish national e-healthcare strategy from the county councils and local government authorities have recognized the importance and need for IT alignment in order to achieve a better performance in the e-healthcare system. However, this research study has its limitations and is only looking to a particular situation from one country but it is obvious that this research would be greatly enhanced by similar studies done in other countries too.

2 The Research Background

Organizations that have been able to successfully integrate technology and business strategy have created significant business returns. Therefore IT has become an important enabler of business strategies in such areas of mass customization, competitive differentiation, quality improvements, and process automation and improvement (Bruce 1998). In fact the managers from organization that have aligned IT with business strategies argue that the integration was crucial to the organization's survival and its success and the IT units have added value to an organization's effectiveness by acting as change agents, focusing on business imperatives, and helping to achieve effectiveness and efficiency (Earl and Feeny 1994). According to Reich and Benbasat (2000) we have the following elements that are contributing to the alignment: the shared domain knowledge between the IT department and the business domain; the IT implementation success; communications and planning connections between IT and business; and finally the business direction. Combined with the previous academic research and managerial practice, Huang and Hu (2005) have introduced an alignment model to investigate the evidence of alignment between business and IT. Therefore in our paper we anchored our research questions on the Huang and Qing Hu (2005) model to guide our exploratory case study: the alignment is achieved through two mechanisms-communication between IT and business managers and connections between IT and business planning processes - with two antecedents, the shared domain knowledge among IT and business managers and successful IT history. This model is largely consistent with the alignment literature with more emphasis on the informal structure and less focus on the processes of alignment as the strategic alignment model requires (Huang and Hu 2005). In their research Huang and Hu (2005) argue that in order to provide a strategic alignment framework that can be used by practitioners as a roadmap and an action plan, both the processes and the information structures of alignment are necessary. From this perspective, they expanded the Reich and Benbasat (2000) model with two new components: the relationship management as an antecedent of alignment, and the balanced scorecard as the mechanism of alignment. In the research we have done, we haven't investigated the role of balanced scorecard in alignment because indeed balanced scorecard has its drawbacks and it cannot be suited for all sorts of organizations, so we removed this component from the Huang and Hu (2005) model. We further analyzed this new model and tried to implement it in a public organization part of the Swedish healthcare sector and we found out that this model can be applied in this case with a change in relationship management. In fact in a public organization, relationship management is a key factor for a better performance therefore in our opinion they need to manage two things, internal relationship management and external relationship management. By external relationship management we mean the relationship with external entities outside organization. In our case this is the relationship with the public. Moreover for a public organization it is important to have quick, fast, reliable including a trust worthy relation with the general public in order to achieve credibility, confidences, and high performance therefore in this case IT provides the mechanism to achieve it. On the other hand, by internal relationship management, we mean cross functional, cross organizational relationship which is the same like it the relationship management described in the research model of Huang and Hu (2005). Removing balanced scorecard from Huang and Hu (2005) model we will provide a road map to achieve IT and business alignment with antecedents leading to the next level. In parallel to these antecedents, a measurement mechanism is needed to be used to measure these activities at every level that finally will lead us to the proposition of a new model based upon the Huang and Hu (2005) and Weiss and Anderson (2004) research. In fact this new model it will provide us a way to achieve IT and business alignment that is a set of activities with antecedents that leads from one phase to another. Very important to notice here is that in this new model each activity is needed to be measured using a measurement tool in order to ensure that the road map is being followed properly. Therefore this tool it will provide a bridge to move from an earlier stage to the next stage minimizing the gap between the two ones. By applying this theory proposition to the model described, we due to the conclusion that IT and Business alignment is an outcome of activities performed for the enablers of road to alignment and measurement of those enablers (as it is shown in figure 1).

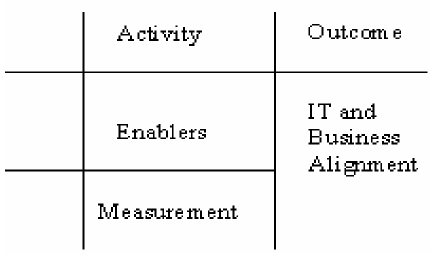


Fig. 1. IT and business alignment matrix (Huang and Hu 2005)

From the research done by Weiss and Anderson (2004) regarding IT and business alignment in case of 15 companies, we have used their "4 C's" model which is applicable at all levels in an organization. The results of using "The 4C's" and Huang and Hu (2005) research models has due to an integrated one with the modifications in relationship management in the IT and business alignment matrix as is depicted in figure 2. In the new integrated research model "The 4 C's" model has been used as a tool to measure the enablers. For validating the new integrated model mentioned before in figure 2 we have used the case study research approach which is the most appropriate when "a how" and "why" question is being asked about a contemporary set of events, over which the investigators has little or no control (Yin 2002).

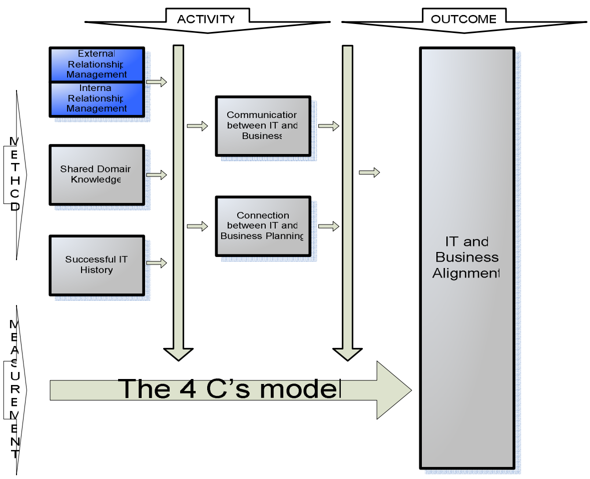


Fig. 2. The integrated "4 C's" and Huang and Hu (2005) research model

3 An Overview of the Swedish Healthcare System

With a vision of "Good health on equal terms", Sweden started to further develop healthcare in 2000, they appear to have the most highly-developed national strategy for healthcare informatics. Its healthcare expenditure is €2,377 per citizen, or 9% of GDP, and the Swedish healthcare system is strongly decentralized with 23 county councils and three city councils being the key operational players (Carelink 2006). Their IT expenditure is €552m, which amounts to €61.67 per head and a massive 2.59% of the health budget – one of the largest amounts in the world (Ross 2005). On the 1st of May 2006 Sweden has just released their latest national strategy for IT in healthcare in which its IT strategy focus on common infrastructure, services on Sjunet, and cooperation for seamless care and security (Nordic Council of Ministers 2005). Today, in Sweden the IT systems vary between different regions and even within regions, which is a reason for losses in efficiency. But the advances in medicine and medical technology and the socioeconomic and demographic development is continue to place new and tougher demands on healthcare system to which is added also the pressure of citizens for the best possible health care adds. All in all, these trends mean that the healthcare sector faces enormous financial, qualitative and structural challenges (Carelink 2006). Here an important role is having Carelink organization which together with the Swedish National Board of Health and Welfare has build the coordination body for the Swedish national IT strategy in Healthcare (Nordic Council of Ministers 2005). Moreover Carelink is providing a strategic support to the county councils and the local authorities, in coordinating their major national IT projects in Swedish healthcare area. In fact there are IT units located in every Swedish county council, which will develop and implement the IT solutions that are suggested in the national IT strategy. As it is shown in Figure 3, there are four major actors in our case study and these are Carelink organization, the IT units in the county councils, the Swedish local authorities and county councils and the Swedish public. In the research we have done we have tried to investigate the relationships among these actors and how they interact between each other in order that the Swedish government to provide better healthcare services to citizens through different strategies.

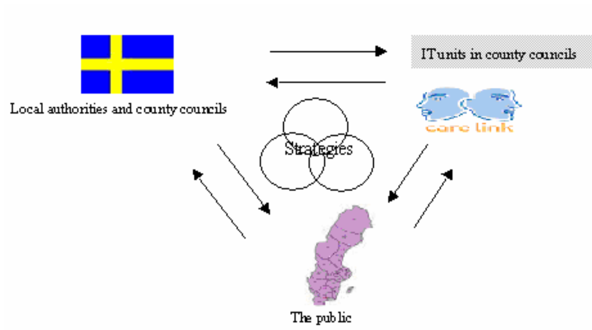


Fig. 3. The actors of the Swedish public healthcare system

4 The Analysis of the Strategic Alignment between Business and IT Planning

It's undoubtedly difficult to measure the level of strategic alignment achieved and maintained in an organization directly. However, indications of strategic alignment can be observed and measured, as are suggested by Reich and Benbasat (2000) and included in our research model. Moreover we have adopted the measures of "connections between business and IT planning" and "communication between business and IT mangers" as indicators of alignment level in the organizations from our case study.

4.1 The Connection between Business and IT Planning

As National Council has mentioned in their report (Carelink 2006), Swedish e-health solutions must be coordinated at national level and be underpinned by a common technical infrastructure. Therefore ICT use must be managed, coordinated and followed up at the national level. Moreover the National e-health strategy requires that all actors in the healthcare sector to cooperate on a number of issues at national level.

On the other hand from our interview with the Carelink manager we have found that there is a big change in the last five years where IT is today more like a management question in all of the Swedish county councils; and as we have seen it's now a management issue not only a technical question (Table 1).

Table 1. The Connection between Business and IT Planning

"The Information System strategy focus on enabling the organization with the necessary information supported on a cost-effective technical infrastructure. Among the most significant elements of this strategy are achieving operational excellence through discovering opportunities to perform operational processes more efficiently and supporting e-Health growth associated with our initiatives to bring better service to citizens." (National Strategy for e-Health in Sweden 2006)
"The formal decision process in this case begins with a proposal from the chief executive officers of SALAR, then the strategy be approved by the governing boards of the latter organizations […], The necessary follow-up work will be undertaken by several bodies: The Ministry of Health and Social Affairs, the National Board of Health and Welfare, […] and Carelink." (Carelink 2006)

4.2 The Communication between Business and IT Unit

As we have understood the communication between the different Swedish healthcare organizations is crucial when a new IT solution comes out. Even from the beginning of the IT application's development, the communications between two groups of people is necessary. Also a close relationship and frequent communication is enabling the IT system to be more meaningful, and will bring benefits in both directions (Table 2).

Table 2. The Communication between Business and IT unit

"We communicate regularly, and have many meeting every year to discuss the national solutions for healthcare, because it forces us … to make sure we meet […]." (Carelink 2006)
"We have a very close relationship and have identified key people within my group and key people within IT who have … every-other-week or monthly meetings on [our IT system]." (Dr.Laili Basu, MD at S:t Görans Sjukhus, Stockholm)

4.3 Antecedents of Strategic Alignment

4.3.1 Internal Relationship Management

In the interview done at Carelink, we have asked our interviewer why we should be care of thinking about the relationship issue while realizing the alignment. The answer of the manager from Carelink was the following: "So now all of us managers within IT have liaisons within the healthcare community. Several times throughout the year we make sure that we stay in touch with other departments; and at the budget time, we have meetings that are more informal to review their requirements… If we don't have a good partnership with them, then we'll fail. So it's really extremely critical. Until you learn that, your IT is not successful". In a discussion with another IT manager from Carelink he has told us that government agencies belong to a very large organization and sometimes it's very difficult to cooperate within it, because all of them have their own systems and working methods. This sure in his opinion it's not an easy task because they have different needs and missions and they need organizations like Carelink to co-ordinate, for the reason that all the county councils know that they cannot do that by themselves. In fact the national healthcare report is showing that everyone agrees on the national healthcare strategy and the mission too, which is very important to manage the internal relationship.

4.3.2 External Relationship Management

The relationship with the public is a key factor in the national healthcare strategy. The high-level management group in Sweden tries hard to empower patients and provide an easier way for them to reach the healthcare information. There is no doubt that a good relationship with the patients and customers will indirectly improve Carelink's partnership with the Swedish healthcare community and also the relationship between IT units and other departments. The county council has today created a web portal available for everybody to get information from it. In addition, all county councils provide telephone-based health advisory services, which allowing callers to contact their local health advisory service on the same telephone number from anywhere in the country. It is in the public interest that these services be expanded, improved and adapted to specific target groups and that clear, easy-to-use information services are developed to be uses by the citizens as complements to the normal care services. In this way the success of these projects has contributed to a high satisfactory rate among the public.

4.3.3 Shared Domain Knowledge

The Swedish National Council encourages cooperation at national level, such as the need for adequate ICT training at all training levels in the healthcare services. Moreover major training initiatives are undertaken on a joint basis to facilitate collaboration between different professional groups and other areas of the healthcare services. Furthermore it is needed a broad selection of suitable training programmers and courses for different professional groups including IT decision-makers (Carelink 2006). In our case study, both the officers in the county councils and the IT managers in Carelink are well aware of the importance of understanding each other's domain; therefore they have tried to enhance their knowledge of other parts of the public healthcare sector through various means.

4.3.4 Successful IT History

A successful IT track record tends to improve its relationships with business at all levels (Rockart et al 1996), and it is argued that the degree of IT implementation success can enhance also the communication between senior officers in National Council and IT units and the connections between business and IT planning processes (Carelink 2006). In our case study, we have found that in general the officers from the county councils had a high level of confidence in their IT units and the officers from the government units have expressed also their satisfaction with some of the major IT projects, such as the Sjunet (an IP-based broadband network).

4.4 The Analysis Using the "4 Cs" Model

By using the "4 C's" model we have tried to measure the outcome of all enablers at different levels of our research model. In the interviews we have conducted with people from the Swedish healthcare public sector we have found it that the high standard national healthcare strategy, organizational policies and IT strategy provides a clear direction to the near and distance future. Moreover IT and other national strategy in the public healthcare area are jointly coordinating the development of the national e-health strategy. Furthermore the highest level of management in Swedish healthcare sector commits to national IT strategy. However, one of the managers in Carelink mentioned that the commitment from high-level management differs in various county councils and she said that some of the county councils still take IT as an implementation tool. In our opinion co-ordination and communications between the various organizations in healthcare sector is one of the key elements to succeed. Therefore Carelink plays an important role for the co-ordination in national IT projects and their support for co-ordination creates efficiency in IT investments and the alignment is leading to the cross-functional integration. Many organizations have in fact realized that IT is an important means to support healthcare, not only as a technical implementation tool. For example one of the IT managers stated that it also differs a lot between different county councils, in some of the county councils they have a very close cooperation between IT planning and business planning and they work together all the time, but the others still stay in the old fashion. However, things are changing, and more and more county councils decided to use IT to change their organizations, working methods and strategies which finally will lead to a very close connected relationship.

5 Conclusions

As we mentioned earlier, it is undoubtedly difficult to say if the Swedish IT strategy is perfectly aligned with the national healthcare strategy but the evidences shows that they have reached a higher level of alignment. Although IT is part of national healthcare strategy but still it is perceived as a process enabler and a service provider, rather than a partner, who generates efficiency in operational functions. As we have noticed before the role of Carelink has been crucial for the Swedish healthcare sector in order to achieve this high level of alignment, which according to our perception is acting as a Chief Information Officer (CIO) for the whole healthcare public sector. Therefore in order to achieve a higher level of IT and business alignment in the public sector, an organization that is acting like a "CIO" could be very usefully in making all the actors to cooperate in the development of the IT strategy and also in using a common business strategy.

References

Bruce, K.: Can you alight IT with business strategy? Strategy & Leadership 26(5), 16 (1998)

Carelink, National strategy for e-health (2006), http://www.sweden.gov.se/content/1/c6/06/43/24/f6405a1c.pdf

Earl, M.J., Feeny, D.F.: Is your CIO adding value? Sloan Management Review 35(3), 11–20 (1994)
Henderson, J.C., Venkatraman, N.: Strategic Alignment: Leveraging Information Technology for Transforming Organization. IBM Systems Journal 32(1), 4–16 (1993)
Hirschheim, R., Sabherwal, R.: Detours in the Path Towards Strategic IS Alignment. California Management Review 44(1), 1–12 (2001)
Huang, C.D., Hu, Q.: Aligning IT with Firm Business Strategies Using the Balance Scorecard System. In: Hawaii Proceedings, pp. 2–5 (2005)
Luftman, J.: Assessing Business-IT Alignment Maturity. Communications of AIS 4, art. 14, 1–50 (2000)
National strategy for e-health in Sweden (2006), http://www.sweden.se/templates/cs/Publication____14832.aspx
Nordic Council of Ministers, Health and Social Sectors with an "e"- A study of the Nordic countries, Copenhagen (2005)
Reich, B.H., Benbasat, I.: Factors That Influence the Social Dimension of Alignment Between Business and Information Technology Objectives. MIS Quarterly 1(24), 84–113 (2000)
Rockart, J.F., Earl, M.J., Ross, J.W.: Eight Imperatives for the New IT Organization. MIT Sloan Management Review 1(38), 43–55 (1996)
Ross, A.: Healthcare IT in Europe and North America, Cambridge (2005)
Tallon, P., Kraemer, K., Gurbanaxi, V.: Executives' perceptions of the business value of IT. Journal of Management Information Systems 16(4), 145–172 (2000)
Weiss, J.W., Anderson, D.: Aligning Technology and Business Strategy: Issues & Frameworks, A Field Study of 15 Companies. In: Hawaii Proceedings, p. 7 (2004)
Yin, R.K.: Case Study Research: Design and Methods, 3rd edn. Sage Publications, Thousand Oaks (2002)

Understanding Network Mobility in Pervasive Markets: Realistic Human Shopping Behavioral Model

Lu Yan

School of Computer Science, University of Hertfordshire
College Lane, Hatfield, Hertfordshire AL10 9AB, UK
lu.yan@ieee.org

Abstract. With recent advances of wireless ad hoc networking, especially opportunistic forwarding and cognitive radio, there is an increasing concern that existing mobility models are insufficient to represent network mobility in real world settings. In this paper, we discuss our proposal for a more realistic mobility model which captures key features of human movements in pervasive markets. Our findings lead to a non-traditional mobility model which can be used to reconstruct the statistical patterns of realistic human shopping behaviors. We believe this model is ground-breaking, since no similar model exists in the literature, to the best of our knowledge.

1 Introduction

The communication environment surrounding our daily experience is increasingly characterized by mobile devices that can exchange information and provide access to various services of complex nature. The trend is clear that future personal computing experience would be more and more based on pervasive communication devices and services, and the underlying mobile networks are becoming cooperative as mobile devices are increasingly rely on nearby nodes to maintain connectivity or relay messages.

In the future scenarios of wireless ad hoc networking like above, local connections and user mobility are as important as infrastructure access today for delivering data [1], but those mobility issues are not well studied in the past. As mobile devices are often attached to users, understanding their mobility patterns would lead to more *realistic* network simulation and better software and communication system design in general. However, existing mobility models are either too simplistic or do not represent the key characteristics of user mobility [2]. In the literature, most commonly used mobility models can be categorized into two types: individual mobility model and group mobility model.

Individual mobility models address the movement at individual node level, where each node is assumed to be independent from others: the Random Walk model [3] is the *de facto* mobility model for most mobile network simulations, which is a direct implementation of Brownian motion. The Random Waypoint model [4] is also widely used in mobile network simulations, where nodes travel between randomly chosen locations. The Gauss-Markov model [5] was designed to adapt to different levels of randomness, where nodes updates their speed and direction at each time step, taking previous values into account.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 114–122, 2008.

In a group mobility model, the movement of a node is calculated relatively to the movement of a reference point in the group it belongs to: the Reference Point Group model [6] was based on the observation that mobile nodes in real world tend to coordinate their movement (e.g., in battlefield, a number of soldiers may move together in a group or platoon; or during disaster relief, various rescue crews form different groups and work cooperatively), where nodes are assumed to be in groups of one leader and a number of members. The movement of the group leader determines the mobility behavior of the entire group. The Social Network and Community model [7] is a recent approach to deriving mobility traces based on the analysis of community structure in social networks, which further considers the group dynamics and clustering techniques in the node movement calculations.

Observing that above approaches are all *top-down*: they try to define the real characteristics that a mobility model should capture and then build the model accordingly, we take a reversed thinking *down-top* that mobility models should be inferred from observations made in real world networks, due to two facts: (1) real characteristics are actually hard to define; (2) node mobility characteristics in real world are very application specific.

The rest of paper is organized as follows. Section 2 provides background information and data collection techniques. Section 3 presents a novel approach to mobility model for real-life networks. Section 4 validates our hypothesis about this model and we conclude the paper in Section 5.

2 Data Collection

Camden market was chosen for collecting user mobility traces. Camden market is a large craft and clothing market in Camden town and the fourth most popular visitor attraction in London, attracting approximately 100,000 people each weekend [8]. HP GPS rx5730 handheld receiver is used for data collection, with a position accuracy of better than 3 meters most of the time. Users were supposed to keep the GPS receiver with them for as much of their visiting time as possible, with most carrying the GPS receiver in pockets. Occasionally, tracking information has discontinuity mainly when users move inside the indoor part of Camden market where GPS signals cannot be received.

The GPS receiver takes reading of the user's position every second and records it into a trace log. The trace log contains at least the following data:

`Latitude;Longitude;Altitude;Speed;Date;Heading` (1)

For the preliminary study, we collected traces of 4 market visitors (2 male and 2 female) over two month period. The assumption we taken here is that every visitor in the Camden market has the same statistical mobility tendency, and we believe it is reasonable to analyze the aggregative statistical patterns instead of individual statistical patterns. This assumption is also found in [9-13]. Therefore we believe it is reasonable to use this assumption in our analysis.

From those traces, we extract the following information: movement length, stay time, direction, and speed. Since we are mainly interested in two dimensional mobility models, we map the raw data from GPS reading into two dimensional ones. Other treatments of the raw dataset are similar to [14]. Figure 1 shows a sample GPS trace visualized in the Google earth.

Fig. 1. Sample GPS trace from Camden market

3 A Levy Walk Mobility Model

Many recent studies [9-13, 15-17] have found, in various areas of real world mobility ranging from physical particles, biology, human behaviors, to computer networks, some fascinating common features pervade them: the once abstract notions of *fractal* space and time appear naturally and inevitably in dynamical systems like above [16], which are not present in traditional random process models.

More specifically, what all these movements have in common is that their mobility patterns are shown to strongly resemble the Levy walk [15] process. A Levy walk is comprised of random sequences of movement-segments, with length l, drawn from a probability distribution function having a power-law tail:

$$p(l) \propto l^{-\gamma} \tag{2}$$

where $\gamma \in (1,3]$. Such a distribution is said to have a heavy-tail [12] because large-length values are more prevalent than would be present within other random distributions, such as Poisson or Gaussian.

Levy walk was used to model animal foraging patterns [9]. According to the foraging theory, animals are presumed to search for nutrients and obtain them in a way to maximize the ratio of energy intake over the time spent for foraging. Levy walk is a commonly observed searching strategy in animal foraging, and it is proved that Levy walk strategy minimizes the mean distance traveled and presumably the mean energy expended before encountering a target [15]. Recent literature demonstrated that the Levy walk system is also very similar to the way that humans shop [9, 11, 12].

Figure 2 shows an abstract model of market visitors' traces: (1) a visitor's directions of successive steps are uncorrelated; (2) the distribution of the lengths of the steps (called flights) is characterized by a long tail.

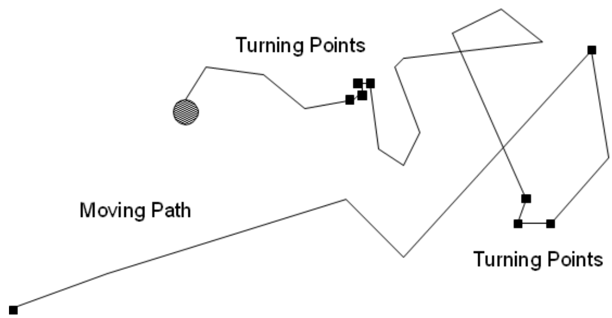


Fig. 2. Abstract graphical model of human shopper

4 Experimental Confirmation

It is confirmed from our measurement that Camden market visitor's trace also statistically resembles the Levy walk model: the flight distance l, which is defined as the longest possible straight line between locations without a directional change or pause, follows a power-law distribution.

4.1 Flight Distance

A power-low distribution of flight distances is the defining feature of Levy walk. We first show a statistical result from our measurement in the Camden market, and then use curve-fitting techniques to extract the scale parameter from the measurement.

We used a similar statistical method as [9]. For market visitors' movements, we first do a spectrum analysis as Figure 3, which already shows some evidences of an intermittent structure of longer flights. Using the frequency counts from the spectrum, we can normalize the distance distribution and derive a distance probability density graph as Figure 4.

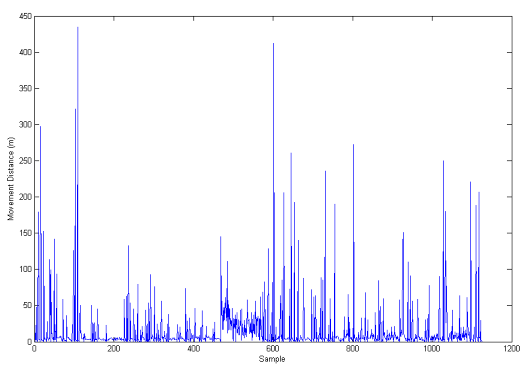


Fig. 3. Spectrum analysis of market visitors' movements

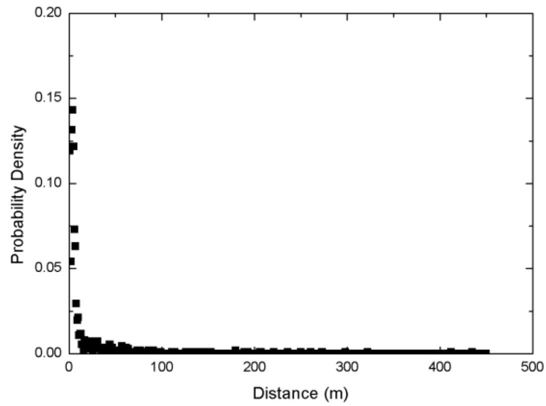


Fig. 4. Normalized distance distribution based on frequency

Figure 4 already exhibits the long tail characteristic of the visitor's movements, but we can show it more clearly in a log-log plot refinement as Figure 5, where the levy characteristic is highlighted as a red line. Though the levy tendency is evident in Figure 5, we still need to quantitatively validate the Levy model with a scale parameter.

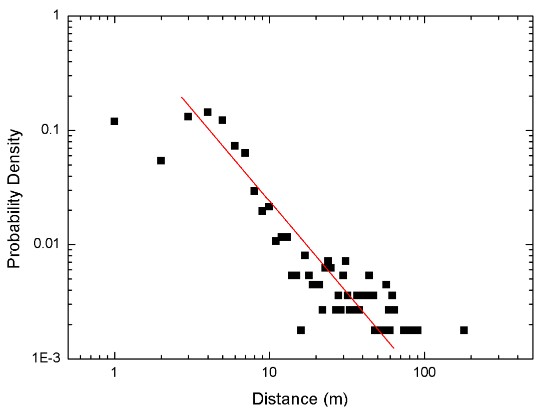


Fig. 5. Log-log plot refinement of Figure 4

We used the maximum likelihood estimation (MLE) to estimate the scale parameter:

$$\gamma = 1 + n[\sum_{i=1}^{n} \ln \frac{x_i}{x_{\min}}]^{-1} \tag{3}$$

where γ is the estimated scale parameter and x_i is the data sample. With this estimated scale parameter γ, we are already able to reconstruct a levy distribution curve. But at this point, we are not yet sure if the reconstructed curve is really a good fit of the original dataset. Thus a goodness-of-fit test is needed, and we used Kolmogorov-Smirnov statistic to validate the fitness:

$$f = \max_{x \geq x_{\min}} \left| S(x) - P(x) \right| \tag{4}$$

where f is the goodness-of-fit, $S(x)$ is the cumulative distribution function (CDF) of the data, and $P(x)$ is the CDF from our reconstructed curve.

Figure 6 shows the quantitative analysis result with an estimated scale parameter $\gamma = 1.8790$ and its goodness-of-fit $f = 0.0421$.

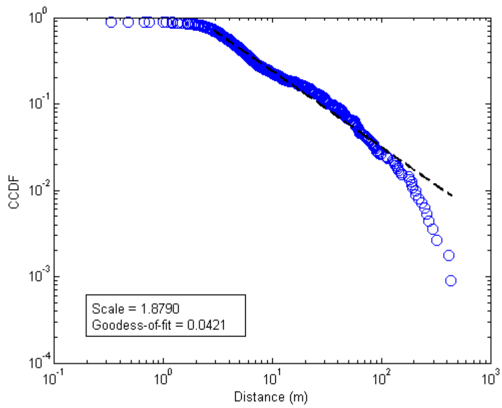


Fig. 6. Quantitative analysis of distance

4.2 Stay Time and Turning Angle

The definition of Levy work *does not* require a power-law distribution of the stay time Δt, which is defined as the pause time in a location. However, surprisingly, we also observed a levy distribution of stay time from the Camden market visitor's traces. Using the same techniques developed in Section 4.1, we can derive a quantitative result with $\gamma = 1.8700$ and $f = 0.0849$ as shown in Figure 7. However, a goodness-of-fit value $f = 0.0849$ implies that Levy tendency in stay time distribution is not as strong as that in distance distribution.

Though power-law distribution of stay time is not necessary in the Levy work definition, it would be interesting to further investigate whether this phenomenon is a pure coincidence or a common feature.

The turning angle θ, which measures the directional changes, not surprisingly, does not follow a power-law distribution. One reasonable assumption can be made here is that turning angles may be influenced by the geographical characteristics since shop placements in the Camden market must follow the geographical and council regulations, a quadrimodal distribution is expected here since urban architecture is dominated by right angles.

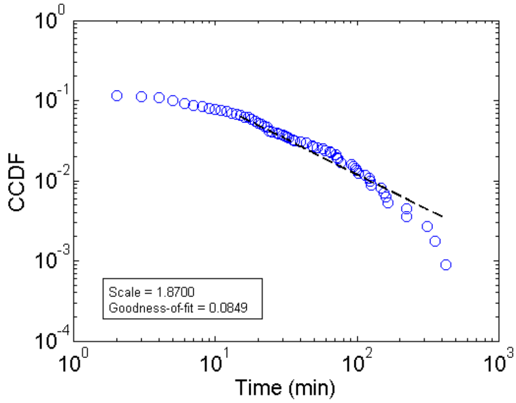


Fig. 7. Quantitative analysis of time

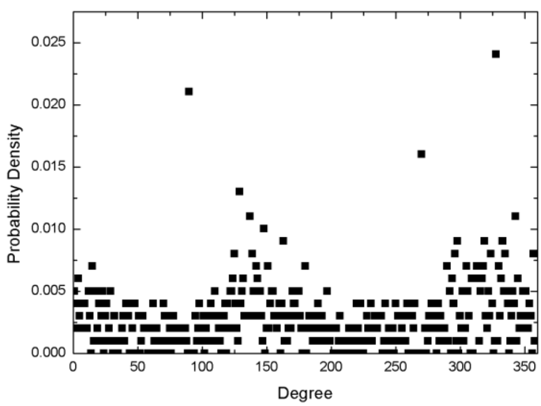


Fig. 8. Turning angle distribution

However, the observed distribution in Figure 8 does not exhibit a strong quadrimodal tendency. This distribution has no Levy tendency either. If we plot this distribution in a cumulative manner, we may observe a linear tendency in Figure 9. Therefore we believe uniform distribution may be a good fit here, though the bias from quadrimodal distribution needs further investigation in this case.

4.3 Reconstruction

Now we are ready to reconstruct the user mobility traces in Camden market with a Levy walk model. The feature of each movement tuple M is captured by three variables:

$$M = (l, \Delta t, \theta) \tag{5}$$

where l, Δt, and θ are flight distance, stay time, and turning angle respectively

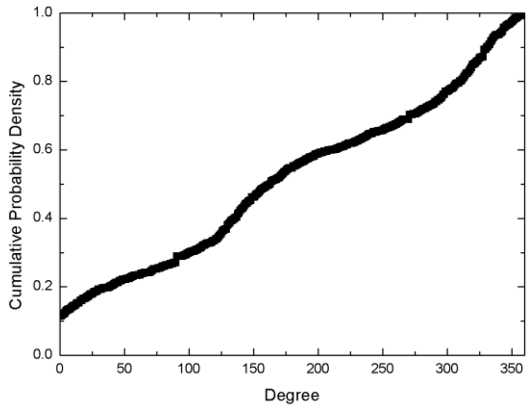


Fig. 9. Cumulative distribution of turning angle

When reconstructing the mobility traces, our model would calculate M_t at time t and randomly generate l_t and $(\Delta t)_t$ with the Levy distribution; while θ_t follows a uniform distribution. Figure 10 shows a comparison of reconstructed sample mobility traces with the random walk model, the random waypoint model, and the Levy walk model respectively.

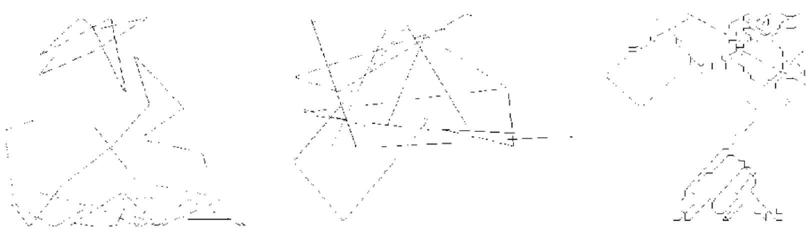


Fig. 10. Reconstructed sample mobility traces with **a.** the random walk model, **b.** the random waypoint model, and **c.** the Levy walk model; (from left to right)

5 Concluding Remarks

Network mobility is an important research area in pervasive computing. Understanding user mobility is critical for simulations of mobile devices in a wireless network, but current mobility models often do not reflect real user movements.

This paper presented a non-traditional phenomenological approach to user mobility modeling in pervasive markets. We introduced the Levy walk model to the user mobility patterns and the preliminary study in Camden market confirmed that market visitor's trace statistically resembles the Levy walk model.

Because of resource constraints, our model presented in this paper mainly captures the features of individual movements at node level. It would be interesting to study both individual and group movements in various types of pervasive markets.

References

1. Su, J., Scott, J., Hui, P., Crowcroft, J., de Lara, E., Diot, C., Goel, A., Lim, M.H., Upton, E.: Haggle: Seamless Networking for Mobile Applications. In: Krumm, J., Abowd, G.D., Seneviratne, A., Strang, T. (eds.) UbiComp 2007. LNCS, vol. 4717, pp. 391–408. Springer, Heidelberg (2007)
2. Camp, T., Boleng, J., Davies, V.: A survey of mobility models for ad hoc network research. Wireless Communications and Mobile Computing 2, 483–502 (2002)
3. Nain, P., Towsley, D., Liu, B., Liu, Z.: Properties of random direction models. In: 24th Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM 2005), Miami, FL, USA, vol. 3, pp. 1897–1907 (2005)
4. Navidi, W., Camp, T.: Stationary distributions for the random waypoint mobility model. IEEE Transactions on Mobile Computing 3, 99–108 (2004)
5. Liang, B., Haas, Z.J.: Predictive distance-based mobility management for PCS networks. In: 18th Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM 1999), New York, USA (1999)
6. Hong, X., Gerla, M., Pei, G., Chiang, C.-C.: A group mobility model for ad hoc wireless networks. In: 2nd ACM international workshop on Modeling, analysis and simulation of wireless and mobile systems (MSWiM 1999), Seattle, Washington, USA (1999)
7. Boldrini, C., Conti, M., Passarella, A.: Impact of Social Mobility on Routing Protocols for Opportunistic Networks. In: IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2007), Helsinki, Finland (2007)
8. Wikipedia: Camden Market
9. Sims, D.W., Southall, E.J., Humphries, N.E., Hays, G.C., Bradshaw, C.J.A., Pitchford, J.W., James, A., Ahmed, M.Z., Brierley, A.S., Hindell, M.A., Morritt, D., Musyl, M.K., Righton, D., Shepard, E.L.C., Wearmouth, V.J., Wilson, R.P., Witt, M.J., Metcalfe, J.D.: Scaling laws of marine predator search behaviour. Nature 451, 1098–1102 (2008)
10. Edwards, A.M., Phillips, R.A., Watkins, N.W., Freeman, M.P., Murphy, E.J., Afanasyev, V., Buldyrev, S.V., Luz, M.G.E.d., Raposo, E.P., Stanley, H.E., Viswanathan, G.M.: Revisiting Lévy flight search patterns of wandering albatrosses, bumblebees and deer. Nature 449, 1044–1048 (2007)
11. Brockmann, D., Hufnagel, L., Geisel, T.: The scaling laws of human travel. Nature 439, 462–465 (2006)
12. Barabási, A.-L.: The origin of bursts and heavy tails in human dynamics. Nature 435, 207–211 (2005)
13. Viswanathan, G.M., Afanasyev, V., Buldyrev, S.V., Murphy, E.J., Prince, P.A., Stanley, H.E.: Lévy flight search patterns of wandering albatrosses. Nature 381, 413–415 (1996)
14. Kim, M., Kotz, D., Kim, S.: Extracting a Mobility Model from Real User Traces. In: 25th IEEE International Conference on Computer Communications (INFOCOM 2006), Barcelona, Spain (2006)
15. Viswanathan, G.M., Afanasyev, V., Buldyrev, S.V., Havlin, S., Luz, M.G.E.d., Raposo, E.P., Stanley, H.E.: Lévy flights in random searches. Physica A: Statistical Mechanics and its Applications 282, 1–12 (2000)
16. Shlesinger, M.F., Zaslavsky, G.M., Klafter, J.: Strange kinetics. Nature 363, 31–37 (1993)
17. Viswanathan, G.M., Buldyrev, S.V., Havlin, S., Luz, M.G.E.d., Raposo, E.P., Stanley, H.E.: Optimizing the success of random searches. Nature 401, 911–914 (1999)

User Information Satisfaction with a Knowledge-Based Virtual Community: An Empirical Investigation

Xiao-Ling Jin[1], Christy M.K. Cheung[2], Matthew K.O. Lee[3], and Huaping Chen[4]

[1] Department of Information Systems, USTC-CityU Joint Advanced Study Institute
xljin@mail.ustc.edu.cn
[2] Department of Finance and Decision Sciences, Hong Kong Baptist University
ccheung@hkbu.edu.hk
[3] Department of Information Systems, City University of Hong Kong
ismatlee@cityu.edu.hk
[4] Department of Information Systems, University of Science and Technology of China
hpchen@ustc.edu.cn

Abstract. Virtual communities provide online social spaces for individuals to share and exchange knowledge. The value of these communities however depends on user ongoing participation. User satisfaction is one of the most crucial factors determining the continuance of using an information system. In this specific context of virtual community, the content (information) is collectively created by members in the community. It is thus important to identify factors determining user information satisfaction. A theoretical model of user information satisfaction was developed and empirically tested with 240 current users of a knowledge-based virtual community. Among the four attributes of information quality, only perceived information relevance, disconfirmation of information accuracy, disconfirmation of comprehensiveness, and disconfirmation of information relevance have significant influence on user information satisfaction. This study has raised many interesting questions. Additional theorizing and empirical investigation for a better understanding of user information satisfaction in knowledge-based virtual communities are encouraged.

Keywords: User satisfaction, information quality, virtual community, expectation disconfirmation theory.

1 Introduction

With the emergence of the Internet as a new communication medium, virtual communities have become prevailing in recent years. Virtual communities create online social spaces for users to share and exchange knowledge by posting questions and answers, and debating issues based on shared interests [9]. The success of knowledge-based virtual communities, however, depends on user ongoing participation. Many initially active virtual communities have failed to retain their members. Previous studies found that user satisfaction is an important determinant of user continuance in electronic networks [11, 17]. Obviously, communities with a lot of unsatisfied members are less likely to survive. In the context of virtual community, one should notice

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 123–130, 2008.

that the information (content) is collectively created and exchanged among members in the community. It is therefore important to explore the factors that determine user information satisfaction with knowledge-based virtual communities.

2 Literature Review

Prior literature provides us with a rich foundation on which to build the research model. In this section, relevant theories and models for explaining user information satisfaction with knowledge-based virtual communities are introduced and discussed.

2.1 User Satisfaction

Satisfaction has been a core research topic of numerous studies from diverse theoretical perspectives. In the marketing discipline, consumer satisfaction is a key concept in maintaining customer relationship and facilitates repeated buying and even loyalty. Similarly, user satisfaction has been extensively studied in the field of Information Systems (IS) and it has been widely adopted as an important determinant of IS success [4, 5]. A large body of user satisfaction research [3, 7, 10] primarily focused on the operationalizations of the satisfaction construct and ignored the theoretical foundation. Noting this limitation, Chin and Lee [2] proposed a research model and measurement instrument by incorporating expectation disconfirmation theory [14] to explain the formation of end user computing satisfaction.

The proliferation of electronic commerce has further provoked IS researchers' interest in the study of satisfaction in the online environment [5, 6, 13]. In this specific context, McKinney et al. [13] proposed a theoretical model of web satisfaction and argued that web satisfaction should be analyzed at the information level and the system level. In other words, web satisfaction can be analyzed in terms of both web information quality satisfaction and web system quality satisfaction. They further built on expectation disconfirmation theory and proposed that web information quality satisfaction and web system quality satisfaction are determined by both the perceived performance and disconfirmation. Indeed, among the diverse theoretical frameworks, expectation disconfirmation theory [14] has been receiving a great deal of attention in recent IS research. These studies provided insights to user psychology and explained user satisfaction formation processes.

2.2 Expectation Disconfirmation Theory

Expectation disconfirmation theory has been the most widely adopted approach in research and managerial practice for understanding consumer satisfaction. Oliver [14] was the pioneer to bring adaptation-level theory into the consumer satisfaction research and explained the satisfaction formation in terms of expectation, performance and disconfirmation. The underlying satisfaction formation process is that: Expectations create a frame of reference as a comparative judgment, where a cognitive comparison of pre-purchase (pre-usage) expectation level with the perception of product or service (information systems) performance is then executed. If the perceived performance exceeds the expectation (a positive disconfirmation), the user will become satisfied. On the other hand, if the perceived performance falls below the expectation (a negative disconfirmation), the user will become dissatisfied. In recent years, we witnessed an increasing amount of IS research using expectation disconfirmation theory to explain user satisfaction in the IS context [e.g., 1, 13].

3 Research Model and Hypotheses

Based on the review of previous studies, expectation disconfirmation theory [14] is adopted as the theoretical approach to explain user information satisfaction with virtual community. Although prior studies identified a lot of different antecedents of user satisfaction, the perceived performance information quality, as well as its disconfirmation is used because of their prominent academic and managerial relevance. Most virtual communities provide online social spaces for members to share their experiences and contribute their expertise to other members. It is believed that the quality of the content (information quality) in knowledge-based virtual community is extremely important and relevant variable in determining user information satisfaction.

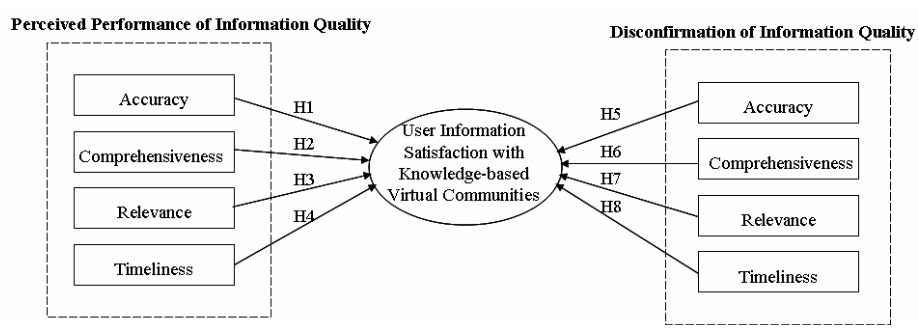


Fig. 1. Research Model

Figure 1 depicts the research model of user information satisfaction with knowledge-based virtual community. User information satisfaction is defined as an overall affective evaluation a user has regarding his or her experience with the community.

3.1 Information Quality

High information quality has long been found associated with system use, user satisfaction, and net benefits. In the current study, information quality is identified as the extent to which users think the information is accurate, comprehensive, relevant, and timely. These four attributes of information quality are widely used in the IS literature. Definitions of the four domain constructs of information quality are listed in Table 1.

Table 1. The Four Attributes of Information Quality

Attributes	**Explanation**
Accuracy	Concerns with the reliability of the content in virtual community. The reliability of website content facilitates consumers to perceive lower risks, better justifications for their decisions and ease in reaching the optimal decisions, and in turn affects their satisfaction.
Comprehensiveness	Refers to the completeness of the content in virtual community. The more detailed the information, the higher the breadth of user categories and user-orientation of that website, and thus results in a greater likelihood of consumer acquisition and retention.
Relevance	Is important as most users are conscious of their time. Internet users rarely read web pages in detail but rather scan the pages to find the information they needed. Users want to find the information that they want quickly and with little effort. It is therefore important to deliver relevant information on the website.
Timeliness	Concerns about whether the content in virtual community is up-to-date. When the website is not updated promptly, it cannot deliver the expected performance and thus provides no added value to users.

Indeed, the relationship between information quality and user information satisfaction has been well established in prior IS research [13]. In the context of knowledge-based virtual community, information with high quality is particularly important in determining user satisfaction [16].

Hypothesis 1: Perceived accuracy of information is positively related to user information satisfaction with a knowledge-based virtual community.

Hypothesis 2: Perceived comprehensiveness of information is positively related to user information satisfaction with a knowledge-based virtual community.

Hypothesis 3: Perceived relevance of information is positively related to user information satisfaction with a knowledge-based virtual community.

Hypothesis 4: Perceived timeliness of information is positively related to user information satisfaction with a knowledge-based virtual community.

3.2 Disconfirmation

According to expectation disconfirmation theory [14], disconfirmation is formed when the performance goes above/below the initial expectation. The disconfirmation in turn affects user satisfaction. Applying this line of reasoning to the current study, the following hypotheses are proposed:

Hypothesis 5: Disconfirmation of the accuracy of information is positively related to user information satisfaction with a knowledge-based virtual community.

Hypothesis 6: Disconfirmation of the comprehensiveness of information is positively related to user information satisfaction with a knowledge-based virtual community.

Hypothesis 7: Disconfirmation of the relevance of information is positively related to user information satisfaction with a knowledge-based virtual community.

Hypothesis 8: Disconfirmation of the timeliness of information is positively related to user information satisfaction with a knowledge-based virtual community.

4 Research Design

A bulletin board system (BBS) of a local university was used in this study to examine user information satisfaction with a knowledge-based virtual community. An invitation message with the URL to the online questionnaire was posted on a number of online groups of the bulletin board system. To increase the response rate, an incentive of USB memory drives was offered as lucky draw prizes.

A total of 240 usable questionnaires were collected in two-week time. The response rate is 18.1% (240 reponses/1327 views) according to the method suggested by Tiwana and Bush [17]. Among the respondents, 77% were male and 23% were female. This ratio was similar to the ratio of male to female students of the university. A majority of the respondents aged between 21 and 25 and had a bachelor degree or above. They were also frequent and experienced users of the bulletin board community, as around 80% of them visited the BBS everyday and the average usage experience with the BBS was more than 3 years.

The constructs of interest to this study were the perceived performance and disconfirmation of information quality (accuracy, comprehensiveness, relevance, and timeliness), and user information satisfaction. The measures of the constructs were borrowed from previous studies [1, 12]. All constructs were measured using multi-item perceptual scales. Appendix shows the measures used in this study.

5 Results

Both psychometric properties and model testing were examined using Partial Least Squares. Following the two-step analytical procedures, the measurement model was first assessed, and then the structural model was evaluated.

5.1 Measurement Model

Table 2 summarizes the composite reliability and average variance extracted of the measures in the research model. A composite reliability of 0.70 or above and an average variance extracted of more than 0.50 are deemed acceptable [8]. All the items have significant path loadings at the 0.01 level and reach the recommended levels of the composite reliability and average variance extracted.

Table 2. Psychometric Properties of the Measures

Construct	**CR**	**AVE**	**Construct**	**CR**	**AVE**
Accuracy	0.93	0.81	Disconfirmation of Accuracy	0.91	0.78
Comprehensiveness	0.94	0.80	Disconfirmation of Comprehensiveness	0.92	0.75
Relevance	0.95	0.83	Disconfirmation of Relevance	0.94	0.79
Timeliness	0.93	0.83	Disconfirmation of Timeliness	0.92	0.80
Satisfaction	0.93	0.77			
Note: CR – Composite Reliability, AVE – Average Variance Extracted					

5.2 Structural Model

Figure 2 presents the results of our study. Tests of significance of all paths were performed using the bootstrap resampling procedure. The model explained 65% of the variance in user information satisfaction. Among the four main dimensions of information quality, it is interesting to find that both ***perceived performance and disconfirmation regarding on relevance*** have significant impacts on user information satisfaction. ***Perceived disconfirmations of accuracy and comprehensiveness*** also have significant influence on user information satisfaction.

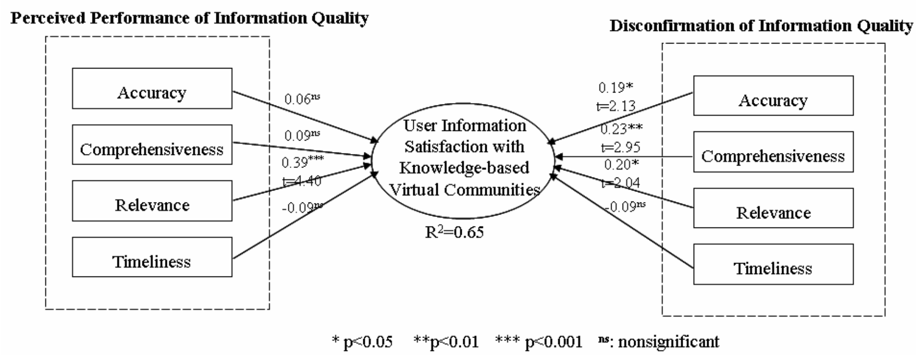


Fig. 2. PLS Result

6 Discussion and Conclusion

The purpose of this study is to examine the antecedents of user information satisfaction with a knowledge-based virtual community. The results are summarized as follows: (1) the model explains 65 percent of the variance; (2) Among the four key attributes of information quality, only perceived information relevance, disconfirmation of information accuracy, disconfirmation of comprehensiveness, and disconfirmation of information relevance exhibit significant influence on user information satisfaction.

Recent studies on user satisfaction have been greatly advanced with a stronger theoretical foundation. Research incorporating expectation disconfirmation theory suggested that satisfaction is a result of a comparison between users' expectation and their actual usage experience. This line of research is further enriched in the current study of knowledge-based virtual communities. In addition, it is interesting to find that there exist some inconsistencies in terms of the significant impacts of the four attributes of information quality on user information satisfaction. The inconsistency may relate to the unique nature of the virtual community being investigated. For example, neither information timeliness nor disconfirmation of information timeliness contributes to user satisfaction. A possible explanation is that people know clearly that they can judge the timeliness of a particular message by looking at the date of the message posted and that there is a function in the bulletin board system which allows them to sort the messages in a reverse chronicle order for reading the latest information first. Hence, both the expectation and the perception are at the same level and therefore disconfirmation of information timeliness was not significant. Future studies could continue this line of research by investigating other types of virtual communities (e.g., blog, MSN, social networking, mental support, entertainment, and else).

Studying user information satisfaction is particularly important to practitioners because a high level of satisfaction is associated with several key favorable outcomes, such as continued usage, positive word-of-mouth, building and maintaining member relationship. This may also attract members to continue to create and share knowledge with others in the community. Attracting members to share knowledge with others is always a challenge to most knowledge-based communities [15]. Future studies could also examine the impact of user satisfaction on knowledge sharing behavior in virtual communities. Considering that this study has raised many interesting questions, additional theorizing and empirical investigation for a better understanding of user satisfaction with virtual communities are encouraged.

References

1. Bhattacherjee, A.: Understanding Information Systems Continuance: An Expectation-Confirmation Model. MIS Q 25, 351–370 (2001)
2. Chin, W.W., Lee, M.K.O.: Proposed Model and Measurement Instrument for the Formation of IS Satisfaction: The Case of End-User Computing Satisfaction. In: Twenty-First International Conference on Information Systems, Brisbane, Australia, pp. 553–563 (2000)
3. Chin, W.W., Newsted, P.R.: The Importance of Specification in Causal Modeling: the Case of End-User Computing Satisfaction. Inf. Sys. Res. 6, 75–81 (1995)
4. DeLone, W.H., McLean, E.R.: Information Systems Success: The Quest for the Dependent Variable. Inf. Sys. Res. 3, 60–95 (1992)
5. DeLone, W.H., McLean, E.R.: The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. J. of MIS 19, 9–30 (2003)
6. Devaraj, S., Fan, M., Kohli, R.: Antecedents of B2C Channel Satisfaction and Preference: Validating E-Commerce Metrics. Inf. Sys. Res. 3, 316–333 (2002)
7. Doll, W.J., Torkzadeh, G.: The Measurement of End-User Computing Satisfaction. MIS Q 12, 259–274 (1988)
8. Fornell, C., Larcker, D.: A Second Generation of Multivariate Analysis: Classification of Methods and Implications for Marketing Research. In: Houston, M.J. (ed.) Review of Marketing, pp. 407–450. American Marketing Association, Chicago (1987)
9. Fuchs, C.: Towards a Dynamic Theory of Virtual Communities. Int. J. of Knowledge and Learning. 3, 372–403 (2007)
10. Ives, B., Olson, M.H., Baroudi, J.: The Measurement of User Information Satisfaction. Communications of the ACM 26, 785–793 (1983)
11. Limayem, M., Cheung, C.M.K.: Understanding Information Systems Continuance: The Case of Internet-based Learning Technologies. I. & M. 45, 227–232 (2008)
12. Lee, Y., Strong, D., Kahn, B., Wang, R.: AIMQ: A Methodology for Information Quality Assessment. I. & M. 40, 133–146 (2002)
13. McKinney, V., Yoon, K., Zahedi, F.M.: The Measurement of Web-Customer Satisfaction: An Expectation and Disconfirmation Approach. Inf. Sys. Res. 13, 296–315 (2002)
14. Oliver, R.L.: A Cognitive Model for the Antecedents and Consequences of Satisfaction. J. of Marketing Res. 17, 460–469 (1980)

15. Rafaeli, S., Raban, D.R.: Information Sharing Online: a Research Challenge. Int. J. of Knowledge and Learning 1, 62–79 (2005)
16. Sangwan, S.: Virtual Community Success: A Uses and Gratifications Perspective. In: Proceedings of the 38th Hawaii International Conference on System Sciences, Big Island, Hawaii, USA (2005)
17. Tiwana, A., Bush, A.A.: Continuance in Expertise-Sharing Networks: A Social Perspective. IEEE Transactions on Engineering Management 52, 85–101 (2005)

Appendix: Measures

Perceived Information Quality	**Disconfirmation of Information Quality**
Based on your experience of using the BBS, please provide your evaluation of the quality of information this BBS.	We are interested in knowing your perceived quality of messages in this BBS compared to your expectations in terms of the following features:
Perceived Information Relevance	**Disconfirmation of Relevance**
Irrelevant /Relevant	The information in this BBS is relevant.
Inappropriate/Appropriate	The information in this BBS is appropriate.
Inapplicable/Applicable	The information in this BBS is applicable.
Perceived Information Timeliness	**Disconfirmation of Timeliness**
Out-dated/Current	The information in this BBS is sufficiently current.
Insufficiently timely/Sufficiently timely	The information in this BBS is sufficiently timely.
Sufficiently out-of-date/Sufficiently up-to-date	The information in this BBS is sufficiently up-to-date.
Perceived Information Accuracy	**Disconfirmation of Accuracy**
Inaccurate/Accurate	The information in this BBS is accurate.
Incorrect/Correct	The information in this BBS is correct.
Unreliable/Reliable	The information in this BBS is reliable.
Perceived Information Comprehensiveness	**Disconfirmation of Comprehensiveness**
The information in this BBS is sufficiently complete for my needs.	The information in this BBS is sufficiently complete for my needs.
The information in this BBS includes all necessary values.	The information in this BBS includes all necessary values.
The information in this BBS covers my need.	The information in this BBS covers my need.
The information in this BBS has sufficient breadth and depth.	The information in this BBS has sufficient breadth and depth.
(Scale: Anchored by Strongly Disagree (-3) and Strongly Agree (3), with Neither (0) in the middle)	(Scale: Much lower than your expectation (-3), the same as your expectation (0) and Much higher than your expectation (3))

Satisfaction (SAT)
How do you feel the overall experience with this BBS?
(Scale: Strongly dissatisfied (-3) and Strongly satisfied (3), with Neither (0) in the middle)
(Scale: Strongly displeased (-3) and Strongly pleased (3), with Neither (0) in the middle)
(Scale: Strongly frustrated (-3) and Strongly contended (3), with Neither (0) in the middle)
(Scale: Absolutely terrible (-3) and Absolutely delighted (3), with Neither (0) in the middle)

ICT and Cultural Heritage Education: Which Added Value?

Michela Ott and Francesca Pozzi

Istituto Tecnologie Didattiche – CNR
Via De Marini, 6, Genoa Italy
{ott,pozzi}@itd.cnr.it

Abstract. The present contribution aims at exploring how digital technologies can be fruitfully used in the field of Cultural Heritage for carrying out educational and awareness raising interventions. It is an attempt to underline the relevance of extending the potential of Educational Technology tools and methods to Cultural Heritage Education, two fields that have not largely been in touch so far. The paper aims at going beyond the idea that technology is a precious mean for offering closer/better view and easier access to cultural heritage artifacts; rather, by assuming a methodological perspective, the paper investigates the pedagogical impact that may derive from exploiting the potential of both technological tools and the related new educational models and approaches in the field of Cultural Heritage Education.

Keywords: ICT, Cultural heritage Education, Educational Technology, innovation.

1 Introduction

Cultural Heritage should be regarded as a key area in today *Knowledge Society*, where the "key factors are knowledge and creativity" and where the most "valuable asset is investment in intangible human and social capital"[1].

As a matter of fact, the relevance of Cultural Heritage Education has already been underlined in 1998 by the Committee of Ministers of the Council of Europe who, through the Recommendation No. R (98) 5 to Member States[2], asserted that "*educational activities in the heritage field are an ideal way of giving meaning to the future by providing a better understanding of the past*".

Even if no specific reference was directly made in the Recommendation as far as the use of Information and Communication Technologies (ICT) for supporting and enhancing Cultural Heritage Education, in the following years, the opportunity to exploit the

[1] European Department for Employment and Social Affairs http://ec.europa.eu/employment_social/knowledge_society/index_en.htm (accessed June, 2008)
[2] http://www.kultura.ejgv.euskadi.net/r46-4874/es/contenidos/informacion/manifiestos_patrimonio/es_8658/adjuntos/DOC56.pdf (accessed June, 2008)

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 131–138, 2008.

high potential of ICT emerged[3]. As a matter of fact, ICT are nowadays recognized as suitable tools for renewing and enhancing education, even in the complex and multi-faceted sector of Cultural Heritage [1]; nevertheless, while ICT are increasingly employed in this field [2] for producing large archives of materials [3; 4], for supporting scientific research, and for fostering the maintenance/preservation of cultural heritage artifacts [5; 6], it seems that the use of ICT has not yet enough affected the approaches to teaching and learning in this field. In other words, ICT are still seen as *tools* to look at cultural heritage artefacts, rather then as *methods* to learn about them; from this perspective, "Educational Technology", which is the field addressing the definition of models and methods for designing effective learning actions with the support of ICT, has not yet entered so much in touch with Cultural Heritage Education.

The present contribution explores how Educational Technology models, methods and approaches can fruitfully contribute to better spreading knowledge, information and awareness about cultural heritage artifacts, mainly those in the domain of arts and archaeology, which are the focus of this paper; it looks at the matter from a methodological point of view and encompasses both educational interventions carried out in formal school settings, and informal educational activities, thus addressing both school students and general public. The authors' concern in the field originates from the involvement in a number of projects, both at national and European level, which allowed to gain an overview on the field, thus bringing into focus the existing gap between Educational Technology and Cultural Heritage Education.

In particular, the paper aims at shedding light on the added value provided by Educational Technology to Cultural Heritage Education by:

- Considering the existing perspectives from which it is possible to look at cultural heritage artifacts, when they are available in digital form.
- Reflecting on the new opportunities offered to Cultural Heritage Education by ICT-enabled educational approaches and methods.
- Giving evidence of the pedagogical impact that may result from an appropriate adoption of ICT in the field of Cultural Heritage Education.

2 Looking at Cultural Heritage Artefacts in Their Digital Form: Existing Perspectives

A huge and fast increasing number of cultural heritage artifacts becomes digital: this has significant effects on Cultural Heritage Education, both because the number of objects available is incredibly enlarged and because each single artifact can be regarded and studied from many different perspectives.

2.1 A "Multidimensional" Perspective

With the advent of digital technologies cultural objects can be viewed both as a whole and in their minimal details; images are no more strictly bi-dimensional, and detailed

[3] See Cerri A. (2006), L'aspetto politico del programma del Consiglio d'Europa in materia di pedagogia del Patrimonio. In Branchesi, L. (ed.): Il patrimonio Culturale e la sua pedagogia per l'Europa. Armando Editore.

study and zoom possibilities of any kind/level are possible. What's more, the representation of cultural heritage artifacts becomes dynamic and interactive: it is the user herself who can directly choose the dimension, the level of detail and also the viewpoint for accessing and exploring each single artifact.

2.2 A "Wider" Perspective

As already mentioned, the new type/level of description of cultural heritage objects which is available thanks to digital technologies, allows to appreciate each single artifact in all its, even minimal, details. Nevertheless, ICT offer even more: they allow the user to shift from looking at each object as a single, isolated element, to view it as part of a wider context, where it lives or has been created/inserted. This means that single cultural artifacts can be seen in a wider perspective and can be perceived as elements of a wider context. Contexts can be various and may differ in shape, nature and size; moreover, they can be *real* or *reconstructed* (i.e. those contexts that have been virtually built on the basis of available data) [7]. An architectural object, for instance, can be viewed in its natural context (i.e. the context where it is nowadays situated), but can also be seen in its original context, which may have been virtually reconstructed on the basis of objective data. [8].

The possibility to examine the context and the landscape where a cultural heritage artifact was /is located has important consequences on the study of the artifact itself and on its analysis and evaluation. In this sense, it is important to mention the emerging field of "Landscape Archaeology", which is quite new and is strongly based on the use of ICT; it puts particular "emphasis on the study of the relationships between archaeological data (e.g. between sites and/or cultural modifications to landscapes such as ditches, burial mounds, field systems, roads, etc.) and such cultural phenomena and their natural setting or environment"[4].

2.3 An "Inner" Perspective

Virtual reality techniques allow students to actually "live" sites (for instance archaeological sites) and move around them, instead of simply looking at images or reading about them. The project "Rome Reborn" [5] is an example of the possibilities offered by digital technology for looking at (and, consequently, for studying) cultural artifacts "from the inside" [9]. It drives the user/student into the Rome of A.D. 320, at the time of the emperor Constantine, and shows the reconstruction of some 7000 buildings of the city. Field experts have rebuilt almost the entire city within its 21-kilometer-long wall, including the Senate, the Colosseum and the Basilica of Massenzio, complete with frescoes and decorations. Buildings, that are now almost completely in ruins, have also been recreated with a "high probability" of accuracy, in such a way that a visitor can move around, having the feeling of walking around streets, entering buildings and looking at them "from the inside".

[4] Citation from Wikipedia http://en.wikipedia.org/wiki/Landscape_archaeology (accessed June, 2008).

[5] The project has been carried out at the University of Virginia (http://www.romereborn.virginia.edu/; accessed June, 2008)

2.4 A "Global" Perspective

In recent years, several countries have created free electronic archives and have made relevant attempts for digitizing their Cultural Heritage [10]; in addition, a number of International and European programs have recently paved the way for the digitization of materials and contents related to cultural patrimony[6] also by defining specific standards[7]. At present, then, the number of resources potentially available for study purposes is amazingly broadened; an idea of the enormous (almost uncountable) amount of available resources can be obtained by visiting the high number of portals devoted to the study of arts and or civilizations available through the net[8].

The possibility to create links among so many online resources allows the user to gain a more "global" perspective on cultural heritage artifacts, that can be seen (and studied) not only as isolated objects, but rather as products of a number of strictly intertwined factors of different nature (socio-economical, historical, geographical, cultural, …).

3 ICT and Innovative Approaches to Cultural Heritage Education

In the previous section the main changes brought about by the digitization of contents in the field of Cultural Heritage, namely the perspectives available when looking at artifacts in the new "digital" form, have been briefly summarized.

In addition to such innovation, in the field of Cultural Heritage Education further relevant opportunities are made available by exploiting ICT potential and by adopting related innovative approaches to teaching and learning.

3.1 Personalized, Inquiry-Based Learning Approaches

As already mentioned, ICT may guarantee the access to a huge amount of information, which – for its nature - lays itself open to be "discovered", rather than "taught". This goes in the direction of both supporting the personalization of learning itineraries and of stimulating experiential learning approaches,: students can access information in many different ways, thus playing an active role in information retrieval and in building up their own learning path, on the basis of their interests, personal aims, needs, etc. This, besides fostering the acquisition of contents, will improve their ability to retrieve information, their working methods and – more in general - their approach to learning.

3.2 On-Site and Anywhere Learning Experiences

Situated learning approaches stress the importance of the cultural and social context where learning takes place, since this context is strictly intertwined with the

---

[6] This happens, for instance, thanks to the eContent program (2001-2004), whose main objective is that of "the production, use and distribution of European digital content …" http://cordis.europa.eu/econtent/ (accessed May, 2008)

[7] The EC project MINERVA can be considered an example of this, http://www.minervaeurope.org/ (accessed May, 2008).

[8] As an example the site http://www.rassegna.unibo.it/archit.html can be viewed (accessed May, 2008).

knowledge development process [11]; from this perspective, school is no longer the only place for education. Educational experiences, especially those concerning Cultural Heritage, should occur in different places, so that students may directly enter in touch with the artefact and/or environment to be studied. As a matter of fact, this has already been acknowledged and fostered by the above mentioned Recommendation of the Council of Europe, where they state that European heritage classes should involve "*fieldwork outside the school*", so that students may "*discover the richness of heritage in its context…*".

Today, thanks to the use of ICT, further interesting possibilities are opened. In particular, taking advantage of the use of mobile technologies, students may carry out ICT-based learning activities in a variety of settings, ranging from the traditional places where this usually occurs (classroom, lab, home, etc.), to places that are even far away from the "typical" ones, such as museums, archeological sites, etc. Thanks to mobile devices, students may be asked to gather data or take annotations on the field, so that afterwards they can elaborate and interpret them. Besides, communication and collaboration facilities offered by mobile technologies should not be underestimated, which may allow data sharing and knowledge co-construction by students, thus paving the way to collaborative approaches to learning.

Moreover, GPS or RFID systems may offer to visitors of archaeological sites the opportunity of getting highly focused information concerning the main points of interests along their actual pathway, so to enrich data coming from "direct observation" with further "external" data.

3.3 Interdisciplinary Learning Approaches

As already mentioned, ICT can help on one side, to study each piece of art in great details, even by localizing it within its original context; on the other side, they offer a new, interdisciplinary dimension, by providing the possibility to embed the artefact within a broader network of historical, socio-cultural, economical and geographical links, which allow a better understanding and interpretation of the artefact itself. Thanks to ICT, such network becomes potentially unlimited and opens the way to interdisciplinary approaches, involving a number of subject matters and teachers, so to provide a wide view on the piece of art. A project addressing the study of an artist and of his/her works, for example, may entail not only the study of its main artistic features, but also the study of the civilization where s/he lived, the socio-cultural conditions at that time, the links with others populations, cultures and artists, etc… From this perspective, ICT can offer unlimited possibilities of finding out new, unexplored links.

3.4 Collaborative Learning Experiences

Socio-constructivism emphasizes negotiation as the basic element in the process of knowledge development, and considers language, dialogue and collaboration as the main learning tools [12]; from this perspective, ICT may support collaborative approaches to learning. Collaborative learning activities in the field of Cultural Heritage, such as peer-to-peer communication, data exchange, joint elaboration of information, etc. become possible not only at local level (e.g. among students belonging to the same class), but even among students of different classes, even if they are very "far" one from the other (classes from different regions, countries, cultures, etc.); the spectrum of possibilities offered by the educational interventions is, thus, potentially widened, even if it should be taken into account that conducting distance educational actions with students belonging to different cultures can yet be considered a real "challenge" [13].

Recently, special attention has been devoted to web 2.0 (wiki, blogs, folksonomies, etc.) [14] as a way to foster collaboration by allowing groups of students to produce shared artefacts.

4 Discussion and Conclusions

The central question in the title of whether a significant added value is offered by ICT to Cultural Heritage Education has been briefly answered above: ICT, if properly and suitably used, can contribute to innovate, tune, convey and improve educational interventions also in this field. If we look at the field of Cultural Heritage Education in the light of the tools and educational methods made available by ICT, we see that a number of new scenarios are opened, where barriers, boundaries, time and space limits seem to diminish or almost disappear.

First of all ICT may allow to approach the study of cultural heritage artifacts by shifting from a subject oriented approach to an inter/ cross/multidisciplinary one, in such a way that, despite the subject-based approach of many educational systems in Europe, students may by contrast appraise the very nature of learning and of knowledge, which are intrinsically interdisciplinary.

Moreover, the concept of "internationalisation of cultures" has concrete possibilities to shift from being a myth to becoming reality: cultural artifacts can be easily viewed and shared far beyond national/regional boundaries, thus becoming common patrimony of all people. As a consequence, a different vision of cultural heritage artifacts may arise: from the idea of regional/national patrimony to the feeling of a common patrimony for all the cultures. The acknowledgment both of "cultural diversity" and "common roots" emerges as a result of the possibility of studying/comparing a multiplicity of cultural objects and of discussing and communicating with people of different cultures; this goes both in the direction of strengthening links among people having common roots and of understanding basic cultural differences thus also providing a significant added value for education to social behaviour.

If the adoption of ICT-based tools and methods in the field of Cultural Heritage Education, helps avoiding or reducing cultural barriers, it can also help in decreasing to some extent other kinds of barriers, such as those related to disability. As a matter of fact, due to physical sensorial or cognitive impairments some students may have limited experiences also in the field of Cultural Heritage Education [15] and the use of specific computer- based tools and environments, as well as related interactive learning experiences may turn out to be especially enriching for them. Thanks to the use of ICT, then, the accessibility to Cultural Heritage patrimony can be fostered, by accurately designing suitable interventions that could have an high social impact [16]. The ambitious goal of providing "equal educational opportunities to all people" is, thus, instantiated by the fact that - thanks to the new technological tools - the number of people that may have some kind of access to cultural objects is potentially enlarged. This contributes, again, to making Cultural Heritage a common patrimony of all people, irrespective of their actual physical, mental, sensorial disabilities and also contributes to the recognition of the right of all students to have the same educational opportunities.

In this panorama, new educational scenarios are opened offering genuine interdisciplinarity, authentic internationalisation of culture, and a wider accessibility.

There is, nevertheless, evidence from research [17] that in almost all educational fields ICT do not make the difference *per se*, simply by being used: rather, educational interventions need to be carefully planned by people who, besides being expert and skillful in the specific subject matter, are also able to make effective educational use of technological tools. This calls for further research in the field and for a strong commitment by national governments and policy makers: the adoption of ICT tools and methods in Cultural Heritage Education may, in fact, have a strong pedagogical impact only if it is based on a substantial re-definition of some significant aspects of the school system, including infrastructures, methods and teacher training.

References

1. Branchesi, L.: La pedagogia del patrimonio e la sua valutazione: ambiti di ricerca, metodologie, risultati e prospettive. In: Branchesi, L. (ed.) Il patrimonio Culturale e la sua pedagogia per l'Europa. Armando Editore (2006)
2. Veltman, K.H.: Challenges for ICT/UCT Applications in Cultural Heritage. In: Carreras, C. (ed.) ICT and Heritage (2005) Online dossier
3. Politou, E.A., Pavlidis, G.P., Chamzas, C.: JPEG2000 and the dissemination of cultural heritage databases over the Internet. IEEE Transactions on Image Processing 13(3), 293–301 (2004)
4. Meyer, É., Grussenmeyer, P., Perrin, J.P., Durand, A., Drap, P.A.: Web information system for the management and the dissemination of Cultural Heritage data. Journal of Cultural Heritage 8(4), 396–411 (2007)
5. Chassagne, P., Bou-Saïd, E., Ceccotti, A., Jullien, J.F., Togni, M.: The contribution of numerical simulation for the diagnosis of the conservation of art objects. Journal of Cultural Heritage 8(3), 215–222 (2007)
6. Townsend, J., Cappitelli, F., Toniolo, L. (eds.): Conservation Science 2007. Archetype Publications (in print, 2008)
7. Di Blas, N., Poggi, C.: 3D for Cultural Heritage and Education: Evaluating the Impact. In: Trant, J., Bearman, D. (eds.) Museums and the Web 2006: Proceedings. Archives & Museum Informatic, Toronto (2006) (accessed June, 2008), `http://www.archimuse.com/mw2006/papers/diblas/diblas.html`
8. Forte, M., Beltrami, R.: A proposito di virtual archaeology: disordini, interazioni cognitive e virtualità. Archeologia e Calcolatori. 11 (2000)
9. Frischer, B.: Mission and Recent Projects of the UCLA Cultural Virtual Reality Laboratory. Acts of Virtual Retrospect 2003, Biarritz, France, November 6-7 (2003) (accessed, June 2008), `http://www.cvrlab.org/research/research.html#publications`
10. UNESCO: Information and Communication Technologies in schools - a Handobook for teachers or how ICT Can Create New, Open Learning Environments (2005) (accessed, June 2008), `http://unesdoc.unesco.org/images/0013/001390/139028e.pdf`

11. Brown, J.S., Collins, A., Duguid, P.: Situated cognition and the culture of learning. Educational Researcher 18(1), 32–42 (1989)
12. Vygotsky, L.: Thought and language (Hanfman, E. & Backer, G., Trans.). MIT Press, Cambridge (1962) (originally published, 1934)
13. Flannery, D.D., Shattuck, K.S.: The challenge of conducting learning across cultures via distance education means: an HRD dilemma. International Journal of Learning and Intellectual Capital (IJLIC) 3(1), 42–56 (2006)
14. Hoogenboom, T., Kloos, M., Bouman, W., Jansen, R.: Sociality and learning in social software. International Journal of Knowledge and Learning (IJKL) 3(4/5), 501–514 (2007)
15. Klironomos, I., Antona, M., Basdekis, I., Stephanidis, C.: EDeAN Secretariat for 2005: White Paper: Promoting Design for All and e-Accessibility in Europe. Universal Access in the Information Society International Journal 5(1) (2006)
16. Molla, A., Al-Jaghoub, S.: Evaluating digital inclusion projects: a livelihood approach. International Journal of Knowledge and Learning (IJKL) 3(6), 592–611 (2007)
17. Moseley, D., Higgins, S., Bramald, R., Hardman, F., Miller, J., Mroz, M., Tse, H., Newton, D., Thompson, I., Williamson, J., Halligan, J., Bramald, S., Tymms, P., Henderson, B., Stout, J.: Ways forward with ICT: Effective Pedagogy using Information and Communications Technology for Literacy and Numeracy in Primary Schools (1999) (accessed, May 2008), http://www.leeds.ac.uk/educol/documents/00001369.htm

A Multi-Agent Model for Mine Detection – MAMMD

Umar Manzoor[1], Samia Nefti[1], Haris Hasan[2], Majid Mehmood[2], Bassam Aslam[2], and Osama Shaukat[2]

[1] Department of Computer Science, School of Computing, Science and Engineering, The University of Salford, Salford, Greater Manchester, UK
[2] Department of Computer Science, National University of Computer & Emerging Sciences, H-11/4 Islamabad, Pakistan
umarmanzoor@gmail.com, s.nefti-meziani@salford.ac.uk

Abstract. From decades mines have taken thousands of innocent lives and a lot of research is going on mine detection problems. In this paper we have proposed a multi-agent based model for detecting (MAMMD) mines in unknown environment. Mine positions are unknown to the agents and they cannot predict there positions using any probability method. Agents have mine detector devices and they coordinate their actions/movements with each other. MAMMD architecture is implemented using layer based approach to make the system distributed and fault tolerant. We are using an algorithm which is quite similar to depth first search algorithm for movement of agents. Proposed architecture is evaluated on large number of test cases including use of different grids sizes from 10x10 to 100x100. Grids had mines randomly placed, occupying 0% to 30% of the search space. Experiments used 5 to 25 agents for each randomly generated grid with same mine ratio. Experimentally we have observed that MAMMD is effective in both time and solution quality.

Keywords: Mine Detection, Collaborative Agent System, MAMMD Architecture, Detecting Mines Using Agents, Multi-Agent System.

1 Introduction

Mine Detection is one of the biggest problem that nowadays effect many countries throughout the world [1]. From decades mines have taken thousands of innocent lives and a lot of research is going on, on mine detection problems [2]. This problem basically includes detection of all mines deployed in a given area and to remove them safely or to provide a safe path from one point to other while avoiding mines.

Agent is a computational system that has goals, sensors and effectors, and decides autonomously which action to take in which situation to maximize progress towards achieving its goal(s). Agent systems allow us to use some unique functionality which makes it best choice for implementing real world problems specially distributed problems [3]. Multi-Agent System (MAS) is a group of independent agents working together to accomplish a specific task and provides a strong base for development of flexible, scalable and decentralized solution [6]. Using MAS we can divide complex problems into simpler one elegantly and better results can be achieved when these agents communicate and collaborate with each other.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 139–148, 2008.

In state space searches where target is unknown, agent has limited knowledge of its surroundings. To know the entire environment, agent has to move from one position to another. While modeling the unknown environment agent has to consider other constraints as well e.g. hurdles in environment. During the task of modeling the unknown environment, agents movement have to be decided dynamically as no prior mine(s) information is available. Each agent has to look in its surrounding for mines and it can't see through the obstacles.

The objective of this paper was to develop intelligent multi agent architecture for mine detection. In this paper we have proposed a Multi-Agent Model for Mine Detection (MAMMD) in unknown environment. The System is implemented using a layered approach to make the system distributed and fault tolerant. For a particular mission Head Quarter is provided an area which is filled with mines and assigned limited number of resources (agents) for the mission. Mine positions are unknown to the agents and they cannot predict mine positions using any probability method. Agents have mine detector devices and they can coordinate their actions only with their team mates. The agents are divided into different formations and each formation depends upon the "Best Formation".

Total area is divided into partitions and division of the area depends on the number of agent formations. Each team consists of some Detector Agents and one Collaborator Agent as team leader. Each team is responsible only for the assigned area. As each mission is assigned fix number of agents, this means when any agent dies due to some reasons we do not have its replacement. So its job will be carried out by other agents of his team. MAMMD is evaluated on large number of test cases and results shows that MAMMD performs very well in unknown environment.

The organization of this paper is as follows. Section 2 presents related work for Mine Detection and the techniques proposed. Section 3 discusses the system architecture of MAMMD, the working of agents, sensing devices capability and the coordination mechanism. Section 4 analyzes the efficiency and performance of the proposed architecture. Section 5 summarizes the conclusion derived out of this research work.

2 System Architecture

The System architecture is implemented using a layered approach to make the system distributed and fault tolerance as shown in Figure 1. The system architecture is composed of the following six modules.

- Formation Creator Module (FCM)
- Land Division Module (LDM)
- Mine Detection Module (MDM)
- Next Location Selector Module (NLSM)
- Path Calculation Module (PCM)
- Statistical Analyzer (SA)

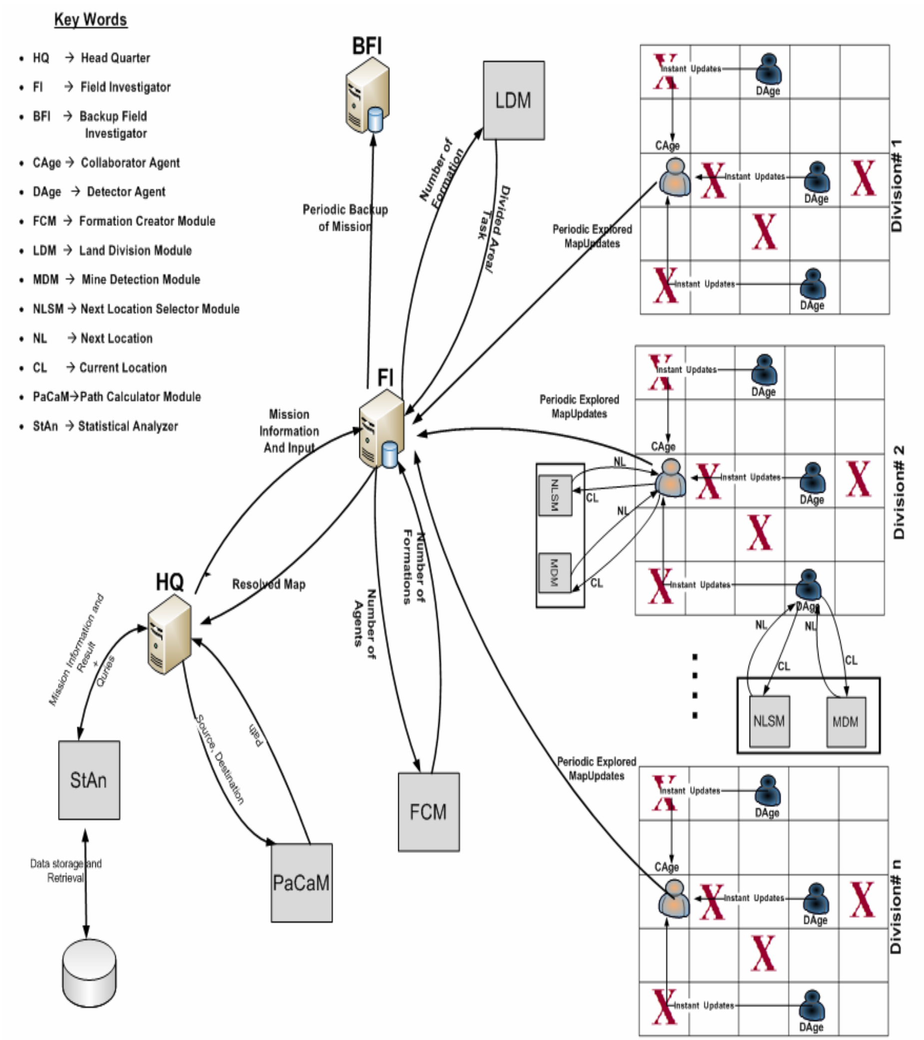


Fig. 1. Architectural Diagram of Multi-Agent Model for Mine Detection

2.1 Formation Creator Module (FCM)

This module takes total number of agents as input and makes the formation of the agents. Division of agents in a formation depends upon the "Best Formation". It is a statistical measure of agents in a Land division which ensure minimum communication and maximum collaboration among agents. In our approach, first the Best Formation is calculated, and then agents are filled in the formation until the agents count equal best formation count. This process is repeated until we divide all agents in different formations.

```
FCM()
{
    BF – Best Formation
    TA – Total Agents
    FC – Formation Count
    AC – Agent Count
    //Calculate the Best Formation
      BF← GetBestFormation(TA)
      FC← 0
    For(i=1 to TA)
    {
            Formation[FC].AC]++
            If(Formation[FC].AC]==BF)
                FC++
      }
 }
```

2.2 Land Division Module (LDM)

This module takes total area as input and divides the area into partitions. Division of the area depends on the number of agent formations. Land Division Module – LDM divides the Mission Area into a number of small missions and assigns each mission to a Formation.

```
LandDivisionModule()
{
    FC ← Formation.Count
    A  ← TotalArea
    Ai ← A/FC
    i    ← 0
    Foreach Formation
    {
          Fomation.Area =Ai
          //SC----Start Column
          Formation.SC =Ai*i
          //EC----End Column
          Formation.EC =Ai*i +Ai-1
          i++
    }
 }
```

2.3 Next Location Selector Module (NLSM)

The basic task of all agents is to locate the mines in the land assigned to it. To explore the area each agent maintains stack of all paths which it has travelled and keeps updating this stack whenever it finds a new path. When ever agent reached dead end it will back track. It pops a location from the stack and move to that location and keeps exploring the path until it receives abort signal from Field Investigator Agent.

```
NLSM ()
{
    //CP - Current Point
    //NP -  Next Point
    //Known set is stack of explored path
    KnownSet ← NULL
    While (! AbortSignal)
    {
        KnownSet.Push(CP)
        SearchMines(CP)
        NP←GetNextLocation(CP)
        if( NP == null)
        {
          CP = KnowSet.Pop()
        }
        else
        {
          CP = NP
        }
      }
  }
```

2.4 Mine Detection Module (MDM)

This module takes agent current position and mine detector range. This Module will check all the positions within the range of mine detector and return all Points status (i.e. has mine or not).

```
MDM (Point CP)
{
    SP[]← SurroundingPoints(CP)
    for( i 1 to SP.Length)
  {
        //MineDetector(Point  P)  return  true  if  P  has
mine
       //other wise false
    SP[i].Has = MineDetector(SP[i]);
      }
   return SP;
  }
```

2.5 Path Calculation Module (PCM)

Head Quarter – HQ uses this module to calculate the shortest path from source to destination. This module needs a map, start and destination point. Our Shortest path algorithm is a slight modification of A* algorithm. Unlike A* algorithm which calculates its cost value with a help of function f = g + h, we calculate it by simply assigning f= g +1 to all adjacent nodes. We also use priority function which directs towards the most appropriate location towards destination. Two cases of Priority are shown in Figure 2.

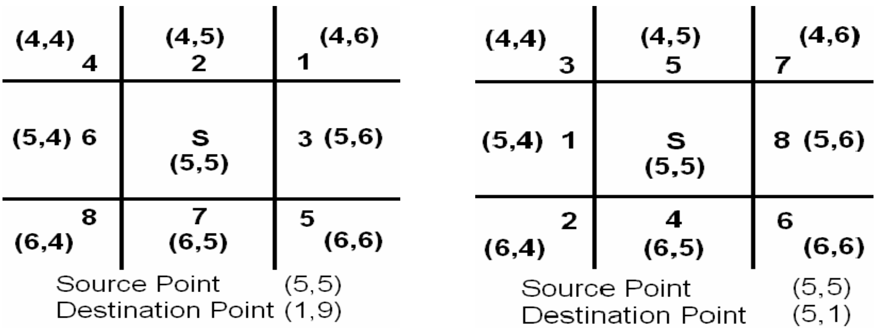


Fig. 2. Priority is Considered in Ascending Order

```
FPQ - Final Path Queue
TPQ - Traversed Point Queue
APQ - Adjacent Points Queue of each TPQ point
SourceToDestination()
{
  TempPoint ← start point;
  TPQ.EnQ(TempPoint)
  While(TPQ.IsNotEmpty() )
  {
    APP[] ← PointInPriorityOrder(TempPoint)
    for(i 1 to APP.Length)
    {
      APP[i].cost = TempPoint.cost+1;
      APQ.EnQ(APP[i])
    }
    TempPoint = TPQ.DeQ();
    APQ.EnQ(TempPoint);
  }
    Return;  //Path NOT Found

}
DestinationToSource()
{
```

```
  /* We do the same procedure from destination to
source as above but we do not calculate the cost. */
  //instead we approach to minimum cost.
  //and EnQ all those points in FPQ
}
```

2.6 Statistical Analyzer (SA)

Using this module Head Quarter – HQ saves all statistics of current mission to database for further analysis. This module also handles analysis request generated by HQ for different parameters and shows the result in graphical notation.

```
StAn(Request)
{
    if(Requst == DbEnteryRequest)
    {
          storeInDb(Request.parameters)
    }
    Else if(Requst == AnalysisRequest)
    {
      Data=RetrieveData(Request.parameters)
      GenrateGraph(Data)
    }
}
```

Different types of agents work collaboratively to detect mines in the specific area. There are four types of agents in the system as shown in Figure 1.

- Head Quarter (HQ)
- Field Investigator (FI)
- Collaborator Agent (CA)
- Detector Agent (DA)

2.7 Head Quarter (HQ)

Head Quarter – HQ is top most entity in hierarchal model and will be responsible for creating the mission(s) and assigns the resources for the mission/task. There will be one HQ for multiple missions but one Field Investigator for each mission. HQ responsibility is to assign task/mission to Field Investigator and to store statistical measures of every mission. For a particular mission HQ is provided an area which is filled with mines and assigned limited number of resources for the mission.

HQ passes this information to FI as a mission. After FI has completed its given mission, it gives resolved area to HQ in the form of Map. HQ utilize Path Calculator module to compute shorted path between source and destination. The shortest path can be used for Army Movement in Wars. After the mission has completed, all the information is passed to Statistical Manipulation Module for later analysis.

2.8 Field Investigator (FI)

Field Investigator – FI is next in the hierarchal model after Head Quarter. When it gets mission information from HQ it distributes resources. For distribution it uses Formation Division Module (FDM) to make teams. Each team consists of some Detector Agents – DAge and one Collaborator Agent – CAge as team leader. FI assign a piece of area to each team using Land Division Module. Each team is responsible only for the assigned area. FI gets periodic updates of explored area from CAge. When the whole area has been explored it sends abort message to all the Collaborator Agents. Finally it passes the complete map to HQ.

2.9 Collaborator Agent (CAge)

Collaborator Agent – CAge is basically a Detector Agent – DAge with some extra responsibilities. Basic functionalities of CAge are same as an DAge but it provides two more features.

1) CAge acts as a Team Lead and gets periodic updates from the Detector Agents working in its area. Updates consist of the part of land explored along with the information whether the area contain mines or not. Cage sends these updates along with its own to the Field Investigator (FI).
2) CAge Monitor provides a communication bridge between the DAge and FI. FI can be constantly updated about the DAge progress in the particular area.

CAge maintains the Map of the assigned area and when the area is explored it send abort message to all the Detector Agents.

2.10 Detector Agent (DAge)

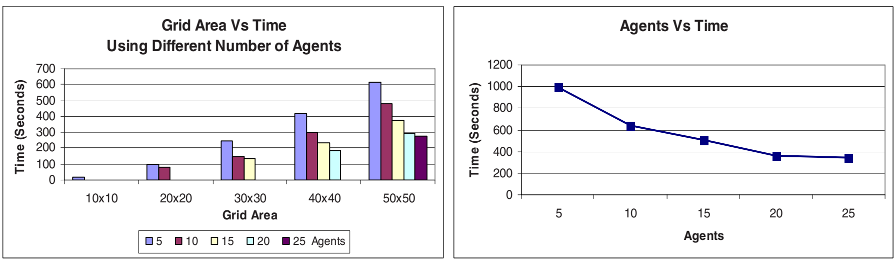
Detector Agent – DAge is lowest level entity in the system hierarchy. DAge core responsibility is to discover the assigned area. Agent has to traverse the whole area efficiently keeping in view the avoidance of collision with other agents. DAge creates a virtual map in its memory based on input data and starts traversing using Next Location Selector Module (NLSM). DAge sends periodic and instantaneous updates to CAge, instantaneous mean whenever DAge finds a mine it will update CAge. The purpose of periodic updates is to update CAge with the latest progress. DAge will continue to search the area until CAge sends the abort signal.

3 Related Work

Researchers are still working to find out efficient and optimal solutions of mine detection problem. Different approaches have been used for mine detection and disposal. Srividhya Sathyanath et al [4] propose mine detection using an approach based on biology. They used artificial immune system as an inspiration for their algorithm. They applied immune system properties to agents for performing task in distributed environment. Shahzad et al in [5] proposes hybrid architecture for implementation of mine detection along with collision detection and agent coordination. In their approach they have used route planning, perception, mine detection and collision avoidance. They used two approaches for exploration of unknown area; frontier based and generalized Voroni graph methods but failed to get optimal results in their experimentations.

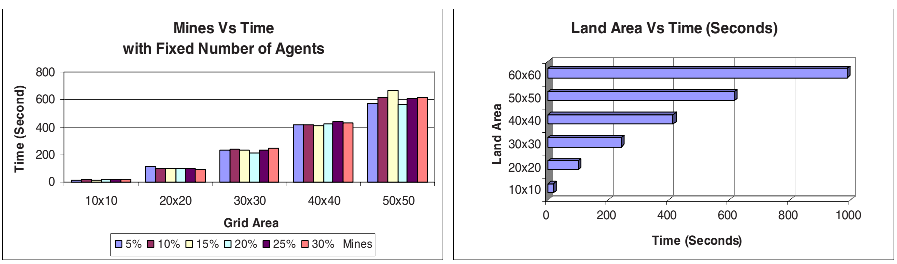
4 Analysis

We have tested MAMMD on large number of test cases with different configurations. We have tested our architecture on varying grid size ranging from 10x10 to 60x60 with increment of 10 with varying size of mines ranging from 5 to 30 percent of the grid size. Each configuration is run with varying number of agents ranging from 5 to (grid size / 2) with an increment of 2.



(a) (b)

Fig. 3 (a). Grid Area Vs Time using different number of Agents. **(b)** Mines Vs Time with Fixed Number of Agents.



(a) (b)

Fig. 4 (a). Grid Area Vs Time using different number of Agents. **(b)** Mines Vs Time with Fixed Number of Agents

Figure 3 (a) shows the time taken by different number of agents to completely explore the given grid area and locate all instances of mines or hurdles. Figure 3 (a) shows that as we increase the grid area for same number of agent time to explore the gird area increases. It is also notable that as we increase the number of agents for the same grid area the time to exploration decreases as shown in Figure 3 (b) but this increase in efficiency is true up to a limit. As we can see that when we increase agent 15 to 25 exploration time is almost the same. This is because of the communication over head so after certain thresh hold increase in agents to carry out the mission will take more time to complete.

Figure 4 (a) shows the time taken by 5 agents to explore mines in different Land Area. It is interesting to observe that time taken by agents to explore the given grid area does not depend upon the mines. This means agent will take same amount of time for different number mines and hurdles present in area. This information is very help full in a sense that we can predict the time to complete a given mission. Figure 4 (b) shows that as you increase the grid area for the fixed number of agents the time to explore the area will increase.

5 Conclusion

Mine Detection is one of the biggest problem that nowadays effect many countries throughout the world. The objective of this paper was to develop intelligent multi agent architecture for mine detection. In this paper we have proposed a Multi-Agent Model for Mine Detection (MAMMD) in unknown environment. Agents have mine detector devices and they can coordinate their actions only with their team mates. The agents are divided into different formations and each formation depends upon the "Best Formation". Experimentally we have observed that MAMMD is effective in both time and solution quality.

References

1. Cassinis, R.: Land mine detection method using swarms of simple robots. In: International Conference on Intelligent Autonomous Systems, Venice, Italy, vol. 6 (2000)
2. Frankliny, D.E., Kahng, A.B., Anthony, M.: Distributed sensing and probing with multiple search agents: toward system-level landmine detection solutions. In: Proceedings of Detection Technologies for Mines and Minelike Targets. LNCS, vol. 2496 (1995)
3. Summiya, Ijaz, K., Manzoor, U., Shahid, A.A.: A Fault Tolerant Infrastructure for Mobile Agents. In: Proceeding of International Conference on International Conference on Intelligent Agents, Web Technologies and Internet Commerce (IAWTIC 2006), Sydney, Australia, November 29– December 01 (2006)
4. Opp, W.J., Sahin, F.: An Artificial Immune System Approach to Mobile Sensor Networks and Mine Detection. In: The Proceedings of 2004 IEEE International Conference on Systems, Man & Cybernetics, October 10 – 13, vol. 1, pp. 947–952 (2004)
5. Zafar, K., Qazi, S.B., Baig, A.R.: Mine Detection and Route Planning in Military Warfare using Multi Agent System. In: Proceedings of the 30th Annual International Computer Software and Applications Conference (COMPSAC) (2006)
6. Weiss, G.: Multiagent Systems A Modern Approach to Distributed Artificial Intelligence, ch. 1-4. The MIT Press, Cambridge (1999)
7. Opp, W.J., Sahin, F.: An artificial immune system approach to mobile sensor networks and mine detection. In: IEEE International Conference on Systems, Man and Cybernetics, vol. 1, pp. 947–952 (2004)

Proposal of a Tool of Support to the Evaluation of User in Educative Web Sites

Maria Elena Alva, Ana Belén Martínez, José Emilio Labra, Maria del Carmen Suárez, Juan Manuel Cueva, and Hernán Sagástegui

Department of Computing of the University of Oviedo7
C./ Calvo Sotelo s/n. 33007 Oviedo, España
{alvamaria,belenmp,labra,macamen,cueva,hsagastegui}@uniovi.es

Abstract. This article presents an analysis of the necessity to implement a tool of evaluation and measurement of the usability to support the ME-USitE methodology that contributes to the detection of problems and failures of usability from the perspective of the user of educative Web sites in a real work environment. Taking into account that the Web sites are designed and implemented for a domain and audience in particular, it's important to consider factors like these for the implementation of a tool that allows not only to carry out the evaluation process but also to support the analysis of the gathered data. Thus, the obtained results may allow us to establish policies for the improvement of the usability of the site, when providing a score that determines whether the level of usability offered covers the requirements for the proposed audience and the profile of the participant user in the evaluation.

Keywords: Usability, educational, tools, evaluation parameters, measurement.

1 Introduction

Though it is true that it have been achieved advances in the development of the applications centered on the user with the emergence of new technologies, also it is that in many cases they limit the access to great users diversity if we consider the necessary requirements of hardware and software to access to them. On the other hand, although new developments are accessible, by no means they guarantee that they are more usable.

The educational web sites are characterized for contributing at the entry of its users to the information society, allowing the universal access to the information and the knowledge without discrimination of race, color, religion, origin or sex [5]. Nevertheless, the complexity of the educational services offered in Internet, though they assure that the access to them should be sufficient, they do not assure the successful use of the content. It for it that both, the study of the usability and his evaluation are turning into important aspects to bear in mind in the development of web applications and, particularly in educational domain applications.

Since that the development of an educational web site is one orientated to a dispersed users community and with diverse features is necessary not only to investigate

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 149–157, 2008.

the diversity of these users with regard to their skills, age, I gender, culture, etc; but also knowledge of these in order to reduce the gap between what the users know and what they need.

This study tries not only to establish a methodology capable of evaluating the usability of an educational web site, but also to enrich web applications of other domains from this scheme of work. For example the governmental web applications that offer services orientated to the user (a wide, complex and diverse community) and that therefore it needs to invest in research that allows to fix principles and guidelines to improve the level of usability of their sites and services, since this way can favor the integration of the different collectives, especially those with special needs, as well as the entrance of the companies in the society of the information.

1.1 Problems in the Evaluation of the Usability in Educative Web Sites

Many investigations have been directed to the activities of evaluation of the usability (methods, techniques, tools). Nevertheless, little it has been made on like integrating these activities in methodical and systematic coherent process, that allows the analysis of the usability results and that take into account the critical aspects in the evaluation as they are the user group (child, young, adult, etc.) or as it is the profile of these (inexperienced, intermediate, advanced).

At the present time different methods and techniques exist that can be used during a usability evaluation: Depending on the purpose of the measurement, the type of measurement to obtain, development cycle stage, etc. (Investigation, [8], Heuristic [16], [14], Evaluation of experts [21]). Nevertheless in their majority these methods have been applied with, really, little participation of the real user in their real environment.

If we consider that the acceptance and the success of an educative Web site depend mainly on their capacity to cover the necessities of real users that they interact with this type of sites in private environment or at least real environment, it is important to consider the features of these users (abilities, interests, gender, age, among others.) like critical factors in the evaluation [11], [19], [5].

Many are the authors whom they have investigated and proposed recommendations for the development of usable applications [16], [23], but very little what has been made on the usability evaluation of the educative Web sites [4]. Nevertheless, it is enough to make an exploration in the Web to verify that this still continues being a problem. As well point out Murray [12], the usability degree of a Web site depends on the intention and the objective audience.

Authors like [17], [20], [13] have carried out studies of the usability of Web sites (in general), pointed out their applicability to Web educative. However these have been inferred considering that all the domains require the same aspects of usability or with the same priority.

1.2 Need of a Methodology That Systematizes This Process

Aspects as the indicated ones in the previous section limit the applicability of the existing tools like support the evaluation of the usability in the interest domain. For that reason, it is necessary the adoption of a methodology that includes the most suitable combination of the methods, techniques, etc., always focused to the profile of the user in the domain of the educative web sites and that allows, of systematic way, to obtain reliable results.

This article shows the methodology of evaluation of usability of educational web site: ME-USitE [1], which includes both the evaluation of the user and the evaluation of the expert as a more complete proposal to the evaluation in the approach of the usability. For the first one there is established a general list of parameters of evaluation of the usability that includes both aspects of interface and aspects of content and, basing on her, realizes the selection only of those that fit to the needs of usability of a particular domain depending on the audience (child, young, adult and elderly) for which was designed and establishes the type of requirement, that is to say, if a requirement is essential (that is determinant in the usability of the site), desirable (that affects partially the usability) or optional (whose absence is not significant in the usability of the site). We will extend on ME-USitE in the following section.

1.3 Need of the Tool of Support to ME-UsitE

Although it is true that the process of evaluation and measurement of the results of the proposal methodology can be carried out in a manual way, also it is true that we must think that the process of evaluation involves on the one hand the application of questionnaires to users (for the obtaining of his/her profile as well as for the obtaining of the data of the evaluation) and the use of lists of verification on the part of the experts, and on the other hand the necessity to process the data obtained thus to achieve concrete results with the consumption of resources and time that this implies. For that reason it seems necessary to use automated tools to give to support to the process of evaluation for the obtaining of data as well as for its treatment and processing.

The at the moment existing tools of support to the measurement of usability have been investigated and have been some oriented mainly to give to support to the evaluation of commercial sites like WAMMI [8], MUMS [7], QUIS [22], PROKUS [27], DRUM [10], etc.

This study has shown that these tools are oriented to measure the satisfaction and performance of the user or the product in Web applications, but its development is focused the domain of commercial applications. In addition they consider that all the requirements of usability evaluation are same for any type of site, independently of the application and the audience, reason why its extension to other domains is possible according to the authors [20], [25].

Nevertheless, each type of domain of application in the Web has its own objectives of development, and is designed for a specific audience (children, young, etc) [19], [11], which can differ in the level of experience due indeed to the dispersed nature of mean of transmission of used knowledge (Internet) that allows the access of different users with diverse motivations. Therefore, we think that it is advisable to design an appropriate tool to give to support to the evaluation.

This article is structured of the following way: in section 2 a description of the methodology ME-USitE appears; in section 3 the necessity of a tool of support to the evaluation is established. Section 4 describes the developed prototype. Finally in section 5 the conclusions appear.

2 ME-USitE Methodology

ME-USitE [1] is a methodology proposed for measure and to evaluate the usability of educative Web sites. The showed approach tries to complement the evaluation from the perspective of the user, being used the method of investigation, and from the perspective of the expert, using inspection methods. The principal goals that Me-USitE persecutes are the following ones:

Evaluation Multiple. It is framed in two main evaluations: evaluation of experts and evaluation of users. The evaluation of experts, involves one or more expert making a global inspection of the application [16, [18] in the different stages from the development cycle (design, development, test). The inspection can be made selected or combining the methods of inspection more suitable (heuristic, standard, guides or consistency) [15], [9] to the type of site to evaluate and the experience and knowledge of the specialist. The evaluation of users, on the other hand, is an investigation evaluation in which users real -while they make tasks in a Web site- they discover the problems that make difficult to them to reach their objectives. This evaluation involves the use of representative end users of the objective audience to use the system and to complete a questionnaire that allows measuring the fulfillment of a set of requirements of usability measured through a set of predefined parameters.

Combination of methods. The combination of the methods of inspection and inquiry for the evaluation of the usability allows discover problems that can be omitted by one of them and vice versa. [15], [9]. To combine the usability inspections and the inquiry evaluation have as goal provide a process of more efficient and effective evaluation. It arises like an alternative proposal to the evaluation of traditional usability based on laboratory tests, whose achievement is expensive and often the obtained results are not the wished ones.

Configuration of the inspection methods. Because the experts are more familiarized with one or some methods, it seems logical that the inspection sees beneficiary if the expert can apply these methods It is for that we considered a requirement for the methodology the possibility that the expert can select the methods with which more is familiarized. Really, this will be translated in an enrichment of the evaluation process.

Consideration of the Audience. Our methodology persecutes to evaluate the usability degree that offers the educative Web site to its users, considering who each site is designed and developed for a specific audience and that this one can differ in level of experience due exactly to the dispersed nature of media of transmission of used knowledge (Internet).

Extension of the evaluation to the phases of analysis and design. Most of existing methodologies fix the evaluation process to the stage of test or when the product is in use. This carries two main problems: the development of a few usable products that does not cover the necessities of the user and an increase in the cost. It is why the methodology can be applied for the evaluation from the earliest stages of the development cycle of the product.

Configuration of the measurement parameters. Considering that the usability requirements defer from a type of Web site to another one is necessary to establish the parameters of evaluation more suitable to the type of site and type of users. Therefore, a general list of parameters of evaluation of usability in a hierarchic structure of three levels of parameters has been defined (criteria, metric and attributes), of which they are selected most suitable to the audience of the site.

Application of a score model. The parameters defined in the hierarchic structure will be the base for the calculation of the global score of the site, for it will become use of a set of functions of aggregation appropriately established that are in charge to calculate the score starting off of the parameters of lower level (the attributes) until those of more high level (criteria) These functions take like entrances the obtained elementary scores from the following way:

- The user assigns a numerical value to each attribute (elementary parameter) $At_i, (i = 1, \ldots n): \; v_i, \forall i = 1, \ldots, n.$ (n = number of attributes of the sub-tree), in a range of possible values in a scale of valuation 1 to 5 (agreement-disagreement). The value assigned by the user is standardized, by means of a function of transformation PE whereby it becomes an Elementary Score or of attribute on a scale from 0 to 100, that it indicates the degree of conformity of the usability parameter with respect to the requirements established for the application domain that is being evaluated.
- The scores aggregated obtained in a level, will become as well in new entrances for the functions of aggregation of the following level. Finally the process will be repeated so that from those functions the global assessment of the site is obtained.

2.1 Evaluation Process

The process of evaluation of ME-USitE is based on a general set of measurement parameters that evaluate the usability requirements that the site must fulfill. Of these parameters are selected the most suitable, regarding to the audience for which the application has been designed. On the other hand, it is necessary the categorization of these users in groups of profiles (based on those qualities that reflect a behavior of the user with the educative environment) that they allow to observe and to analyze the similarities within a same group and/or the differences with the others.

Requirements tree. In order to carry out the evaluation process from the user perspective, an evaluation structure called requirements tree has considered itself advisable to define. The components of evaluation of this tree are defined on the basis of a hierarchic model that includes three levels: criteria (parameters of first level), metric (parameters of second level) and attributes (parameters of third level). The main purpose when designing the tree of requirements is to manage to split the parameters of evaluation (criteria) in elements simpler than they facilitate the assignment of weights and the calculation of scores and for that reason must be smallest possible but trying to include the most important aspects in function to the objective audience.

Measurement model. Once established the parameters it is necessary to assign a quantitative valuation to them, being therefore necessary the establishment of a measurement model. This model is based on the evaluation model cost/benefits LSP (Logic Scoring of Preference) proposed by Dujmovic et.al.[23] that was developed for the comparison and selection of alternatives of systems of hardware or complex software, and use aggregation functions that reflect the preference of the evaluator users. It is applied taking care of two criteria: analysis of the preference in the quality and analysis of the cost, nevertheless, since we are interested in determining the level of usability of a site, we have not considered in our model the cost analysis. This model has been used [7] for the valuation of quality of Web sites on the user based.

3 Need of a User Evaluation Tool

If we considered that the evaluation process consumes long time, since involves by a side the application of questionnaires to users and the use of lists of verification on the part of the experts, and on the other hand implies the information processing thus obtained to achieve concrete results, seems necessary to use automated tools. These tools will as much give to support to the process of evaluation for the obtaining of data as the treatment and processing of such.

In order to cover these needs it is necessary to look for a tool that helps to automate the process proposed by ME-USitE. For that reason a study of the existing tools of support for the usability evaluation has been made [1]. The examined tools are: WAMMI [6], ISOMETRIC [5], SUMMI [3], PROKUS [26], DRUM [9] and SMEQ [25]. We have reviewed each one of the mentioned tools previously, in order to analyze if some of them adapts to the methods and techniques proposed in ME-USitE. As we can see in the table, the tools have been designed in basis of a perspective (user) no of them takes into account aspects like the profile from the evaluator user or the level of audience of this user, aspects that the methodology considers fundamental in the evaluation process.

Table 1. Comparison of usability evaluation tools

Tool	**Methods combination** Inquiry / inspection	**Applied Technical** (Questionnaire /check list)	**Stage of the development** (Design, development, test)	**In focus** (User and expert)	**User profile**	**Audience**
WAMMI	X	√	√	X	X	X
ISOMETRIC	X	√	√	X	X	X
MUMS	X	√	X	X	X	X
PROKUS	√	√	√	X	X	X
QUIS	X	√	X	X	X	X
SUMI	X	√	X	X	X	X
DRUM	X	X	√	X	X	X
SMEQ	X	X	X	X	X	X
TLX	X	X	X	X	X	X

3.1 Desirable Characteristics of the Evaluation Tool

The tool must be able to offer a support for the evaluation and the processing of the data collected according to the proposed methodology. Therefore, the goal pursued in the development of a tool of this type will be grouped around two fundamental aspects: the evaluation and the processing.

Support for the evaluation. To achieve this target it must provide the following characteristics:

- Support for different types of users
- Control of the evaluation sites.
- Determination of the level and profile of the evaluator user.
- Storage of the tree of requirements.
- Selection of the site to evaluate.
- Selection of tasks.
- Configuration of the evaluation.
- Application of the questionnaire of evaluation.
- Update of the requirements tree.
- Help and Documentation.

Support for the measurement and processing. The tool must provide the following characteristics:

- Calculation of the punctuation of attributes.
- Calculation of the usability score.
- Obtaining of the global and entire score.
- Obtaining of partial scores.
- Obtaining of the score for user's level.
- Obtaining of special results.

4 Proposed Tool for ME-USitE

Finally and to cover the needs previously exposed it has been decided to construct the first prototype at present in execution. The characteristics of this prototype are provided across three modules:

Registration Module. The designed prototype allows identifying three types of users: evaluator, recorder of the Educational Web site and manager. To cover the needs mentioned in the section 3.2. this module includes: The register of the site to evaluate and the register of the evaluator user**.**

Evaluation Module. This module takes charge of the necessary management to realize the evaluation on the part of the user, as well as the presentation of the results. It includes the following functionalities: determination of the level and user's profile, automatic configuration of the usability requirements tree, selection of the Web site to evaluate, configuration of the evaluation (selection of tasks, application of the questionnaire of evaluation and calculation of the scores).

Module for the basic management of the application. For the suitable functioning of the prototype it is necessary information such as: authorized users, Web sites to evaluate, requirements tree, etc. For the experimental character of the prototype it is necessary to be able to adapt and to update the above mentioned information. Normally this task will be carrying out by the manager user: control of access, control of sites and management of users, update of the requirements tree, help and documentation.

5 Conclusions

To the need of a methodology for assessing and measuring educational web sites usability as ME-USitE, arises the need of a tool to systematize the process of evaluation. Nevertheless, and due to the approach proposed in the methodology (focused on the audience and user's profile), Of the existing tools, there has not been one that satisfies the needs raised in the paragraph 3.2. For that, it was necessary to propose the development of a tool adapted to our proposal.

In this article a designed tool to cover the functionalities needed to contribute in the detection of problems and mistakes of usability of educational Web sites from the user's perspective in his environment of real work, is showed. The results obtained across the tool allow the capture of decisions for the improves of the usability of the site in question, since they provide a score that determines if the level of usability reached by the site it covers the requisites outlined for the proposed audience and the user's profile taking part in the evaluation.

For the development of the tool it was proposed as demand that this one fulfills two principal functionalities: support to the evaluation process, with this first functionality aspects are covered as the identification of the profile of the user and the determination of the group of the audience to which the evaluator user belongs in order to identify of the corresponding requirements tree as well as the questionnaire to apply, and the support to the query of the gathering data. As soon as the evaluation was carried out, the obtained data will have to be processed in order to obtain results of the usability of the site. In this sense, the tool calculates the scores added for attributes, metric and criteria being based on the evaluations given by the taking part users, and it shows the obtained results of a partial or complete way for site, profile, genre, criterion, metrics, attribute or hand of the handling of the mouse.

References

1. Alva, O., María, E.: Metodología de evaluación y medición de la usabilidad de sitios web educativos: ME-USitE. Tesis inédita. Universidad de Oviedo, España (2005)
2. Alva, M., Martinez, A., Cueva, J., Sagástegui, H., Lopez, B.: Comparison of methods and existing tools for measurement of usability in the Web. In: Cueva Lovelle, J.M., Rodríguez, B.M.G., Gayo, J.E.L., del Ruiz, M.P.P., Aguilar, L.J. (eds.) ICWE 2003. LNCS, vol. 2722, pp. 386–389. Springer, Heidelberg (2003)
3. Bevan, N.: Measuring usability as quality of use. Software Quality journal 4, 115–150 (1995)
4. Carvalho, A.: Usability testing of educational software methods, techniques and evaluators. In: 3º Simposio Internacional de Informática Educativa, Portugal (2002)

5. Celik, H., Ipcioglu, I.: Gender differences in the acceptance of information and communication technologies: The case of internet usage. International Journal of Knowledge and learning 3(6), 576–591 (2007)
6. Gedica, G., Hamborg, K., Duentsch, I.: The IsoMetrics usability inventory: an operationalization of ISO 9241-10 supporting summative and formative evaluation of software systems. Ireland; Behaviour & Information Technology 18(3), 151–164 (1999)
7. Human Factors Research Group.: MUMMS: Measuring the usability of multi-media systems. University College Cork, Ireland, `http://www.ucc.ie/hfrg/questionnaires/mumms/info.html`
8. Kirakowski, J., Claridge, N., Whitehand, R.: Human centered measures of success in Web site design. In: Human Factors and the Web Workshop, Basking Ridge, NJ (1998)
9. Mack, R., Nielsen, J.: Executive summary. In: Nielsen, J., Mack, R.L. (eds.) Usability Inspection Methods. John Wiley & Sons, New York (1994)
10. Macleod, M., Rengger, R.: The Development of DRUM: A Software Tool for Video- assisted Usability Evaluation. In: People and Computers VII. Cambridge University Press, Cambridge (1993)
11. Mineta, N.: Americans in the Information Age - Falling Through the Net. U.S. Department of Commerce (2000)
12. Murray, G., Constanzo, T.: Usability and the Web: An overview, Canada (1999), `http://www.nlc-bnc.ca/9/1/p1-260-e.html`
13. Nakwichian, S., Sunetnanta, T.: User-centric Web quality assessment model. Mahidol University Computing Center, Bangkok 10400, Thailand. Revisado en Diciembre del (2003)
14. Nielsen, J., Molich, R.: Heuristic evaluation of user interfaces. In: Proceedings of the CHI 1990, pp. 349–356. ACM, New York (1990)
15. Nielsen, J.: Heuristic evaluation. In: Nielsen, J., Mack, R.L. (eds.) Usability Inspection Methods. John Wiley & Sons, USA (1994)
16. Nielsen, J., Mack, R.: Usability inspection methods. Wiley, New York (1994)
17. Nielsen, J.: The Web usage paradox: Why do people use something this bad? Alertbox, August 9 (1998) (January 3, 2001), `http://www.useit.com/alertbox/980809.html`
18. Nielsen, J.: Usability inspection methods -SunSoft. Mountain View, CA. ACM Press, New York (2002)
19. Nielsen, J.: Usability of Websites for Teenagers. Alertbox, January 31(2005)
20. Paolini, P., Di Blas, N.: Automatically evaluating the usability of Web sites. In: CHI 2002 Workshop, Italy (2002)
21. Preece, J.: A Guide to Usability: Human factors in computing. Addison Wesley, The Open University (1993)
22. QUIS-Questionnaire for user interaction satisfaction. Human Computer Interaction Lab/ University of Maryland (1998)
23. Shneiderman, B.: Designing the user interface. Addison-Wesley, Reading (1998)
24. Su, S., Dujimovic, J., Batory, B., Navathe, S., Elnicki, R.: A Cost-Benefit Decision Model: nalysis, Comparison, and Selection of Data Management Systems. ACM 12(3), 472–520 (1987)
25. Tromp, J., Benford, S.: Methodology of Usability Evaluation for Collaborative Virtual Environments. In: Proceedings of 4th UK VR SIG conference, Bristol (1997)
26. Zijlstra, F.: Efficiency in work behaviour: A design approach for modern tools. Delft University Press, Delft (1993)
27. Zülch, G., Stowasser, S.: Usability evaluation of user interfaces with the computer aided-evaluation tool- PROKUS-. Institut für Arbeitswissenschaft und Betriebsorganisation-Universität Karlsruhe, Kaiserstraße 12, 76128 MMI-Interaktiv, Nr. 3, Zülch & Stowasser, Germany (2000) ISSN 1439-7854

Time Orientation Device for Special Education

José M. Falcó, Álvaro Marco, Ángel Asensio, Rubén Blasco, Roberto Casas, and Joaquín Ezpeleta

Tecnodiscap Group, University of Zaragoza, María de Luna 1,
Ed. Ada Byron, 50018 Zaragoza, Spain
{chefalco,amarco,aasensio,rblasco,rcasas,ezpeleta}@unizar.es

Abstract. Time understanding and its measurement could be a challenge for people with some cognitive impairment. In this paper, a second iteration of a Temporal Orientation Device (TOD) designed for helping that people in understanding the sense of time is showed. TOD is an electronic panel which first version was tested in special education classrooms and the results of the evaluation allowed authors to improve the design. The new concept separates electronic tasks—turning on/off colour leds—from intelligence tasks—scheduling children activities—in order to make it easier to use TOD for teachers with low informatics skills. To be accessible via internet, Google Calendar compatibility has been added.

1 Introduction

Time passing is one of these concepts which are not easy to explain, but we assume that everyone know what it is and how it is measured. However, this assumption is not true. No one can consistently identify time down to the exact minute, but whilst studies indicate that roughly 95% of the normal adult population can identify the time of day to within an hour or so, people with cognitive disorders can lack this time awareness and have great difficulty in understanding measuring of time with conventional clocks. Day, month, year, and day-of-the-week are chosen on the basis of evidence suggesting that the subset may be similarly predictive of cognitive impairment, yet less sensitive to confounding by education level [1]. Consequently, these persons can suffer from disorientation and are not able to carry out activities which depend on the time. Moreover, in autism situations, the beginning of some activities which are not sufficiently anticipated can lead to anxiety and crisis states. In these cases, it is necessary to provide an alternative way to measure time and for anticipating situations, that relate time sense with any easier concept.

A number of organizations have studied that problem, and have developed some devices for temporal training and reeducation of people with disabilities. One of these is the Swedish institution CERTEC (Center for Rehabilitation Engineering Research Lund Institute of Technology) [2], which proposes some examples for alternative measurement of time. From their studies, it is concluded that the quarter of an hour is the simplest temporal unit to assimilate the sense of time for people with cognitive disabilities.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 158–166, 2008.

Another aid to assimilate time passing is to relate it with the full/empty concepts, as an hourglass do. Combining these two ideas, a special clock will consist of an array of LEDs, each one symbolizing a quarter of an hour, which will remain switched on at the beginning of the day, and will switch off as time goes by.

A first TOD prototype [3] was designed, developed by the “Tecnodiscap group” (University of Zaragoza) and tested in the classroom of two state schools: “Alborada” (Zaragoza, Spain) and “Arboleda” (Teruel, Spain). This paper presents the design of a new TOD version which corrects the detected weakness in prior version and introduces some improvements to meet teachers’ requirements.

2 State of Art

While a standard alarm wristwatch or timer will provide an audible or beep cue, it will not provide information about the task to be performed for individuals with deficits in self-initiation. So, it should be combined with added information about the task to do [4].

Several devices have been developed to help time management for people with memory impairments or attention deficit. The Quarter hour watch [5] represents events with pictures and the time remaining to the event is shown as lighted points (one point represents one quarter of an hour); TimeTimer [6] shows elapsed time; ISAAC [7] is a patented, fully individualized cognitive prosthetic system which allows for the organization and delivery of individualized prompts; Tick Task™ [8] is an analog clock which's red minute hand stands out and points to the activity magnets arranged around the circle; WatchMinder2 [9] uses a vibrator alarm to silently remind the event; the “Invisible Clock” [10] beeps or silently vibrates to discreetly signal repetitive tasks or multiple personal reminders. All of them are designed for individual use. Only “The Quarter hour watch” and Tick Task use pictures or icons to represent events. Finally, only “The Quarter hour watch” uses a quarter of an hour as measure of time.

There are also some software applications developed to provide aids with time management. “Picture Planner” [11] is an icon-driven software which helps users with cognitive disabilities and caregivers to construct and manage activity schedules; the “Student occupational time line”™ [12] provides both a text and visual overview of daily student-on-task school performance. The former is once again designed for individual use. The second is designed for schools use but its worksheets are printed with just text and colours for individual use.

Finally, “Weekly Schedule Board” [13] is a colorful schedule board with Velcro dots to show desired behavior. Board programming is completely artisan.

None of the precedents fulfill the Alborada and Arboleda teachers' needs: to schedule both individual and class group activities at one time, to call attention with time enough to avoid anxiety, to use a temporal unit easy to assimilate and to display the next event information in a friendly way.

3 Design Constraints

The evaluation of the first TOD prototype in two special education schools yields interesting results that help us in the design of the new iteration. Most of the teachers fit into a standard user profile and demand a simple interface without such complex functionality like database support, device configuration, etc. Some other teachers have a higher informatics level and demand advanced functions, which allow them schedule activities for the whole week or even a month, or access to the full configuration of the device. However, all of them agree that the communication and programming of the device was rambling.

Anyhow, the device showed to be very promising, so a new version was raised to solve the detected problems and to incorporate the suggestions teachers made after the testing period.

3.1 Teachers' Functional Specifications

The teachers' evaluation of the project discovered new needs as well as suggestions about the user interface, and after testing the usability of the TOD for a year, the special education schools Alborada and Arboleda teachers give us some functional specifications for the new software:

- The user interface must be easy and friendly, allowing a whole week schedule.
- The software must be able to program different timetable-panels, keeping different identities for each one.
- It must also allow some users (children) management: puting up/down a child, changing a personal melody… and offer teachers' remote control management.

This stage also points out the need of two different profiles:

- Administrator profile (Chief of studies), which:
  - Can access and manage every timetable-panel in the school (changing led colors, melodies…).
  - Has access to all weekly schedules and can manage them.
  - Can manage users.
  - Has general control of the system.
- Teacher profile, which:
  - Has access and can manage his classroom timetable-panel only.
  - Can manage classroom's children and weekly schedule.

3.2 Added Functional Specifications

Technical team analysis brought us to some new specifications:

- **Inclusion of a therapist profile.** It is similar to teacher profile, but therapist profile allows to make a therapy schedule (speech therapy, physiotherapy...), what child must assist each hour, instead of classroom schedule. Therapy's weekly schedules will merge with different children classroom weekly schedules.
- **Implementation of a database management.** Now teachers make weekly schedule which can be saved in a database system. This data can be used in new planning, reports... and help teachers to concentrate attention on everyday children activities instead of office work.
- **iCAL format and connection with Google Calendar.** Though this was not even an option when the prototype of the TOD was tested, nowadays the access to the web is a requirement every school meets. As some teachers asked for

timetable-panels with wireless communication in order to program them with something else but a PC, which means they can make the weekly schedule outside the classroom, we have come to offer too the possibility of import or export a classroom calendar with the iCAL format. This way, teachers can use web services to program the timetable-panel.

4 Device Hardware Architecture

Major concerns in the hardware architecture of the previous system were device robustness and programming. To face this, we decide simplify the hardware architecture to the outmost, removing most of the device intelligence from the electronics, and turning device into a "lights" peripheral, controlled through a serial interface. This way, electronic development is simplified, and there is no need to programming the device, as LEDs are driven directly by the host where the peripheral is connected to.

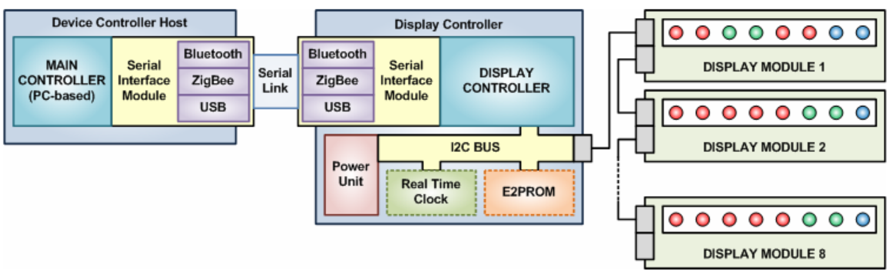


Fig. 1. Hardware architecture

Figure 1 shows hardware architecture of the device, where we can identify three blocks: device controller host, display controller, and display modules. The display module is an isolated element with eight RGB surface mounts LEDs which are driven by three MAX7315 (one for each color), and only the analogical conditioning electronics is present in the board. The display module implements an I2C slave, whose address is switch-configured, allowing up to eight display modules connected to the display controller. Power is supplied also through the connection cable by the display controller.

The display controller acts as an I2C master to drive display modules, and its main purpose is to offer an interface to the device controller host, where main intelligence is. The display controller will receive commands from the device controller host, referring to acting over some RGB LED of some display module, and will translate them into I2C commands addressed to the three MAX7315 of the board, for driving the referred LED of the display module. This interface is implemented also in three physical "channels": Bluetooth, ZigBee and USB. The board provides a mounting slot where either a Bluetooth adapter—providing a point-to-point link—or a ZigBee adapter—allowing a networked operation with several devices—can be plugged. USB interface provides direct—wired—connection to the host controller device. Display controller integrates also an E2PROM memory and a real time clock managed through I2C bus, which can be used for auxiliary tasks, such as playing predefined light patterns stored in the local memory.

Device controller host is the element where the functionality of the TOD is implemented, and typically will be a PC, smart device or any other embedded PC. This element not only manages display controller through its serial interface, but it also offers the interface with the user, allowing clock programming and configuration, and acting also as coordinator in networked scenarios (i.e. ZigBee).

5 Analysis and Software Development

As stated in the previous section, most of the intelligence of the device is removed, and management of the clock resides now in a device controller host, which will drive the visualizations through a serial interface. So the software subsystem is responsible of the interface system-users, the trace of system activity and the weekly schedule translation into timetable-panel micros's code.

We use Java as programming language because it is object oriented, it is simple (no headers), and—specially—it is portable: *write once, run anywhere*… Moreover, the timetable-panel schedule software is built to run either in a PC, a laptop or a PDA, so Java is the best language that meets our needs. Main functionality provided by the Device Controller Host is grouped into several modules, as shown in Figure 2.

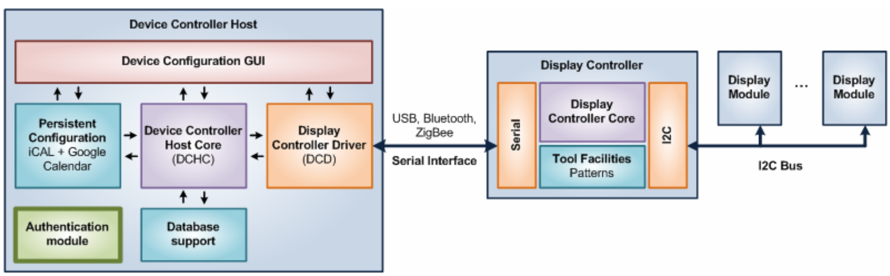


Fig. 2. Software architecture

Authentication Module
When the system begins the user must be identified. The authentication module assigns him an authentication level to grant secure access to services he can manage.

Database module
The database module manages the system data. Depending on the authentication level it will provide access to any data (Administrator), one classroom children, icons and music files and previous weekly schedules (teacher) or just one therapy data (therapist).

Device configuration GUI
To avoid designing a good TOD which results unusable for teachers the user interface design was made together with the teachers who tested the first prototype. They

suggested a friendly interface, oriented to manage the timetable-panel relation to pupils instead of to manage data information. However teachers with a good computer skill demand being able to manage previous weekly schedule to make a new one. We've designed a "wizard" which guide teachers trough the process step-by-step.

Device Controller Host Core
This module provides schedule editing dialog. Depending on the authentication level the user will have access to any timetable-panel (Administrator), just one class timetable-panel (teacher) or just one therapy schedule (therapist).

Display Controller Driver
This module provides communication with the classroom timetable-panel. The module acts as an interpreter of the data to submit code to the timetable-panel, rendering a virtual Display Controller. It is also provided asynchronous communication to every teacher's device with the system host using the school LAN.

Persistent configuration module
The use of iCAL format allows exporting and importing weekly schedules to be handled by any calendar application supporting iCAL format. Particularly, an interface to Google Calendar API has been implemented, which allows transmitting in/out weekly schedules using an internet connection, being accessible and modifiable from any computer not connected to the TOD across the Internet.

Configuring the timing of the daily activities and the timing clock is compatible with the Google Calendar application to be accessible via internet. In the same way the reciprocal process is also possible, modifying the timings with Google Calendar it is possible to alter the planning of the events to be displayed. This way, the user can make use of a personal event agenda with every communication capacity offered by Google Calendar

Users are not required to have a Gmail account, but they are required to have a free Google Account. The calendar related to a Google account could be shared with other Google accounts how are able to add, modify or delete tasks or timetables. So an administrator can check the configuration.

From the GUI, task can be added and deleted, and start and end times of the timetable can be managed too

5.1 System Analysis

The software development methodology is based on the model designed by Larman [14]. It uses UML as modeling language and is iterative, so we can use our previous work in the first prototype design.

Use cases
We consider two actors and seven scenarios in the operation of the TOD. The actors are: Chief of studies—as system administrator—and teacher or therapist—as user—. The chief of studies needs computer skills, and teacher and therapist are the same actor as they initiate the same cases. The pupils aren't actors as they just watch the timetable-panel.

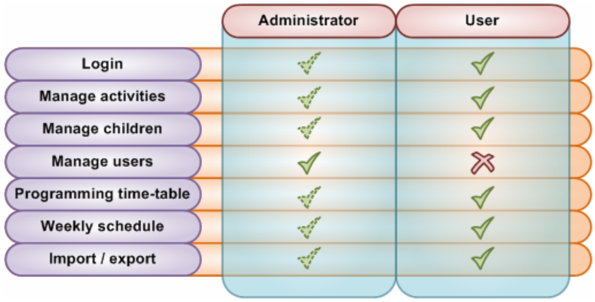


Fig. 3. Case uses

In Figure 3 we can see the case uses indicating the scenarios related to each actor. The scenarios that we have considered are:

- Administrator or teacher login in. It depends on the user's profile to have access to the whole system. Only administrator profile can manage users.
- Administrator or teacher putting up/down an activity. If the activity is put up the user must choose name, icon and music to associate with it. If it is put down the users just deletes the activity record.
- Administrator or teacher putting up/down a pupil in the classroom. Each teacher can manage only his/her classroom pupils. Administrator can manage all the pupils in the school.
- Administrator or teacher making a weekly schedule. Once again a teacher can just make or update his/her classroom schedule while administrator can make and update any school schedule.
- Administrator or teacher importing/exporting a weekly schedule. One of the new TOD features is Google Calendar compatibility. Users can import/export his/her weekly schedules to/from his/her google calendar account.
- Administrator or teacher programming the timetable-panel. Once the schedule is made or updated the user has to send it to the timetable-panel.
- Administrator putting/up down a teacher or therapist. This case can be only run under administrator profile.

States diagrams

States diagrams describe the behavior of the system in terms of states and transitions. A state represents a particular set of the values of the system objects described with the conceptual model. Given a state, the future state the system can move and the conditions needed for the change is a transition.

For the sake of simplicity, we have not shown the whole set of diagrams. In Figure 4 we can see one of the use case state diagrams: the communication with the timetable-panel. Once the user is identified and authenticated if he selects "Google Calendar Update" the system begins the communication, waits for the timetable-panel submitting data, updates and then sends them back to timetable-panel. If the communication breaks down during data transmission the system displays a warning message.

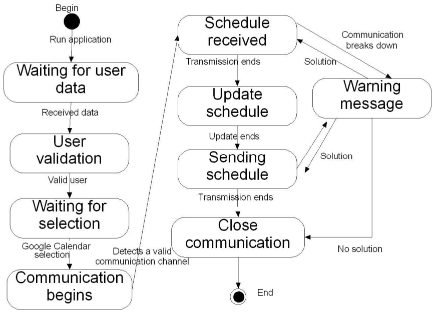


Fig. 4. Google Cal. update state diagram

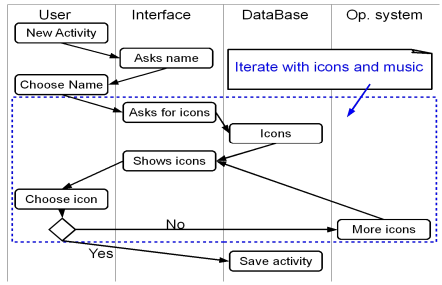


Fig. 5. New-activity activity diagram

Dynamic desing

As the software system interacts with users and with the timetable-panel system the objects that make up the system go through necessary changes to accommodate interactions. The activity diagram highlights the activities. Activity diagram describing how a user interacts with the system to add a new-activity to the database is depicted in Figure 5. After choosing the new-activity name the user asks for icons and music. If none of the database icons meets the activity then the system asks for any other icon stored in the PC.

6 Conclusions

A new version of TOD has been designed and it's being developed. Previous version showed it was useful to help special education schools teachers to manage activities schedule so children knew with enough anticipation what would be the next task or event. After testing the prototype in two state schools some improvements have been made.

Clock device hardware is simplified, turning it into a lights peripheral, which allows using it to any other functionality, such as for remainders, warnings or as an adapted interface.

To simplify tasks scheduling a software application has been developed following future users (teachers) requirements. The new TOD programming is completely made by software and it is compatible with Google Calendar application to be accessible via internet. The user interface design is made together with teachers. It is friendly interface, oriented to manage the timetable-panel relation to pupils.

Our first next task is to test the new TOD version to check changes. Another open task is to implement a Bluetooth OBEX Synchronization profile, which allows to exchange clock events with Bluetooth equipped devices, such as PDAs or mobile phones, without the need of a PC, and allowing configure the clock in such way.

We also expect using the TOD in AmI applications, as an adapted interface device for the elderly.

Acknowledgments

This work was supported in part by the by the European Union, under the projects MonAmI and EasyLine+ and by the Spanish MCYT under AmbienNET project (TIN2006-15617-C03-02).

References

1. Tractenberg, R.E., Weinstein, M., Weiner, M.F., Aisen, P.S., Fuh, J.-L., Goldman, N., Chuang, Y.L.: Benchmarking a test of temporal orientation with data from American and Taiwanese persons with Alzheimer's Disease and American normal elderly. Neuroepidemiology 24, 110–116 (2005)
2. Web side of CERTEC - Center for Rehabilitation Engineering Research Lund Institute of Technology (Last visit: June 2008), http://www.certec.lth.se/doc/certecscore/
3. Falcó, J.L., Muro, C., Plaza, I., Roy, A.: Temporal Orientation Panel for Special Education. In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A.I. (eds.) ICCHP 2006. LNCS, vol. 4061, pp. 831–838. Springer, Heidelberg (2006)
4. LoPresti, E.F., Mihailidis, A., Kirsch, N.: Assistive technology for cognitive rehabilitation: State of the art. Neuropsychological Rehabilitation 14(1-2), 5–39 (2004)
5. http://www.handitek.se/detta_ar_kvarturet/&catName=kvarturet (Last visit: June 2008)
6. http://www.timetimer.com/ (Last visit: June 2008)
7. http://www.cosys.us/index.htm (Last visit: June 2008)
8. http://www.ticktask.com/ (Last visit: June 2008)
9. http://portal.wpspublish.com/portal/page?_pageid=53,70585&_dad=portal&_-schema=PORTAL (Last visit: June 2008)
10. http://www.attainmentcompany.com/xcart/product.php?productid=16160&cat=0&-page=1 (Last visit: June 2008)
11. Keating, T.: Picture Planner: An Icon-Based Personal Management Application for Individuals with Cognitive Disabilities. In: Proceedings of the 8th International ACM SIGACCESS Conference on Computers and Accessibility, ASSETS 2006, Portland, Oregon, USA (2006)
12. http://www.school-readytherapy.com/sotl.html (Last visit: June 2008)
13. http://www.eyeboxtoolsinc.com/index.php?pg=products (Last visit: June 2008)
14. Larman, C.: UML y Patrones. Una introducción al análisis y diseño orientado a objetos y al proceso unificado. Pearson Education, Madrid (2003)

Designing Collaborative Learning and Innovation Systems for Education Professionals

Albert A. Angehrn[1], Katrina Maxwell[1], A. Marco Luccini[1], and Federico Rajola[2]

[1] Centre for Advanced Learning Technologies (CALT), INSEAD, boulevard de Constance, 77300 Fontainebleau, France
{albert.angehrn,katrina.maxwell,marco.luccini}@insead.edu
[2] Centre of Technology, Innovation and Finance (CeTIF), Università Cattolica, Via S. Vittore, 18, 20123 Milan, Italy
federico.rajola@unicatt.it

Abstract. Designing online systems to stimulate and support knowledge exchange, collaborative learning and innovation in distributed communities of professionals is a challenging task. In this paper we document the design of CMTube, a system aimed at stimulating and supporting value-adding online interactions among a distributed group of independent higher education professionals using the same learning approach, i.e., a management simulation. CMTube is based on latest web trends and makes extensive use of video, profiling, game dynamics, agents and network visualizations in order to capture the attention and involvement of community members by generating three different types of value: connection value, actionable learning value, as well as entertainment and instant gratification value. We also discuss the assessment of these different value dimensions, as well as ongoing and planned research directions.

Keywords: change management, connection dynamics, connection games, intelligent social agents, interactive learning, knowledge management, learning networks, network visualization, virtual communities.

1 Introduction

Effective knowledge exchange is necessary for learning and innovation. In today's competitive business environment, innovation is increasingly recognized as a powerful source of competitive advantage [1][2][3]. Innovation often occurs through "knowledge fusion", that is, the social process of new knowledge creation through the combination, adaptation, and additional development of separate knowledge assets from diverse contexts [4][5][6][7]. In order to be successful at knowledge fusion actors need to develop networks of interpersonal and inter-group interactions which increase the likelihood that novel ideas can emerge within and across domains [8]. Recently the on-line exchange of knowledge has become particularly valuable in many different situations because of the increasingly distributed nature of knowledge sources and people. In addition, collaboration complexity is significantly increased by not being in the same place at the same time, and by the ICT technologies used to

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 167–176, 2008.

support the communication of distributed groups. Unfortunately, many collaboration systems do not take sufficiently into account the emotional, psychological and social needs of individuals. Only if users see real value for themselves will they actively use and contribute their own knowledge.

Thus the main challenge in the design of an effective system to support an online community is to (i) provide sustainable value to users, and at the same time (ii) stimulate users to contribute their knowledge, insights and experiences on a continuous basis. Features supporting social exchanges that occur between members of communities of practice, learning or creation [7], particularly the ability to generate "connections" between people, are needed to give users more opportunities to engage in informal knowledge exchange, and stimulate them to actively participate in sharing and building on each others' knowledge and experience [9][10][11][12][13][14].

In this paper, we describe the design of CMTube, a system aimed at stimulating and supporting value-adding online interactions among the members of a distributed community of independent higher education professionals using the same learning approach, i.e. a management simulation. CMTube is based on the latest web trends and makes extensive use of video, profiling, game dynamics, agents and network visualizations in order to capture the attention and involvement of the learning community members by generating three different types of value: connection value, actionable learning value, as well as entertainment and instant gratification value. An important key concept underlying the design of CMTube is that it also generates the necessary data (log files) to allow researchers to assess platform usage and to evaluate system benefits along the three user value dimensions.

The remainder of the paper is structured as follows. In the next section, we describe the learning community deployment context. This is followed by a detailed description of the key design features of CMTube showing how each feature can increase connectedness and user value. We then discuss the planned assessment of CMTube's impact, and conclude with ongoing and future research directions.

2 Learning Community Deployment Context

The learning community addressed by CMTube consists of over 1000 globally distributed faculty, corporate trainers, and independent consultants who develop and run change management workshops based on the EIS (Executive Information System) management simulation [15]. Since 1999, this community has been using an online platform on a regular basis to access information and news about the EIS simulation, to download software and related teaching material, and to manage transactions such as session booking. Although the platform does contain basic mechanisms to allow members to communicate with each other, and in spite of invitations to do so, members have not taken advantage of this knowledge exchange and collaboration opportunity, but perceive the platform mainly as an individual service, to "get what they need and leave".

As an initial hypothesis we attributed this to the fact that the platform was lacking a number of features to make knowledge exchange dynamics both attractive and conducive to value-adding exchanges among members. The reasons for this might include the fact that the content is mainly text-based, simple and poorly filled members profiles, no emphasis on social networking or linking members to knowledge assets, and also no reason at all to visit the platform for entertainment value. To validate the impact of these factors we designed a number of features and dynamics in order to integrate them in the original platform to encourage members of this learning community to finally start interactively sharing their own experiences in different contexts, as well as their ideas about new ways of developing further, deploying, or debriefing the simulation. The resulting online environment, CMTube, is described in the following section. A key characteristic of this system is that each feature is aimed at generating a high level of user value by connecting members to each other and relevant knowledge assets, by making them aware of new experiences, ideas and projects, and by stimulating them to share their own experiences and ideas and join others in developing ideas and projects. CMTube also provides members with a certain amount of entertainment and instant gratification value.

3 CMTube Design

CMTube was mainly designed to motivate and enable members of the EIS learning community to share experiences, ideas and projects on which they are working in order to continually innovate and improve the EIS workshop experience in different types of organizational contexts (public vs. private organizations, different cultures, etc.) and with different types of audiences such as top managers and decision makers, change agents and consultants, and management students (see Fig. 1). From a user perspective CMTube appears as a set of four coupled environments: a Video Exchange Channel, a Network Visualization and Navigation Tool, a Profiles Space, and a Connection Game Space.

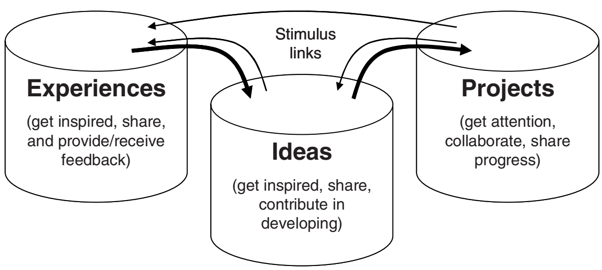


Fig. 1. The CMTube innovation and improvement cycle

3.1 Video Exchange Channel

On the CMTube Channel members can very easily view, search, comment, tag, rate and submit videos in a similar way to YouTube (www.youtube.com). The key specificities of the CMTube Channel are:

- The environment is “closed” (i.e., not public).
- Members are identified when entering, have a profile, and their activities are recorded in a log file.

- All members are peers and can see each others' profiles.
- Videos can be either imported from other sources, such as YouTube or produced and submitted by the members.
- Links and documents can be attached to videos.
- Videos in the CMTube Channel belong to one of these three categories:

  EIS Experience Videos - these videos feature presentations related to EIS training experiences; for example, "Deployment at ALBA", "EIS at FIAT", or "Experiences from a participant perspective";

  EIS Idea Videos - these videos feature presentations related to new ideas for deploying EIS, such as in "Research on Emotions", "Alternative Scenario Ideas", or "Ideas for on-line deployment";

  EIS Project Videos - these videos feature presentations about new EIS-related projects; for example, "Adapting EIS for a Crisis Management project" or "Potential Diffusion" project.

Fig. 2. The CMTube Video Exchange Channel

The CMTube Video Exchange Channel (Fig. 2) creates connection opportunities by enabling members to submit and see videos submitted by other members. The Channel also increases connectedness to videos and other members by supporting the commenting and discussion of individual videos. Two further connection-oriented embedded mechanisms include tagging videos and rating.

3.2 Network Visualization and Navigation Tool

A Network Visualization and Navigation Tool (NVNT) helps members visualize and browse through the links between three types of objects (see Fig. 3):

- people – community members
- knowledge assets (KA) – videos about experiences, ideas and projects
- tags – keywords which describe the subject of the video

There are a number of relationships between these objects as shown in Table 1.

Fig. 3. The CMTube Network Visualization and Navigation Tool

Table 1. Relationships between connected objects

Relationship	Objects connected	Comment
knows	person to person	A person knows another person (5 different intensity levels)
has_seen	person to KA	A person has seen a video
is_related_to	tag to KA	Tags the video submitter has given indicating the subjects the video covers
has_submitted	person to KA	A person has submitted a video
is_a_new_version_of	KA to KA	A person has provided a new version of a previously submitted video
is_inspired_by	KA to KA	A person has indicated that the video she uploaded was inspired by another video

The NVNT supports productive connections by enabling members to freely navigate through the different relationships and networks, and access other members' profiles. Users can also create links to other users and rate the intensity of their relationships. Further connection-oriented embedded dynamics include the possibility to search specific sub-networks, as well as a "time-machine" enabling members to explore/navigate the evolution of the network over time, showing for instance the growing popularity of a specific video, or tracing the gradual development of specific ideas and projects.

3.3 Profiles Space

The CMTube Profiles Space encourages members to access information about other members, their interests, competences and networks. Such an environment aims at increasing the visibility of each member and stimulating users to identify members with whom to "connect". The Profiles Space also contains an embedded chat room.

3.4 Connection Games Space

The CMTube Connection Games Space (see Fig. 4) aims at proactively encouraging members to access videos and connects members to each other in a playful way (compared e.g., with recommendation agents). In the current Space, users can play (for just 5 minutes or for much longer) a conceptually very simple but actually very effective two-player matching/guessing game. During each game, two anonymous players view the same video in parallel and try to describe it (using words they insert realtime). Players can type as many words as they want while they watch the video. At the end of the game, the two players are asked if they wish to reveal their identity. If they both agree, they are connected to the profile and network of the other player.

Fig. 4. The CMTube Connection Games Space

The logic of the Connection Game embedded in CMTube is similar to the one of the ESP game [16] and the ProfilAMat game [17], with the exception that the object the users play with is not a picture but one of the videos included in the CMTube Channel. Figure 4 shows a screen from the CMTube Connection Game. A key design principle underlying this game, which makes it not only entertaining, but also effective, is the selection of the relevant videos and the matching/connection of the users. In fact, in each game, the video displayed and the pair of players are “selected” by a connection agent trying to maximize the potential connection value involved.

3.5 Connection Agents

Beyond the four components illustrated above, CMTube also contains three types of embedded Connection Agents: a game-related connection agent, a recommendation connection agent, and a similarity connection agent which gather information about a member’s profile and system use. The game-related connection agent mentioned above selects the most appropriate videos and members to connect through a game. The recommendation connection agent provides direct personal recommendations about the most relevant videos and members to connect with, and stimulates members to watch and submit videos. The similarity connection agent identifies “similarity” among members as a function of their behavior (e.g., which videos they have seen, submitted, and the tags they use) and their profile information, and displays this similarity-related information in different forms, stimulating users to explore the profiles of other selected community members.

To explore the features of a public version of the system, see [18].

4 Assessing the Impact of CMTube

In the area of human computer interfaces, a number of evaluation methods are used such as field studies, laboratory experiments, and inspections. Each method assesses different aspects of the interfaces and places different demands on the developer, user, and evaluator [19]. In the area of knowledge management, there does not appear to be a systematic way to evaluate knowledge management systems. Common approaches are requirements analysis, usability studies, case studies, user cases and surveys [20]. However, despite, or perhaps because of, the many frameworks and studies on metrics adapted to the specific environment and needs of various users; it has not been possible to generalize metrics for knowledge management evaluation [21]. It also appears that the measurement of value, and of the psychological and social processes involved in the use of knowledge management systems, remain areas that still need to be developed. Emphasis on social dimensions such as participation and interaction appear to be more salient in the evaluation of online communities. Ethnographic techniques such as interaction logging are widely used and have the advantage of being both easy and unobtrusive [22][23]; however, they also have the disadvantage of posing some ethical questions about privacy. Nonetheless, given the experimental learning community members' permission, the rich descriptions generated in log files can greatly contribute to our understanding of both individual and collective behavior within online communities.

Within a system like CMTube, we have identified three different types of user value: Connection value, Actionable Learning value, Entertainment & Instant Gratification value. Table 2 shows the link between each value type and the corresponding CMTube components.

We are currently developing mechanisms for measuring and tracking value creation along these three dimensions at the individual and at the overall community

Table 2. Relationship between user value, CMTube component and visit context

Value Type	CMTube Element	Context
Connection	NVNT, Profiles Space, Connection Agents	Discover and engage with relevant people. Get inspiration from others experiences, contribute to developing ideas, and discover projects in which to collaborate. Discover relationships between people (e.g. separation degrees) and content.
Actionable Learning	Video Exchange Channel, discussions and chat spaces	Get feedback. Get and contribute to new ideas. Exchange with others. Collaborate in projects.
Entertainment & Instant Gratification	Connection Games, Video Exchange Channel	Have fun. Discover new videos or people. Drop in for quick visit (see new videos or play a quick game).

level. From a research perspective, the advantage of a system like CMTube is that a large amount of data can be collected automatically in log files, including relevant indicators like sign in frequency, time spent playing games, time spent navigating and exploring relationship networks, number of videos watched and submitted, number of new connections originating from games, or number of suggestions followed from recommending agents. Additional insights will be gathered through surveys and interviews aimed at measuring each of the three value dimensions.

5 Conclusions

Many on-line knowledge exchange communities fail because they do not take sufficiently into account the emotional, psychological and social needs of individuals. The addition of new social features is also a current trend in open community sites; for example, LinkedIn has just started suggesting people with whom you may which to connect [25]. A modern interactive knowledge exchange and learning environment which incorporates the latest web trends and connection dynamics such as knowledge asset-based games can provide real value to learning community members by encouraging them to engage with each other while viewing knowledge assets. Increasing the connectedness of people to other people, and to relevant knowledge assets, should motivate them to move from lurkers to active community contributors.

We are currently starting to validate the impact of CMTube and in particular the extent to which the different connection dynamics embedded in such a system effectively stimulate and enable community members to:

- share and discuss their experiences,
- explore, develop or submit ideas,
- collaborate in joint projects,
- improve their professional competence and effectiveness,
- contribute actively to innovation and diffusion of innovation.

Ultimately we expect this experience with distributed education professionals to generate insights about the factors which can determine in more general terms the success or failure of knowledge exchange initiatives in organizational or community contexts. We are currently developing mechanisms for measuring and tracking value creation along these three dimensions at the individual and at the overall community level.

Acknowledgements

We would like to thank the CALT Team for their valuable software development and research assistance. This work has been partially sponsored by the Laboranova and TENCompetence Integrated Projects funded by the European Commission's 6th Framework Programme.

References

1. Damanpour, F., Szabat, K.A., Evan, W.V.: The relationship between types of innovation and organizational performance. Journal of Management Studies 26(6), 587–602 (1989)
2. Dyer, J.H., Singh, H.: The relational view: cooperative strategy and source of interorganizational competitive advantage. Academy of Management Review 23(4), 660–679 (1998)
3. Loof, H., Heshmati, A.: On the relationship between innovation and performance: a sensitivity analysis. Economics of Innovation and New Technology 15(4-5), 317–344 (2006)
4. Fliaster, A.: Towards People-Focused Knowledge Fusion Paradigm of Organizational Innovation Management. In: Edwards, J., Kidd, J. (eds.) Proceedings of the KMAC 2000 Conference Knowledge Management Beyond the Hype: Looking Towards the New Millennium. Organized by the Operational Research Society. Aston Business School, Aston University (2000)
5. Fliaster, A.: Cross-Hierarchical Interconnectivity: Forms, Mechanisms and Transformation of Leadership Culture. Knowledge Management Research & Practice 2, 48–57 (2004)
6. Fliaster, A., Spiess, J.: Knowledge Mobilization through Social Ties: The Cost-Benefit Analysis. Schmalenbach Business Review, pp. 99–117 (January 2008)
7. Sawhney, M., Prandelli, E.: Communities of Creation: Managing Distributed Innovation in Turbulent Markets. California Management Review 42(4), 24–54 (Summer 2000)
8. Ford, C.M.: Striking Inspirational Sparks and Fanning Creative Flames: A Multi-Domain Model of Creative Action taking. In: Ford, C.M., Gioia, D.A. (eds.) Creative Action in Organizations: Ivory Tower Visions & Real World Voices, pp. 330–354. Sage Publications, Thousand Oaks (1996)
9. Brown, J.S., Duguid, P.: The Social Life of Information. HBS Press, Boston (2000)
10. Cheak, A., Angehrn, A.A., Sloep, P.B.: Enhancing Lifelong Competence Development and Management Systems with Social Network-based Concepts and Tools. In: ICALT 2006, pp. 487–488 (2006)
11. Cross, R., Parker, A., Prusak, L., Borgatti, S.: Knowing What We Know: Supporting Knowledge Creation and Sharing in Social Networks. Organizational Dynamics 30(2), 100–120 (2001)
12. McAfee, A.P.: Enterprise 2.0: The Dawn of Emergent Collaboration. MIT Sloan Management Review 47(3), 21–28 (Spring 2006)
13. O'Reilly, T.: What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software. O'Reilly, Sebastopol (2005), `http://www.oreilly.com/` (retrieved April 23, 2007)
14. Wenger, E., McDermott, R., Snyder, W.M.: Cultivating Communities of Practice: a Guide to Managing Knowledge. HBS Press, Boston (2002)
15. Angehrn, A.A.: Designing SmallWorld Simulations: Experiences and Developments. In: The 6th IEEE International Conference on Advanced Learning Technologies (ICALT 2006), Kerkrade, July 5-7 (2006)
16. von Ahn, L., Dabbish, L.: Labeling Images with a Computer Game. In: ACM CHI-2004, Vienna, April 24-29 (2004)
17. Angehrn, A.A., Maxwell, K., Sereno, B.: Enhancing Social Interaction in Competence Development Networks: A Conceptual Framework. International Journal of Learning Technology (June 2008)
18. CMTube, `http://www.calt.insead.edu/eis/changemasterstube` with username: guest@guest.com and password: lab1 (May 7, 2008) (2008)

19. Cugini, J., Damianos, L., Hirschman, L., Kozierok, R., Kurtz, J., Laskowski, S., Sholtz, J.: Methodology for the Evaluation of Collaboration Systems, The Evaluation Working Group of The DARPA Intelligent Collaboration and Visualization Program (1997) (Retrieved May 7, 2008), `http://www.itl.nist.gov/iad/vvrg/nist-icv/documents/method.pdf`
20. Chen, M.Y., Chen, A.P.: Knowledge management performance evaluation: a decade review from 1995-2004. Journal of Information Science 32(1), 17–38 (2006)
21. Folkens, F., Spiliopoulou, M.: Towards an evaluation framework for knowledge management systems. In: Karagiannis, D., Reimer, U. (eds.) PAKM 2004. LNCS (LNAI), vol. 3336, pp. 23–34. Springer, Heidelberg (2004)
22. Nonnecke, B., Preece, J.: Lurker Demographics: Counting the Silent. In: Proceedings of CHI 2000, Hague, pp. 73–80 (2000)
23. Smith, M.A.: Invisible crowds in cyberspace: mapping the social structure of the Usenet. In: Smith, M.A., Kollack, P. (eds.) Communities in Cyberspace, Routledge, New York (1999)
24. Goldman, J.: Learn more about People You May Know, LinkedIn blog (2008) (Retrieved May 22, 2008), `http://blog.linkedin.com/blog/2008/04/learn-more-abou.html`

Personalized Learning Using Ontologies and Semantic Web Technologies

Maria Vargas-Vera[1] and Miltiadis Lytras[2]

[1] Computing Department, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK
m.vargas-vera@open.ac.uk
[2] Computer Engineering and Informatics Department, University of Patras
lytras@ceid.upatras.gr

Abstract. This paper presents an in-depth analysis of the semantic web contribution towards personalization in e-learning content exploitation. The aim of this research work is to develop a framework for analyzing the semantic web and ontological issues related with the design and implementation of high performance e-learning systems enabled by advanced semantic web and ontological engineering. Within this context the concept of personalization is linked to the state of the art of semantic web and Ontologies research. The main emphasis is paid to the management of personal profiles and identities.

Keywords: Semantic Web, E-learning, Learning Portals, Personalization.

1 Introduction

Semantic web (Davies *et al*., 2007; Vossen *et al*., 2007; Lytras, 2005) has contributed to numerous real world applications, especially in the context of industry. Furthermore at governmental level there is significant funding on research concerning semantic web and ontologies. The initial vision of machine understandable data and interoperable intelligent infrastructures has been also revisited significantly. The need to develop infrastructures and data containers permitting high levels of adoptability and relevance to personal profiles with dynamic algorithms is a key requirement for the new wave of human intelligence through computer science. The development of Dynamic E-learning Systems with increased capacities for personalization requires the understanding of the complex 'learning' performance (Lytras and Pouloudi, 2006). Several surveys and various researchers around the world link the learning performance with several 'dynamic' components (Lytras *et al*., 2005a–b):

- *Learners profiles* – diverse characteristics related mostly with behavioural and psychological parameters require codification, assessment, and enhancement or exploitation within e-learning systems.
- *Learning objects* – the downsizing of learning content to meaningful units with manual, semi-automated and automatic procedures is a tough process (Lytras and Sicilia, 2005).

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 177–186, 2008.

- *Learning contexts/learning processes* – In any learning/didactical context it is of critical importance to organise the diffusion of content according to well defined learning strategies. This perfect match is not accomplished without significant effort. The definition of multiple dimensions related to learning exploitation requires the modelling of various complementary views of learning performance (Barriocanal *et al*., 2006), (Lytras *et al*., 2002).
- *Learning community* – the in fashion concept of learning communities, partially due to the promotion of Web 2.0 technologies, within 'established' educational systems is a challenge.
- *Learning services* – The poor performance of the commercial e-learning platforms, in terms of learning services requires a deep reconsideration of priorities concerning the learning goals that are accomplished in the context of use of learning systems.
- *Interactivity- Integration of learners' interaction* – Most of commercial application apply a 'storage' perspective. In simple words in most of cases it is considered that the learning content integrated to a static learning path, will work towards high learning performance. Both in formal and informal learning cases, the workflow of learning requires an integration of providers and users of learning/didactic units. Semantic web challenges the conceptual modeling of the learning context by promoting a manifesto where Ontologies provide the key aspects of learning case.
- *Evaluation/Assessment* – Assessment in an e-learning environment or in general in technology enhanced learning contexts requires a multidimensional consideration of parameters that must be measured in an objective way. Semantic web technologies and Ontologies permit the representation of assessment Ontologies and competencies Ontologies that link learning with personal and team development (Lytras *et al*., 2007).
- *Open Agoras of content* – In our days it is exciting challenging the plethora of 'learning resources' of information and knowledge located in different places and also in marketplaces of content. The provision of learning marketplaces requires a global agreement on content structuring based on ontological considerations.

2 Semantic E-Learning in the Quest of Personalisation

In this section we will elaborate on the main facets of the learning performance directly linked to semantic web capacities for better performance. Let us from the beginning describe a context for our analysis: "*There is a tremendous need for a main Learning Portal Organization in Europe to redesign the value offering to learners and others members of a huge learning community. What is needed is a step forward concerning personalization of content and value adding services. Within the workflow of the Learning Portal, the dominant model relates with content contributions from senior authors/contributors and a continuous enrichment of content through an extensive 'knowledge mining' of resources. The Learning Portal Organization is also cooperating in an 'Agora' of learning resources, where interoperable systems are able to exchange information and learning content. The main issue to be addressed is a demonstrated gap in fulfilling learners expectations concerning their performance. It is discussed to exploit semantic web technologies towards a new era in the learning* *services of the learning portal. It is expected that this initiative will bring the learning portal closer to fast changing learning needs of our times*."

2.1 Ontologising Knowledge Flows/Domain Ontologies

From a learning content perspective it is evident that every knowledge/learning flow is linked directly to the 'constitutional elements' of each learning units. One of the greatest challenges nowadays relates with the provision of value adding layers of metadata to original concrete pieces of learning content (Naeve *et al*., 2006; Sampson *et al*., 2004). The so called learning-objects manifestation and the consequent learning design approach recognises myopically that learning is a case of matching content to context. To an extend this consideration is valid to the level the required element are provisioned in an accurate level with quality assessment methods. What practice says is that there is a key performance gap in two levels: First of all learning objects lack in terms of metadata provision and more important there is a blur understanding of learning design approaches to real world learning contexts. A bold response to this issue relates with a dual response to the problem of learning content representation and diffusion. According to semantic web promises/milestones, several domain ontologies can map important scientific domains by providing critical knowledge storage infrastructures, helping the development of meaningful learning paths on the top of domain ontologies (Sicilia *et al*., 2006). So given our case some questions from a practical point of view require answers that can be implemented and functional:

- Are there domain ontologies which we can customise and exploit in an e-learning system aiming to annotate the content according to their depth and interoperability capabilities? Are there systems which given an ontology, can (semi)automatically annotate and populate with required metadata existed or under development learning content? From an Architectural of e-learning system perspective, are there any guidelines for the 'components' or Ontologies that must work complimentary in order to specify the learning logic.

2.2 Semantic Social-Learning Networking

Most of the dominant learning management systems in the market, demonstrate very poor performance concerning team learning. Several times industry is sceptical to adopt new ideas, new systems, or services. There is a critical need for new proposition to demonstrate their capacity to be adopted by end users or stakeholders of targeted organizations.

Learning units/semantic annotation of content with semantics and metadata
Representing knowledge and learning objects is a key requirement for any technology enhanced learning environment. Semantic web technologies and specific languages like OWL and RDF can integrate learning objects components to exploitable graphs and structures. The parameterization of a learning environment based on learning units it must be based on a clear definition of metadata elements that support multiple views of same content.

Learning processes/semantic modelling of processes/ ontological agreement
From a learning performance perspective, the exploitation of learning content must be seen in the context of various didactical/learning sub-processes which multiply the

effect of learning. In a semantic e-learning environment we can promote extensive conceptual modeling techniques in order to summarize the underlying logic of content exploitation for learning purposes.

Learning scenarios/learning designs/learning context
The personalization on a semantic e-learning environment based on scenarios/context or design requires an intelligent mechanism for the matching of learning needs to a variety of complimentary aspects of a unified approach to the design of learning context (Sicilia and Lytras, 2005a–b). In simple words semantic web technologies, with rule languages and semantic web services can provide a palette of various well-defined aspects of the learning context.

Competencies plans – personal development programmes – semantic models
Semantic e-learning personalisation based on competencies plans is more demanding in terms of modelling. The modelling of skills and competencies it requires ontologies of skills and competencies as well as competencies development programmes based on learning experiences designed for people with specific profiles. From a semantic web perspective, such a step requires several ontological agreements towards interoperable content and competencies models.

Dynamic assessment – assessment ontologies
Personalisation in a semantic e-learning environment can be also based on dynamic assessment models/methods. One of the weakest points in e-learning is the 'narrow', 'simple' evaluation methods that are used. Semantic web technologies can support a new era of assessment by providing multiple layers and components for evaluation.

Matching of knowledge gaps to personal learning programmes
The semantic mapping of knowledge gaps is a high intellectual process. The relevant semantic web technologies including, ontologies visualisation, ontologies mapping can support intelligent components in the next generation of semantic e-learning systems. In the last years the European Union, funded several projects aiming to promote the semantic web vision in e-learning and knowledge management at European level. An interesting project related to the vision for a new era of learning management systems is the case of OpenLearn initiative. Distance learning has traditionally been a fairly isolated activity, but the collaborative tools included in OpenLearn initiative changes this view from isolated learning to collaborative learning. OpenLearn[1] launched in October 2006 at The Open University, UK enables users to learn together. These is achieved through its functionalities using e-learning tools such as discussion forums, instant messaging, Flash meeting (The Open University's video-conferencing tool) and knowledge maps (a way of creating visual representations of ideas). OpenLearn material has been used by people who do not have the money to access higher education and because the content is in a digital form they can access it from home.

In the next section, we go beyond the discussion for the merits of semantic web towards a new generation of personalized learning portals and we provide a real world implementation for a semantic learning portal.

3 Personalised E-Learning Portals: Reconsidering the Learning Content Diffusion

Personalisation approaches: learner profiles – learning objects match

Ontological interest-profiling would enhance retrieval methods in an e-learning scenario as the student can obtain the educational resources of interest quickly and tailored to student interest. A possible fix to this problem would have been to provide a keyword-based search engine. This class of solution, however, has the known limitations that every body experienced with keywords-based search engines (*e.g.*, unrelated matches). Therefore, a method which allows user to specify his/her interest and then search for articles that match these interests has been suggested. An ontology-driven personalization relies in a initial definition of the user profile using a controlled vocabulary contained in an given ontology. Additionally, an ontology can be used in search and then the search results are improved by using inferences capabilities provided by a given ontology. Therefore, the system can reason about the categories selected by applying ontology driven deduction. For example, if Maria is interested in `Research Area` *Genetic Programming*, a search engine would return all the articles that talk about that `Research Area` by employing the string-matching technique which might return zero matches. However, by using the ontological relations that hold between these categories we can find which `Projects` have as `Research Area` *Genetic Programming* and then the system search for articles that talk about these `Projects`. These would then be included in the answer set as potentially interesting articles although they do not explicitly mention the *Genetic Programming* `Research Area`. In the same fashion, a system based on this ideas can perform more inferences such as finding `Technologies` that have been used in `Projects` and `People` who are members or leaders of these `Projects` – which have as `Research Area` *Genetic Programming* – therefore inferring that these `People` might be a potential contact for information on `Technologies` for *Genetic Programming*.The system also store the selections a user makes, this way the system records the user's profile with respect to the selected interests. This profile can be edited later on as well as used for finding pro-actively articles that match it. The matching of interests in the electronic newsletter corpus is based on string matching but employs the notion of 'cue phrases' and 'cue words' which are associated with the instances of the categories given above. The notion of 'cue': evidence and abstraction is introduced. A cue phrase is both an abstraction of the category that is associated with and evidence that the article which contains it is relevant to that category. For example, we define as a cue phrase for the `Research Area` *Ontologies*, the phrase 'knowledge sharing and reuse'. This is an abstraction of the term *Ontologies*. Whenever we find that phrase in an article we assume that this article is relevant to *Ontologies*. This finding is the evidence of relevance.

Learning paths through ontological engineering

E-learning is an area which can benefit from semantic web technologies. Current approaches to e-learning implement the teacher-student model: students are presented with material (in a limited personalised way) and then tested to assess their learning. However, e-learning frameworks should take advantages of semantic services, interoperability, ontologies and semantic annotation. The semantic web could offer more flexibility in e-learning systems through use of new emergent semantic web technologies such as collaborative/discussion and annotations tools.

Annotation

Annotation is the activity of annotating text documents written in plain ASCII or HTML with a set of tags that are the names of slots of the selected class in an ontology. In particular, in an e-learning context, the ontology could include a class called Course with a slots entitled 'name' (indicating the name of the course), 'has-level' (year/difficulty of the course), 'has-provider' (educational establishment offering the course) and 'objectives' (indicating learning outcomes). Then documents can be annotated using any of these slots. There are initiatives to standardise annotations using a common language. One of the major problems of this approach is 'who is going to do the annotations?'. Not many people are willing to annotate resources unless they can see an immediate gain in doing it. Therefore, alternative approaches should be considered, including (semi-)automated systems. This approach was taken in the student essay annotation system described later. Annotation tools for producing semantic markup include Annotea (Kahan *et al.*, 2001), SHOE Knowledge Annotator (Heflin and Hendler, 2001), the COHSE Mozilla Annotator (Bechhofer and Goble, 2001), AeroDAML (Kogut and Holmes, 2001), Melita (Ciravegna *et al.*, 2002) and OntoMat-Annotizer (Handschuh *et al.*, 2001). Annotea provides RDF-based markup but does not support information extraction nor is it linked to an ontology server. It does, however, have an annotation server which makes annotations publicly available.

- SHOE Knowledge Annotator allows users to mark up pages in SHOE guided by ontologies available locally or via a URL. SHOE-aware tools such as SHOE Search can query these marked up pages.
- The COHSE Mozilla Annotator uses an ontology server to mark up pages in DAML. The results can be saved as RDF.
- AeroDAML is available as a web page. The user simply enters a URL and the system automatically returns DAML annotations on another web page using a predefined ontology based on WordNet.
- Melita, like MnM, provides information extraction-based semantic annotation. Work on Melita has focused on Human-Computer Interaction issues such as limiting intrusivity of the information extraction system and maximising proactivity and timeliness in suggestions. Melita does not provide sophisticated access to the ontology, unlike MnM. In this sense Melita explored issues complementary to those explored in developing MnM and the two approaches could be integrated. MnM (Vargas-Vera *et al.*, 2002) is an annotation tool which provides both automated and semi-automated support for marking up web pages with semantic contents. MnM integrates a web browser with an ontology editor and provides open APIs to link up to ontology servers and for integrating information extraction tools. It is an early example of the next generation of ontology editors: web-based, oriented to semantic markup and providing mechanisms for large-scale automatic markup of web pages.
- OntoMat, which uses the CREAM annotation framework, is closest to MnM in both spirit and functionality. Both allow browsing of predefined ontologies as a means of annotating the web pages displayed using their HTML browsers. Both can save annotations in the document or as a knowledge base. While

MnM already provides automated extraction, this is currently only planned for OntoMat.

Ontologies
In a nutshell, the idea of interoperating agents able to exchange information and carrying out complex problem-solving on the web is based on the assumption that they will share common, explicitly-defined, generic conceptualisations. These are typically models of a particular area, such as product catalogues or taxonomies of medical conditions. However, ontologies can also be used to support the specification of reasoning services (McIlraith *et al.*, 2001; Motta, 1999), thus allowing not only 'static' interoperability through shared domain conceptualisations, but also 'dynamic' interoperability through the explicit publication of competence specifications, which can be reasoned about to determine whether a particular semantic web service is appropriate for a particular task. In summary, ontologies can be used in e-learning as a formal means to describe the organisation of universities and courses and to define services. An e-learning ontology should include descriptions of educational organisations, courses and people involved in the teaching and learning process.

4 A Semantic Web Learning Portal Architecture: Beyond Learning Objects

Research in e-learning has been concentrated around learning objects. However, authors believe that to offer courseware only using learning objects is a static view in an e-learning scenario. Students need to be supported in making connections in engaging critical analysis, in locating the right knowledge, in making sense of pedagogic narratives. Our proposal goes beyond learning objects, in fact, we propose to use semantic technologies in e-learning. Therefore, in this section describes our proposed architecture for a student semantic portal. Architecturally, a semantic portal consists of a user who has access to services, repositories and databases through an interface. In the suggested architecture, the first step would be registering each service with a registry, so that services can then be invoked through the service broker. The broker is a central component in this distributed architecture: it allows communication between service providers and requesters. In particular, it attempts to match a request for a service to the closest service that can provide that functionality. Services interact with resources and, in particular, subscribe to relevant ontologies. Other resources include databases and documents published on the internet. We envision a scenario where educational services can be mediated on student behalf. The user/student will confirm that suggestions are acceptable. The advantage of having a semantic portal is that students need not look for courses distributed across many locations (unlike current solutions). Moreover, semantic services perform inferences in the background (taking into account student preferences) as opposed to having users manually searching the traditional way. An e-learning portal might include services such as smart question-answering, exam marking, intelligent tutoring systems, online courses and a service to help students improve their essays. Of these services, we have so far dealt with the implementation of a question-answering service (AQUA) and SVE, a visualisation tool for student essays (Moreale and Vargas-Vera, 2003). AQUA searches for answers in different resources such as ontologies and documents on the web. AQUA is described in detail elsewhere and we refer the reader to these papers (Vargas-Vera and Motta, 2004; Vargas-Vera *et al*., 2003). We envisage the use of these components as part of a student semantic portal, seen as a door to obtaining knowledge which may be mediated by a set of semantic services (Moreale and Vargas-Vera, 2004). To illustrate, we will now go through an e-learning scenario. A student first searches for an online course (optionally specifying any constraints): the broker handles the request and returns a set of choices satisfying the query. If no course is found, the user can register with a notification service. Otherwise, the user may find a suitable course among the offerings and then makes a final decision about registering for the course. Processing the registration can be seen as a complex service involving registering with the system (resource management), creating a confirmation notification, creating a student account (authentication/authorisation), providing learning materials (provide materials) and processing payment (booking and payment), if applicable. Once all this is in place, the student can start the course. As part of the course, a student will be logging on and checking her learning agenda (*e.g.*, next assignment due). This request is answered by combining several sources of information, such as course schedule, current date and student progress to date (*e.g.*, completed units). Complex services can be obtained by combining simple services. In our view, semantic services can be described as logic statements. Then the composition problem can be seen as merging logic statements with constraints. Work reported in (Vargas-Vera and Robertson, 1994; Vargas-Vera 1995) describes an automatic system which combines logic programmes using programme histories. Further research needs to be carried out in this direction. Another, equally important challenge, which needs to be addressed in the web services arena is that, when services are subscribed to different ontologies, then our framework has to deal with ontology mapping between ontologies. There are several approaches to ontology mapping such as the one taken in the GLUE system (Doan *et al*., 2002); Noy and Musen (2000) also developed a tool for ontology alignment. Our architecture moves away from the traditional teacher-student model in which the teacher determines the learning material to be absorbed by students and towards a new, more flexible learning structure in which students take responsibility for their own learning, determine their learning agenda, including what is to be included and in what order.

5 Conclusions

As a conclusion, we want to make bold the contribution of semantic web for more effective e-learning systems. It is also true that many disciplines have to converge and to contribute in order the technological capacities of semantic web to be integrated with fresh ideas on pedagogy and learning, closer to the needs of our modern interconnected societies. Towards a humanistic vision for the knowledge society, semantic learning portals is a key pillar of research in which we plan to contribute further.

References

Barriocanal, E.G., Sicilia, M.A., Lytras, M.: Pedagogical classification frameworks for learning objects: a case study. Computers in Human Behavior 23(6), 2641–2655 (2006)

Bechhofer, S., Goble, C.: Towards annotation using DAML+OIL. In: First International Conference on Knowledge Capture (K-CAP 2001), Workshop on Semantic Markup and Annotation, Victoria, BC, Canada (2001)

Ciravegna, F., Dingli, A., Petrelli, D., Wilks, Y.: User-system cooperation in document annotation based on information extraction. In: Gómez-Pérez, A., Benjamins, V.R. (eds.) EKAW 2002. LNCS (LNAI), vol. 2473. Springer, Heidelberg (2002)

Davies, J., Lytras, M., Sheth, P.: Semantic-web-based knowledge management. IEEE Internet Computing 11(5), 14–16 (2007)

Doan, A.H., Madhavan, J., Domingos, P., Halevy, A.: Learning to map between ontologies on the semantic web. In: World Wide Web Conference WWW 2002, Hawaii, USA, pp. 662–673 (2002)

Handschuh, S., Staab, S., Maedche, A.: CREAM – creating relational metadata with a component-based, ontology-driven annotation framework. In: First International Conference on Knowledge Capture (K-CAP 2001), Victoria, BC, Canada (2001)

Heflin, J., Hendler, J.J.: A portrait of the semantic web in action. IEEE Intelligent Systems 16(2) (2001)

Kahan, J., Koivunen, M., Prud'Hommeaux, E., Swick, R.: Annotea: Open RDF infrastructure for shared web annotations. In: Proc. of the WWW10 International Conference, Hong Kong (2001)

Kogut, P., Holmes, W.: AeroDAML: Applying information extraction to generate DAML annotations from web pages. In: First International Conference on Knowledge Capture (K-CAP 2001), Workshop on Knowledge Markup and Semantic Annotation, Victoria, BC, Canada (2001)

Lytras, M.: The semantic electronic government: knowledge management for citizen relationship and new assessment scenarios. Electronic Government, an International 3(1), 5–17 (2005)

Lytras, M., Pouloudi, N.: Towords the development of a novel taxonomy of knowledge management systems from a learning perspective. Journal of Knowledge Management 10(6), 64–80 (2006)

Lytras, M., Naeve, A., Pouloudi, A.: A knowledge management roadmap for e-learning: the way ahead. International Journal of Distance Education Technologies 3(2), 1–11 (2005a)

Lytras, M., Naeve, A., Pouloudi, A.: Knowledge management as a reference theory for e-learning: a conceptual and technological perspective. International Journal of Distance Education Technologies 3(2), 66–73 (2005b)

Lytras, M., Ordóñez, P., Mantziou, M.: Information and communication technologies and management of education. Int. J. Management in Education (IJMIE) 1(3), 193–198 (2007)

Lytras, M., Pouloudi, N., Poulymenakou, A.: Dynamic e-learning settings through advanced semantics. The value justification of a knowledge management oriented metadata schema. International Journal on E-learning 1(4), 49–61 (2002)

Lytras, M., Sicilia, M.: Knowledge society a manifesto for knowledge and learning. Int. J. Knowledge and Learning 1(1), 1–11 (2005)

McIlraith, S., Son, T.C., Zeng, H.: Semantic web services. IEEE Intelligent Systems, Special Issue on the Semantic Web 16(2), 46–53 (2001)

Moreale, E., Vargas-Vera, M.: Genre analysis and the automated extraction of arguments from student essays. In: The Seventh International Computer Assisted Assessment Conference (CAA-2003), Loughborough University, July 8–9 (2003)

Moreale, E., Vargas-Vera, M.: Semantic services in e-learning: an argumentation case study. IFETS Journal of Educational Technology & Society, Special Issue on Ontologies and the Semantic Web for E-learning 7(4) (2004)

Motta, E.: Reusable components for knowledge models: case studies in parametric design problem solving. Frontiers in Artificial Intelligence and Applications 53 (1999) ISBN: 1-58603-003-5

Naeve, A., Lytras, M., Nejdl, W., Harding, J., Balacheff, N.: Advances of semantic web for e-learning: expanding learning frontiers. British of Educational Technology 37(3), 321–330 (2006)

Noy, N., Musen, M.: PROMPT: algorithm and tool for automated ontology merging and alignment. In: Proc. of the 17th National Conference on Artificial Intelligence (AAAI), Austin, Texas, USA (2000)

Sampson, D., Lytras, M., Wagner, G., Diaz, P.: Ontologies and the semantic web for e-learning. IEEE LTTF ETS Journal 7(4), 26–28 (2004)

Sicilia, M., Lytras, M.: Scenario-oriented reusable learning object characterizations. Int. J. Knowledge and Learning 1(4), 332–341 (2005a)

Sicilia, M., Lytras, M.: The semantic learning organization. The Learning Organization 12(5), 402–410 (2005b)

Sicilia, M., Lytras, M., Rodríguez, E., García-Barriocanal, E.: Integrating descriptions of knowledge management learning activities into large ontological structures: a case study. Data & Knowledge Engineering 57(2), 111–121 (2006)

Vargas-Vera, M.: Using prolog techniques to guide program composition, PhD thesis, Dept. of Artificial Intelligence, Edinburgh University (1995)

Vargas-Vera, M., Motta, E.: AQUA – ontology-based question answering system. In: Monroy, R., Arroyo-Figueroa, G., Sucar, L.E., Sossa, H. (eds.) MICAI 2004. LNCS (LNAI), vol. 2972, pp. 468–477. Springer, Heidelberg (2004)

Vargas-Vera, M., Motta, E., Domingue, J., Lanzoni, M., Stutt, A., Ciravegna, F.: MnM: ontology driven semi-automatic and automatic support for semantic markup. In: Gómez-Pérez, A., Benjamins, V.R. (eds.) EKAW 2002. LNCS (LNAI), vol. 2473, pp. 379–391. Springer, Heidelberg (2002)

Vargas-Vera, M., Robertson, D.: An environment for combining prolog programs based on knowledge about their construction. In: The 10th Workshop on Logic Programming (WLP 1994), University of Zurich, October, pp. 73–76 (1994)

Vossen, G., Lytras, M., Koudas, N.: Knowledge and data engineering in the semantic web era. IEEE Transactions on Knowledge and Data Engineering 19(2), 145–148 (2007)

Notes

1 www.openlearn.open.ac.uk

3 www.u3a-info.co.uk

LIA: An Intelligent Advisor for e-Learning

Nicola Capuano[1,2], Matteo Gaeta[1], Sergio Miranda[1], Francesco Orciuoli[1,2], and Pierluigi Ritrovato[1]

[1] University of Salerno, Department of Information Engineering and Applied Mathematics, via Ponte don Melillo, 84084 Fisciano (SA), Italy
[2] CRMPA, Centro di Ricerca in Matematica Pura ed Applicata, via Ponte don Melillo, 84084 Fisciano (SA), Italy
ncapuano@unisa.it, {gaeta,smiranda,orciuoli, ritrovato}@diima.unisa.it

Abstract. Intelligent e-learning systems have revolutionized online education by providing individualized and personalized instruction for each learner. Nevertheless, till now very few systems were able to leave academic labs and be integrated in real commercial products. One of this few exceptions is the Learning Intelligent Advisor (LIA) described in this paper, built on results coming from several research projects and currently integrated in a complete e-learning solution named IWT. The purpose of this paper is to describe how LIA works and how it cooperates with IWT in the provisioning of an individualized and personalized e-learning experience. Results of experimentations with real users coming from IWT customers are also presented and discussed in order to demonstrate the benefits of LIA as an add-on in on-line learning.

Keywords: e-Learning, ITS, Knowledge Representation, Planning.

1 Introduction

The Learning Intelligent Advisor (LIA) is an intelligent tutoring engine capable of integrating, in “traditional” e-learning systems, “intelligent” features like learner modelling and learning experience individualisation. LIA was born from the co-operation of an high-tech company named MoMA with the Research Centre in Pure and Applied Mathematics (CRMPA) and the Information Engineering and Applied Mathematics Dept. of the University of Salerno. It is currently included in a complete solution for e-learning named Intelligent Web Teacher (IWT) [1].

LIA is based on a set of models able to represent the main entities involved in the process of teaching/learning and on a set of methodologies, leveraging on such models, for the generation of individualised learning experiences with respect to learning objectives, pre-existing knowledge and learning preferences. Models and methodologies behind LIA integrate and extend results coming from several researches on knowledge representation and intelligent tutoring systems made by the authors, some of which partially founded by the European Commission.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 187–196, 2008.

A first prototype of an intelligent system for learning, based on conceptual graphs and software agents and able to generate individualised learning courses was proposed by authors in [2]. Defined models and methodologies were then improved introducing description logic for knowledge representation, planning techniques for learning path generation and machine learning techniques for learning preferences discovery and adaptation leading to a new prototype described in [3].

Obtained results convinced the authors to start the development of a complete system for learning (IWT) also involving a spin-off company (MoMA). The obtained system, providing a comprehensive set of "traditional" e-learning features and including a component (LIA) offering "intelligent" features coming from research was described in [4].

This first version of the system had several limitations like: limiting domain model offering only a small and pre-defined set of relations between concepts, impossibility to specify any teaching preference connected to domain concepts, imprecise and computationally expensive algorithms for course generation applying no optimisation techniques, impossibility to consider global optimisation parameters like the total cost or duration of a learning experience, impossibility to deal with resources different from learning objects (i.e. lack of support for learning services), impossibility to revise the evaluation of concepts once they are considered as known by the system, lack of support for pre-test.

To overcome these limitations, models and methodologies applied by LIA have been fully reorganised and, in some cases, completely re-thought. The purpose of this paper is to describe improved models (chapter 2) as well as related methodologies and how they are used during the whole learning life-cycle (chapter 3). Results of a small-scale experimentations with real users (chapter 4) are also presented.

2 LIA Models

The first step needed to describe the whole process of teaching/learning is to formally represent main involved actors and objects by means of appropriate models. The next paragraphs describe the four modes adopted by LIA while the next chapter shows how they are used in the teaching/learning process.

2.1 The Domain Model

The domain model describes the knowledge that is object of teaching through a set of concepts (representing the topics to be taught) and a set of relations between concepts (representing connections among topics). Such structure can be formally represented with a ***concepts graph*** G (C, R_1,… R_n) where C is the set of nodes representing domain concepts and each R_i is a set of arcs corresponding to the i-th kind of relation.

Two categories of relations are supported: *hierarchical* relations are used to factorise high-level concepts in low-level concepts while *ordering* relations are used to impose partial orderings in the concept set. Without loss of generality in this paper we consider a concept graph G (C, BT, IRB, SO) with three relations BT, IRB and SO whose meaning is explained below (where a and b are two concepts of C):

- *BT* (*a, b*) means that the concept *a belongs to b* i.e. *b* is understood iif every *a* so that *a* belongs to *b* is understood (hierarchical relation);
- *IRB* (*a, b*) means that the concept *a is required by b* i.e. a necessary condition to study *b* is to have understood *a* (ordering relation);
- *SO* (*a, b*) means that the *suggested order* between *a* and *b* is that *a* precedes *b* i.e. to favour learning, it is desirable to study *a* before *b* (ordering relation).

Any number of additional relations may be introduced provided that they belong to one of the two categories above. The figure 1 shows a sample domain model in the didactics of artificial intelligence exploiting the relations defined above and stating that to understand "logics" means to understand "formal systems", "propositional logic" and "first order logic" but, before approaching any of these topics it is necessary to have an "outline of set theory" first. Moreover, "formal systems" must be taught before both "propositional logics" and "first order logic" while it is desirable (but not compulsory) to teach "propositional logics" before "first order logic".

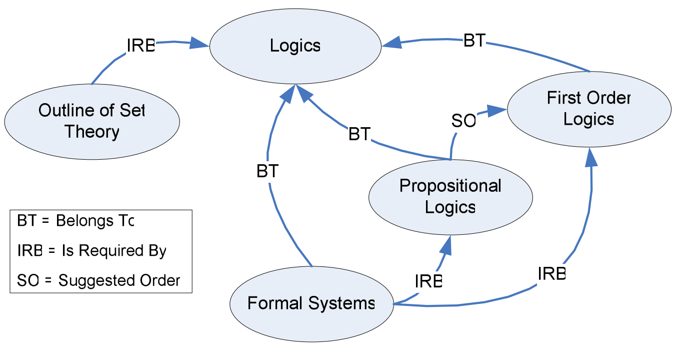


Fig. 1. A sample concepts graph

A set of ***teaching preferences*** may be added to the domain model to define feasible teaching strategies that may be applied for each available concept. Such preferences are represented as an application $TP\ (C \times Props \times PropVals) \rightarrow [0, 10]$ where *Props* is the set of didactical properties and *PropVals* is the set of feasible values for such properties. The table 1 provides some (non exhaustive) example of didactical property and associated feasible values. It is worth noting that *TP* is defined only for couples of *Props* and *PropVals* elements belonging to the same row in table 1.

Table 1. Example of didactical properties and feasible values

Properties	Feasible values
didactic method	deductive, inductive, etc.
activity type	text reading, video clip, simulation, discussion with a peer, discussion with the teacher, etc.
interactivity level	high, medium, low

2.2 The Learner Model

The learner is the main actor of the whole learning process and it is represented with a cognitive state and a set of learning preferences. The **cognitive state** represents the knowledge reached by a learner at a given time and it is represented as an application $CS\ (C) \rightarrow [0, 10]$ where C is the set of concepts of a given domain model. Given a concept c, $CS\ (c)$ indicates the degree of knowledge (or grade) reached by a given learner for c. If such grade is greater then a given "passing" threshold θ then c is considered as known, otherwise it is considered as unknown.

The ***learning preferences*** provide an evaluation of learning strategies that may be adopted for a given learner. They are represented as an application $LP\ (Props \times PropVals) \rightarrow [0, 10]$ where *Props* and *PropVals* are the same sets defined in 2.1. Differently from teaching preferences, learning preferences are not linked to a domain concept but refer to a specific learner.

The cognitive state of any learner is initially void (i.e. $CS\ (c) = 0$ for any c included in a given domain model) and may be initialized on a teaching domain with a pre-test. Learning preferences may be initialized by the teacher or directly by learners through a questionnaire capable of evaluating learners styles and transform them in suitable values for learning preferences. Both parts of the learner model are automatically updated during learning activities by a ***learner model updating algorithm*** (see 3.4).

2.3 The Learning Activity Model

A learning activity must be performed by a learner to acquire one or more domain concepts. According to IMS-LD [5], activities may relate to learning objects (e.g. textual lessons, presentations, videoclips, podcasts, simulations, exercises, etc.) or learning services (e.g. virtual labs, wikis, folksonomies, forums, etc.). The ***learning presentation generation algorithm*** (see 3.1) uses learning activities as bricks to generate learning experiences. In order to be effectively used in this way, a learning activity A is described through the following elements:

- a set of ***concepts*** C_A part of a given domain model, that are covered by in the learning activity;
- a set of ***didactical properties*** expressed as an application $DP_A\ (property) = value$ representing learning strategies applied by the learning activity;
- a set of ***cost properties*** expressed as an application $CP_A\ (property) = value$ that must be taken into account in the optimisation process connected with the *learning presentation generation algorithm*.

Didactical properties components have the same meaning with respect to teaching and learning preferences i.e. *property* and *value* may assume values from a closed vocabulary (see table 1). Differently from learning and teaching preferences, they are neither linked to a domain concept nor to a specific student but to a learning activity.

Cost properties are couples that may be optionally associated to learning activities, whose properties may assume values from the closed vocabulary {price, duration} and whose values are positive real numbers representing, respectively the eventual price of a single learning resource and its average duration in minutes.

Testing activities are learning activities used to verify the knowledge acquired by the learner. As learning activities, a testing activity T is connected to a set C_T of covered concepts indicating, in this case, the list of concepts verified by the activity. Once executed by a specific learner, they return an evaluation E_T belonging to the range [0, 10] indicating the degree of fulfilment of the test by that learner. Differently from other activities here DP_T and CP_T are not significant.

2.4 The Unit of Learning

An unit of learning represents a sequence of learning activities needed to a learner in order to understand a set of target concepts in a given domain with respect to a set of defined cost constraints. It is composed by the following elements:

- a set of ***target concepts*** *TC* part of a domain model, that have to be mastered by a given learner in order to successfully accomplish the unit of learning;
- a set of ***cost constraints*** *CC* (*property*) = *value* that must be taken into account in the optimisation process connected with the *learning presentation generation algorithm*;
- a ***learning path*** *LPath* ($c_1, \ldots, c_n$) i.e. an ordered sequence of concepts that must be taught to a specific learner in order to let him master target concepts;
- a ***learning presentation*** *LPres* ($a_1, \ldots, a_m$) i.e. an ordered sequence of learning activities that must be presented to a specific learner in order to let him/her master the target concepts.

While target concepts and cost constraints are defined by the course teacher, the learning path and the learning presentation are calculated and updated after each testing activity by specific generation algorithms (described in section 3). Concerning cost constraints, the *property* may assume values from the closed vocabulary {price, duration}. Feasible values are positive real numbers representing, respectively the maximum total price and the maximum total duration of the unit of learning.

3 The Learning Life-Cycle

After having seen how the main involved actors and objects are represented by means of appropriate models, it is necessary to see how LIA uses such models to automate some of the phases of the teaching/learning process. LIA sees the learning life-cycle as composed by five phases, each including activities that have to be performed by the actors involved in the process (namely the teacher and the learner) or by LIA itself.

In the **preparation phase** the teacher defines or selects a feasible domain model and prepares or selects a set of learning activities that may be used in the learning experience while learners may define their learning preferences.

In the **starting phase** the teacher initializes a unit of learning by setting target concepts and cost constraints and associates learners to it. Then LIA generates a personalised *learning path* for each learner through a *learning path generation algorithm* and introduces placeholders for testing activities (*milestones*) through a *milestone setting algorithm.*

In the **execution phase**, LIA selects a fragment of the learning path and generates the best learning presentation for each enrolled learner by applying the *learning presentation generation algorithm*. The learner then undertakes the learning and testing activities of the learning presentation until its end.

In the **evaluation phase**, when the learner ends a learning presentation fragment, his/her learner model is updated on the basis of the results of tests included in the fragment according to the *learner model updating algorithm* and a new execution phase starts by generating a new learning presentation fragment that will possibly include recovery activities for concepts that the student did not understand.

In the **closure phase**, once all concepts of the unit of learning are mastered by the learner, the system collects statistical information on the process that may be used by teachers to improve the domain model and/or learning and testing activities.

The following paragraphs describe in more details the algorithms exploited by LIA in the several phases of the learning life-cycle.

3.1 Learning Path Generation

The generation of the learning path is the first step to completely generate a unit of learning. Starting from a set of ***target concepts*** *TC* and from a ***domain model***, a feasible learning path must be generated taking into account the *concepts graph* $G(C, BT, IRB, SO)$ part of the domain model (with $TC \subseteq C$). The four steps of the learning path generation algorithm are summarizes below.

- The ***first step*** builds the graph $G'(C, BT, IRB', SO')$ by propagating ordering relations downward the hierarchical relation. *IRB'* and *SO'* are initially set to *IRB* and *SO* respectively and then modified by applying the following rule: for each arc $ab \in IRB' \cup SO'$ substitute it with arcs ac for all $c \in C$ such that there exist a path from c to b on the arcs from *BT*.
- The ***second step*** builds the graph $G''(C', R)$ where C' is the subset of C including all concept that must be taught according to *TC* i.e. C' is composed by all nodes of G' from which there is a ordered path in $BT \cup IRB'$ to concepts in *TC* (including target concepts themselves). R is initially set to $BT \cup IRB' \cup SO'$ but all arcs referring to concepts external to C' are removed.
- The ***third step*** finds a linear ordering of nodes of G'' by using depth-first search so by visiting the graph nodes along a path as deep as possible. The obtained list L will constitute a first approximation of the learning path.
- The ***fourth step*** generates the final learning path *LPath* by deleting from L all non-atomic concepts with respect to the graph G i.e. *LPath* will include any concept of L apart concepts b so that $ab \in BT$ for some a. This ensures that only leaf concepts will be part of *LPath*.

As an example we may consider the concept graph in figure 1 as G and the set {“First Order Logics”} as *TC*. The algorithm result on this input is:

LPath = (“Outline of Set Theory”, “Formal Systems”, “First Order Logics”).

3.2 Milestones Setting

Once the learning path is generated, it is necessary to insert in it placeholders for testing activities named ***milestones***. While concepts of the learning path will be converted in learning activities different from tests by the presentation generation algorithm, milestones will be converted in testing activities by the same algorithm.

Milestones can be placed in the learning path directly by teachers or, alternatively, they can be placed basing on a list of percentages given by the teacher (e.g. the input list [0.2, 0.5, 0.7, 1] means that four milestones should be placed in the learning path approximately at 20%, 50%, 70% and at the end).

Each milestone covers all preceding concepts in the learning path until the beginning of the course apart concepts already known by the learner according to his/her cognitive state (i.e. any concept a so that $CS(a) \geq$ the "passing" threshold θ as defined in 2.2).

A milestone at 0% of the learning path is a special milestone meaning that a ***pre-test*** is necessary before entering in the unit of learning. Differently for other milestones, pre-test milestones may be of different kinds: a *pre-test on requirements* tests concepts of the learning path considered as known by the learner; a *pre-test on content* tests concepts of the learning path considered as unknown by the learner.

3.3 Learning Presentation Generation

The presentation generation algorithm is purposed to build a fragment of presentation, part of an unit of learning, suitable for a specific learner basing on a ***learning path*** *LPath'* that have to be covered, on a set of teaching preferences *TP* belonging to a ***domain model***, on a cognitive state *CS* and a set of learning preferences *LP* both part of the ***learner model*** associated to the target learner, on a set of optional ***cost constraints*** *CC* and on a set of available ***learning activities*** (including tests). The three steps of the presentation generation algorithm are summarizes below.

- The ***first step*** is to select the sub-list *L* of *LPath'* that have to be converted in a presentation. *L* is the sequence of all the concepts of *LPath'* not already known by the learner (i.e. any concept a so that $CS(a) < \theta$) from the beginning to the first milestone preceded by at least one concept not already known by the learner. If *L* is empty then the algorithm ends because the learner already knows all concepts of the learning path.
- The ***second step*** is to define the best sequence of learning activities *P*, selected from available learning activities (not including tests), covering *L* on the basis of *TP*, *LP* and *CC*. This requires the resolution of an optimisation problem that will be discussed later.
- The ***third step*** is to add testing activities at the end of *P* so obtaining the final learning presentation *Pres*. Testing activities are selected in order to cover all concepts of *L* without taking into account didactical and cost properties eventually linked to testing activities.

If *LPath* starts with a ***pre-test*** milestone, then *L* will be defined in order to include all concepts that should be tested according to the kind of pre-test milestone (as defined in 3.2), *P* is then settled to be void and only the third step is executed. Then the pre-test milestone is removed from *LPath*.

Let's give more details about the second step. Its purpose is to find the optimal set of learning activities *P* covering *L* on the basis of *TP*, *LP* and *CC*. First of all a measure of distance $d_{TP}(A, c)$ between an activity *A* and the set of preferences *TP* has to be defined with respect to a concept *c*. In a similar way a measure of distance d_{LP} (*A*) basing on *LP* may be defined. A further measure *d* (*A*, *c*) shall be defined as a weighted sum of the two measures.

Once a feasible measure of distance is defined the problem of selecting the best set of activities *P* covering concepts of *L* becomes a *facility location problem* [6]. *P* must be built as the smallest set of activities covering all concepts of *L* with the minimum sum of distances between activities and covered concepts. To solve this problem it is possible to use a greedy algorithm to obtain a first feasible solution and, then, a local search algorithm to try to improve the initial solution. These algorithm are well know in the literature [6] so their description is out of the scope of this paper.

3.4 Learner Model Updating

For each testing activity *T* executed by the learner in the last learning presentation fragment, the test returns (as explained in 3.3) an evaluation E_T between 1 and 10 representing the degree of fulfilment of the test by the involved learner. For each concepts *c* belonging to C_T, the cognitive state of the learner is modified in this way: if *CS* (*c*) is not defined then *CS* (*c*) = E_T, otherwise *CS* (*c*) = (*CS* (*c*) + E_T) / 2. This is repeated for any executed testing activity *T* in *LPres*.

The evaluation of each concept is then propagated over required concepts in the concepts graph following backward the ordering relation *IRB*. Iterated failures to understand a set of concepts may in fact indicate a possible misconception in a common requirement. Such procedure helps to find these misconceptions and forces the learning presentation generation algorithm to introduce activities covering them in subsequent fragments by decreasing their grade in the learner cognitive state.

After a testing phase, learning preferences may be also modified in the following way: if the same learning activity *A* has been proposed *n* times to the learner (for a given *n*) without success (so bringing to a negative score in testing activities on related concepts), then the system decreases, for each didactical property DP_A (*property*) = *value* associated with *A*, learner preferences *LP* (*property*, *value*) of a given constant δ. Conversely learning activities that demonstrate to be successful (bringing to positive scores in testing activities) will increase learner preferences related to activities' didactical properties.

4 Experimental Results

As anticipated, LIA models and methodologies are integrated in a complete e-learning solution named Intelligent Web Teacher (IWT). IWT is currently used by about 30 Italian organisations including companies as well as University departments. IWT was also selected by the Italian Ministry of Education as the base technology for a project purposed to introduce e-learning in 550 Italian schools.

In such contexts a small-scale experimentation was performed to demonstrate the benefits of LIA as an add-on in on-line learning. Such experimentation involved a group of 28 voluntary learners belonging to 7 Small and Medium Enterprises dealing with vocational training on enterprise management. The group of learners was split in two separate sub-groups: a first sub-group composed of 20 learners was enabled to use all IWT facilities except LIA while a second sub-group composed of 8 learners was enabled to access the whole IWT (including LIA).

All the voluntary learners were tested before and after a training phase on the same topics. In all the tests the learners' skills in the chosen domain were quantified using three ability ranges: low-level (0-3 scores), medium-level (4-7 scores) and high-level (8-10 scores). The figure 5 shows the performances of the two sub-groups. As it can be seen, the progress made by the second group of students is much sharper with respect to the first group.

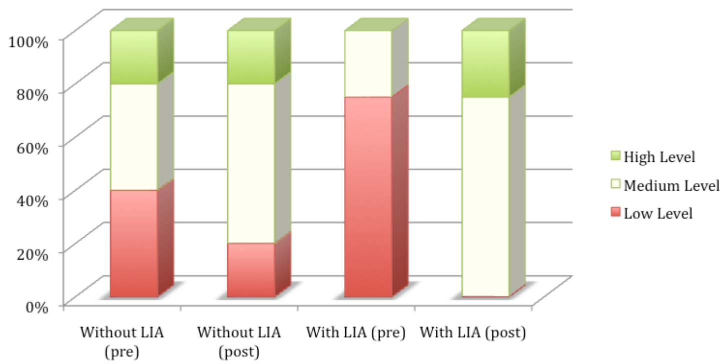


Fig. 2. Experimentation results on a group of 28 learners with and without LIA

5 Conclusions and Future Work

In this paper we have described an intelligent tutoring engine named LIA and how it cooperates with a complete system for e-learning named IWT in the provisioning of individualized and personalized e-learning experiences. Defined algorithms and underlying models have been described. Results of a small-scale experimentation with real users have been also presented and demonstrate the benefits of LIA as an add-on in on-line learning. A large-scale experimentation is still in course and results will be published in a future paper.

The approach carried out by LIA (together with IWT) has a strong linkage with the **Knowledge Society** perspective providing an effective mean for lifelong learning and knowledge spreading, capable of overcoming time and place barriers while adapting learning goals and strategies to virtually everyone starting point, context, perceptive capabilities and cognitive abilities.

Thanks to the innovative features provided by LIA, IWT is currently adopted by about 30 Italian organisations (with more then 40.000 users) and in November 2007 it won the prize "Best Practices for Innovation" from the General Confederation for Italian Industry. Despite that, the research on LIA is still active and further improvements are under study.

Among the other things, memetic algorithms for learning presentation generation are under study (preliminary results have been published in [7]) as well as algorithms and tools for the semi-automatic extraction of domain models starting from pre-existing learning material. Further research work purposed to improve the support for didactic methods in the domain model [8] as well as the support for learning styles in the learner model [9] is in-progress. A visionary hypotheses of extension of LIA to fully support enterprise learning has been also recently proposed [10].

References

1. MoMA, s.r.l.: IWT Intelligent Web Teacher, http://www.momanet.it/english/iwt_eng.html
2. Capuano, N., Marsella, M., Salerno, S.: ABITS: An Agent Based Intelligent Tutoring System for Distance Learning. In: Proceedings of the International Workshop on Adaptive and Intelligent Web-Based Education Systems held in Conjunction with ITS 2000, Montreal, Canada, June 19-23, pp. 17–28 (2000)
3. Capuano, N., Gaeta, M., Micarelli, A., Sangineto, E.: An Integrated Architecture for Automatic Course Generation. In: Petrushin, R.V., Kommers, P., Kinshuk, Galeev, I. (eds.) Proceedings of the IEEE International Conference on Advanced Learning Technologies (ICALT 2002), Kazan, Russia, September 9-12, pp. 322–326. IEEE Computer Society, Los Alamitos (2002)
4. Capuano, N., Gaeta, M., Micarelli, A.: IWT: Una Piattaforma Innovativa per la Didattica Intelligente su Web. AI*IA Notizie, year XVI (1), 57–61 (2003)
5. IMS Learning Design Specification, http://www.imsglobal.org/learningdesign
6. Shmoys, D., Tardos, E., Aardal, K.: Approximation Algorithms for Facility Location Problems. In: Proceedings of the 29th Annual ACM Symposium on Theory of Computing, El Paso, Texas, United States, pp. 265–274 (1997)
7. Acanfora, G., Gaeta, M., Loia, V., Ritrovato, P., Salerno, S.: Optimizing Learning Path Selection through Memetic Algorithms. In: Proceedings of IEEE World Congress on Computational Intelligence, Hong Kong, June 1-6 (2008)
8. Albano, G., Gaeta, M., Ritrovato, P.: IWT: an innovative solution for AGS e-Learning model. Intl. Journal of Knowledge and Learning 3(2/3), 209–224 (2007)
9. Sangineto, E., Capuano, N., Gaeta, M., Micarelli, A.: Adaptive Course Generation through Learning Styles Representation. Universal Access in the Information Society International Journal 7(1/2), 1–23 (2008)
10. Capuano, N., Gaeta, M., Ritrovato, P., Salerno, S.: How to Integrate Technology Enhanced Learning with Business Process Management. Journal of Knowledge Management (to appear)

A Strategy for Achieving Learning Content Repurposing

Diva de S.S. Rodrigues[1], Sean W.M. Siqueira[2], Maria Helena L.B. Braz[3], and Rubens N. Melo[4]

[1] IBGE UE-MG, Belo Horizonte, Brazil
divasouz@ibge.gov.br
[2] Federal University of the State of Rio de Janeiro, Rio de Janeiro, Brazil
sean@uniriotec.br
[3] DECivil/IST/Technical University of Lisbon, Lisbon, Portugal
mhb@civil.ist.utl.pt
[4] Pontifical Catholic University of Rio de Janeiro. Rio de Janeiro, Brazil
rubens@inf.puc-rio.br

Abstract. The development of instructional content using new Information Technologies is an expensive, time-consuming and complex process that points to the establishment of new methodologies. It was in this context that the concept of Learning Objects (LOs) was proposed as an approach that promotes content reuse. However, if content is conveyed in small LOs, they must be combined and sequenced in order to build more elaborated and complex content. This paper presents a strategy to deal with this problem based on the definition of smaller LOs, which represent not only content but also practice, here called Component Objects (COs). These COs are structured and combined according to a conceptual metamodel, which is the basis for the definition of conceptual schemas representing the existing material. Considering these ideas the paper presents a strategy for searching, extracting and sequencing COs, which supports a teacher/professor to better control the implementation of a complex content such as a course, reducing errors and eventual omissions in the authoring process. Finally, a case study that shows the proposed approach and some results of using the algorithm are presented.

Keywords: Learning Objects; Conceptual Schema; Content Sequencing; Metamodel; Component Objects.

1 Introduction

It is well known that learning content development and implementation processes are expensive and time-consuming [1]. Therefore, in order to reduce costs and improve development speed it is important to consider reuse of existing instructional materials and other available documents. It was in this context that the term Learning Object was coined and it is possible to find in literature many different approaches based on this concept aiming at increasing reusability.

Nevertheless the reusability of LOs is not as high as desirable and one of the identified aspects related with lack of reuse was the LOs' granularity. As Wiley [2] stated, there is an inverse relationship between LO size and reusability.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 197–204, 2008.

Considering this statement, in this work, content, practice and assessment embedded in learning environments are represented through Component Objects (COs) that can be understood as atomic LOs with a precise semantic learning meaning. Assessment in this work refers to strategies for applying practices.

COs can be combined in different ways and according to different needs, to form semantically richer and more complete objects such as lessons. Using this approach means that COs can be reused in different contexts instead of reusing the files where they were embedded.

COs are structured and combined according to a conceptual metamodel. The definition of this metamodel was based on previous experiences and proposals on information processing, learning content structuring and classification of learning content and activities. Differently from other approaches for developing LOs, the metamodel and its specialization provide a mental framework, which guides learning. The used specialization is based on proposed categories of content and practice while contextual information is considered through metadata associated with COs.

Besides defining COs, and in order to reuse them, it is necessary to be able to select and group them in complex LOs. This paper presents the strategy adopted for searching, extracting and sequencing COs. This strategy includes the use of pedagogical approaches for extracting and sequencing COs. Possible sequences of available COs are described using a formal language specified in [3].

The remainder of this paper is organized as follows: Section 2 describes the modeling approach for content and practice COs as it is essential for understanding the proposed strategy. Section 3 details the strategy adopted for searching, extracting and sequencing COs. Section 4 shows the use of the proposed approach in a case study. Finally, in Section 5, some concluding remarks are presented.

2 Modeling and Sequencing Content and Practice COs

The strategy described in the paper is part of a framework developed with the aim of facilitating the repurposing of learning content. Within this framework the conceptual metamodel is essential for reaching the mentioned goal.

As shown in Figure 1, the conceptual metamodel considers that a simple LO (SLO) is composed of COc (CO representing content, i.e., an information to be learned) or COp (CO representing a learning practice).

When modeling content it was considered that an Information is composed of Conceptual Units (units of information with a specific learning semantic) that can be related to other Conceptual Units or detailed by another Information, so, we can see in Figure 1 that a COc is composed of COu, COu can be related to other COu and/or can be detailed by other COc. The relationship between a COu that is detailed by a COc shows that the meaning of this COu can be explained through another COc. Relationships between different COc are also considered.

More information on the relationship among Information and Conceptual Units can be found in [4].

For learning practices, a similar approach is considered, so it would be easier to understand and use it. In this conceptual schema, a Practice is composed of Actions

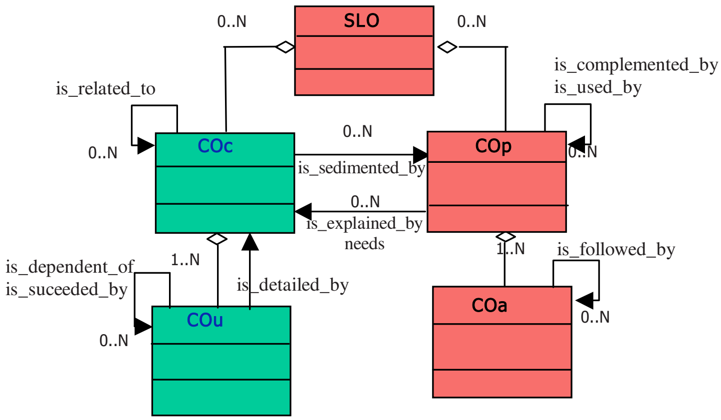


Fig. 1. Conceptual metamodel for describing content and practice

and can be related to other Practices. The following elements are considered: a Practice (COp) is an experience, that is, a set of actions that aims at consolidating knowledge obtained from a learning content; an Action (COa) is a description/specification of something to be done in order to achieve a learning objective.

In addition, to establish the specific learning semantic of the different components it is important to specialize the classes of the conceptual metamodel.

An adaptation of Barritt's [5] proposal was used for specializing content. In this adaptation, pieces of information are classified as: concepts, facts, principles, processes, or procedures. For each of these information types, the Barritt's proposal specifies some sub-components. More details about this specialization process can be found in [4]

An adaptation of [6] proposal was considered for practice. In this adaptation, practices are classified as: assimilative, information handling, adaptive, communicative, productive or experiential. The actions are: reading, viewing, listening, gathering, ordering, classifying, selecting, analyzing, manipulating, modeling, simulating, discussing, presenting, debating, creating, producing, writing, drawing, composing, critiquing, synthesizing, re-mixing, practicing, applying, mimicking, experiencing, exploring, investigating, and performing. More details about this specialization process can be found in [3].

3 Strategy for Searching, Extracting and Sequencing COs

The strategy for searching, extracting and sequencing COs is composed of several actions that contribute to the goal of helping a teacher in the authoring process of a complex object like a lesson or a course, by reusing existing instructional material stored in a repository and modeled according to the conceptual metamodel briefly presented at section 2.

The first aspect to consider in the strategy is the input data that is needed for searching COs: the Input Keyword (IK); Input Metadata (IM); and the Teacher Profile (TP).

The IK is a term or set of terms given by the user needed to find adequate COs, as for instance "Set Theory" or "Fuzzy Logic".

The IM are known characteristics of the material that the user wants to use and is based on IEEE LOM standard [7]. On the searching phase these characteristics are compared with existing metadata of SLOs in order to decide about their selection.

Examples of possible IM parameters are 5.1:Educational. Language = "pt" that states de educational language of the student to be Portuguese, or 1.3:General.Language = "en" stating that the language used in the SLO is English.

As for the TP, it is expected to be able to identify the preferences according to pedagogical approaches and learning theories followed by the teacher and have a classification that incorporates these preferences. As this aspect is not yet sufficiently studied it was decided to use a simplified classification based on the mainstream lines described in learning models literature. The classification uses the classes Practice-Oriented, Content-Oriented and Exploratory. The meaning associated with these classes is a simplification that stresses aspects like the importance of practice versus content or the possibility of freely accessing the available resources.

After collecting the input data, it is possible to search the repository of instructional content to find objects that match the query.

There are two main activities to be preformed. First, the system will look for SLOs (corresponding to COs structures that were previously defined) that match the input data. If some SLOs are found, they are selected and all COs that are part of these SLOs are marked as selected to avoid duplication. Then, the system looks for COcs and COps, not yet selected, that match the IK and selects them.

At this moment it is possible to select additional COs that have semantic relations (as identified in the metamodel) with the COs selected by the IK criterion. These additional COs are filtered considering the classes of the teacher profile.

At this moment, all the COp and COc that match the input data or that are related with them by specific semantic relations chosen according the teacher profile have been identified.

Now, it is possible to semi-automatically arrange them in a meaningful sequence according to the semantic relationships they participate. As there are no relationships between SLOs they are placed in an arbitrary order in the beginning of the sequence and then filtered COs are organized according to their semantic relations forming a new SLO. Then the user can change the proposed order.

The automatic ordering of the COs begins by the identification of all the COps or COcs selected in the previous phase that can be considered as roots. For identifying roots it will not be considered relations between COc and COp (as these relations do not influence the definition of root objects) and then analyze for each CO the relations it participates. COcs will be classified as roots if they do not participate in any relation is_related_to or are the first argument of this relation, which means they do not depend on any other selected content to be understood. For COp the considered relationships are is_used_by and is_complemented_by and, in a similar way, COps will be classified as roots if they do not participate in these relations or participate only as the first argument, which means they do not depend on any other selected practice. The sequence of the filtered COs will then begin with all the root COs. If TP is Exploratory it is not needed to perform additional sorting. If TP is Practice-oriented all root COps will precede root COc. If TP is Content-Oriented all root COcs will precede root COp.

By convention, the sequence of root COs follows the hierarchy established in the specialization. For type content (Concept -> Fact -> Process -> Procedure -> Principle) and for type practice (Information Handling -> Adaptive -> Communicative -> Productive -> Experiential). Notice that Assimilative practices are considered inherent to any CO so they are not included as a specific practice.

It is possible now to include in the sequence all the other COs filtered by tracing the existing relations between root COs and the other components. Once a list of COs is established, it is needed to replace each one of these COs by its components to be able to finish the specification of the new SLO. The order of the sub-components also considers the relations between COus and COps (is_detailed_by), between COus (is_dependent_of, is_succeded_by) and between COa (is_followed_by) if they are specified.

4 Case Study

In order to provide a better understanding of the approach used and to show the results of applying the strategy to search, extract and sequence COs, an example is presented. It considers an existing learning material of a course on Set Theory. The learning material was modeled considering the metamodel presented in section 2.1 and its instantiations. However, to facilitate the understanding of the proposed approach, only a small number of COs was considered. These COs are showed in the diagram of Figure 2.

Considering that the IK was "Set", that no IM were specified, that the TP was Content-Oriented, the system can look for COs matching this input data. Assuming that the selected COs were those marked with gray in Figure 2, it is possible to realize that the Content-Oriented filtering would also select all COs marked with a pattern.

At this moment it is possible to identify COc A, COp 1 and COp 2 as roots and generating the sequence COc A, COc B, COc C, COc D, COc E, COp 1, COp 2.

Now each CO will be replaced by its components generating the expression:

```
Class_Set_Theory :=

[ [COu Introduction A, COu Definition A, {COu
Short_Fact A, COu Example A1, COu Example A2}], [COu
Introduction E, COu Figure E], [COu Definition B], [COu
Definition C], [COu List of Facts D], {[COa Analyzing
1, COa Selecting 1], [COa Creating 2]}]
```

Notice that this expression is written using the language presented in [3] where [ ] delimits ordered lists and { } delimits unordered lists.

At this moment the teacher can accept the sequence proposed or, as there are other possible paths for exploring COs, he could redesign the sequence.

It is important to notice that more complex specifications, dealing with different learning strategies / approaches could be considered. The language allows defining possible learning paths, which are adapted according to user parameters. Note that the

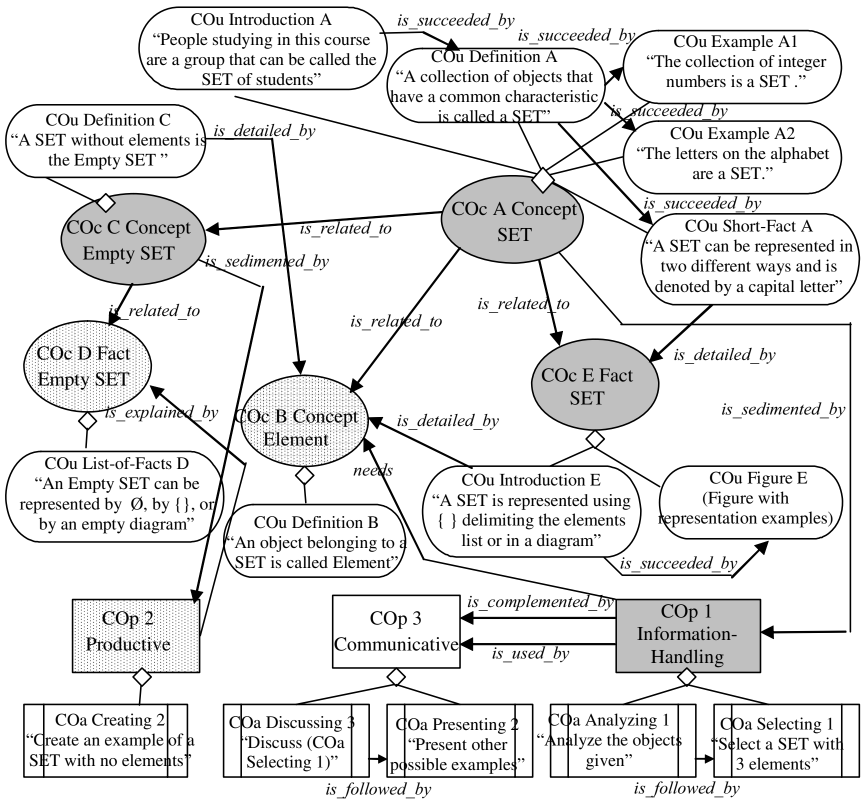


Fig. 2. Conceptual schemas representing existing COs in the case study

modeling approach of smaller LOs according to a metamodel and its specialization, as proposed in this paper, provides richer mechanisms for establishing more interesting learning alternatives.

5 Conclusion

In this paper it was presented an approach for semi-automatically sequencing COs corresponding to content and practice elements. The user can search for the elements he/she wants to teach or learn according to keywords, metadata elements and his/her profile. Then the system searches for COs and present a proposal for a sequence of these elements, which is based on the relationships of these objects as well as some learning characteristics of the user. Finally, the user can readjust the sequence according to the order he/she prefer most, including more advanced sequencing strategies such as repeating some elements according to a specific condition, selecting optional elements, or allowing a random order of some elements. This advanced sequencing is possible through a user interface that structures the sequence according to a specific language.

Having a system based on these ideas will contribute to enhance the possibility of authoring and reusing learning content, adapted to the learner, in an easier way, offering better learning experiences and contributing to increase knowledge acquisition, a crucial aspect for the knowledge society.

Some Learning Objects that were developed by the authors about database and semantic web were manually broken into COs and ten Computer Science master students tested the approach searching for a specific subject of these courses in order to give part of a specific class, for instance one student was responsible for presenting the entity-relationship model. The students executed their respective queries and got the sequenced elements. Although all of them redefined their sequences, they were also unanimous in the benefits of the approach, guarantying the proposed sequences helped in ordering the elements and creating their respective classes. Therefore, although ongoing work on how to transform existing LOs into COs are still underway and future works on making different planning strategies are needed in order to provide all the benefits of the adopted language, the proof of concept was very encouraging and the developed prototype already allows some support on sequencing COs.

There are some proposals on how to sequence LOs, such as the IMS Simple Sequencing [8] and proposals for grouping together LOs, such as IMS Content Packaging [9]. However, besides using content and practice embedded in LOs instead of using the whole multimedia file, the proposed approach also provides mechanisms for sequencing these elements according to their own relationships and learning characteristics of the user. In addition, the adopted language provides advanced mechanisms for sequencing such elements, which gives more flexibility to the user to configure the sequences. The IMS Simple Sequencing Specification [8] can be understood as an implementation mechanism for these sequences.

There are proposals on representing parts of LOs and automatically planning sequences of these parts, such as [10], but the presented approach details and explores the relationships among content and practice elements, which are richer than AND/OR graphs. Paquette & Magnan [11] present a conceptual model based on ontologies, but aggregation is through graphic scenario editor and there is not an automatic planning for helping this task. iClass [12] seems to be an interesting approach for generating a workflow of content and practices, but it is based on LOs (and not on its components) and a more detailed description of the proposed mechanisms is necessary. Other works dealing with LO sequences can be found, but it is important to notice the proposed approach focuses on LO components, including content and practice elements, providing a suggestion on a sequence of the content and practice elements, but it is up to the user to define the final sequence. Therefore, diverse learning scenarios could be considered and the best approach is yet to be determined by the teachers and their experiences as well as through the institutions pedagogical and didactical orientations.

Acknowledgments. The authors would like to thank the Knowledge and Reasoning Representation research group (RCR) from UNIRIO, the Database Technology research group (TecBD) from PUC-Rio and the E-learning Technology research group from ICIST/DECivil. This paper was partially supported by FCT Portugal, through funds of ICIST.

References

1. Christiansen, J., Anderson, T.: Feasibility of course development based on learning objects: research analysis of three case studies. International Journal of Instructional Technology and Distance Education 1(2), 21–38 (2004)
2. Wiley, D.A.: Learning object design and sequencing theory. Dissertation submitted to the faculty of Brigham Young University, Department of Instructional Psychology, USA (2000)
3. Rodrigues, D.S.S., Siqueira, S.W.M., Braz, M.H.L.B., Melo, R.N.: Modeling Learning Practices as Components of Learning Objects and Specifying Sequences of Content and Practice. In: IASTED International Conference Web-based Education (WBE 2008), 2008, Insbruck, Proceedings of the Seventh IASTED International Conference Web-based Education. ACTA Press, Canada (2008)
4. Siqueira, S.W.M., Braz, M.H.L.B., Melo, R.N.: Navigational Exploration of Learning Content. In: Proc. Brazilian Workshop on Semantic Web and Education, Brazilian Symposium on Informatics in Education, Sao Paulo, Brazil (2007)
5. Barritt, C., Lewis, D.: Reusable Learning Object Strategy: Definition, Creation Process, and Guidelines for Building. Version 3.1, April 22, 45 p. Cisco Systems, Inc. (2000)
6. Conole, G.: Design effective online resources. In: ESRC Research Methods Programme Workshop, Manchester, UK (invited talk) (2004)
7. IEEE Learning Technology Standards Committee (LTSC): Draft standard of learning object metadata, IEEE 1484.12.1 (2002), `http://www.ieeeltsc.org/standards/1484-12-1-2002`
8. IMS Global Learning Consortium: IMS Simple Sequencing Specification (March 2003), `http://www.imsglobal.org/simplesequencing/index.html`
9. IMS Global Learning Consortium: IMS Content Packaging Information Model v1.1.3 (March 2003), `http://www.imsglobal.org/content/packaging/cpv1p1p3/imscp_infov1p1p3.html`
10. Brusilovsky, P., Vassileva, J.: Course Sequencing Techniques for Large-scale Web-based Education. Int. J. Continuing Engineering Education and Lifelong Learning 13(1/2), 75–94 (2003)
11. Paquette, G., Magnan, F.: Learning Resource Referencing, Search and Aggregation at the eLearning System Level. In: 1st International Workshop on Learning Object Discovery & Exchange (LODE 2007), Crete, Greece (2007)
12. Turker, A., Gorgun, I., Conlan, O.: The Challenge of Content Creation to Facilitate Personalized E-Learning Experiences. International Journal on E-Learning (IJeL), Special Issue: Learning Objects in Context 5(1), 11–17 (2006)

Supporting Effective Monitoring and Knowledge Building in Online Collaborative Learning Systems

Santi Caballé[1], Angel A. Juan[1], and Fatos Xhafa[2]

[1] Open University of Catalonia, Dept of Computer Science
Rambla Poblenou, 156. 08018 Barcelona, Spain
{scaballe,ajuanp}@uoc.edu
[2] Polytechnic University of Catalonia, Dept. of Languages and Informatics Systems
Jordi Girona, 1-3. 08034 Barcelona
fatos@lsi.upc.edu

Abstract. This paper aims to report on an experience of using an innovative groupware tool to support real, collaborative learning. We base the success of on-line collaborative learning on extracting relevant knowledge from interaction data analysis in order to provide learners and instructors with efficient awareness, feedback, and monitoring as regards individual and group performance and collaboration. Monitoring is especially important for online instructors since they can use this valuable provision of information as a meta cognitive tool for regulating the collaborative learning process more conveniently and provide adequate support when needed. In addition, learning and knowledge building may be greatly enhanced by presenting selected knowledge to learners as for their particular skills exhibited during interaction, such as the impact and effectiveness of their contributions. Indeed, by letting learners be aware of both their own and others' progress in the process of knowledge building may promote learners' participation and boost group performance. The ultimate goal of this paper is to provide a model to achieve a more effective support and assessment of the collaborative process while enhancing and improving the learning experience. To validate this study, a real online learning environment is employed to support asynchronous collaborative activities.

Keywords: Collaborative Learning, Groupware, Knowledge Discovery.

1 Introduction

A relevant research topic in Computer Supported Collaborative Learning (CSCL) is to explore the importance of efficient management of event information generated from group activity in collaborative learning practices for its further use in extracting and providing knowledge on interaction behavior [1]. This view is especially notorious in the current shifting from a traditional educational paradigm (centered in the figure of a masterful instructor) to an emergent educational paradigm which considers students as active and central actors in their learning process. In the Age of the Knowledge Society, students learn, with the help of instructors, technology and other students, what they will potentially need in order to develop their future academic or professional activities [2].

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 205–214, 2008.

The essential issue here is first how to design a CSCL setting that can be used for real, long-term, complex collaborative problem solving situations and which enables the instructor to both analyze group interaction effectively and provide an adequate support when needed. Secondly, how to extract relevant knowledge from collaboration in order to provide learners with efficient awareness and feedback as regards individual and group performance and assessment. We therefore base the success of CSCL applications on the capability of such applications to embed information and knowledge extracted from group activity interaction and use it to achieve a more effective group monitoring [3].

Large amounts of information data are generated from asynchronous interaction, usually stored in log files, which includes complex issues of the collaborative work and learning process (e.g., group well-being as well as self-, peer- and group activity evaluation [3]). This knowledge is then fed back and presented to the participants in a suitable manner to greatly influence the collaborative process by allowing students to compare their individual performance to the group one [4]. This information also serves for the instructor to identify groups with a low activity level, which allows for establishing just-in-time assistance for them [5].

The real context in this study is the virtual learning environment of the Open University of Catalonia (UOC)[1]. Part of UOC courses' curricula includes the participation of students in on-line discussions with the aim of sharing and discussing their ideas. Indeed, the discussion process plays an important social task where participants can think about the activity being performed, collaborate with each other through the exchange of ideas that may arise, propose new resolution mechanisms, as well as justify and refine their own contributions and thus acquire new knowledge [6].

The paper is organized as follows: Section 2 introduces the main ideas of a theoretical framework for collaborative discussion processes, whose purpose is both to model the main interactions that describe a generic discussion process and to provide a global scheme for monitoring purposes. Based on these principles, Section 3 reports on the experiences and the evaluation results achieved from using ad hoc computer systems that provide effective knowledge to students and assist instructors by means of monitoring reports on the discussion process. Finally, Section 4 concludes by summarizing the main contribution presented in this paper and outlining ongoing and future work.

2 Use of Interaction Data Analysis in a Discussion Process

Given the added value of asynchronous online discussion groups as one of the main elements of the pedagogical model in many educational organizations, it is essential to provide adequate on-line tools to support the whole discussion process, which also includes students' monitoring and evaluation. In this context, an important issue raised in collaborative learning interactions is the change from divergence to shared understanding and to possible construction of knowledge. The point is to understand

---

[1] The Open University of Catalonia (UOC) is located in Barcelona, Spain. The UOC offers full distance education through the Internet since 1994. About 50,000 students, lecturers and tutors are involved in 600 on-line official courses from 23 official degrees and other PhD and post-graduate programs. The UOC is found at http://www.uoc.edu

how collaborative interactions develop over time: whether students raise new issues (ideas) more frequently as they become more familiar with the discussion and discussants, and whether shared knowledge building becomes richer over time, and subsequent evidence that students were able to construct their own understanding based on their interactions with others in formal educational settings [7], [8], [9]. To this end, our model annotates and examines a variety of elements that contribute to the understanding of the nature of the collaborative interactions, such as the students' passivity, proactivity, reactivity as well as the effectiveness and impact of their contributions to the overall goal of the discussion (see a complete description of this model in [4]).

In overall, we believe that there are more evident key discourse elements and aspects that play an important role both for promoting student participation and enhancing group and individual performance, such as, the impact and effectiveness of students' contributions, among others, that we explore in this work. By making these elements explicit, our discussion model accomplishes high students' participation rates and contribution quality in a more natural and effective way. Indeed, our approach goes beyond a mere interaction analysis of asynchronous discussion in the sense that it builds a multi-functional model that fosters knowledge sharing and construction, develops a strong sense of community among students, provides the instructor a powerful tool for students' monitoring and discussion regulation, while it allows peer facilitation through self-, peer- and group awareness and assessment. To this end, it is important that the system is capable of managing both qualitative and quantitative information and transforming it into useful knowledge for all the implicated parties in an efficient and clear way.

Furthermore, instructors need to face the important challenge of the high dropout rates typically found in any type of distance program and activity [2]. Indeed, the nature of distance education can create a sense of isolation in learners who can feel disconnected from the instructor, the rest of the class, and even the institution. It is necessary, then, that instructors provide just-in-time guidance and assistance to students' activities and also that they provide regular feedback on these activities. However, the evaluation of hundreds of contributions in a multi-member discussion and thoroughly track all the activities performed can be a tedious and time-consuming task for instructors and should be adequately supported. It is even much more complex to figure out the interactions taking place among students and/or groups of students, to identify the relevant actors –groups' leaders and followers–, to detect students that are likely to dropout the course, or to perceive possible group internal conflicts or malfunction before it gets too late to efficiently manage these problems [1], [3]. To this end, our model on interactions includes the provision of monitoring reports that can be used by instructors to easily track down the learners' online behavior and group's activity at specific milestones during the discussion process, gather feedback from the learners and scaffold groups with low degree of activity as well as to regulate the discussion by providing just-in-time assistance according to groups' and students' necessities.

Consequently, the analysis of the interactions occurring in an online discussion process yields very useful conclusions on aspects such as individual and group working, dynamics, performance and success, which allows the instructor to obtain a global account of the progress of the individual and group work and thus to identify possible conflicts and monitor the whole learning process much better. The aim is both to provide reliable indicators that qualify the contributions and to promote the discussion's dynamics by increasing the users' interaction with the system. The definition and measurement of the indicators used to assess participation behavior, knowledge building and performance are entirely discussed in [4].

3 A Knowledge Building and Monitoring System

In order to validate the previous ideas, in this section, we introduce both a prototype of a web-based structured discussion forum system, called Discussion Forum (DF) (see [4] for a detailed description of this application) and a global scheme of the monitoring system called Student Activity Monitoring using Overview Spreadsheets (SAMOS) [5], which were developed to bring new opportunities to learning by discussion and to meet new pedagogical models. We report here on this novel experience and the results achieved in the real learning context of the Open University of Catalonia.

4 An Effective Structured Discussion Forum

The DF supports a complete discussion and reasoning process based on specific types of generic contributions, namely problem statement, elaboration and consensus. The problem statement occurs during the initial stage of the discussion process carried out by the instructor or group member who contributes by defining a new situation to discuss. Elaboration refers to specific contributions in which a sub-problem is stated, extended, and finally reached a consensus on a solution proposed. Finally, when one or more solutions are proposed, the consensus exchanges take place for their approval. When a solution is finally approved, the discussion terminates.

In order to support this discussion process, the DF design includes certain thematic annotation cards based on the low-level exchange categories (Fig. 1), such as information-clarification and request of opinion that qualifies each contribution and as a result structure the discussion process conveniently for later processing and analysis. Consequently, following the principles mentioned in Sect. 2, all contributions are recorded, analyzed as information and the knowledge extracted is presented to participants in (almost) real time with the aim of guiding directly students during the learning activity and also for monitoring purposes. Fig. 2 shows the provision to students of updated knowledge about the discussion in the form of complex feedback. This feedback allows students to compare their performance to the group as well as to identify which dimension of their participation needs to be improved.

Finally, the DF provides additional features to support the discussion in comparison to traditional discussion tools, such as discussion threads in fully separated rooms and open-closed branched dialogs [4].

In order to evaluate our prototype of the DF and analyze its effects in the discussion process, 80 graduated students enrolled in the course Methodology and Management of Computer Science Projects during the last term were involved in this

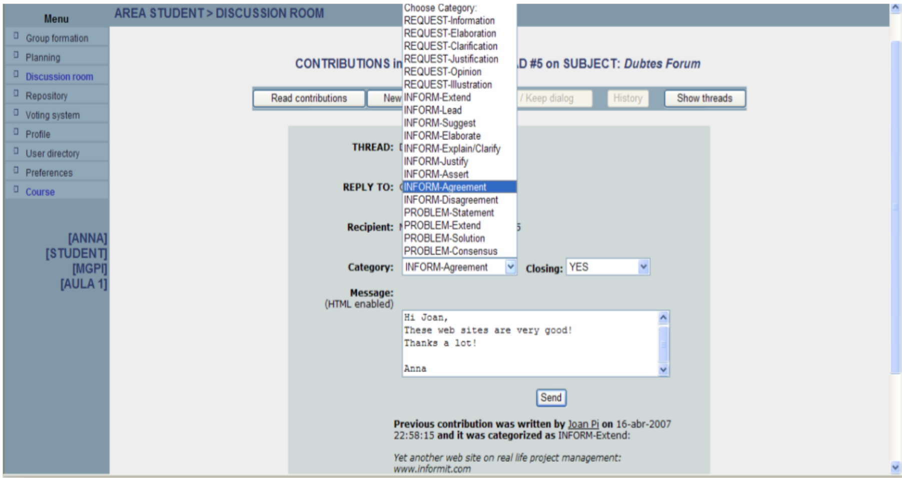
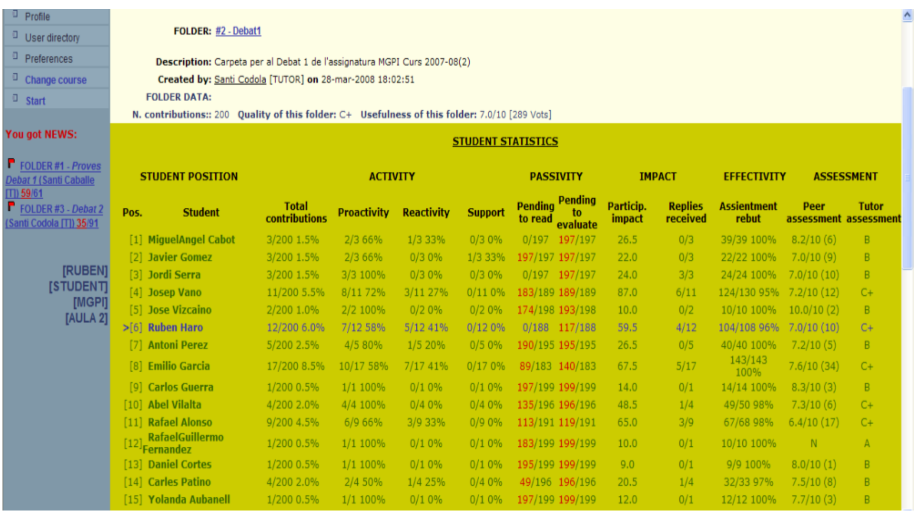


Fig. 1. A list of tags to qualify a contribution

experience. Students were equally distributed into two classrooms and participated in the experience at the same time and during the same time (i.e., a fortnight). Students from one classroom were required to use the well-known asynchronous threaded discussion forum offered by the UOC virtual campus while the other group of students used the new DF outside the campus to support the same discussion with the same rules.

In comparison to the traditional discussion tool used in the other classroom, the DF provided students with relevant feedback from the discussion process, such as the current mean number of all contributions' qualitative mark for each student, peer



STUDENT POSITION		ACTIVITY				PASSIVITY		IMPACT		EFFECTIVITY	ASSESSMENT	
Pos.	Student	Total contributions	Proactivity	Reactivity	Support	Pending to read	Pending to evaluate	Particip. impact	Replies received	Assientment rebut	Peer assessment	Tutor assessment
[1]	MiguelAngel Cabot	3/200 1.5%	2/3 66%	1/3 33%	0/3 0%	0/197	197/197	26.5	0/3	39/39 100%	8.2/10 (6)	B
[2]	Javier Gomez	3/200 1.5%	2/3 66%	0/3 0%	1/3 33%	197/197	197/197	22.0	0/3	22/22 100%	7.0/10 (9)	B
[3]	Jordi Serra	3/200 1.5%	3/3 100%	0/3 0%	0/3 0%	0/197	197/197	24.0	3/3	24/24 100%	7.0/10 (10)	B
[4]	Josep Vano	11/200 5.5%	8/11 72%	3/11 27%	0/11 0%	183/189	189/189	87.0	6/11	124/130 95%	7.2/10 (12)	C+
[5]	Jose Vizcaino	2/200 1.0%	2/2 100%	0/2 0%	0/2 0%	174/198	193/198	10.0	0/2	10/10 100%	10.0/10 (2)	B
>[6]	Ruben Haro	12/200 6.0%	7/12 58%	5/12 41%	0/12 0%	0/188	117/188	59.5	4/12	104/108 96%	7.0/10 (10)	C+
[7]	Antoni Perez	5/200 2.5%	4/5 80%	1/5 20%	0/5 0%	190/195	195/195	26.5	0/5	40/40 100%	7.2/10 (5)	B
[8]	Emilio Garcia	17/200 8.5%	10/17 58%	7/17 41%	0/17 0%	89/183	140/183	67.5	5/17	143/143 100%	7.6/10 (34)	C+
[9]	Carlos Guerra	1/200 0.5%	1/1 100%	0/1 0%	0/1 0%	197/199	199/199	14.0	0/1	14/14 100%	8.3/10 (3)	B
[10]	Abel Vilalta	4/200 2.0%	4/4 100%	0/4 0%	0/4 0%	135/196	196/196	48.5	1/4	49/50 98%	7.3/10 (6)	C+
[11]	Rafael Alonso	9/200 4.5%	6/9 66%	3/9 33%	0/9 0%	113/191	119/191	65.0	3/9	67/68 98%	6.4/10 (17)	C+
[12]	RafaelGuillermo Fernandez	1/200 0.5%	1/1 100%	0/1 0%	0/1 0%	183/199	199/199	10.0	0/1	10/10 100%	N	A
[13]	Daniel Cortes	1/200 0.5%	1/1 100%	0/1 0%	0/1 0%	195/199	199/199	9.0	0/1	9/9 100%	8.0/10 (1)	B
[14]	Carles Patino	4/200 2.0%	2/4 50%	1/4 25%	0/4 0%	49/196	196/196	20.5	1/4	32/33 97%	7.5/10 (8)	B
[15]	Yolanda Aubanell	1/200 0.5%	1/1 100%	0/1 0%	0/1 0%	197/199	199/199	12.0	0/1	12/12 100%	7.7/10 (3)	B

Fig. 2. A snapshot of complex and updated feedback provided to all participants

assessment, passivity level, and the impact value and effectiveness of each student's contributions (Fig. 2).

A statistical analysis of the results comparing both the standard and the DF tools is shown in Table 1. Despite the standard tool generated more threads, most of them were actually empty (i.e. just 8 threads were contributed with more than 1 post vs. 42 threads in the DF). Moreover, the standard deviation (SD) for the posts/thread mean appears to be high in the DF, which proves the heterogeneity of the discussion involving threads of very different length. Finally, note the very high SD statistic in the posts/students mean due to a single outlier, without which SD is 6,3.

Table 1. Main statistics extracted from the discussion using both discussion tools

Statistics	Standard tool	Discussion Forum (DF)
Number of students	40	40
Number of threads	48	44
Total of posts	95	351
Mean number (posts/thread)	M=1.9 SD=2.4	M=7.9 SD=5.0
Mean number (posts/student)	M=2.3 SD=1.9	M=8.7 SD=8.1

The results of the semi-automatic assessment were very promising since the instructor in charge of the DF agreed with the final marks proposed by the system in more than 75% of cases. 31 out of 40 students in the DF's rank (see Fig. 2) matched the same position as in the rank appeared in the instructor's manual evaluation. In addition, the instructor reported the promising benefits from the DF in the monitoring process since this new tool alleviates instructors and moderators from the tedious work of tracking and evaluating the discussion's dynamics and outcomes manually. Next, we present additional mechanisms for the instructor to monitor the discussion.

4.1 The Global Scheme of a Monitoring System

This sub section shows the global scheme of the monitoring system that we have developed and tested in real collaborative learning settings. The general functioning of this system is explain next (see [5] for a complete description and Fig. 3):

1. Students participate in the collaborative spaces associated to their working group: they post or read contributions in the discussion tool, send or read e-mails, upload or download documents, manage folders and files, etc. Each of these activities can be considered as an event of a certain type which has been carried out by a particular student at a certain time and web space.
2. Events generated by students are registered in log files in the learning management system (a BSCW server [10] in our case, but the approach is generic and it could be any other learning management system).
3. A specific Java application, called EICA [5], is used to automatically read and process new incoming log files and to store the extracted data into a unique persistent database in the corresponding server.

4. Database files are then processed by SAMOS application. SAMOS was specifically designed and developed to generate weekly reports which summarize group and student activity levels in a graphical manner.
5. The server automatically sends these reports to instructors by e-mail.
6. Instructors receive these reports and analyze them, looking for groups and students which seem to be “at risk”, i.e.: students with low activity levels –which makes them likely to be non-participating students and possible dropout students–, and groups with low activity levels –which makes them to be possible malfunctioning groups.
7. These results are then combined and contrasted with the qualitative self-, peer- and group evaluation reports which are generated by the students themselves.
8. Once the groups and students at risk have been detected, and the specific problems have been identified and classified according to whether they refer to task, group functioning or group social cohesion, instructors contact them to offer specific guidance and support towards the best development and completion of their collaborative activities.

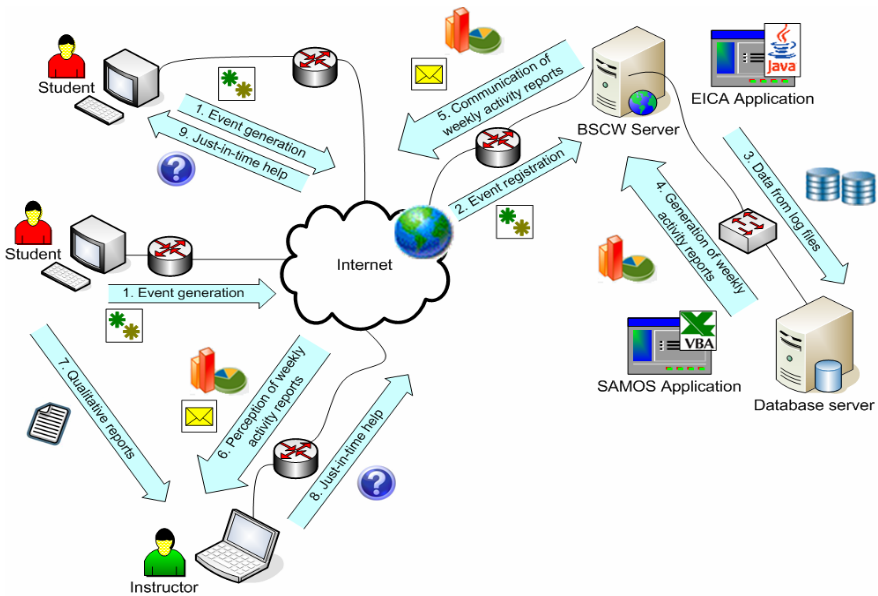


Fig. 3. General scheme of our monitoring model

This way, students and groups at risk, receive just-in-time and efficient guidance and support so that to enhance and continue their individual or collaborative work during the discussion more successfully.

As an initial design option, we chose to generate weekly monitoring reports with the aim to show a small set of graphs that were easily and quickly understood by instructors, so that they did not have to invest extra time in analyzing data. To this end, we designed the following charts: (1) groups’ classification graph, (2) students’ classification graph, (3) group's activity-evolution graph, and (4) student's activity-evolution graph.

For the sake of exemplifying the type of monitoring reports, we present here the *groups' classification graph* (a detailed description of the other charts can be found in [5]). This chart (Fig. 4) is a scatter plot of the following two variables: X = "average number of events per member that have been generated by group i during this (current) week" ($i = 1, 2, \ldots, n$), and Y = "average number of events per member that have been generated by group i during an average week".

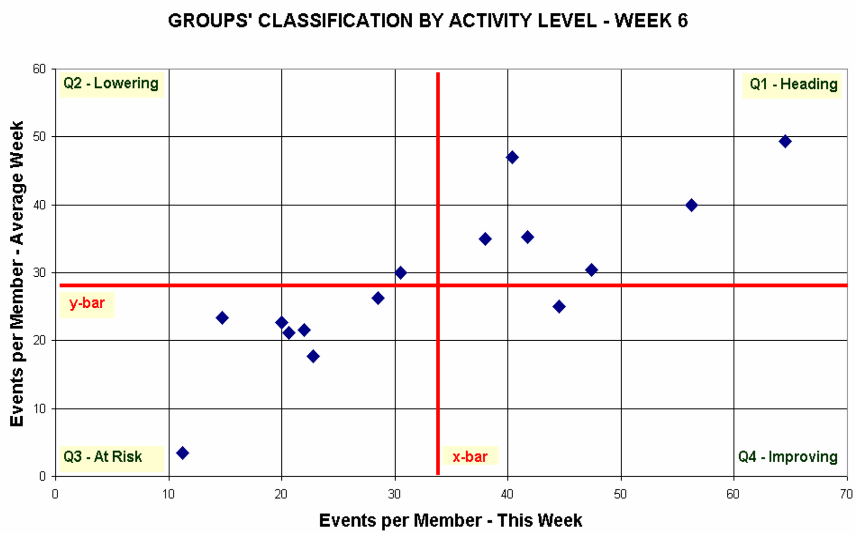


Fig. 4. Groups' classification graph

The plot also includes the straight lines $x = \overline{x}$ and $y = \overline{y}$, which divide the graph in four quadrants, Q1 to Q4. That way, points in Q1 can be seen as representing *heading* groups since their activity levels are above the two activity means –current week and average week–; points in Q2 can be considered as *lowering* groups, since even when historically their activity level has been above the activity level for an average week, their current activity level is below the average; points in Q3 represent those groups which are below the two activity means –current and historical– and, therefore, they can be considered as groups *at risk*, since they are the most likely to suffer from low task contribution, group malfunctioning, lack of social cohesion and eventually from students' dropouts; finally, points in Q4 can be seen as *improving* groups, since even though their activity level has been historically below the mean, their level has been above the mean during the current week, so they are experimenting some improvement in their activity level. Note that these interpretations can be stronger as the distance between the considered point and the straight line is greater –e.g.: considering its distance from the x-bar line, there is good evidence that the activity of the group in Q4 has been fairly improved during the current week.

In order to test whether the information provided by SAMOS may significantly influence groups' and students' performance in real collaborative learning situations in a more systematic and extensive way, we carried out the following experiment during the last academic term: a random sample of size 40 students was drawn from the population of groups that were participating in several discussions in collaborative e-learning courses. During the semester, instructors of these selected groups were provided with weekly reports generated by SAMOS, so that they could detect students and groups at risk and provide them with just-in-time guidance and support. At the end of the semester, we calculated the following indexes:

1. Percentage of sampled groups which concluded their discussions according to its initial specifications (PGF).
2. Percentage of sampled groups which received a positive evaluation of their discussions at the end of the semester (PGP).
3. Percentage of sampled groups which experimented dropouts (PGD) –that is, some of the group members abandoned the discussion during the semester.

Moreover, we used historical data from previous semesters to obtain the before-SAMOS population percentages for these indexes, p_0^i ($i = 1, 2, 3$). Then, for each selected index i , we considered the corresponding hypothesis tests about the population proportions, i.e.: $H_0 :\ p_{SAMOS}^i = p_0^i$ versus $H_A :\ p_{SAMOS}^i \neq p_0^i$. Both percentages and results for these tests are shown in Table 2.

Table 2. Hypothesis tests about the population proportions

Index	p_0 (Historical)	p_{SAMOS} (n = 40)	95% CI	p-value
1. PGF	55%	75% (30)	(0.59, 0.8	0.011
2. PGP	49%	65% (26)	(0.48, 0.79)	0.056
3. PGD	43%	25% (10)	(0.13, 0.41)	0.025

Using a standard significance level, $\alpha = 0.05$, we could conclude from the corresponding p-values that the tests associated with indexes 1 and 3 were significant. In other words, statistical evidence supports the idea that the information provided by SAMOS has contributed to significantly enhance the PGF and PGD indexes in collaborative e-learning courses offered in our e-learning environment.

5 Conclusions and Future Work

This paper describes a promising approach for enhancing knowledge management that contributes to the improvement of the discussion process in virtual collaborative learning environments from both the knowledge building and monitoring perspective. The results of the experiences reported here are not conclusive due to its exploratory nature. However, from the analysis of the results it has been proved to promise significant benefits for students in the context of discussion by learning, project-based learning, and in education in general.

A decentralized distributed infrastructure has been recently added to our prototypes [11] in order to meet certain important non-functional requirements that may influence the learning process a great deal, such as performance, scalability, fault-tolerance, and interoperability. The gain in performance might help us, for instance, include more complex information of the collaboration to be generated and presented in real time (such as modelling the participants' behaviour during the discussion by combining individual and group session and navigation information). We plan to explore these interesting possibilities further.

Acknowledgements. This work has been partially supported by the Spanish MCYT project TSI2005-08225-C07-05.

References

1. Dillenbourg, P. (ed.): What do you mean by "Collaborative Learning"? Collaborative learning. Cognitive and computational approaches, pp. 1–19. Elsevier Science, Oxford (1999)
2. Simonson, M., Smaldino, S., Albright, M., Zvacek, S.: Teaching and Learning at a Distance. Prentice Hall, Upper Saddle River (2003)
3. Daradoumis, T., Martínez, A., Xhafa, F.: A Layered Framework for Evaluating Online Collaborative Learning Interactions. Int. J. of Human-Computer Studies 64(7), 622–635 (2006)
4. Caballé, S., Daradoumis, T., Xhafa, F.: Providing an Effective Structured and Context-aware Asynchronous Discussion Forum for Collaborative Knowledge Building. In: Proceedings of the World Conference on Educational Multimedia, Hypermedia and Telecommunications (ED-MEDIA 2008), Vienna, Austria. AACE Press (2008)
5. Juan, A., Daradoumis, T., Faulin, J., Xhafa, F.: Developing an Information System for Monitoring Student's Activity in Online Collaborative Learning. In: Proceedings of the Second International Conference on Complex, Intelligent and Software Intensive Systems (CISIS 2008), Barcelona, Spain. IEEE Computer Society, Los Alamitos (2008)
6. Stahl, G.: Group Cognition: Computer Support for Building Collaborative Knowledge. Acting with Technology Series. MIT Press, Cambridge (2006)
7. Puntambekar, S.: Analyzing collaborative interactions: divergence, shared understanding and construction of knowledge. Computers & Education 47(3), 332–351 (2006)
8. Schellens, T., Valcke, M.: Fostering knowledge construction in university students through asynchronous discussion groups. Computers & Education 46(4), 349–370 (2006)
9. Soller, A.: Supporting Social Interaction in an Intelligent Collaborative Learning System. Int. J. of Artificial Intelligence in Education 12, 40–62 (2001)
10. Bentley, R., Appelt, W., Busbach, U., Hinrichs, E., Kerr, D., Sikkel, S., Trevor, J., Woetzel, G.: Basic Support for Cooperative Work on the World Wide Web. International Journal of Human-Computer Studies 46(6), 827–846 (1997)
11. Caballé, S., Xhafa, F., Daradoumis, T.: A Service-oriented Platform for the Enhancement and Effectiveness of the Collaborative Learning Process in Distributed Environments. In: Meersman, R., Tari, Z. (eds.) OTM 2007, Part II. LNCS, vol. 4804, pp. 1280–1287. Springer, Heidelberg (2007)

Educational Games Design Issues: Motivation and Multimodal Interaction

Mladjan Jovanovic[1], Dusan Starcevic[2], Velimir Stavljanin[2], and Miroslav Minovic[2]

[1] Faculty of Electrical Engineering, University of Belgrade
mladjan@afrodita.rcub.bg.ac.yu
[2] Faculty of Organizational Sciences, University of Belgrade
{starcev,velimirs,miroslav.minovic}@fon.bg.ac,yu

Abstract. In this paper we present an approach to identifying and constructing profiles of user interfaces for educational games. Our approach is based on framing games as educational tools that incorporate fun and learning through motivation as the key ingredient in the learning process, and multimodal interaction as the medium for conveying educational material. To date, there is no common standard to design this kind of games and individual solutions are usually carried out by an *ad hoc* process. Proposed solution formalizes design process describing educational games in terms of estimated effects they produce on players. Building upon research on learning and motivation theory, we are connecting these effects with player learning preferences and motivation states. Our main contribution is to suggest design issues that should be taken into account when designing educational games. We exemplify the approach through our ongoing VStrat project, framework for designing educational games

Keywords: Multimodal Interaction, Motivation, Fun, Learning, Educational game.

1 Introduction

Digital games are becoming more and more considered to have a promising role in education process. Features of games that could be applied to address the increasing demand for high quality education are already identified as [1]: clear goals, lessons that can be practiced repeatedly until mastered, monitoring learner progress and adjusting instruction to learner level of mastery, closing the gap between what is learned and its use, motivation that encourages time on task, personalization of learning, and infinite patience. In addition, modern video games may develop higher order thinking skills such as problem solving, strategic thinking, analysis, planning and executing, resource management, multi-tasking, and adapting to changing work scenarios. In order to exploit these attributes of games to improve learning outcomes, contextual bridging is needed between inherent motivational aspects of games and player learning abilities and preferences. This paper addresses the problem of closing the aforementioned gap using ideas from the multimodal human-computer interaction. We intend to suggest formal guidelines for designing games for education.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 215–224, 2008.

The structure of the paper is as follows. After this introduction, we examine, in Section 2, the evolution of games for learning, the motivational aspects of learning end education, as well as basic concepts of multimodal interaction from our point of interest. Section 3 gives an overview of the research field and some existing solutions. This leads us to propose, in Section 4, our approach where we present modeling framework based on existing metamodel of multimodal human-computer interaction. In Section 5 we demonstrate our approach giving a design case study example on framework for educational games we are developing. Section 6 concludes.

2 Problem Background

In our approach we are reusing ideas from multimodal user interfaces and psychological theories of motivation and learning in order to combine them in the designing of educational games. In this section we give an overview of these fields, emphasizing their critical aspects.

2.1 Evolution of Games for Learning

Video games can teach science and engineering better than lectures [2]. They expose potential to address many drawbacks of contemporary educational system for reasons presented by [2]. Massive reach that video games have achieved[1] gives teachers the ability to reach students where they live. Effective learning paradigms are supported by specific kinds of instructions found in video games and generally improve learning outcomes. Video games stimulate chemical changes in the brain that promote learning. Bransford et al. [3] found that playing video games stimulates dopamine release, which is a chemical precursor to the memory storage process. Time on task is another potential role of video games in education. Compelling video games[2] that can deliver educational content would increase the time spent on learning.

However, research is needed to advance games for learning. These research need to determine how (1) to design learning games to deliver positive learning outcomes, (2) to develop tools to automate the process of developing games for learning, and (3) to propose methods and techniques to assess the knowledge and skills learners acquire from educational games.

2.2 Motivation in Education

Motivation concerns energy, direction, persistence and equifinality – all aspects of activation and intention [4]. We have chosen Self-Determination Theory (SDT) approach to motivation, since it reflects great potential in the field of education. SDT gives following classification of motivation [4]:

- **Intrinsic motivation** – refers to doing an activity for the inherent satisfaction of the activity itself;

[1] A typical immersive game on the Internet typically involves more than 250,000 active subscribers [2].

[2] The Entertainment Software Association's 2005 survey of video game habits and demonstrations found that average gamer in the U.S. spends about 6.8 hours a week on video games [2].

- **Extrinsic motivation** – refers to the performance of an activity in order to attain some separable outcome;
- **Amotivation** - denotes the absence of motivation.

According to SDT, the human's social development is driven by the satisfaction of innate psychological needs for *competence*, *autonomy* and *relatedness*. High degrees of motivation require satisfaction of innate psychological needs and are directed towards what people find interesting or important [4]. Motivation leads to the activation of efficient cognitive strategies for long-term memory issues like monitoring, elaborating or organizing information. On the opposite, amotivation decreases memorization and personal development. Motivation appears to be a key asset to get actively involved, in time and mind, in the learning process.

2.3 Multimodal Human-Computer Interaction

Multimodal interaction is part of everyday human discourse: We speak, move, gesture, and shift our gaze in an effective flow of communication [5]. Enriching HCI with these elements of natural human behavior is the primary task of multimodal user interfaces. Oviatt et al. [6] gave a practical definition of multimodal systems, saying they combine natural human input modalities - such as speech, pen, touch, hand gestures, eye gaze, and head and body movements – in a coordinated manner with multimedia system output. Computers and humans establish various communication channels over which they exchange messages with associated effects. Modalities process or produce these effects, while various interaction constraints reduce or completely eliminate some of these effects. Universal accessibility and related approaches such as “Inclusive Design” or “Design for All” aim to produce systems that can be use by everyone, regardless of their physical or cognitive skills. While multimodal interaction research focuses on adding more natural human communication channels into HCI, accessibility research is looking for substitute ways of communication when some of these channels, due to various restrictions, are of limited bandwidth [7]. Multimodal interfaces can improve accessibility for diverse users and usage contexts, advance performance scalability, robustness, expressive power, and efficiency of communication [6]. Multimodal interfaces can also improve interaction between player and game as interactivity appears to be one of the key features of today's digital games.

3 Previous Works

The development of educational games that integrate learning with video gaming technologies is increasing.

One of the potential roles of video games in education is recognized as effective learning paradigms [2]. Discovery-based learning is an approach to learning that emphasizes learner's active exploration of a subject. Immune Attack [8] is a PC-based single-player video game that combines a realistic 3D depiction of biological structure and function with educational technologies for teaching immunology. Like a discovery game that requires players to earn the right to take on new challenges, Immune

Attack compels its players to learn rules of the immune system before it reveals deeper biological insight [8].

The notion of using computer games for military training is almost irresistible [9]. Defense Advanced Research Project Agency (DARPA) developed DARPA's universal persistent, on-demand training WARS program (DARWARS) as a lightweight training simulation. Chatham [9] states that DARPA simulations teach habits of thought so soldiers respond on the first day of combat as if they had been there a week.

In many video games, story is the glue between missions, providing the necessary goals and motivation for the player to progress to the next segment of game play. In educational games, story can be used to structure the players experience to achieve educational objectives. Example includes Storytelling Alice programming environment [10] for creating interactive 3D virtual worlds. Kelleher and Pausch [10] state that creating an animated movie and learning to program a computer can be fundamentally the same activity.

Carnegie Melon University created its Entertainment Technology Center (ETC) as a professional master's degree to prepare students for the video game and themed and digital entertainment industries by putting artists and technologies together in interdisciplinary teams to create interactive experience [11].

While there are numerous efforts that games can be applied to learning, relatively few attempts can be found where principles of learning and motivation theories were explicitly followed a priori in design. Standards for the quality of gameplay and pedagogy are nonexistent [2]. Cognitive modeling and assessment tools have to be incorporated into educational games, giving insight into learning outcomes and enabling their evaluation. The challenge with these games is also that they are very costly to develop, as they must compete with commercial video games in terms of quality of graphics, challenges, and game play [1].

4 Proposed Approach

Our approach is inspired by the model-driven development, where software development's primary focus and products are models rather than computer programs. In this way, it is possible to use concepts that are much less bound to underlying technology and are much closer to the problem domain [12].

4.1 Educational Game Metamodel

Defining educational game models requires a vocabulary of modeling primitives. Therefore, our metamodel describes basic educational game concepts. Figure 1 shows a simplified educational game metamodel.

The metamodel's main concept is EduGameElement which is used as a basis for defining other concepts of educational game. EduGameKnowledge defines educational content that is aimed to convey to players in learning process. Expertise in science area is needed for managing complexities of the underlying knowledge. Educational content needs to be presented in some form to the user, therefore we introduce

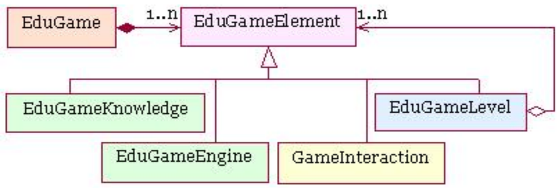


Fig. 1. Educational game basic concepts

concept of EduGameEngine. It describes the mechanism used to present knowledge, which, for example, might be the learning tool to generate and answer questions that guide learner through the exploration and discovery of the required science area. GameInteraction concept describes communication between player and game. This concept describes interaction at high level of abstraction regardless of specific manifestations. In broad outline, interaction is established using multiple channels of communications [5]. The overall goal is to convey knowledge in interactions rather than static data. EduGameLevel comprises previous modeling primitives in order to provide inherent and natural evaluation mechanism in which levels are grades. It also allows creating games at multiple scales of knowledge and skills.

4.2 Game Interaction Metamodel

Interaction between player and game is realized using multiple channels of communication. In order to describe relevant concepts of communication between player and game, we propose metamodel as depicted by Figure 2.

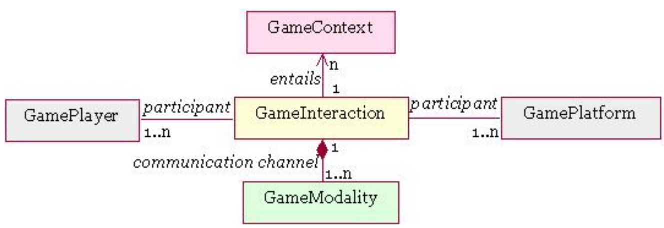


Fig. 2. Basic concepts of communication between player and game

Main concept in metamodel of communication between player and game is *GameModality*. It is defined as a form of interaction between player and game, which engages human capabilities to produce some effects on users. Presented concept of *GameModality* is derived from existing metamodel of multimodal human-computer interaction [5]. Multimodal interaction can be establishe between multiple players (*GamePlayer*) and multiple game platforms (*GamePlatform*). *GameContext* defines set of conditions and facts that are pertinent to specific situation, and can affect interaction between player and game. *GameContext* is additionally classified into:

- Physical context – defines environment conditions such as kind of space in which interaction is established, temperature value, luminance level, noise, humidity;

- Situational context – defines current situation in environment from the point of view of the task that user has to accomplish;
- Common knowledge – represents a set of facts that are understood by humans and computer;
- Social context – defines social environment of the interaction.

Each modality engages human capabilities, producing some effect on the user. Effects are classified into four main categories [5]:

- **Sensory effects** describe the human sensory apparatus's processing of stimuli;
- **Perceptual effects** result from the human perceptual system's analysis of sensor data;
- **Motor effects** describe human mechanical actions, such as head movement or pressure;
- **Cognitive effects** occur at higher levels of human information processing and include memory, attention, and curiosity. In the design of educational games, these are the key asset.

In this way, user interface can be described in terms of messages (effects) that designer sends to the user. Effects are interconnected. For example, all perceptual effects results from sensory effects. These relationships enable designers predicting the result of using some effects.

4.3 Game Player Profiles Metamodel

We have classified players/learners according to multiple intelligence theory [13]. The eight intelligences are as follows [14]:

1. Linguistic: think in words,
2. Logical/Mathematical: think by reasoning,
3. Spatial: think in images and pictures,
4. Bodily/Kinesthetic: think through somatic sensations,
5. Musical: think via rhythms and melodies,
6. Interpersonal: think by bouncing ideas off other people,
7. Intrapersonal: think in relation to their needs, feelings, and goals,
8. Naturalist: think through nature and natural forms.

Figure 3 gives an overview of player types.

The fact that some people impose multiple types of intelligences justifies introduction of Complex type. Gardner states that most schools focus on the linguistic and logical/mathematical intelligences. In this way individuals who show gifts in the other intelligences: the artists, architects, musicians, naturalists, designers, dancers, therapists, entrepreneurs are learning-confined by traditional educational process. Unfortunately, many children who have these gifts do not receive much reinforcement for them in school. McCue [15] describes how computer games can provide a multiintelligence approach to learning by exemplifying particular intelligences. In our approach we are reusing multiple intelligence concepts in order to (1) comprise users with diverse learning preferences inherently predefined by particular intelligences (2)

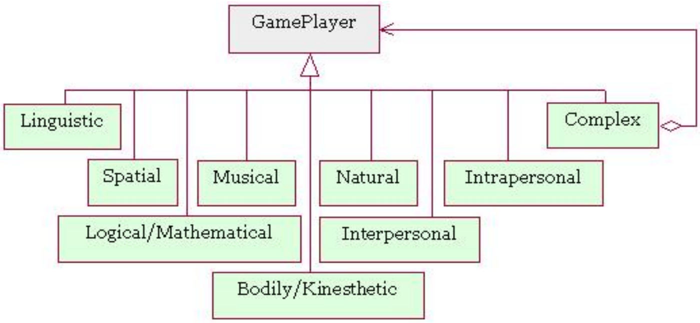


Fig. 3. Proposed player classification

identify the dominant content of learning interface according to intelligence type as [14]: words (linguistic intelligence), numbers or logic (logical-mathematical intelligence), pictures (spatial intelligence), music (musical intelligence), self-reflection (intrapersonal intelligence), a physical experience (bodily-kinesthetic intelligence), a social experience (interpersonal intelligence), an experience in the natural world (naturalist experience).

4.4 Game Player States

Educational games are examples of user-centered designs that motivate through learning. On the other hand, motivation appears to be very effective in video games since it deals with fun, a potent source of intrinsic motivation [16]. Figure 4 classifies player's states that are pertinent to learning process.

In describing player's states, we are building on work by Denis and Jouvelot [16]. Looking at motivation through the impact of challenges and skills, the notion of parallelism between fun and learning is introduced: curiosity and proficiency as cognitive desire and pleasure. Ludic tension describes unstable whirlwind existing between pleasure and desire [16]. Immersion is defined as the experience of feeling part of the synthetic experience and is closely related to the state of flow which occurs when a player is engaged in an activity (physical, mental, or both) at a level of immersion that causes the player to lose track of time and the outside world [17]. Intrinsic motivation encompasses flow, arousal, and control. Arousal and control are temporary regulation phases that reflect the dynamics of a learning curve, which has to be constantly renewed and balanced to maintain the player's engagement.

The overall goal of educational games is to draw the learner learning curve dynamics nearer to zone of proximal development[3].

Table 1 gives survey of intrinsically motivated states associated with corresponding cognitive effects. Proposed classification of learner's states with associated messages that trigger the state entry gives designers an opportunity to predict results of using some effects early in the design phase.

3 "The distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" [18].

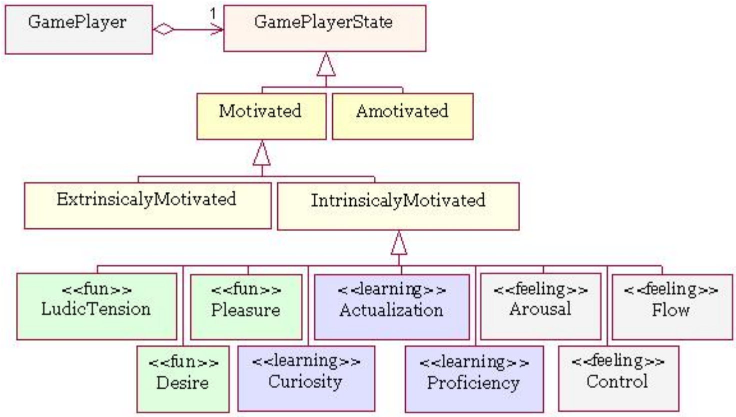


Fig. 4. Formal description of player's states

Table 1. Classification of motivational effects

State	Messages (Effects) that trigger state entry
Pleasure	Fantasy, Control, Social interaction, Immersion, Comedy, Direct system response, Experience of effectance, Creation
Desire	Challenge, Curiosity, Problem-solving, Competition, Competence
Ludic Tension	Discovery, Conflict, Suspense, Relief, Surprise, Narration

5 Design Case Study

We have applied our approach in designing pilot project educational game V-Strat[4]. V-Strat game logic is very similar to the logic of the ancient strategic game Risiko. Project is developed according to proposed design issues for educational games. Figure 5 gives an example of game's interface. Scientific knowledge facts are embedded into game rules (answering questions instead of throwing the cube). Discovery-based learning is supported by mapping of geometric gamepad symbols to domain knowledge values through ancient strategy principles. Game's interface dominant content is aimed for complex intelligence type. Chat room enables to take the advantage of all existing communication types for collaborating, negotiating, plotting, and competing among players. This also defines overall game's context. In order to take into account type of learner, game level mastery, domain knowledge characteristics, and environment, our method allows definition of different models of interfaces, at different levels of abstraction. Models can be organized hierarchically and grouped according to different aspects. The models can be reused, which reduces the effort. In our experience, creation of the initial model is the most time consuming effort.

[4] This work is part of a project "Corporate portal for employee long life learning", funded by the Ministry of science and technology Republic of Serbia, grant no: 006221.

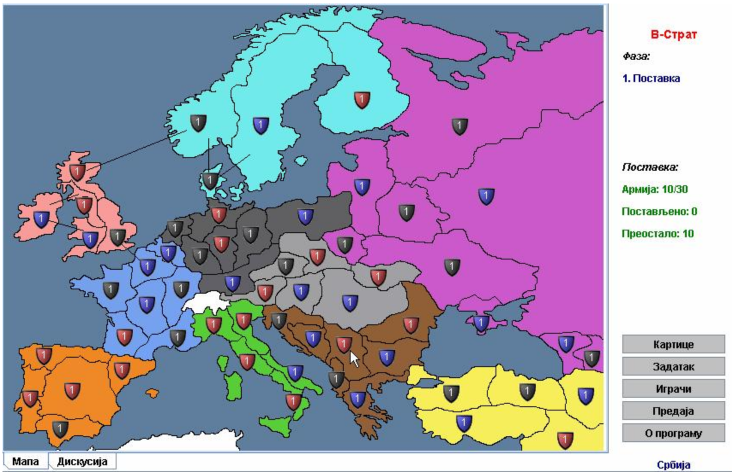


Fig. 5. An example of developed game's interface

6 Conclusion

Educational games are examples of user-centered designs that motivate through learning, arousing players' interest and giving them the power to ample expression. The presented work describes an approach to modeling educational games that incorporates principles of motivation theory as well as multimodal human-computer interaction. The key challenge is to increase player's motivation for learning. Proposed modeling framework is aimed to design educational games that motivate users with diverse learning abilities and preferences to get actually involved in learning process. This is achieved by (1) classifying motivational states that are pertinent to learning process and identifying messages that cause transitions to these states, and (2) identifying game player profiles according to player learning abilities and preferences. The efficiency of usage of our method depends very much on the efficiency of supporting tools. In our current approach, we are relying on the existing UML modeling tools, and their integration mechanisms. The advantage is that the designers who are familiar with UML can do the design in their natural environments. Additional advantage is that the UML tools, such as Rational Rose, enable integration of custom code connecting the tool with other systems. However, the problem with UML tolls is lack of rigorousness in modeling, which requires discipline at the side of the designer. We have illustrated our approach on the example of V-Strat project that we are currently developing. Presented example is a part of ongoing project and is developed as an experimental prototype. In our future work, we plan to work on implementation of tools for designing and evaluating educational games based on the presented technique and to integrate our solution into existing CASE tools.

References

1. Federation of American Scientists, R&D Challenges in Games for Learning. Tech. Rep., Washington D.C. (2006), http://www.fas.org/learningfederation
2. Mayo, J.M.: Games for science and engineering education. Communications of the ACM 50(7), 31–35 (2007)
3. Bransford, J., Brown, A., Cocking, R.: How people learn: brain, mind, experience, and school. National Academy Press, Washington (2000)
4. Ryan, R.M., Deci, L.E.: Self-Determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist 55(1), 68–78 (2000)
5. Obrenovic, Z., Starcevic, D.: Modeling multimodal Human-Computer interaction. IEEE Computer 37(9), 62–69 (2004)
6. Oviatt, S., Darrell, T., Flickner, M.: Multimodal interfaces that flex, adapt, and persist. Communication of the ACM 47(1), 30–33 (2004)
7. Obrenovic, Z., Abascal, J., Starcevic, D.: Universal accessibility as a multimodal design issue. Communications of the ACM 50(5), 83–88 (2007)
8. Kelly, H., Howell, K., Glinert, E., Holding, L., Swain, C., Burrowbridge, A., Roper, M.: How to build serious games. Communications of the ACM 50(7), 45–49 (2007)
9. Chatham, E.R.: Games for training. Communications of the ACM 50(7), 37–43 (2007)
10. Kelleher, C., Pausch, R.: Using storytelling to motivate programming. Communications of the ACM 50(7), 59–64 (2007)
11. Pausch, R., Marinelli, D.: Combining the left and right brain. Communications of the ACM 50(7), 51–57 (2007)
12. Selic, B.: The pragmatics of model-driven development. IEEE Software, 19–25 (2003)
13. Howard, G.: Intelligence reframed: Multiple Intelligences for the 21st century (2000)
14. Armstrong, T.: Multiple Intelligences (2000), http://www.thomasarmstrong.com/multiple_intelligences.htm
15. McCue, P.: The crucial role of animated children's educational games. In: The 32nd International Conference on Computer Graphics and Interactive Techniques (2005)
16. Denis, G., Jouvelot, P.: Motivation-driven educational game design: Applying best practices to music education. In: ACE 2005, Valencia, Spain (2005)
17. Fullerton, T., Swain, C.: Game design workshop: Designing, prototyping, and playtesting games. CMP Books (2004)
18. Vygotsky, L.S.: Mind in society: The development of higher psychological processes. Harvard University Press, Cambridge (1978)

A Business Plans Training Tool Based on the Semantic Web Principles

Aristomenis M. Macris and Dimitrios A. Georgakellos

Dept. of Business Administration, University of Piraeus,
80 Karaoli & Dimitriou str., 185 34 Piraeus, Greece

Abstract. This paper presents the development of a training tool that enhances and empowers trainees' ability in developing business projects by preparing high-quality business plans. An ontology-based knowledge network was developed for the semantic representation of the business plans preparation procedure. The model can combine existing multimedia material with ontology constructs in order to build user-training scenarios and satisfy specific training needs. Hence, users are enabled to actively participate in the business plan preparing process, since, they are now equipped with an appropriate tool for acquiring a clear and in-depth understanding of this process, because the training scenarios designed show not only the meaning and the importance of the various business functional plans, but also how they affect each other within a business development project. Knowledge reusability is also achieved, since knowledge constructs instilled into a knowledge network can be used into new scenarios in order to meet new training needs.

Keywords: Business plans; Semantic web; Training tool; Ontology-based knowledge networks.

1 Introduction

World economy has been transformed into a knowledge economy. In that economy the application of knowledge is the main means of production and has become more important than traditional resources, such as labour, capita or base materials. Traditional economy that was primarily driven by transformational activities (turning raw product into finished product, or turning data into information) has been transformed into knowledge economy where the highest-value activities are complex interactions between people and systems. This shift from transformation activities to interactions represents a broad shift in the nature of economic activity. Economic success and most productivity gains in the future are going to be in interactions. Hence, enterprises are beginning to realize that strategic advantage becomes less focused on ownership of distinctive stocks of knowledge. Instead, strategic advantage resides in the institutional capacity to get better and faster the most promising flows of knowledge and in the rapid integration of the knowledge acquired from these flows into the enterprise activities [1].

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 225–233, 2008.

1.1 Training Knowledge Workers for the Knowledge Economy

Knowledge workers can be described as highly professional, highly competent individuals with an excellent education, globally mobile and even independent from specific national restrictions. They are global "knowledge players" with a main function to act as "knowledge brokers".

On the other hand there are candidate knowledge workers. Those individuals own qualifications on a high level too and are capable to welcome constantly new working tasks. However, they are less virtuous and qualified than knowledge workers.

One of the key issues for the successful integration of knowledge flows into the enterprise activities is active user participation. This is achieved through continuous interactions between experts (knowledge workers) and trainees (candidate knowledge workers). In essence, active user participation which is enabled through user training is considered a knowledge-creation spiral that emerges when the interaction between tacit and explicit knowledge is elevated dynamically from lower to higher ontological levels [2]. Figure 1 shows graphically how existing individual's tacit knowledge is converted by experts into explicit knowledge. In turn, this knowledge is enriched in order to be converted into group's knowledge through group training, thus enabling user groups (trainees) participate in the development of new systems in co-operation with experts. New processes designed represent organizational knowledge in intra-organizational process activities and inter-organizational knowledge in inter-organizational process activities.

The approach is outlined through a case study involving the development of a training scenario for the preparation of business plans.

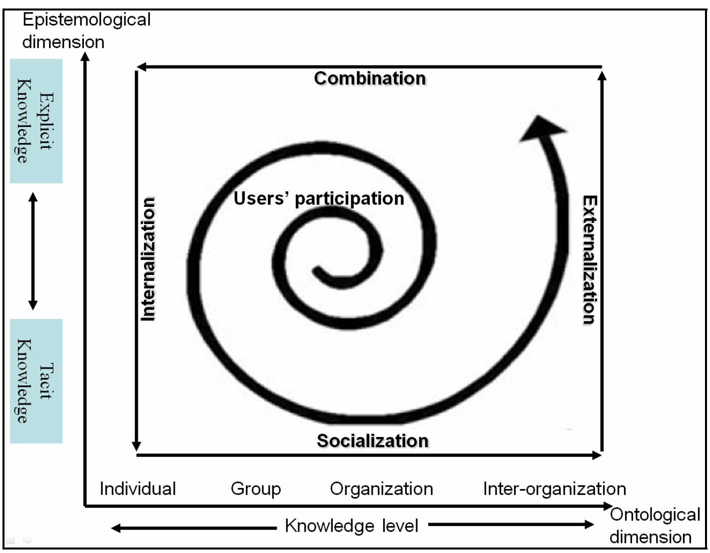


Fig. 1. Developing organizational knowledge through users' participation

1.2 Development of Business Plans

The process of putting together a business plan forces the person who makes it to take an objective, critical, unemotional look at this business project in its entirety. The business plan is an operating tool that, if properly used, will help manage the business more effectively, identify areas of weakness and strength, pinpoint needs, spot opportunities early, best achieve business goals, see problems before they grow large and help identify their source, thus suggesting ways to solve them. The business plan also provides information needed by others to evaluate the venture, since a thorough business plan can quickly become a complete financing proposal that will meet the requirements of most lenders. Since many business plans are submitted to banks or other sources of financing, it is important to realize how a banker analyses a business plan in order to assess the degree of risk for each proposed loan and to be satisfied that the loan can be repaid by the borrower while still allowing the business to operate profitably. This analysis is based on factors such as: the nature of the business, the purpose of the loan, the amount of the loan, the ability to repay the loan and the character and management skills of the business owner. Bankers, lawyers and certified public accountants are professionals in their fields and should be included in the planning at whatever points their knowledge and expertise can be helpful. A well organized, insightful business plan must convince a banker of the entrepreneurs' ability to understand their market, demonstrate their technical knowledge required in the field, and the company's ability to understand and respond to customer needs. The plan must ultimately show their ability to manage the business so it can be operated in a profitable way and repay the loans. Although there are numerous software packages that will assist someone in preparing a business plan, one should not rely on the software and simply "fill in the blanks", but instead one must understand the document and avoid preparing a document ignoring the meaning of its content [3], [4].

From these considerations, the research problem addressed in this paper is concerned with the development of a training tool that enables users understand business process modeling concepts in general, with the objective to enhance and empower their ability in developing business projects by preparing good business plans. To this end, an ontology-based knowledge network is developed that can be used as a tool for the semantic representation of how a business project is being created and functions and, hence, as a means for the development of an appropriate training aid in business plan preparing.

2 Design of an Ontology-Based Training Tool

The proposed model is developed on the bases of the principles set by various initiatives like the semantic web, all having in common the focus on extending current web technology with machine-understandable metadata [5]. Those metadata are stored in ontologies [6] and play an essential role in semantic web, since they provide the shared conceptualizations expressed in a logical form. The semantic web vision has been combined with the principles of knowledge transformation in order to provide a theoretical model of e-learning processes [2], [7], [8], [9] thus enhancing the

Knowledge-creating company towards the vision of the Semantic Learning Organization (SLO) [10].

Most of the existing automated training aids are essentially collections of multimedia objects (content). These multimedia objects are usually grouped hierarchically (e.g. in units and sub-units), indexed and combined, through hyperlinks, in order to support various training needs. However, these training aids only provide for manipulating and restructuring multimedia objects in order to create training material, without making the underlying knowledge explicit and reusable. The proposed methodology aims to fill in this gap of knowledge externalization, diffusion and reusability.

In designing an ontology-based training aid, the main objective is to capture and represent the knowledge, which is implicit in the application domain so that it can be made reusable. Thus, domain experts record their knowledge on the particular field under consideration in terms of an ontology, which is recorded in the *ontology repository* and, hence, better communicate it and make it reusable. Therefore each ontology construct is recorded only once and can be made available to every training scenario using it. In addition, relevant supportive material (either existing or created), in the form of multimedia objects (e.g. text, image, video and animation), is used in order to develop a collection of reusable multimedia objects that are related to the knowledge domain under consideration [11], [12]. This collection of multimedia objects comprises the *content repository*. The ontology and content repositories are then used to create knowledge networks, each corresponding to a training scenario, which are recorded in the *knowledge repository*.

Contrary to traditionally designed training scenarios which are based on mere user navigation to multimedia objects, training scenarios that are based on the proposed approach are enhanced and empowered in that they allow users to navigate into the domain knowledge which has been represented in the form of a knowledge network. Thus, the user of the training scenarios is guided either through a semantic search followed by a navigation to the knowledge network, or directly through navigation to the knowledge network. To enhance his/her understanding of each ontology construct included in a knowledge network, the user can access relevant supportive material in the form of multimedia objects and identify the relation of the particular construct with other relevant constructs.

3 The Business Plan Training Tool

In order to enable trainees understand the business plan preparing process and make them capable in participating actively and successfully in such a process, a training scenario (knowledge network) incorporating the underlying logic was created using the tools developed by the CULTOS (Cultural Units of Learning - Tools and Services; http://www.cultos.org) project.

3.1 The Business Plan Outline

The first step for the development of a business plan training tool is to understand what is this document and which are its contents. A business plan is a formal document, which explains in detail the strategy for developing a financially successful business and research has shown that businesses that start with a formal business plan are considerably more likely to succeed than those that go without a written plan [13], [14].

A business plan is a road map for the development of a company and implementing the entrepreneur's ideas into actual business practices, products or services; to identify the strengths and weaknesses of a company and its competitors; to provide a strategy to further a company's growth; to develop guidelines for the operation of a company; to assist the entrepreneur to obtain money from lenders or investors. According to the literature, the body of the business plan can be divided into four distinct sections: a) the marketing plan, b) the operations plan, c) the project implementation plan, and d) the financial plan. Additional sections of the business plan should include the executive summary, supporting documents and financial projections [15], [16]. In a good business plan the following issues should be included: (a) *Business Description*, (b) *Product/Service*, (c) *Location*, (c) *Marketing plan*, (d) *Management plan* and (e) *Financial plan* [17], [18], [19], [20].

Hence, the business plan is a written document prepared by the entrepreneur that describes all the relevant external and internal elements involved in starting a new venture. It is often an integration of functional plans such as marketing, finance, manufacturing, and human resources. It also addresses both short-term and long-term decision making for the first three to five years of operation. Thus, the business plan - or, as it is sometimes referred to, the game plan or road map answers the questions: Where am I now? Where am I going? How will I get there? Potential investors, suppliers, and even customers will request or require business plan [21], [22].

3.2 The Business Plan Training Ontology-Based Knowledge Network

Figure 2 shows the ontology concepts of the business plan preparing process considered, in the form of a generalization-specialization hierarchy, linked with relations.

The upper ontology consists of the six categorizations of concepts proposed by Sowa [23]. These concepts are then further specialized into lower level sub-concepts. For example, in Figure 2, the Physical Continuant concept is specialized into the concepts *personnel* and *raw materials and factory supplies* while the *personnel* concept is specialized into the concepts *marketing personnel* and *production personnel.* Also, the Physical Occurrent concept is specialized into the concepts *technology selection* and *land site selection* etc. Moreover, relations are defined between ontology concepts of upper and lower level of resolution. Any relation defined between two concepts holds also for lower level concepts. The training scenario (knowledge network) was designed on the business plan preparing process considered where concepts are represented as rounded rectangle nodes and relations are represented as oval edges. In what follows, a description of the above process is provided using ontology concepts (shown in italics) and ontology relations (shown in single quote enclosures). Figure 3 shows the training scenario on the above business plan preparing process.

Figure 3 shows how one could prepare a business plan. For example, *project strategy and marketing concept* (one of the three opening steps of the process, together with *operational and organizational structure* and *project implementation plan*)

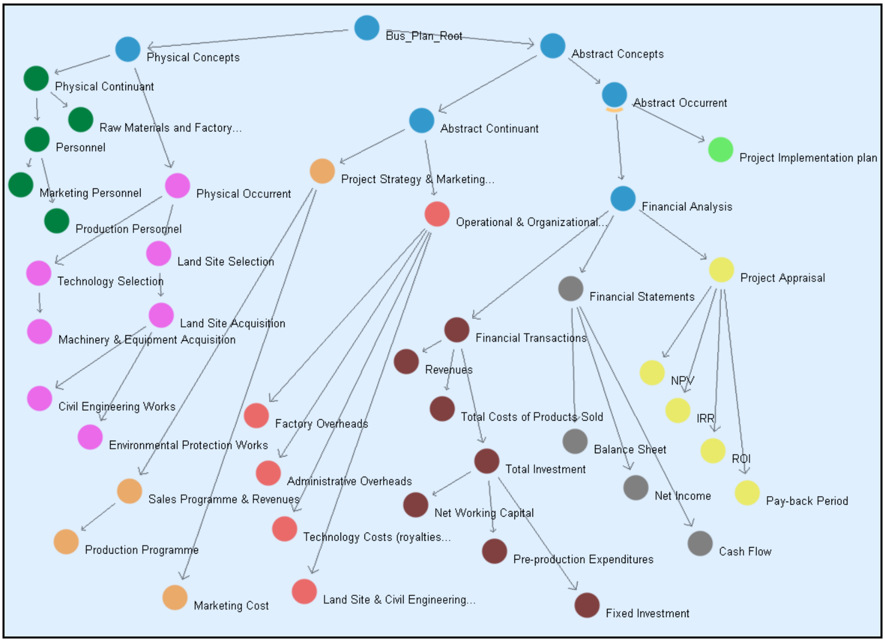


Fig. 2. A training ontology for the business plan preparation process

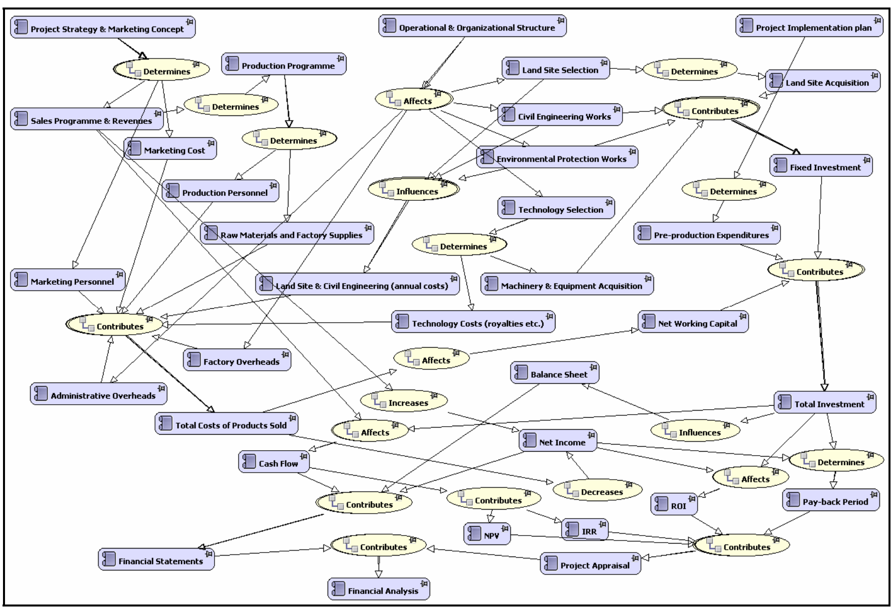


Fig. 3. The training scenario for the business plan preparation process

'determines' *sales programme and revenues*, *marketing personnel* and *marketing cost*. The latter 'contributes' (among other) to the *total cost of products sold*, which 'affects' *net working capital* and 'decreases' *net income*. The latter 'affects' *ROI* (return over investment) and 'determines' *pay back period*, which both 'contribute' to the *project appraisal*, while it 'contributes' also to the *financial statements*. Subsequently, *project appraisal* and *financial statements* 'contribute' to the *financial analysis*, which is the target of a business plan, or (in other words) the core outcome of all business plans. In practice, using the above approach for designing training material would involve both a high level view of a business plan model, such as the one described above, and a low level view of the model that takes into account the characteristics of a particular product or service. In addition, multimedia objects are associated with concepts and relations in order to demonstrate the specific features of each product or service under investigation through the business plan. Moreover, the training scenario designed can be easily used to show to the trainees, not only the meaning and the importance of functional plans such as marketing, finance, manufacturing, human resources etc, but also and mainly how they affect each other within a business development project. Likewise, in some extent, it could be easily adapted to represent other versions of the business project considered so that to enable trainees assess the pros and cons of a business redesign exercise. Redesign of a business project can be performed by simply manipulating already defined objects, hence providing flexibility, agility and reusability of the training material designed.

4 Discussion and Concluding Remarks

The approach proposed in this paper is mainly concerned with capturing and representing the knowledge found in the logic, the structure and the ways of use of business plan preparing processes as an ontology-based knowledge network, i.e. a training scenario serving a specific training need. The ontology contains all the relative concepts and the relations between them. The knowledge network relates the basic entities defined in the ontology with the various multimedia objects, which are supportive for better understanding the ontology constructs. Thus, the user of the resulting training material is enabled to search for an ontology construct (for example a business function) and understand its meaning and usage with the help of the supportive multimedia. Furthermore, the user can navigate to associated ontology constructs in order to acquire an in depth knowledge about the business project, the data and control flows between business processes and functions and, finally, the needs for preparing a high-quality and reliable business plan. More precisely, the objective of the approach presented in this paper is to enable users get familiar with and, hence, be able to participate actively in business plan preparing activities. In this context, a training scenario in this domain was built, based on a self-contained reusable knowledge repository which combines the ontology constructs (stored in the ontology repository) with supportive multimedia objects (stored in the content repository).

The proposed approach to user training may have significant impact to enabling users participate actively in the business plan preparing process since they are equipped with an appropriate tool for acquiring a clear and an in depth understanding of this process. Specifically, regarding the trainee, the main advantages of the proposed model are the following: a) Semantic search - This allows to search ontology or knowledge constructs semantically instead of textually putting emphasis on matching the content and the real meaning of each relevant concept searched [24]; b) Knowledge or conceptual navigation - This allows the use of browsing and navigation capabilities in order to identify the ontology or knowledge constructs as they are recorded into the knowledge repository and used in the training scenario and involves: (i) navigation into the knowledge domain under consideration, (ii) navigation into the business context and (iii) navigation into the structure of the educational scenario [24]; and c) Knowledge dissemination – This is an important function of any kind of training activity that can only be achieved if the trainee is provided with the ability to extract the knowledge implicit in the problem domain, as opposed to the mere presentation of facts and disconnected information which, in most cases, is not adequate. With the proposed model, knowledge is made explicit in order to assist the trainees' combination (from explicit to explicit) and internalisation (from explicit to tacit) knowledge transformation processes [2].

In addition, significant advantages of the proposed model could be identified for the creator of the training material as well. The most important of them can be grouped around its three main components (repositories): a) Ontology repository - There are many benefits when using ontologies that have already been recognized in the learning technology community [25], [26]; b) Content repository - Content reusability is a key issue in the literature [11], [12]; and c) Knowledge repository - A knowledge network is a self contained entity that serves a specific training need in a specific knowledge domain, in a specific business context and has a specific structure [24]. Reusability of knowledge recorded into training scenarios is also achieved as knowledge constructs instilled into older scenarios can be used into new scenarios in order to meet new training needs.

It must be noted, however, that the proposed model enhances and empowers existing methodologies by allowing the semantic representation of knowledge so that to enable trainees navigate into the underlying knowledge of the application domain under consideration. Thus, the model can combine the existing multimedia material with ontology constructs, using knowledge-based multimedia authoring tools, in order to build user training scenarios and satisfy specific training needs. Hence, in addition to the existing multimedia objects, the knowledge built into both the ontology and the training scenarios is fully reusable. Finally, due to the encouraging features of the approach described, it is intended to evaluate it extensively using more elaborate implementation tools and more complex business processes.

References

1. Tome, E.: IC and KM in a macroeconomic perspective: the Portuguese case. International Journal of Learning and Intellectual Capital 5(1), 7–19 (2008)
2. Nonaka, I., Takeuchi, H.: The Knowledge-Creating Company. Oxford University Press, New York (1995)
3. Bhide, A.: How entrepreneurs craft strategies that work. In: Harvard Business Review on Entrepreneurship. Harvard Business School Press, Boston (1999)
4. Lambing, P.A., Kuehl, C.R.: Entrepreneurship. Prentice Hall, New Jersey (2003)

5. Berners-Lee, T., Hendler, J., Lassila, O.: The Semantic Web. Scientific American 28–37 (May 2001)
6. Gruber, T.R.: A translation approach to portable ontology specifications. Knowledge Acquisition 5(2), 199–220 (1993)
7. Naeve, A., Yli-Luoma, P., Kravcik, M., Lytras, M., Lindegren, M., Nilsson, M., Korfiatis, N., Wild, F., Wessblad, R., Kamtsiou, V., Pappa, D., Kieslinger, B.: A conceptual modelling approach to studying the learning process with a special focus on knowledge creation, Deliverable 5.3 of the Prolearn EU/FP6 Network of Excellence, IST 507310 (June 2005)
8. Yli-Luoma, P.V.J., Naeve, A.: Towards a semantic e-learning theory by using a modelling approach. British Journal of Educational Technology 37(3), 445–459 (2006)
9. Collazos, C.A., Garcia, R.: Semantics-supported cooperative learning for enhanced awareness. International Journal of Knowledge and Learning 3(4/5), 421–436 (2007)
10. Sicilia, M.-A., Lytras, M.D.: The semantic learning organization. The Learning Organization 12(5), 402–410 (2005)
11. Chebotko, A., Deng, Y., Lu, S., Fotouhi, F., Aristar, A.: An Ontology-Based Multimedia Annotator for the Semantic Web of Language Engineering. International Journal of Semantic Web and Information Systems 1(1), 50–67 (2005)
12. Steinmetz, R., Seeberg, C.: Meta-information for Multimedia e-Learning. In: Klein, R., Six, H.-W., Wegner, L. (eds.) Computer Science in Perspective. LNCS, vol. 2598, pp. 293–303. Springer, Heidelberg (2003)
13. Tidd, J., Bessant, J., Pavitt, K.: Managing Innovation. John Willey and Sons, Chichester (1999)
14. Gate2Growth, Guide to business plan writing, G2G/European Commission (2002a)
15. Behrens, W., Hawrauk, P.M.: Manual for the preparation of industrial feasibility studies, UNIDO, Vienna (2000)
16. Hisrich, R.D., Peters, M.P., Shepherd, D.A.: Entrepreneurship. McGraw-Hill, New York (2005)
17. Sahlman, W.A.: How to write a great business plan. In: Harvard Business Review on Entrepreneurship. Harvard Business School Press, Boston (1999)
18. Eglash, J.: How to write a. com business plan. McGraw-Hill, New York (2001)
19. Gate2Growth, Preparing a technology business plan, G2G/European Commission (2002b)
20. Stutely, R.: The definitive business plan, Financial Times. Prentice Hall, Harlow (2002)
21. Siegel, E.S., Ford, B.R., Bornstein, J.M.: The Ernst & Young business plan guide. John Willey and Sons, New York (1993)
22. USDA, Cooperative feasibility studies, United States Department of Agriculture, RBS Service Report 58 (2000)
23. Sowa, J.: Knowledge Representation - Logical, Philosophical and Computational Foundations, Brooks/Cole, USA (2000)
24. Stojanovic, L., Saab, S., Studer, R.: eLearning based on the Semantic Web. In: Proceedings of the World Conference on the WWW and the Internet (WebNet 2001), Orlando, FL, USA (2001)
25. Sampson, D.G., Lytras, M.D., Wagner, G., Diaz, P.: Guest editorial: ontologies and the Semantic Web for e-learning. Educational Technology and Society 7(4), 26–28 (2004)
26. Lytras, M., Tsilira, A., Themistocleous, M.: Towards the semantic e-learning: an ontological orientated discussion of the new research agenda in e-learning. In: Proceedings of the 9th Americas Conference on Information Systems, Tampa, FL, USA, pp. 2985–2997 (2003)

Asynchronous Tele-education and Computer-Enhanced Learning Services in the Greek School Network

Michael N. Kalochristianakis[1,2], Michael Paraskevas[2], and Emmanouel Varvarigos[1,2]

[1] Research Academic Computer Technology Institute
[2] University of Patras, Dept. of Computer Engineering & Informatics, Rion, 26500, Greece
kalohr@cti.gr

Abstract. The Greek School Network (GSN) has developed and put into production a number of e-learning services, including synchronous and asynchronous tele-education, electronic class management, blogs, video-on-demand, podcasts and multimedia libraries. These new services complement established and accepted e-learning services, such as teleconferencing, user wikis, forums, email, electronic publishing, and e-magazines. This report presents the most prominent digital e-learning services offered by GSN, with emphasis on the asynchronous tele-education service, which is presented in detail. Its implementation platform, the Moodle course management system, is compared against well-known asynchronous open source tele-education platforms such as COSE, Claroline, Fle3, ILIAS, Manhattan, KEWL, Comentor, e-Class and Eledge. The evaluation of the asynchronous tele-education platforms is based on detailed comparisons of their characteristics and of the methodology they adopt in order to deliver educational services. The comparison is based on evaluation criteria derived from the documented experiences of research institutes and educational bodies and also from the experience of GSN itself. The paper concludes with the presentation of an extension to Moodle for implementing communities of practice (CoPs) that facilitate the creation and delivery of electronic educational open content for teachers in a synergetic manner.

Keywords: Asynchronous tele-education, school network, e-learning platforms, comparison.

1 Introduction

The Greek School Network (GSN) [1] is the educational intranet of the Ministry of Education (MOE) [2], interconnecting and providing basic and advanced telematic services to all schools in Greece and [1]. The implementation of GSN is funded by the Operational Programme for the Information Society [3] in a close cooperation schema between MOE and 12 Research Centers and Highest Education Institutes [1], specialized in internet technologies and education. The GSN project was initiated to address the primary and secondary education institutions' requirements for innovative educational methods, access to digital content and collaboration between geographically distributed users' groups. GSN spans across all 51 Greek prefectures, and is the

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 234–242, 2008.

second largest nationwide network. Currently GSN connects almost all first and secondary education units, serving more than 67.000 teachers. GSN has received international best practice awards [4] in 2004 and 2003. Among other strategic goals, GSN aims to grow in the direction of broadband technologies and interactive web-based telematic services based on open technologies [5]. The strategic priorities set are based on international best practice, the current national telecom environment and the MOE's directions in terms of equipment, services and growth goals.

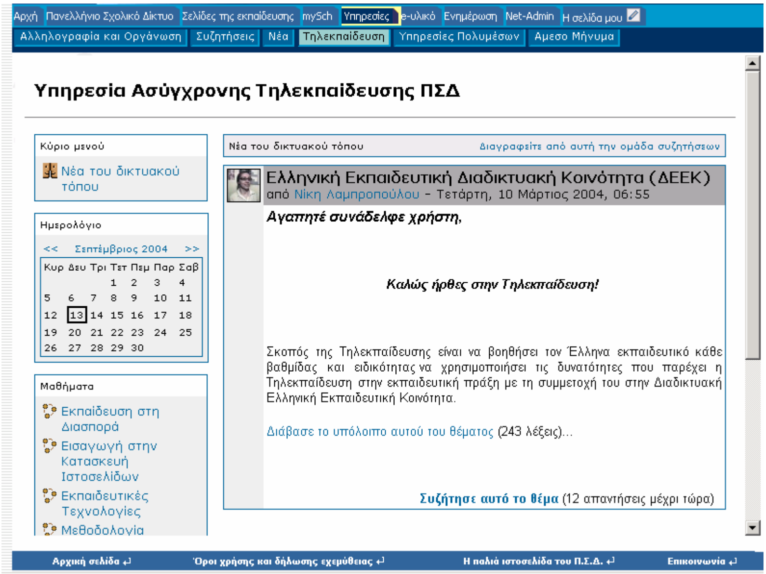
2 The e-Learning Service

The e-learning service, or asynchronous tele-education [6], is offered through the GSN portal [1] and is currently a production service, following a successful pilot operation. The service is based on the Moodle [7] open source learning management system (LMS) for course management in order to implement role-based, spatially and temporally independent educational procedures.

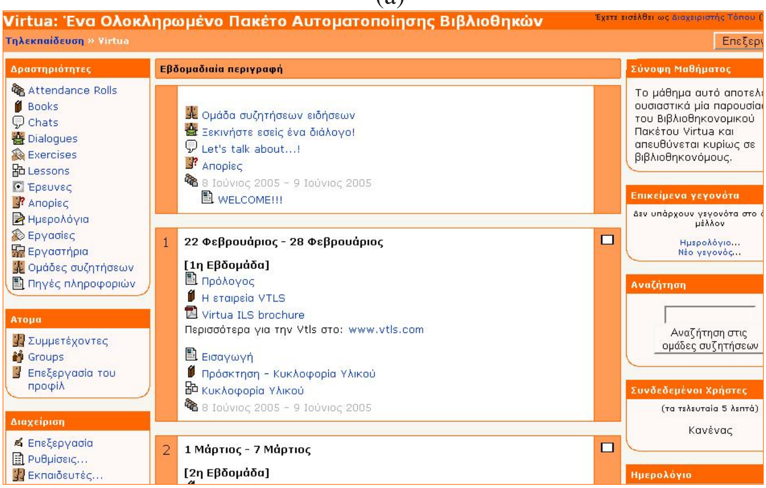
The e-learning service was built in order to aid the introduction of modern educational methods to the national educational system. Moodle is based on social constructionism pedagogy [8] that supports the position that knowledge is actively constructed by students and that knowledge acquisition is an adaptive process involving interaction with and feedback from the experienced world. Moodle is suitable for many educational methods such as self-paced, group and social learning and it does not necessitate a constructivist teaching approach. It is currently one of the most successful course management systems (CMS) and there are numerous reports of successful installations in production systems [9] [10]. It has been the subject of thorough evaluation [11] [12] and comparisons [13], and has received considerable attention from the open source community since it is increasingly being used, extended, and included in integration initiatives [7].

GSN exposes the e-learning service through the GSN portal and the GSN students portal [14]. Users can thus use the service in the same way they use other GSN services, via the web interface. The service was initially introduced to schools, teachers and students in pilot operation so that users familiarize themselves with it. The result of the pilot operation has been a mature, established deployment that covers the production requirements for the service.

GSN e-learning currently involves 84 courses organized under 9 course categories, including the e-learning familiarization category that contains 4 courses, the information technology category that contains 22 courses, the GSN services category that contains 8 courses, the education category that contains 13 courses, and the new courses category that currently contains 21 courses. In addition to the latter, administrative categories serve the purposes of administrative course management practice. According to statistics provided by the service platform at the time the present text was written, the most participatory course during the last 2 months was the 2nd grade course titled: "Application development in a programming environment" [15]. The course has received 34 messages until now and has been accessed 22 times, giving a participation ratio of 1.55. During the same period the most active user had an activity index of 1841, while the five most active users averaged 621. Table 1 summarizes statistics about the e-learning pilot service. The interface of the service is presented in figure 1.



(a)



(b)

Fig. 1. The e-Learning service as offered via (a) the GSN portal and (b) the GSN students portal

The e-learning service has been created by integrating Moodle with the platforms used for GSN services. Moodle has been integrated with the GSN directory service and has been customized so as to receive configuration parameters that are stored in the directory profiles of users. The directory server is highly available, supporting all GSN users on a 24x7 basis. Since it is optimized for read access, it was chosen to store the GSN user profiles for the e-learning service. Whenever users log in the

Table 1. E-learning statistics

Category	Sub Category	Service
General	Course categories	9
	Number of courses	84
	Number of users	5.365
	Number of teachers	100
	Users registered in courses	2.750
Information sources	Web pages and catalogs	801
	Books	45
Activities	Forums	185
	Messages	1.365
	Chats	34
	Quiz's	51
	Users that sat in for the quiz	160
	Total quiz requests	473
	Assignments	89
	Submitted assignments	153
	Lessons	24
	Glossaries	27
	Glossaries entries	207
	Wikis	14
	Wiki pages	76

e-learning service, their personal settings are read from the directory server and are directed to the e-learning tool. Thus, the service is personalized and users adapt it to their needs or preferences by changing their GSN profile settings through a web application built for this purpose. The e-learning service supports a bilingual, Greek and English, interface.

The GSN e-learning platform supports various user types, such as administrators, lesson creators / teachers, students and guests. Administrators are responsible for the management and the operation of the services. They fine tune global settings such as default profiles, languages and themes, they set up user accounts and assign permissions and roles using the Moodle platform roles and permissions system. Lesson creators and teachers can create courses, manage course material and manage the ways material is presented to students. The latter are the prime participants in courses and can be involved in all types of course activities, including material acquisition, communication via forums, quizzes, exams, etc.

The GSN services development team actively participates in the open source Moodle community [7]. GSN has developed new tools and features, and has contributed code that complements existent course management functionality. GSN has contributed to the calendar, educational profiles, course wizard, wonders and quizzes modules. All the modules have been made available to the Moodle project. Most of them have been contributed since version 1.3 of the platform. All modules are accompanied with documentation and manuals in English and Greek. The calendar module allows the programming and the viewing of events, providing the ability to filter special events for every user, course, or group of students. The activity module can automatically create such events for teachers or students. The course wizard is a tool that creates new courses or alters parameters of existing courses. Teachers can use the course wizard or the mainstream course creation procedure of the platform that provides a detailed but also more cumbersome way to construct and manage courses. The Wonders module is a course activity module that allows a dialog question-answer process among teachers and students. The information exchanged is injected in the platform's knowledge base allowing the automatic response to questions, if they are similar to past ones, without any participation from the teacher. The quiz module allows the categorization of questions based on their level of difficulty and their presentation, allowing teachers to manage quizzes according to class needs and capabilities. The quiz module is available to the community of Moodle developers. The educational profile module manages information about students who are registered in lessons. GSN has contributed to the development of the module and has introduced additional information concerning student performance, participation and activity. In addition to the above modules, GSN has contributed to the development of the student activity, document management, personal messages, and email sending modules.

3 The e-Learning Platforms Comparison

There is an abundance of proprietary and open source platforms for asynchronous tele-education. The majority of the most successful systems are LMS web-based systems. This section compares the free open source systems (FOSS) for e-learning that were considered for the implementation of the GSN asynchronous tele-education service based on the richness of features they provide and the use cases they support. The comparison was based on work [16] conducted by the University of Macedonia, one GSN consortium members. The study focused on the following systems: COSE 2.0 [17], Claroline 1.3.1 [18], FLE 3 [19], ILIAS 2.3 [20], Manhattan 2.0.1 [21], KEWL, 1.1 [22] CoMentor 1.0 [23], Moodle 1.0 [7], e-Class 1.2 [24] and Eledge 1.8 [25].

3.1 Methodology

The comparison of the e-learning systems was based on evaluations conducted by organizations and tele-education evaluation bodies and on relevant literature. The comparison took into account sources such as reports, evaluations and publications from the Western Cooperative for Educational Telecommunications (WCET) [26], the Centre for Curriculum Transfer and Design (C2T2) [27], the EduTools [28] and EduTech [29] projects, the Joint Information Systems Committee [30], and the Centre for the Application of Information Technologies [31]. These sources contain references to a significant volume of criteria and corresponding material for the detailed description and evaluation for tele-education systems. For the purposes of the current study, a limited amount of comparison criteria has been selected. The criteria were chosen to be adequate for the description of systems that are capable to support the basic principles of the educational procedure, to reproduce the class environment, to be installed in school environments and to be easily usable by all school users.

The evaluation criteria were categorized in terms of technical specifications, teacher convenience tools and features, student convenience tools and features, communication tools, system administration/management features, and other criteria. Criteria that fall in the technical specifications category attempt to evaluate the infrastructure configurations required to setup and operate the LMS. The prime interest is the compatibility with the mostly used server platforms and the exposed interface. Criteria that fall in the teacher convenience category evaluate the quantity and the quality of tools provided by the LMS to enable teachers design, manage and conduct courses efficiently and effectively. Student convenience criteria evaluate the services offered to students within the context of courses. This category of criteria aims to be descriptive of the student-initialed interaction, active involvement, organization and self-assessment. The communication criteria category groups together the LMS evaluation criteria that characterize the communication among teachers and students, such as synchronous communication, messaging and all the tools and features that contribute to the educational practice. The administration/management criteria group evaluates the LMS against administration complexity and security factors. Evaluation criteria that do not fall into any of the above categories are included in the category "other".

3.2 Results

All the systems compared are web based LMS and, with the exception of KEWL, which is specifically designed for windows server platforms, they support all types of operating systems, including windows and Unix/Linux. The Claroline, KEWL, e-Class, ILIAS, Moodle, Eledge platforms require database backends. All the complementary requirements can be covered by open-source packages.

None of the evaluated platform requires teacher users to be specialized in the use of IT or computers in order to operate them, with the exception of Elegde that requires knowledge of the html language. All the platforms come with detailed user guides and course design is supported in all platforms. Teachers are generally autonomous in managing content, except for the case of Comentor, where teachers need to engage administrators even for operations on courses they teach. Synergetic teaching, the support of teacher assistants, is supported by all systems except Moodle, KEWL and Eledge. Student groups and subgroups are supported by all systems but Eledge, which scores the lowest in teacher convenience tools and features. The COSE and ILIAS are the only platforms that support subgroup types with respect to the type of users that are grouped and the aim of the group. Content sending to groups is also supported by all systems but Moodle and Eledge. Except for the cases of Comentor and Fle, multiple choice tests are supported. All platforms but Comentor, Fle3 ad Manhattan support tests and automated grading; however, only half of them support automatic grading book as a means for student performance monitoring (Moodle, ILIAS, KEWL, Claroline, Eledge). Only Moodle, Cose and KEWL allow teachers to send personalized instructions to a single student. KEWL, eClass and Elegde are the only systems that do not support a participation monitoring functionality.

As far as student tools are concerned, none of the e-learning platforms maintains a database populated with student questions. Personal student folders are supported by ILIAS, KEWL, COSE, Fle and Elegde. COSE provides a full set of personal folder management. On the contrary COSE, Claronline, Manhattan and e-Class do not support student personal web pages. KEWL, COSE, ILIAS and Fle also support a full organization suite for course organization that includes thesaurus, agenda, content search, user search, notepad, bookmarks. Along with Comentor they support the creation of groups of students without teacher interference and the detailed monitoring of user actions. Student profile is kept and managed by all systems but Cose, Claroline, Manhattan and eClass. Claroline, Manhattan and eClass also do not support personal notes, a feature supported by the rest of the tools. Only ILIAS supports printing services, and along with Comentor and Manhattan anonymous users. ILIAS, Cose and Eledge are the only platforms that support performance monitor and ILIAS, Manhattan are the only that offer reminder services. All systems but Comentor, Fle3 and eClass offer students web access to grades and all but Comentor, Fle3 and Claroline offer self-assessment functionality.

All systems include communication tools for information exchange between users. However, ILIAS, KEWL, COSE, Comentor and Manhattan embody autonomous e-mail engines, while the rest of the systems use standard external solutions for e-mail. All of them support file sharing and disussion. Forums are also supported by all but ILIAS, Fle3, Claroline, eClass and Elegde. Moodle, KEWL, COSE, Comentor and Manhattan support chat, while KEWL and Comentor supports whiteboard. All systems but Fle3, Manhattan and Eledge support announcements. Messaging is supported by ILIAS, KEWL, COSW and Comentor.

Manhattan is the system that offers the richest administrative options. It supports login notifications and a full-featured user and system monitoring system that can even be used for helpdesk application. Similar features are provided by Moodle, ILIAS, COSE, Fle3 and e-Class. All systems offer complete permissions systems and at least basic authentication. All but ILIAS, Comentor, Elegde offer security at the level of content. All but Moodle, eClass and Elegde offer content management system functionality. Six of the platforms, namely Moodle, ILIAS, KEWl, Fle3, Claroline and Manhattan, are multilingual. None of the systems offers a remote management functionality.

All systems, except for Eledge and Comentor, support multimedia content and applications. All systems, except for Elegde, provide satisfactory internationalization documentation as well as user manuals, tutorials and demos. Multilingual interface is supported by Moodle, ILIAS, KEWL, Fle3 and Claroline. ILIAS, KEWL and COSE provide useful tools for working offline. ILIAS and COSE allow standardized content metadata editing. KEWL and COSE also support the lesson cd-roms.

4 Conclusions and Future Work

We presented the GSN e-learning service and provided a comparison of various LMS systems that were considered for the implementation of the corresponding platform. Selecting an LMS requires the consideration of specific criteria according to needs. GSN has employed Moodle to build the national school network asynchronous tele-education service, even if it did not rank first in the evaluation. Moodle is modular and was easily customized in the case of GSN e-learning. It is also supported by a very dynamic community in which GSN is an active contributor [5]. In the future, GSN plans to extend Moodle to support communities of practice (CoP) [32] [33] for secondary education teachers. The prospective features include metadata indexing, third party content and content feedback. The indexing module and interfaces will be used for inserting and retrieving useful metadata of the CoP content. Metadata will be indexed in a database so that users enjoy optimized search functionality. The content feedback module will allow peer teachers and learners to provide feedback on the content itself and share experience obtained in class or through their individual interaction with the content.

References

1. Greek School Network (May 2008), http://www.sch.gr/en
2. Ministry Of Education and Religious Affairs (May 2008), http://www.ypepth.gr
3. Information Society, managing authority and operational program (May 2008), http://www.infosoc.gr
4. http://www.sch.gr/sch-portlets/aboutSch/honors/GSNBest_Practice_2004.pdf (May 2008)
5. Kalochristianakis, M., Paraskevas, M., Varvarigos, E., Xypolitos, N.: The Greek School Network: A Paradigm of Successful Educational Services Based on the Dynamics of Open-Source Technology. IEEE Transactions on Education 50(4), 321–330 (2007)
6. GSN asynchronous tele-education service (May 2008), http://www.sch.gr/e-learning
7. Moodle (May 2008), http://www.moodle.org
8. Berger, P., Luckmann, T.: The Social Construction of Reality: A Treatise in the Sociology of Knowledge, Anchor (1967) ISBN 0-385-05898-5
9. Suchanska, K.: Some aspects of employing the moodle platform as a tool for enchancing the teaching and learning process. In: EUROCON 2007, Proceedings International Conference on Computer as a Tool, pp. 2465–2467 (September 2007)
10. Brine, J., Wilson, I., Debopriyo, R.: Using Moodle and Other Software Tools in EFL Courses in a Japanese IT University. In: Proceedings 7th IEEE International Conference on Computer and Information Technology, pp. 1059–1064 (2007)
11. Buendia, F., Hervas, A.: An Evaluation Framework for e-Learning Platforms Based on Educational Standard Specifications. In: Proceedings Sixth International Conference on Advanced Learning Technologies, pp. 184–186 (July 2006)
12. Graf, S., List, B.: An Evaluation of Open Source E-Learning Platforms Stressing Adaptation Issues. In: Proceedings Fifth IEEE International Conference on Advanced Learning Technologies, pp. 163–165. IEEE Computer Society, Los Alamitos (2005)
13. Machado, M., Tao, E.: Blackboard vs. moodle: Comparing user experience of learning management systems. In: 37th annual Frontiers in education conference - global engineering: knowledge without borders, opportunities without passports (FIE 2007), pp. S4J-7–S4J-12 (October 2007)
14. The Greek School Network Students Portal (May 2008), http://students.sch.gr/
15. Pedagogic institute (May 2008), http://www.pi-schools.gr/
16. Bagianos, G., Grigogropoulos, E., Tsinakos, A.: Asynchronous teleeducation platforms (May 2008), http://www.it.uom.gr/projects/cms/files/VLE_review.pdf
17. Creation Of Study Environments, Staffordshire University, http://www.staffs.ac.uk/COSE/

18. Claroline Open Source Management System, University of Louvain (UCL), http://www.claroline.net/
19. Future Learning Environment, University of Art and Design - Center for Research on Networked Learning and Knowledge Building, University of Helsinki, http://fle3.uiah.fi
20. ILIAS open-source, University of Cologne, http://www.ilias.uni-koeln.de/ios/index-e.html
21. Manhattan Virtual Classroom, Western New England College, http://manhattan.sourceforge.net
22. Knowledge Environment for Web-based Learning, University of the Western Cape, Cape Town, http://kewl.uwc.ac.za
23. Comentor Leaning Environment, School of Human and Health Sciences, University of Huddersfield, http://comentor.hud.ac.uk/
24. ECLASS 2003, Gunet Asynchronous Class Management platform, National & Kapodistrian University of Athens (2003), http://eclass.gunet.gr/
25. Eledge Open Learning Management System, University of Utah, http://eledge.sourceforge.net/
26. Western Cooperative for Educational Telecommunications (May 2008), http://www.wcet.info/2.0/
27. Centre for Curriculum Transfer and Design (May 2008), http://www.aved.gov.bc.ca/c2t2/
28. EduTools project (May 2008), http://www.edutools.info/index.jsp
29. EduTech project, Higher Education and New Technologies (May 2008), http://www.edutech.ch
30. Joint Information Systems Committee (May 2008), http://www.jisc.ac.uk/
31. Centre for the Application of Information Technologies (May 2008), http://www.cait.wustl.edu/
32. Wenger, E., Snyder, W.: Communities of Practice: The Organizational Frontier. Harvard Business Review (January-February 2000)
33. Adams, R., Allendoerfer, C., Bell, P., Fleming, L., Leifer, L.: Special session - communities in practice in engineering education: what are we learning? In: Proceedings 35th Annual Conference Frontiers in Education 2005, FIE 2005, October 19-22, pp. T2A- 1-2 (2005) ISBN: 0-7803-9077-6

Particle Swarms for Competency-Based Curriculum Sequencing

Luis de-Marcos, José-Javier Martínez, and José-Antonio Gutiérrez

Computer Science Department. University of Alcalá
Ctra. Barcelona km 33.6. Alcalá de Henares, Spain
{luis.demarcos,josej.martinez,jantonio.gutierrez}@uah.es

Abstract. In e-learning initiatives content creators are usually required to arrange a set of learning resources in order to present them in a comprehensive way to the learner. Course materials are usually divided into reusable chunks called Learning Objects (LOs) and the ordered set of LOs is called sequence, so the process is called LO sequencing. In this paper an intelligent agent that performs the LO sequencing process is presented. Metadata and competencies are used to define relations between LOs so that the sequencing problem can be characterized as a Constraint Satisfaction Problem (CSP) and artificial intelligent techniques can be used to solve it. A Particle Swarm Optimization (PSO) agent is proposed, built, tuned and tested. Results show that the agent succeeds in solving the problem and that it handles reasonably combinatorial explosion inherent to this kind of problems.

Keywords: e-Learning, Learning Object Sequencing, Swarm Intelligence, Particle Swarm Optimization (PSO).

1 Introduction

Brusilovsky [1] envisages Web-based adaptive courses and systems as being able to achieve some important features including the ability to substitute teachers and other students support, and the ability to adapt (and so be used in) to different environments by different users (learners). These systems may use a wide variety of techniques and methods. Among them, curriculum sequencing technology "is to provide the students with the most suitable individually planned sequence of knowledge units to learn and sequence the learning tasks … to work with". These methods derive from adaptive hypermedia field [2] and rely on complex conceptual models, usually driven by sequencing rules [3, 4]. E-learning traditional approaches and paradigms, that promote reusability and interoperability, are generally ignored, thus resulting in (adaptive) proprietary systems (such as AHA! [5]) and non-portable courseware.

In this paper an innovative sequencing technique is proposed. E-learning standards and learning object paradigm are used in order to promote and ensure interoperability. Learning units' sequences are defined in terms of competencies in such a way that sequencing problem can be modeled like a classical Constraint Satisfaction Problem (CSP). And Particle Swarm Optimization (PSO) is used to find a suitable sequence

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 243–252, 2008.

within the solution space respecting all constraints. In section 2, the problem model for competency-based learning object sequencing is presented. Section 3 describes the particle swarm optimization approach for solving the problem. Current literature is surveyed and several enhancements over the original algorithm are proposed. Section 4 presents the results obtained from implementing and testing the intelligent algorithm in a real world situation (course sequencing in an online Master in Engineering program). And finally Section 5 depicts conclusions and future research lines.

2 Learning Objects and Sequencing

Within e-learning, the learning object paradigm drives almost all commercial initiatives. This paradigm encourages the creation of small reusable learning units called Learning Objects (LOs). These LOs are then assembled and/or aggregated in order to create greater units of instruction (lessons, courses, etc) [6].

LOs must be arranged in a suitable sequence previously to its delivery to learners. Currently, sequencing is performed by instructors who do not create a personalized sequence for each learner, but instead create generic courses, targeting generic learner profiles. These sequences are then coded using a standard specification to ensure interoperability. Most commonly used specification is SCORM [7]. Courseware that conforms SCORM´s Content Aggregation Model is virtually portable between a wide variety of Learning Management Systems (LMSs). Though, SCORM usage hinders the automatic LO sequencing due to its system-centered vision. Other metadata-driven approaches offer better possibilities. Just LO metadata will enable automatic sequencing process to be performed. And the appropriate combination of metadata and competencies will enable adaptive and automatic content sequencing.

2.1 Competencies for Interoperable Learning Object Sequencing

Competencies can be formally described as “multidimensional, comprised of knowledge, skills and psychological factors that are brought together in complex behavioral responses to environmental cues” [8]. Some e-learning trends are trying to standardize competency definitions so that they could be interchanged and processed by machines. It is worth quoting the following efforts: (1) IMS "Reusable Definition of Competency or Educational Objective” (RDCEO) specification [9]. (2) IEEE Learning Technology Standards Committee (LTSC) “Standard for Learning Technology - Data Model for Reusable Competency Definitions" specification (currently an approved standard, pending publishing) [10]. (3) HR-XML Consortium "Competencies (Measurable Characteristics) Recommendation" [11]. And, CEN/ISSS “A European Model for Learner Competencies” workshop agreement [12].

According to RDCEO and IEEE nomenclature, a competency record is called ‘Reusable Competency Definition’ (RCD). RCDs can be attached to LOs in order to define their prerequisites and their learning outcomes. We have used this approach to model LO sequences. By defining a competency (or a set of competencies) as a LO outcome, and by defining the same competency as the prerequisite for another LO (fig 1), a constraint between the two LOs is established so that the first one must precede the second LO in a valid sequence. Metadata (MD) definitions are attached to LOs, and within those definitions references to competencies (prerequisites and learning outcomes) are included. LOM [13] records have been used for specifying LO meta-data. LOM element 9, 'Classification', is used to include competency references as recommended in [14, 15]. So, LOM element 9.1, 'Purpose', is set to 'prerequisite' or 'educational objective' from among the permitted vocabulary for this element; and LOM element 9.2 'Taxon Path', including its sub-elements, is used to reference the competency (note that more than one Classification element can be included in one single LO in order to specify more than one prerequisite and/or learning outcome).

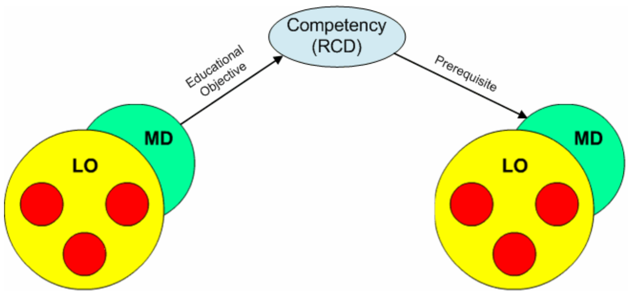


Fig. 1. LO sequencing through competencies

3 Competency-Based Intelligent Sequencing

Given a random LOs' sequence modeled as described above, the question of finding a correct sequence can be envisaged as a classical Constraint Satisfaction Problem (CSP). In this manner, the solution space comprises all possible sequences ($n!$ will be its size, total number of states, for n LOs), and a (feasible) solution is a sequence that satisfies all established constraints. LO permutations inside the sequence are the operations that define transitions between states. So we face a permutation problem, which is a special kind of CSP.

3.1 Mathematical Characterization

According to [16] a CSP is triple (X,D,C) where $X=\{x_0,x_1,\ldots,x_{(n-1)}\}$ is a finite set of variables, D is a function that maps each variable to its corresponding domain $D(X)$, and $C_{ij} \subset D_i \times D_j$ is a set of constraints for each pair of values (i, j) with $0 \leq i < j < n$. To solve the CSP is to assign all variables x_i in X a value from its domain D, in such a way that all constraints are satisfied. A constraint is satisfied when $(x_i,x_j) \in C_{(i,j)}$, and then (x_i, x_j) it is said to be a valid assignment. If $(x_i, x_j) \notin C_{(i,j)}$ then the assignment (x_i, x_j) violates the constraint.

If all solutions from a CSP are permutations of a given tuple then it is said that the problem is a permutation CSP or PermutCSP. A PermutCSP is defined by a quadruple (X,D,C,P) where (X,D,C) is a CSP and $P=<v_0, v_1, \ldots, v_{n-1}>$ is a tuple of $|X|=n$ values. A solution S of a PermutCSP must be a solution of (X,D,C) and a complete permutation of P.

The learning object sequencing problem could be modeled as a PermutCSP. For example, considering five learning objects titled 1,2,3,4 and 5, the PermutCSP which only solution is the set *S={1,2,3,4,5}* (all learning objects must be ordered) can be defined as:

$X = \{x_1,x_2,x_3,x_4,x_5\}$
$D(X_i) = \{1,2,3,4,5\} \quad \forall x_i \in X$
$C = \{ x_{(i+1)}\text{-}x_i>0 : x_i \in X, i \in \{1,2,3,4\} \}$
$P = <1,2,3,4,5>$

3.2 Particle Swarm Optimization for Learning Object Sequencing

Particle Swarm Optimization (PSO) is an evolutionary computing optimization algorithm. PSO mimics the behavior of social insects like bees. A random initialized particles' population (states) flies through the solution space sharing the information they gather. Particles use this information to dynamically adjust their velocity and cooperate towards finding a solution. Best solution found: (1) by a particle is called *pbest*, (2) within a set of neighbor particles is called *nbest*, (3) and within the whole swarm is called *gbest*. PSO have been used to solve a wide variety of problems [17].

Original PSO [18, 19] is intended to work on continuous spaces. A discrete binary version was presented in [20]. This version uses the concept of velocity as a probability of changing a bit state from zero to one or vice versa. A version that deals with permutation problems was introduced in [21]. In this latter version, velocity is computed for each element in the sequence, and this velocity is also used as a probability of changing the element, but in this case, the element is swapped establishing its value to the value in the same position in *nbest*. The mutation concept was also introduced in the permutPSO version; after updating each particle´s velocity, if the current particle is equal to *nbest* then two randomly selected positions from the particle sequence are swapped. In [21] is demonstrated that permutation PSO outperforms genetic algorithms for the N-Queens problem. So we decided to try PSO, before any other technique, for LO sequencing problem. Discrete full-informed version [22] of the PSO was implemented in order to test its performance for solving the LO sequencing problem. But several other issues concerning design and implementation of the PSO were decided. In the rest of this section each of these issues is discussed and the selection criteria are explained.

Fitness Function. It is critical to choose a function that accurately represents the goodness of a solution [23]. A standard penalty function is a common choice for CSPs. We propose the following formula:

$$\text{fitness}(s) = \sum_{i=0}^{n} s[i].pr_n \tag{1}$$

where *s* is the LO sequence, *n* is the number of LOs in *s*, *s[i]* is the i-th LO in the sequence, and pr_n is the number of prerequisites in a LO not delivered by their predecessors in the sequence. pr_n is computed using a function that recursively process all outcomes delivered by previous LOs in the sequence, checking for each prerequisite accomplishment.

The fitness value of a feasible solution should be zero, so PSO tries to minimize this function. When a solution fitness function call returns 0, the operation of the algorithm is stopped returning the current state (solution).

PSO Parameters. One important advantage of PSO is that it uses a relative small number of parameters compared with other techniques like genetic algorithms. However, much literature on PSO parameter subject has been written. Among it, Hu et. al. [21] established the set of parameters so that PSO works properly for solving permutation problems. We decided to take their recommendations, and parameters were set as follows: Learning rates (*c1*, *c2*) are set to 1.49445 and the inertial weight (w) is computed according to the following equation:

$$w = 0.5 + (\mathrm{rnd}() / 2) \tag{2}$$

Population size was set to 20 particles and the fully informed version of PSO was used. The number of iterations was also defined as an input parameter. It was used as a measurement of the number of calls to the fitness function that were allowed to find a solution. It should be noted that some problems may not have a solution, so number of iterations setting can avoid infinite computing

Proposed improvements. During the initial agent development we found that in some situations the algorithm got stuck in a local minimum, and it was not able to find a feasible solution. For that reason, two enhancements were envisaged in order to improve algorithm performance for LO sequencing. First improvement is to change *pbest* and *gbest* values when an equal or best fitness value is found by a particle. In other words all particle`s comparisons concerning *pbest* and *gbest* against the actual state were set to less or equal (<=). Original algorithm determines that *pbest* and *gbest* only change if a better state is found (comparisons <). Second improvement is to randomly decide whether the permutation of a particle's position was performed from *gbest* or from *pbest* (p=0.5). In the original version all permutations are done regarding *gbest*. These changes resemble to be quite logical ways for increasing particles' mobility and for avoiding quick convergence to local minimums.

Finally, when the implementation was finished and test suites were being launched a deeper knowledge of the solution space was acquired by the authors and an additional improvement was introduced due to the following fact: It could be observed that in huge solution spaces some velocity values tend to grow indefinably and fast in one direction. So that these 'great' values reduce the probability assigned to other values from moving towards *gbest* when normalized velocity is computed. This problem was avoided introducing a special function that limits the velocity of each value to a maximum value. It seems evident that this value must not be a fixed parameter and that it must depend on the number of learning objects that comprise the sequence. Initially, it was decided to set the velocity limit equal to the number of LOs in the sequence. Therefore, each velocity value of the normalized velocity vector (V_{norm}) is not allowed to grow beyond a maximum value equal to the number of learning objects in the sequence. This improvement also intends to introduce a massive movement towards *gbest* when the number of iterations increase and all the velocity values reach that limit, so that the region close to *gbest* is explored. It should be noted that mutation ensures that these particles are close to but not equal to *gbest* in order to not lose computational resources exploring the same solution repeatedly.

The following code presents the final algorithm code with all these improvements.

```
initialize the population
do {
  for each particle {
    calculate fitness value
    if (new fitness <= gBest)
      set gbest = currentValue
    if (new fitness <= pBest)
      set pbest = currentValue
    Calculate new velocity as
      Vnew = w × Vold+ (c1×rnd()×(pbest-currentValue))
                     + (c2×rnd()×(gbest-currentValue))
    Normalize Velocity as
      Vnorm = Vnew/max(Vnew)
    Check Vnorm limit
      for each v[i] in  Vnorm {
        if(v[i] > length(X))
          v[i] = length(X)
      }
    Update particle value
      for each v[i] in Vnorm {
          if(rand() < 0.5)
            swap currentValue[i] for
              currentValue[indexOf(pBest, currentValue[i]
          else
            swap currentValue[i] for
              currentValue[indexOf(gBest, currentValue[i]
      }
    Check Mutation
      if (currentValue = gBest) swap two
        random positions from currentValue
  }
} until termination criterion is met
```

where *currentValue* is a vector of *n* learning objects representing the current position of the particle (state or solution being computed), and, V_{new}, V_{old} and V_{norm} are vectors of *n* positions representing different velocities required by the algorithm.

4 Results

The PSO algorithm for LOs sequencing described above was implemented using Microsoft Visual Studio C#. We wanted to test its performance in a real scenario so a problem concerning course sequencing for a Master in Engineering (M.Eng.) program in our institution was chosen for testing. The (web engineering) M.Eng, program comprises 23 courses (subjects) grouped in:

- Basic courses (7). All of them must be completed before taking any other kind of course. There may be restrictions between two basic courses, for example 'HTML' course must precede 'Javascript' course,
- 'Itinerary' courses (5) that must be taken in a fixed ordered sequence.
- Compulsory courses (5). There may be restrictions between two compulsory courses.
- Elective courses (6). Additional constraints regarding any other course may be set.

All courses have a (expected) learning time that range from 30 to 50 hours. They are delivered online using a LMS [24] and they have their metadata records. Competency records were created to specify LOs' restrictions, and LOs' metadata records were updated to reflect prerequisite and learning outcome competencies as detailed in section 2. A feasible sequence must have 23 LOs satisfying all constraints. The graph showing all LOs and constraints is very complex, and so it is to calculate the exact number of feasible solutions. Just estimations have been used. We have estimated that the relation between feasible solutions and total solutions order is $8{,}9\text{x}10^{12}$. This number reflects the number of states (non-feasible solutions) for each feasible solution.

Once the problem was established, PSO agent parameters were set to test four different configurations that reflect all possibilities concerning the first two proposed improvements introduced in Section 3. These configurations are:

- Configuration 1. Comparisons for changing particle *pbest* and *gbest* values are set to strictly less (<). Permutation of the particle position is performed regarding *gbest*. These are the original settings.
- Configuration 2. Comparisons set to less or equal (<=). All permutations are performed from *gbest*.
- Configuration 3. Comparison set to strictly less (<). Permutation of the particle position is randomly selected from *gbest* or from *pbest*.
- Configuration 4. . Comparison set to less o equal (<=). Permutation of the particle position is randomly selected from *gbest* or from *pbest*.

Figure 2 shows the results for the four configurations. Each configuration was run 100 times and the results represent the mean fitness value evolution. From the results, it can be seen that all configurations converge to a feasible solution, but configuration 1 (original settings) outperform all others. Configurations 1 and 2 show similar performance but configuration 1 reaches before any other a 100% success ratio in 100 runs.

All these tests were run checking the normalized velocity limit (third proposed improvement in Section 3.2). In order to test the real performance of this improvement, the four configuration sets where run without performing the velocity check. Table 1 compares the results obtained in both cases by showing the mean values required for 100 runs to reach a solution. As it can be shown velocity check dramatically improves performance and original settings (concerning the other two improvements) also displays better performance for both cases.

The tested scenario may seem to have many feasible solutions that would make doubtful PSO performance in more 'challenging' scenarios, so PSO agent was tested in 'more difficult' situations. Test sequences of 5, 10, 20, 30, 40, 50, 60, 75 and 100 LOs with only one feasible solution were designed. Each test suite was run 100 times with and without the velocity check and mean values were computed. Figure 3 shows the results and it supports the argument that velocity control improves agent performance as the solution space size grows. It could also be inferred that the proposed PSO agent handles reasonably combinatorial explosion for this particular problem. It should be noted that while the number of learning objects grows linearly the size of the solution space grows exponentially.

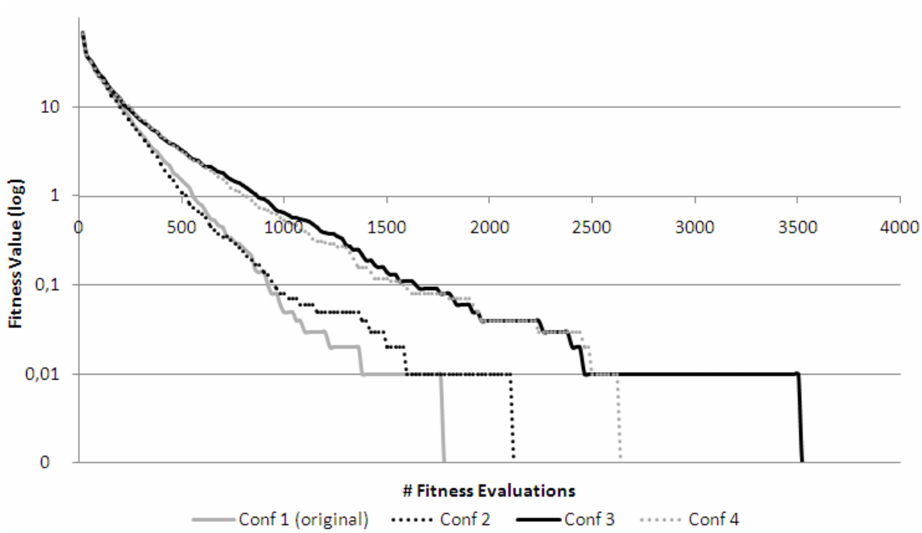


Fig. 2. PSO Configurations performance comparison

Table 1. Mean number of fitness evaluations for each configuration with and without normalized velocity check

Configuration	μ Fitness Evaluations without Velocity Check	μ Fitness Evaluations with Velocity Check
Conf 1. comp <, permut gbest (original)	1158	641
Conf 2. comp <=, permut gbest	1237	645
Conf 3. comp <, permut gbest/pbest	1817	1008
Conf 4. comp <=, permut gbest/pbest	1412	975

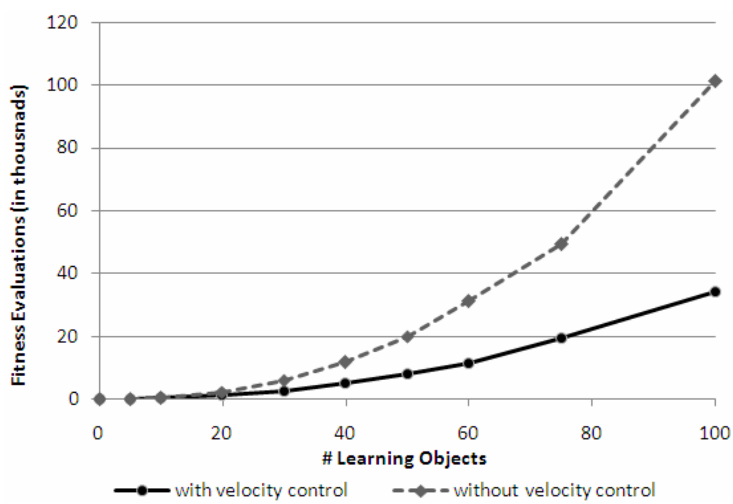


Fig. 3. Number of fitness evaluations required for different number of LOs

5 Conclusions and Future Work

The purpose of the study was to design, develop and test a PSO agent that performs automatic LO sequencing through competencies. The PSO for permutation problem have been extended for the LO sequencing problem. Testing three envisaged improvements was also performed. Results show that: (1) PSO succeeds in solving the problem, (2) the original configuration is the best one, and (3) velocity check for limiting the normalized velocity of each particle value improves performance in the tested scenarios.

Further implications arise from the model proposal (Section 2): (1) E-learning standards are promoted. XML records and bindings are used, so elements will be easily interchanged and processed by compliant systems. (2) Instructor's role is automated reducing costs. Sequencing process works even in complex scenarios were humans face difficulties. And (3), the model can be extended to an automated intelligent system for building personalized e-learning experiences. But this third implication is more appertained to future work. Sequencing process can be complemented with gap analysis process and competency learner modeling techniques to build personalized courses. This courses could also be SCORM [7] compliant, so they could be imported to current LMSs.

Acknowledgements. This research is co-funded by the University of Alcalá FPI research staff education program and by the Spanish Ministry of Industry, Tourism and Commerce Plan Avanza program (grant PAV-070000-2007-103).

References

1. Brusilovsky, P.: Adaptive and Intelligent Technologies for Web-based Education. Künstliche Intelligenz, Special Issue on Intelligent Systems and Teleteaching 4, 19–25 (1999)
2. Brusilovsky, P.: Methods and techniques of adaptive hypermedia. User Modeling and User-Adapted Interaction 6, 87–129 (1996)
3. De Bra, P., Houben, G.-J., Wu, H.: AHAM: a Dexter-based reference model for adaptive hypermedia. In: Proceedings of the tenth ACM Conference on Hypertext and hypermedia. ACM Press, Darmstadt (1999)
4. Karampiperis, P.: Automatic Learning Object Selection and Sequencing in Web-Based Intelligent Learning Systems. In: Zongmin, M. (ed.) Web-Based Intelligent E-Learning Systems: Technologies and Applications. Idea Group, London (2006)
5. De Bra, P., Aerts, A., Berden, B., de Lange, B., Rousseau, B., Santic, T., Smits, D., Stash, N.: AHA! The adaptive hypermedia architecture. In: Proceedings of the fourteenth ACM conference on Hypertext and hypermedia. ACM Press, Nottingham (2003)
6. Wiley, D.A.: Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy. In: Wiley, D.A. (ed.) The Instructional Use of Learning Objects (2000)
7. ADL: Shareable Content Object Reference Model (SCORM). The SCORM 2004 Overview. Advanced Distributed Learning (ADL) Initiative (2004)
8. Wilkinson, J.: A matter of life or death: re-engineering competency-based education through the use of a multimedia CD-ROM. In: Proceedings of IEEE International Conference on Advanced Learning Technologies, 2001, pp. 205–208 (2001)

9. IMS: Reusable Definition of Competency or Educational Objective - Information Model. IMS Global Learning Consortium (2002)
10. IEEE: Learning Technology Standards Committee (LTSC). Draft Standard for Learning-Technology - Data Model for Reusable Competency Definitions. IEEE (2007)
11. HR-XML: Competencies (Measurable Characteristics) Recommendation. HR-XML Consortium (2006)
12. CEN/ISSS: European Model for Learner Competencies. Comité Européen de Normalisation / Information Society Standardization System (CEN/ISSS) (2006)
13. IEEE: Learning Technology Standards Committee (LTSC). Learning Object Metadata (LOM). 1484.12.1. IEEE (2002)
14. IEEE: Learning Technology Standards Committee (LTSC). Standard for Learning Technology—Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata. 1484.12.3. IEEE (2005)
15. IMS: Reusable Definition of Competency or Educational Objective - Best Practice and Implementation Guide. IMS Global Learning Consortium (2002)
16. Tsang, E.: Foundations of Constraint Satisfaction. Academic Press, London (1993)
17. Hinchey, M.G., Sterritt, R., Rouff, C.: Swarms and Swarm Intelligence. Computer 40, 111–113 (2007)
18. Eberhart, R., Kennedy, J.: A new optimizer using particle swarm theory. In: Proceedings of the Sixth International Symposium on Micro Machine and Human Science, MHS 1995, Nagoya, Japan, pp. 39–43 (1995)
19. Kennedy, J., Eberhart, R.: Particle swarm optimization. In: Proceedings of IEEE International Conference on Neural Networks, Perth, WA, Australia, vol. 1944, pp. 1942– 1948 (1995)
20. Kennedy, J., Eberhart, R.C.: A discrete binary version of the particle swarm algorithm. In: IEEE International Conference on Systems, Man, and Cybernetics. Computational Cybernetics and Simulation, vol. 5, pp. 4104–4108 (1997)
21. Xiaohui, H., Eberhart, R.C., Yuhui, S.: Swarm intelligence for permutation optimization: a case study of n-queens problem. In: Proceedings of the 2003 IEEE Swarm Intelligence Symposium, pp. 243–246. IEEE Press, Indianapolis (2003)
22. Mendes, R., Kennedy, J., Neves, J.: The fully informed particle swarm: simpler, maybe better. IEEE Transactions on Evolutionary Computation 8, 204–210 (2004)
23. Robinson, J., Rahmat-Samii, Y.: Particle swarm optimization in electromagnetics. IEEE Transactions on Antennas and Propagation 52, 397–407 (2004)
24. Barchino, R., Gutiérrez, J.M., Otón, S.: An Example of Learning Management System. In: Isaías, P., Baptista, M., Palma, A. (eds.) IADIS Virtual Multi Conference on Computer Science and Information Systems (MCCSIS 2005), vol. 1, pp. 140–141. IADIS Press, Virtual (2005)

Copyright Management for the LUISA Semantic Learning Content Management System

Roberto García[1] and Tomas Pariente[2]

[1] Universitat de Lleida. Jaume II 69, 25001 Lleida, Spain
rgarcia@diei.udl.cat
[2] ATOS Origin SAE – Atos Research and Innovation.
Albarracín 25, 20037 Madrid, Spain
tomas.parientelobo@atosorigin.com

Abstract. Semantic Web technology is able to provide the required computational semantics for interoperability of learning resources across different Learning Management Systems (LMS) and Learning Object Repositories (LOR). The EU research project LUISA (Learning Content Management System Using Innovative Semantic Web Services Architecture) addresses the development of a reference semantic architecture for the major challenges in the search, interchange and delivery of learning objects in a service-oriented context. One of the key issues, highlighted in this paper, is Digital Rights Management (DRM) interoperability. A Semantic Web approach to copyright management has been followed, which places a Copyright Ontology as the key component for interoperability among existing DRM systems and other licensing schemes like Creative Commons. Moreover, Semantic Web tools like reasoners, rule engines and semantic queries facilitate the implementation of an interoperable copyright management component in the LUISA architecture.

1 Introduction

The widespread adoption of e-Learning solutions across the World Wide Web has placed the focus on the interoperability requirement, specially referring to learning resources across different Learning Management Systems (LMS) and Learning Object Repositories (LOR). This interoperability is required in order to build the knowledge-intensive, open and accessible learning services that our knowledge society demands.

The central paradigm of such technology is the notion of learning objects (LO) as digital reusable pieces of learning activities or contents. However, transportability across platforms is only a basic step towards higher levels of automation and possibilities of delegation of tasks to software agents or modules. Such advanced technology requires richer semantics than those offered by current metadata specifications for learning resources. Semantic Web technology and the use of ontologies are able to provide the required computational semantics for the automation of tasks (Collazos & García, 2007), in this case those related to learning objects as selection or composition.

This paper concentrates on one of the issues of e-Learning systems interoperability, that of the learning contents copyright terms. Most e-Learning systems provide little

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 253–262, 2008.

support for copyright interoperability. They provide some attributes that can be used to specify the licensing terms of a given learning object but their main function is to just provide a placeholder for content licensing terms. The copyright attribute values are free text and there are not predefined terms or guides about how to build these licenses. At most, they rely on predefined licenses specialised on concrete licensing schemes like open content.

This is also a problem of other content management systems and consequently there are some initiatives, related with Digital Right Management (DRM), trying to establish standard ways to represent copyright terms. DRM languages define the terms and grammars that can be used in order to represent licensing terms. However, most of them are more like rigid access control languages that lack flexibility, make interoperability among different DRM languages more difficult and are not able to model copyright (Rosenblatt, 2005).

Our proposal for interoperability at the copyright level is also based on Semantic Web technologies and methodologies (Lytras & García, 2008). This approach makes it possible to attain a greater level of expressivity while modelling licensing terms, with greater flexibility, interoperability facilities and capable of representing part of the underlying copyright law notions. This papers presents the overall platform LUISA in Section 2, then focuses on DRM and copyright issues and how they are solved using Semantic Web technologies in Section 3. The key component for Semantic DRM is the Copyright Ontology presented in Section 3.1. The ontology is then used in order to model the licenses for learning contents, as shown in Section 3.2. Conclusions and future work in Section 4.

1.1 Related Work

This paper concentrates on the copyright management part of the LUISA platforms and, due to space limitations, in this paper we just analyse the related work for this part. Currently, some effort has been placed on interoperability at the learning objects licensing level (Porter, 2003; Kang, Kim, Park, Lee, & Kil, 2006). The main problem of existing e-Learning systems is that they do not provide structured and formal ways to express the licensing terms of learning objects.

For instance, Sakai[1] defines some predefined and simple copyright status sentences that provide very limited information and little support for computerised copyright management of learning objects. For instance, it is possible to state: “Material is in public domain” or “I hold copyright”. Moreover, there is the “Use copyright below” option that provides a text box that allows providing a textual description for other legal status.

Something similar happens with Moodle (Cole & Foster, 2007), even if metadata schemes like LOM (Harman & Koohang, 2006) are reused. LOM provides as set of attributes for stating for learning object rights, there are the “Cost”, “Copyright and Other Restrictions” and “Description” attributes. However, there is the same problem as in the previous case, the “Description” attribute is the more informative one but there are no restrictions about its content, it is an unstructured attribute so little help can be anticipated for automated processing.

[1] Sakai Project, http://sakaiproject.org

Recently, many Learning Objects Repositories have adopted a set of more expressive and legally formal licenses defined by the Creative Commons initiative (Lessig, 2002). However, Creative Commons (CC) licenses are restricted to open licensing schemes, like in Open Courseware[2]. Although some extensions for user defined licensing schemes have been recently added, CCPlus[3], these extensions suffer from the same limitations. The extensions are based on user defined additions and not in formalised license building blocks.

Due to the limitations of the previous approaches, there have been some attempts to adapt generic Digital Rights Management (DRM) languages for learning objects licensing (Liu, Yang, Yan, Jin, & Deng, 2005; Iannella, 2004). The main DRM languages come from standardisation efforts like ISO/IEC MPEG-21 (de Walle & Burnett, 2005). MPEG-21 Rights Expression Language (REL) is a XML schema that defines the grammar of a license building language.

Thought DRM standards are a good solution in more or less closed environments, where the involved systems adhere to one of the existing standards, they do not scale well to open environments like the Web. They cause interoperability issues like the ones identified by the Electronic Frontier Foundation (Doctorow, 2005), which are one of the main complains highlighted by DRM end-users.

Moreover, the syntax-based approach of most DRM languages, due to its limited expressivity, makes it very difficult to accommodate copyright law into DRM systems. Consequently, DRM standards follow a traditional access control approach. The limited support for copyright law is a concern for end-users because DRM systems fail to accommodate rights reserved for them.

Our contribution tries to leverage DRM systems to copyright management systems, which support the whole value chain, from creators to consumers, and build on top of copyright law. The proposal is based on a copyright ontology, described in Section 3, that provides the building blocks and restrictions that make it possible to model licensing terms for learning objects in a very flexible way.

This approach is related with other ontological approaches to DRM, which are much more expressive than XML-based grammars (Pease & Rust, 2008). Additionally, our proposal contributes the copyright dimension and support for the whole value chain, from learning objects authors to consumers. This support is difficult to attain if the underlying legal framework is not taken into account. Moreover, our proposal, like the LUISA architecture, is based on Semantic Web technologies. They are chosen in this project in order to build and open and flexible learning management systems as it is detailed in the next section.

2 Semantic Learning Management Architecture

LUISA, a project funded by the European Commission under the ICT sixth Framework Programme from March 2006 to August 2008, addresses one essential problem: the location of (the appropriate) learning resources for some given needs (of learners, instructors or groups). In order to achieve this, LUISA exploits the advantages of a

[2] OpenCourseWare Consortium, http://www.ocwconsortium.org

[3] Creative Commons Plus, http://wiki.creativecommons.org/Ccplus

Semantic Web Service architecture to addresses the development of a reference semantic architecture for the major challenges in the search, interchange and delivery of learning objects in a service-oriented context.

This entails the technical description of the solution in terms of current SWS technology, and also the provision of the ontologies and facilities required to enhance existing learning technology systems with the computational semantics capabilities. LUISA is put in a context of relevant learning scenarios – both academic and industrial. The outcomes are expected to make a significant contribution to the automation of learning systems beyond current standards, fostering the advancement of Web-based learning with an increase in the capacity to locate and negotiate learning resources. Figure 1 shows the main functional blocks of the LUISA architecture, which are detailed next.

At the top there is the *Interface Layer*, which contains all of the applications that may access the functionalities provided by the LUISA Infrastructure as well as the tools that support the development of items stored within the infrastructure. Below, there is the *Negotiation Layer*, which aims at supporting the learning objective of an end-user by using the functionalities provided by the Semantic Web Service Layer below and implementing the organizational rules. The composition of learning objects based on the organizational rules or driven by the user request is also performed in this layer. Then, there is the *Service Layer*, which acts as a SWS broker for the bottom layer, the *Data Layer*, which contains all systems that provide resources to support a learning process.

During the negotiation process, learning objects are selected and combined in order to fulfil user needs. One of the aspects into consideration during this process is the copyright situation of the involved learning object. In order to make different rights

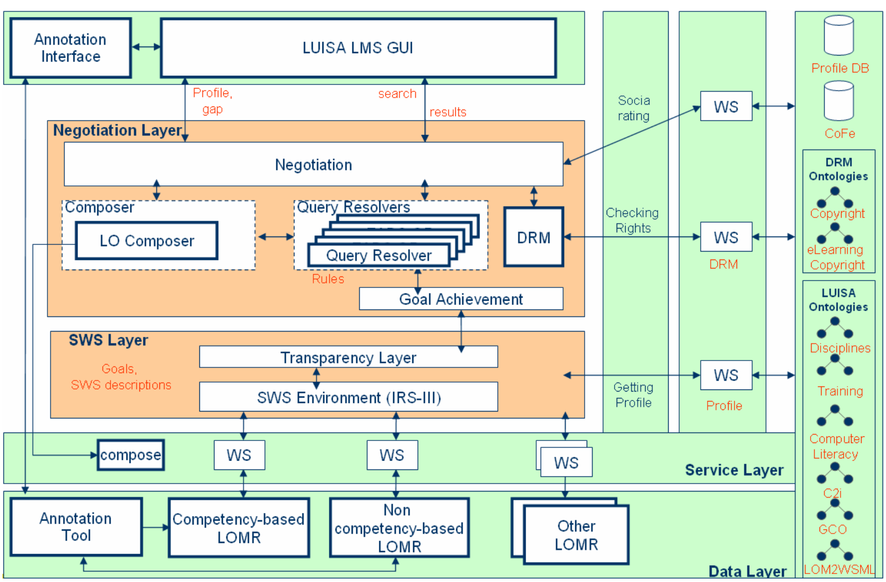


Fig. 1. The LUISA architecture

expression languages interoperable, the DRM module infrastructure uses a Copyright Ontology, e-Learning licenses expressed using this ontology and some reasoning mechanism detailed in the next section.

3 Semantic Learning Copyright Management

The previous reference learning management architecture is complemented with a copyright management module that is also based on Semantic Web technologies. This module is capable of dealing with the underlying legal framework and, simultaneously, benefits from computerised support. Semantic Web technologies make it possible to attain a greater level of expressivity for copyright licenses modeling, based on ontologies as knowledge representation tools (García, 2005). This allows including the underlying legal framework into the formalisation. This is a key issue in order to build a generic framework that facilitates interoperability.

The result of this approach is the Copyright Ontology[4], detailed in Section 3.1. The ontology is implemented as an OWL Web ontology (McGuinness & van Harmelen, 2004) based on the Description Logic (DL) variant, OWL-DL. This implementation facilitates development because license checking is implemented using existing Semantic Web reasoners, as it is shown in Section 3.2. There, it is also shown how to model learning objects licenses based on the Copyright Ontology building blocks.

3.1 Copyright Ontology

The Copyright Ontology formalises knowledge from the copyright legal domain in order to define a more expressive and interoperable license modelling framework. It is true that copyright law diverges depending on local regimes but, as the World

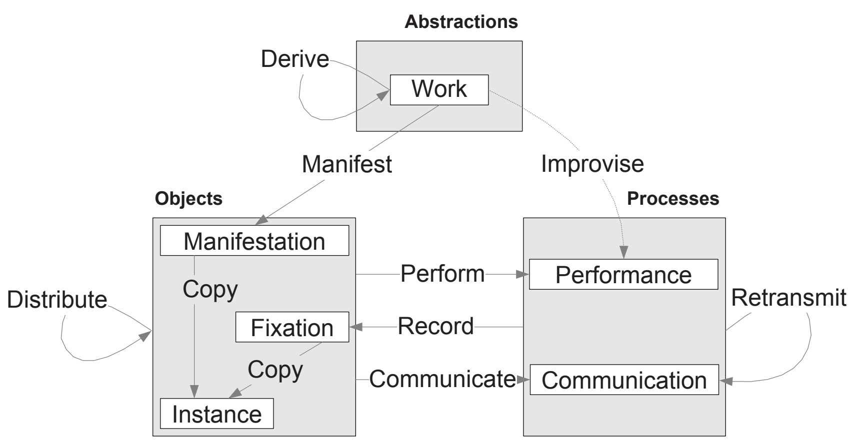


Fig. 2. Relations between action and creation

[4] Copyright Ontology, http://rhizomik.net/ontologies/copyrightonto

Intellectual Property Organisation[5] promotes, there is a common legal base and fruitful efforts towards a greater level of copyright law worldwide harmonisation.

Starting from this legal framework, the Copyright Ontology models the primitive actions that can be performed on the creations. The actions make creations evolve through their life cycle, from abstract creations to the concrete things or events that are consumed, as it is shown in Figure 2.

A Work is a distinct intellectual or artistic creation. It is the original idea behind many possible expressions based on it. For instance, some pedagogical ideas and methodologies for a concrete subject that are realised into physical things that might be perceived. One kind of physical realisation of a Work is a Manifestation, its materialisation in a concrete medium, a tangible or digital object. For instance, a learning object. There might be many copies called Instances.

On the other hand, there are Performances, the expression in time of a Work. For instance, a teacher's dissertation in a classroom. The Performance might be recorded into a Fixation, which then can be copied and distributed (e.g. a CD copy of a learning object) or communicated, the process when the public is not present at the place and or time where the communication originates. Examples of Communication are a broadcast of the teaching session or a Web streaming.

The previous set of primitive actions and kinds of creations make it possible to build licenses for all the different forms that a learning object can take as long as copyright law is concerned. These actions are regulated by the rights in the Rights Model. For the economic rights, these are the governed actions:

- **Reproduction Right:** to reproduce, commonly speaking *Copy*.
- **Distribution Right:** *Distribute*. More specifically *Sell*, *Rent* and *Lend*.
- **Public Performance Right:** *Perform*; it is regulated when it is a public performance and not a private one.
- **Fixation Right:** to fix something, *Record*.
- **Communication Right:** generically *Communicate*, other related actions depending on the intended audience are *Broadcast* or *Make Available*.
- **Transformation Right:** *Derive*. Specialisations are *Adapt* or *Translate*.

The action concepts are complemented with a set of relations that link them to the action participants. This set is adopted from the linguistics field. It is based on case roles (Sowa, 2000) and shown in Table 1. Their use is illustrated in the next section while modelling licenses in the e-Learning domain.

3.2 Copyright Licenses for Learning Objects

As it has been shown, the Copyright Ontology defines a set of primitive building blocks, inspired by the underlying copyright legal framework. They are combined in order to model licenses. Licenses should capture the obligations, permissions and prohibitions that make sense in the copyright domain.

First of all, action patterns are introduced as the way to state what is obliged, permitted or prohibited by a license. The previous actions and case roles are used to

[5] WIPO, World Intellectual Property Organization, http://www.wipo.int

Table 1. Action Model case roles

	initiator	**resource**	**goal**	**essence**
Action	agent, effector	instru-ment	result, recipient	patient, theme
Process	agent, origin	matter	result, recipient	patient, theme
Transfer	agent, origin	instru-ment, medium	experiencer, recipient	theme
Spatial	origin	path	destination	location
Temporal	start	duration	completion	pointIn-Time
Ambient	reason	manner	aim, consequence	condition

model action patterns in the copyright domain. Patterns are implemented as OWL classes made up from the combination of classes for actions, e.g. *Copy* or *Access*, and a set of OWL restrictions.

Each restriction defines a constraint on how members of the class, the domain, are related through the specified property to other ones, the range. Restrictions are combined using the intersection, union and complement logical operators in order to compose action patterns. For instance, Figure 3 shows the conceptual model for a license that combines commercial and open access terms.

Table 2 shows the OWL-DL logic notation for the class definition that models the commercial copy pattern in Figure 3, called Pattern. Each restriction reduces the initial set of actions, which corresponds to all *Copy* actions (1). First, (2) models the

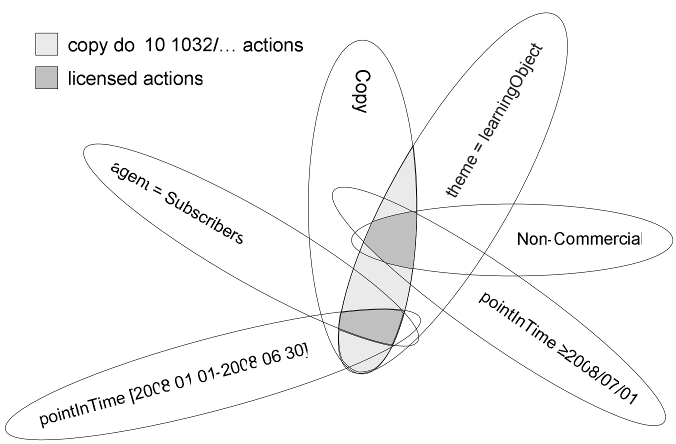


Fig. 3. Building an action pattern as an intersection of restrictions

time range. Constraints (2) and (3) restrict the range of *agent* to instances of the "Subscribers" class and *theme* to just the instance "learningObject".

From this point, it is possible to implement pattern matching using DL reasoners, which are specially suited for classifying individuals into classes. They can answer if an individual, considering its relations to other individuals and attribute values, satisfies all the restrictions of a class pattern and, thus, can be classified as an instance of that class. This functionality is used to check if a particular action, modelled as an individual, is included by an action pattern, modelled as a class.

Table 2. OWL-DL Class for the commercial copy action pattern

Pattern $\equiv$	Copy $\sqcap$	(1)
	$\forall$pointInTime.$\geq$ 2008-01-01, $\leq$ 2008-06-30 $\sqcap$	(2)
	$\exists$agent.Subscribers $\sqcap$	(3)
	$\exists$theme.{learningObject}	(4)
Condition $\equiv$	Transfer $\sqcap$	(5)
	$\exists$recipient.{owner} $\sqcap$	(6)
	$\exists$theme.{3EurosAmount}	(7)
	$\exists$agent.Subscribers $\sqcap$	(8)
	$\exists$aim.Pattern $\sqcap$ ($\leq$ 1 aim)	(9)

Action patterns are then used in order to state what is permitted by a license. Permissions are modelled by a new action, *Agree*, and the permitted pattern is linked using the *theme* case role. Following with the example in Table 2, in order to authorise the pattern that it models, an instance of the *Agree* action is connected to the class Pattern through the *theme* case role.

Conditions and obligations are also modelled using patterns that must be satisfied. The *condition* case role is used to associate the condition pattern with the conditioned pattern and the *aim* case role to state that a concrete action satisfying a condition pattern is geared towards fulfilling the specified action pattern. The Condition pattern in Table 2 models the condition required to exercise the actions captured by Pattern. The condition is that the "owner" agent (6) receives a 3 Euros (7) transfer (5) from the "consumer" agent (8). The condition pattern is linked to the conditioned one using the *aim* case role as shown in (9).

The combination of the patterns in Table 2 builds up a simple license for a learning object based on Copyright Ontology terms. Table 3 shows and example copy action *copy_01* that is included by Pattern. It is associated with an economic transfer *transfer_01* that fulfils the required Condition pattern. Consequently, it would be authorised.

Table 3. Copy action, and conditioning transfer, authorised by Table 2 license

```
:copy_01 a co:Copy ;                                  :transfer_01 a co:Transfer ;
    co:agent :consumer ;                                  co:agent :consumer ;
    co:theme :learningObject .                            co:recipient :owner ;
    co:pointInTime "2008-06-19"^^xsd:date ;               co:theme :Amount3Euros ;
:consumer a :Subscriber.                                  co:aim :copy_01.
```

The pattern matching part of the previous license checking is performed by an OWL-DL reasoner like Pellet (Sirin, Parsia, Grau, Kalyanpur, & Katz, 2007). The main limitation of the OWL-DL implementation is that it is not possible to restrict using OWL the agent in the Pattern and the Condition to the same instance because there are not variables in OWL-DL. In order to overcome this limitation, we have used the Semantic Web query language SPARQL (Prud'hommeaux & Seaborne, 2008), which is also used to check that a given action is classified into a class pattern that is permitted by an agreement, which completes the implementation of the license checking process.

4 Conclusions and Future Work

This papers presents the European project LUISA, a reference architecture for Learning Content Management, and concentrates on the DRM module responsible for learning objects licensing terms integration, copyright management and license checking. This module, as the whole LUISA architecture, is based on Semantic Web technologies and methodologies.

In the case of the copyright management module, this choice makes it possible to develop a Copyright Ontology that captures copyright terms in an interoperable and flexible way. Moreover, it is possible to take profit from Semantic Web tools, reasoners and semantic query engines, in order to easily implement license checking. Future work concentrates now on modelling the whole range of licenses used in the LUISA project and performing a detailed test of the copyright management module. Another objective is to test the scalability of this solution.

References

Cole, J., Foster, H.: Using Moodle: Teaching with the Popular Open Source Course Management System. O'Reilly Media, Sebastopol (2007)

Collazos, C., García, R.: Semantics-Supported Cooperative Learning for Enhanced Awareness. International Journal of Knowledge and Learning 3(2/3), 59–66 (2007)

de Walle, R.V., Burnett, I.: The MPEG-21 Book. John Wiley & Sons, Chichester (2005)

Doctorow, C.: Critique of NAVSHP (FP6) DRM Requirements Report. Electronic Frontier Foundation (2005), `http://www.eff.org/IP/DRM/NAVSHP`

García, R.: A Semantic Web Approach to Digital Rights Management. PhD Thesis, Universitat Pompeu Fabra, Barcelona, Spain (2005), `http://rhizomik.net/~roberto/thesis`

Harman, K., Koohang, A.: Learning Objects: Standards, Metadata, Repositories, and LCMS. Informing Science Press (2006)

Iannella, R.: On-line Trading of Rights-Enabled Learning Objects. International Journal of Electronic Commerce 8(4), 99–113 (2004)

Kang, M., Kim, S., Park, G.-C., Lee, G., Kil, M.: Design of DRM-LMS Model in M-Learning Environment. In: Gabrys, B., Howlett, R.J., Jain, L.C. (eds.) KES 2006, Part III. LNCS (LNAI), vol. 4253, pp. 1075–1082. Springer, Heidelberg (2006)

Lessig, L.: The Future of Ideas: The Fate of the Commons in a Connected World. Vintage (2002)

Liu, Q., Yang, Z., Yan, K., Jin, J., Deng, W.: Research on DRM-enabled learning objects model. In: Proceedings of the International Conference on Information Technology: Coding and Computing, ITCC 2005, vol. 2, pp. 772–773. IEEE Computer Society, Los Alamitos (2005)

Lytras, M., García, R.: Semantic Web Applications: A framework for industry and business exploitation - What is needed for the adoption of the Semantic Web from the market and industry. International Journal of Knowledge and Learning 4(1) (to appear, 2008)

McGuinness, D.L., van Harmelen, F. (2004). OWL Web Ontology Language Overview. W3C Recommendation (February 10, 2004) http://www.w3.org/TR/owl-features

Pease, A., Rust, G.: Formal Ontology for Media Rights Transactions. In: García, R. (ed.) Semantic Web for Business: Cases and Applications. IGI Global (in press, 2008)

Porter, D.: Bringing Customer Value to the Learning Ecosystem. In: Proceedings of the 2nd Canarie eLeanring Workshop, Montreal, Quebec (2003), http://www.canarie.ca/programmes/learning/workshop-2002/presentations/porter.pdf

Rosenblatt, B.: 2005 Year in Review: DRM Standards. DRM Watch, (January 2, 2006), http://www.drmwatch.com/standards/article.php/3574511

Sirin, E., Parsia, B., Grau, B., Kalyanpur, A., Katz, Y.: Pellet: A practical OWL-DL reasoner. Journal of Web Semantics 5(2), 51–53 (2007)

Sowa, J.F.: Knowledge Representation. Logical, philosophical and computational foundations. Brooks Cole Publishing Co. (2000)

Teaching of English to Hearing Impaired Individuals Whose Mother Language Is the Sign Language

Athanasios Drigas, Dimitris Kouremenos, and John Vrettaros

NCSR 'Demokritos',
Institute of Informatics and Telecommunications,
Net Media Lab,
Agia Paraskevi, 153 10, Athens, Greece
{dr,dk,jvr}@imm.demokritos.gr

Abstract. The teaching of the English language as a second language to deaf and hearing impaired individuals, whose mother language is the sign language, through the prism of the project 'Dedalos', is the main topic of this article. More particularly, a special e-learning platform was developed, which incorporated special pedagogic methods of distant linguistic training as well as innovative and high-quality educational e-content, suitably adapted to the needs of hearing impaired people through the use of contemporary animation and digital video technologies. In addition, audits and evaluation tests were incorporated within the platform, in order to assess and evaluate the linguistic skills of the hearing impaired students and the educational e-content was divided into various levels according to the educational level of each e-student. Both the evaluation process and the setting of the e-content to the appropriate level are achieved through the use of an intelligent taxonomy system.

Keywords: E-learning, deaf and hearing impaired, sign language, videoconference, expert system, taxonomy.

1 Introduction

It is commonly known that despite the vast and rapid evolution of information and communication services and products, only a small percentage of these are used within the linguist training circle and even a smaller percentage of information and communication services and facilities is used to support the linguistic training of impaired people and especially of the deaf and hearing impaired people.

The general idea is that the majority of the Information and Communication Technologies (ICTs) [1], substructures and services targets the common citizen and user, and excludes handicapped people and other sensitive community groups. This fact provokes and creates the phenomenon that is commonly known as "digital divide", i.e. the exact opposite of e-inclusion, which is supported internationally by several policies, organized actions and also by projects like 'Dedalos'.

The main objective of the 'Dedalos' project is the promotion of the English language as a second language for Deaf and hearing impaired people whose first language is the sign language. For this, special pedagogic methodology of distant

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 263–270, 2008.

linguistic training was designed and used as well as innovative educational e-content, suitably adapted to this special group of people. The whole process includes audits and evaluation of the linguistic skills of the e-students. The educational e-content has been designed to be divided into different levels according to the knowledge of the student. The system has been designed to evaluate the student and set the pedagogic material at the corresponding level using an intelligent taxonomy system. Particular emphasis was given to the quality and innovation of the educational material of self-paced learning where new animation and digital video technologies were extensively used into the Sign Language of each partner [2], [3], [4], [5], [6].

An important element of the project was the promotion of equality of the deaf and hearing impaired people through their participation in the European Community. Nowadays, the English Language as a second language constitutes an important resource and asset in the professional field, for all individuals. It is a common ascertainment that the deaf and hearing impaired people face adaptation problems in their social activities, especially in the European countries, where English is used as the main communication language. In addition, the ICT sector uses mainly the English language and the vast majority of information on the Internet is in English, while the terminology used in the economy and electronic trade sector requires the knowledge of English.

2 The Characteristics of GSL (Greek Sign Language)

The Greek Sign Language (GSL) is a natural visual language used by the members of the Greek Deaf Community, which counts several thousands of native and non-native signers [7], [8]. It is used widely in the Greek deaf community and the estimation for GSL users is about 40,600 (1986 surveys of Gallaudet University). There is also a large number of hearing non-native signers of GSL, mainly students of GSL and families of deaf people [9], [10]. The recent increase of mainstreamed deaf students in education, as well as the population of deaf students scattered in other institutions, minor town units for the deaf and private tuition may well double the total number of secondary and potential Sign language users [11], [12]. Official settings where GSL is being used include eleven deaf clubs in Greek urban centers and a total of fourteen deaf primary, secondary and tertiary educational settings [13], [14], [15].

3 Presentation of the ‘Dedalos’ Project

The basic objective of the ‘Dedalos’ project is to support the equal rights of deaf people for their access and real participation in professional training [16]. Moreover, the main aim of the project is the promotion of the English language as a second language for the deaf and hearing impaired individuals through distant linguistic training using innovative educational material (e-content) suitably adapted to the needs of this special group of people. In the present Leonardo Da Vinci ‘Dedalos’ project the following steps were followed:

a) Development of an e-learning environment for the deaf and hearing impaired people, adapted to their special needs via their sign language. The environment has been designed and is based on the use of the advanced teleconference services of the Internet (network virtual classrooms) and offers a number of facilities and services that support education and training via an easy and user-friendly way, in the form of lifelong and continuous education and training for the deaf people.

b) Design and development of electronic informative and adaptive material (e-content) for the deaf and hearing impaired people on the Web. This informative material includes text and video (multimedia) and aims at the teaching of the English language (Fig. 1). The material has been designed to be translated in its entirety in the sign language via streaming digital video according to the e-content specifications of the A.I.C.C.

c) Design and use of innovative e-learning methods for the Linguistic Training of self-paced learning. Processes of synchronous learning and collaborative methods of asynchronous self-paced learning were used [17], [18].

d) Design and operation of an application for lifelong and distance training of the English language. In this application, all the aforementioned actions and developments were designed and coordinated so that the desired outcome of training is available to the deaf community for application and evaluation that will lead to the final improvements of the central as well as of the subsidiary design and developments. Taking into account the circumstances in Greece, deaf people do not have the proportional financial resources in order to be equipped with suitable material and technical systems for the use of e-learning. This being the case, the project aims at the creation of centers of distance training into the deaf / hard of hearing associations so that through the proportional material - technical equipment and parallel training of the

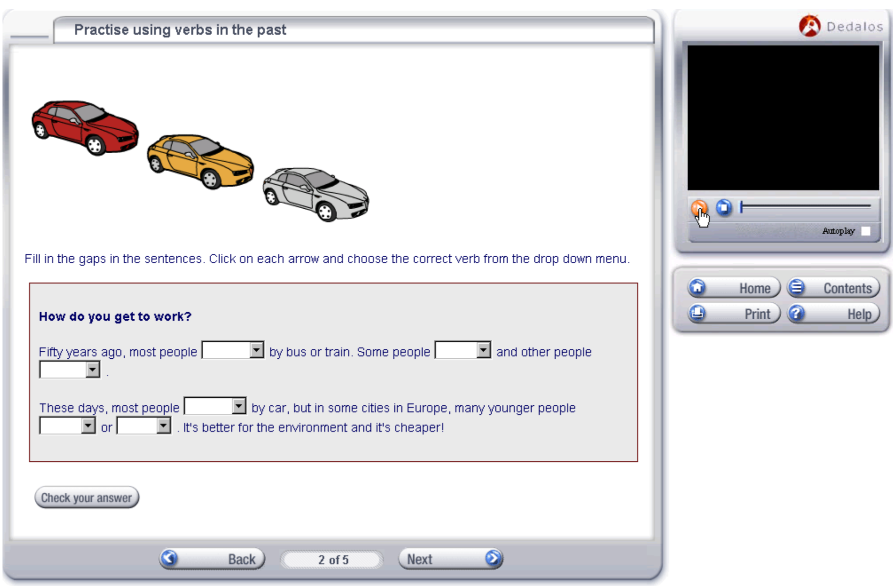


Fig. 1. Sample of the e-Material including Text and video

teachers of deaf people, the services of the new Information Society will be provided to the deaf and hearing impaired people.

4 An E-Learning Platform for the Deaf and Hearing Impaired Individuals

4.1 The E-Learning Platform

The 'Dedalos' environment has been designed using asynchronous services for the delivery of the educational material as well as modern and asynchronous services of communication and collaboration, trying to exceed the exclusions that are related with the time and the place of training but also to satisfy the needs of deaf and hearing impaired students with a variety of possibilities of equipment and communication.

Furthermore, the model of the visual classroom has been designed using videoconference services through images, at the same time with the possibility of realization of cooperative real-time activities (whiteboard, application sharing, file sharing).

Apart from the designed visual classroom model, the model of supported self learning is also in use. A basic rule that should condition the systems of tele-education for self learning is the control. This means that the educated person is simultaneously able to use the course but is also able to intervene in the flow and its structure. In this designed model the strategy is learner centered.

The designed services that are provided by the environment are categorized into three fundamental axes:

-Visual order: line of courses in real time with the possibility of interaction through the Internet.

-Self-instruction: access (search and recuperation) to training and informative material for various cognitive and more general subjects that interest teachers.

-Cooperative learning: communication and attendance in thematic circles of discussions and development of cooperative activities.

4.2 The E-Content

The purpose of the discussed special e-learning environment could be summarized as teaching - tutoring deaf students in order to meet the ESOL level 1 and level 2 standards (developed by the Department for Education and Skills (DfES) and the Basic Skills Agency (BSA)). One could figure out that each of these two levels consists of the same five sections namely A, B, C, D, and E. Their semantic differential is located on the language skills acquisition each level defines as necessary - appropriate.

An abstract e-learning schema of the final system is the following: The learning process consists of three phases. Each individual deaf student must successfully complete each phase in order to proceed to the next. Also, a fundamental assumption is that there exists a (logical - obvious) priority list containing all sections in a certain ascending order.

Section Priority List

[A] Letter recognition and alphabetical order
[B] Spelling - vocabulary

[C] Grammar - sentence structure
[D] Reading
[E] Writing

The e-learning process is presented in length in the next paragraphs. Moreover, some key issues are being analyzed.

Phase 1 → [Acquiring the necessary language skills for each individual section] Per section questions or questionnaires are interchanged with corresponding instruction/lesson sessions. This process ends only after the deaf individual completes all sections successfully. In case an accurate assessment (according to statistical thresholds) of the student's language level cannot be reached, more questions are employed.

Phase 2 → [Acquiring language skills relevant to each section and to the section(s) lying above it]. The deaf student is provided with questions relevant to a certain section and simultaneously relevant to all the corresponding prerequisite sections (of the section under consideration). Two issues are of vital importance; answers could be simultaneously right according to some sections and wrong according to others and also the part of an answer relating to a specific section could be partially right. Moreover, the question itself exhibits different, in general, degree of relevance/weight with respect to each individual section (Fig. 2).

Phase 3 → [Overall verification - evaluation of the student's exact language level] Questions at this phase are more complex combining various arbitrary sections, which are chosen randomly instead of being selected in some formal way (for instance by depending on a priority table). Although these questions differ from the questions of Phase 2, their construction and internal structure is similar.

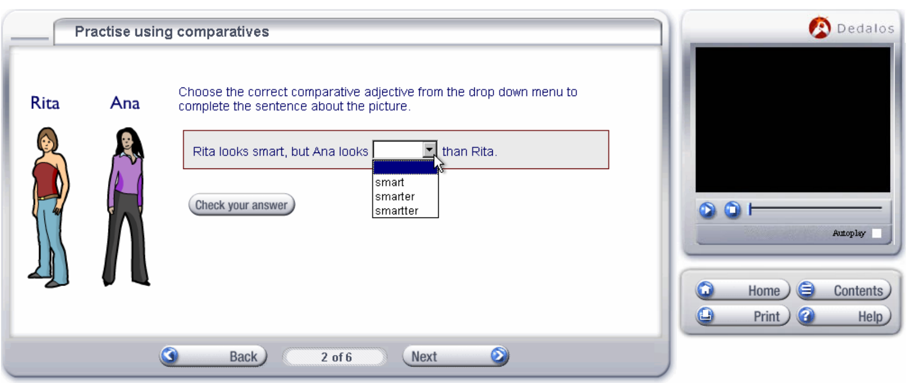


Fig. 2. Sample of the self assessment tests

4.3 Adaptive Fuzzy Subsystem for Assessing the Learning Procedure

The fuzzy inference system is a popular computing framework based on the concepts of fuzzy set theory, fuzzy if then rules and fuzzy reasoning. It has found successful applications in a wide variety of fields. Because of its multidisciplinary nature, the fuzzy inference system is known by numerous other names, such as fuzzy-rule-based system, fuzzy expert system, fuzzy model, fuzzy associative memory and simply fuzzy system.

The basic structure of a fuzzy inference system consists of three conceptual components: a rule base, which contains a selection of fuzzy rules; a database (or dictionary), which defines the membership functions used in the fuzzy rules; and a reasoning mechanism, which performs the inference procedure upon the rules and given facts to derive a reasonable output or conclusion.

The target system under consideration is the language skill evaluation - assessment expert subsystem of the e-learning environment. The fuzzy system is then expected to be able to reproduce the behavior of the target system.

Literally, the designed expert system, which is part of the general e-learning environment, demonstrates functionality equivalent to adaptive fuzzy inference systems. Correspondingly, the proposed architecture - model is referred to as AFELS, which stands for Adaptive Fuzzy E-Learning Subsystem.

5 Conclusions

The implementation of an intelligent system for the evaluation of deaf students is in the immediate future work plans, in the framework of this project.

The final system uses modern techniques of neural networks and fuzzy logic. This system classifies the student in knowledge levels, which also determines the final structure of the educational material. More analytically, it is a system of measurement of the level of acquisition of knowledge and skills of the student for the duration of the training process.

The official approach becomes with the use of a short test in each unit. However, it is known that the process of learning is figured with various students behaviors that depend on the experience, the background and the particularities of the student. The approach that will be developed is the classification of various behaviors through unclear (fuzzy) proposals and their connection through fuzzy rules which will be used by an experienced system. The experienced system will choose the most suitable strategy for each student. All the processes will become through the follow-up of a hypertext environment through which we can represent the behavior of the student and which constitutes the condition in order to have the possibility of fuzzy inference.

The main limitations of the study are divided into linguistic, educational and technical limitations. Most of the limitations are typical in video streaming projects, and were expected before the beginning of the project. From a linguistic and educational point of view, the major issues that need to be addressed are the following:

In some areas of the language there are no standardized signs, so there may be some theoretical objections as to the use of particular entries. However, a platform such as the one described in this article allows multiple translations but also has some limitations as to the size of the files since these files have to be published in the form of streaming video through the web. A second problem is the ability to make changes in the database of video files.

The data available in GSL, for example when compared with data in Greek, are dauntingly scarce. Error correction mechanisms were sought after, in order to assure reliability of results. Such back-up mechanisms are the use of approved dictionaries, the consulting of the Pedagogical Institute and the feedback from the deaf community along with the continuing data from GSL linguistic research.

Lastly, all schools in Greece have access to the Internet, deaf settings included. In practice however, there are many more accessibility barriers for a considerable number of deaf students who have additional special needs. Relevant provisions have been made according to general accessibility principles for these students (as to text size, keyboard settings etc) but the pilot implementation of the project after six months has indicated more points for development.

Technical problems include the following:

A qualitative videoconference sign language communication is highly expensive in terms of bandwidth. Especially in the case of multipoint continuous presence communication the demand of bandwidth is multiplied according to the number of the conferring signers. Under these circumstances, DSL links of at least 384Kbps are considered as the minimal requirement for a Sign Language Virtual Classroom.

Given that the platform under discussion consists of an original research object, successful completion of its development has opened the way to a complete support system for the education of the deaf community members in Greece.

Acknowledgments. The authors of this article wish to acknowledge the assistance of all groups involved in the implementation of the discussed platform: computational linguists, computer scientists, GSL specialists, the Greek National University of Athens, the panel of GSL consultants and the representatives of the Greek Deaf Community, who acted as our informants. This work is partially supported by the Leonardo Da Vinci project grant Dedalos.

References

1. United Nations Educational, Scientific and Cultural Organization, Institute for Information Technologies in Education, Information and Communications Technologies is Distance Education (2002)
2. Tavangarian, D., Leypold, M., Nölting, K., Röser, M., Voigt, D.: Is E-Learning the Solution for Individual Learning? Electronic Journal of E-Learning 2(2) (2004)
3. Rosenberg, M.: E-Learning: Strategies for Delivering Knowledge in the Digital Age. The Knowledge Management Magazine Series. The McGraw-Hill Companies, New York (October 2000)
4. Lewis, M.: Interactive Multimedia Pedagogy: How Interactivity Supports Learning (2003), http://www.thelearningcurve.com/lessons/resources/media/TLC_interactive%20pedagogy.pdf
5. National Learning Network, Paving the Way to Excellence in E-Learning, http://www.nln.ac.uk/materials/tutors/Paving_the_way.asp?menuitem=paving
6. Drigas, A.S., Koukianakis, L.G.: An Open Distance Learning E-System to Support SMEs E-Enterprising. In: 5th WSEAS International Conference on Artificial Intelligence, Knowledge Engineering, Databases (AIKED 2006), Madrid, Spain (2006)
7. Antzakas, K., Woll, B.: Head Movements and Negation in Greek Sign Language. In: Gesture Workshop, City University of London, pp. 193–196 (2001)

8. Lampropoulou, V.: Meeting the Needs of Deaf Children in Greece. A Systematic Approach. Journal of the British Association of Teachers of the Deaf 16, 33–34 (1992)
9. Lampropoulou, V.: Greek Sign Language Research: Comments on Phonological Analysis, Athens, Greece (1997)
10. Bellugi, U., Fischer, S.: A Comparison of Sign Language and Spoken Language. Cognition 1, 173–200 (1972)
11. Kyle, J.G., Woll, B.: Sign Language: The Study of Deaf People and Their Language. Cambridge University Press, Cambridge (1985)
12. Efthimiou, E., Katsoyannou, M.: Research Issues on GSL: A Study of Vocabulary and Lexicon Creation. Studies in Greek Linguistics. Computational Linguistics, vol. 2, pp. 42–50 (2001)
13. Logiadis, N., Logiadis, M.: Dictionary of Sign Language. Potamitis Press (in Greek)
14. Brien, D., Brennan, M.: Dictionary of British Sign Language. Faber and Faber, London Boston (1992)
15. Wilcox, S., Scheibmann, J., Wood, D., Cokely, D., Stokoe, W.: Multimedia Dictionary of American Sign Language. In: Proceedings of ASSETS Conference, Association for Computing Machinery, pp. 9–16 (1994)
16. Phipps, L., Sutherland, A., Seale, J.: Access All Areas: Disability, Technologies and Learning ISBN 1-904190-18-9
17. Moore, M.G.: Three Types of Interaction. The American Journal of Distance Education (1989)
18. Moore, M.G., Kearsley, G.: Distance Education: A Systems View (1996)

The Determinants of the Effectiveness of Online Discussion Board Systems in eLearning: A Case Study

Habin Lee[1], Jong Woo Kim[2], and Ray Hackney[1]

[1] Brunel Business School, Brunel University, Uxbridge, Middlesex, UK
{Habin.Lee,Ray.Hackney}@brunel.ac.uk
[2] School of Business, Hanyang University, Seoul, Korea
kjw@hanyang.ac.kr

Abstract. This paper aims to reveal the determinants of the effectiveness of online discussion board systems (ODBSs) in eLearning environments to foster the interactions among the learners and/or instructors. A case in which an ODBS failed to foster the interactions among learners / instructors for knowledge sharing is introduced and hypotheses to explain the failure are developed based on thorough literature review in technology acceptance model (TAM) and knowledge hoarding. The hypotheses are tested via statistical analysis on the data collected from a questionnaire survey against the students who actually involved in the case study. The result shows that the low perceived usefulness of the ODBS by the students played major role in the failure of the system. Also it is hinted that network externalities as an intrinsic motivator is more effective than extrinsic motivators to increase the students' activities on the ODBS. Finally the paper provides the designers of eLearning systems with advice for successful operation of ODBS in eLearning.

1 Introduction

The proposition, the more interaction between learners – learners / instructors, the higher learning outcome, is well supported by many studies (Fredericksen et al., 2000)(Swan et al., 2000).

Considering this, it is vital to integrate mechanisms to facilitate the interactions among students / instructors within teaching sessions. As a result, many teaching methods that incorporate the interactions among students like a small group discussion have been well adopted in physical classes in which learners and instructors can have synchronous interactions in many educational institutes.

However, most of the Internet-based eLearning systems are based on asynchronous interactions among the learners / instructors and this provides a different learning context from that of physical classes. One of the most common interaction support system in today's eLearning is online discussion board system (ODBS) which supports asynchronous interactions among students and instructors. However, despite of the needs there have been very few studies to reveal the determinants of effective ODBS implementation and operation in eLearning context.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 271–277, 2008.

This paper aims to identify the determinants of the effectiveness of ODBS via a case study in which an ODBS failed to foster the interactions among learners / instructors for knowledge sharing. We employ the technology acceptance model (TAM) and knowledge hoarding as theoretical context to explain the failure of the ODBS in the case study. Based on theoretical review, we develop hypotheses as the explanation of the failure and test them via questionnaire survey against the students who were involved in the eLearning sessions in the case study. The findings suggest that the perceived usefulness of the ODBS played major role in the failure while their attitude toward and the easy-of-use of the system were positive. Furthermore, intrinsic motivator such as network externalities or critical mass effect turned out to be more effective than extrinsic reward as an enabler to use ODBSs.

The organization of the paper is as follows. Next section will provide a case in which an ODBS failed to deliver higher learning outcome to its participants. Section 3 derives hypotheses to explain the failure in the case in section 2 via theoretical review. Section 4 describes the methodology employed in the paper to test the hypotheses and the results. Section 5 discusses the implications of the findings and concludes this paper.

2 An ODBS Failure Case

The target module was designed based on an eLearning system and offered to level-1 students in the Brunel Business School, Brunel University West London. The total number of registered students was about six hundreds and it provided both virtual class sessions (students could visit the online sessions anytime they want) for gaining theoretical knowledge on information technology and statistics and physical lab sessions (students should attend the sessions at the same place at the same time) for obtaining practical knowledge on how to use HTML script language and a statistic-software.

In the module, students were asked to attend the virtual lecture on the Internet to obtain new knowledge and they were tested at the online testing system during their physical lab sessions. As a result, the physical sessions consisted of two sub sessions: online testing and computer lab session. The web site for virtual lecture sessions provided an ODBS to allow the students post any questions with regard to the new topic of the theories in the virtual lectures.

As the physical sessions were dedicated to the computer labs, the ODBS was supposed to be the major place in which students and instructors could interact with each other to discuss about topics to prepare the online exams. And the proposition was that the more students participate to the ODBS, the higher learning outcome (the online exam marks) they will achieve.

To investigate above proposition, data has been collected and analysed. Firstly, all the participants of the ODBS have been listed and their markings of the online exams have been collected. Total 78 students posted articles on the ODBS and their average mark of the online exam was 14 out of 20 while the total average mark of the whole class was 13.74 showing no difference between the two groups. Also the failure of the ODBS to deliver higher learning outcome can also be seen in terms of the number of postings and users. At the time the data was collected, there had been 4 online exams since the beginning of the academic term and the number of postings on the ODBS had been decreased as the time went. For example, before the first exam, total 173 postings were made on the ODBS and the number decreased into 28, 13, 49, and 25.

3 Theoretical Context

While many different factors may involve for the success of ODBSs in eLearning, the paper derives the theoretical model focusing on the technology acceptance model (TAM) (Davis 1989)(Davis, Bogozzi, & Warshaw, 1989) and knowledge hoarding perspective.

TAM has been widely adopted in Information Systems research area to identify any behavioural issues of end users in the acceptance of new technologies (Venkatesh, 2000)(Venkatesh et al., 2003)(Lu et al., 2003)(Naarmala, 2004). TAM emphasizes three major variables that play major roles in the acceptance of new technology by users: users' attitude, perceived usefulness, and perceived ease of use. According to Davis, the actual use of a technology is affected by the intention to use it. Intention to use a technology is affected by both attitude and perceived usefulness of the technology. Again attitude is affected by perceived usefulness and perceived ease-of-use. Following the theory, we can infer that any of the three variables were not satisfied by the students of the ODBS in the case. According to this inference, we define three hypotheses for the three variables of the TAM.

H11: The negative attitude of the students led to the low usage of the ODBS
H12: The low perceived usefulness of the ODBS led to the low usage of the ODBS
H13: The low perceived easy-of-use let to the low usage of the ODBS

The above hypotheses are centred on the acceptance of new technology while ignoring the knowledge exchange perspective within the ODBS. As the major intended use of ODBS in the module was to facilitate the knowledge exchange among the students or students and instructors, it is vital to investigate the attitude of the students on the ODBS from knowledge exchange perspective. Cabrera and Cabrera (2002) assert that sharing knowledge causes cost to the knowledge-sharer which suppresses the knowledge sharing in organizational context. Their assertion is in line with Husted and Michailova (2002) who claims that individuals and organizations are basically hostile on knowledge sharing and how to fight against the hostility is crucial for successful knowledge sharing in organizations. They also suggested five reasons of knowledge hoarding by organizational members: protection of individual competence, reluctance of spending time, fear of hosting "knowledge parasites", avoidance of exposure, uncertainty aversion, and compliance to hierarchy and formal power. As the major reason of using ODBS by the students was to prepare online exams and broaden their knowledge in eLearning context, the paper derives hypotheses based on only three reasons among the five for knowledge hoarding in ODBSs.

H21: The reluctance to share their knowledge with others due to the competition in the online exams led to low usage of the ODBS.

H22: The reluctance to bother to reply to any queries on ODBSs led to low usage of the ODBS.

H23: The reluctance to be exposed in public led to the low usage of the ODBS.

While above hypotheses are used to explain why the ODBS in the case study was not linked with higher learning performance, we are also interested in what would make the students use ODBSs. In motivation theories, there are two types of motivator: extrinsic and intrinsic motivators (Bénabou &Tirole, 2003). For this purpose, we are developing hypotheses with regard to the incentives to the participation to ODBSs. In education, external rewards such as best-student award have been widely used to improve learners' learning performance (Deci et al., 2001). In eLearning context, the performance can be interpreted as their final grade. As a result, it is a natural incentive to link students' activities with their final grades. This leads to

H31: Students will be willing to participate to ODBSs if their activities in the ODBSs are linked with their final grades.

On the other hand, as an intrinsic motivator of an ODBS, we are focusing on network externalities (Katz and Shapiro, 1984). Shapiro and Varian (1999) defines network product as follows:

"When the value of a product to one user depends on how many other users there are, economists say that this product exhibits network externalities…"

The representative example of such product is communication services like telephone, email, fax, and Internet. One of the major characteristics of such products is that the adoption of the products in the market is accelerated by positive feedback: as the install base of users increases more users feel it is worth to use the products. As an ODBS also seems to be affected by network externalities, we can make a hypothesis that the increased and maintained number of student-base of an ODBS will attract more students. Furthermore, in Luo et al.'s (2000) study, critical mass effect showed positive impact on perceived usefulness and perceived easy-of-use in the TAM.

H32: Students will be willing to participate to ODBSs if most of their friends or colleagues are participating to the ODBSs.

Figure 1 shows the theoretical context of this paper that summarises the above hypotheses. Our assumption is that the more interactions are made among students or between students and instructors the higher the learning outcome will be derived. This

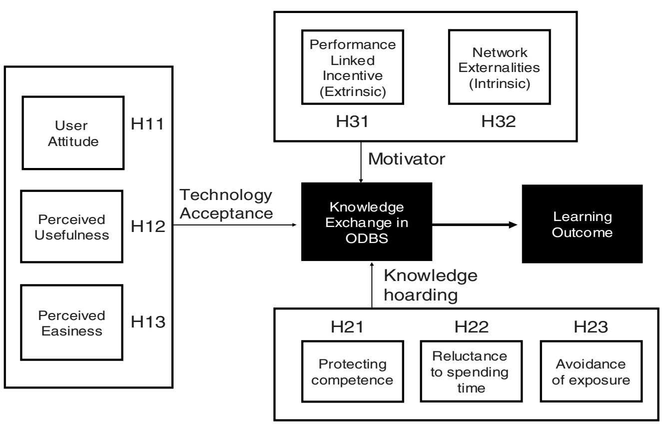


Fig. 1. The theoretical context of the study

hypothesis (the two black boxes linked with a bold arrow in Figure 1) has been tested in other studies and as a result not included in this study. On the other hand, this study focuses on identification of factors that affected (negatively) the knowledge exchange activities of students in the ODBS in the case study in section 2. The hypotheses H11, H12, and H13 will be tested to see if the ODBS was not accepted by the students and if so which variable was particularly affected to the non-acceptance by the students. The hypotheses H21, H22, and H23 will be used to test if any knowledge hoardings played a role in the failure of the ODBS. Finally, the hypotheses H31 and H32 will be tested to test if extrinsic or intrinsic incentive will motivate the students for more proactive use of the ODBS.

4 Methodology and Result

A questionnaire to test the hypotheses in section 3 has been designed to have twenty four five-scaled questions. The questions have been grouped into 3 categories. The first part of the questionnaire was devoted to collect basic information about the respondents such as sex, the number of visits to and postings on the ODBS. Second part consisted of questions with regard to the hypotheses in section 3. In the module, 600 students were divided into 20 groups making each group consist of about 30 students. The questionnaires were distributed during randomly selected 3 groups. Total 62 have been collected among 74 questionnaires.

Among the 62 questionnaires, 13 unreliable questionnaires have been aborted. The unreliable questionnaires have been filtered if they violated the instructions of the questionnaire. For example, the questionnaire has been designed to guide the respondents through different routes according to their response in the early stage questions. If they did not go thorough as instructed, then the questionnaires have been aborted. This is expected to improve the reliability of the responses as the respondents had to read the questions and instructions carefully to answer to the questions. The questionnaires have been distributed at the beginning of the physical lab sessions and collected at the end of the same sessions during January 2008 (after 5 virtual sessions have been completed from the beginning of the school term in September 2007.

Table 1. The result of statistical test of the hypotheses

H*	H11	H12	H13	H21	H22	H23	H31	H32
N	59	59	51	57	57	55	56	55
m	2.5	2.83	2.06	3.82	3.53	3.98	2.77	2.64
s	0.8	0.85	0.83	1.09	0.95	1.01	1.19	0.99
SE	0.1	0.11	0.12	0.14	0.13	0.14	0.16	0.13
Null H.	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3
A	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
df	58	58	50	56	56	54	55	54
t-value	-4.26	-1.52	-8.05	5.72	4.20	7.22	-1.46	-2.73
LCV	-1.67	-1.67	-1.67	-1.67	-1.67	-1.67	-1.67	-1.67
Decision	Acc	Rej	Acc	Rej	Rej	Rej	Rej	Acc

* H: Hypothesis, N: Sample size, m: mean, s: standard deviation, SE: Standard Error, df: degree of freedom, LCV: Lower critical value.

T-test has been adopted to test the hypotheses against the collected data. Even though it is difficult to say that the samples were collected from a population that follow normal distribution, the scatter diagram shows mound shape and the t-values can be used as meaningful indicators (Mendenhall and Reinmuth, 1971).

The result shows that among the three variables in TAM, students did not perceive that the ODBS was useful while they perceived that it was easy to use and they have positive attitude against the ODBS. The perceived usefulness of the ODBS by the students turned out the major factor explaining the failure of the ODBS in the case study.

The three hypotheses related with knowledge hoarding of the students have all been rejected indicating that the students did not have any objection for sharing their knowledge on the ODBS.

Finally, network externalities turned out the major motivator to increase the intention of using ODBSs. On the other hand, the explicit reward (linking the activities in ODBSs with final grade) was not fully supported by the students. The average was 2.77 which is smaller than 3 (neutral) but not statistically significant at 95% confidence level.

5 Discussion: Toward Open Knowledge Society

This result indicates that module designers who are intending to implement eLearning should have special attention on how to increase perceived usefulness of ODBSs by their students beforehand. With regard to this, it is worth to note the result on the additional questions from the questionnaire. Students were asked if they would contact their friends, the module leader / tutors via email, or the ODBS. The students responded in following order: friends, module leader / tutors, and ODBS putting ODBS as the last place to visit to ask a question. Combined with the low perceived usefulness of the ODBS, this may indicate that the timeliness of the response is one of the important factors for the usefulness of ODBS in eLearning context.

While many knowledge hoarding cases are reported in the literature (Disterer, 2001), it seems not the case in the case study. This may be explained by the special characteristic of the ODBS in eLearning context. In eLearning context, students may recognize ODBS as a place of bi-directional knowledge transferring rather than a uni-directional. As a result, they may have felt that it is a fair knowledge market (give and take). This would be also another future research direction of this study.

The preference of network externalities to reward as the motivator of using ODBSs by students in this paper supports Deci and Ryan's (2001) cognitive evaluation theory (CET). According to the result of this study, students do not like extrinsic reward (linkage between the activities in the ODBS and final grade) but prefer network externalities. The network externalities can be considered as an implicit motivator. According to CET, an external event becomes an extrinsic or intrinsic motivator depending how it is perceived by the actor: control or information. It is reasonable to consider that the link with final grade is perceived by students as control while network externalities as information. While the literature insists that external reward may affect intrinsic motivator negatively, this is supported by the students' perspective.

The result provides us with important implications for open knowledge society. Various types of group supporting system (GSS) have been considered as a key tool to facilitate knowledge sharing among organizational members. ODBS is one of the mostly used GSS for sharing knowledge in virtual world. However, Despite of some efforts to find success factors of group decision support systems in 1990s, there was no study to reveal the success factors of knowledge exchange within ODBS environments. This study suggests that obtaining and maintaining enough level of network externalities is one of the success factors. For this the managers of ODBSs need to consider mechanisms to increase the perceived usefulness of the systems and once initial level of user bases are obtained, they need to provide systematic approaches to maintain the user bases for a while in particular in the beginning of the deployment of the systems. Furthermore, governments need to disseminate the implications into their societies when they facilitate knowledge exchange via the Internet technology.

References

Cabrera, A., Cabrera, E.F.: Knowledge-sharing Dillemmas. Organization Studies 23(5), 687–710 (2002)

Bénabou, R., Tirole, J.: Intrinsic and Extrinsic Motivation. Review of Economic Studies 70(3), 489–520 (2003)

Davis, F.: Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly 13(3), 319–340 (1989)

Deci, E.L., Koestner, R., Ryan, R.M.: Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review of Educational Research 71(1), 1–27 (2001)

Deci, E.L., Ryan, R.M.: The empirical exploration of intrinsic motivational processes. In: Berkowitz, L. (ed.) Advances in experimental social psychology, vol. 13, pp. 39–80. Academic Press, New York (1980)

Disterer, G.: Individual and social barriers to knowledge transfer. In: Proceedings of the 34th Hawaii International Conference on System Sciences (2001)

Fredericksen, E., Pickett, A., Pelz, W., Shea, P., Swan, K.: Student satisfaction and perceived learning with online courses: principles and examples from the SUNY learning network. Journal of Asynchronous Learning Networks 14(2) (2000)

Hevner, A.R., Martin, S.T., Park, J.: Design Science in Information Systems Research. MIS Quarterly 28(1), 75–105 (2004)

Husted, K., Michailova, S.: Diagnosing and fight knowledge-sharing hostility. Organizational Dynamics 31(1), 60–73 (2002)

Lee, M.K.O., Cheung, C.J.K., Chen, Z.: Acceptance of Internet-based learning medium: the role of extrinsic and intrinsic motivation. Information & Management 42, 1095–1104 (2005)

Lou, H., Luo, W., Strong, D.: Perceived critical mass effect on groupware acceptance. European Journal of Information Systems 9(1), 91–103 (2000)

Lu, J., Yu, C.-S., Liu, C., Yao, J.E.: Technology acceptance model for wireless internet. Internet Research: Electronic Networking Applications and Policy 13(3), 206–222 (2003)

Mendenhall, W., Reinmuth, J.: Statistics for Management and Economics. Duxberry, Belmont (1971)

Shapiro, C., Varian, H.R.: Information Rules: A strategic guide to network economy. HBS Press, Boston (1999)

Swan, K., Shea, P., Fredericksen, E., Pickett, A., Pelz, W., Maher, G.: Building knowledge building communities: cnosistency, contact and communication in the virtual classroom. Journal of Educational Computing Research 23(4), 359–383 (2000)

Venkatesh, V.: A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science 46(2), 186–204 (2000)

Can the Learning Process in a Distance University Be Improved?

Elisabet Ruiz and Helena Chuliá

Department of Economics and Business, Universitat Oberta de Catalunya. Av. Tibidabo 39-43, 08035, Barcelona, Spain
{eruizd,hchulia}@uoc.edu

Abstract. In a distance university, the materials are one key element in the learning process. The main objective of this paper is to describe a project undertaken by the Open University of Catalonia (UOC) to develop an innovative set of electronic learning materials for Introduction to Financial Mathematics. The purpose of this set of materials is twofold. First, they are designed to facilitate the learning process through content and timing. Second, they give the students a methodology to be followed when solving financial problems. In addition to describing the materials, we report on students' learning experiences using this set of electronic materials. Results show that the number of students passing the subject has increased considerably. Furthermore, the new material has helped the students become familiar with the methodology employed in solving financial problems.

Keywords: distance education, flexible material, learning process, quantitative courses.

1 Introduction

The term "distance education" has been used to describe the process of providing education where the instructor is distant (geographically separated) from the student (Gallagher and McCormick, 1999), or any instructional arrangement in which the teacher and learner are geographically separated to an extent that requires communication through media such as print or some other form of technology (Moore and Thompson 1997, Perraton 1988, Keegan 1986 and Garrison and Shale 1987).

The continued growth of distance education has much to do with the advent of radio, television, and other media, which allowed for learning at a distance. This growth accelerated significantly during the 1990s with the use of computer-mediated learning technologies, online or offline Internet Web-based instruction (Phipps and Merisotis 1999, Sherry 1996 and Wernet et al. 2000).

The institutions offering distance courses have adopted a model of flexibility that results in substantial changes to both individual practice and organisational culture, which must be resourced and managed (Shurville and Browne 2006,). A commonly accepted definition of flexible learning is that an institution provides students with flexible access to learning experiences in terms of at least one of the following: time,

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 278–285, 2008.

place, pace, learning style, content, assessment and pathways (e.g., Browne 1999, Ling et al. 2001). This definition is based on the view that learning requires the active engagement of students; and that students should be more independent and more responsible for their own learning.

Traditionally distance education has been suitable mainly for subjects wholly relying on printed study material, i.e. cognitive learning, mainly in arts subjects. However, using audio and video recordings, computer programs, and other media, a great number of other subject areas have shown themselves to be accessible and learnable at a distance. With quantitative subjects, both the lecturer and the student expend great effort but the electronic learning materials can be used to encourage and motivate students to become active participants in the learning process.

The main objective of this paper is to describe a project undertaken by the Department of Economics and Business at the Open University of Catalonia (UOC) to develop web based guides for Introduction to Financial Mathematics (IFM hereafter). The purpose of this new set of electronic materials was to help the students to understand the content of the subject as well as becoming familiar with the methodology employed in solving financial problems. In this way, the material enables students to control the focus, pace and direction of the learning process. In addition, the material allows students to use their initiative and take an active role in deciding which route to take through the material and the examples and exercises to be undertaken. This material can be used alone or as an additional teaching and learning resource. Moreover its structure could be useful as an example to develop new materials for other distance courses no matter the previous skills of the students. Finally, we also report on students' learning experiences using this material.

The remainder of the paper is organized as follows. Section 2 presents the UOC's model. Section 3 analyzes the main problems of learning a quantitative subject in a distance university. Section 4 provides the design of the e-learning web based guides. Section 5 presents the contents of the survey and results. Finally, Section 6 summarizes and concludes.

2 UOC'S Model

The Open University of Catalonia (UOC) was created in 1995 by the Catalan Government. At the UOC, as in other distance universities, students are often required to find far greater reserves of self-discipline and time management skills than with other more conventional educational experiences (Calder and McCollum, 1998; Candy, 1991).

The UOC structures its educational strategy around the concept of a Virtual Campus. The Virtual Campus encompasses the support and learning area, where the student accesses resources and can interact with the university community. The fundamental nucleus of the UOC's pedagogical model is the Virtual Classroom. The Virtual Classroom is the area students are offered on Campus for each subject they have registered to study. At the UOC, there are two options for assessment. The first consists of passing a final exam. The second consists of a continuous assessment system. The later involves the execution of a set of activities that are guided and assessed by the Subject Tutor throughout the course of the semester. This assessment system guarantees that the student achieves the objectives for each subject and obtains the competencies for their particular qualification. In this way, the student is able to monitor their learning process continuously and evaluate their progress at any time. In the continuous assessment system, students are still required to pass a final exam, but it is shorter.

3 Problems of Learning a Quantitative Subject in a Distance University

As we have pointed out earlier, it is no easy task to teach quantitative subjects through distance courses. With IFM, students face two difficulties. Firstly, it is a quantitative subject which is offered in the first year at the UOC. This implies that students must have some previous knowledge of mathematics and for most students this is not the case. Secondly, students must know specifically how to approach financial mathematical problems and must do more than consult a textbook for the correct answer to a particular problem. When tackling problems, it is important to follow a methodology, such as understanding the information, identifying known and unknown variables, representing the information in a graphic form and finding the result. Therefore, students not only have to understand the concepts, but also have to acquire a methodology without this being explicitly provided for them. The acquisition of this methodology is easier to achieve within a face to face environment, but is extremely difficult in a distance course since professors face challenges to communicate effectively.

Before the design of the new material, a workshop was arranged, attended by teachers experienced in both distance learning and financial mathematics. The web material produced as a consequence of this workshop was then arranged within five web based guides.

4 Design of the e-Learning Web-Based Guides

Our first objective when designing the guides was to organize and prepare the contents and timings to facilitate the learning process. Therefore, we decided to organize materials and support resources into equally sized units. This is extremely important for our students as they have indicated they prefer to follow a format. A central tenet when designing the guides was that the student had the opportunity to understand the basic concepts of IFM and become familiar with the methodology employed in solving financial problems.

One of the requirements of the guides was that they must be short and easily linked in order to provide depth when required. Therefore the contents could be as long or as short as desired. Figure 1 illustrates the structure of the guides.

The web design allows the student to select which part/s or element/s he or she wants to practice or study in depth. As a result, within each guide, the available knowledge can be different for each student and is adaptable to meet their individual learning needs.

Each guide was organized in three sections: theory, practice and queries. Figure 2 shows an example of a guide. In the first section, a summary or an introduction to the

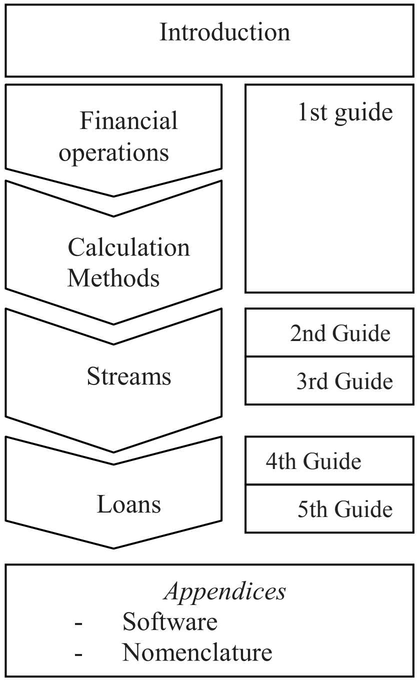


Fig. 1. Structure of the web based guides

guide is given and the contents of the unit are detailed. Some aspects have examples or additional teaching materials appended, which are linked and, again, the student can decide whether to use them or not.

The second section presents the learning activities. This includes worked examples and learning activities. In the case of worked examples, we presented two solutions for each example, a full solution and a more simplified one. This was provided to support the engagement of the most advanced students and reduce the opportunity for them to become bored by the process. Consequently, those students who just wanted to practise solving the exercises independently could identify whether they have solved the problem correctly or not by reference to the brief solution. Moreover, the solutions are always divided into three parts. The first part consists of a visual representation of the information including all the available data. The second part identifies the known and unknown variables and the necessary formulae to apply when solving specific financial problems. Finally, in the third part, the result is presented.

All worked examples and learning activities in the guides follow the same structure so that students can become familiar with the methodology employed when solving financial problems. The format is clear to enable students to identify miscalculations easily at an earlier stage without having to return to the step by step process, and this also has the advantage of preventing the students feeling that they are wasting time.

The extended solution was designed as a tool for use when practising the methodology to be followed and as a way of learning the concepts involved. The solution

Guide 2

Financial Streams I

1. Comprehension

A. Go to...

… Section 'Financial Streams', read 'Definition and classification', 'Valuation of a stream: present value and final value'.

B. Read the Section 'Constant continuous streams'.

C. Finally see this worked example.

Would you like a summary of what you have just learned? You have it here!
Would you like to know the most commonly made mistakes in this unit? Click here!

2. In depth study

We will now go through some worked examples to identify the concepts in use. It is not necessary to go through all of these if you feel you have understood the concepts.

- Exercises on constant financial streams (Exercises 3, 4, 5 and 6 are strongly recommended).
- If you would like to practice further, you can look at these Exercises, with the final solution given or these Exercises, which you can discuss with fellow students or your Subject Tutors.

3. Queries

If you still have questions and are finding it difficult to understand all the concepts, you might find it useful to contact you Subject Tutor. He or she can help to meet your learning needs. Go for it!

Other support resources:

- **Glossary of financial rents**
- **Formula/e of financial rents**

Fig. 2. Example of a guide

given here is more detailed and everything is explained as if the student were in a conventional university situation. The extended solution is considered to reinforce both the methodology and the theory.

In the full solution, the students are required to follow three steps to solve financial problems. Moreover, frequently made mistakes are shown and commented on. Apart from worked examples, the second section also presents a set of exercises to be solved by the students. They can discuss the results with their classmates and the Subject Tutor in the Virtual Classroom.

The guides also include a third section entitled Queries. We considered it necessary to inform students that Subject Tutors are available at any time if queries arise. This last step in the learning process is extremely important in distance learning. Finally, each guide concludes with what we call *Other support resources*. These are links that can be useful to complete the learning process and includes a glossary and a set of formulae used.

5 Survey and Results

In order to understand how the web-based guides impacted upon the learning process, we sent a survey to all the students enrolled on the course during the semester September 2006 – February 2007. We also compared the marks before and after using the guides. The questions focused on the structure of the guides and the extent to which students found them accessible, and whether they helped students in the development of a systematic methodology. Students evaluated their experience on a scale from 1 to 5, 1 being totally disagree and 5 being totally agree.

The survey and results are presented in Table 1. The responses showed that 80% of the students gave a positive response, agreeing or totally agreeing to almost all questions. 92% of the students considered that the full solution was useful for learning concepts and for practice (Question 2), with nearly 60% totally agreeing. Moreover, nearly 90% of students considered the three steps of the guides useful in understanding the exercises (Question 7). However, only 64% of students considered that there were enough exercises to practise (Question 3).

Questions 8 to 11 were introduced in order to evaluate whether design of material was important to encourage students to follow the continuous assessment system. It is interesting to note that 95% of students who responded used the guides to solve the continuous assessment tasks (Question 8). Around 90% of the students thought that the three steps were useful in solving the exercises (Question 7). It is also remarkable that 92% of the students considered that the guides were well organized and useful in solving the continuous assessment tasks (Question 9), with around 67% of the students totally agreeing.

These results suggest that we have achieved our aim of helping students to become familiar with the methodology employed in solving financial problems. Moreover, well organized and flexible materials allow students to be encouraged to follow a continuous assessment system.

Apart from the result of the survey, we wanted to know if the e-learning web-based guides had an effect on the students' marks and to this end we analyzed the number of students who passed final exam and the number of students registered over six semesters, three semesters before using the guides and three after using them. We observed that before using the guides, the pass rate was approximately 63% of students. However, after introducing the guides approximately 76% of students passed the subject. Thus, there is a noticeable difference between the pass rates in the semesters before and after the introduction of the e-learning web-based guides.

Table 1. Results of the survey

Questions	Totally agree	Agree	Indifferent	Disagree	Totally disagree
The guides were clear	30.1%	55.2%	7.7%	4.9%	2.1%
I used the "full solution"	59.4%	32.2%	6.3%	1.4%	0.7%
The number of exercises was enough	22.4%	42.0%	14.0%	18.9%	2.8%
The summaries of the guides were useful.	33.6%	43.4%	15.4%	6.3%	1.4%
The examples in the guides were clear.	34.3%	53.8%	7.7%	3.5%	0.7%
The examples were useful to internalize the methodology.	42.0%	44.1%	11.2%	2.8%	0.0%
The three steps of the guides were useful	49.7%	39.2%	9.1%	2.1%	0.0%
I have used the guides to learn the concepts and solve the continuous assessment tasks.	67.8%	27.3%	2.8%	1.4%	0.7%
The guides were well organized and useful in solving the continuous assessment tasks	46.9%	44.8%	3.5%	4.9%	0.0%
I used the three steps in solving the continuous assessment tasks.	37.1%	46.9%	9.8%	5.6%	0.7%
The guides and the material were enough to pass the subject	36.4%	45.5%	9.1%	7.7%	1.4%

6 Conclusions

New technologies have allowed commuting the learning model. Overall nature of the demand for distance education has changed with significant numbers of citizens choosing distance education for the convenience of not having to displace or neither to coincide in time (Gallagher, 2001). In response to such demand, universities and institutions have now reengineered themselves to offer flexible learning courses. Adopting distance learning implies that the design of courses is basic in order to be successful.

An important element to play with is the materials, which should be adaptable to anyone independent from their pervious skills. Therefore the way materials are presented can affect the learning process. In distance courses, it is the task of the professor to think how a subject can be designed in order to be flexible and easily understood by students. It is also important keep the materials up-to date (Pankratius and Vassen, 2005).

The main objective of this paper is to describe a new set of web-based learning materials for IFM. In order to do this, we have developed a set of five electronic learning guides which enables the student to follow the correct sequence of steps when attempting the exercises and gain appropriate depth of knowledge wherever it is necessary. The structure of this material could be useful to design other distance courses.

Finally, we also report on students' learning experiences of this set of electronic materials. The results show that the guides have helped students becoming familiar with the methodology employed in solving financial problems. In addition to this, the pass rate has increased after the introduction of the web-based guides. Our results suggest that the e-learning web-based guides have had a positive effect on the learning process of students.

References

Browne, C.: Academic Board: LTOP Working Party on Flexibility in Pedagogy, Final Report. Australia: Monash University (1999)

Calder, J., McCollum, A.: Open and Flexible Learning in Vocational Education and Training. Kogan Page, London (1998)

Gallagher, P.A., McCormick, K.: Student Satisfaction with Two-Way Interactive Distance Learning for Delivery of Early Childhood Special Education Coursework. Journal of Special Education Technology 14, 32–47 (1999)

Gallagher, M.: E-learning in Australia: Universities and the new Distance Education. Centre for Educational Research and Innovation OECD (2001)

Garrison, D.R., Shale, D.: Mapping the Boundaries of Distance Education: Problems in Defining the Field. The American Journal of Distance Education 1(1), 4–13 (1987)

Keegan, D.: The Foundations of Distance Education. Crom Helm, London (1986)

Ling, P., Arger, G., Smallwood, H., Toomey, R., Kirkpatrick, D., Barnard, I.: The Effectiveness of Models of Flexible Provision of Higher Education (2001), `http://www.dest.gov.au/highered/eippubs/eip01_9/default.htm`

Moore, M.G., Thompson, M.M.: The Effects of Distance Learning. Rev. ed. ACSDE Research Monograph No. 15. University Park, PA: American Center for the Study of Distance Education, Pennsylvania State University (1997)

Pankratius, V., Gottfried, V.: Reenginering of Educational Material: a Style Approach. International Journal of Knowledge and Learning 1(3), 229–248 (2005)

Perraton, H.: A Theory for Distance Education. In: Sewart, D., Desmond, K., Holmberg, B. (eds.) Distance Education: International Perspectives. Routledge, London (1988)

Phipps, R., Merisotis, J.: What's the Difference? A Review of Contemporary Research on the Effectiveness of Distance Learning in Higher Education. The Institute for Higher Education Policy, Washington (1999)

Sherry, L., Morse, R.A.: An Assessment of Training Needs in the Use of Distance Education for Instruction. International Journal of Telecommunications 1(1), 5–22 (1995)

Shurville, S., Browne, T.: ICT-driven Change in Higher Education: Learning from e-learning. Journal of Organisational Transformation and Social Change 3(1), 245–250 (2006)

Wernet, S., Olliges, R., Delicath, T.: Postcourse Evaluations of WebCT (Web Course Tools) Classes by Social Work Students. Research on Social Work Practice 10(4), 487–504 (2000)

Approaches to Knowledge Management in Greek Firms

Panagiotis Kyriazopoulos and Irene Samanta-Rounti

Technoligical Education Institute of Piraeus
Department of Business Administration
Marketing Laboratory
Petrou Ralli and Thivon 250 Aigaleo 12244 Athens Greece
pkyriaz@teipir.gr, isamanta@teipir.gr

Abstract. The purpose of this research is to examine knowledge-sharing in organizations from a number of aspects, including innovation culture, roles, structure, and teamwork and leadership creativity. **A** survey was conducted of 100 Greek firms and we interviewed top and bottom management using a questionnaire which comprised twenty-eight questions divided into five categories. Most organizations appeared to have a knowledge system but its existence does not guarantee its use. This can be largely attributed to the fact that knowledge-sharing initiatives are preoccupied with technology infrastructure as the basic knowledge-sharing enabler. Most of them fail to focus on the individuals who engage in knowledge-sharing. It was found that resistance by management and employees was a critically important factor influencing the success or otherwise of organizational knowledge efforts. Knowledge-sharing is difficult to accomplish in such circumstances According to our cluster analysis, two types of firms are identified: those which have benefited from KM to invest in innovative strategies, and those which have not.

Keywords: Knowledge Management, Innovation Culture, Leadership.

1 Introduction

The globalisation of product and service markets is accelerating. European firms face increasing competition not only for sales, but also for technical know – how and skills. In this environment, competitiveness at the company level depends crucially on the speed with which new products can be brought to the market place and on the importance of achieving new cost – saving improvements. Similarly, the creation of wealth and employment depends to a very large extent on the speed with which scientific and technological breakthroughs are converted into practical and attractive solutions. According to (Harari, 1994; Nonaka, 1994; West, 1992), the organizations that are able to stimulate and to improve the knowledge of their human capital are much more prepared to face today's rapid changes and to innovate in the domain where they decide to invest and to compete. It should be underlined that the knowledge development in the fields of technological innovations, specialisation on business processes, and innovative products is the strongest source of competencies. Moreover, all competitive efforts, which come from competitors' knowledge and

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 286–295, 2008.

innovations, dramatically affect the success of strategies (Gatignon and Robertson, 1993). (Curren *et al.*, 1992). (Cited in Carneiro A., 2000, pp. 87-98)

Innovation – the ability to reap the rewards of scientific achievement – requires much more than the ability to turn a new idea into a working product. Efficient flows of technology are not enough; ready supplies of finance and of business skills are also needed. There must be accessible protection for intellectual property and adequate incentives for entrepreneurial drive. In short, what is needed is a dynamic, self – sustaining culture of innovation (Kyriazopoulos, 2000).

The dimension of the innovativeness of firms is strongly determined by two economic variables, three organizational variables and one infrastructure variable. Specifically, the companies that demonstrate innovative leadership are characterized by a relative high contribution of machinery and equipment cost to their operations; devote relatively more company resources to R&D; consider innovative ideas promptly; have a strategic plan in operation that lead their team through a process to define what innovation really means inside their business unit (Ahanotu, 1998). The variables associated with this dimension of organizational innovativeness have been documented by many researchers in the past. Specifically, (Barney, 1991).has found that innovative firms spend more on R&D than the less innovative firms. Other authors, (Barney, 1991), (Ambastha. and Momaya, 2004) similarly (Danskin, 2005) documented that firms possessing internal technical expertise are more innovative than firms without such expertise. Finally, (Carneiro, 2000) and (Barney, 1991), among others, have shown that innovative firms co-operate with outside scientific and technical establishments and make deliberate efforts to survey externally generated ideas.

In every organization there are unlimited qualifications for the implementation of innovation and improvement. Simultaneously, employees should have plenty of time so as to process these primitive ideas. The purpose of this survey is to obtain an understanding of the level of knowledge-sharing the innovation culture of Greek firms; the strategies applied that aim to associate this knowledge with business targets, the application of the innovation values into the firm's internal environment. A number of aspects, including innovation culture, roles, structure, teamwork and leadership creativity are identified.

2 Literature Review

2.1 Knowledge Management

In the knowledge era, the viability and competitiveness of all kinds of organizations depend on their ability to create and share the knowledge. The dissemination and use of knowledge throughout the organization, in order to create innovation and sustain competitive advantage, is indisputably a core process for an active engagement into knowledge management initiatives. Firms are seeking to implement special knowledge management projects, which aim to *"...establish an environment conductive to more effective knowledge creation, transfer, and use"*. (Davenport, De Long and Beers, 1998). Studying thirty-one (31) knowledge management projects in twenty-four (24) companies, Davenport, De Long and Beers (1998) found out that organizations tend to focus on knowledge management projects that "...were trying to build awareness and cultural receptivity to knowledge, initiatives attempting to change behavior relating to knowledge, attempts to improve the knowledge management process".

Effective knowledge-sharing initiatives are exceptionally hard to accomplish in large and widely dispersed organizations. explain what happens when "...a firm grows beyond a small group"; "its growth outpaces the ability to maintain the level of personal connectivity required for effective knowledge-sharing, and which enabled the innovation which made the initiative possible to begin with". Orlikowski (2002) conducted an empirical study in a geographically dispersed high-tech organization to find that "...the competence to do global product development is both collective and distributed, grounded in everyday practices of organizational members" and it is not attributed to a "...particular technology or infrastructure, or any strategy or leader, or any specific set of design and production skills". Orlikowski (2002) identified a repertoire of five practices that enable the company to routinely and repeatedly enact a collective competence in product development work. The five practices are: Sharing identity (knowing the organization); interacting face to face (knowing the players in the game); Aligning effort (knowing how to coordinate across time and space); Learning by doing (Knowing how to develop capabilities); Supporting participation (Knowing how to innovate).

Despite all the diverse views, different knowledge management strategies are nothing but a different way that "...knowledge management initiatives try to foster the sharing of knowledge, ideas, and experiences, in whatever form, among individuals or groups" (Cabrera and Cabrera, 2002). Although knowledge thrives in organizations, its existence does not guarantee its use (Davenport and Prusak, 2000). "Convincing personnel to share their individual knowledge amongst themselves has, for years, been a promising yet elusive goal for many organizations"

2.2 Culture Embraces Innovation

A culture that embraces innovation is not just implemented to achieve product/service development process efficiency and customer relationships, but should be implemented throughout a company especially in strategic alignment or innovation initiatives with that are in line with a firm’s business goals, policies and processes (Sveiby , 1997). At the same time organizations focus toward the market when assessing and undertaking opportunities for innovation including risk acceptance and an understanding that inevitable mistakes and even failures are often the basis for future success. Also, support on exploratory thinking, idea generation and experimentation should be emphasised. Other crucial factors are related to interpersonal relationships and internal teamwork, with a climate of mutual commitment and support and finally cross-functional, cross-discipline communication, collaboration and teaming within the organization and with external partners (Christensen and Rosenbloom1995).

2.3 Creating an Innovative Business Environment

Innovation requires following a number of phases (Table 1) that have structural impact deliberately creating an environment in which Innovation is integrated into every

Table 1. Phases of the Innovation Process

Phase One	Executive Orientation
Phase Two	Innovation Camp
Phase three	Team Building
Phase Four	Leadership Coaching
Phase five	Performance Enhancement

process and where each individual in the company has adopted a culture of innovation (Ingram, 1997, Tidd, 2001).

3 Research Methodology

3.1 Construct Measurement

For the accomplishment of the research objectives, the questionnaire developed by the American firm Thunderbolt Thinking Inc., which specializes in re-organizing the internal environment of their companies- customers according to innovation, was used. Modifications made to the instruments included semantic changes to suit the needs of this study. For the purpose of the research, taking into account the economic environment of Greece, questions were including regarding globalization and the free market economy, the pressure from the competitors and the use of innovative processes.

The questionnaire was composed of 10 ordinals, 13 nominal and 6 scale questions. The items of the questionnaire was in the form statements on the 5-point Likert –type scale anchored on1=not important, through 5=critically important. The applied questionnaire refereed to issues, which are essential for the recording of the opinions of respondents. The topics were as follows: :

- Organization's approach and effectiveness to the innovation effort
- Leadership Competencies that Drive Innovation
- Resource Allocation and its Impact on Innovation Success

3.2 Sample Frame

This study consists a part of the author's doctoral thesis and the sample which participates consists of 68 firms with a satisfactory representation of different kinds of companies according to their personnel (0-50 people (66.3%), 50-150 people (15.1%) and 150 or more people (18.8%)) and the sector which B2B companies belong. The research conducted in Greece with the method of private interviews; the number of firms which responded was 32. The firms that finally composed the sample come from five various representative industrial sectors.The research took place in December 2006and January 2007. Finally the whole procedure was analysed using the statistical programme SPSS V.13.

3.2.1 Firm's Approach/Effectiveness to Innovation Management

Observing Table 2, it can be seen that the adoption of the procedures which will promote innovation in the company takes place according to plan and is based on organized methods.

Table 2. Firm's approach/effectiveness to innovation

Variables	*Mean*	*Median*	*Mode*
Firm has moved beyond hit-and-miss innovation to a more strategic approach that is aligned with organization growth strategies.	4,03	4	4,00
Firm has fostered a culture that expects everyone, at every level, to contribute to the innovation process.	3,81	4	4,00
Firm has built networks, pathways and platforms that promote the flow of innovation both internally and externally through alliances and partnerships.	3,56	3	3,00
Firm has adopted/adapted a step-by step funnel process that facilitates idea generation/collection right through the development of a business case and deployment of the new product/service/process.	3,63	4	4,00
Firm has created opportunities to learn by building systems that capture key leanings from the innovation process and communicate these leanings across the entire enterprise.	3,5	3,5	3,50

Firm has created somewhat opportunities to learn by building systems that capture key leanings from the innovation process and communicate these leanings across the entire enterprise (Table 3).

Table 3. Learning the innovation process across the entire enterprise

Communicate the innovation process across the entire enterprise.	Percentage
Not at all	9,4%
Somewhat	40,6%
Mostly	34,4%
Consistently and effectively	15,6%

As far as innovation benefits are concerned, a manager pay attention firstly at the satisfaction of the customers followed by loyalty on the firm’s brand and last is the employees’ performance (Table 4).

Table 4. Innovation benefits

Variables	Yes	No
Value creation in products/services	65,6%	34,4%
Customer satisfaction	87,5%	12,5%
Brand Loyalty	56,3%	43,7%
Employee performance	31,3%	68,7%

3.2.2 Innovation Sources

Table 5 shows that t the majority of the respondents, in order to create a product or to improve their processes, prefer mainly to research the procedures their competitors apply in the market.

Table 5. Creation of new product

Variable	Percentage
Standard procedure	25%
Research in competitors	56,3%
Creativity method	18,8%

Collaboration with external organizations is also considered to be an important innovation source. Table 6 indicates that most of the sample companies cooperate occasionally with an external organization such as universities, research institutes etc., to obtain useful information for potential market and technological changes .An important finding is that a significant portion of the same (28,1%) does not accept the concept of partnerships.

Table 6. Collaboration with external organization

Variable	Percentage
No collaboration	28,1%
Occasional collaboration	43,8%
Constant and long-term collaboration	28,1%

Regarding technology acquisition, Table 7 demonstrates that firms prefer to develop technology in their R&D department, considering research as the most reliable way of technological and competitive advantage. Access to innovation is created by the majority of the sample (53, 1%) through the development of a R/D department, which is also verified by the previous result concerning independence maintenance, while a small percentage (18,8%) develops innovative technology through a partnership.

Table 7. Technology acquisition

Variable	Percentage
Developed in the R&D department	53,1%
Buying royalties	3,1%
Buying equipment	25%

3.2.3 Leadership Competencies That Drive Innovation

The figures presented in the table below show that managers' leadership skills are sufficiently developed, providing the personnel with the right directions for innovative results Table 8.

Table 8. Leadership skills of innovation

Variables	Mean	Median
(Visionary Leadership) I take the mystery out of innovation by defining it. As a leader, I have lead our team through a process to define what innovation really means inside our organization/business unit. We've developed a clear, concise definition of innovation based on our organizational culture and internal/external parameters.	3,59	4,00
(Aligning for Success) Linking the innovation to our business goals. As a leader, I've positioned innovation within my business unit/department, as an integrated aspect of our organization's overall success--not as a gimmick. We have created an Innovation Model that ties our business strategies into the day to day innovative process	3,56	4,00
(Strategic Decision Making) Definition of challenges specifically. As a leader, I have targeted important challenges that require innovative solutions. I have prioritized these areas and I've allocated resources to ensure implementation	3,44	3,00
(Communication) Encouragement for active communications. As a leader, I've created an environment of mutual support among co-workers. I've facilitated discussion across the organization by helping to set up effective lines of communications no only in our own team, but also among other departments/divisions.	3,94	4,00

4 Factor Analysis

It is used the orthogonal factor model with the Principal Component method. The correlation matrix is analyzed and used the Varimax rotation method for better interpretation of the factors. The variables that were used for the growth of factor model were: Q_A_1 – Q_A_4 and Q_D_1 – Q_D_4. They are all of categorical – ordinal type Table 9.

Table 9. Total Variance Explained

Component	Rotation Sums of squared Loadings		
	Total	% of variance	Cumulative %
1	2.081	26.014	26.014
2	1.539	19.242	45.256
3	1.520	18.999	64.255
4	1.429	17.863	82.118

Extraction method: Principal Component Analysis.

Table 10. Factor Analysis

Variables	(Strategic Decision Making) m Challenges' definition	Loadings
1. Leadership Competencies that Drive Innovation	*Q_D_3: The leader has targeted important challenges that require innovative solutions and prioritized these areas and have allocated resources to ensure implementation.*	0.892
	(Communication) Active encouragement communications. The leader have created an environment of mutual support among co-workers. He has facilitated discussion across the organization by helping to set up effective lines of communications no only in our own team, but also among other departments/divisions.	0.771
	Q_D_2: (Aligning for Success) Link of innovation to our business goals. The leader has positioned innovation within business unit/department, as an integrated aspect of our organization's overall success--not as a gimmick. It has created an Innovation Model that ties business strategies into the day to day innovative process.	0.673
2. Organization's approach/ knowledge and effectiveness to innovation	*Q_A_4: Firm has adopted/adapted a step-by step funnel process that facilitates idea generation/collection right through the development of a business case and deployment of the new product/service/process.*	0.870
	Q_A_3: Firm has built networks, pathways and platforms that promote the flow of innovation both internally and externally through alliances and partnerships.	0.664
3. The fostering of knowledge dissemination to establish knowledge sharing initiatives	*Q_D_1: Visionary Leadership) I take the mystery out of innovation by defining it. The leader has leaded the team through a process to define what innovation really means inside the organization/business unit. It has been developed a clear, concise definition of innovation based on the organizational culture and internal/external parameters.*	0.808
	Q_A_1: Firm has moved beyond hit-and-miss innovation to a more strategic approach that is aligned with organization growth strategies.	0.770
4. Knowledge sharing culture	*Q_A_2: Firm has fostered a culture that expects everyone, at every level, to contribute to the innovation process.*	0.826

5 Conclusion

Knowledge management (KM) has been gaining ground in the management agenda, since it has been realized that caring for organizational knowledge is perhaps the only way to enhance innovation and achieve sustainable competitive advantage in the contemporary business environment. Knowledge management involves the fostering of knowledge creation, dissemination and use, aiming to transform individual knowledge and competence into organizational knowledge and shared practices. The establishment of successful knowledge sharing initiatives, however, is very hard to accomplish. As Davenport and Prusak (2000) point out, although firms do not usually lack knowledge, its existence does not guarantee its use. This can be largely attributed to the fact that knowledge sharing initiatives are merely preoccupied with technology infrastructure, as the basic knowledge sharing enabler. Most of them fail, however, to focus on the individuals that engage in knowledge sharing. As Koulopoulos and Frappaolo (1999) pointed out, "convincing personnel to share their individual knowledge amongst themselves has, for years, been a promising yet elusive goal for many organizations.

Firms face the difficult task of encouraging an innovative culture of sharing and networking, while at the same time maintaining a high level of individual expertise and excellence. Major tactics used (within the context of strong top management role-modelling and leadership) to encourage an innovation culture are continued investment in IT infrastructure in order to facilitate networking, change of performance measures and recognition structures to encourage team-based behaviour, emphasizing large-integrated-projects which require multidisciplinary and multifunctional participation. Innovation strategy is a core process and this is being strengthened through more effective management of knowledge, development of supporting systems and structures for innovation, development of appropriate strategic alliances and partnerships and an innovation culture which supports a knowledge organisation.

It was also noted that top-management has a tendency to develop an innovation culture, which has as a result a reference to a specific innovation strategy with specific procedures towards innovation with fast ways of innovation transmission, so that networks that promote innovation are developed. The respondents' development for creating scale economies is accomplished through occasional partnerships or stable long-term partnerships. The leadership skills that refer to innovation have to do mainly with communication development that meets the goals and innovation assessment of the company. These results lead to the verification of a human-centric system, which has the human factor as a priority, followed by technological equipment. Therefore internal effective communication creates the conditions for knowledge sharing.

References

1. Ahanotu, N.D.: Empowerment and production workers: a knowledge-based perspective. Empowerment in Organizations 6(7), 177–186 (1998)
2. Cabrera, A., Cabrera, E.F.: Knowledge-sharing dilemmas. Organization Studies 23(5), 687–710 (2002)
3. Carneiro, A.: How does knowledge management influence innovation and competitiveness? Journal of Knowledge Management 4, 87–98 (2000)
4. Davenport, T.H., Prusak, L.: Working knowledge: how organizations manage what they know. Harvard Business School Press, Boston (2000)
5. Davenport, T.H., De Long, D.W., Beers, M.C.: Successful knowledge management projects. Sloan Management Review 39(2), 43–57 (1998)
6. Cameron, D.K.S., Quinn, R.E.: Diagnosing and Changing Organizational Culture: Based on the Competing Values Framework. Addison-Wesley Series on Organization Development. Addison-Wesley Pub. Co., Reading (1998)
7. Ingram, H.: Performance management: processes, quality and team working. International Journal of Contemporary Hospitality Management 9(7), 295–303 (1997)
8. Nonaka, I.: The dynamic theory of organizational knowledge creation. Organization Science 5(1), 14–37 (1994)
9. Orlikowski, W.J.: Knowing in practice: enacting a collective capability in distributed organizing. Organization Science 13(3), 249–273 (2002)
10. NYJohnson, G., Scholes, K.: An Integrated Approach. In: Mifflin Company, Boston, Exploring Corporate Strategy, Houghton. Prentice Hall, London (1997)

11. Kyriazopoulos, P.: The Modern firm in the starting of the 21st century. In: 8th E-Commerce, pp. 284–323. Synchrony Ekdotiki Athens (2000)
12. Szeto, E.: Innovation capacity: working towards a mechanism for improving innovation within an inter-organizational network. The TQM Magazine 12(2), 149–158 (2000)
13. Thomond, P., Lettice, F.: Disruptive Innovation Explored. In: 9th IPSE International Conference on Concurrent Engineering: Research and Applications (CE 2002) (2002)
14. Tidd, J., Bessant, J., Pavitt, K.: Managing Innovation, Integrating Technological, Market and Organizational Change (2001)

Lecomps5: A Framework for the Automatic Building of Personalized Learning Sequences

Carla Limongelli[1], Filippo Sciarrone[3], Marco Temperini[2], and Giulia Vaste[1]

[1] Roma Tre University, Dept. of Computer Science and Automation,
Via della Vasca Navale 79 – 00146 Rome, Italy
{limongel,vaste}@dia.uniroma3.it
[2] Sapienza University, Dept. of Computer and Systems Science,
Via Ariosto 25 – 00184 Rome, Italy
marte@dis.uniroma1.it
[3] Open Informatica srl, E-learning Division,
Via dei Castelli Romani 12/A – 00040 Pomezia, Italy
f.sciarrone@openinformatica.org

Abstract. In the context of distance learning, Adaptive Web-based Educational System focus on personalization and adaptation, that is on “learner’s satisfaction”. In this paper we address *the other side of the coin*, that is the "teacher’s satisfaction" problem, which is quite seldom taken into account in educational systems. We present a new version of the Lecomps5 Web-based Educational System, a system capable of providing personalization and adaptation on the basis of learner’s knowledge, learning styles and learning progresses. In this new version, a framework provides the teacher with an easy and flexible tool for managing learning material, expressing different didactic strategies and sequencing personalized courses by means of an embedded planner. Such functionalities are supported by the system basing on evaluations of learner’s knowledge, learning styles, and learning progresses. We report on a first controlled experiment, we made to evaluate the “teacher’s satisfaction”.

1 Introduction

Modern research in distance learning focuses most attention on personalization and adaptation of courses to learner’s needs, as opposite to the traditional "one-size-fits-all" approach [2]. Lecomps5, presented in [9], is a Web-based Educational System, in which the learning experience can be personalized, making adaptive the learning content together with its delivery.

The personalization of the learning experience is sought for several reasons: individualized content, built up through appropriately designed learning resources, can be expected to be better accepted by the learner, as (s)he might better understand it and consider it relevant to her apparent needs; this, in turn, may have good effects on learner’s motivation and collaboration, and then in overall satisfaction. Such effectiveness can also let gain in efficiency, as better motivated learners may be more likely to qualify, and in good time. All the above motivations might be considered as different facets of the term “learner’s satisfaction”.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 296–303, 2008.

As a matter of facts, the aspect of "teacher's satisfaction" is quite seldom taken into account, while discussing about adaptive Web-based Educational Systems. Producing learning material is a task that needs a considerable effort by the teacher, but, often, the teacher is also asked to define appropriate metadata or rules in order to sequence the material in a suitable way. The first task can not be performed in an automatic way, but the second one can be made easier by suitable tools. So, we are seeking for a *light-as-possible* approach to course personalization, trying to focus on the aspects we think might affect personal satisfaction of both learner and teacher, good quality of the learning content, efficiency of its use and reuse, and good support to initial and continuing adaptation of the course to the learner (from both the content and presentation viewpoints).

In this work we address the "teacher's satisfaction" problem. In particular, we focus on the sequencing problem: Lecomps5 is improved with the Pdk Planner [5], and now provides the teacher with an easy and flexible tool for course configuration. If we examine some available adaptive educational systems, we see that sequencing is generally performed following two main approaches: sequencing given step-by-step to the students, through techniques such as adaptive link annotation and direct guidance, and sequencing that plans the entire learning path at the beginning, then modifying it, when the study does not succeed as it should. The first approach is applied, for example, in the AHA! System [6] and in the ELM-ART system [11]. The second approach is used in the DCG system [3] and in the IWT system [4]. Frequently, the sequencing techniques, are rule-based, such as in AHA!, or graph-based, such as in IWT. These techniques, however, lack in attention to teacher's needs, either requiring heavy teacher's work, or being useless for expressing different pedagogical approach or didactic preferences that the teacher might desire. The Lecomps5 system provides the teacher with an easy tool for managing learning material, for expressing different didactic strategies, and for sequencing personalized courses, both on the basis of student's knowledge, learning styles, learning progresses during the study, and on the basis of teacher's didactic strategies.

In the rest of the paper, Sec.2 illustrates the architecture of Lecomps5; Sec.3 details on the Pdk planner and shows advantages in its use for sequencing strategies from the teacher's point of view; Sec.4 presents an experimental system evaluation in a real instructional environment. Finally, in Sec.5 conclusions and future works are drawn.

2 The Lecomps5 System

We present a new version of the Lecomps5 system, presented in [9], where, with respect to the old version, it is possible to provide adaptation by means of a planner embedded in the system. This updated version is a web-based learning environment supporting teacher's, learner's and administrator's functionalities, capable to generate personalized and adaptive courses on the basis of the student's starting knowledge on the domain of interest, and on the basis of the student's learning styles. A personalized course, related to a given subject matter, is characterized by the Target Knowledge (TK) and by the Starting Knowledge (SK). TK is the knowledge to be acquired by the student through the course. SK is the learner's knowledge about the topic prior of the course. In the system, knowledge is represented by atomic elements, called

Knowledge Items (KI). A course is composed by a set of Learning Components (LC), i.e., learning objects enriched with the specification of the Required Knowledge (RK, prerequisites) and the Acquired Knowledge (AK), related to the learner's fruition of the component's learning content (both expressed as sets of KI); a value for the *effort* needed on the component by the learner is also specified; moreover the component contains different presentations of the learning material, according to the dimensions of Felder and Silverman's learning style theory [7]. The real acquisition of the AK of a given LC can be evaluated through post-tests, also included in the LC and related to the concepts managed there. All the LCs related to a given subject matter are collected together into a pool, that is a sort of knowledge database. The teacher defines prerequisite relationships among LCs. This task is made easy by the graphic visualization of such relationships, in a graph of LCs, as shown in Fig.1. Lecomps5 configures the personalized course for a given learner basing on her SK, measured by a pre-test, her TK, pre-stated by the teacher, and navigating the LCs, as arranged by the teacher in the graph. During the configuration process LCs are selected, such that their overall AK, together with the SK, covers the TK. The automated configuration of the course is achieved by the Pdk planner, as shown in next Section. LCs editing is performed through the FCK Web editor[1], while the graphical visualization of LCs in a pool and in personalized courses is obtained by producing SVG interactive web pages through the Graphviz system [8].

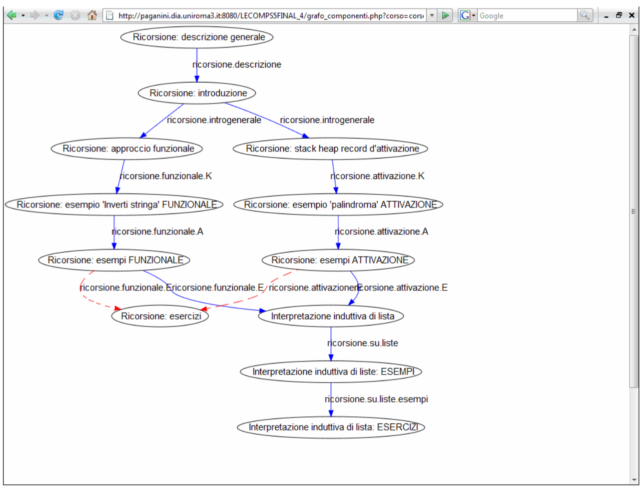


Fig. 1. The graph represents prerequisite relationships among Learning Components of the pool

3 The Planner

Here we show how automated planning can help the teacher to apply a didactic approach and how it can support sequencing and adaptation, handling with different learning styles as well.

[1] Available at http://www.fckeditor.net/ web site.

Course configuration problems can easily be seen as planning problems, where the learner is the executing agent, the initial world state is the initial student model (including her initial cognitive state and learning styles), and actions in the plan correspond to learning components of the pool (see for example [10] for an introduction to automated planning problems). When a learner executes an action, (s)he is offered fruition of a learning material according to her learning style. To understand such a material, the learner may need other knowledge (the action preconditions); after studying that learning material, and after a possible test, (s)he may be assumed to possess additional knowledge (the action effects). The plan goal corresponds to the course TK and course configuration corresponds to synthesizing a sequence of actions leading to the goal.

In *Artificial Intelligence* (AI) *planning*, planning languages are used to specify problems in a uniform and simplified way. Also for the case of course sequencing we want to use a tool that allows a plain specification of requirements for teachers and learners. Here we focus on logic-based planners, which can exploit some important functionalities such as: domain validation, redundant actions detection or control knowledge specification, helping the teacher during the learning components arrangement. In AI planning, the term *control knowledge* means the additional information that can enrich the planning domain (given as mere list of actions with their preconditions and effects) and guide the plan synthesis. For instance, once a pool is arranged, a teacher might want to specify that a given LC must be studied before another one also if there is not a prerequisite relationship between them, or that a sequential[1] student wants to alternate explanations and examples, while a global[2] student prefers to see first all the explanations and then examples. What is needed is a language that allows the teacher to specify such kind of "control knowledge". The Pdk[3] (Planning with Domain Knowledge) planner conforms to the "planning as satisfiability" paradigm, and the logic used to encode planning problems is the propositional Linear Time Logic (LTL) [12]. The related planning language PDDL-K [5] guides the user into the specification of control knowledge. Pdk accepts PDDL-K as input language, translates the problem description into its LTL representation and reduces planning to model search.

Moreover, in the didactic context the user is the teacher that can decide:

1. at which level some concepts must be given. Following *Bloom's Taxonomy* [1] we can differentiate LCs, for example at three levels: *Knowledge*, *Application* and *Evaluation*,
2. to sequence the LCs differently for different students' learning styles, e.g.: examples and explanations can be differently sequenced for global or sequential students,
3. that some contents are mandatory for all the students, even if they already know them, and wants to force the sequence to present these contents,
4. different didactic strategies: for example the teacher could decide to explain recursion either with the induction principle or activation records,
5. that knowledge can be "classified" in different categories (theoretic, exercises, examples, etc.), each category enjoying common properties: the teacher can specify

[2] According to Felder and Silverman learning styles theory.
[3] Available at http://pdk.dia.uniroma3.it/

that an action of a given category (for instance, an example) must always follow a given kind of action (theoretical material).
6. to define alternative prerequisites for given LC (see dashed arrows in Fig.1).

The use of control knowledge in planning domain description languages enriches the expressivity of relations among concepts and helps both in configuring optimized courses and managing the LC pool, as it will be shown in the next section.

Moreover, Pdk provides tools to support the *debugging* phase, by exploiting the fact that the planning problem is entirely encoded as a logical theory. In course sequencing, these tools can help in detecting "conceptual holes" such as about:

7. action executability: an action is not executable when its preconditions can never be satisfied; this happens in presence of *loops* in the components graph.
8. control rules redundancy, and coherence with the PDDL-K pool representation.

Some of the above cited features (1, 2, 4, 6) are already available in Lecomps5; the others can be easily implemented through suitable interfaces.

4 The Evaluation of the System

We carried out a first evaluation of the Lecomps5 system with the aim of measuring the efficiency and effectiveness of the proposed framework from the teacher's point of view. Efficiency stands for the costs-benefits ratio, i.e., what is the required overall workload, in terms of time spent to prepare the course, compared to the didactical benefits due to the system's use. By effectiveness we mean how good is the course proposed by the system, compared to the one proposed by the teacher himself. We followed the classical schema of a controlled experiment, performed in an environment where the human plays a fundamental role. Our main research questions are:

- RQ_1: Does Lecomps5 help the teacher to prepare his didactic plans?
- RQ_2: Is Lecomps5 able to generate reasonable didactic plans?
- RQ_3: What is the degree of teacher satisfaction after using Lecomps5?

We implemented an experimental plan, by firstly selecting a sample of twenty computer science teachers, and then applying the following steps: test administration, experimental data gathering and results evaluation.

Test Administration

The chosen learning domain was *Recursion*, supported by an experimental pool with twelve LCs. A sample LC was *Ricorsione:introduzione* (Recursion:introduction); another was *Ricorsione:esercizi* (Recursion:exercises). According to our research questions, we submitted our sample to two different tasks. In the first task, hand-written, teachers were required to write down two distinct learning sequences, to deal with two different learner's profiles in the same Recursion learning pool. To this aim first we prepared a questionnaire, suited to measure the student's SK on the domain; then we simulated two different sets of answers for two distinct student profiles, referenced in the following as Profile A and Profile B and, finally, we submitted these profiles to the teachers and had back the proposed learning sequences. Such sequences were to be built only by LCs from the experimental pool, made available to the teacher. In the second task, teachers were required to actually use Lecomps5 and to build a learning sequence accomplishing the same learning goal as in the first task. Teachers were invited to firstly complete the specification of the learning components of the pool (submitted incomplete on purpose), by stating their RKs and AKs. Then the system was used to automatically configure two learning sequences, one for each of the above mentioned learner's profiles.

Data Gathering

We gathered the following data for every teacher involved in the experimentation: two learning sequences, hand-written, one *happy sheet* on the satisfaction degree in the use of Lecomps5, two learning sequences produced by the system, and a questionnaire in which each teacher assessed the learning sequences produced by the system and compared them with those produced by himself.

Statistical Analysis and Results

In Fig.2 the experimental results, concerning the teacher assessments for both profiles A and B are shown. In the figure, the x-axis is the ordinal scale ranging from –10 to +10; the y-axis, for every value of the ordinal scale, reports the frequency of teachers choosing that value. For the profile A, i.e., a student with an empty starting Knowledge on the recursion domain, the teachers assessed a good similarity degree between their hand-written course, compared to the one produced by the system. In fact, the 40% of the sample, i.e., eight teachers, gave "6" as similarity degree, that is the two courses were similar enough. The remaining 60% of the sample, i.e., twelve teachers, assessed "8" as similarity degree, i.e., a very high value of similarity degree. In both cases, for this profile, the teachers judged as positive the courses produced by the system. For the profile B, i.e., a student with a poor starting knowledge, 20% of the teachers, i.e., 4 teachers, evaluated the work of the system very similar to their hand-written work, giving "8". Four teachers, that is the 20%, gave "0", assessing in this way a neutral position with respect to the course produced by the system. Finally, twelve teachers, i.e., 60%, gave "4", assessing a sufficient degree of similarity.

In conclusion, we can say that both our experimental frequency distributions are entirely contained in the right part of the "0" point and consequently we can deduce that for both profiles the system performed well, as assessed by our sample.

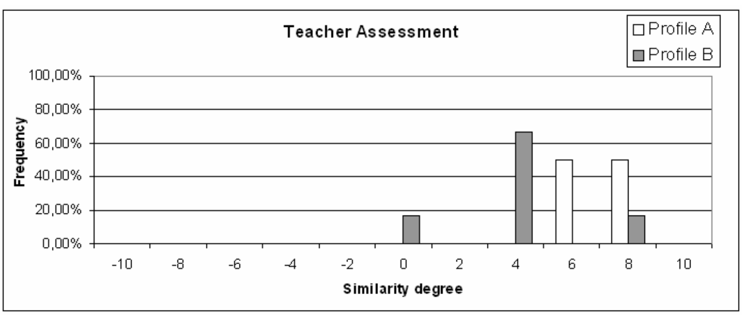


Fig. 2. Teacher assessment on similarity degree

In Fig.3, we show the distribution frequency of the answers to question Q2, with the same ordinal scale of the previous case, for both A and B student profiles. By this question we want to measure the didactic quality of the course produced by the system, also in case it is different from the one produced by the teacher.

Again, for the A profile, the frequency distribution is shifted right of the "0" point, indicating that courses produced by the system are indeed reasonable. The 33,3% of the teachers gave "8" and "10", assessing in this way a very good capability of the system in producing didactically valid courses. Values of "2" and "6" were assessed by the 16,7% of the sample.

For the B profile, the frequency distribution was less positive, but however, with the 84% of the values in the right part with respect to the "0" point.

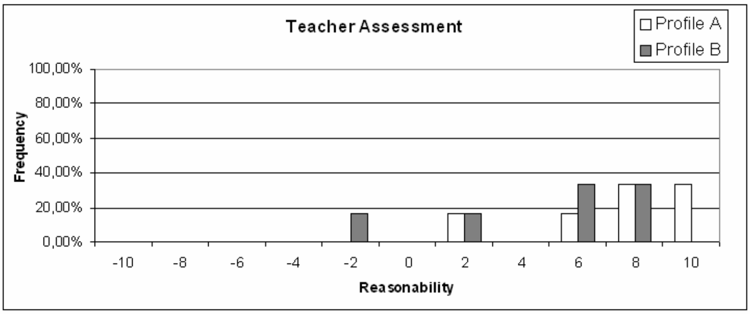


Fig. 3. Teacher assessment on reasonable quality of the course produced by the system

We submitted an *happy sheet* to the teachers, asking for their degree of satisfaction in using the system, together with other questions concerning the time spent to complete the task, with the goal of gathering some indications about usability as well. For example to the question: *How much do you consider the Lecomps5 system useful in preparing learning courses?,* the 50% of the sample answered "useful", 25% "very useful" and 25% "not so useful", with respect to an ordinal scale ("useless", "not so useful", "indifferent", "useful", "very useful").

This first experimentation of the system gave positive indications about usefulness and didactic reliability of the system. Our sample's assessment seems to say that automatically produced courses are reasonable enough, and similar enough to those produced by the teacher.

5 Conclusions and Future Work

The issue of how to define, manage and deliver personalized didactic courses is of great relevance in the evolving knowledge society. Nowadays, the knowledge that one can use comes out to be an asset of economic value. So then, transmitting knowledge (in general) and training learners (in our particular case), by using the internet and in a most efficient way, is a facet of how technology can be used to produce wealth. In such formative actions, personalization is a key issue, allowing to gain in efficiency and effectiveness.

In this paper we presented an upgraded version of the Lecomps5 system, a Web-based Educational System, addressing the "teacher's satisfaction" problem. The teacher, through the system, and through a graphical environment, is able to configure the learning components which the knowledge domain is based on. We performed a controlled evaluation of the system by means of statistical analysis with encouraging results supporting our approach. We plan, as next steps in our ongoing research, to extend the PDDL-K language with new syntactic elements that would help the teacher in arranging the pool of learning components and to improve the usability of the system in order to allow the teacher to communicate in a more effective way his didactical strategies to the system.

References

1. Bloom, B.S.: Taxonomy of Educational Objectives. David McKay Company Inc. (1964)
2. Brusilowsky, P.: Adaptive Hypermedia. Journal of User Modeling and User-Adapted Interaction 11, 87–110 (2001)
3. Brusilowsky, P., Vassileva, J.: Course sequencing techniques for large-scale webbased education. International Journal of Continuing Engineering Education and Life-long Learning 13, 75–94 (2003)
4. Capuano, N., Gaeta, M., Micarelli, A., Sangineto, E.: Automatic student personalization in preferred learning categories. In: 3rd International Conference on Universal Access in Human-Computer Interaction (2005)
5. Cialdea Mayer, M., Limongelli, C., Orlandini, A., Poggioni, V.: Linear temporal logic as an executable semantics for planning languages. J. of Logic, Lang. and Inf. 1(16), 63–89 (2007)
6. De Bra, P., Smits, D., Stash, N.: Creating and delivering adaptive courses with AHA! In: Nejdl, W., Tochtermann, K. (eds.) EC-TEL 2006. LNCS, vol. 4227, pp. 21–33. Springer, Heidelberg (2006)
7. Felder, R.M., Silverman, L.K.: Learning and teaching styles in engineering education. Engineering Education 78(7) (1988)
8. Gansner, E.R., North, S.C.: An open graph visualization system and its applications to software engineering. Software – Practice and Experience 30(11), 1203–1233 (2000)
9. Limongelli, C., Sciarrone, F., Temperini, M., Vaste, G.: LECOMPS5: A Web-Based Learning System for Course Personalization and Adaptation. In: IADIS International Conference e-Learning 2008, Amsterdam, The Netherlands, July 22 - 25 (accepted, 2008)
10. Russel, S., Norvig, P.: Artificial Intelligence: A Modern Approach. Prentice-Hall, Englewood Cliffs (2003)
11. Weber, G., Brusilovsky, P.: Elm-art: An adaptive versatile system for web-based instruction. International Journal of AI in Education 12(4), 351–384 (2001)
12. Wolper, P.: The tableau method for temporal logic: an overview. Journal of Logique et Analyse 28, 119 (1985)

Evolving Mechanisms of Virtual Learning Communities: Lessons Learned from a Case in Higher Education

Angelo Corallo*, Marco De Maggio, Francesca Grippa, and Giuseppina Passiante

e-Business Management Section, S.S. ISUFI,
University of Salento, Via per Monteroni snc, 73100 Lecce, Italy
{angelo.corallo,marco.demaggio,francesca.grippa,
giuseppina.passiante}@ebms.unile.it

Abstract. This paper presents an explorative case of a Virtual Learning Community built around a Master's Program intended to create "e-Business Solutions Engineers". To monitor the evolution of the learning community we applied a methodological framework composed of four dimensions: knowledge improvement, mental models' evolution, social networks dynamics, and overall satisfaction measurement. The analysis of data, collected through ten months of exchanged e-mails and five monthly web-surveys, has been validated through interviews to a key informant. The application of Social Network Analysis provided a dynamic visualization of the interactions that we matched with the learning outcomes at individual and team level.

Keywords: Web 2.0 applications, Social Network Analysis, Virtual Learning Community, Project-based Learning Strategy, Technology Enhanced Learning.

1 Introduction

During the last decades several research has been spent in focusing and explaining the effectiveness of collaboration in both working and learning environments. Accordingly, the main contributions [1] identify clearly the importance of interactivity as the determinant of positive performances in learning communities where the supportive dimension of exchanges is balanced by the interactive one.

This paper presents an explorative case of a Virtual Learning Community built around a Higher Education Program intended to create "e-Business Solutions Engineers". The adoption of a project-based learning strategy required a constant collaboration between peers and tutors, as well as with industrial and academic partners who were constantly involved in the Program's activities.

Collaboration was facilitated by the use of a technological platform that enabled the creation of personal and team blog, a forum and a wiki around the topics of new product development in the aerospace and software industry.

* Corresponding author.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 304–313, 2008.

2 Theoretical Background

Knowledge is a social product, built from the community's general need to understand and solve problems [2]. Different perspectives emerge in literature among the scholars who support the recognition of learning and knowledge creation as a social and cognitive construction.

According to some of them, the theoretical explanation of "collaborative learning effectiveness" relies on the theory of Social Interdependence [3], whose central focus is the analysis of connections between the behavioral dimension of interacting individuals and the influence of this group's behavior on the learning outcome. A positive interdependence is generally related to the cohesion of a group where people support each others in the commitment toward the achievement of the stated group's goal [4].

Another perspective points the importance of cooperation for new elaboration: since learning represents the process by which knowledge is created and shaped into new and meaningful information, it is more effective when learners elaborate on new material [5]. Accordingly "cooperative learning" increases elaboration through higher-order thinking, metacognitive processes, and divergent thinking [3].

The constructivist perspective recognizes "interaction" as a key success dimension of working against isolation [5]. The behaviorists, although they follow a teacher-centred, systematic and structured approach, recognize collaborative interactivity as a way to reinforce group activity and rewards for learning [6].

The perspective of learning as a social-dialogical process [7] points the social dialogue as the best practice for the creation of learning communities, able to develop among their members the awareness of plurality of ideas and different contributions to the solution of problems, of the multiple ways of viewing the world, and of the importance of collaboration for both the team and the personal growth [8].

Further improvement has been expressed in literature about the correlation between the social and the cognitive dimension of learning, giving proof of the impact of social settings not only on the process of learning but also on the learning outcomes [3], [9]. Accordingly, the characteristics of a setting conducive for productive learning became a central focus of interest in both social and cognitive theories. As Ruth Geer pointed in 2000, traditional pedagogy has been quite clear about the physical or virtual place where socialization should take place: it should be outside the formalised structure of the classroom.

Wide evidence has been provided in literature about the effectiveness of collaborative learning environments enabled by advanced technology [1], [10]. In particular, Web 2.0 technologies have emerged to represent a valuable vehicle for more personalized learning system, mainly for their property of enabling processes of knowledge sharing, participated learning and continuous flows of ideas within and across the community [11]. They place learners at the centre of online activities and enable new types of collaboration and consumption. A social constructivist paradigm has been used to explain the success of Web 2.0 applications, especially Wikis, in making the learning process more effective [12], [13]. Blogs and wikis represent "social software" able to support users to develop Web content in a cooperative way [14]. They are able to create positive interdependence of group members, future face-to-face meetings, individual accountability, and appropriate use of collaborative skills [15], [16].

The creation of effective collaborative learning environments implies deepening the social aspects of collaborative learning and the needs for the identification of methodological frameworks able to move from the theoretical assumptions about the learning process to face the challenge of monitoring the evolving mechanisms of learning communities, to provide suggestions on the cultural and structural aspects to improve, to support collaboration, as well as to map the areas of improvement.

3 Problem Identification

Since the "community" dimension is recognized as an effective setting to facilitate the improvement of individual and team performance, many education programs, as well as corporate training initiatives considered the development of communities a strategic process enabling competencies' growth. Developing managerial competencies requires a learning-by-doing pedagogy which can be easily translated into workplace learning (learning-while-doing). If the effectiveness of the "community-based learning" is strongly confirmed in literature [17], the shift from a traditional and "closed" classroom context to an "open" community setting still requires empirical evidence in terms of mechanisms to monitor the community's boundaries and evolution. To address this challenge, our paper is built around the following research questions: "*How to monitor the evolution of a learning community?", "How to discover the drawbacks in the process of individual development and team growth in the context of a collaborative learning community?"*. We propose a methodological framework to scan the individual and collective dimensions of a Virtual Learning Community built around a Higher Education Program. Such a framework has been applied to monitor the ongoing critical areas in the community, and it has been tested by measuring the reactions of the community after the corrective interventions.

4 The Case of a Collaborative Master's Program

Our study's population consisted of a learning community composed by Masters' students, tutors, mentors and external actors from industry and academic institutions. The Master's Program was jointly organized by the e-Business Management School, University of Salento, Italy and industrial partners in the software and aerospace industry. The mission was to create *e-Business Solutions Engineers* able to design:

a) new *organizational architectures* for industrial districts through the analysis and reengineering of critical business processes using advanced ICT tools;
b) new *ICT platforms* for the integration of innovative services adaptable to specific situations.

Compared to the traditional pedagogy, the approach to competencies' development in the Master's design had significant differences in the *Content* and *Delivery* dimensions, as well as in the *Learning Strategy*.

a. *Content Dimension*. Students were exposed to a dialectic process of inquiry based on knowledge domains: *Business Management* (Globalization Forces, Innovation

Management, Business Profitability); *Technology Management* (e-business solutions, Knowledge Management Systems); *Internet Business Management* (e-business models, Business Process Redesign).

b. *Learning Strategy Dimension.* The learning approach was "learner centered" integrating learning-in-action, project-based, case-based, community-based and collaborative learning strategies. It applied an "on-demand" teaching approach: students attended "basic modules" and were then encouraged to propose personal or team sessions when a knowledge gap emerged. Accordingly, the Master's Program was organized in three phases:

1. *Learning Community Creation*: a four month-phase with specialized seminars held by academic and industry testimonials, to acquire business and technology management fundamentals.
2. *Project-Assignment*: a six month-period in the School's section dedicated to improving methodologies and techniques of new product development.
3. *Internship*: three months spent in companies in the aerospace and software industries.

c. *Delivery Dimension.* In the *Learning Community Creation* phase, students and tutors had the task to create a web 2.0 platform to facilitate collaborative learning. The Wiki they built used an open source content management system called "Plone", built on top of the Zope application server. Other available collaboration tools were a forum and a blog, which helped the learning community to co-create the content within the wiki.

5 Conceptual Framework

To identify the mechanisms influencing the evolution of Virtual Learning Communities we propose a conceptual framework where the community is analyzed at two levels: *Individual Growth* and *Team's Growth* (see Figure 1).

The *Individual Growth* is function of the *Personal Development* and of the *Overall Satisfaction* reported by students. Personal development is operationalized using

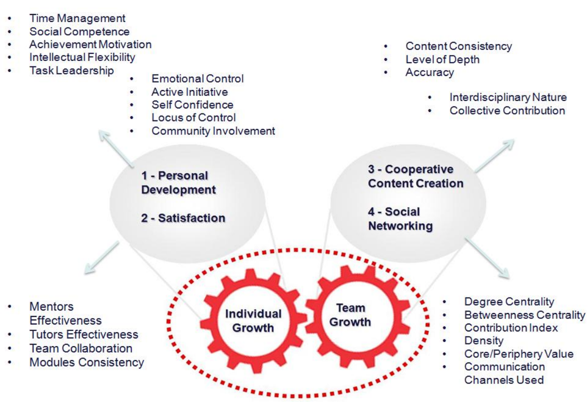


Fig. 1. Conceptual Framework to Monitor Learning Communities' Evolution

indicators like self-esteem, emotional development, communication skills, while satisfaction is translated in the assessment of mentors' and tutors' support and the evaluation of the learning modules. The *Team's Growth,* is related to the evolution of the content and the connections generated. The evaluation of the knowledge created (*Cooperative Content Creation*) is operationalized through variables like content consistency and accuracy. The *Social Networking* dimension is interpreted looking at social network indicators like: degree and betweenness centrality [18], contribution index [19], density, core/periphery fitness value.

6 Research Methodology

We chose the "case study" as research methodology for testing the framework for several reasons: firstly, the case study strategy is consistent with the aim of understanding complex social phenomena dealing with the holistic and meaningful characteristics of the real-life events; second, for the extent of control over behavioural events as well as for the focus on contemporary events, the case study strategy is more suitable to develop contemporary events' analysis [20].

Consistently with the research's objective, the learning community is the unit of analysis. We considered two areas of variables in developing the framework. Within the area of *Individual Growth*, we used the "Life Effectiveness Questionnaire (LEQ)" tool designed by [21] Neill, Marsh and Richards (2003) to acquire data on the *Personal Development* dimension. It is based on the following items:

- *Time Management*: the individual ability to make efficient use of time
- *Social Competence*: the individual ability to be effective in social situations.
- *Achievement Motivation*: the more a person is motivated to achieve, the more likely it is that he/she will reach the his/her objective.
- *Intellectual Flexibility*: the ability to adjust personal views to accommodate the ideas of other people.
- *Task Leadership*: ability to perform in a leadership role when required
- *Emotional Control*: ability to deal with emotions under difficult situations.
- *Active Initiative*: ability to actively initiate new actions and thoughts
- *Self Confidence*: individual general self-esteem, self-efficacy and confidence.
- *Locus of Control*: feeling of responsibility for the proper own action.
- *Community Involvement:* how much a person enjoys working with others.

As for the dimension *Overall Satisfaction*, factors like mentors' and tutors' effectiveness, assessment of the team collaboration and learning modules' consistency were investigated to complete the understanding on the individuals' commitment into the Program. Within the area of *Team Growth,* we applied the following *Social Network* metrics:

- *Degree Centrality*: the number of other points to which a point is adjacent.
- *Betweenness Centrality*: to identify actors who can act as *gatekeepers* controlling the flow of resources between the alters that he or she connects.
- *Contribution Index*: the communication frequency in terms of sent/received e-mails.

- *Group Degree Centrality*: the number of nodes connected to group members.
- *Group Betweenness Centrality*: the proportion of geodesics connecting pairs of non-group members that pass through the group.
- *Network Density*: the number of ties divided by the total possible number of them.
- *Core/Periphery Fitness Value*: to identify the presence of dense, cohesive core and sparse, unconnected periphery.

As for the dimension *Cooperative Content Creation* we analyzed the following dimensions: a) content consistency, b) level of analysis in describing the wiki content, c) accuracy in reporting information and references, d) interdisciplinary nature, e) collective contribution.

6.1 Data Collection

We used a triangulation of data to collect information on the individual and team development . We conducted focused interviews with the Program's Coordinator, we gathered the e-mail exchanged by students, and we administered online questionnaires with a response rate of 100% (see Table 1).

Table 1. Summary of the research techniques used in the study

	Dimension	Research Technique
Individual Growth	**Satisfaction**	Web-Questionnaire: 27 questions to measure the level of satisfaction. Measurement Scale from 1 (=very low) to 8 (=very high)
	Personal Development	Web-Questionnaire: 18 items to describe learners' profile and its evolution over time. Measurement Scale from 1 to 8 with the following meaning: 1-2: This statement doesn't describe me at all 3-4: More false than true 5-6: More true than false 7-8: This statement describes me very well
Team Growth	**Social Networking**	E-mail boxes of the 10 Master's students collected for 10 months. The e-mailboxes of the 10 Master's students were directly taken from the server.
	Cooperative Content Creation	Semi-structured Interviews: A key informant was asked to assess the two wikis created by students according to Content Consistency, Level of Depth, Accuracy, Collective Contribution. Measurement scale from 1 to 7 (1=very low, 7=very high)

6.2 Data Analysis

The analysis was based on matching indicators of individual and team level growth, so to test the validity of the framework. To discover potential areas of improvement, we continuously observed the evolution of the main indicators, the pattern of communication, the informal roles emerging in the community, the satisfaction level. The

Personal Development and the *Satisfaction* indicators were plotted as graphs within a report available to the tutors on the Master's portal.

In order to dynamically visualize the communication patterns within the learning community, we adopted the methodology of Social Network Analysis and a software tool able to provide a dynamic visualization of the connections over time [22].

The overall analysis was articulated on a three steps process. The *first* step was to look at the evolution over time in terms of social interactions, to identify peaks and trough in the community's evolution and observe the emergence of informal roles (i.e. ambassador, gatekeeper, boundary spanner). The *second* step consisted of comparing the insights emerging from the network analysis with the data on *Personal Development* and *Satisfaction*. The *third* step was to match this data with the assessment of the *Cooperative Content Creation*.

7 Results and Discussion

As for the dimension of *social networking*, we analysed the interactions within the community and we plotted the trends in terms of *Degree* Centrality, *Betweenness Centrality and Contribution Index*. The network increased in 10 months from 30 connections among 17 nodes to 316 connections among 103 nodes, indicating a progressive extension of the community's boundaries.

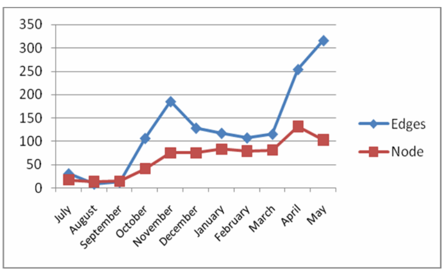


Fig. 2a. Edges and Nodes over time

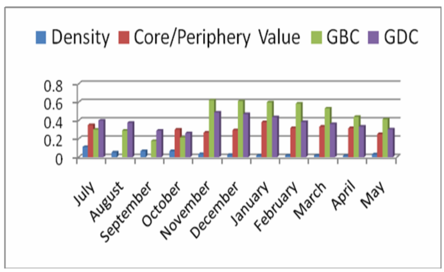


Fig. 2b. Group Level Indicators Over Time

Looking week by week at the evolution of the social network indicators (Figure 2.b) we noticed a shift in the period "October-November", in terms of *Group Betweenness Centrality (GBC)*, together with an increase in the number of actors within the network. The value of *GBC* is 1 for a perfect star structure, where one person dominates the communication, and is equal to 0 when the information flows more freely. Three trends emerged by comparing the Social Network Analysis insights with the *Individual Growth* data.

As first trend, we observed a growth in the *Satisfaction* index (Figure 3.a) from September to October (0.3 average increased value). The trend changed in the next month when no increase was recorded. At the beginning of November the learning community's members expressed less satisfaction and were less motivated. The second trend was a decrease in the *Personal Development* indicator (Figure 3.b): for the first two months there was no improvement in the reported values of personal

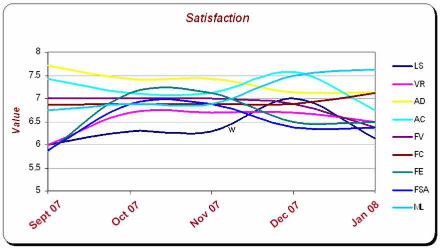


Fig. 3a. Satisfaction Over Time

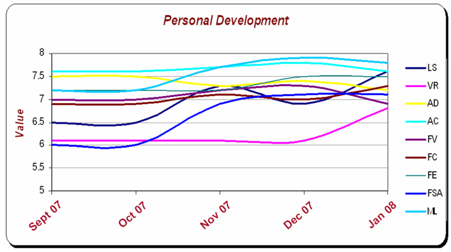


Fig. 3b. Personal Development Over Time

development, which then increased at an average rate of 0,27 at the beginning of the third month, when the aerospace wiki was presented to external companies.

At the beginning of November a clear trend is visible by matching the *Social Networking* of the community with its overall *Individual Growth* expressed by the average value of the stated dimensions (Figure 3.c): at the beginning of November the community started to develop an internal organization, with central figures performing the role of coordinators or gatekeepers; at the same time the group was experiencing an improvement in the personal growth, and a decreasing in the average "personal satisfaction and motivation". We interpreted this trend as an expression of the maturation process of a community's phase, and of the need to intervene in the course program to create new stimuli for the students.

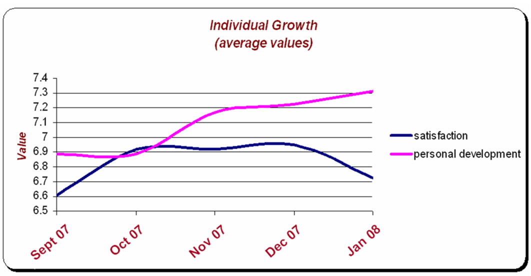


Fig. 3c. Individual Growth: Average Values of Satisfaction and Personal Development

The third trend is visible by matching the above described results with the assessment of the *Cooperative Content Creation* made by the interview to a key informant. Until October 2007 students had the goal to finalize and present the *aerospace wiki* to the managers of the partner companies. In this phase, the community had been inwardly oriented, only focused on the specific task. After the final presentation to managers, the students were in a period of increased self esteem, higher awareness of their increased competencies, and at the same time they perceived they need to advance their level of knowledge in the aerospace and software industry.

The discussion of these insights with the Program Coordinator led to the decision to promote a new *software wiki* project. In the same period, the increase in GBC

(+27%) was associated to a higher involvement of the software companies' managers as speakers in the master's, in order to better contextualize the wiki content. The result was a better satisfaction in what they were doing (with a further increase of the average value of about 0.05), a higher pride and a social network structure more centralized around the mentors coming from academia and industry.

The process of continuous monitoring the community through the application of the framework allowed the Coordinator to manage the group through a direct satisfaction of individual specific needs, related to both the relational dynamics and the competence development process, planning time by time individual meetings with members who had irregular trends in some of the selected indicators. The results of the analysis suggested also to open the community to new members, extending its boundaries to include testimonials from partner organizations.

8 Conclusions

The methodological framework has been used to monitor over time the areas where the Master's community and the individual student required more attention. It was intended as a warning system to identify significant phases in the evolution of the learning community. The analysis permitted *ad-hoc* activities such as specialized seminars, meetings, one-to-one coaching. The set of instruments and metrics we used helped to identify development gaps in the individual and team growth. It allowed to follow the changing patterns of a virtual learning community, providing a deeper comprehension of the phases in its lifecycle. The application of the framework provided tangible managerial inputs that shaped the Direction's proposal to intervene "*in fieri*" trying to adjust critical trends at both individual and group level. The results of the analysis will be presented to the involved learning community at the end of the program, to be studied under the perspective of the same population that represented the unit of analysis of the work.

References

1. Hiltz, S.R.: Collaborative learning in Asynchronous Learning Networks: Building learning communities (1998), `http://eies.njit.edu/~hiltz/collaborative_learning_in_asynch.htm`
2. Johnson, D.W., Johnson, R.T.: Cooperation and the use of technology. In: David, J. (ed.) Handbook of Research for Educational Communication and Technology, pp. 1017–1044 (1996)
3. Geer, R.: Social Interdependence in Collaborative Interactivity in an Internet Based Learning Environment (2000), `http://www.unisanet.unisa.edu.au/cccc/papers/non_refereed/geer.htm`
4. Johnson, D.W., Johnson, R.T.: Cooperative Learning and Social Interdependence Theory (1998), `http://www.clcrc.com/pages/SIT.html`

5. Susman, E.B.: Cooperative Learning: A review of factors that increase the effectiveness of cooperative computer-based instruction. Journal of Educational Computing Research 18(4), 303–322 (1998)
6. Deutsch, M.: Homans in the Skinner Box. In: Turk, H., Simpson, R. (eds.) Institutions and Social Exchange, Indianapolis, Bobbs-Merril (1971)
7. Duffy, T.M., Cunningham, D.J.: Constructivism: Implications for the design and delivery of instruction. In: Jonassen, D.H. (ed.) Handbook of Research for Educational Communications and Technology, Macmillan Library Reference, New York (1996)
8. Scardamalia, M., Bereiter, C.: Computer Support for Knowledge-building Communities. In: Koschmann, T.M. (ed.) CSCL: Theory and Practice of an Emerging Discipline, pp. 249–268. Lawrence-Erlbaum Associates, Mahwah (1996)
9. Jonassen, D.H., Peck, K.L., Wilson, B.G.: Learning with Technology: A Constructivist Perspective, Merrill. Upper Saddle River, New Jersey (1999)
10. King, J.L., Doerfert, D.L.: Interaction in the distance education setting (1996), `http://www.ssu.missouri.edu/ssu/Aged/NAERM/s-e-4.htm`
11. Delich, P.: Pedagogical and interface modifications: What instructors change after teaching online, Published doctoral dissertation, Pepperdine University, Malibu, CA (2006), `http://proquest.umi.com/pqdlink?Ver=1&Exp=09-09-2012&FMT=7&DID=1144195631&RQT=309&attempt=1`
12. Miers, J.: Belts or Braces? Technology School of the Future (2004), `http://www.tsof.edu.au/research/Reports04/miers.asp`
13. Higgs, B., McCarthy, M.: Active learning – from lecture theatre to field-work. In: O'Neill, G., Moore, S., McMullin, B., Dublin (eds.) Emerging issues in the practice of university learning and teaching, pp. 37–44. All Ireland Society for Higher Education (2005)
14. Tapscott, D., Williams, A.D.: Wikinomics. How mass collaboration changes everything, Portfolio First Edition (2006)
15. Schaffert, S., Bischof, D., Buerger, T., Gruber, A., Hilzensauer, W., Schaffert, S.: Learning with semantic wikis. In: Proceedings of the First Workshop on Semantic Wikis–From Wiki To Semantics, Budva, Montenegro, pp. 109–123 (2006)
16. Parker, K.R., Chao, J.T.: Wiki as a Teaching Tool. Interdisciplinary Journal of Knowledge and Learning Objects 3, 57–72 (2007)
17. Hite, J.H.: Learning in Chaos. Gulf Publishing Company (1999)
18. Borgatti, S.P., Everett, M.G.: Models of Core/Periphery Structures. Social Networks 21, 375–395 (1999)
19. Gloor, P.A., Laubacher, R., Dynes, S.B.C., Zhao, Y.: Visualization of Communication Patterns in Collaborative Innovation Networks: Analysis of some W3C working groups. In: ACM CKIM International Conference on Information and Knowledge Management, New Orleans (2003)
20. Yin, R.K.: Case Study Research. Sage Publications, Thousand Oaks (1994)
21. Neill, J.T., Marsh, H.W., Richards, G.E.: The Life Effectiveness Questionnaire: Development and Psychometrics (2003), `http://wilderdom.com/abstracts/NeillMarchRichards2003LEQDevelopmentPsychometrics.htm`
22. Gloor, P.: Swarm creativity. Competitive advantage through collaborative Innovation Networks. Oxford University Press, Oxford (2005)

A Recommender System Architecture for Instructional Engineering

Manuel E. Prieto[1], Víctor H. Menéndez[2], Alejandra A. Segura[3], and Christian L. Vidal[3]

[1] Univ. de Castilla-La Mancha. ESI. Po. de la Universidad. 4, 13071 Ciudad Real, Spain
[2] Univ. Autónoma de Yucatán. FMat. Periférico Norte. 13615, 97110 Mérida, Yuc, Mexico
[3] Universidad del Bio-Bio, Avda. Collao 1202. Concepción, Chile
manuel.prieto@uclm.es, mdoming@uady.mx, cvidal@ubiobio.cl, asegura@ubiobio.cl

Abstract. In recent years, Recommender System's models and techniques, have been applied in e-Learning and main efforts are been centered in learners, their guide and their success when using Learning Management Systems and other Web-based and virtual artifacts. Several techniques were adapted or even developed for this purposes. Our current project is concerned to the need to develop a Recommender System Architecture that may assist teachers in their e-Learning design practices. Instructional Design Methods, Learning Theories, Efficient Searching Methods and Tools and Meta-data Managing, are examples of the necessary knowledge and abilities. In this document we are centered in presenting the overall system architecture and describing their main parts. We are also reporting actual results. Due to it´s wide conception, this project involves Knowledge Engineering, Software Engineering, Machine Learning, Semantic Web Searching, and Data Mining models and tools.

1 Introduction

The history of computer aided learning is already long. Many achievements and failures have been done from different approaches, mainly with solutions trying to support students. Actually, great efforts are given to course management and also to the system's adaptation to the student's preferences and needs [1].

e-Learning models often consider courses characteristics and students information in separated ways. However there are other solutions trying to adapt their functionalities to the student's requirements using data mining techniques.

These recommendation mechanisms have been applied mainly in e-commerce, while some approaches exist in order to recommend e-Learning Web resources, documents, videos, and presentations [2].

For e-Learning, according to [3], these systems can be seen from two different points of view:

- Directed to the students. They help students to adapt contents and make suggestions, in order to improve the learning process. This is the most used approach.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 314–321, 2008.

- Directed to the authors. They help teachers to classify students according to their interaction with the system, in such a way that it is possible to improve the system's performance and the instructional process itself.

In the context of Learning Objects, their development, search and use, recommendation will allow teachers to obtain more appropriate resources taking into account the instructional context and their personal experience.

We present our approach of a Recommender System Architecture for e-Learning that assists teacher-designers in the development of learning resources, considering information about their preferences and profiles and also, much available Instructional Design knowledge.

2 AGORA Project

The construction of Learning Objects is a complex process, which needs the application of learning resource's design, traditionally known as Instructional Design Methods [4]. In this process, different knowledge and competencies are involved. Among them, there could be mentioned: Learning Theories, Learning Styles, Pedagogical Patterns, Learning Contents, Multimedia Design and Quality Evaluation.

The AGORA project (in Spanish Ayuda para la Gestión de Objetos Reutilizables de Aprendizaje or Help for the Management of Reusable Learning Objects) [5] is oriented to assist teacher-designers in the construction process of e-learning resources conforming their instructional needs, using a Recommender System Architecture.

The model considers construction, recovering and storing of information and rules concerning Instructional Design. The architecture contains four elements (see square

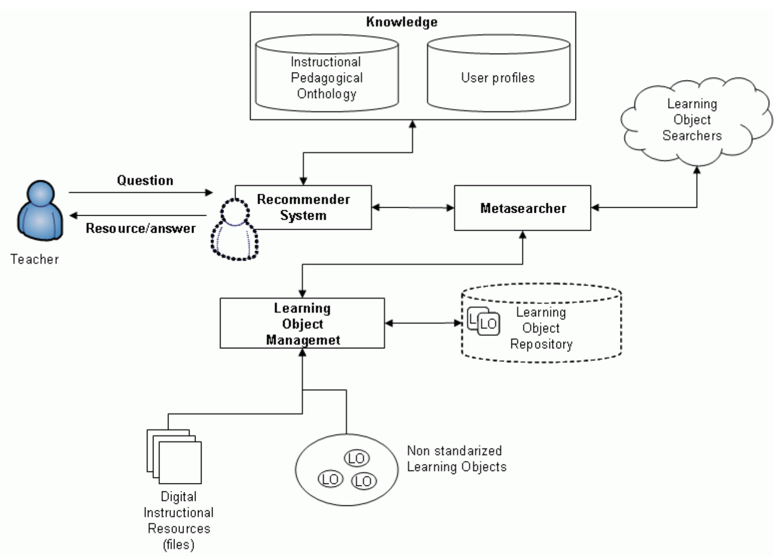


Fig. 1. AGORA Architecture

boxes in fig. 1), each one specialized in part of the process. In the next sub-sections, the elements that shape the system's complete architecture are described.

2.1 Knowledge Models

AGORA model proposes the use of an Instructional Design Ontology [5] that represents the needed knowledge for learning resources development. It includes:

- **Instructional Design Methods:** The utilitarian aim of Learning Objects is to allow and improve learning processes. However, according to [6], these resources lack of a defined instructional strategy. For this reason, instructional theories must be considered in the development of learning-aided resources. Methods which take care of instructional theories for constructing learning resources are traditionally known as Instructional Design (ID) Methods. Merrill [7] called them Instructional System Development (ISD). In this point of view, emphasis is given in the development process and not on the way of teaching with resulting products. Some of these methods are: ADDIE, ASSURE, ARCS, Merrill's Component Display, Dick and Carey's Model and MISA.
- **Psycho-pedagogical Learning Categories:** This ontology represents knowledge that helps to explain how the student perceives, gathers and uses the received information. For instance, Felder and Silverman proposes in [8] four dimensions that are: active-reflexive, sensory-intuitive, visual-verbal, and sequential-global. The combination of these dimensions generates 16 possible learning styles that will be helpful in order to recommend more suitable learning resources according to Instructional Design Methods.
- **Techniques for Teaching and Learning**: This ontology contains knowledge about teaching techniques. For example, problem-based learning, games and case analysis, among others. This ontology contains good practices, orientation criteria, suggestions and frequent learning difficulties, all of them obtained from expert´s experience, so that they can be used during design recommendations.

The Instructional Design Ontology contains knowledge from both theoretical and practical dimensions as shown in Table 1.

Table 1. Instructional Design Ontology main dimensions

	Instructional Design Methods Ontology	**Techniques for Teaching and Learning Ontology**	**Psycho-pedagogical Learning Categories Ontology**
Theoretical Dimension	ID Theories IF Methods	Technical fundamentals of teaching and learning	Theoretical fundaments from learning theories and learning styles
Practical Dimension	Experiences with ID methods ID Patterns ID Best Practices	Best Practices in techniques for teaching and learning Experience in applying techniques	Experiences applying learning theories and learning styles in learning resources construction

The theoretical dimension contains definitions and interpretations about ID Methods and other fundaments provided by literature or experts. A fragment of ID phases and activities is shown (fig. 2).

The practical dimension reflects experiences of applying knowledge from the theoretical dimension in real construction of learning resources. Elicitation process is used to obtain knowledge about criteria, tactics, strategies, guidelines, tips, etc., used the implementation of some ID Method or in the concrete use of some learning technique.

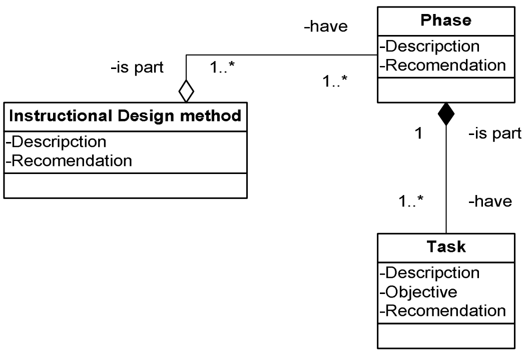


Fig. 2. Partial view of Instructional Design Ontology (theoretical dimension) using UML

Rules in ontology allow supporting inexperienced designers, providing the necessary knowledge to advice them in the learning resources design process. The following expression is a way to simplify the suggestion of some instructional strategy based on the context:

```
IF context THEN instructional design strategy
```

Here, `context` is a comprised form of related factors as learning objectives, teacher's profile, requirements or available technological facilities, among other. `instructional design strategy` are the guidelines and resulting advices to implement ID Methods for the construction of learning resources.

2.2 LO Management

In AGORA, Learning Objects are the basic structure of instructional content. Any instructional resource that needs to be managed by the architecture is converted into a Learning Object. This allows the reusability of the resources regardless of where they were created or where they will be used [9].

The Learning Object Management Module is the element in charge of the incorporation, transformation, storage and recovery of Learning Objects. New Learning Objects are generated from digital resources or non-standardized Learning Objects in order to be located, composed, and packaged for its distribution (fig. 3).

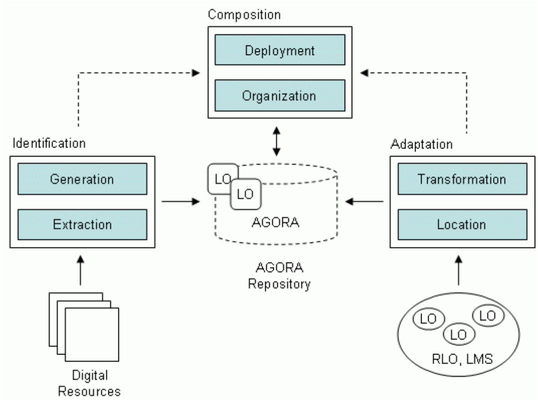


Fig. 3. The Learning Objects Management Module

During the identification process, Learning Objects generation takes place from instructional resources stored as simple files. The module extracts all available textual information (text, keywords, format, version, etc) contained in the file. This information is used to generate as much as possible Learning Object metadata fields.

The identified metadata are used as searching parameters in the AGORA repository (or in other repositories) in order to find similar Learning Objects. At this point, it is possible to suggest values for missing metadata fields, by using the Learning Objects Metadata Similarity Algorithm developed within the system.

The composition process recovers the *more adequate* Learning Objects for the declared specific learning objectives. Once identified, this more suitable Learning Objects, are sequenced in a didactic structure and packed for delivery and utilization by other elements in AGORA.

2.3 LO Metasearcher

The Learning Object Meta-searching service acts accessing multiple learning resources repositories with a search-machine using information about teaching needs and the pre-defined instructional context. Meta-searcher is enriched with semantic knowledge models to perform better searches.

The LO Meta-searcher is conformed by the basic components described in [10] but adapted to the e-Learning context with an additional semantic expansion of queries (fig. 4). Concepts contained in the teacher's query are expanded or refined using knowledge models such as thesauri, dictionaries and domain ontologies. Then, the Database Selector determines the more relevant search-machine or repository.

The Resource Selector defines the characteristics of documents to be obtained. The connection with server and repositories is configured, and the query dispatcher performs the query. Result Merger joins results from different repositories and search-machines removing duplicate documents. Results are then sorted by the LO Meta-searcher using a Ranking Function.

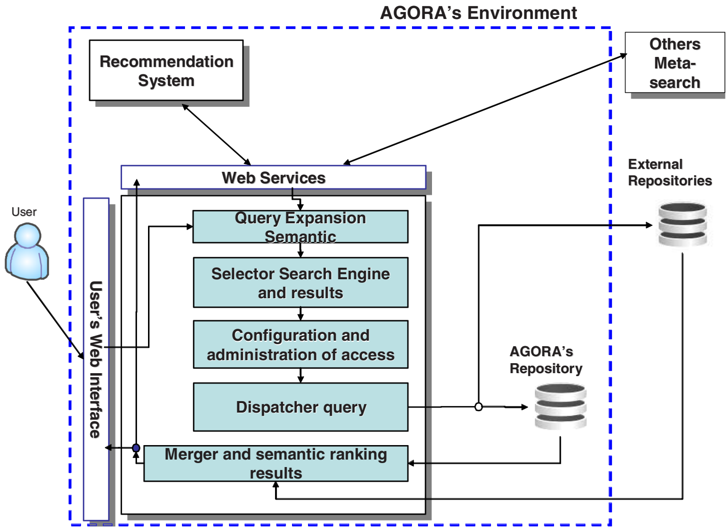


Fig. 4. The LO Meta-searcher Module

2.4 Recommendation

Recommender Systems uses information from data repositories, ontologies, structures etc., in order to perform many functions [11, 12]. We consider three main functions described as follows:

1. Course classification. Determine the course or resource main needs and characteristics; including knowledge, skills and attitudes the student's must develop. From this analysis, a classification is obtained, as factors to be considered when recommending some instructional design method.
2. Instructional Design Recommendation. The Recommender System suggests the more suitable instructional design methods, using course classification, teacher profile, learning aims and the interaction with the Instructional Design Ontology. Then, teachers may act, considering recommendations.
3. Learning Object Request and Recommendation. The Recommender System uses the LO Management services and the LO Metasearch service, to obtain and suggest adequate Learning Objects.

3 Results, Conclusions and Future Work

Actually, AGORA is implemented in a test version. A stable version of the Learning Objects Management Platform has been developed and now the work is centered in improvement of the Instructional Design Ontology, the Data Mining algorithms, and the Meta-search facilities. Then, results will be it evaluated with the algorithm proposed by [13] considering different domain ontologies.

LO Management was modeled as a wizard that guides the process of generating and incorporating Learning Objects (fig. 5). Teacher-designers may select among digital resources stored in files or in URL´s, to generate metadata in either an automatic or a manual way.

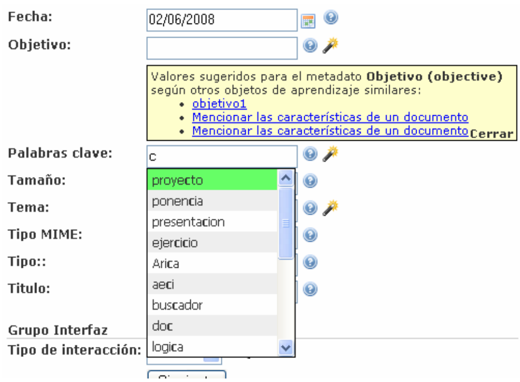


Fig. 5. Learning Objects tagging wizard

The Recommender System is capable to assist teachers from a technical point of view, providing useful resources and tools making easier the learning resources design activity. Considering the pedagogical perspective, the Recommender System can suggest alternative methods or tips to design learning resources adapted to the group characteristics or instructional requirements.

A new plug-in version for LMS´s (Moodle and others) will be developed soon.

Acknowledgments. This work is partially supported by A/8172/07 project, AECID, Spain; the Department of Information Technologies of the UCLM, Spain and the YUC 2006-C05-65811 project, FOMIX, CONACYT, México.

References

1. Yang, J.Y., C., W.: An attribute-based ant colony system for adaptive learning object recommendation. Expert Systems with Applications (in Press, 2008) (Corrected Proof)
2. Gouvêa, M.T.A.: Designing Support to Participation in Communities of Practice through Recommender Systems. In: Proceedings of the Fifth IEEE International Conference on Advanced Learning Technologies (ICALT 2005), Kaohsiung, Taiwan (2005)
3. Romero, C., Ventura, S., Hervas, C.: Estado actual de la aplicación de la minería de datos a los sistemas de enseñanza basada en Web. In: Thomson (ed.) Proceedings III Taller Nacional de Minería de Datos y Aprendizaje, TAMIDA 2005 (2005) ISBN 84-9732-449-8
4. Mohan, P.: Reusable Online Learning Resources: Problems, Solutions and Opportunities. In: IEEE ICALT 2004 Proceedings. IEEE Computer Society, Joensuu (2004)
5. Menendez, V., Vidal, C., Urzaiz, J., Prieto, M.: A Web Services-Based Model for the Composition of Reusable Learning Objects. In: Proceedings of INTED 2008 International Technology, Education and Development Conference, Valencia (2008) ISBN: 978-84-612-0190-7

6. Zouaq, A., Nkambou, R., Frasson, C.: An Integrated Approach for Automatic Aggregation of Learning Knowledge Objects. Int. J. of Knowl. and Learning Objects 3, 136–162 (2007)
7. Merril, M.D.: Instructional Transaction Theory: An Instructional Design Model based on Knowledge Objects. Educational Technology 36(7) (1996)
8. Felder, R.M., Silverman, L.K.: Learning and Teaching Styles in Engineering Education. Engineering Education 78(7), 674–681 (1988)
9. Willey, D.A.: Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy, `http://www.reusability.org/read`
10. Wenying, G., Deren, C.: Semantic Approach for e-learning System. In: First Int. Multi-Symposiums on Computer and Computational Sciences. IMSCCS 2006, vol. 2, pp. 442–446 (2006)
11. Christakou, C., Vrettos, S., Stafylopatis, A.: A Hybrid Movie Recommender System Based on Neural Networks. Int. J. of Artificial Intelligence Tools 16(5), 771–792 (2007)
12. Zhang, F., Chang, H.: On a Hybrid Rule Based Recommender System. In: Proceed. Fifth International Conference on Computer and Information Technology (CIT 2005), pp. 194–196 (2005)
13. Lee, M.-C., Tsai, K.H., Wang, T.I.: A practical ontology query expansion algorithm for semantic-aware learning objects retrieval. Computers & Education 50, 1240–1257 (2008)

Programming Robots in Primary Schools Deserves a Renewed Attention

G. Barbara Demo

Dipartimento Informatica, Università di Torino, c.so Svizzera 185,
10149 Torino, Italy
barbara@di.unito.it

Abstract. Robot programming is introduced in primary schools in order to offer both children and teachers the opportunity of *concrete programming* that is approaching the basics of informatics as a science while performing activities concerning the standard curricula subjects. Fundamental components of our proposal are: a) the use of different types of *small autonomous robots* as computer systems children develop programs for, b) *programming with a textual, Logo-like language* in order to avoid problems caused by the language in use during first programming activities, c) a *cross-disciplinary didactical methodology* where each robot activity is a learning environment nurturing as its principal concern concepts from traditional school subjects, d) a *community of practice* teachers can rely on, so that they do not hesitate experimenting because guaranteed of quick technical and pedagogical help. During 2007/2008 school year, the approach concerned about 30 primary school classes using different robots.

Keywords: Cross-disciplinary Activities, Schoolchildren-Centered Learning, Scientific Competences.

1 Introduction

S. Papert about 40 years ago and M. Resnick after two decades, began the best known projects aiming at offering children and teachers in primary schools the opportunity of approaching the basics of informatics by writing programs for small robots [1], [2]. Quite a number of researches can be found in the literature showing a continuing interest for the approach, yet neither the philosophy of Logo nor the "philosophy of robots" have entered schools everyday life. Indeed, how to use computers in primary schools is still often discussed among those involved in education. Nowadays a concurrence of reasons motivates our belief that the introduction of programmable robots in primary schools deserves a renewed attention: *several different types of robots are available that are suitable for children of all ages, robots are sold at affordable prices*, *small robots components are touchable and thus easier to understand, constructive learning of scientific and of non scientific subjects* is naturally possible, a fast yet *deep introduction to ICT is gained through robot programming*, "*global earth classroom" is nowadays possible via internet.* In Section 2. we develop these points.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 322–331, 2008.

Yet introducing programmable robots in primary schools is not easy: we must avoid the misuse of reducing robot programming to a syntactical playground as it already happened in several other cases. In early 90's, an Italian paper titled "Beyond small houses and cute flowers" discussed the difficulties teachers were having using Logo in schools. The title was too harsh but it explained the feelings of many teachers who, after a while, quit working with the turtle mostly because integrating turtle activities with the standard curricula to be taught was not easy (and in most cases teachers had very little or no help). Another example, not about ICT yet well known, concerns set theory as the rationale for using it in connection with mathematical basics was lost in too many primary schools in few years. Our concern is toward not contributing to engender the most dangerous habit of superficiality by introducing activities only syntactically perceived by pupils.

In this paper we refer to the project *Using robots in primary schools standard curricula* begun by G. Marcianó and S. Siega in 2003, where we have recently been active by contributing to reassess the programming language, implement compilers, design and implement an Integrated Development Environment to be used by schoolchildren, and to create and maintain a community of practice connecting people within the project. The global experience addresses schoolchildren from around five to about fifteen years old. During the 2007/2008 school-year, School-Net has counted three kindergarten, five primary schools and four secondary, first level, schools for about 50 classes using different types of robots starting with the BeeBot robot used by youngest, not yet writing pupils, then moving to the Parallax Scribbler robot or to the Lego RCX, and using the NXT Lego brick from primary school last year [3].

Fundamental components of the approach are: a) the use of *different types of small autonomous and mobile robots* as computer systems children develop programs for, b) the *programming language* NQCBaby, textual and children oriented, i.e. Logo-like, based on the macro version designed by G. Marcianò in 2004, described in [4]; indeed, during first programming activities, problems are mostly caused by the language in use, c) *a cross-disciplinary didactical methodology* where robot activities are not our goal yet rather are learning environments concerning school subjects, such as mathematics, physics, geography, music and even grammar [3]. Indeed, NQCBaby introduction is harmonized with pupils learning to write and the choice of using a textual language allows to have the same representation both for programming the robot and for the written natural language, d) *a community of practice* where, after an introduction to robots, teachers do not hesitate experimenting with their pupils because they are guaranteed of pedagogical and quick technical help and, also, where both teachers and schoolchildren can collaborate and foster their experience to other (new) schools. http://i-teach.educ.di.unito.it/course/view.php?id=89 is our community address.

NQCBaby language, sketched in Section 3, is conceived as a set of languages having a common small kernel named NQCBaby0 with few commands, without parameters, corresponding to buttons as the only programming tools in basic robots. The first actual programming language is NQCBaby1 used by children when they are given more powerful robots, with richer hardware components that can be programmed via a programming language. NQCBaby1 is enriched to NQCBaby2 and so on, till the top level language NQCBaby6 that allows a concrete and full programming experience as discussed in [5]. Thus, the language grows with children, with their school education and with what they can/want to do with their different robots. In Section 3 we also briefly describe software tools developed for supporting activities with robots such as compilers and an integrated development environment (IDE), all open source systems implemented by undergraduate students in Informatics at the University of Torino. Tool downloads are available at our community of practice address.

In Section 4 we mention some examples of robot programming and describe an activity where schoolchildren finally discovered that for a given task each group had given a different interpretation. The task then became discovering what problem a code was going to solve, i.e. which interpretation the group, author of the code, had given to the same task. The challenge of working on non-standard problems with non-standard solutions is quite relevant for the following education life of each student. Yet it is an experience that schoolchildren have very little possibility of living because in primary schools, in particular for the scientific subjects, they are most typically given problems with unique solutions. This becomes another reason to claim that robot programming can have an important role in primary school education.

2 Motivations

A small robot is a very simple computer that can autonomously move, by means of wheels or tracks, and execute a program that specifies its behavior. Teachers often say that "Children have to stumble on a problem" to be interested in it. The possibility of moving autonomously makes the very difference between a robot and a computer in primary schools and moving a robot on a trip becomes the "problem against which schoolchildren stumble". Moreover it is a problem pupils know how to solve "on their own body", whose planning and testing, once children begin coding the trip, becomes quite a physical activity, reason why we called *concrete programming* the use of programmable robots in primary schools [5]. Several reasons motivate our belief that the introduction of programmable robots in primary schools deserves a renewed attention today.

- *Several types of small programmable robots are available* suitable for the different ages of schoolchildren thus allowing an experience covering the entire education lifespan of a student. In the beginning, children about five years old are not given kits rather they use already assembled robots such as the BeeBot, http://www.tts-group.co.uk/Bee-Bot. This is a big "bee" with buttons on its back, each button corresponding to a command for moving one step forward, backward, right, left, for clearing (the commands previously given) and, obviously, a button for starting a sequence of commands children have given to the BeeBot by pushing its buttons. Thus children, not yet writing, begin robot programming using this button i.e. *iconic language*. Grown up pupils are given robots to be assembled and then programmed by using different types (iconic or visual or textual) of programming languages;
- *Affordable prices*: small autonomous robots or kits for assembling them are these days offered at very affordable prices, thus it becomes possible organizing pupils in small groups each working at programming one robot;

- *Deep introduction to ICT*: activities with small robots are quite suitable for providing both teachers and schoolchildren a reasonably fast yet deep introduction to computer programming because one can manipulate hardware components getting a very concrete understanding of how robots and software–hardware connections inside them work. Such immediacy is generally impossible when dealing with most commonly used programming languages these days, with their trappings that beginners cannot get rid of while doing first activities.
- *Small robots components are touchable*: often teachers are involved in many activities and cannot sufficiently concentrate on teaching methods for new technical subjects. In small robots, hardware components are simple enough that pupils can easily grasp how each one works: hence if robots are used with languages and software systems especially tailored for children, they contribute by themselves conveying to pupils a good deal of the learning environment we want they to experience and, by the way, teachers can learn with their pupils.
- *Constructive learning of sciences:* in several European countries, but particularly in Italy, the number of students having considerable difficulties in scientific subjects is increasing and consequently a diminishing number chooses a scientific career on entering the university. Robot programming can provide a constructive learning environment where scientific concepts are manipulated and thus better understood than by only using other learning approaches
- *Constructive learning of non-scientific subjects:* cross-disciplinary robot programming activities contribute to shape learning environments suitable for a better understanding of more difficult subjects, scientific or not. That is robots are not exclusively oriented to help science learning. Indeed this requires a cooperation among teachers so that robot programming activities are crosswise used as learning environments: reducing programming to a technical subject is an error to be avoided, even worst if confined to a laboratory activity, excluded from the other subjects.
- *Nowadays the "global earth classroom" is possible:* the wide use of internet and the many existing online communities on the net prove that we are on the way of realizing Alan Kay's auspice of "going from a single classroom to the global earth classroom" in [6]. This means that teachers can count on getting help from net mates beginning from mates in the community of practice among people within each single project. Often little suggestion for cross-disciplinary activities comes from teachers concerning standard school subjects where they are quite competent, because they are uneasy with ICT.

3 One Programming Language for Different Robots

We use a single programming language called NQCBaby for all different robots. This language is based on the language G. Marcianò presented in several conferences since 2004 [3], [4], [7]. It is a textual language mother-tongue-based and, according to the Logo philosophy, with primitives coming from children language, i.e. children oriented rather than robot oriented. Schoolchildren are first introduced to a kernel of the language, then to several extensions: either a different robot needing/allowing new primitives or new hardware components, in general sensors. Ordered introductions of new components, for example sensors, and of primitives for using them in robot-programmed behaviors shall comply the advances of schoolchildren logical and linguistic abilities [3], [7]. Thus robot-programming fits the general learning progresses children go through and becomes an original tool for contributing to strengthening standard curricula advances. As we wrote in the Introduction, the language grows with children, with their school education and with what they can/want to do with their different robots.

NQCBaby is not a complete language because our purpose is not making children become good programmers but rather giving them the opportunity to solve problems by using the basic yet complete structures of algorithmics, as from Jacopini-Böhm theorem [8]. In this section we focus on the rationale of NQCBaby gradual introduction to schoolchildren and sketch its enrichments from children at prewriting level using NQCBaby0 to NQCBaby6 level, usually for the last grade of primary school or first grades of secondary school.

3.1 Children's Early Activities with Robots

Up to now one compiler has been implemented translating NQCBaby into the NQC (Not Quite C) language. NQC is a complete programming language, released in early 2004, for different types of robots and developed by Dave Baum [9]. In beginning experiences with robots in primary schools, programming by using available languages was found too difficult for schoolchildren: a Logo like, mother tongue based language was then introduced by Marcianó's macros in order to offer children and teachers a language children oriented, i.e. with expressions present in their language and with a semantic close to natural language expressions. The idea was designing easier languages rather than implementing tools for making easier using existing languages as in other approaches, for example in Tern proposals by Horn and Jakob [10].

NQCBaby is not a complete language: restrictions concern variables and data structures in general and conditions, typically for selection statements. In a natural language, selection statements are one of the ways to introduce subordination in sentences thus they are introduced late in primary school being enrichments of NQCBaby sentences parallel to the enrichment of children ability in her/his logical abilities and natural language writing.

Children about five years old use already assembled robots such as the BeeBot carrying buttons on its back, each button corresponding to a command for moving one step forward, backward, right, left, for clearing (the commands previously given) and, obviously, for starting a sequence of commands children have given to the robot by pushing buttons. Thus children not yet writing use an *iconic language*, let's call it NQCBaby0, where icons are buttons on the back of the bee. Often, in their early activities with robots, children say aloud what button they are pushing apparently for checking what they are doing with their teacher and their mates. NQCBaby0 contains only a few primitives with no operands. Once children have begun learning how to write in their native natural language, they are given different robots, often still already assembled if safety reasons suggest it because pupils are too young, but without buttons on their backs thus needing software tools to communicate the behavior children have decided for them. Some schools of our Net use the Scribbler robot by Parallax; others use RCX and NXT Lego programmable bricks that children have to assemble. These robots can be moved either by writing the same commands that children say aloud when pushing related buttons on a BeeBot or by writing other commands with operands: i.e. kids can write n times forward as they pushed n times the forward-button on the BeeBot, but they can also write forward (n). NQCBaby1 language contains NQCBaby0 primitives, the same primitives with operands, i.e. forward (n), backward (n), right (n), left (n) and commands such as: speed (n), stopeverything, repeatalways, repeat (n) and few others. A typical first example of program is shown here where schoolchildren simply try many of the primitives of the language without a specific goal; it is shown in English for sake of comprehension:

```
Hi Robbi

    speed(3) forward(100) speed(7) backward(100)
    repeat(3) right(90) left(90) end
    repeat(2) backward(10) forward(20)  end

thanks-bye
```

The following code is the equivalent program in NQC:

```
task main()
{  SetPower(OUT_A+OUT_C,3);
   OnFwd(OUT_A+OUT_C); Wait(100);
   SetPower(OUT_A+OUT_C,7);
   OnRev(OUT_A+OUT_C); Wait(100);
   repeat(3)
      {  OnFwd(OUT_A); OnRev(OUT_C); Wait(90);
         OnFwd(OUT_C); OnRev(OUT_A); Wait(90);
         Off(OUT_A+OUT_C);
      }
   repeat(2)
      {  OnRev(OUT_A+OUT_C); Wait(10);
         OnFwd(OUT_A+OUT_C); Wait(20); Off(OUT_A+OUT_C);
      }
   Off(OUT_A+OUT_C);

}
```

First activities, where schoolchildren only want to try some primitives, in NQC would result quite elaborated, even disappointing for pupils and teachers using Italian keyboards without {and }.

3.2 Selection Statements

Selection statements are one of the ways to introduce subordination in sentences. With the touch sensor we first introduce the one-way selection statement only, `if-touches`. The two-ways selection statement appears with the light sensor with its testing primitives if-light and if-dark, one opposite of the other, in NQCBaby5 normally used during the Italian fifth grade. All fundamental algorithmic structures, as from the Jacopini-Böhm theorem, are present in NQCBaby5. At this step, schoolchildren have got a full programming experience by means of *concrete programming experiences* as those carried out for making robots move the way each children group has planned as we point out in [5].

An example of NQCBaby5 shows the function flip-coin that in the NQC language version corresponds to a call of the function `random`. This robot is named Susi.

```
 Hi Susi
     repeatAlways
            speed(75)
            forward(500)
            if ( flip-coin = heads)
                   right(360)
            else        // it's cross
                   left(360)
            end;
     end-repeat;
thanks-bye
```

The NQC version for this program is as follows:

```
task main()
{   while(true)
    {      OnFwd(OUT_AC, 75);
           Wait(500);
           if (Random(2)=1)
           {      OnRev(OUT_C, 75); }
           else
           {      OnRev(OUT_A, 75); }
    Wait(360);
    }
}.
```

3.3 Technology Support to Children and Teachers

Tools giving support to teachers and schoolchildren are obviously the compilers and also the integrated development environments (IDE) for a better accessibility to the different tools for editing, translating, possibly correcting and, finally, sending to the robot the coded behavior. Moreover tools to collaborate and learn together are mandatory when introducing robotics in schools: thus another must is an on-line community of practice environment where teachers and technical staff can integrate their skills for each other knowledge evolution.

The introduction of robot programming in schools heavily depends on all teachers because, in our project, robots must be used in activities where teachers introduce or make children work with concepts from primary school standard curricula. Thus teachers must be confident with using robots and also shall possibly get hints from colleagues as if they were, almost, together in the classroom and quickly knowing what activities the class has carried out. Using robots shall be a learning environment for children and for teachers as from Marcianó, 2007: hence the support of a community of practice is necessary so that teachers do not hesitate experimenting as they feel guaranteed of quick help from technicians and colleagues and, also, where teachers and schoolchildren can collaborate and foster their experience to other (new) schools, according to what Alan Kay said in a 2003 interview "Our idea is to extend the one-room schoolhouse to the entire world".

In previous paragraphs we described how NQCBaby is introduced to children by subsets according to educational steps measured to their learning. This is the reason to

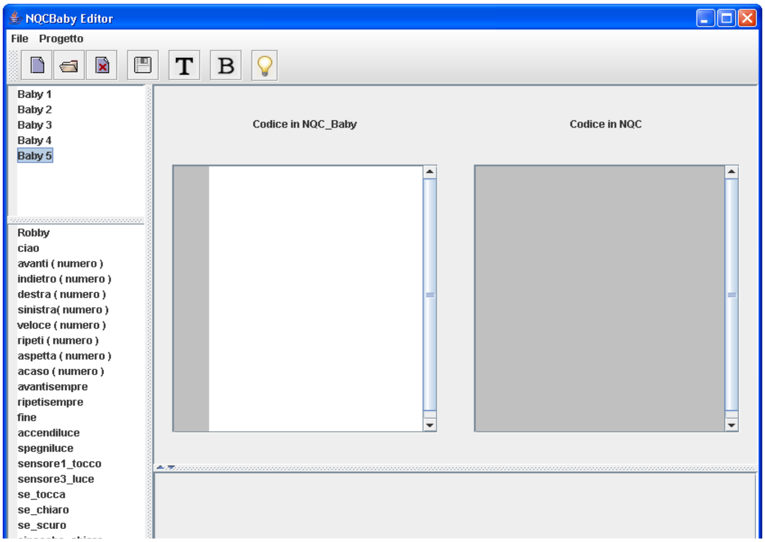


Fig. 1. The integrated development environment

have Baby1, Baby2 till Baby5 on top of the left column in Fig. 1 where our integrated development environment window is shown. On top left side, we have the tool bar where the button T is used for translating what children write in the white "blackboard" of the window. Errors are reported on the bottom with a code line number.

4 Discovering What Problem a Given Code Solves

Small robots walking through a maze and soccer games with robots teams are becoming quite popular but these activities are yet complex exercises as for algorithms and modelling components involved. Simpler walks shall not be underestimated because they are a necessary first step into robot programming needed at all ages and because even simple walks can be quite interesting for pupils and teachers. Indeed teachers can convey cross-disciplinary components in children ideas as those conceived and implemented by Baveno pupils with S. Siega in school year 2006/2007 [5]. We propose two of them: *The marriage* and *My holidays*, good examples of how also robot behaviors that are simple to code can produce quite successful shows. In *The marriage* two robots dressed up, one with a bowtie, the other with a long white veil, leave their homes in different part of a town. They meet in front of the church and then go

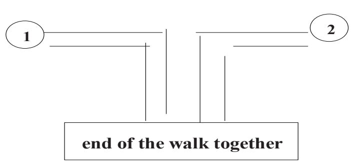


Fig. 2. When we meet we walk together

side by side to the altar with a proper music sounding: Fig. 2, with the altar as the end of the walk, refers to *The marriage* show.

In *My holidays* activity one robot, wearing a bright t-shirt, hat and sun glasses, leaves Baveno where the school is situated, near the mountains, on the northwest of Italy, to go to Venice to visit around. Then he moves to Ravenna (on the coast south of Venice) to say hallo to his/her grandmother. But she is not at home, thus the robot goes to the beach going on and off to the grandmother's house checking whether she is back. After a while, the robot can say hallo, then go to Rome for the summer concert where he sings. Finally he reaches the seaside in Sicily, to rest!

We conclude our paper with a third interesting activity concerning fifth grade pupils of a primary school. They were asked to design an exhibition where their robots could show the geometrical shapes children had "thaught" her/him during the school year. Some groups wrote programs where several shapes are drawn on the floor one after the other always the same in the same sequence. One group came out with a program shown here in a short version (we do not show a code sequence concerning triangles, similar to the one shown here for quadrangle figures):

```
Ciao Susi                                Hi Susi
ripeti(4)                                repeat(4)
    ripetiSinoCheScuro                       repeatUntilDark
           avanti(1)                                forward(1)
    fine                                     end
    ripetiSinoaCheChiaro                     repeatUntilLight
           destra(1)                                right(1)
    fine                                     end
fine                                     end
grazieCiao                            thanksSeeyou
```

Children organized a show where their robot Susi starts moving on a white ribbon on the class floor. When the robot finds a black strip it goes right until a white ribbon is reached again and then moves straight as before until a black ribbon is found. Each run of the program one different child of the group is Susi's pilot thus in charge of deciding her path, i.e. deciding which four sided geometric shape perimeter the robot has to move on by sticking on the floor white and black ribbons. The robot goes right 4 times roughly moving on the quadrangle, regular or not, perimeter decided by her current pilot assuming the pilot closes the ribbons sequence.

Six schoolchildren groups were given the same idea to work on and began planning how their robot shall move, writing short code sequences to recall how long are the distances covered by some robot commands, drawing several designs each group for the trip they have to make his/her robot cover. The most important results concern the experience that each pupil went through while trying to plan the robot show. Particularly relevant results for the following education life of each student are:

- Realizing that his/her other group members can *differently understand a given non-standard problem*. Non-standard problems are an experience that schoolchildren have very little possibility of getting in touch with because they are usually given problems with unique solutions.
- *Grasping* these possibly *different understandings*,
- *Finding to which problem is a solution what they think and, perhaps, they code in a program* when they find out that it is not a solution to the case meant by other children in the group.

Indeed discussing different interpretations of a given task is the beginning of learning: having questions on a subject is the true starting step of the learning process. As we said for the above robot show, one group only has produced a general solution to the given task but all the other group works have been considered positive solutions to different interesting tasks. Moreover, as a final show, this class presented all solutions in a sort of game where the public had to pair the six code sequences with six tasks.

Besides all the cross-disciplinary activities that primary schools pupils experience with robot programming, other important results concern digital literacy competences since pupils learn how to write in a formal language, what an integrated development environment tool is and how to use the one we implemented specifically for this project; they learn what a translator is, its error finding action and use different translators for the different robots. Thus their digital literacy is to the one of pupils only using any Office suite or similar, as the musical technique of piano players is to the one of stereo players, following the *Pianos Not Stereos* paper by M. Resnick, Bruckman and Martin [11].

References

1. Papert, S.: Mindstorms: Children, Computers, and Powerful Ideas. Basic Books, New York (1980)
2. Resnick, M.: Behavior Construction Kits. J. Communications of the ACM 36(7), 64–71 (1993)
3. Marcianò, G.: Robotics as a learning environment. In: Didamatica Conference 2007, Cesena, pp. 22–30 (2007) (in Italian)
4. Marcianò, G.: Robotics languages for schools. In: Didamatica Conference 2006, Cagliari, pp. 185–197 (2006) (in Italian)
5. Demo, G.B., Marcianó, G., Siega, S.: Concrete Programming using Small Robots in Primary Schools. In: 8th IEEE International Conference on Advanced Learning Technologies, pp. 301–302. IEEE Press, New York (2008)
6. Kay, A.: Face to Face: Alan Kay Still Waiting for the Revolution (April/ May 2003), `http://www2.scholastic.com/browse/article.jsp?id=5`
7. Demo, G.B., Marcianó, G.: Contributing to the Development of Linguistic and Logical Abilities through Robotics. In: 10th IEEE International Conference EuroLogo, p. 46. Comenious University Press, Bratislava (2007), `http://www.eurologo2007.org/proceedings`
8. Böhm, C., Jacopini, G.: Flow Diagrams, Turing Machines and Languages with Only Two Formation Rules. J. Communications of the ACM 9(5), 367–371 (1966)
9. Baum, D.: NQC language, `http://bricxcc.sourceforge.net/nqc`
10. Horn, M.S., Jacob, R.J.K.: Tangible programming in the classroom with Tern. In: CHI 2007 Conference On Human factors in computing systems, San Jose, pp. 1965–1970 (2007)
11. Resnick, M., Bruckman, A., Martin, F.: Pianos Not Stereos: Creating Computational Construction Kits. J. Interactions 3(6) (1996)

The Development of a Self-assessment System for the Learners Answers with the Use of GPNN

John Pavlopoulos[1], John Vrettaros[1], George Vouros[2], and Athanasios S. Drigas[1]

[1] NCSR DEMOKRITOS, Department of Applied Technologies,
Patriarhou Grigoriou, 15310 Ag. Paraskevi, Greece
[2] Aegean University, Info and Communication Systems Eng,
83200, Karlovassi, Samos, Greece
{dr,jvr}imm.demokritos.gr, annis.pavlo@gmail.com,
georgev@aegean.gr

Abstract. The goal of this study is the development of an assessment system with the support of a Neural Network approach optimized with the use of Genetic Programming. The data used as training data are real data derived from an educational project. The developed system is proved capable of assessing data from both single select and multiple choice questions in an e-learning environment. The final result is the assessment of the learners' answers through various criteria.

Keywords: neural network, genetic programming, assessment, learners.

1 Introduction

This paper presents the development of an assessment system of the gained knowledge of students. In specific, the results of self-assessment exercises provided by a learning environment are examined, in order for the students to obtain the knowledge level they have possessed in each learning section solely and overall. The final aim is for the assessment system to be trained in order to play the role of an instructor. The assessment system is based on a Neural Network approach, optimized with the aid of Genetic Programming.

Neural Networks (NNs) mimic the way human brain functions. Through a large number of interconnections organized in layers, they can capture complex non linear relationships between input and output variables. NNs can be trained (that is adjust their parameters to a certain pattern recognition problem) in order to be able to generalize to unknown data (under linear or non linear relationships). Moreover, hybrid methods can include the use of evolutionary techniques (Genetic Programming or Genetic Algorithms), in order to optimize the architecture and the training parameters of the NNs.

Genetic Programming (GP) is inspired by natural evolution and provides a way to develop computer programs, such as appropriately designed and trained NNs, which produce some desired output for particular inputs [3]. In this paper, in order to produce the assessment system acquired, we examined whether a Genetic Programming

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 332–340, 2008.

Neural Networks (GPNN) approach [4, 5] is able to model the assessment role of a pedagogical expert.

GPNN uses input and output data in order to train an initial population of NNs through GP. The training procedure stops when a minimum error point is reached or a maximum number of iterations is exceeded. Until now, it was being used as a powerful statistical pattern recognition tool through ten final GPNN models [4, 5]. However, its ability for quick convergence to the solution for linear and non linear relations between the input and the output, make GPNN a very good candidate for an expert system application.

GPNN Assessment System (GPNNAS) is a GPNN system that is trained with data, which consists of answers of students and their evaluation according to a pedagogical expert. The final purpose of the GPNNAS is to be able to evaluate the answer of a student according to some criteria. The final system consists of one Neural Network (NN) approach for each criterion, optimized with Genetic Programming so that each NN approach is able to evaluate the answer according to the specific criterion. Thus, the output of the assessment system for a question is an evaluation of a student's answer for each criterion.

The data generated by the learner going through a mini-test consists of a string of characters and values which are built based on certain criteria. The types of questions are both single-select and multi-select and have several answer options. The questions test learners against more than one sector while each question has a relevance value against every sector.

2 Data of the Expert System

The data of the developed system are real data that were extracted from the answers of learners from the Dedalos[1] educational project. The modeling of the data was proved to be precise.

Dedalos learners undertook a mini-test at the end of each module to assess their understanding of the learning points covered. Each mini-test comprises a series of multiple choice questions and each answer option selected provides the GPNN Assessment System (GPNNAS) with two types of data: test data and training data. Pedagogical experts have assigned educational values to the test and training data which, in turn, allows GPNNAS to assess the learner's understanding of the module.

The rest of this section describes these two data types and how values are assigned to them.

2.1 Purpose and Transmission of Test Data

Test data assesses how relevant a question is against one of the following areas of learning:

1. letter recognition and alphabetical order
2. spelling/vocabulary

[1] Dedalos: Teaching English as a second language to deaf people, whose first language is sign language, via e-learning tools. LEONARDO DA VINCI, Community Action Programme on Vocational Training, Second phase: 2000- 2006.

3. grammar/sentence structure
4. reading
5. writing

Test data also evaluates the answer options against the five areas of learning and specifies whether the answer is correct, partially correct or incorrect.

2.2 Assignment of Test Data

Firstly, each question is assigned a relevance value between 0 and 4 by a pedagogical expert. For example, the question "Which sign is in capital letters?" mainly tests the learner's skills in section A and hence, receives a relevance value of 4 here. It is also about an underpinning reading skill at a low level and therefore it is given a relevance value of 1 in section D. It does not test spelling/vocabulary, grammar/sentence structure or writing at all, hence these sections receive a relevance value of 0.

Table 1. Relevance of questions

Section Code	Section name	Relevance Value
A	Letter recognition and alphabetical order	4
B	Spelling/vocabulary	0
C	Grammar/sentence structure	0
D	Reading	1
E	Writing	0

Secondly, each answer option is assigned evaluation values. Evaluation values are also set against the five learning areas. However, the mini-tests comprise two types of multiple choice questions: single select and multi select. While the principle behind the assignment of evaluation values remains the same, a different form of the data set is sent to GPNNAS for each question type.

In single select questions there is only one correct answer. For example for the question "Which sign is in capital letters?" option 2 is the only correct answer and the evaluation values are assigned as follows:

Table 2. Evaluation of answers in single-select type questions

Answer Code	Answer Options	Correct /Incorrect	Evaluation Values				
			A	B	C	D	E
1	Open	Incorrect	0	-1	-1	0	-1
2	NO ENTRY	Correct	1.0	-1	-1	1.0	-1
3	Closed	Incorrect	0	-1	-1	0	-1
4	Staff Only	Incorrect	0.3	-1	-1	0.3	-1

Hence:

- **1.0** is assigned to cell 2A because the answer option is correct and the question is relevant to area A - Letter recognition and alphabetical order.
- **1.0** is assigned to cell 2D because the answer option is correct and the question is relevant to area D - Reading
- **0.3** is assigned to cell 4A because the answer option 'Staff Only' is partially correct as it contains two capital letters and the question is relevant to area A
- **0.3** is assigned to cell 4D because the answer option 'Staff Only' is partially correct as it contains two capital letters and the question is relevant to area D
- **0** is assigned where an answer option was wrong but the question is relevant to the learning area
- **-1** is assigned where an answer option was wrong and the question is not relevant to the learning area

In multiple select questions there can be two or more correct answers. For example, for the question "Which of these are capital letters?" there are three correct answers (options 2, 3 and 6) and the evaluation values are assigned as follows:

Table 3. Evaluation of answers in multi-select type questions

Answer Code	Answer Options	Correct /Incorrect	Evaluation values				
			A	B	C	D	E
1	V	Incorrect	0	-1	-1	0	-1
2	G	Correct	1.0	-1	-1	1.0	-1
3	C	Correct	1.0	-1	-1	1.0	-1
4	P	Incorrect	0	-1	-1	0	-1
5	H	Incorrect	0	-1	-1	0	-1
6	B	Correct	1.0	-1	-1	1.0	-1

The question is primarily devised to test the learner's knowledge of area A - Letter recognition and alphabetical order and to a lesser extent knowledge of area D - Reading.

The following values are assigned to the correct answer options (2, 3 and 6):

- Section A: **1.0** – because the answer is correct and the question is relevant to this area
- Section D: **1.0** – because the answer is correct and the question is relevant to this area
- Sections B, C and E: **-1** because the question is not relevant to these areas

3 Methodology

In order for a system to be able to evaluate correctly a learner's answer, it should be trained in a way that each input (answer pattern) can be related with a particular output (the evaluation). Neural Networks are capable of this task, once they are appropriately trained.

NNs are weighted interconnected networks of artificial neurons (computational models based on the biological neuron). The training procedure consists of modeling the structure of the NNs as well as defining the values of their weights. Although a gradient descent algorithm such as back-propagation is most often used as a training algorithm, an evolutionary algorithm such as GP has the potential to produce a global minimum of the weight space and thereby avoid local minima [7].

Such a hybrid methodology is GPNN, which produces an initial population of randomly generated NNs and then recombines them through GP operations (reproduction, crossover and mutation) in order for the fittest to survive. The extracted NN is considered to be the most appropriate one for the generalization of the input pattern to the output pattern.

3.1 Genetic Programming Neural Networks

GPNN was initially developed by Richie et al. [4] to improve upon the trial-and-error process of choosing an optimal architecture for a pure feed forward back propagation NN. However, the methodology was re-implemented at the Biosim Lab of the National Technical University of Athens, Greece in order to study the genetic and environmental underlay of diseases. In this paper is presented an application of this implementation which aims at training a system (the trained NNs) to evaluate automatically the answers of learners according to a number of criteria.

Optimization of NN architecture using GP was first proposed by Koza and Rice [1]. The use of binary expression trees allows for the flexibility of the GP to evolve a tree-like structure that adheres to the components of a NN (Fig.1). The GP is constrained in a way, that it uses standard GP operators, but retains the typical structure of a feed-forward NN. A set of rules is defined prior to network evolution, to ensure that the GP tree maintains a structure that represents a NN [1, 2]. The flexibility of the GPNN allows optimal network architectures to be generated in such a way that they will consist of the appropriate inputs, connections, and weights for a given data set [6].

The steps of the GPNN method are described in brief as follows. In step one, GPNN has a set of parameters that must be initialized before the beginning of the evolution of the NN models. These include, an independent variable input set, a list of

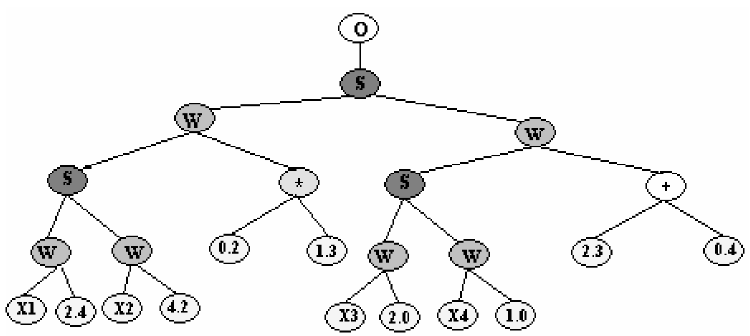


Fig. 1. The tree structure of a Neural Network. The o-node is the output node, the w-node is the weight node and the s-node is the activation function node.

mathematical functions, a fitness function, and finally the operating parameters of the GP. These operating parameters include the population size, and the number of generations. In step two, the training data are modeled according to the tested problem. In step three, the training of the GPNN begins by generating an initial population of random solutions. Each solution is a binary expression tree representation of a NN (Fig.1). In step four, each GPNN is evaluated on the training set and its recorded fitness. In step five, the best solutions are selected for crossover and reproduction, using a fitness-proportionate selection technique, called roulette wheel selection, based on the classification error of the training data [4, 5].

Classification error is defined as the proportion of individuals for whom the output was incorrectly specified. A predefined proportion of the best solutions are directly copied (reproduced) into the new generation. Another proportion of the solutions are used for crossover with other best solutions and finally the last solutions are mutated. The extracted NN, which is the best-so-far solution, is considered to be capable of classifying the data with the minimum error. In the last step, the best-so-far solution is being held and the new generation, which is equal in size to the original population, begins the cycle again. This continues until some criterion is met, and at that point the GPNN stops. This criterion is either a classification error of zero (best-so-far solution) or the maximum number of generations reached (error message).

3.2 Application of GPNN

Until now, GPNN was mostly used for pattern recognition in the field of Bioinformatics [4, 5]. However, this GPNN application aims at modeling the classification of the answers of learners and thus, the NNs are expected to associate each answer (NN input) with an evaluation (NN output).

The training procedure of the assessment system for each question consisted of training six NNs, one for each of the five criteria and one for the overall performance. The inputs of the NNs (answer patterns) consisted of binary strings representing different answer codes. Inside the binary string, the 1's represented the correct choices according to the user while the 0's the false ones. For example, the NN input string 1-0-0-0, for a single select question, would indicate that the learner selected the first choice as the correct one. The output of each NN (answer evaluation) could either be negative, indicating an irrelevant criterion, or a number from the space [0, 1], representing the evaluation of the learner's answer according to the specific criterion.

GPNNAS, in its pattern operation has been applied for both a question of single select and a question of multi select type and has modeled the data successfully proving the system's capability of modeling this kind of data. The single select type question was "Which sign is in capital letters?" and there were four possible student answers, while the multi select type question was "Which of these are capital letters?" and there were nine possible answers.

For each criterion, the initial NN population was set to be 100 NNs while the generations, through which NNs' genetic recombination took place, were set to be 50. The training procedure of the three NNs that were responsible for the first three criteria of the single select type question is depicted in Fig.3. As it can be observed,

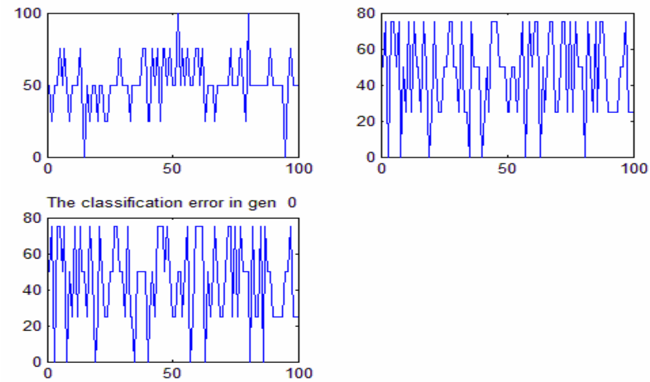


Fig. 3. The classification error of 100 NNs of the initial population after 0 Generations

the 3rd fittest NN (classification error 0) was found inside the initial population (generation 0) and needed no GP operations, indicating the simplicity of the modeled functions.

The answers of the learners were uploaded via a web page to the main server (Fig. 4), wherein they were encoded in an appropriate form and were processed by the GPNNAS.

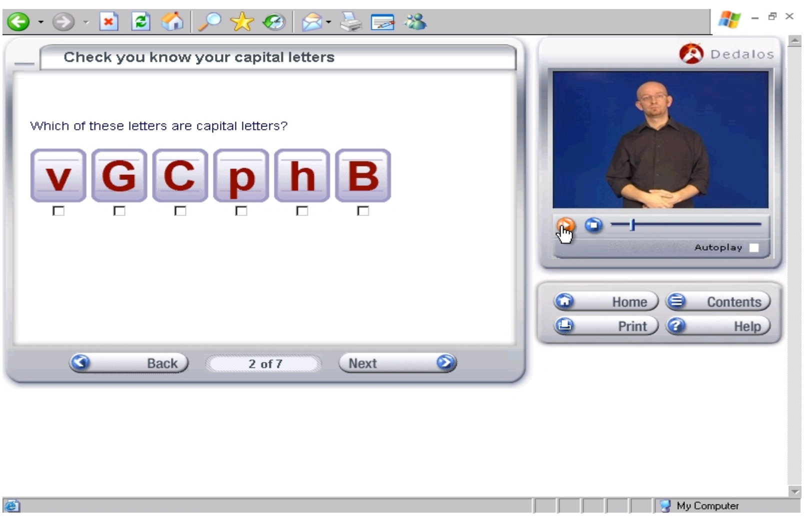


Fig. 4. The question interface for the Dedalos e-learning environment

The output of the system was the learner's evaluation for the five criteria examined as well as for the learner's overall performance. Furthermore, the evaluation was presented to the learner through a bar diagram (Fig. 5), forwarding intelligibility of the results for the user.

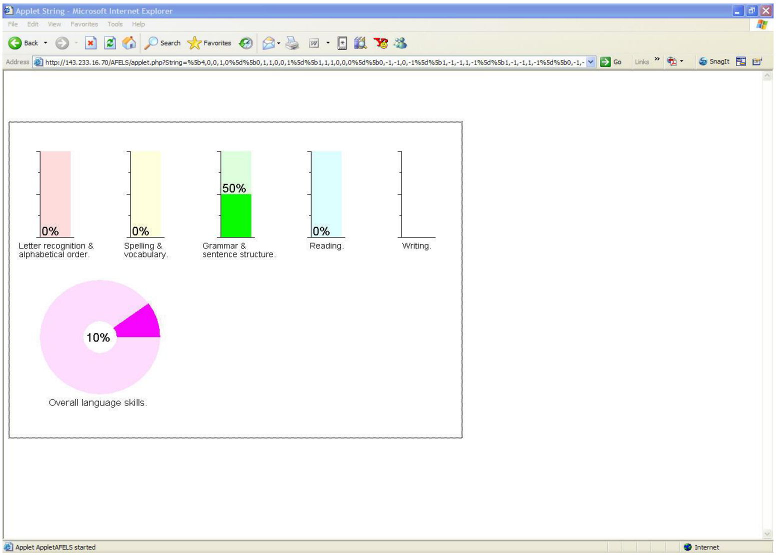


Fig. 5. Classification form of the results

4 Future Work

In this paper, a hybrid expert system with use of GPNN is developed for the evaluation of learners' answers according to a number of criteria. Thus, the assessment data could be represented to the learner in a meaningful and useful way in order to help the learner improve his skills in the cognitive sections where he showed low performance in the relevant test. The application of the GPNN methodology for e-learning purposes allows for generalization of the assessment process which could lead to the implementation of an intelligent e-Tutor. The system was applied and evaluated successfully learners' answers, which were derived from an educational project for the teaching of English as a second language to deaf people whose first language is the sign language. The next challenge is a fully automated training procedure wherein the training data will be presented to the assessment system online and the system could be trained in real time, as well as over different and more complicated kinds of tests. Thus, an e-learning system could be implemented that could serve various kinds of learners who need to improve their learning abilities according to various criteria.

References

1. Koza, J.R., Rice, J.P.: Genetic generation of both the weights and architecture for a neural network. In: IJCNN 1991-Seattle International Joint Conference on Neural Networks, vol. 2, pp. 397–404 (1991)
2. Koza, J.R.: Survey of genetic algorithms and genetic programming. In: WESCON 1995 Conference: Microelectronics Communications Technology Producing Quality Products Mobile and Portable Power Emerging Technologies, pp. 589–594 (1995)

3. Koza, J.R.: Genetic Programming: A paradigm for genetically breeding populations of computer programs to solve problems. Technical Report STAN-CS-90-1314, Stanford University Computer Science Department (1990)
4. Ritchie, M.D., Motsinger, A.A., Bush, W.S., Coffey, C.S., Moore, J.H.: Genetic Programming neural networks: A powerful bioinformatics tool for human genetics. Applied Soft Computing 7, 471–479 (2007)
5. Ritchie, M.D., White, B.C., Parker, J.S., Hahn, L.W., Moore, J.H.: Optimization of neural network architecture using genetic programming improves detection and modeling of gene-gene interactions in studies of human diseases. BMC Bioinformatics 4(1), rec.NO 28 (2003)
6. Spears, W.M.: A Study of Crossover Operators in Genetic Programming. In: Raś, Z.W., Zemankova, M. (eds.) ISMIS 1991. LNCS, vol. 542, pp. 409–418. Springer, Heidelberg (1991)
7. Siddique, M.N.H., Tokhi, M.O.: Training Neural Networks: Backpropagation vs. Genetic Algorithms. In: Proceedings of the IEEE International Joint Conference on Neural Networks, vol. 4, pp. 2673–2678 (2001)

Development of Online Inquiry Environments to Support Project-Based Learning of Robotics

Min Jou, Ming-Jenn Wu, and Din-Wu Wu

Department of Industrial Education, National Taiwan Normal University
Taipei, Taiwan
joum@ntnu.edu.tw

Abstract. Robotics, an interdisciplinary engineering subject, has been a recurring theme in engineering education. Project-based learning provides opportunities for interdisciplinary learning. Thus, this research aims to develop interactive e-learning environments to support project-based learning of robotics and to enhance student participation, motivation, and learning effectiveness. This project developed inquiry modules to allow students to present their queries in natural Chinese language fashion and through engineering graphics. In addition, this study developed interactive learning platforms for robotic design including mechanism design, assembly and manipulation, manufacturing processes, and integration of mechatronics. Quantitative and qualitative methods such as questionnaires and interviews were used to evaluate the effects of the developed system. Findings showed that inquiry modules were able to facilitate investigation and planning activities on project developing stages. The results also showed that there were significant improvements in the participants' motivation and learning. Generally, the online interactive e-learning environment is beneficial to the participants and ought to be given the attention it deserves as an alternative to traditional classes.

Keywords: project-based learning, online inquiry environment, robotics.

1 Introduction

Competing in a highly competitive global market requires the commercialization of knowledge and technology to produce better, faster, cheaper, multi-functional, flexible, and intelligent products. Engineers involved in the product realization process must master technology as it develops and quickly integrate it into products well ahead of the competition. Thus, many educators have developed a variety of pedagogical tools and curriculums to increase the ability and competence of students in engineering. Robotics, being an interdisciplinary engineering subject, plays a key role in achieving this goal. Thus, robots have been a recurring theme in engineering education. The major areas of any robotics curriculum are robotic manipulation, computer vision, artificial intelligence, and mechatronics. Robotic manipulation is a theoretical course covering the foundations of kinematics and dynamics of mechanisms. The course of computer vision covers the fundamental techniques and background of

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 341–353, 2008.

machine vision from basic digital image processing to symbolic image understanding. The course material of artificial intelligence is theoretical in nature, covering problem spaces, search, game playing, predicate logic, knowledge representation, reasoning, natural language, learning, and more. Mechatronics integrates various technologies, including mechanisms, electronics, and controls to achieve a functional system.

Many robotics researchers have developed a variety of tools to support educators to teach students about robotic-related technologies. Initial attempts were to simplify robot instruction by employing programming tools to control robot arms for students to learn robotic thinking [1-2]. In order to overcome the limitation of hardware constraints, graphic simulators of robotic dynamics are developed to allow more students to participate in courses [3-4]. Vibet assembled elements to teach robot control [5]. Pota employed an interdisciplinary project to construct a flexible manipulator to teach the integration of robotic mechanisms with electronics [6]. Richard developed an interactive system that allows the student to gain practical experience with image processing and machine vision operators [7]. The evolution of Internet technologies has made it easy to allow students to access robots for meaningful learning experiences everywhere. Real robots can be remotely controlled through the internet [8-9]. A Web-based simulation of the actual robot operating was implemented [10]. The simulation is written in JavaScript employing a freeware game library, which controls robot elements and environmental objects in a flexible manner. A package called RobotDraw applied internet-based programming tools to generate three-dimensional virtual models of robot manipulators from a DH parameter table. Internet users can generate three-dimensional robot manipulator models on their computer screens, navigate around the robot model and examine it from any angle. The package was designed as a visualization aid in robotics education and allows educators and students to easily visualize robotic structures and directly evaluate the effect of a parameter variation on the overall robot [11].

Robotics has been integrated into undergraduate courses to enhance teaching and learning activities [12-15]. Robotic Autonomy is a seven-week, hands-on introduction to robotics designed for high school students [16]. The course presents a broad survey of robotics, beginning with mechanisms and electronics and ending with robot behavior, navigation and remote teleoperation. Some robotic educators employed Lego [17] and Parallax [18] to design curriculums around both robot morphology and construction as well as robot programming and interaction [19-20]. Many robot contests offer various design projects to encourage students to apply knowledge gained throughout the engineering curriculum. The contests span different education levels, from the high school competition FIRST [21] to advanced research programs, such as robotic soccer (RoboCup), the walking machine decathlon contest [22], and urban search and rescue (USAR) initiatives [23-24]. Pack et al. **present the benefits of an autonomous fire-fighting robot design competition as an effective tool for undergraduate education** [25]**.** The uniqueness is that it offers a design challenge that can be addressed by students and professionals of all ages and skill levels.

The robotic educational endeavors are extremely large and diverse. These efforts represent significant advances in robotics education. However, there appears to be great demand for further study on how to enhance teaching and learning effectiveness. The emergence of the Internet has reformed the concept and methods of engineering education. In this paper, we present interactive e-learning environments to increase students' motivation and participation in project-based learning of robotics. Online learning utilizing the features of the Web is increasingly becoming an important tool for education. It overcomes time and space limitations in traditional schools. In general, online learning environments have shown potential in promoting thinking skills [26]. Furthermore, Dockrill [27] found that students perceived interactive teaching and learning approaches as facilitating the acquisition of critical thinking skills. Despite the many benefits of e-learning, it may weaken students' motivation due to lack of face-to-face communication. In order to make the learning process effective, we have to motivate students to be engaged in the learning activities. Therefore, this study adopted a project-based learning model which is based on the constructivist approach, to provide motivation, self-learning, and collaborative learning for students in the Web environment.

The project-based learning (PBL) approach engages students in exploring meaningful questions through a process of investigation and collaboration [28]. In the PBL environment, students build their own knowledge by active learning, interacting with the environment as suggested by the constructivist approach, and working independently or collaborating in teams, while the teacher directs and guides and they make a real product [29].

2 Inquiry System Design

With project-based learning approaches, planning activities and investigations will play a critical role in the process of working on projects. Students look for dates in order to deal with a problem. They plan their work and create a synthesis of information retrieved from numerous resources. However, Meng and Yang [30] pointed out that most existing QA (Question and Answering) systems suffer from precision problems. Since the amount of available information has increased, users waste considerable time in searching and browsing various websites to obtain the required information. Users must click and browse all documents returned by keyword search to identify their desired information. When numerous documents are returned, users may waste lots of time dealing with many unsuitable documents. Studies of learner use of the WWW have indicated that students frequently fail to establish task-relevant, meaningful, reflective activity [31]. The root problem is that keyword searches are not an ideal method for users to present their real intentions. To solve this problem, this research developed two inquiry methods for students to process question statements in natural Chinese language fashion and engineering drawing to find out the intention of the user query.

The whole system is created based on N-tier architecture. The application tier side consists of a web server and a Java application server. A presentation tier is a client-side terminal that comprises the HTML, XML, and 3D web player plug-in. The client, which runs in a web browser, provides a student interface that handles input and output (displaying results, simulation). The web server performs actions and computations based on student input by using XML and JSP language. The application server reads and writes to the databases by JavaBean and interfaces with external software packages. The content of the course is primarily presented with Web pages which are

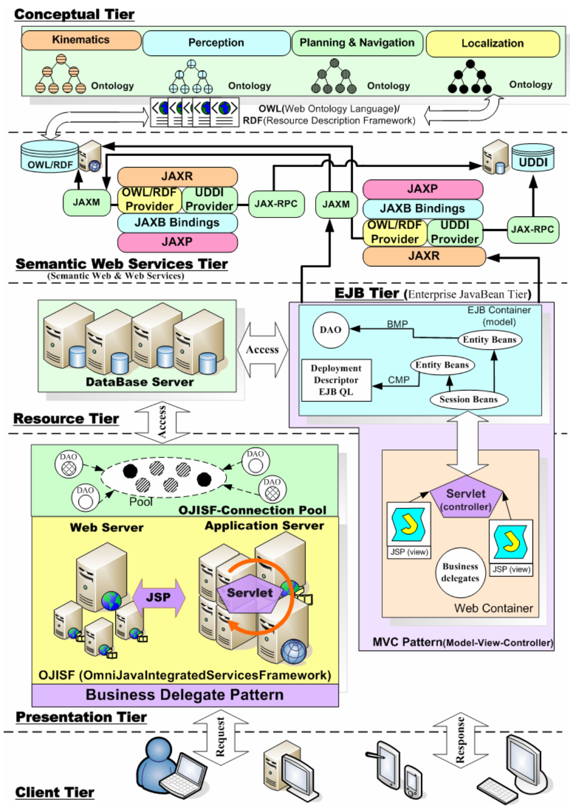


Fig. 1. Framework of semantic e-learning system

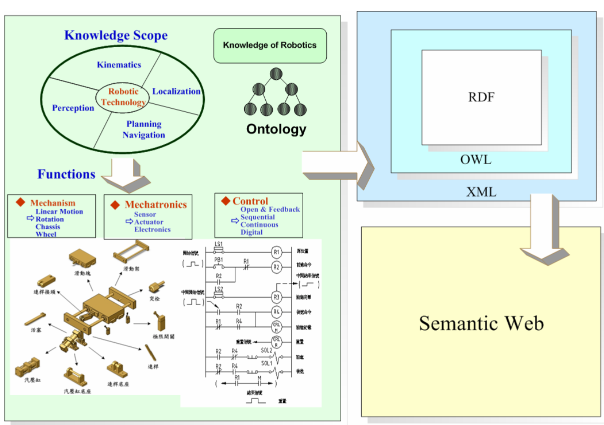


Fig. 2. Knowledge infrastructure of robotics

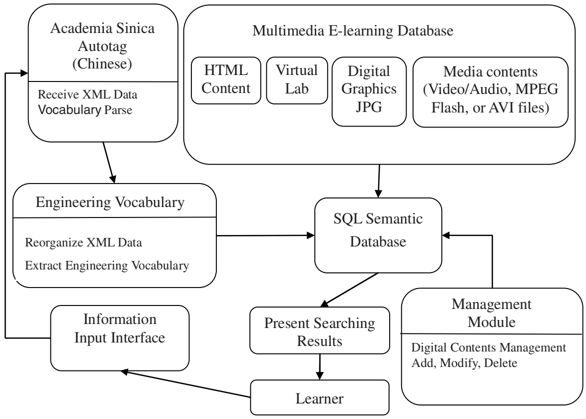


Fig. 3. Semantic inquiry module

written in HTML. In order to move courses from one system to another, and extract and/or perform automated processing on the documents, standardized definitions for course structures are necessary. To meet requirements, Extensible Markup Language (XML) is used to develop course structures. In order to get cross-platform applications, JAVA language is used in programming to develop interactive Web pages. The framework of the developed e-learning system is shown in Fig. 1.

The first inquiry method is developed based on the concepts of semantic web theory. Semantic approach has become an increasingly important issue in advanced knowledge technologies. It provides a knowledge infrastructure to support the management and application of scientific and engineering knowledge. The semantic approach advances Web-application to be the syntactic and semantic level. The Semantic Web is an extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation [32]. It is the idea of having data on the Web defined and linked in a way that it can be used for more effective discovery, automation, integration, and reuse across various applications. The knowledge infrastructure of robotics is depicted in Fig. 2.

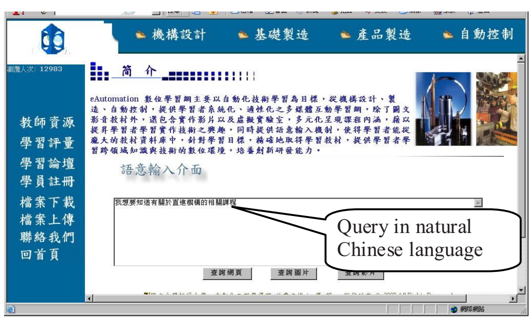


Fig. 4. Screenshot of semantic inquiry interface (in Chinese)

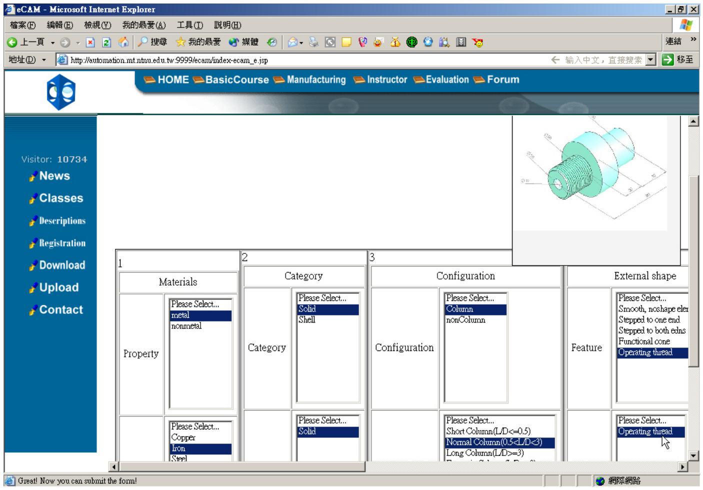


Fig. 5. Screenshot of graphic inquiry interface

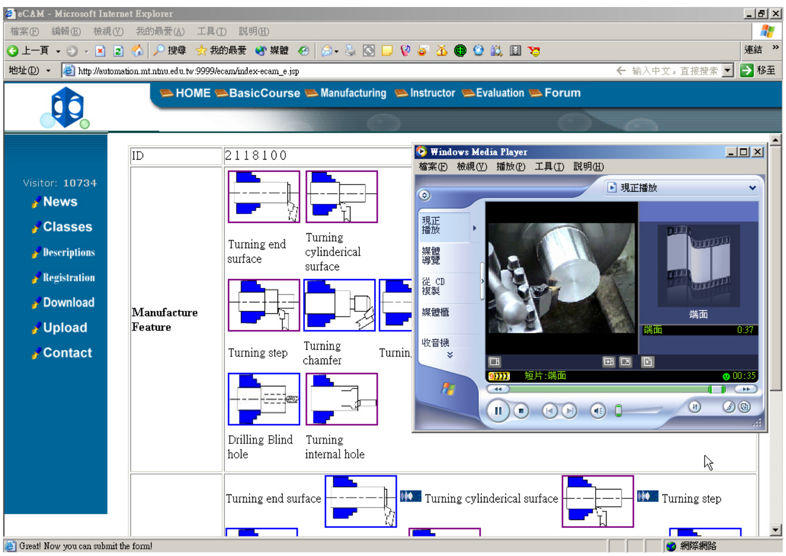


Fig. 6. Manufacturing processes planning and multi-media contents

The developed module interprets the students' question (i.e., document source) to extract the semantic information. The system then contrasts the source documents with the existing engineering database by heuristic rules to retrieve useful and precise results that meet the expectations of users. Fig. 3 shows the architecture of the proposed method. Autotag, developed by Academia Sinica of Taiwan, is employed in this system to parse Chinese characters into meaningful words. The online interface for queries in natural Chinese language is shown in Fig.4.

Besides the semantic inquiry module, this research developed another inquiry module to allow students to present their queries by engineering graphics. After uploading the engineering drawings (2D or 3D), this module interprets the input data and then extracts the engineering information to analyze manufacturing methods (Fig. 5). The appropriate machining procedures are displayed for students to learn the principles of manufacturing process planning. Students can click each manufacturing feature to browse its machining methods, which are displayed in multimedia form (Fig.6). In this phase, the objective is to teach students the ability to extract the manufacturing features for a complex part from a mechanical drawing in either 2D or 3D. Furthermore, students have a chance to accept the training of manufacturing process planning in this stage.

3 Implementation and Discussion

The participants in this study were sophomore students who participated in a "Special Project Design" course for the spring semester. The aim was to design a mobile robot to perform a specific task. The participants were required to complete the course online without face-to-face instruction and were also required to work on their design in small groups of 4-5 participants. They were encouraged to retrieve relevant information from the developed e-learning system. After the course, each group was required to submit a final technical report detailing the design process, the engineering considerations that led to the final design, a review of the relevant engineering literature, and the group's conclusions.

The first module was designed for students to investigate robotic manipulation including mechanisms, robot motion, and path planning. Students explored the website site in advance and proposed what they wished to investigate through the developed inquiry modules in natural Chinese language (Fig. 4). The infrastructure of this module was developed based on context-aware approaches, which are able to manage the context model representing contextual information and provide relevant information and/or services to the user depending on the user's task. Thus, the system will respond to the questions with accurate answers in the form of contextual information (Fig. 7). Students are able to click desired items and browse the detailed documents which contain text, graphics, multimedia, and interactive simulation (Fig. 8). Furthermore, students are able to observe robot arm link inertias of motions and study the trajectory generation and control from this module. In addition to inquiry modules, this study developed platforms for students to assemble mechanical parts and integrate mechatronics (i.e. sensors, actuators, and control units) to design robots. The assembly platform (Fig. 9) can allow students to design and modify the mechanical components of robots to meet the project goal as expected. The platform of mechatronics was designed to help students in learning robotic sensors, actuators, and controllers (Fig. 10). With this platform, students can design and construct functioning models, gaining experience and insight in designing robotic mechantronics. For robotic sensors (Fig. 11), the learning contents cover proprioceptive sensors, exteroceptive sensors, sensor performance, and design criteria. For actuators, the system contains a number of

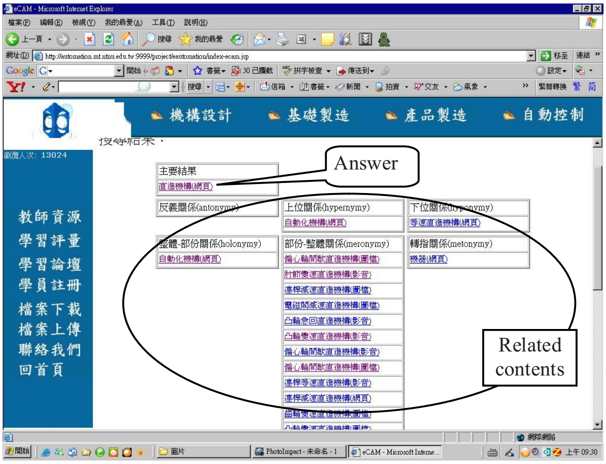


Fig. 7. Hypertext information

Fig. 8. Desired mechanism and its dynamic simulation

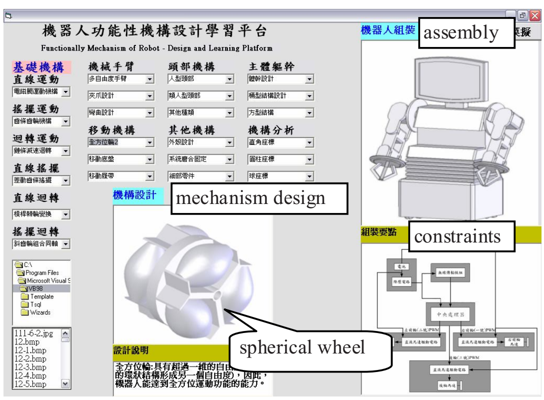


Fig. 9. Design and learning platform of mechanisms

motors for study (Fig. 12). Through this platform, the students confronts the realities of robotic control and learn to deal with them (Fig. 13). Fig. 14 shows the entire structure of a two-armed mobile robot designed by one of the groups in this course.

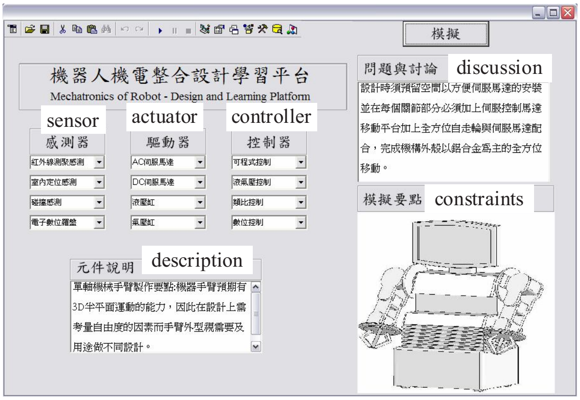


Fig. 10. Design and learning platform of mechantronics

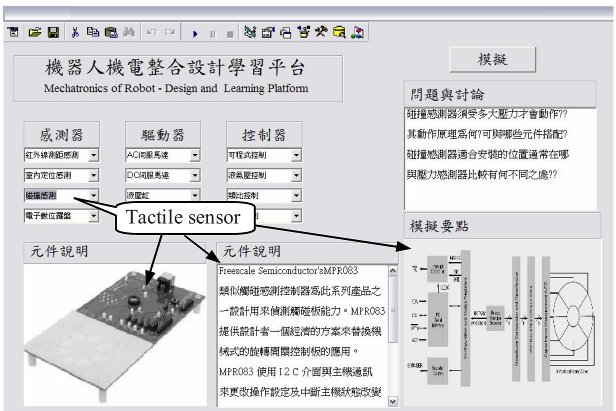


Fig. 11. Design & learning of robotic sensors

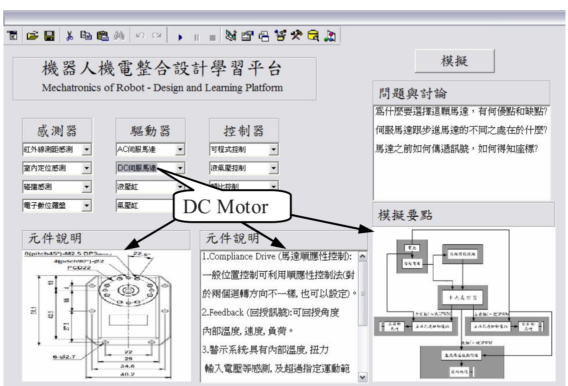


Fig. 12. Design & learning of robotic actuators

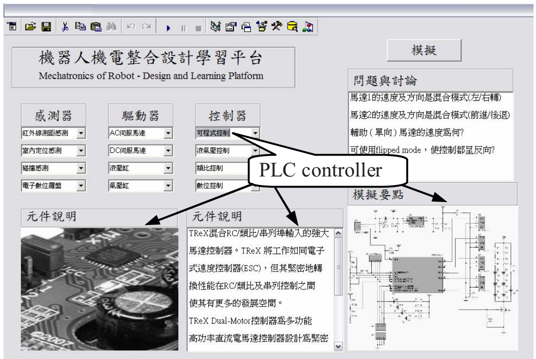


Fig. 13. Design & learning of robotic control

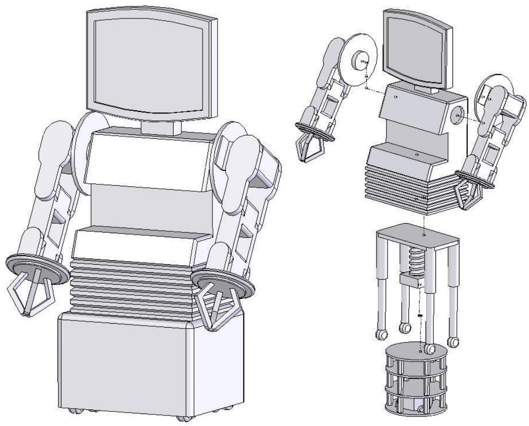


Fig. 14. Assembly model of designed robot and its mechanisms

4 Assessment

This study employed a pre-experimental approach without the utilization of control groups [33]. Quantitative data were collected using questionnaires, while qualitative data were collected through interviews. According to Windschitl [34], qualitative data can capture unique phenomena on online learning. The participants of the study comprised 20 sophomore students who participated in a "Special Project Design" course for the spring semester. They were required to work on their design in small groups of 5 participants. The questionnaires also measured the participants' satisfaction toward the course as well as their perceptions on the delivery method, course structure, inquiry method, interactions among the participants, interactions between the participants and the materials, and the participants' autonomy. The questionnaires were administered to the participants before and after the completion of the online course. Follow-up interviews were carried out with the participants at the end of the course.

Nearly 75 percent of the participants agreed that the interface design was user friendly, simple, and attractive. In addition, they found the course content to be well organized. They also felt that the inquiry modules were able to facilitate investigation and planning activities on project developing stages. Furthermore, these course activities were able to enhance their interests toward robotics. The participants believed that the course not only helped them to enhance their problem solving skills, it also enhanced their integration ability of technologies. However, a small number of participants felt isolated while completing the online course. This could be attributed to the lack of face-to-face interactions. Meanwhile, the interviews showed that the participants believed that the course was challenging, stimulating and fun for them. The participants also showed positive attitudes toward robotics.

5 Conclusions

In this paper, we proposed an interactive e-learning environment to support project-based learning of robotics at a distance. The robot presented in this paper was conducted in the developed online PBL system. By means of such an environment, students can explore the essence of design, manufacturing, mechanisms, control, and the integration of mechatronics. In this learning environment, the students constructed their own knowledge through active learning and interaction with an e-learning system. Thus, the developed online PBL supports the constructivist approach to teaching. The responses obtained were very encouraging. Students in the course were appreciative of these on-going changes and indicated that these were indeed helping them to develop their engineering thinking and their intuition, increasing their motivation to study.

Acknowledgment

The authors gratefully acknowledge the support of this study by the National Science Council of Taiwan, under the Grant No. NSC96-2516-S-003-003-MY3. They also would like to thank National Taiwan Normal University for providing the necessary equipments for the project.

References

1. Vira, N., Tunstel, E.: Use of symbolic computation in robotics education. IEEE Trans. Educ. 35, 18–30 (1992)
2. Mrad, F.T., Deeb, G.: Extending the utility of the RHINO educational robot. IEEE Trans. Educ. 40, 184–189 (1997)
3. Raz, T.: Graphics robot simulator for teaching introductory robotics. IEEE Trans. Educ. 32, 153–159 (1989)
4. Inigo, R., Morton, J.: Simulation of the dynamics of an industrial robot. IEEE Trans. Educ. 34(1), 89–99 (1991)
5. Vibet, C.: Elements to teach robot control design. IEEE Trans. Educ. 36, 45–51 (1993)

6. Pota, H.: A prototype flexible robot arm-An interdisciplinary undergraduate project. IEEE Trans. Educ. 35(1), 83–90 (1992)
7. Richard, W.: An educational image processing/machine vision system. IEEE Trans. Educ. 34(1), 129–133 (1991)
8. Newman, K.E., Hamblen, J.O., Hall, T.S.: An introductory digital design course using a low-cost autonomous robot. IEEE Trans. Educ. 45, 289–296 (2002)
9. Carley, L., Khosla, R.P., Unetich, R.: Teaching introduction to electrical and computer engineering in context. Proc. IEEE 88, 8–22 (2000)
10. Kuc, R., Jackson, E.W., Kuc, A.: Teaching Introductory Autonomous Robotics with JavaScript Simulations and Actual Robots. IEEE Trans. Educ. 47(1) (February 2004)
11. Robinette, M.F., Manseur, A.R.: ROBOT-DRAW, an Internet-Based Visualization Tool for Robotics Education. IEEE Trans. Educ. 44(1) (February 2001)
12. Maxwell, B.A., Meeden, L.A.: Integrating Robotics Research with Undergraduate Education. IEEE Intelligent Systems (November/December 2000)
13. Mehrl, D.J., Parten, E., Vines, D.L.: Robots Enhance Engineering Education. In: Frontiers in Education Conference (1997)
14. Rawat, K.S., Massiha, G.H.: A Hands-On Laboratory Based Approach to Undergraduate Robotics Education. In: Proceedings of the 2004 IEEE International Conference on Robotics and Automation, New Orleans, LA (2004)
15. Nagai, K.: Learning While Doing: Practical Robotics Education. Robotics & Automation Magazine, IEEE 8(2), 39–43 (2001)
16. RASC (2003), http://www.cs.cmu.edu/~rasc
17. LEGO Mindstorm, http://mindstorms.lego.com/
18. Parallax, Inc., http://www.parallax.com/
19. Stein, C.: Botball: Autonomous Students Engineering Autonomous Robots. In: Proceedings of the ASEE Conference (2002)
20. Wolz, U.: Teaching Design and Project Management with Lego RCX Robots. In: Proc. SIGCSE Conference (2000)
21. Foundation for the Inspiration and Recognition of Science and Technology, http://www.usfirst.org
22. Walking Machine Decathlon (June 12, 2003), http://www.sae.org/students/walking.htm
23. Verner, I., Waks, S.: Educational Features of Robot Contests: The RoboCup 1998 Survey. Advanced Robotics 14(1), 65–74 (2000)
24. Osuka, K., Murphy, R., Schultz, A.: USAR Competitions for Physically Situated Robots. IEEE Robot. Automat. Mag. 9, 26–33 (2002)
25. Pack., D.J., Avanzato, R., Ahlgren, D.J., Verner, I.M.: Fire-fighting Mobile Robotics and Interdisciplinary Design-comparative Perspectives. IEEE Trans. Educ. 47(3) (2004)
26. Saba, F.: Research in Distance Education: A Status Report. International Review of Research in Open and Distance Learning 1(1) (2000), http://www.irrodl.org/index.php/irrodl/article/view/4/24
27. Dockrill, P.M.: Facilitating Critical Thinking in First Year Community College Students. Master's thesis, St. Francis Xavier University, Canada (2003)
28. Krajcik, J., Czerniak, C., Berger, C.: Teaching Science: A Project-Based Approach. McGraw-Hill College, New York (1999)
29. Thomas, J.W.: A Review of Research on Project-based Learning, http://www.autodesk.com/foundation/pbl/research
30. Meng, I.H., Yang, W.P.: An Effective Engine for Answering Questions Based upon Chinese Semantic Extraction. Info. Mang. Scis. 14(4), 27–48 (2003)

31. Hill, J.R., Hannafin, M.J.: Cognitive Strategies and Learning from the world wide web. Educ. Tech. Res. & Dev. 45(4), 37–64 (1997)
32. Berners-Lee, T., Hendler, J., Lassila, O.: The semantic web. Scientific American 284(5), 34–43 (2001)
33. Creswell, J.W.: Research design: Qualitative and Quantitative Approaches. Sage Publication, California (1994)
34. Windschitl, M.: The WWW and Classroom Research: What path should we take? Educational Researcher 27(1), 28–33 (1998)

Ontology-Based User Modelling Personalization: Analyzing the Requirements of a Semantic Learning Portal

Liana Razmerita[1] and Miltiadis D. Lytras[2]

[1] Copenhagen Business School
Center of Applied Information and Communication Technologies
Howitzvej 60, 1st floor, DK - 2000 Frederiksberg, Denmark
Tel.: +45 3815 2489
liana.razmerita@cbs.dk
[2] University of Patras
Argolidos 40-42, 153-44 Gerakas Attikis, Greece
miltiadis.lytras@gmail.com
http://www.miltiadislytras.net

Abstract. In last decade a number of design approaches have been adopted towards high performance e-learning systems. In this context Users/Learners modelling is a key milestone towards the specification of characteristics and features of learners that potentially can modify the flow of learning. In this article we are introducing an Ontology-Based User Modelling framework and and we show how it can be used in the context of a Semantic Learning Portal. The main contribution of the article relates to the detailed analysis for the design variables and requirements for Semantic Learning Applications towards adoption of services, personalization and management of personal profiles and identities of learners.

Keywords: Semantic Web, Databases, Personalization Semantic Web Evolution, Semantic Web Mining.

1 Introduction

User modeling is a process which aims to construct and maintain user models in order to support personalized interaction. Since the early 1970's the domain of user modeling has constantly grown. The evolution of computer technology has brought not only new technological platforms, techniques and application domains but also new challenges and new opportunities for user modeling. The aim of user modeling is very ambitious and it spans many active research areas of artificial intelligence (AI) e.g., natural language processing, knowledge representation, automated reasoning, (multi-agent) planning, machine learning, belief revision and plan recognition.The early research on user modeling was developed in the context of natural language dialogue systems. Kobsa (1989) analyses the characteristics of user-modeling systems designed in the context of natural language dialog systems. He emphasizes that "*a flexible user-oriented dialog behavior of such systems can be achieved only if the system has*

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 354–363, 2008.

access to a model of the user containing assumptions about his/her background knowledge as well his/her goals and plans in consulting the system."

In the last few years, user modeling has been widely applied to systems where interaction is based on, concerned with, or aimed at dialogue, consultation, information presentation and retrieval, hypermedia, help, training and tutoring. The next generations of information systems are foreseen to be systems that adapt their behavior to the individual characteristics of their users and systems that better support the user in performing his tasks (Bradshaw, 1997). One of the most important aspects needed in building such systems is the information about the users: their goals, their needs, moods, preferences, intentions, etc. This collection of data about the users is often referred as user models. In the context of computer applications the user model is usually restricted to some characteristics that are supposed to be the most meaningful in the context of the user interaction with the system. These characteristics vary according to the different applications in which the user model is used, but the most common ones are: the user's knowledge, the user's interests and goals. The user's characteristics (e.g. the user's knowledge, the user's interests, his/her goals) can be acquired by an explicit or implicit process called user modeling. To *model the user* for software system means to interpret the user's actions with the purpose of improving the interaction between the user and the system.

In general, some of the main questions in user modeling can be broadly grouped into the following questions:

- What should the user model contain? or more explicitly: What are the user's most meaningful characteristics, which can be taken into account in a software system?
- How can a system better acquire relevant information about the user?
    - To ask the user about relevant user related data (e.g. his/her learning goals, research interests)?
    - To try to classify the users?
    - To try to learn about the user?
    - To infer assumptions related to the users?
- What use can be made of any such information captured? or
- How can the system use the information captured about its users in order to improve the interaction between the users and the system?

The last question addressed: "What use can be made of any such information captured?" brings to attention some major challenges of user-modeling research like: how to make high-functionality applications more usable, useful and learnable (Fischer, 2001) or how to better filter and personalize the information according to the user's needs and goals? This first research direction has emerged as important in the last few years because software systems have become complex and they often perform a wide variety of tasks and support diverse groups of users with different needs. Fischer (2001) emphasizes the fact that: "designers of collaborative human-computer systems face the formidable task of writing software for millions of users (at design time) while making it work as if it were designed for each individual user (only known at use time)." The second research direction has emerged because of the vast amount of data available on the web and the information overload problem we face in our daily life.

2 Ontology-Based User Modelling for Personalized Interaction

The user model is the key element enabling to personalize the interaction with an information system. The user model can be created based on the actions performed by a user during the interaction with the system (implicitly) or by acquiring these data directly from the users (explicitly). Advanced user models are part of the user-modeling systems. The user modeling system enables the application to acquire and to maintain user models. The core of a user modeling systems consists of mechanisms for representing the user model, and mechanisms for inferring assumptions about the users of the system. We define user models as explicit representation of the user's characteristics that are relevant for personalized interaction. Personalized interaction can include:

- Direct access to customized relevant knowledge assets;
- Provide unobtrusive assistance;
- Helping to find/recall information needed for a task;
- Offering to automate certain tasks through implicit or explicit interventions.

We argue that *personalization, and contextualization will be key issues in achieving intelligent features for advanced ISs*. The vision is that Semantic Web-enabled information systems will extract relevant information from the Web, process and combine different pieces of distributed information in such a way that the content selection and presentation fits to the individual needs of the user (Baumgartner, 2005).In general, the goal of personalization is to improve the efficiency of interaction with the users, to simplify the interaction, to filter information and knowledge and to make complex systems more usable. The process of ***personalization*** can achieved in two different ways:

- Based on the agent intervention
- Based on various types of intelligent services that are transparent for the users also addressed as adaptive features in the user modeling literature.

Adaptive features can include adaptation of content, adaptation of structure and adaptation of presentation and modality. A personalised hypermedia application is defined as a hypermedia system that adapts the content, structure and/or presentation of networked hypermedia to each individual user's characteristics, usage behaviour and/or usage environment (A. Kobsa, Koenemann, J., and Pohl, W., , 2000).

In the last few years, the concept of ontology has started to be used frequently in connection with Semantic Web research vision. An ontology enables the conceptualization of the domain knowledge for an application. Ontology aims to structure and represent domain knowledge in a generic way which may be reused and shared across various applications and groups of people. Annotating resources, representing concepts and the relationships between concepts is key for implementing semantic-enabled applications and achieving the Semantic Web vision (Berners-Lee, 2006).

Creating flexible, powerful representation knowledge structures on the web is the grounding for achieving web-enabled, personalized systems. These knowledge structures need to better capture and describe the semantics of data. Ontology-based representations are flexible and powerful representation structures, and they have become a topic of much discussion recently. Ontologies are semantic-enhanced data models.

Moreover ontologies are seen as a key technology for resolving the problem of meaningful information sharing (Stuckenschmidt, 2005). The process of building an ontology is often a complex, challenging task. It is the first step to achieve semantic-enabled systems. The complexity of the task lies in its cross-disciplinarily including new techniques, methods and tools.

A generic Ontology-based User Modeling framework (OntobUMf), as proposed by Razmerita et al. (2003) relies on the use of ontologies as a core representation mechanism. The OntobUMf's architecture is represented in Figure 1. Within this framework, user modeling techniques and the personalization mechanisms are represented as intelligent services. The user model data for a specific user is acquired based on an explicit definition, provided by the user, through the user profile editor, and by an implicit part maintained by the category extractor represented as intelligent service. Category extractor infers certain characteristics of the users based on their activity in the system. The activity of the users in the system is captured as log instances.

The OntobUMf's architecture, as represented in Figure 1, integrates: an user profile editor and intelligent services. The user profile editor is a specialized ontology editor, dedicated to the end-users to instantiate the user ontology. The **user ontology** structures the characteristics of the users in concepts, sub-concepts, properties and their relationships.

The user profile editor initializes the user model but it also enables the user to visualize it, revise it and update it. Intelligent services have two main roles in the system:

- to update and to maintain the user model on the basis of usage data available from the running system through the **category extractor.** OntobUMf's category extractor integrates specific mechanisms for modeling the characteristics of the users interacting with a knowledge management system. User's are classified according to their level of knowledge sharing, according to their type of activity and according to their level of activity.
- to provide a set of **personalized services** based on the characteristics of the users.

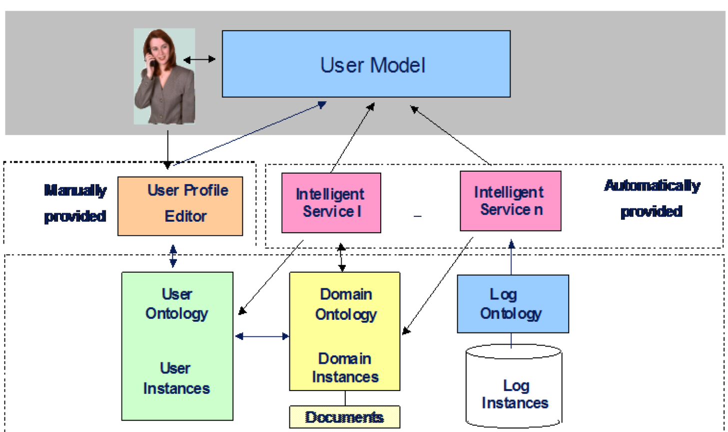


Fig. 1. Ontology-based user modeling architecture

The use of ontology for user modelling has been recently proposed for different scenarios. A multi agent-based architecture for intelligent and adaptive learning systems aimed at helping people to learn and adopt knowledge-sharing management practices has been proposed by Nabeth et al. (2005). Dolog and Nejdl (2007) emphasize the use of ontology for adaptive learning content and smart learning spaces. Kay and Lum (2005) pinpoint to the challenge and need of being able to construct domain ontology automatically and cheaply. Context features and situational statements for ubiquitous computing have been integrated in a General User Model Ontology proposed by Heckman (2005; Heckmann, Schwarzkopf, Mori, Dengler, & Kroner, 2007). In the next section we provide an initial discussion of this approach in the context of a Semantic Web Portal.

3 The Semantic Learning Portal: Exploiting Ontology Based User Modeling for Dynamic Learning Designs

Despite years of research in the area, e-Learning is still facing provocative challenges related to how to better support learning processes on the Web. On one hand, the continuous development of new technologies such as Semantic Web, Grid computing has opened new perspectives for advanced learning services. On the other hand, new paradigms of learning need to be integrated in the design of these new learning services. The learner is no longer a simple passive receiver of knowledge; he is stimulated to play an important role in constructing his knowledge. Learning processes can also take place through complex interactions such as games, conversations, and collaborations with colleagues and friends. These days we also speak about social learning, a more ludic form of learning (Razmerita, Gouarderes, & Conte, 2005).

We summarize the offerings of the Semantic Learning Portal concerning exploitation of Ontology-based user modelling and we comment on key requirements for the successful adoption in a real world environment.

According to our approach the technological solution for the Semantic Learning Portal needs to be based eight pillars:

1. *Advanced Features for Structuring of Learning Content*
2. *Advanced features for Knowledge Networking*
3. *Advanced features for Interoperability*
4. *Advanced features for Learning Designs and Dynamic Learning Models*
5. *Advanced characteristics of Learners Modeling*
6. *Advanced features for (Domain) Ontologies Management*
7. *Advanced features for Business Process Integration*
8. *Advanced features for Competencies management*

Figure 1 illustrates a generic approach to the Semantic Learning Portal. In fact two aspects are highlighted: The **Semantic Web Portal Modules** and the **Semantic Learning Portal Workflow.** A third layer not presented in this figure is related to the **Application Integrators** which enables the Semantic Portal to offer services in wider contexts of exploitation e.g. within Enterprise Resource Planning Systems, or Knowledge Management Systems.

The underline philosophy of Semantic Learning Portal is anchored in four perspectives:

The Content Based View
One of the most powerful characteristics of a Semantic Learning Portal relates to the Advanced Content Management Module. Four Major components are providing the main functionalities:

- ***The Ontology Builder and Integrator:*** This component enables the construction, maintenance and exploitation of ontologies. It supports advanced ontology engineering capabilities related to different types of ontologies. In the context of Semantic Learning Portal this component provides generic services for learning exploitation.
- ***The Domain Knowledge Acquisition System:*** This subsystem provides advanced features for the continuous enrichment of the learning content base of the Semantic Learning Portal.
- ***The Ontology Visualization System:*** This system supports content authors as well as learners to explore the various supported ontologies in a learning meaningful context. Several advanced services such as personalized content exploration and personal learning paths are supported.
- ***The Annotator:*** Its main roles are the semantic annotation of content with general and learning specific semantics and metadata. Various techniques may be exploited, such as semi-automatic, automatic, and manual annotation of content.

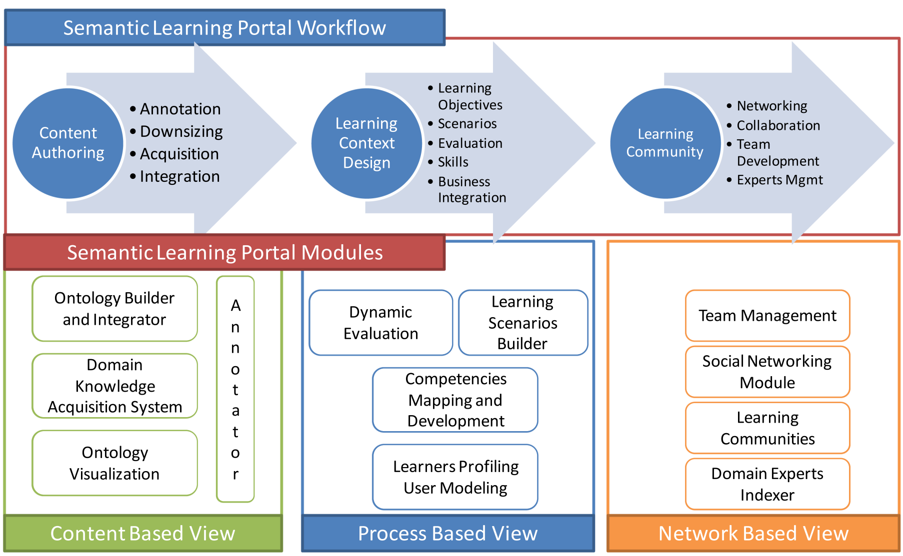


Fig. 2. Semantic Learning Portal

The Process Based View

The Process Based View of the Semantic Learning Portal has a key orientation to learning performance. The cornerstone in the learning strategy of the Semantic Learning Portal is the parameterization of the learning context according to learners' models and learning strategies as well as the integration with business systems. The following are the main components of the process-based module of the Semantic Learning Portal:

- ***Learners Profiling / User Modeling Systems:*** They deal with the analysis and design of user/learner models by applying advanced methods of user modeling. The Semantic Learning Portal is exploiting a number of standards that relate implicitly or explicitly with the specification of the learners' identity.
- ***Competencies Mapping and Skills Development:*** It deals with the integration of Semantic Learning Portal with business applications and human resources management systems aiming to provide ontology competency models for linking learning performance with skills and competencies acquisition.
- ***Learning Scenarios Builder: It*** enables the definition of customized learning scenes and paths for learners. A key aspect of this subsystem focuses on the exploitation of domain ontologies for the development of learning scenarios.
- ***Dynamic Evaluation System:*** It exploits the dynamic match of learners' models with learning scenarios. From this perspective the evaluation within the Semantic Learning Portal emphasizes the measurement of the learning effect in learners behavior. The domain ontologies play a key role in Dynamic Evaluation system since they provide the linked nodes of significant concepts that represent or relate to significant learning objectives.

The process-based view of the Semantic Learning Portal is enabled through a variety of Semantic Web Services. A key issue in the Semantic Learning Portal is the Definition, Design, Implementation and Support of a customizable Learning Design. Given this layer at an interoperability layer various agents can explore the Semantic Learning Portal functionalities in order to run a number of business rules and queries related to learning-oriented objectives.

The Network Based View

The third module of the Semantic Learning Portal is focusing on the provision of an intelligent knowledge and learning networking infrastructure.

- ***Learning and Social Networking Module:*** In the Semantic Learning Portal a key challenge is the development of learning networks on the basis of a common agreement/understanding of the learning context. In simple words the learning and social networks facilitated by the operation of the Semantic Learning Portal explore not only semantic web standards or tools like FOAF but explore personal identities with a learning perspective. E.g. learning and social networking module is used for the continuous extension of the domain ontology.
- ***Learning Communities module***
- ***Team Learning and Management***

- ***Domain Experts Indexer:*** In any learning system one of the major pitfall relates to the continuous enrichment of learning content base. Within Semantic Learning Portal there is a key mechanism which is responsible for the exploitation of implicit semantics related with experts' tacit knowledge. The domain experts' indexer is a module which potentially links domain experts and gives the opportunity to learners to get advice from experts or sharing with them ideas and questions.

The network based perspective of the Semantic Learning Portal is serving the learning orientation of the full system in various directions. Two of them are worth notable. The major criticism of Learning Portals is their poor performance towards integrates of team and social dynamics as they appear in a learning context. In simple words in most of cases learning content is perceived to be static, packaged with limited capacity of enrichment from the collaborative filtering of learners or "users". In the Semantic Learning Portal, the Network Based view exploits the "personal learners identities" as well as the "collaborative/team identity" for the provision of a dynamic mechanism in which tacit knowledge of participants is used for reinforcing the "quality" of learning content.

The Application Integration /Interoperability Based View

On the top of the infrastructure provided in Figure 1, the Semantic Learning Portal has an application integration/interoperability layer. At an operational level, the provision of content within a learning system must follow a well defined workflow. In most of real world cases the learning content found in learning portals is not integrated to the "business" or "application" domains. In the Semantic learning Portal the Interoperability layer provided a number of "integrators" for the co-operation and interoperability of the portal with a number of applications such as ERPs systems or human resource management systems.

4 Conclusions

In this paper we discussed the critical issue of User Modeling towards adaptive dynamic e-learning settings. The effort to develop customized learning experiences requires a deep analysis of performance factors in the context of learners profiles and identities. In this article the initial discussion was focused on architectural guidelines. In a next paper we will provide more technical specifications for the LearningSema an FP7 Proposal that will be submitted aiming to develop a Semantic Learning Portal Toolkit.

References

Barriocanal, E.G., Sicilia, M.A., Lytras, M.: Pedagogical clasification frameworks for learning objects: A case study. Computers in Human Behavior 23(6), 2641–2655

Baumgartner, R., Enzi, C., Henze, N., Herrlich, M., Herzog, M., Kriesell, M., Tomaschewski, K.: Semantic Web enabled Information Systems: Personalized Views on Web Data. In: The International Ubiquitous Web Systems and Intelligence Workshop (2005)

Berners-Lee, T., Hall, W., Hendler, J.A., O'Hara, K., Shadbolt, N., Weitzner, D.J.: A Framework for Web Science. Foundations and Trends in Web Science 1(1), 1–130 (2006)

Bradshaw, J.: Software Agents. MIT Press, Cambridge (1997)

Dolog, P., Nejdl, W.: Semantic Web Technologies for the Adaptive Web. In: Brusilovsky, P., Kobsa, A., Nejdl, W. (eds.) The Adaptive Web, pp. 697–719. Springer, Heidelberg (2007)

Heckmann, D., Schwartz, T., Brandherm, B., Schmitz, M., von Wilamowitz-Moellendorff, M.: GUMO - the General User Model Ontology. In: Ardissono, L., Brna, P., Mitrović, A. (eds.) UM 2005. LNCS (LNAI), vol. 3538, pp. 428–432. Springer, Heidelberg (2005)

Heckmann, D., Schwarzkopf, E., Mori, J., Dengler, D., Kroner, A.: The User Model and Context Ontology GUMO revisited for future Web 2.0 Extensions (2007)

Kay, J., Lum, A.: Ontology-based user modelling for semantic web. In: Ardissono, L., Brna, P., Mitrović, A. (eds.) UM 2005. LNCS (LNAI), vol. 3538. Springer, Heidelberg (2005)

Kobsa, A., Koenemann, J., Pohl, W.: Personalized hypermedia presentation techniques for improving online customer relationships. The Knowledge Engineering Review 16, 111–155 (2000)

Kobsa, A., Wahlster, W.: User Models in Dialog Systems. Springer, Heidelberg (1989)

Lytras, M.: The semantic electronic government: knowledge management for citizen relationship and new assessment scenarios. Electronic Government, an International 3(1), 5–17 (2006)

Lytras, M., Naeve, A.: Semantic e-learning: synthesizing fantasies. British of Educational Technology 37(3), 479–491 (2006)

Lytras, M., Naeve, A., Pouloudi, A.: A knowledge management roadmap for e-learning: the way ahead. International Journal of Distance Education Technologies 3(2), 1–11 (2005a)

Lytras, M., Naeve, A., Pouloudi, A.: Knowledge management as a reference theory for e-learning: a conceptual and technological perspective. International Journal of Distance Education Technologies 3(2), 66–73 (2005b)

Lytras, M., Sicilia, M.: Knowledge society a manifesto for knowledge and learning. Int. J. Knowledge and Learning 1(1), 1–11 (2005)

Lytras, M.: Semantic Web and Information Systems: An Agenda Based on Discourse with Community Leaders. International on Semantic Web and Information Systems, Inaugural Issue 1(1), i–xii (2005)

Sicilia, M., Lytras, M.: Scenario-Oriented Reusable Learning Object Characterizations. International of Knowledge and Learning 1(4), 332–341 (2005)

Sicilia, M., Lytras, M., Rodríguez, E., García-Barriocanal, E.: Integrating descriptions of knowledge management learning activities into large ontological structures: A case study. Data & Knowledge Engineering 57(2), 111–121 (2006)

Lytras, M.: The Semantic Electronic Government: knowledge management for citizen relationship and new assessment scenarios. Electronic Government, an International 3(1), 5–17 (2006)

Sicilia, M., Lytras, M.: The semantic learning organization. The Learning Organization 12(5), 402–410 (2005)

Naeve, A., Lytras, M., Nejdl, W., Harding, J., Balacheff, N.: Advances of Semantic Web for E-learning: Expanding learning frontiers. British of Educational Technology 37(3), 321–330 (2006)

Lytras, M., Naeve, A.: Semantic E-learning: Synthesizing Fantasies. British of Educational Technology 37(3), 479–491 (2006)

Nabeth, T., Razmerita, L., Angehrn, A., Roda, C.: InCA: a Cognitive Multi-Agents architecture for Designing Intelligent & Adaptive Learning Systems. International Journal ComSIS (Computer Science and Information Systems), special issue Cognition and Exploratory Learning in Digital Age 2(2), 99–113 (2005)

Razmerita, L., Angehrn, A., Maedche, A.: Ontology-based User Modeling for Knowledge Management Systems. Proceedings of the Ninth International Conference of User Modeling 2003 (2003)

Razmerita, L., Gouarderes, G., Conte, E.: Ontology-based User Modeling and e-Portfolio Grid Learning Services. Applied Artificial Intelligence 19(9/10), 905–932 (2005)

Stuckenschmidt, H., van Harmelen, F. (eds.): Information Sharing on the Semantic Web. Springer, Heidelberg (2005)

Social Recommendations within the Multimedia Sharing Systems

Katarzyna Musiał[1], Przemysław Kazienko[1], and Tomasz Kajdanowicz[2]

[1] Wrocław University of Technology,
Wyb.Wyspiańskiego 27, 50-370 Wrocław, Poland
{katarzyna.musial,kazienko}@pwr.wroc.pl
[2] Hewlett Packard Polska Sp. z o.o.,
ul. Szturmowa 2A, 02-678 Warszawa, Poland
tomasz.kajdanowicz@hp.com

Abstract. The social recommender system that supports the creation of new relations between users in the multimedia sharing system is presented in the paper. To generate suggestions the new concept of the multirelational social network was introduced. It covers both direct as well as object-based relationships that reflect social and semantic links between users. The main goal of the new method is to create the personalized suggestions that are continuously adapted to users' needs depending on the personal weights assigned to each layer from the social network. The conducted experiments confirmed the usefulness of the proposed model.

Keywords: recommender system, multirelational social network, multimedia sharing system, social network analysis.

1 Introduction

Nowadays, the multimedia sharing systems (MSS) like *Flickr* or *YouTube* successfully attract more and more users who share their multimedia content such as photos, videos, animations, etc. These systems that facilitate users to upload, download, manage and browse multimedia objects (MOs) are typical examples of Web 2.0 applications. Each of the multimedia object can be tagged by its author. In other words, users can describe their MO with one or more short phrases that are most meaningful for the authors and usually describe the content of this element.

In the multimedia sharing system, users simultaneously interact, collaborate and influence one another and in this way form a kind of social community. Hence, users can not only tag multimedia objects they have published but also comment the items added by others, include them to their favourites, etc. Additionally, users have the opportunity to set up new, direct relationships with other system users as well as establish groups of collective interests and directly enumerate their friends or acquaintances.

The main goal of every MSS is to enable people to share their MOs, i.e. that users usually contact with one another via MO and this is the basis for object-based relationship creation. Moreover, they very rarely maintain the direct personal relationships

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 364–372, 2008.

with other users of the system. Nevertheless, the users' activity within the MSS enables to discover people who act in a similar way. Based on that knowledge the direct social relationships can be set up what in consequence can lead to the development of the new dimension within the MSS, which enables people to contact with one another.

2 Related Work

Recommender systems became an important part of the web sites; the vast numbers of them are applied to e-commerce. They help people to make decision, what items to buy, which news to read [19] or which movie to watch. Recommender systems are especially useful in environments with information overload since they cope with selection of a small subset of items that appears to fit to the users' preferences [2, 12, 18, 21]. Furthermore, these systems enable to maintain the loyalty of the customers and increase the sales [10].

In general, four categories of recommender systems can be enumerated: demographic filtering, collaborative filtering, content-based filtering, as well as hybrid recommendations [2, 12]. Demographic filtering approach uses descriptions of users to create the relationship between a single item and the type of people who appear to like it. The user profiles are extracted by classifying users in stereotypical descriptions, that represent the features of user types. The user personal data is necessary to classify users in terms of these demographic data. [12].

The collaborative filtering technique relies on opinions about items delivered by users. The system recommends products or people that have been positively evaluated by other people, whose ratings and tastes are similar to the preferences of the user who will receive recommendation [2, 5, 19].

There are two main variants of collaborative filtering. The first one is the k-nearest neighbour and the second one is the nearest neighbourhood. In the content-based filtering the items that are recommended to the user are similar to the items that user had liked previously [14]. The hybrid method combines two previously enumerated approaches [7, 9, 10].

Nowadays, these four approaches are usually utilized in order to suggest different products or services to users. However, not only products or multimedia content can be proposed. The new area, where recommender systems can be applied are multimedia sharing systems that rapidly develop in the web and usually have thousands or even millions of members like *Flickr* or *YouTube*. The main goal of a recommender system in this case is to find the most interesting users for the given member and to help the user to establish new relationships.

A recommender system that suggests multimedia objects (MOs) based on social similarity of ontologies maintained separately for each user and each multimedia object was presented in [11, 15].

The focus of this paper is to suggest one human being to another and in consequence to expand the human community that is not explicitly visible for users, because they are rather connected via MOs than direct links. The proposed recommendation framework is supposed to be applied to this community also called the social network.

A social network is the set of the actors (a single person is the node of the network) and ties, called also relationships, that link the nodes [1, 20]. The evolution of the social network depends on the mutual experience, knowledge, relative interpersonal interests, and trust of human beings [3, 17, 22].

Some measurements can be applied to investigate the number and the quality of the relationships within the network. The crucial techniques currently used to identify the structure of a social network are: full network method, snowball method, and ego centric methods [6].

3 Multirelational Social Network in MSS

Based on the information about the MSS users and their activities, the multirelational social network (MSN) can be created. The network nodes are MSS users whereas the relationships emerge from the common activities or interaction between users. Overall, three kinds of relations can be distinguished in MSS: direct intentional relations, object-based relations with equal roles, and object-based relations with different roles. The first one exists if one user directly points to another one, e.g. by adding the given person to the contact list (Fig. 1).

Fig. 1. The direct tie in the social network in the Internet

The second type appears when two users participate in common activity related to the certain multimedia object (MO or tag) with the same role (Fig. 2), e.g. users add to favourites the same MO or use the same tag. Finally, the object-based relation with different roles connects two users through the multimedia object but their roles are different (Fig. 3), e.g. one user comments MO (*commentator*) that was published by another one (*author*).

During the research, 11 types of relations were identified in the *Flickr* MSS, which can be classify in all the above kinds of relations. They include: tags used by more than one user R^t, user groups R^g, MOs added by users to their favourites R^{fa}, R^{af}, R^{ff}, opinions about MOs created by users R^{oa}, R^{ao}, R^{oo}, and the relations derived from the contact lists R^{cc}, R^{ac}, R^{cac}. The contact-based direct relations can be split into three relations: user x and y are both in the contact list of another user z (R^{cc}), x is in the y's contact list (R^{ca}), and x is the z's contact list but z is also in the y's contact list (R^{cac}). All the relations were used to create 11 layers in the multirelational social network. [16]. Tag-based R^t, group-based R^g, favourite-favourite R^{ff}, and opinion-opinion relations R^{oo} are instances of object-based relations with equal roles, whereas favourite-author R^{fa}, author-favourite R^{af}, opinion-author R^{oa}, and author-opinion R^{ao} are object-based relations with different roles. The appropriate strength value s_{ikj} is calculated for each pair of users $k \rightarrow j$ and layer i.

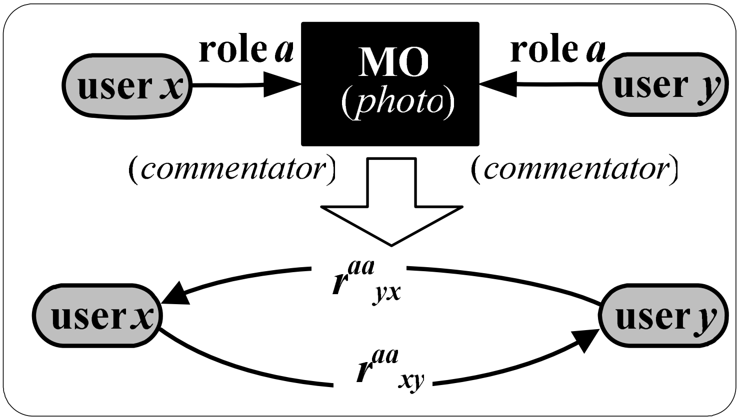


Fig. 2. The object-based relation with equal roles: *commentator*

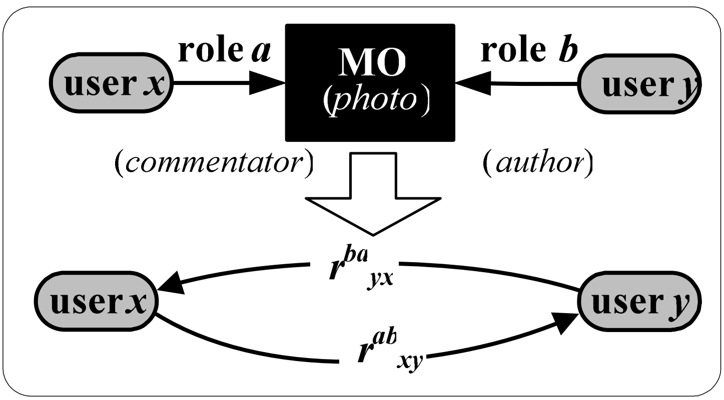


Fig. 3. The object-based relation with different roles: *commentator* and *author*

4 Social Recommendations within MSS

The main idea of recommendations in the multimedia sharing system is to make use of relations between users that can be derived from the multirelational social network MSN existing in the MSS by recommendation to the active user some other users potentially interesting for the given one, Fig. 4.

In the first step, MSN is created and continuously updated based on the data available in the MSS, including new comments, MMOs, items in contact lists or groups, etc., see Sec. 2. MSN contains all 11 layers of relationships and provides similarities s_{ikj} (strengths of relationships) from user k to another user j, separately for each such pair $k \rightarrow j$ and each relationship layer i. The values of s_{ikj} are calculated in the different way depending on the layer profile.

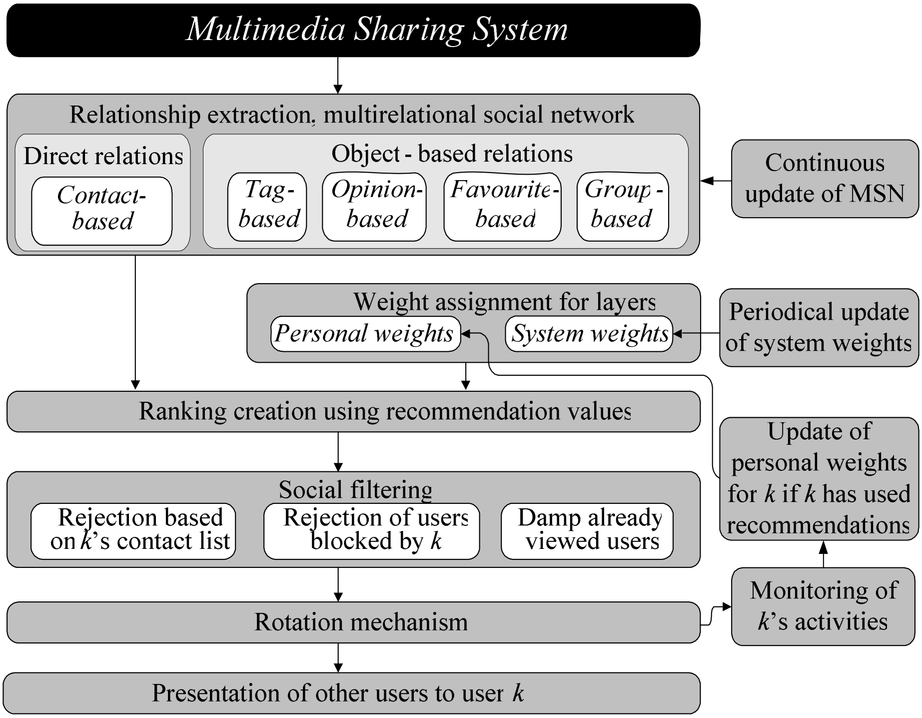


Fig. 4. Recommendation of humans in MSS for user *k* using multirelational social network

The MSS system maintains two kinds of weights for each layer *i* in MSN: system and personal. The system weight w_i^{sys} for layer *i* is the aggregation of all personal weights for layer *i*. It is updated periodically, e.g. ones a day.

Personal weight of layers w_{ik}^{usr} reflects the current usefulness of layer *i* for the given user *k*. Both system and personal weights belong to the range [0;1] but the sum of w_{ik}^{usr} for the given user *k* equals 1. For the new user *k*, at the beginning, $w_{ik}^{usr}=w_i^{sys}$ is assigned. All personal weights for user *k* are updated according to *k*'s activities that refer to the recommended persons *j* like browsing *j*th profile, adding *j* to the *k*th contact list, comments to *j*th MMOs, etc. In the experimental environment, users were requested to rate the presented recommendations and these rates were used as the feedback from user activities.

Based on the similarities derived from MSN as well as system and personal weights, the system calculates the recommendation values v_{kj} for the current user *k* related to the other users *j*, as the aggregations of similarities from all *l* layers, as follows:

$$v_{kj} = \sum_{i=1}^{l} \frac{(w_i^{sys} + w_{ik}^{usr}) \cdot s_{ikj}}{\max_i \left(s_{ikj}\right)} . \quad (1)$$

The recommendation values v_{kj} are used to create the ranking list for user *k* that contains top users *j* with the greatest value of v_{kj}. Next, some users *j* are removed during the social filtering process. Its goal is to prevent from recommendation of users that already are in the kth contact list or are blocked by k. Besides, the recommendation values of users who have already been viewed by k are damped. To the remaining list rotation mechanism is applied so that the recommendation list changes with every user request to the system, see [8] for details.

After presentation, the system monitors activities of user k related to the recommended users j. It includes viewing the j's profile and establishment of the new relation $k \rightarrow j$ in any layer. The level of interest of user k directed to j reflected by k's activities can be lower (viewing the jth profile) or greater (adding to k's contact list). Hence, each type of activity possesses its own importance $a_{kj} \in [0;1]$. Next, based on this feedback, k's personal weights w_{ik}^{usr} are adapted after each k's relevant activity, as follows:

$$w_{ik}^{usr(new)} = \frac{w_{ik}^{usr(old)} \cdot (1+\varepsilon) + c_{ikj} \cdot \left(a_{kj} - w_{ik}^{usr(old)}\right)}{\sum_{m=1}^{l} \left(w_{mk}^{usr(old)} + c_{mkj} \cdot \left(a_{kj} - w_{mk}^{usr(old)}\right)\right)}, \quad (2)$$

where:

ε is a very small constant;

$c_{ikj} \in [0;1]$ is the normalized contribution of the ith layer (among all layers) within the recommendation of user j to user k; the value of c_{ikj} is calculated in the following way: $c_{ikj} = s_{ikj} / \sum_{m=1}^{l} s_{mkj}$.

Eq. (2) preserves property of $w_{ik}^{usr(new)}$ autobalancing in the range of [0;1] and takes into account the perspective on the global importance of particular kinds of relations in the entire MSN.

5 Experiments

The experiments have been carried out based on the online *FlickrFront* framework. During the experiments, 21,640 user profiles were downloaded from *Flickr* to prepare recommendations for 8 volunteers who rated the provided suggestions. The rates replaced the monitored user activities a_{kj} in Eq. (2).

Upon the collected profiles and the concept from sec. 3, two separate recommendation lists, three suggested users each, were presented to 8 users who rated them. The adaptation derived from users' ratings (a_{kj}) and layer contributions was applied after the first list was rated.

Users have generally rated higher the recommendations provided in the second list (after adaptation), in average 8% better Fig. 5. Besides, the social layer based on reciprocal contact list R^{cac} and author-opinion R^{ao} gained in their contribution (average w_i^{usr}) much after adaptation, by 220% and 65% respectively, Fig. 6. Tag-based layer R^t increased a little – by 8%, whereas the other layers lost in their importance. The least vital layers were R^{oa}, R^{ff}, R^{af} drop by -59% to -66%.

These results have confirmed that the proposed method of weight adaptation (Eq. 2) increased the user satisfaction (rise in rates). This have been achieved by the highlighting strong social components (R^{cac}) at expense of some semantic relationships like favorite-favorite (R^{ff}). The layer opinion-author R^{oa} lost and author-opinion

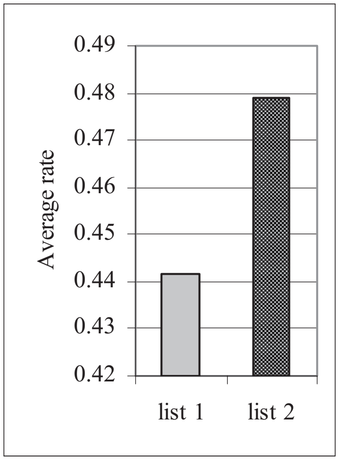


Fig. 5. Average users' ratings for layers in MSN

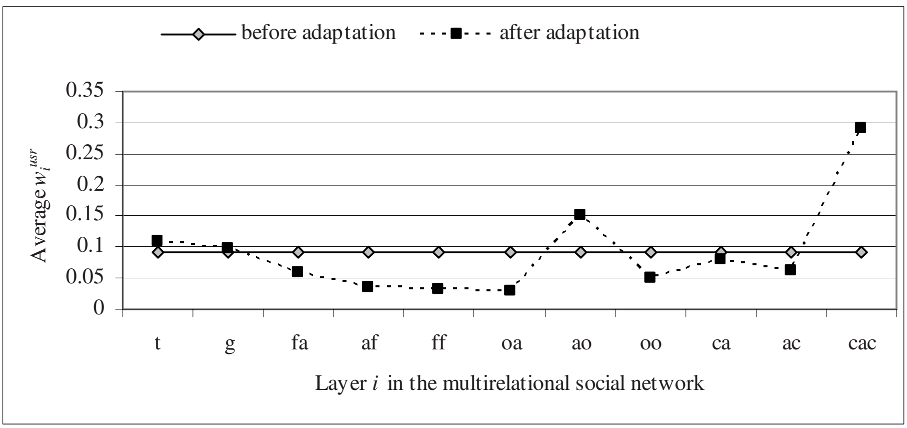


Fig. 6. Average user weights for layers in MSN

R^{ao} gained because the former reflect relationships to authors of MOs that have been commented by the current users. These authors are not so attractive compared to those who have commended photos delivered by the current user. Hence, people are interested in other people who reviewed their achievements.

6 Conclusions and Future Work

The new proposed method supports the creation of recommendations of humans in the multimedia sharing system MSS based on the new social concept – the multirelational social network MSN. The presented framework takes into account the activities of users in each of eleven MSN layers extracted from the MSS data. Both system and personal weights that are assigned separately to each layer make the process of recommendation personalized. Moreover, the system is adaptive due to weights that are adaptively recalculated when the user utilizes the recommendations.

The vast amount of calculations results in problems with efficiency as the whole process is performed online. In order to address this issue, some tasks can be performed offline and periodically repeated, e.g. the creation of the lists and storing only *n* most similar users to the given one.

The future work will concentrate on improving the process effectiveness and conducting the large-scale experiments.

Acknowledgments. The work was supported by The Polish Ministry of Science and Higher Education, grant no. N516 037 31/3708.

References

1. Adamic, L.A., Adar, E.: Friends and Neighbors on the Web. Social Networks 25(3), 211–230 (2003)
2. Adomavicius, G., Tuzhilin, A.: Toward the Next Generation of Recommender Systems: A Survey of the State-of-the-Art and Possible Extensions. IEEE Transactions on Knowledge and Data Engineering 17(6), 734–749 (2005)
3. Golbeck, J.: Computing and Applying Trust in Web-Based Social Networks. Ph.D. Thesis, University of Maryland (2005), `http://www.cafepress.com/trustnet.20473616`
4. Golbeck, J., Hendler, J.A.: Accuracy of Metrics for Inferring Trust and Reputation in Semantic Web-Based Social Networks. In: Motta, E., Shadbolt, N.R., Stutt, A., Gibbins, N. (eds.) EKAW 2004. LNCS (LNAI), vol. 3257, pp. 116–131. Springer, Heidelberg (2004)
5. Ha, S.H.: Helping Online Customers Decide through Web Personalization. IEEE Intelligent Systems 17(6), 34–43 (2002)
6. Hanneman, R., Riddle, M.: Introduction to social network methods. Online textbook (2005), `http://faculty.ucr.edu/~hanneman/nettext/`
7. Hsief, S.M., Huang, S.J., Hsu, C.C., Chang, H.C.: Personal Documents Recommendation System Based on Data Mining Techniques. In: IEEE/WIC/ACM International Conference on Web Intelligence, pp. 51–57. IEEE Computer Society, Los Alamitos (2004)
8. Kazienko, P., Adamski, M.: AdROSA - Adaptive Personalization of Web Advertising. Information Sciences 177(11), 2269–2295 (2007)
9. Kazienko, P., Kiewra, M.: Personalized Recommendation of Web Pages. In: Nguyen, T. (ed.) Intelligent Technologies for Inconsistent Knowledge Processing, ch. 10. Advanced Knowledge International, Adelaide, South Australia, pp. 163–183 (2004)
10. Kazienko, P., Kołodziejski, P.: WindOwls – Adaptive System for the Integration of Recommendation Methods in E-commerce. In: Szczepaniak, P.S., Kacprzyk, J., Niewiadomski, A. (eds.) AWIC 2005. LNCS (LNAI), vol. 3528, pp. 218–224. Springer, Heidelberg (2005)
11. Kazienko, P., Musiał, K., Juszczyszyn, K.: Recommendation of Multimedia Objects based on Similarity of Ontologies. In: KES 2008, 12th International Conference on Knowledge-Based and Intelligent Information & Engineering Systems. LNCS (LNAI), vol. 5177, pp. 194–201. Springer, Heidelberg (2008)

12. McDonald, D.W.: Ubiquitous recommendation systems. IEEE Computer 36(10), 111–112 (2003)
13. Montaner, M., López, B., de la Rosa, J.L.: A Taxonomy of Recommender Agents on the Internet. Artificial Intelligence Review 19(4), 285–330 (2003)
14. Mooney, R.J., Roy, L.: Content-based book recommending using learning for text categorization. In: The Fifth ACM Conference on Digital Libraries, pp. 195–204 (2000)
15. Musiał, K., Juszczyszyn, K., Kazienko, P.: Ontology-based Recommendation in Multimedia Sharing Systems. System Science (to appear, 2008)
16. Musiał, K., Kazienko, P., Kajdanowicz, T.: Multirelational Social Networks in Multimedia Sharing Systems. In: Nguyen, N.T., Kołaczek, G., Gabryś, B. (eds.) Knowledge Processing and Reasoning for Information Society, pp. 275–292. Academic Publishing House EXIT, Warsaw (2008)
17. Palau, J., Montaner, M., López, B., de la Rosa, J.L.: Collaboration Analysis in Recommender Systems Using Social Networks. In: Klusch, M., Ossowski, S., Kashyap, V., Unland, R. (eds.) CIA 2004. LNCS (LNAI), vol. 3191, pp. 137–151. Springer, Heidelberg (2004)
18. Perguini, S., Goncalves, M.A., Fox, E.A.: Recommender systems research: A Connection-Centric Survey. Journal of Intelligent Information Systems 23(2), 107–143 (2004)
19. Terveen, L., Hill, W., Amento, B., McDonald, D., Creter, J.: PHOAKS: A system for sharing recommendations. Communications of the ACM 40(3), 59–62 (1997)
20. Wasserman, S., Faust, K.: Social network analysis: Methods and applications. Cambridge University Press, New York (1994)
21. Weng, L.T., Xu, Y., Li, Y.: A Framework For E-commerce Oriented Recommendation Systems. In: The 2005 International Conference on Active Media Technology, AMT 2005, pp. 309–314. IEEE Press, Los Alamitos (2005)
22. Ziegler, C.N., Golbeck, J.: Investigating Correlations of Trust and Interest Similarity - Do Birds of a Feather Really Flock Together? Decision Support Services (submitted, 2005)

Webstrategy Formulation: Benefiting from Web 2.0 Concepts to Deliver Business Values

Senoaji Wijaya[1], Marco R. Spruit[1], and Wim J. Scheper[1,2]

[1] Institute of Information and Computing Sciences, Utrecht University, Utrecht, The Netherlands
[2] Strategy, Finance, and Operations, Deloitte Consulting, Orteliuslaan 1041, 3528 BE Utrecht, The Netherlands
Senoaji.Wijaya@gmail.com, {M.R.Spruit,Wim}@cs.uu.nl

Abstract. With the accelerating growth of internet users, a rise of globalization, distributed work environments, knowledge-based economies, and collaborative business models, it becomes clear that there is currently a high and growing number of organizations that demand a proper webstrategy. The emergence of web 2.0 technologies has led many internet companies, such as Google, Amazon, Wikipedia, and Facebook, to successfully adjust their webstrategy by adopting web 2.0 concepts to sustain their competitive advantage and reach their objectives. This has raised an interest for more traditional organizations to benefit from web 2.0 concepts in order to enhance their competitive advantage. This article discusses the effective webstrategy formulation based on the web 2.0 concepts in [21] and the differing requirements, characteristics, and objectives in different types of organizations. This research categorizes organizations into Customer Intimacy, Operational Excellence, and Product Leadership, according to the Value Disciplines model in [26].

Keywords: web 2.0, webstrategy, framework, collaboration, globalization, business model, value disciplines.

1 Introduction

The growth of internet usage has been increasing tremendously in the past years. Illustratively, Internet World Stats [14] reports that there are approximately 1.25 billion internet users in the world. This is one of the triggers of the emergence of internet businesses nowadays. Most of the successful internet companies tend to develop and nurture a web community. The increasing importance of business communities confirms that there is a shift in business models from a traditional hierarchical system and competition into more collaboration and social networking, which are considered to be two of the most important web 2.0 concepts [2], [6], [7], [25].

Web 2.0 is defined as "the philosophy of mutually maximizing collective intelligence and added values for each participant by formalized and dynamic information sharing and creation" [13]. An interesting and currently much highlighted prospect for web 2.0 is to aid organizations to enhance their businesses by sustaining their competitive advantage [11]. Web 2.0 has been successfully adopted by many of the

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 373–384, 2008.

successful internet companies, such as YouTube, Amazon, Wikipedia, and Facebook. They are able to maintain and raise their big web communities by applying web 2.0 concepts in their webstrategy [21]. Therefore, the following research question arises: "*how can more traditional organizations benefit from web 2.0 concepts?*". This article investigates this research question regarding the formulation of webstrategy benefiting from web 2.0 on any type of organization.

2 Organizational Developments

Organizations nowadays have to adapt to and deal with fast-paced changes in order to effectively continue pursuing their business objectives. Today's dynamic environment pressures organizations to adapt to these changes by reconsidering its structures, processes, and relationships with its clients, competitors, and partners [10]. Notable changes that have been identified up until now, which are intensely connected to web 2.0 concepts, include the followings:

- Globalization is continuously rising. More and more, organizations need to be able to operate in an increasingly complex environment [7], [8], [25]
- The movement towards a distributed work environment is greater than ever before [5], [16]
- There is a shift towards a knowledge-based economy in which knowledge and information are the primary sources of value creation [15], [19]

Organizations are now able to provide their products and services to one global market. In order to outperform their competitors, organizations should think globally and work collaboratively with their chain partners [25]. This means that the environment and the work for organizations are becoming more complex and require greater coordination and interaction [10]. Advanced technologies enable individuals and organizations to be mobile and to work together while being spatially and temporally decoupled from one another. This mobility development influences not only organizations but also the entire society [16]. As a result, the changes in the organization's requirements to maintain a high level of communication are inevitable [19]. Web 2.0 concepts, as one of the IT resources, can be employed to help enable such an organizational environment [3].

Next to that, knowledge is considered as an increasingly important source of wealth creation and competitive advantage for organizations [7], [9], [25]. Information is digitized and the revolution of communication technologies has led to many developments where knowledge is captured, organized, stored, shared and evaluated [24]. These facts have tickled our curiosity on how web 2.0 concepts can serve organizations in this knowledge economy and globalization era, in which organizations require to accommodate the increasing needs of collaborative efforts.

3 Collaborative Business Model

Chesbrough [7] defines business model as a useful framework to link and convert ideas and technologies into economic values. Alongside other things, a business model performs two important functions: *value creation* and *value capture* [7]. In order to thrive in this twenty-first century with its globalization and knowledge-based economy, the business models of organizations are required to be adapted and improved [7].

The most recent business model improvement in today's business environment is to involve key suppliers and customers in the value creation and value capturing activities as the business partners of the organization, entering into a relationship where both technical and business risks are shared [1], [7]. This type of collaboration aims at harnessing collective intelligence through peer-production, in a more effective and efficient way than ever before [25]. This concept is starting to displace the traditional corporation hierarchies as the main system of wealth creation in the economy. This has led to the facts that many of the resources for effective information production and communication are now owned by and available to much bigger communities [2], [25]. The individual freedom to cooperate with the others in creating economic value is no longer limited to certain geographical area and timeframe. Communication and collaboration patterns, as well as information consumption and production are reshaped [13], [17].

Furthermore, the collaborative business model is characterized by the following [2]:

- Nonproprietary information is becoming more common and important in the information production.
- The use of continuously expanding computer network that connects billions of people, which provides a platform where the aggregate effect of individual action produces the coordinate effect of a new and rich information environment.
- The rise of the effective and large scale cooperative peer-production of information, knowledge and culture.

4 Webstrategy Framework

This research aims to assist organizations to formulate an effective webstrategy for their businesses. But how do we define a webstrategy? In order to define the term 'webstrategy', we may want to know how strategy is described. Wikipedia [28] defines strategy as "*a long term plan of action designed to achieve a particular goal, most often "winning"*". Moreover, James Brian Quinn in *The Strategy Process: Concepts and Contexts* indicates strategy as "*the pattern or plan that integrates an organization's major goals, policies, and action sequences into a cohesive whole*". From these strategy definitions, we define webstrategy within the context of this research as "*The plan of action, involving important elements, revolving around a web environment with regard to web 2.0 concepts, designed and implemented in order to achieve organization's business goals*". The important elements include: goal, clients, products, time, resources, and tools/channels [12], [20], [22].

We believe that the different types of organizations with differing requirements, characteristics, and objectives require a different webstrategy. Therefore, an effective webstrategy formulation is necessary to be performed. In this research, the *Value*

Disciplines introduced by Treacy and Wiersema [26] is used as an organization typology. Value Disciplines categorizes organizations into three types: Customer Intimacy, Operational Excellence, and Product Leadership.

The differing requirements of different organization types have led us to think about how a webstrategy would be best formulated for the specific organization's situation. In order to perform an effective webstrategy formulation and web 2.0 adoption, we have developed a webstrategy framework. The purpose of the webstrategy framework is to assess the current (as-is) webstrategy of an organization, give the direction of the desired (to-be) webstrategy of the organization, and finally provide advices regarding possible improvements and propose a new effective webstrategy. These phases are executed according to the organization's situation and maturity revolving around the important elements of webstrategy.

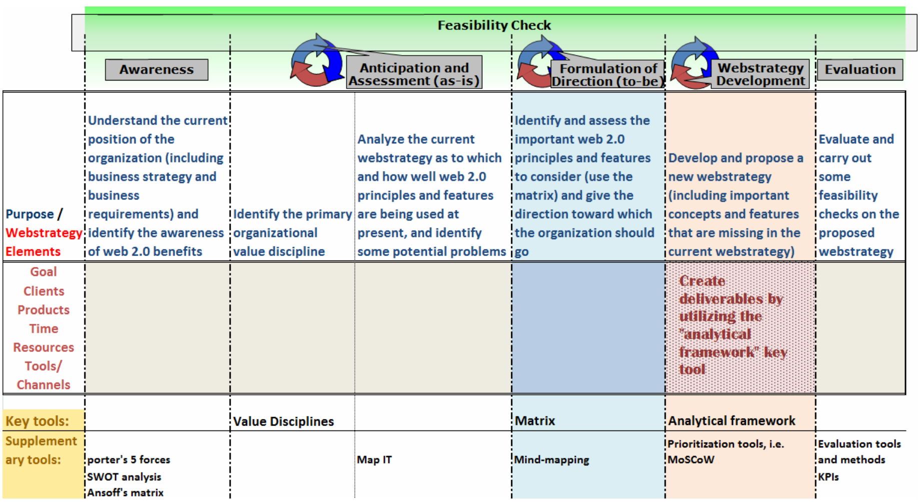


Fig. 1. A fragment of the webstrategy framework

The webstrategy framework depicted in figure 1 incorporates five phases, one additional activity, six webstrategy elements, key tools, and optional supplementary tools. These phases function to guide through the whole webstrategy formulation in search for a good solution. These should include internal and external aspects [20], [22]. The webstrategy formulation phases are:

- *Awareness:* In this phase, information the organization should be gathered. This includes its business strategy, business requirements, maturity compared to its competitors, the industry trends, and their awareness of web 2.0 benefits.
- *Anticipation and Assessment (as-is):* Value discipline is identified, and the current webstrategy and as-is situation of the organization are assessed, as to which and how well web 2.0 concepts and features are being used at present. The potential problems should also be identified.

- *Formulation of Direction (to-be):* Based on the organization type, the desired situation is formulated toward which the organization should improve their webstrategy. This direction is provided by the "Matrix" (see section 4.1), one of the key tools supporting the utilization of this webstrategy framework.
- *Webstrategy Development:* In this phase, the new webstrategy is formulated. The "Analytical Framework" key tool was developed to aid this phase. The design of the analytical framework is further elaborated in section 4.2.
- *Evaluation:* Whether or not the proposed webstrategy is aligned with the business strategy, delivers what it was intended to, is able to achieve organization's objectives and is accepted by the users are evaluated.

In the webstrategy framework shown in figure 1, we can see the one additional activity that is performed throughout the whole webstrategy formulation process:

- *Feasibility Check:* Feasibility check is performed continuously throughout the whole process in order to identify potential problems at early stage, thus, save time from analyzing and formulating ineffective or inefficient webstrategy.

The *supplementary tools* are optional and can be used to support information gathering and the completion of particular phases. Examples of supplementary tools include Porter's five forces, SWOT analysis, Ansoff's matrix, MapIT, Mind-mapping, MoSCoW prioritization tool, and Key Performance Indicators (KPIs). Unlike the supplementary tools, the *key tools* are strictly attached to and must be used along with the webstrategy framework.

4.1 Key Tool: The Matrix

Web 2.0 is not a single philosophy or technology, rather many that should be considered [18]. Hoegg et al. [13] present the fundament of web 2.0 as collective intelligence maximization, transparency of the information creation and sharing process, and network effects. Breslin et al. [4] denote web 2.0 as social networking communities. However, these terms are leaning toward the seven higher level key concepts that are enunciated by O'Reilly [21]: *the web as platform* (1), *harnessing collective intelligence* (2), *data is the next intel inside* (3), *end of the software release cycle* (4), *lightweight programming models* (5), *software above the level of a single device* (6), *and rich user experiences* (7).

This matrix is one of the key tools involved in the webstrategy framework, which will be used in the Formulation of Direction phase. The purpose of this matrix is to give the meaningful and accountable direction of which web 2.0 concepts an organization should focus on. This direction consists of the different significance and effectiveness of each web 2.0 key concept for an organization to sustain or even enhance its competitive advantage, depending on its type.

4.1.1 Methodology

The matrix was developed with the characteristics of each organization type on one dimension [12], [27], and the seven web 2.0 key concepts on another dimension [21].

In order to fill in this matrix, 12 expert interviews have been conducted with web 2.0 experts. Even though the 12 experts have various experience, specialization and

Table 1. Matrix composition

Organization Types and its Characteristics	Web 2.0 Key Concepts						
	1	2	3	4	5	6	7
Customer Intimacy							
- *Build bonds with customers*	c1						
- *Understand customers*	c2						
- *Tailor its products and services*	c3						
- *Customer loyalty is the greatest asset*	c4						
Operational Excellence							
- *Improve operational quality*							
- *Improve efficiency*							
- *Ease of purchase*							
- *Low prices*							
- *Hassle-free services*							
Product Leadership							
- *Keep innovating*							
- *Creation of new knowledge*							
- *Require highly creative environment and culture*							
- *Ability to bring/commercialize new ideas to market quickly*							
- *Have state-of-the-art products or services*							

industry focus, all of them have strong interest and good understanding, knowledge, and experience on web 2.0 projects.

The duration of each expert interview was ranging between 90 and 120 minutes. During the interview, additional information was provided to ensure that the concepts being discussed were exactly and correctly understood by both the experts and the researcher. During this session, the experts were required to complete this matrix by giving a score for each concept toward every characteristic of each organization type. The relationship between the concept and the characteristic is '*how important is this concept for helping the particular organization type to support the corresponding characteristic?*'. The score ranges between 1 – 5, where 1 indicates 'least important' and 5 is interpreted as 'extremely important'.

The analysis was performed in two ways by investigating the *averages* and the *frequencies*. The analysis on average values was performed by taking into consideration the standard deviations and potential outliers. The steps taken are:

1. The sum scores of the characteristics of each organization type per concept are calculated for every respondent. Since the number of characteristics, and thus the sum of maximum scores, of the customer intimacy organization is not the same as the other two types, therefore, the calculation is done in percentage in order to make comparable measurements among the 3 organization types, i.e. $(c1+c2+c3+c4)/(c1_{max}+c2_{max}+c3_{max}+c4_{max}) * 100$.
2. From the previous calculations, the average scores of the sum, of the 12 respondents, on each concept per organization type are calculated to draw the final result. The higher the average score, the more important the concept is.

The second analysis is focusing on the frequency. The steps taken are:

1. The average scores of the characteristics of each organization type per concept are calculated for every respondent.
2. The average scores are categorized into 1-2, 2-3, 3-4, and 4-5, and certain points are assigned to each category. The points assigned to the categories are 1 point, 2 points, 3 points, and 4 points respectively.
3. The frequencies of the average scores in all categories are analyzed by calculating the points that each concept obtained on each organization type. The higher the point, the more important the concept is.

4.1.2 Results

Figure 2 presents an overview of the importance of each web 2.0 concept to different types of organizations. It shows that according to the experts, “harnessing collective intelligence” (2) is a very important concept for the success of customer intimacy and product leadership organizations. Next to this, “end of the software release cycle” (4) and “lightweight programming models” (5) concepts appear to be valued the most by product leadership organizations compared to the other types of organizations. Expectedly, “software above the level of a single device” (6) and “rich user experiences” (7) are shown to deliver most values for customer intimacy organizations. Moreover, the “the web as platform” (1) concept scores slightly higher on operational excellence organizations, while the “data is the next intel inside” (3) concept scores higher on customer intimacy. The same interpretation can also be seen in the result of the frequency analysis in table 2.

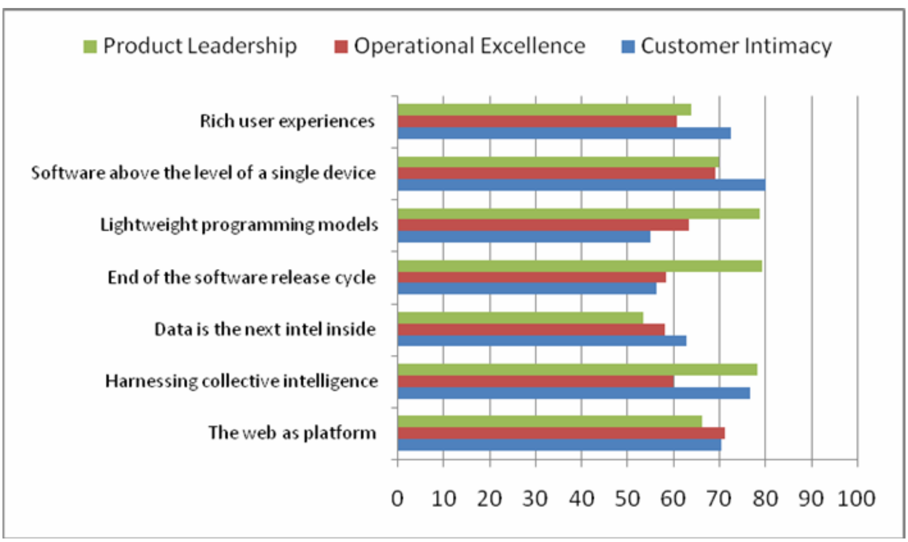


Fig. 2. The result of the average analysis

Table 2. The result of the frequency analysis

Organization Types (Average Score Categorization)	Web 2.0 Key Concepts (Frequency)						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Customer Intimacy							
1-2 (x1 point)	1	0	1	0	3	0	0
2-3 (x2 points)	1	1	3	9	2	0	1
3-4 (x3 points)	6	3	5	2	5	6	6
4-5 (x4 points)	4	8	3	1	2	6	5
Total Points	**37**	**43***	**34**	**28**	**30**	**42***	**40**
Operational Excellence							
1-2 (x1 point)	0	1	0	0	0	0	1
2-3 (x2 points)	2	3	6	7	3	3	5
3-4 (x3 points)	5	6	4	3	8	4	4
4-5 (x4 points)	5	2	2	2	1	5	2
Total Points	**39***	**33**	**32**	**31**	**34**	**38***	**31**
Product Leadership							
1-2 (x1 point)	0	0	2	0	0	0	1
2-3 (x2 points)	1	1	4	0	0	2	5
3-4 (x3 points)	10	5	5	6	4	8	4
4-5 (x4 points)	1	6	1	6	8	2	2
Total Points	**36**	**41***	**29**	**42***	**44***	**36**	**31**

* The most important web 2.0 concept for corresponding organization type.

The results of both the average and the frequency analyses are complementing to each other, thus a reliable conclusion was drawn as illustrated in table 3.

Table 3. The mapping of the 7 web 2.0 concepts toward organization types based on their importance level in delivering business values

Organization Type	*Very Important*	*Important*	*Less Important*
Customer Intimacy	- Software above the level of a single device (6) - Harnessing collective intelligence (2)	- Rich user experiences (7) - The web as platform (1) - Data is the next intel inside (3)	- End of the software release cycle (4) - Lightweight programming models (5)
Operational Excellence	- The web as platform (1) - Software above the level of a single device (6)	- Lightweight programming models (5) - Rich user experiences (7) - Harnessing collective intelligence (2) - End of the software release cycle (4) - Data is the next intel inside (3)	
Product Leadership	- End of the software release cycle (4) - Lightweight programming models (5) - Harnessing collective intelligence (2)	- Software above the level of a single device (6) - The web as platform (1) - Rich user experiences (7)	- Data is the next intel inside (3)

4.2 Key Tool: The Analytical Framework

The analytical framework is developed to investigate the information gathered from the previous phases of the webstrategy framework, and to be used in the "*webstrategy development*" phase. This systematic tool gives the guideline on how the new webstrategy should be formulated and proposed, based on the internal and external aspects of the organization.

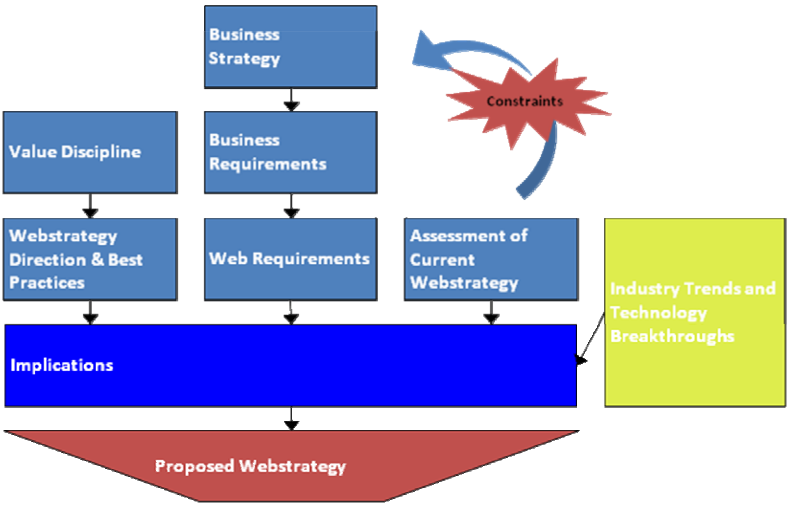


Fig. 3. The analytical framework

Some deliverables are expected to be created by utilizing this analytical framework. These deliverables are essential in formulating an effective webstrategy:

- *Business Strategy*: is identified by analyzing the information gathered in the first phase of the webstrategy framework, namely "*awareness*". This is the long term business plans of the organization to achieve its long term goals.
- *Business Requirements*: are derived from the business strategy, constitute a specification of what the business wants and describe in business terms what must be delivered or accomplished to provide value.
- *Web Requirements*: are translated from the business requirements, and contain the necessities of web-related technologies capabilities in order to support the business and achieve its objectives.
- *Value Discipline*: describes the type of the organization, and is identified in the "*anticipation and assessment (as-is)*" phase of the webstrategy framework.
- *Webstrategy Direction & Best Practices*: describe which web 2.0 concepts are essential in delivering business value to the organization. This deliverable refers to the "*formulation of direction (to-be)*" phase of the framework.

- *Assessment of Current Webstrategy*: is produced from the information gathered in the "*anticipation and assessment (as-is)*" phase. This includes not only the assessment of the current webstrategy, but also the impact on the business strategy. Any *constraints* from the current webstrategy that limit or do not support the effectiveness of the organization's business strategy are listed.
- *Industry Trends and Technology Breakthroughs*: concern more of external forces that are able to deliver business values to and influence the organization.
- *Implications*: involve internal as well as external influences, and must give clear ideas on which the formulation of the webstrategy will be based.
- *Proposed Webstrategy*: should be aligned with the organization's business strategy, capabilities, and goals [23]. Thus, the proposed webstrategy is expected to effectively address the issues that the organization has, deliver the business values to the organization, and improve its business performance.

5 Conclusions

In this twenty-first century, where the knowledge-based economy has emerged, information and communication technologies are crucial to the success of the organizations. Taking IT into an organization requires a good alignment between the capabilities of different business aspects and IT. Business models have also started to shift toward collaboration and community involvement. Organizations create pores to allow information and knowledge to flow in and out of the organization, which would stimulate creation of knowledge and innovation. This approach effectively gains through web 2.0 technologies and their underlying concepts, which suggests that collective intelligence, even from individuals, matters.

For an organization to successfully adopt web 2.0 concepts into its webstrategy, there are a number of aspects which need to be considered, including the value discipline which best describes its organization type and the unique value that is to be delivered in the long term. The webstrategy of the organization requires to be able to sustain and even improve this unique value to the next level in order to outperform its competitors. Therefore, the categorization of web 2.0 concepts based on their effectiveness in addressing the issues and delivering business values to specific organization type was emphasized.

Next to the value discipline, webstrategy formulation involves other aspects as described in section 4. An effective webstrategy should consider its alignment with the organization's business strategy, objectives, resources and capabilities, as well as with the industry trends and technology breakthroughs. This research has sought to consider these elements and the alignment in formulating an effective webstrategy with the adoption of web 2.0 concepts for different types of organizations. The webstrategy framework and its key tools were introduced and the explanations of the fragments were provided. The differing needs of web 2.0 solutions for different organization types were also presented. The webstrategy framework as described in this article will assist in formulating an effective webstrategy by incorporating the appropriate web 2.0 concepts to effectively deliver business values for the organization.

References

1. Batenburg, R., Rutten, R.: Managing Innovation in Regional Supply Networks: a Dutch Case of Knowledge Industry Clustering. Supply Chain Management: An International Journal 8(3), 263–270 (2003)
2. Benkler, Y.: The Wealth of Networks: how social production transforms markets and freedom. Yale University Press (2006)
3. Bouman, W., Hoogenboom, T., Jansen, R., Kloos, M.: Sociality and Learning in Social Software. International Journal of Knowledge and Learning 3(4/5), 501–514 (2007)
4. Breslin, J.G., Decker, S., O'Marchu, I.: Online Social and Business Networking Communities. DERI – Digital Enterprise Research Institute - Technical Report (2004), http://www.deri.at/fileadmin/documents/DERI-TR-2004-08-11.pdf
5. Brown, B., Harper, R., O'Hara, K., Perry, M., Sellen, A.: Dealing with Mobility: Understanding access anytime, anywhere. ACM Transactions on Computer-Human Interaction 8(4), 323–347 (2001)
6. Chatti, M.A., Frosch-Wilke, D., Jarke, M.: The Future of E-learning: a shift to knowledge networking and social software. International Journal of Knowledge and Learning 3(4/5), 404–420 (2007)
7. Chesbrough, H.: Open Business Models: How to Thrive in the New Innovation Landscape. Harvard Business School Press (2006)
8. Daft, R.L.: Organization Theory and Design. Thomson South Western, Mason (2004)
9. Donaldson, L.: Reflections on knowledge and knowledge-intensive firms. Human Relations 54(7), 955–963 (2001)
10. Gallois, C., Gardner, J., Jones, E., Watson, B.: Organizational Communication: Challenges for the New Century. Journal of Communication 54(4), 722–750 (2004)
11. Gilchrist, A.: Can Web 2.0 be Used Effectively Inside Organisations? Bilgi Dünyası 8(1), 123–139 (2007)
12. Haggie, K., Kingston, J.: Choosing Your Knowledge Management Strategy. Journal of Knowledge Management Practice 4 (2003), http://www.tlainc.com/articl51.htm
13. Hoegg, R., Martignoni, R., Meckel, M., Stanoevska-Slabeva, K.: Overview of business models for Web 2.0 communities. In: Dresden, S. (ed.) Proceedings of GeNeMe 2006, pp. 23–37 (2006)
14. Internet World Stats: Usage and Population Statistics (2007), http://www.internetworldstats.com
15. Jashapara, A.: Knowledge Management: An Integrated Approach. Pearson Education Limited, Essex (2004)
16. Kakihara, M., Sorenson, C.: Mobility: an extended perspective. In: Proceedings of the 35th Annual Hawaii International Conference on System Sciences, Hawaii, pp. 1756–1766 (2002)
17. Kolbitsch, J., Maurer, H.: The Transformation of the Web: How Emerging Communities Shape the Information We Consume. Journal of Universal Computer Science 12(2), 187–213 (2006)
18. Manafy, M.: The Collective Wisdom at Work. Econtent 29(7), 6 (2006)
19. Nurmi, R.: Knowledge-Intensive Firms. Business Horizons 26–32 (1998)
20. Ohmae, K.: The Mind of the Strategist: Business Planning for Competitive Advantage. Penguin (1982)

21. O'Reilly, T.: What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software (2005), http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html
22. Porter, M.E.: Competitive Strategy: Techniques for Analyzing Industries and Competitors. Free Press (1980)
23. Scheper, W.J.: Business IT Alignment: solution for the productivity paradox (In Dutch). Deloitte & Touche, Netherlands (2002)
24. Sigala, M.: Integrating Web 2.0 in e-learning environments: a socio-technical approach. International Journal of Knowledge and Learning 3(6), 628–648 (2007)
25. Tapscott, D., Williams, A.D.: Wikinomics: How Mass Collaboration Changed Everything. Portfolio Hardcover (2006)
26. Treacy, M., Wiersema, F.: Customer Intimacy and Other Value Disciplines. Harvard Business Review (1993)
27. Treacy, M., Wiersema, F.: How Market Leaders Keep Their Edge. Fortune 131(2), 88–93 (1995)
28. Wikipedia: Strategy (2008), http://en.wikipedia.org/wiki/Strategy

The Rhizomer Semantic Content Management System

Roberto García[1], Juan Manuel Gimeno[1], Ferran Perdrix[1,2], Rosa Gil[1], and Marta Oliva[1]

[1] Universitat of Lleida
Jaume II, 69
25001 Lleida, Spain
{rgarcia,jmgimeno,ferranp,oliva,rgil}@diei.udl.cat
[2] Segre Media Group
Del Riu 6
25007 Lleida, Spain
fperdrix@diarisegre.com

Abstract. The Rhizomer platform is a Content Management System (CMS) based on a Resource Oriented Approach (RESTful) and Semantic Web technologies. It achieves a great level of flexibility and provides sophisticated content management services. All content is described using semantic metadata semi-automatically extracted from multimedia content, which enriches the browsing experience and enables semantic queries. A usable user interface is built on top of the CMS in order to facilitate the interaction with content and enhance it with the information provided by the associated semantic metadata. As an application scenario of the platform, its use in a media company where audio content is managed and its speech transcript semantically annotated is described.

1 Introduction

Existing CMSs lack consistent and scalable content annotation mechanisms that allow them to deal with the highly heterogeneous domains that information architectures for the knowledge society demand. Recently, some CMS and wiki systems have started to incorporate semantic metadata modules in order to cope with this lack, such as Drupal RDF Modules[1] or the RDF Tools for Wordpress [1]. It is even planned that the next version of Drupal [2] will be entirely based on Semantic Web technologies [3].

However, all these initiatives, except maybe for the future Drupal 7, do not constitute a fully featured semantic CMS, especially if one considers content beyond HTML documents. The same applies to many initiatives from the Semantic Web community. For instance, ODESeW [4] (a Semantic Web application development platform), ontology editors like SWOOP [5], semantic wikis like the semantic extension for Media Wiki [6] (which mix wiki mark-up and semantic annotations) or RDF Browsers like Tabulator [7] or Disco [8] (which just provide browsing capabilities and in some cases metadata edition).

[1] Drupal RDF modules, http://drupal.org/node/222788.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 385–394, 2008.

The aim of the Rhizomer platform is to develop a multimedia CMS combined with a fully featured semantic metadata repository with reasoning capabilities. Both components, the CMS and the semantic repository, are integrated in a transparent way for the end-users and enable more sophisticated and usable interactions.

The Semantic Content Management System (SemCMS) is based on simple foundations, which make it flexible, scalable and capable of adapting to different deployment and use scenarios. Its core is rooted in simple HTTP mechanisms and follows a RESTful approach [9].

Each content item managed by the SemCMS has its own URL, thus basing the whole system on a Resource Oriented Approach. The basic HTTP commands (GET, PUT, POST and DELETE) allow managing each resource. Those same commands are also used to manage semantic metadata about content items: the GET command is employed to pose semantic queries; similarly, PUT, POST and DELETE are used to update resource metadata, generate a new annotation or remove it respectively.

The HTTP functionality is implemented by the Rhizomer server component, shown in Fig. 1. There are additional functionalities, especially those geared towards making the user interaction with the Rhizomer server more usable, which are encapsulated in the user browser and implemented using Javascript and asynchronous HTTP calls (AJAX [10]).

The Rhizomer platform is described in more detail in Section 2, where its metadata and content managing functionalities are explained. Next, a sample scenario where this platform has been applied is presented in Section 3. Finally, the future plans and the conclusions are outlined in Section 4.

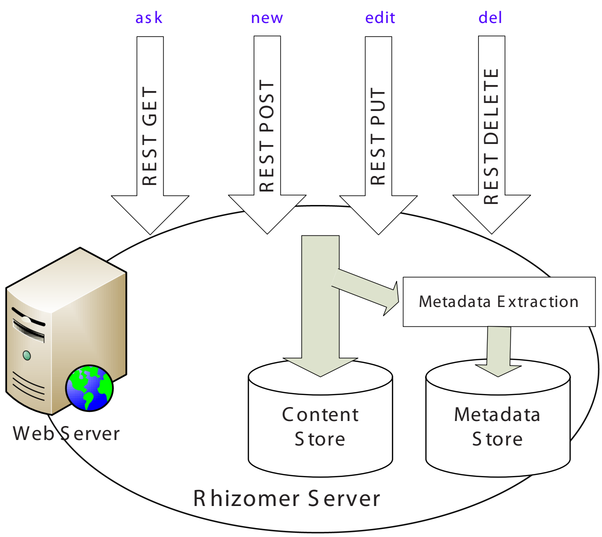


Fig. 1. The Rhizomer Server architecture

2 The Rhizomer Platform

As it has been presented in the introduction, the aim of the Rhizomer platform[2] [11] is to constitute a generic content management system capable of dealing with very heterogeneous content items thanks to its semantic metadata foundations. Moreover, it is based on simple HTTP commands in order to make it more scalable and adaptable to different deployment environments.

HTTP commands are mapped to common data management operations following the REST approach. GET retrieves the content item, PUT updates the specified URL with the provided content, POST creates a new content item in the CMS generating its corresponding URL and DELETE removes the specified item.

The same commands are used for semantic metadata management. However, the GET command for metadata is also used to pose semantic queries based on the SPARQL standard [12]. These queries retrieve both the metadata for a given resource and the descriptions for resources satisfying the constraints defined by the query.

Moreover, in some cases the semantic metadata might refer to resources outside the CMS scope, for instance people or places. These resources have URIs that do not belong to the URL space where the CMS is deployed and therefore cannot be retrieved using the REST approach. In this case, SPARQL queries sent through the GET command are used in order to retrieve metadata.

Therefore, the resources described by semantic metadata can be both content and non-content entities. For non-content resources, HTTP commands operate on the pieces of metadata (RDF triples) describing those resources. For content elements, managed by the Semantic CMS (HTML documents, images, videos...), HTTP commands operate on both the content item and its associated metadata.

Content elements are described using semantic metadata. Whenever a new content is stored in the SemCMS, a metadata extraction plugin specifically tailored for this content type is triggered to extract relevant metadata and store it in semantic form, as it is shown in Fig. 1.

The full user experience is built on top of these operations. However, RDF, the language of the semantic web, is completely hidden in order to increase usability. As end-users typically interact with HTML web pages through their browsers, Rhizomer incorporates a generic transformation from RDF to HTML. This transformation is not tied to any particular ontology or scheme, as it is the case in most template-based approaches. This HTML rendering is used to build a transparent browsing experience on top of the SPARQL endpoint that retrieves semantic metadata.

The browsing steps are based on a fragmentation of the underlying RDF graph, which is detailed in Section 2.1. The same fragments are used in order to constraint the range of the update and deletion operations, as it is detailed in Section 2.2. Updates and new metadata generation are carried out through semantic-enabled HTML forms, which also help to hide the burdens of RDF metadata from users.

Besides, Rhizomer incorporates Semantic Web services providing interaction means beyond content retrieval and metadata browsing. Each user action corresponds to a Semantic Web service whose description incorporates the constraints a resource must satisfy to be a valid input for the service. Consequently, the semantic description of a resource determines which actions can be applied to it.

---

[2] http://rhizomik.net/rhizomer

For instance, let us consider a scenario where the platform is used to retrieve and browse a set of news items described using semantic metadata. These descriptions include date and time information and, in some cases, the geographical localization of the event covered by the news items. At first, these descriptions are visualised as generic HTML pages based on the RDF to HTML rendering. These pages allow the user to visualise the descriptions of the corresponding resources, the metadata, and to browse them interactively by navigating the underlying graph.

This generic approach can be applied to any kind of resource. However, in this scenario, it would surely be desirable to have more specific views and more accurate ways to interact with events. Calendars or timelines are good choices for time stamped resources, while maps should be helpful for geographically located ones.

The objective of the Rhizomer platform, and the reason why Semantic Web services have been chosen as the way to implement actions, is to build a generic and dynamic system which can directly deal with generic RDF metadata while being easily extensible to incorporate specialised ways to view and interact with particular kinds of resources.

Finally, in order to populate the semantic metadata describing content items, the platform is able to incorporate different metadata extraction plug-ins. Section 2.3 shows some examples of this functionality. It details how metadata can be automatically extracted when new content items are uploaded to the platform. Then, the resulting metadata can be browsed as detailed in Section 2.1 and edited in order to correct or enrich the metadata automatically extracted as detailed in Section 2.2.

2.1 Metadata Browsing

Browsing is the basic interaction paradigm in the Web. It is based on the successive visualisation of Web pages following the links connecting them. Pages and links are the main building blocks upon which the interaction is built. Web pages are intended for human users' consumption and well-established methodologies to make them usable and accessible exist.

However, neither the browsing paradigm nor the principles to make the whole thing usable and accessible can be directly applied to the Semantic Web. That is so because it is based on a model not built upon pages and links but on triples (subject-predicate-object), which makes the browsing approach quite different from the Web.

The combination of many triples builds up a graph and, though the resulting model is easier to process by computers, the consumers of Semantic Web metadata are, at the end, humans so usable and accessible interaction mechanisms are required.

First of all, the basic browsing paradigm should change because the Semantic Web makes it very difficult to base the browsing steps on documents. In other words, it does not seem appropriate, for each step, to show all the triples in the corresponding document to the user as it is done in the Web. The amount of information in a single document can be too large, more than thousands of triplets. Moreover, the frontiers among documents are very fuzzy in the Semantic Web: usually, many documents are combined in order to get a coherent graph.

Semantic Web browsers like Tabulator [7] follow this approach and show all the triples from a Semantic Web document as an unfoldable tree. As preliminary user tests show, this approach causes many usability problems because, as the tree grows, it rapidly becomes difficult to manage. As it has been said, documents contain many triples and, additionally, each navigation step adds more triples from the new document to the current set.

Another approach is faceted browsing, as in /facet [13]. However, our objective is a simpler and more polyvalent browsing mechanism, which deals better with heterogeneous information spaces, although it might lack the guidance provided by facets. Anyway, it is not clear how systems like /facet deal with metadata structures that feature many anonymous resources, as it is the case for the semantic metadata managed in the application scenario described in Section 3.

Now, the problem is where to put the limits of each browsing step when presenting semantic metadata. In other words, how each browsing piece is built and how new pieces are created and presented following user needs in order to compose a browsing experience through the whole graph.

In order to facilitate browsing, the proposed approach is based on the construction of graph fragments. Following this approach, it is possible to construct fragments for any graph starting from any node that is not anonymous. For instance, the starting point for the metadata describing a piece of content is the node that represents the piece, which is the subject for all the triples describing it. This node has an ID and consequently is not anonymous.

All the triples that start from this node are part of the fragment and the triples describing anonymous objects are also added to the fragment. This happens for all nodes that are only identifiable in the context of the starting node. For instance, Fig. 2 shows how an example graph would be fragmented following this approach.

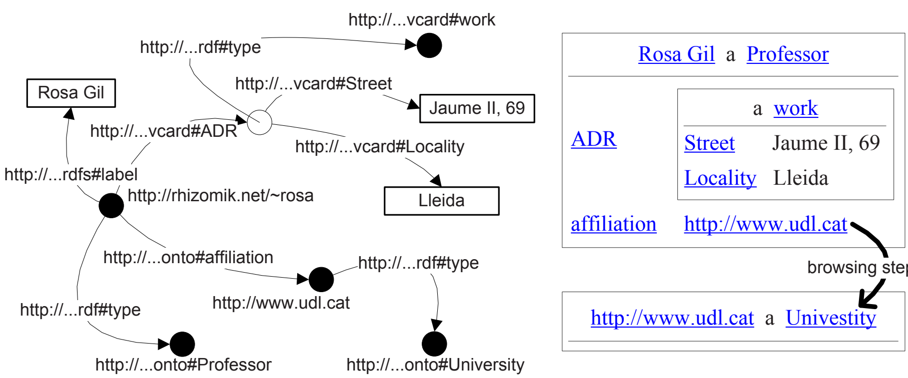


Fig. 2. Fragmentation of an example RDF graph and the resulting HTML rendering

As it can be seen, there are two fragments, each one corresponding to an identified resource described by at least one triple, for which it is the subject. The first fragment describes http://rhizomik.net/~rosa and includes an anonymous resource for the address. The second one, for http://www.udl.cat, can be reached from the first one through a browsing step. Unlike the address, it is shown independently because it is not anonymous.

This process of building fragments continues iteratively and interactively because from a fragment, if the user wants more information about a resource, it is possible to follow the next browsing step starting from any non anonymous object: the metadata describing the selected identified node is retrieved and the new fragment is built. Moreover, when the results are rendered to the users all the URIs are replaced by labels, if they are available, making the results much more usable.

Finally, fragments are rendered using HTML, which is viewable using a web browser, a tool users feel comfortable with. In order to generate HTML from RDF, fragments are serialised as RDF/XML and transformed using an XSL. The XSL transformation, which is part of the Rhizomer platform, guarantees consistent results whenever the input RDF/XML has been generated from fragments based on the Rhizomer approach.

This mechanism has been implemented as successive DESCRIBE queries for the identified resource URIs to the SPARQL endpoint. The DESCRIBE operation of the SPARQL endpoint has been reimplemented in order to build the proposed fragments, which also include all the available labels. Then, the XSL transformation from RDF/XML to HTML is invoked from the client using AJAX, which is also responsible for sending the SPARQL queries and making the whole process go smoothly behind the scenes, making the user experience even more comfortable.

2.2 Editing Metadata

The previous fragment-based approach, besides being the foundation for browsing, allows constraining the metadata editing and deletion actions to a limited set of triples. This way, it is possible to implement editing actions as the replacement of a given fragment with the one resulting from the editing process. The same strategy applies for the deletion action.

All these operations are also carried out through an HTML interface. In addition to the RDF to HTML transformation, the Rhizomer platform includes an XSL transformation from RDF to HTML forms. These forms are generated automatically from the RDF/XML corresponding to a fragment. The same approach as in the RDF to HTML transformation is followed but, instead of generating text values and links for literals and resource, this transformation generates input fields for each triple. The field is named using the corresponding property URI and its value corresponds to the triple value. The fields can be used in order to edit the property value, either a resource URIs or a literal.

Moreover, properties and values can be removed or added. Currently, the user enjoys little assistance during the editing process. Basically, when the user chooses to add a new property, a SPARQL query is used in order to retrieve all the available properties for the resource being edited. These are the properties not constrained to a particular resource type plus those constrained to the types of the resource being edited. The future plan is to improve this support in order to assist users during the whole editing process, as it is detailed in Section 4.

Finally, an algorithm has been developed in order to reverse the mapping from RDF to HTML forms. In other words, this algorithm is responsible for generating the RDF that results from the editing process by mapping the form input fields to the corresponding triples. This completes the roundtrip for RDF metadata editing from RDF to HTML forms and back to RDF.

2.3 Content Uploading and Annotation

As it has been previously introduced, a side effect of a content item upload is the metadata extraction step. A metadata extraction plug-in specific for the content type is triggered in order to extract relevant metadata and store it in semantic form.

For instance, if an HTML document is stored, the corresponding plug-in is executed in order to generate semantic metadata associated to the document URL. This metadata specifies attributes such as “title”, “keywords”, etc. available from the uploaded document. If the content is a picture, EXIF [14] metadata is extracted and stored as semantic metadata. For video content, automatic metadata extraction applications are used in order to retrieve relevant metadata. The semantic metadata generated is based on semantic web standards.

For editorial metadata (title, date of publication…) Dublin Core is considered and for content metadata (audio and video features, temporal decompositions, structure, knowledge captured by content…) the ontology versions of standards such as MPEG-7 [15], TV-Anytime... are considered. In any case, the metadata extracted is just an annotation proposal. The user can edit it through the user interface previously detailed.

Additional annotations can be triggered for HTML and other textual content. Text content is semantically annotated based on natural language processing techniques. These might be as simple as named entities detection. In this case, when a piece of content is uploaded to Rhizomer, for instance a news item or a blog post, external services are used in order to generate content-based semantic annotations. Two annotation services have been tested so far, the Open Calais API[3] from Reuters and the Freeling [16] Open Source NLP package. Moreover, if content is uploaded from external URLs, a plug-in recovers the tags attached to them in collaborative bookmarking services such as del.icio.us[4] and generates semantic versions of the tags. Textual semantic annotations can be leveraged to audio content too. As it is detailed in Section 3, for speech in audio content a transcript might be generated thus allowing the resulting text to be annotated as any other textual source.

3 Application Scenario

The Rhizomer platform has been put into practice in the Segre[5] media group in the context of the S5T[6] research project. S5T extends semantic annotation to the audio part of audiovisual contents. In order to do that, a transcript of the audio voices is automatically generated and processed in order to detect key terms and produce semantic annotations based on these terms. More details about this process are available in [17].

The news items management system is based on the Rhizomer platform and allows browsing the audiovisual contents through their transcripts or, in a complementary way, together with the ontologies and metadata in their semantic annotations. All the metadata and the ontologies are based on RDF, so they can be browsed in a generic

[3] http://www.opencalais.com
[4] http://del.icio.us
[5] http://www.diarisegre.com
[6] http://nets.ii.uam.es/~s5t

way by means of the RDF to HTML transformation provided by the platform. It is also possible to perform queries through the SPARQL endpoint.

Metadata for audio content items is generated following the audio transcript plus semantic annotation process described before. This process has been integrated into the Rhizomer platform as a metadata extraction plug-in. When an audio file corresponding to a news item is uploaded to the Rhizomer platform in the S5T project, the audio transcription is generated and the process continues with a semantic annotation similar to the one carried out by the OpenCalais API commented in Section 2.3. In this case, ontologies tailored to the kind of news items managed in the project are used in order to produce more relevant semantic annotations.

On top of this content and metadata base, some services have been added in order to carry out actions specific to the Segre scenario and which depend on the type of object being manipulated. For audiovisual contents with an annotated transcript, a semantic web service implementing one of these specific actions has been added, which is described in Section 3.1. The rest of the services and features, e.g. metadata rendering and browsing, are directly reused from the Rhizomer platform.

3.1 Transcript-Based Interaction Service

In the Segre scenario, there is a specific interaction action enabled for audiovisual resources, i.e. resource of type *mpeg7:AudioType*, with an associated *transcript* property. The corresponding web service provides a view, shown in the right part of Fig. 3, which permits additional interaction possibilities through the semantic annotations automatically generated [17] from the audio transcript.

This view permits rendering audio and video content and interacting with it through a clickable version of the audio transcription. Two kinds of interactions are possible from the transcript. First, it is possible to click on any indexed word in the transcript in order to perform a keyword-based query for all the pieces of content containing that keyword. Second, the transcript is enriched with links to the ontology used for semantic annotation. Each word whose meaning is represented by an ontology concept is linked to a description of that concept.

Fig. 3. Metadata view (left) and transcript view (right) available through the "play" service

For instance, the transcript includes the name of a politician indexed and modeled in the ontology. Consequently, it can be clicked in order to get all the audiovisual items where his name appears or, alternatively, to browse all the knowledge about that politician encoded in the corresponding domain ontology.

4 Conclusions and Future Work

The Rizhomer platform constitutes a simple yet flexible content management system. Thanks to its semantic metadata, it facilitates content management in heterogeneous scenarios and builds an improved user experience. Metadata is produced when content items are uploaded to the platform. Specialised metadata extraction plug-ins are incorporated and extract relevant metadata depending on content type, from EXIF metadata for pictures to semantic annotations for text content.

The platform offers a generic RDF to HTML transformation that makes it possible to navigate through semantic metadata and the associate ontologies. Apart from metadata browsing capabilities and content retrieval, users can carry out additional actions implemented by means of Semantic Web services. These services are associated to the resources by a matching process based on their semantic descriptions.

The platform has been applied in the Segre media group to develop an audio news items management system. The platform features a metadata extraction plug-in that produces semantic annotations for the audio voice transcripts of the uploaded audio files. The resulting metadata is used by a specialised interaction service that plays audiovisual content together with a transcript for the audio voice. The transcript is enriched with semantic annotations that can be used to retrieve other pieces of content or browse the semantic annotations metadata.

Future work focuses on metadata edition facilities. In addition to the assistance when a user tries to add a new property to the current description. Property ranges and restrictions that apply to the kind of resource being edited will be considered to suggest resources which could constitute a proper value for the property. Moreover, new metadata extraction plug-ins and interaction services for additional application scenarios will be explored. For instance, plug-ins to extract information from collaborative bookmarking and ranking sites will also be considered, trying to leverage information already present on the web.

Acknowledgements

The work described in this paper has been partially supported by Spanish Ministry of Science and Education through the Scalable Semantic personalised Search of Spoken and written contents on the Semantic Web (S5T) research project (TIN2005-06885).

References

1. Nowack, B.: RDF Tools - An RDF Store for WordPress. BNode (January 15, 2008), http://bnode.org/blog/2008/01/15/rdf-tools-an-rdf-store-for-wordpress

2. Buytaert, D.: DrupalCon Boston 2008: State of Drupal presentation. DrupalCon 2008, Boston, MA (2008), http://buytaert.net/files/state-of-drupal-2008-boston.pdf
3. Lytras, M., García, R.: Semantic Web Applications: A framework for industry and business exploitation - What is needed for the adoption of the Semantic Web from the market and industry. International Journal of Knowledge and Learning 4(1) (in press, 2008)
4. Corcho, O., López-Cima, A., Gómez-Pérez, A.: The ODESeW 2.0 semantic web application framework. In: Proceedings of the 15th International Conference on World Wide Web, WWW 2006, pp. 1049–1050. ACM Press, New York (2006)
5. Kalyanpur, A., Parsia, B., Hendler, J.: A Tool for Working with Web Ontologies. International Journal of Semantic Web and Information Systems 1(1), 36–49 (2005)
6. Krötzsch, M., Vrandečić, D., Völkel, M.: Semantic MediaWiki. In: Cruz, I., Decker, S., Allemang, D., Preist, C., Schwabe, D., Mika, P., Uschold, M., Aroyo, L.M. (eds.) ISWC 2006. LNCS, vol. 4273, pp. 935–942. Springer, Heidelberg (2006)
7. Berners-Lee, et al.: Exploring and Analyzing linked dates on the Semantic Web. In: Proc. of the 3rd International Semantic Web User Interaction Workshop (2006)
8. Bojars, U., Passant, A., Giasson, F., Breslin, J.G.: An Architecture to Discover and Query Decentralized RDF Data. In: Proceedings of the ESWC 2007 Workshop on Scripting for the Semantic Web, SFSW 2007. CEUR Workshop Proceedings, vol. 248 (2007)
9. Richardson, L., Ruby, S.: Restful Web Services. O'Reilly, Sebastopol (2007)
10. Crane, D., Pascarello, E., James, D.: "Ajax in Action". Manning Publications (2005)
11. García, R., Gil, R.: Improving Human-Semantic Web Interaction: The Rhizomer Experience. In: CEUR Workshop Proceedings, vol. 201, pp. 57–64 (2006)
12. Prud'hommeaux, E., Seaborne, A.: SPARQL Query Language for RDF. Recommendation, World Wide Web Consortium (2008), http://www.w3.org/TR/rdf-sparql-query
13. Hildebrand, M., Ossenbruggen, J., Hardman, L.: /facet: A Browser for Heterogeneous Semantic Web Repositories. In: Cruz, I., Decker, S., Allemang, D., Preist, C., Schwabe, D., Mika, P., Uschold, M., Aroyo, L.M. (eds.) ISWC 2006. LNCS, vol. 4273, pp. 272–285. Springer, Heidelberg (2006)
14. Kanzaki, M.: Exif vocabulary workspace - RDF Schema. W3C Technical Report (2003), http://www.w3.org/2003/12/exif
15. García, R., Tsinaraki, C., Celma, O., Christodoulakis, S.: Multimedia Content Description using Semantic Web Languages. In: Kompatsiaris, Y., Hobson, P. (eds.) Semantic Multimedia and Ontologies: Theory and Applications. Springer, Heidelberg (2008)
16. Atserias, J., Casas, B., Comelles, E., González, M., Padró, L., Padró, M.: FreeLing 1.3: Syntactic and semantic services in an open-source NLP library. In: Proc. of the 5th Int. Conf. on Language Resources and Evaluation (LREC 2006), Genoa, Italy (2006)
17. Tejedor, J., García, R., Fernández, M., López, F., Perdrix, F., Macías, J.A., Gil, R., Oliva, M., Moya, D., Colás, J., Castells, P.: Ontology-Based Retrieval of Human Speech. In: Proc. of the 6th International Workshop on Web Semantics, WebS 2007. IEEE Computer Society Press, Los Alamitos (2007)

Business Metrics Discovery by Business Rules

Franceso Arigliano[3], Paolo Ceravolo[1], Cristiano Fugazza[1], and Davide Storelli[2]

[1] Università degli studi di Milano, Dipartimento di Tecnologie dell'Informazione
via Bramante, 65
26013 Crema (CR), Italy
{ceravolo,fugazza}@dti.unimi.it
[2] e-Business Management Section of S.S. ISUFI, University of Salento
via per Monteroni, s.n.
Lecce, 73100, Italy
davide.storelli@ebms.unile.it
[3] Engineering Ingegneria Informatica S.p.A., R&D Lab,
via Trinchese, 61
Lecce, 73100, Italy
francesco.arigliano@eng.it

Abstract. This work contributes to the results of the TEKNE projec[1], a project aimed at developing a framework for Business Process Management (BPM), supporting the designer with a set of *performance indicators*. The indicators drive the designer in estimating if the process comply to the objectives and when necessary enable re-engineering of the process. In particular this paper discuses how to derive performance indicators directly from requirements expressed in a Business Rules (BR) format.

1 Introduction

In modern organizations business process (BP) design and management is more and more a critical asset. Global competition stresses to the adoption of continuing design methodologies, where business processes are rapidly re-engineered to conform to the evolution of marked demand. In this context it is straightforward to see the relevance of business process monitoring.

In principle monitoring can be done in many ways; traditional approaches rely on interviews to the actors executing the process or on the analysis of market data. But nowadays much interest is on using informative systems (IS) to support business process management. Among the benefits provided by such an approach is a strong support in monitoring the business execution. Indeed, all the events generated in the enactment of a process are recorder in a log. This provides a continuing feedback on the actual development of the process that can be compared with requirements such as the *BP model* or *directives* (goals, strategies, standards, and regulations) that the process need to comply with. Note that the information obtained is complementary to the one in the business process model because, at the design time, one may model

[1] This work was partly funded by the Italian Ministry of Research Fund for Basic Research (FIRB) under project RBNE05FKZ2_004 TEKNE. Web-site: http://www.tekne-project.it/

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 395–402, 2008.

optional and alternative activities. Also, some requirements cannot be enforced directly in the process design because of their external origin (standards, regulations, protocols, etc), or because of a lack of control on activities (outsourcing, user decision, etc). In short, the event logs can radically improve the effectiveness of monitoring tasks, reducing the time of analysis and facilitating re-engineering of the process.

But drawbacks exist. The main problem is how to relate the events generated by the execution layer to business activities in the process model. In fact, log data can provide insightful information only if a univocal relation is established between events and activities. In traditional approaches, event logs and business activities are completely uncoupled. However, in the literature, several works propose the integration of BPM with an execution layer. In general we can distinguish two approaches. The first is based on the adoption of procedural languages aimed at describing business process policies. These approaches rely on a formal description of the business process and support the monitoring of formal properties, such as for instance, termination, cycles, and transaction. The formal representation guaranties algorithms and techniques for driving the analysis but requires an ad hoc mapping among formal policies and the business requirements to be monitored.

The other approach is based on enriching the event log with metadata relating them to business activities. This way, we have a closer connection between requirements and event logs. But the adoption of metadata introduces an additional layer. Indeed in a business context requirements are represented using business rules (BR) standards, traditionally implemented with natural language eventually coupled with a graphical notations, while events logs refer to business activities via annotations, in form of tags or simple assertions.

Our approach is aimed at reducing the gap between the representation of event logs and BR. The platform we developed supports the design of BR, BP and IS in a single framework, where the relation among all these notations is explicit.

In particular, our approach identifies a specialization of the BR, named *directives,* aimed at describing constraints to be applied to the BP in order to comply with a given objective, strategy, or regulation. Directives are used to derive performance indicators aimed at assisting the designer with measures on the process, to be used in the re-engineering phase.

The paper is structured as follows: the first section introduces performance indicators discussing the methodology adopted in the TEKNE project; the second section details the architecture; while the third presents the related works.

2 Monitoring the Process

2.1 Performance Indicators

As proposed in -- --process monitoring techniques can support three services: *discovery*, *conformance* and *extension*. *Discovery* is about deriving a process model from data in the event log. Using an inductive approach, the process executions are generalized in a model consistent with all the recorded instances. *Conformance* is about verifying if the executions follow the prescribed control flow or comply with external directives such as business goals, regulations, standards etc. In this case, the information gathered by logs must be compared to the business model and to the business rules; moreover, when a violation is detected it is pointed out. *Extension* is about enriching the business model and the business rules with new constraints derived from the process instances described in logs.

This works develop a *conformance* approach, the problem of evaluating performances can be describe by the following implication:

$$\mathrm{S},\mathrm{W} \rightarrow R \tag{1}$$

Where *S* is a specification of the behavior that must result from execution of the process to be developed; *W* represents a set of world properties, i.e. the context where the process is executed; and *R* represents a set of requirements to be met by the process. To prove that the specifications will satisfy the requirements in a specific world context, it is necessary to show that this implication holds.

As described in details in following sections our framework provides the designer with support for the specification of all these descriptions. In particular the BXModeller editor allows to describe the BP model relating it with an execution layer (IS). This editor is coupled with XBeaver, an editor for vocabulary and BR allowing to describe both the business context (*W*) and the requirements of the business (*R*).

The aim of our system is to verify that the implication 1 holds. This can be done both *ex-ante* and *ex-post*. Ex-ante is acting on the process specification only, for instance by constraining the naming of objects in conformance with the entities declared in the business context, or verifying that the overall set of BR is consistent. These indicators are implemented without considering the execution phase; for this reason they lay outside the scope of this paper. Instead we concentrate on conformance indicators that are obtained by comparing the process specification to the process execution, i.e. ex-post. Using such an approach the process *S* to be tested is not the BP model. Indeed *S* represents an instance of BP execution. Moreover *R* can represent both the BP model and the directives. In the first case we evaluate if the execution conforms to the design, in the second case we evaluate if the execution conforms to a constraint not contained in the BP model.

A typical method adopted in order to implement conformance indicators is to identify a set of requirements and verify which executed instances of the process violate it. The notion of *violation* is very useful because it provides a simple criterion of measurement. Given a set of requirements *R* if the Implication (1) does not holds, *S* and *W* violate *R*. Note that this notion has an important property. Pointing out violations, we obtain a measure of the process performance with a method that is completely independent from the specific semantics of *R*, so we can support as many indicators as the number of requirements sets *R* we are able to represent. In other words, our methodology is independent of the specific requirements to be evaluated.

A methodology independent form requirements is crucial for our goals, because, as said, one of the aims of the TEKNE project is to directly use the BR to derive performance indicators. But such a methodology is not the only condition to be supported in order to use BR directives directly as performance indicators. The other condition is providing an algorithm, which is able to conjunctively evaluate *S*, *W,* and *R*, as a single knowledge based. This algorithm has to work as a black box taking in input *S*, *W, R*, computing the consistency of the knowledge based, and in case of inconsistency point out a violation. Such an algorithm is compatible only with a representation of *S*, *W* and *R* in declarative form, and assuming a uniform naming space.

The algorithm verifying violations is executed by a theorem prover representing the knowledge base *S*, *W, R*, as a set of logical assertions. This approach is compatible with the standards adopted.

BXModeller represents the process in Business Process Modeling Notation (BPMN[2]), this notation is based on a flowcharting technique that is tailored for the purpose of creating graphical models of business operations. A straightforward way for translating it in logical assertions is to represent it using a logic-based formalism (specifically, OWL DL data structures). For this purpose, we shall use the Business Management Ontology (BMO[3]) as a means to express the structural properties of the process. XBeaver directly adopts a declarative approach because the BR language implemented by the tool (SBVR) was natively designed to be represented in First Order Logic.

2.2 Implementing Performance Indicators

At a first glance the notion of violation could appear poor, because related to the evaluation of a Boolean condition. But considering the occurrence of a specific violation it is possible to develop more complex indicators. In [4] some of us discussed the adoption of an approach based on violation for evaluating alethic and deontic conditions with either relative or absolute thresholds. Alethic directives are used to model necessities that cannot be violated, even in principle. For example, an alethic directive may state that an employee must be born on at most one date. Deontic directives are used to model obligations (e.g., resulting from company policy) which ought to be obeyed, but may be violated in real world scenarios. For example, a deontic directive may state that it is forbidden that any person smokes inside any company building. In order to support indicators expressing both alethic and deontic directives two behaviors are to be implemented. The primer must spotlight non-conformity of the process any time a violation is detected. The former must report on the occurrence of a violation. A directive expressing an absolute threshold prescribes the exact occurrence of a given event; while a directive expressing a relative threshold prescribe that the occurrence of a given event must be in a relation (i.e. a percentage) with another event.

Unfortunately representing this category of modal constraints in logical format suitable for a theorem prover it is not straightforward. Indeed it is well acknowledged that the introduction of modalities and disequations in a logical language lead to hard computational complexities.

In order to face this problem we dissociate the representation of constraints from the logical assertions representing directives. In other words, starting from a directive expressed as a BR we derive a twofold representation: (i) a logical assertion in universal form, to be evaluated by the theorem prover, plus (ii) a constraint representing the suitable modality or threshold to be supported. In particular we generate a *constraint function f* of the cardinalities of the facts generated by the process flow to be

---

[2] BPMN web-site: http://www.bpmn.org

[3] Jenz and Partner. Business Management Ontology (BMO). Technical report, 2004.

used as an indicator of the process performance. Then, this cardinality is linked to thresholds expressed by directives. Equation (2) formalizes this point as follows:

$$f(Card_{A_1}, Card_{A_2}, ..., Card_{A_n}) \leq \alpha. \tag{2}$$

This equation is not evaluated directly by the theorem prover but in a module dedicated to constraint functions.

Considering for example a business rule like the following:

The number of <u>customers</u> that *apply* for a <u>Premium Card</u> **must** be at least 90% of the number of <u>customers</u> that do **not** *have* a <u>Premium Card</u>. (3)

It can be represented by a universal assertion:

all <u>customers</u> *apply* for a <u>Premium Card</u>; (4)

plus a constraint in form of disequation:

$$\underline{\text{customers}} \text{ that } \textit{apply} \text{ for a } \underline{\text{Premium Card}}$$
$$\geqslant 0.9 * \underline{customers}\ that\ do\ \textbf{not}\ \textit{have}\ a\ \underline{PremiumCard}. \tag{5}$$

In particular, Figure 1 shows how the system interrelates the theorem prover with the module tasked to represent constraints and the module tasked to evaluate them. Basically given a specific execution of the process *Sj,* the system starts evaluating all the directive violated by a knowledge base composed by *Sj* plus the business context

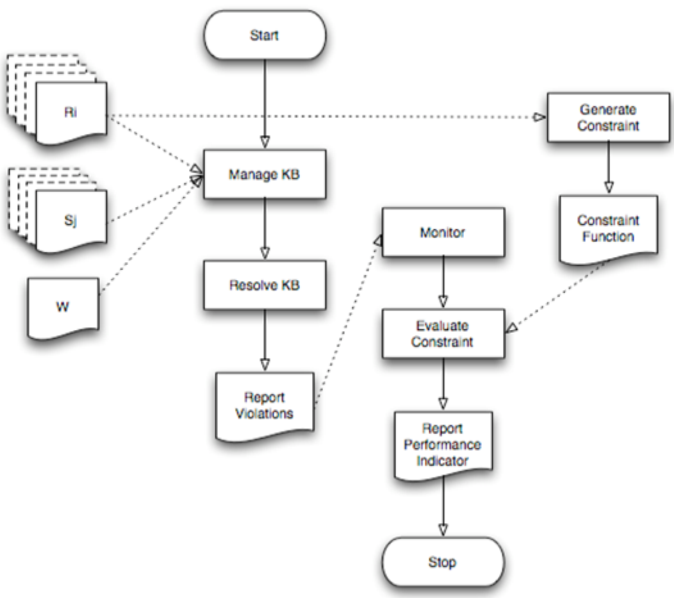


Fig. 1. The module generating performance indicators

W. In parallel a directive is translated in a constraint of the form described by Equation (2). When all instances of the execution of process S are evaluated by the prover, the system compares for each directive the occurrences of violations with the constraint and generate an indicator on the compliance of the process execution.

3 The TEKNE Architecture

The proposed architecture is compound by three parts that address the specification, execution and monitoring of a process, of its business context and of the expected requirements. The first part supports business engineers on design-time. It provides components and tools for modeling any business process together with its context and directives. The control flow is defined through the BXModeller, a collaborative web-application that represents processes through OMG BPMN (Business Process Modeling Notation)and exports their serialisation to a standard format for workflow execution: the XPDL 2.0 (XML Process Definition Language). The business context and the directives are described through the XBeaver application, that adopts a declarative approach, leveraging SBVR (Semantics of Business Vocabulary and Business Rules), another OMG standard. The adoption of SBVR is motivated by two features: i) SBVR models can be expressed by means of an easy to use natural-language-based notation; ii) the SBVR metamodel is compliant and mapped to first order logic, thus fully supporting automatic interpretation and reasoning upon its assertions. The combination of both features allows the definition of automatable metrics that can be referred directly to business policies and business rules. The architecture provides, indeed, a tool for coupling elements of a business domain with activities of a business process, thus binding generic logical assertions to generic operations. The second part of the architecture is constituted by the run-time environment in which the XPDL representation of the process is executed and the workflow operations are recorded in a log repository. This allows making important information available for analysis and metrics measurement. Thanks to the previous mapping phase among elements of the BPMN and of the SBVR models, it is possible to derive rules from actual instances of process activities. The resolution of rules is of responsibility of the third major part of the proposed architecture: the Metrics Framework.

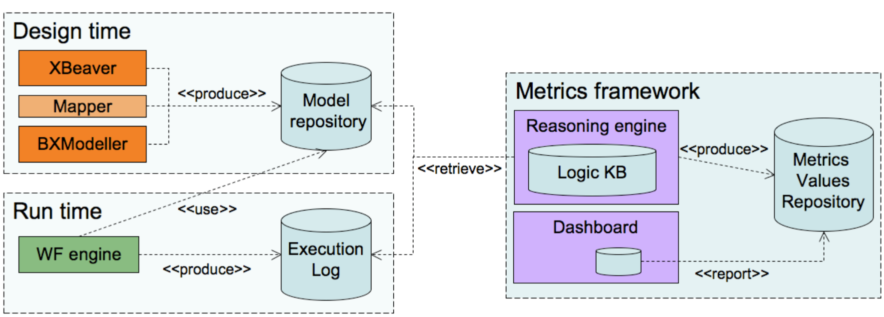


Fig. 2. A synthetic view on the proposed architecture

Here data from the design-time and run-time repositories are retrieved, merged and transformed into a logical formalism, thus constituting a knowledge base where logical assertions can be evaluated and metrics can be measured. Moreover a dashboard is provided in order to allow business managers to directly monitor the actual values of the metrics they have previously defined.

4 Related Works

Approaches aimed at supporting business process monitoring by an execution layer are not new in the literature. For example a wide literature exist on workflow mining [1]. In the web services literature there are several approaches dealing with monitoring the communication over service enabled business processes [8][9], verifying the correct execution of the prescribed flow, specifying coordination with other applications or internal time of response [7][10][13] Advanced researches proposed dedicated policy languages for describing conditions.

Other works have focused on the introduction of a metadata layer supporting an enriched description of processes. Various authors [3][12] use planners over service description in DAML-S. In [5] a complete architecture for the analysis, prediction, monitoring, control and optimization of process executions in BPM Systems is presented. In [6] [11][2] we have one of the first proposals and implementation in the direction of integration Semantic Web technologies and BP.

References

[1] van der Aalst, W.M.P., van Dongen, B.F., Herbst, J., Maruster, L., Schimm, G., Weijters, A.J.M.M.: Workflow mining: A survey of issues and approaches. Data & Knowledge Engineering 47, 237–267 (2003)

[2] Alves de Medeiros, A.K., Pedrinaci, C., van der Aalst, W.M.P., Domingue, J., Song, M., Rozinat, A., Norton, B., Cabral, L.: An Outlook on Semantic Business Process Mining and Monitoring. In: Meersman, R., Tari, Z., Herrero, P. (eds.) OTM-WS 2007, Part II. LNCS, vol. 4806, pp. 1244–1255. Springer, Heidelberg (2007)

[3] Ankolekar, A., Burstein, M., Hobbs, J., Lassila, O., Martin, D., McDermott, D., McIlraith, S., Narayanan, S., Paolucci, M., Payne, T., Sycara, K.: DAML-S: Web Service Description for the Semantic Web. In: Horrocks, I., Hendler, J. (eds.) ISWC 2002. LNCS, vol. 2342. Springer, Heidelberg (2002)

[4] Ceravolo, P., Damiani, E., Fugazza, C., Mulazzani, F., Russo, B.: Business Process Monitoring via Ontology-based Representation Models. Journal Computers in Human Behaviour (24) (2008)

[5] Grigori, D., Casati, F., Castellanos, M., Dayal, U., Sayal, M., Shan, M.: Business Process Intelligence. Computers in Industry 53(3), 321–343 (2004)

[6] Hepp, M., Leymann, F., Domingue, j., Wahler, A., Fensel, D.: Semantic business process management: A vision towards using semantic web services for business process management. In: ICEBE, pp. 535–540 (2005)

[7] Lazovik, M., Aiello, M., Papazoglou, M.: Planning and monitoring the execution of web service requests. In: Orlowska, M.E., Weerawarana, S., Papazoglou, M.P., Yang, J. (eds.) ICSOC 2003. LNCS, vol. 2910, pp. 335–350. Springer, Heidelberg (2003)

[8] McDermott, D.: Estimated-regression planning for interactions with Web Services. In: 6th Int. Conf. on AI Planning and Scheduling. AAAI Press, Menlo Park (2002)

[9] McIlraith, S., Son, T.C.: Adapting Golog for composition of semantic web-services. In: Fensel, D., Giunchiglia, F., McGuinness, D., Williams, M. (eds.) Conf. on principles of Knowledge Representation (KR) (2002)

[10] Pistore, M., Barbon, F., Bertoli, P., Shaparau, D., Traverso, P.: Planning and Monitoring Web Service Composition. In: ICAPS 2004 Workshop on Planning and Scheduling for Web and Grid Services (June 2004)

[11] Sell, D., Cabral, L., Motta, E., Domingue, J., Pacheco, P.: Adding Semantics to Business Intelligence. In: DEXA Workshops, pp. 543–547. IEEE Computer Society Press, Los Alamitos (2005)

[12] Srivastava, B., Koehler, J.: Web Service Composition. Current Solutions and Open Problems. In: Proc. of ICAPS Workshop on Planning for Web Services (2003)

[13] Wu, D., Sirin, E., Hendler, J., Nau, D., Parsia, B.: Automatic Web Services Composition Using SHOP2. In: Proc. of ICAPS Workshop on Planning for Web Services (2003)

The Origin, Representation, and Use of Collaboration Patterns in a Medical Community of Practice

Göran Falkman[1], Marie Gustafsson[1,2], Olof Torgersson[2], and Mats Jontell[3]

[1] School of Humanities and Informatics,
University of Skövde, SE-541 28 Skövde, Sweden
{goran.falkman,marie.gustafsson}@his.se
[2] Department of Computer Science and Engineering, Chalmers
University of Technology/University of Gothenburg, SE-412 96 Göteborg, Sweden
{mariegus,oloft}@chalmers.se
[3] Institute of Odontology, Sahlgrenska Academy, University of Gothenburg,
P.O. Box 450, SE-405 30 Göteborg, Sweden
Mats.Jontell@odontologi.gu.se

Abstract. Founded on the Semantic Web technologies OWL and RDF, SOMWeb is an online community of practice that is used for knowledge sharing and dissemination within an oral medicine community in Sweden. It is shown how patterns for communication and collaboration within SOMWeb can be identified and represented in OWL, in terms of knowledge components, such as ontologies describing domain knowledge, user models, and organization models. It is described how patterns could be put into use and inform the design of future versions of SOMWeb.

1 Introduction

The purpose of health information systems (HIS) is to contribute to optimal health care, with maximized patient benefits and with the use of the least possible resources. In recent years, HIS have been governed by the understanding of optimal health care as being evidence-based, i.e., as being based on identifying, validating, and using the latest research results as a basis for clinical decisions [1]. Distributed, networked health care organizations (HCO) and care providers that require co-operative care and increased communication between health care professionals have been identified as a key components of evidence-based medicine (EBM) [2]. An example where this is evident is oral medicine, a sub discipline of dentistry concerned with diseases related to the oral and paraoral structures, in which co-operation between distributed clinics is necessary for providing a means for consultation and learning, as well as for collecting diverse and numerous cases for further research and education.

The Internet and modern ICT provide the infrastructure for supporting networked clinical collaboration. However, so far, most work within e-health has been on telemedicine, and the utility of e-health systems to promote clinical

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 403–412, 2008.

collaboration has received little attention [3]. In addition, the design, development, and adoption of ICT within medical communities is to a large extent a socio-technical problem [4], requiring more research on the communication and knowledge processes of everyday clinical practice and research [5].

Semantic Web technologies have been put forward as enablers of Internet-based tools supporting knowledge-intensive tasks [6]. However, the adoption of these technologies within the medical domain has turned out to be more problematic and slower than many had hoped [7]. In terms of knowledge management, there has been a lot of activity on knowledge elements, components, and processes associated with patients and the delivery of care, but less work on clinicians as learners and researchers [8]. A re-curring problem is how to identify knowledge elements, components, and processes, and on what level of granularity and abstraction these should be defined.

We have previously studied clinicians' use of an online community of practice (CoP) within oral medicine [9] as well as the possibility of using ideas from the Pragmatic Web [10] to describe communications patterns within the community [11]. In this paper, we continue this research by describing how collaboration patterns within the domain can be identified, represented, and be put into use.

2 SOMNet: An Oral Medicine Community of Practice

Since the early 1990's, the Swedish Oral Medicine Network (SOMNet) has promoted the harmonization and dissemination of medical knowledge and sharing of clinical experience within oral medicine in Sweden. SOMNet has enabled consultations within the relatively small discipline, where experts are sparse and clinics are geographically dispersed. SOMNet's members are mainly dentists with a professional interest in oral medicine, including general practitioner dentists, hospital dentists, specialists in jaw surgery, and oral pathologists. Some members are also certified by the Swedish Oral Medicine Society (SOMS).

Through regularly held teleconference meetings, SOMNet provides means for distance consultations and discussion of cases, the collection of interesting cases for research, and continuing education for a broader audience. In this, SOMNet functions as a CoP within oral medicine in Sweden, and plays a central role in the interaction between oral medicine and related medical specialties.

2.1 SOMWeb

SOMWeb is an online system supporting SOMNet's activities by providing facilities for conducting SOMNet meetings. SOMWeb is best described as a combined research and learning portal [12] targeted at information sharing [13]. Community aspects, e.g., users, meetings, and cases, are modeled in OWL and data is stored with the Resource Description Framework (RDF) [14]. By June 2008, SOMWeb has 90 registered users and 93 cases have been added to the system.

The principal parts of SOMWeb are shown in Fig. 1. In the menu to the left, there are links to the current meeting and to lists of past and upcoming

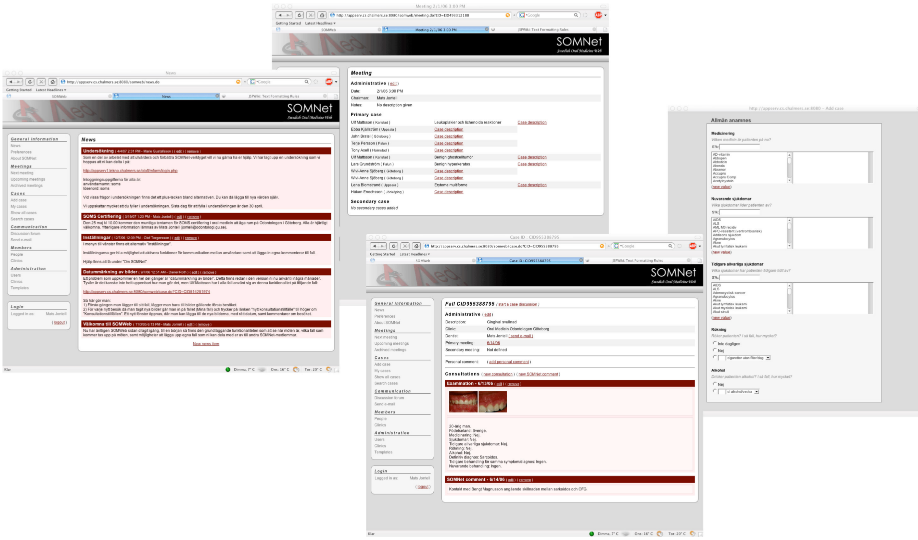


Fig. 1. The SOMWeb Community Collaboration System

meetings. A meeting page (top window in Fig. 1) displays administrative details and a list of cases to be discussed, either for the first time or as follow-ups from previous meetings. Each case is presented by a title, its owner, and a link to the corresponding case presentation page. From the cases submenu, a user can add a case, list all cases, and search over all cases. A new case is added by filling in a form generated from a case submission template, including any associated images (right window in Fig. 1). Finally, the case can be assigned to an upcoming meeting for consultation or discussion. A case presentation page (bottom window in Fig. 1) displays the case owner, the case title, and any assigned meetings. A presentation of the case, generated from the case data, is shown together with thumbnails of images and any associated discussion threads. Clicking on a thumbnail opens up an image browser. Users can add private notes to the case.

3 Origin of Collaboration Patterns

3.1 Communication and Collaboration within SOMNet

During 2007–2008, ten out of 20 SOMNet meetings have been observed. A questionnaire was provided to the members SOMNet. Users were polled for, e.g., perceived usefulness of the system. Nine members have also been interviewed. We refer to [9] for details on the results of these studies.

The SOMNet teleconference meetings are held on a monthly basis. Usually, three to six cases are new, and up to three cases are follow-ups. An assigned chairperson leads the meeting, guides case presentations, sums up discussions, and records decisions made. The presenter of a case 'tells the story' of his/her encounters with the patient and reports on treatments tried and results achieved so far. The other participants ask questions and start suggesting possible diagnosis and treatments. Similar cases or general treatment strategies will sometimes accompany the suggestions. A broader discussion may ensue, about, e.g., reported side effects for medications. When a number of options have been put forth, the chairperson summarizes the discussion and a few suggestions are noted.

3.2 CoP, Medical Team Meetings, and Models of HCO

de Moor [15] uses generic collaboration patterns to describe community memory activation. Transferred to SOMNet, community memory activation is initiated, e.g., by a specialist requesting consultation about a case. The consultation request is translated into a consultation pattern, in which the relevant goal pattern is either establishing a diagnosis or a treatment plan; communication patterns include getting approval of the submitted case from the chairperson and notifying identified community members with interest in the case; information patterns define how to search for relevant external evidence and assess its quality; task patterns include setting the date of the meeting when the case is scheduled and creating lists of interested parties; and the relevant meta-patterns include what to do if no specialist or no evidence supporting the case can be found.

Wenger, McDermott, and Snyder [16] propose that participants of CoP can be divided into groups of core, active, and peripheral. Core members drive the activities of the community, active members participate without being drivers, and peripheral members mostly observe the interactions of other members. In SOMNet, we have seen behavior indicating different levels of participation.

A SOMNet meeting is an example of a multidisciplinary medical team meeting (MDTM), where the team members meet to review patient cases, establish a diagnosis, and decide on the most appropriate treatment plan for the patient [17]. The processes associated with a MDTM system are: (1) pre-meeting activities; (2) case presentation; (3) case discussion; (4) deciding on the diagnosis and treatment; (5) recording of the outcome; and (6) post-meeting activities. The same processes can be discerned in a SOMNet meeting and, thus, they could serve as the appropriate level of abstraction for identifying and defining knowledge elements and knowledge components in the collaboration within SOMNet.

An ontology for HCOs is presented in [18]. Central to the model is the representation of an activity. The HCO ontology also includes goals, roles, and authority. While we have used their model as an inspiration, there are differences between a regular HCO and a CoP for clinical collaboration and research, e.g., the issue of authority and the patient being more prominent in the former while the case being emphasized in the latter.

Vidou et al. [18] present thoughts on an ontology about CoP. The central community concept includes individual members/actors with different roles, processes/activities that produces and uses resources, and lessons learnt. A collaboration concept is also introduced, where collaboration is defined by objectives, composed of activities, needs and produces resources, and implies actors.

4 Representation of Collaboration Patterns

Collaboration patterns involved in the SOMNet activities have been identified through our study of the communication and collaboration within SOMNet's collaboration and the use of SOMWeb. The patterns are composed of classes from ontologies for users, organizations, and a domain ontology for oral medicine.

4.1 Knowledge Components

Ontologies of Users and Organization. The most important class of the user ontology is the `SOMNetMember` class, a subclass of `Person`. For each `Person`, contact information is specified. Each `Person` `hasEducation` of `EducationType`, which has subclasses `AcademicTitles`, `FormalDentalEducation`, and `Certification` (of which `SOMSCertification` is an instance). Each member also has a `FormalOrganization` and a property `numberOfYearsOfExperience`. Also included are `hasInterests` and `hasExpertise`, which take values from e.g., diagnosis and treatment classes of the oral medicine ontology.

The organization ontology includes concepts both related to the organization of SOMWeb and the organizations that are the workplaces of the members. Thus, the class `Organization` has subclasses `CommunityOfPractice` (of which `SOMNet` is an instance) and `FormalOrganization`, of which subclasses are e.g., `PrimaryDentalCare` and `UniversityDepartment`. An `Organization` has `Resources`, including `MemberResource`, `CaseResource`, and `ArticleResource`. The `Support` class refers to some `Resource`, for a certain `Case`, with some `SupportRelevance`, and is used as support for decisions made by the organization. A `CoreMember` is a member with SOMS certification or who has chaired at least one meeting. An `ActiveMember` is defined as a member that has added at least one case. A `PeripheralMember` is a member who is not entailed by the definition of `CoreMember` or `ActiveMember`.

Oral Medicine Ontology. The ontology for oral medicine includes templates for examinations and terminology used in the examination instances [19].

The `Case` class (Fig. 2) is central to SOMWeb. Cases submitted to SOMNet for consultation are added to the SOMWeb database. A case is composed of a set of consultations and, optionally, support material, both of which have further subclasses, e.g., `InitialExamination` and `Article`, respectively. Each type of consultation and support material is associated with a user-defined template that is used for filling in data. A template defines the available categories (e.g., personal details and anamnesis) together with associated input questions. Prescribed lists of values for input questions are defined separately.

4.2 Collaboration Patterns

Request and Activity Patterns. Important parts of SOMWeb's collaboration are the requests, which initiate activities. Each request takes an input resource (a case), is initiated by a member, has a purpose, and results in an activity.

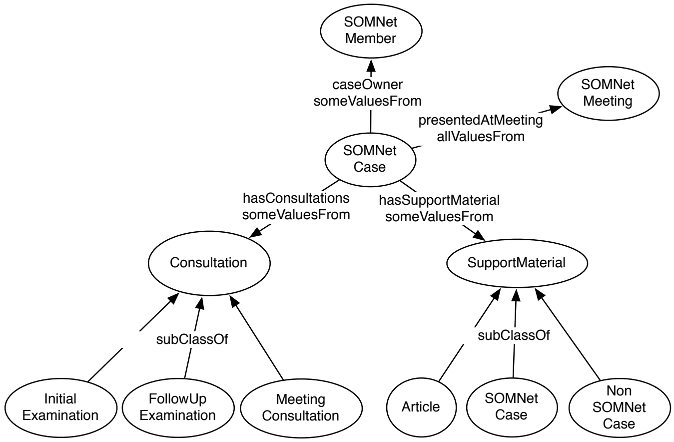


Fig. 2. The `Case` class

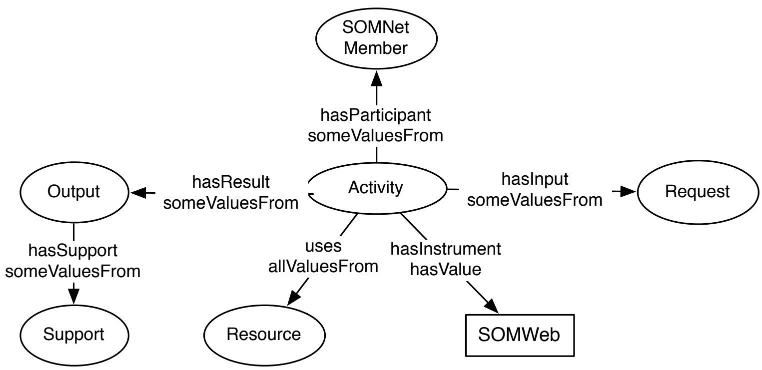


Fig. 3. The activity pattern describes the implementation of an activity request

Our study of how SOMWeb is used indicates that the goals of members adding cases are to seek consultation on a case, to share information about a case, or to create discussion about a case. This is modeled with a class `RequestGoal` (which is a subclass of the `Goal` class) and its three subclasses: `ConsultationGoal`, `CreateDiscussionGoal`, and `ShareInformationGoal`.

A request results in an `Activity`, as determined by the `RequestGoal`. The corresponding activity pattern is depicted in Fig. 3. An activity takes the request as input, has participants (SOMNet members), uses community resources (members, stored cases, and articles), and results in an output which has a specified support. SOMWeb is instrumental to an activity.

Case Activities Patterns. In SOMWeb, activities are mostly case activities. The `CaseActivity` class has three subclasses: `CaseConsultationActivity`, `CaseDiscussionActivity`, and `CaseSharingActivity`.

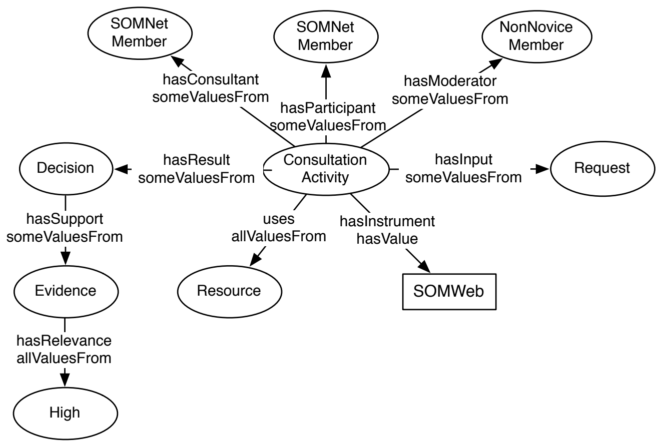


Fig. 4. The consultation activity pattern describes a specialization of an activity

In a `CaseConsultationActivity` (Fig. 4), members participate in different roles: the case presenter is a `SOMNetMember`, the moderator is a `NonNoviceMember` and the participants are `SOMNetMembers`. A `CaseConsultationActivity` results in a `Decision`, which has subclasses such as `DiagnosisDecision` and `TreatmentPlanDecision`. A `Decision` is supported by `Evidence`, a subclass of `Support`, whose relevance is given by `EvidenceRelevance`. A `Decision` in SOMWeb must be supported by `HighRelevanceEvidence`.

5 Use of Collaboration Patterns

We describe the use of the collaboration patterns with a scenario, giving suggestions of how the patterns can inform system design and be used prescriptively.

Our scenario follows a SOMNet member, M, who has SOMS certification and is an experienced SOMWeb user. M wants to add a new case to the system for consultation, and is presented with an input form, generated from an OWL template of what needs to be entered for initial case entry. As the case will be used for decisions about diagnosis or treatment, the system adopts a stricter policy about what data has to be entered. The system then initiates a matching process to add support material to the case automatically. This may be cases added by M on a similar subject or members with relevant areas of expertise.

When the case has been added to the system, M can choose to assign it to an upcoming teleconference meeting. The case consultation pattern specifies that there should be a moderator. By default, the moderator will be the chairperson of the chosen meeting. An email is sent to the chairperson with information about M's consultation request. It may be that the chairperson finds that e.g., a pathologist is needed for consultation on the case, and that such will not attend the chosen meeting and the consultation may therefore be re-scheduled. When the consultation has a definite meeting assignment, invitations can be sent out to interested parties, informed by interests entered in the user profile.

In the meeting, the consultation pattern can be used by the system to guide the moderator in the discussions and towards a decision fulfilling the goal of M's request. After the meeting, the pattern structure can be used to remind members when a pattern is not complete. For example, if a decision has not been recorded within one week of presentation, an e-mail reminder is sent to the moderator.

6 Discussion

Modeling activities within SOMWeb is related to the general study of modeling and formalizing workflows. However, so far, OWL-based representations for workflow management have mostly been used within business process models (cf. [20]). Also related to our activity patterns are clinical practice guidelines. While many formalisms for clinical guidelines use ontologies at the conceptual level, they have so far not used OWL [21]. Not until recently, OWL and related technologies have been applied to clinical practice guidelines [22].

Collaboration patterns can be one part of promoting EBM. Patterns put emphasis on the interaction and communicative actions in clinical knowledge processes and on the contexts and processes in which evidence is used, thereby giving the clinicians the experience that EBM services are beneficial. Thus, pattern-based services have the potential of being integrated into clinical practice, offering good possibilities for long-term use and increased patient benefit. In addition, general reusable patterns of clinical knowledge and decision-making could be turned into improved health care strategies. Differences between different HIS with regard to the usage of clinical information is, compared to differences in fundamental health care processes and medical knowledge, a larger impeding factor when it comes to the possibilities for communication and information exchange between today's HIS. Collaboration patterns could serve as an abstract unifying model in this respect.

In terms of pillars of the emerging knowledge society, our presented patterns can be seen as an initiative towards resuable knowledge objects, as design patterns linking strategies for knowledge and learning with knowledge and learning objects [23]. Key elements of the social construct of the knowledge society are the individual, the team, and the organization. In oral medicine, a major hindrance for how the discipline should move from an eminence to an evidence-based approach is the traditional manner of conducting clinical work. This barrier is particularly obvious between academic institutions and care providers serving different public health organizations. For the individual, it is obvious that less experienced clinicians are learning from both submitting own cases and from participating in discussions of cases presented by more experienced colleagues. At the team level, SOMWeb has made SOMNet members more visible to each other. Another consequence is that more members feel involved in the work of SOMNet, and that knowledge is spread to more people.

SOMWeb is the result of more than 10 years of collaboration between medical practitioners and researchers, computer scientists, and researchers within interaction design. Already from the start, the composition of the development team included members acting as a ‘bridge’ between the clinicians and the researchers, securing the results of the latter being of real use and being adopted in practice by the former. A distinguishing feature of SOMWeb is the delegation of control of fundamental parts of the system to the end-users. This means that the clinicians themselves have been able to adopt the system to their specific needs, contributing to the overall acceptance of the system. Our studies of the collaboration within SOMNet and use of SOMWeb, and the the presented collaboration patterns can be seen as a the first step towards a computational model of the SOMNet community [24].

7 Conclusions

We have described how patterns for collaboration within a CoP in oral medicine can be identified, represented, and put into use. Our research indicates that work within the Pragmatic Web, multidisciplinary medical team meetings, CoP, and the modeling of HCOs can be used for both identifying and deciding on a suitable level of abstraction of relevant knowledge components, e.g., ontologies. We have also shown how OWL can be used to represent patterns and how patterns can be used to inform the design of an existing online medical CoP.

The objective of our research is to understand collaboration and interaction between clinicians better, in order to improve ICT tools that support EBM. In the short term, this translates to elaborate the presented patterns, taking additional theories and models into account (e.g., social networking and narratives). In the longer term, developing a generic tool that builds online CoPs from a pattern-based description of a medical domain is an interesting prospect.

Acknowledgements

This work is funded by the Swedish Governmental Agency for Innovation Systems (VINNOVA), research grant 2006-02792.

References

1. Rosenberg, W., Donald, A.: Evidence based medicine: An approach to clinical problem solving. Brit. Med. J. 310(6987), 1122–1126 (1995)
2. Haux, R.: Health information systems—Past, present, future. Int. J. Med. Inform. 75(3–4), 268–281 (2006)
3. Powell, J., Buchan, I.: Electronic health records should support clinical research. J. Med. Internet Res. 7(1), 4 (2005)
4. Stefanelli, M.: The socio-organizational age in artificial intelligence in medicine. Artif. Intell. Med. 23(1), 25–47 (2001)
5. Byrne, E., Gregory, J.: Co-constructing local meanings for child health indicators in communi-based information systems: The Uthukela district child survival project in KwaZulu-Natal. Int. J. Med. Inform. 76(1), 78–88 (2007)

6. Podgorelec, V., Pavlic, L.: Supporting collaboration of medical informatics researchers and teams. In: Proc. 20th IEEE Int. Symposium on Computer-Based Medical Systems, pp. 97–102. IEEE Press, Los Alamitos (2007)
7. Yu, A.: Methods in biomedical ontology. J. Biomed. Inform. 39(3), 252–266 (2006)
8. Abidi, S.S.R.: Healthcare knowledge management: The art of the possible. In: Riaño, D. (ed.) K4CARE 2007. LNCS (LNAI), vol. 4924, pp. 1–20. Springer, Heidelberg (2008)
9. Falkman, G., Gustafsson, M., Jontell, M., Torgersson, O.: SOMWeb: A Semantic Web-based system for supporting collaboration of distributed medical communities of practice. J. Med. Internet Res. (Medicine 2.0) (2008) (forthcoming)
10. Schoop, M., de Moor, A., Dietz, J.L.: The Pragmatic web: A manifesto. Commun. ACM 49(5), 75–76 (2006)
11. Falkman, G., Gustafsson, M., Torgersson, O., Jontell, M.: Towards pragmatic patterns for clinical knowledge management. In: Proc. 2nd Int. Conference on the Pragmatic Web (ICPW 2007), pp. 65–74. ACM, New York (2007)
12. Devedžić, V.: Research community knowledge portals. Int. J. Knowledge and Learning 1(1–2), 96–112 (2005)
13. Rafaeli, S., Raban, D.R.: Information sharing online: A research challenge. Int. J. Knowledge and Learning 1(1–2), 62–79 (2005)
14. Gustafsson, M., Falkman, G., Lindahl, F., Torgersson, O.: Enabling an online community for sharing oral medicine cases using Semantic web technologies. In: Cruz, I., Decker, S., Allemang, D., Preist, C., Schwabe, D., Mika, P., Uschold, M., Aroyo, L.M. (eds.) ISWC 2006. LNCS, vol. 4273, pp. 820–832. Springer, Heidelberg (2006)
15. de Moor, A.: Community memory activation with collaboration patterns. In: Proc. 3rd Conf. on Community Informatics Research Network (CIRN 2006), pp. 1–18 (2006)
16. Wenger, E., McDermott, R., Snyder, W.: Cultivating Communities of Practice. Harvard Business School Press, Boston (2002)
17. Kane, B., Luz, S.: Multidisciplinary medical team meetings: An analysis of collaborative working with special attention to timing and teleconferencing. Comput. Support. Coop. Work 15(5–6), 501–535 (2006)
18. Vidou, G., Dieng-Kuntz, R., El Ghali, A., Evangelou, C., Giboin, A., Tifous, A., Jacquemart, S.: Towards an ontology for knowledge management in communities of practice. In: Reimer, U., Karagiannis, D. (eds.) PAKM 2006. LNCS (LNAI), vol. 4333, pp. 303–314. Springer, Heidelberg (2006)
19. Gustafsson, M., Falkman, F.: Experiences in modeling clinical examinations in oral medicine using OWL. In: Proc. OWLED 2007 Workshop on OWL: Experiences and Directions (2007)
20. Yao, Z., Liu, S., Han, L., Reddy, Y.V.R., Yu, J., Liu, Y., Zhang, C., Zheng, Z.: An ontology based workflow centric collaboration system. In: Shen, W., Luo, J.-Z., Lin, Z., Barthès, J.-P.A., Hao, Q. (eds.) CSCWD. LNCS, vol. 4402, pp. 689–698. Springer, Heidelberg (2007)
21. Peleg, M.: Guidelines and workflow models. In: Greenes, R.A. (ed.) Clinical Decision Support – The Road Ahead, pp. 281–306. Elsevier, Amsterdam (2007)
22. Cateleiro, M.A., Diz, J.J.D.: Clinical practice guidelines: A case study of combining OWL-S, OWL, and SWRL. Knowl.-Based Syst. 21, 257–265 (2008)
23. Lytras, M.D., Sicilia, M.A.: The knowledge society: a manifesto for knowledge and learning. Int. J. Knowledge and Learning 1(1–2), 1–11 (2005)
24. Kalfoglou, Y.: Knowledge society arguments revisited in the semantic technologies era. Int. J. Knowledge and Learning 3(2–3), 225–244 (2007)

Semantics-Aware Resolution of Multi-part Persistent Indentifiers

Emanuele Bellini[1], Ernesto Damiani[2],
Cristiano Fugazza[2], and Maurizio Lunghi[1]

[1] Fondazione Rinascimento Digitale
{bellini,lunghi}@rinascimento-digitale.it
[2] Dipartimento di Tecnologie dell'Informazione
Università degli Studi di Milano
{damiani,fugazza}@dti.unimi.it

Abstract. In this paper, we outline the achievements of the NBN project w.r.t. persistent identification in the context of federated repositories and outline the capabilities of the current prototype. We describe the generalities on the approach adopted for PI assignment and resolution in the twofold modality of hierarchical and peer-to-peer request forwarding. The final implementation will enable each PI domain to communicate with other domains by using the same resolution interface.

We also describe the advanced capabilities under development for the retrieval of complex objects by automated agents, combining the PMH interaction protocol with ORE data structures extended as to suit the purpose of digital preservation. We also sketch how to enable metadata interoperability by allowing clients to specify the native metadata format when interrogating a repository and translating proprietary descriptions accordingly.

Keywords: Persistent Identification, Metadata, Ontologies.

1 Introduction

Namespace definition and naming service implementation are both time-honored research topics. Besides a vast scientific literature, many important standards exist, from those dealing with the Internet Domain Name System (DNS) itself, to the standards defining namespaces for *persistent identifiers* (PI) and their resolution techniques. Until now, interoperability of PI schemata has been only considered at the namespace definition level, as for the National Bibliographic Number (NBN) introduced in Germany: In this case, individual countries are encouraged to establish their own NBN namespace, syntactically consistent with the German one, but this does not per se ensure any practical provision for mutual assistance in name resolution and/or metadata mapping.

Monitoring the physical location of digital resources that are ascribed to a given PI and following the evolution of the former throughout their life cycle represents a fundamental requirement for the efficient dissemination of scientific

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 413–422, 2008.

and cultural content. A large number of competing PI systems addressing these issues exist; moreover, individual application scenarios and knowledge domains are expected to introduce independent systems for the purpose of customizing the metadata formats associated with them. All PI systems define resolution services for translating identifiers into the actual network addresses that allow for the retrieval of the corresponding digital content.

Today, it is increasingly acknowledged that the diversity of actors and communities that specify requirements for PI platforms prevents achieving integration by top-down standardization. For these reasons, an advanced interoperability framework must be provided, supporting self-organization and autonomous negotiation among entities managing the various namespaces and supporting trustworthiness, dependability, and longevity of resolution services. Also, a flexible and evolvable mapping between metadata stored under each individual PI management system must be provided.

This paper presents the capabilities of the NBN registry prototype[1], implementing the two core functionalities of the infrastructure, namely, synchronization among registries and PI resolution. Also, this work illustrates the capabilities that are being implemented for the final release of the software. This paper is organized as follows: In Sec. 2 we introduce the state of the art and pinpoint the shortcomings that make seamless integration of PI schemata a difficult task. Sec. 3 illustrates the generalities of the infrastructure and the integration criteria unerpinning it, while Sec. 4 is detailing the query facilities for navigating aggregated resources, also sketching the metadata interoperability framework we are envisaging. Finally, Sec. 5 draws the conclusions and outlines future work in this field.

2 State of the Art

Among existing standards for PIs, the more relevant are the following: Uniform Resource Names (URN)[12], Life Science Identifiers (LSID)[8], Persistent URL (PURL)[9], Archival Resource Key (ARK)[4], Handle System[13], and the Library of Congress Control Number (LCCN)[7]. Moreover, further PI schemata have been layered upon the aforementioned standards. As an example, the Digital Object Identifier system (DOI)[10], a business-oriented solution widely adopted by the publishing industry, provides administrative tools and DRM-aware work flows along with persistent identification of digital objects based on the Handle System.

A further aspect contributing to this fragmentation is the lack of applications capable of wrapping multiple PI schemata: As an example, ARK provides peculiar functionalities that are not featured by the other PI schemata, e.g., the capability of separating the univocal identifier assigned to a resource from the (potentially multiple) addresses that may act as a proxy to the final resource. Furthermore, we may also find multiple, proprietary implementations for a given schema: The URN-based schema grounded on NBNs has been registered and

[1] http://nbn.rinascimento-digitale.info/

adopted by the Nordic Metadata Projects[2] but is being separately implemented by individual systems with no reference implementation enabling coordination of information sources.

Finally, the different metadata that are associated with PI schemata represent a further source of incompatibility when addressing integration of heterogeneous PI formats by means of automated agents. As an example, PI schemata are currently implemented by widely acknowledged platforms for content management, such as DSpace[3] and Fedora[4]. These applications extend the semantics of identifiers with custom metadata as well as notification facilities, such as the Open Archives Initiatives Protocol for Metadata Harvesting (OAI-PMH)[5]. Unfortunately, the constraints that these tools pose on digital object production and maintenance make it difficult to suit the distinct practices that participants in a federated repository need to comply with.

The scenarios described so far clearly demonstrate that the challenge is not how to develop another general-purpose, universal identification system but rather to guarantee interoperability among the different solutions across different domains. A notable experience that is trying to address this challenge is the EPICUR Project[11] by the Deutsche Nationalbibliothek (DDE): The DDE registry is linked to national registries as well as to the commercial DOI platform. As a consequence, the resolution service is capable of resolving both the NBN identifiers generated by the National Library and also the DOI namespace.

In Italy, a research group involving the authors of this paper and led by Fondazione Rinascimento Digitale has been developing a novel PI resolution infrastructure based on an extended Domain Name System (DNS) mechanism. This infrastructure fully supports the National Bibliographic Numbers (NBN) namespace [2]; also, it provides interoperability inasmuch each registered institution, beside generating and resolving its own NBN identifiers, is also able to resolve NBNs of other institutions linked to the infrastructure as well as the DOI namespace. In the remainder of the paper, we shall discuss the ideas underlying the new infrastructure's design.

3 Semantics-Aware PI Resolution

Our infrastructure is envisaging a comprehensive, semantics-aware solution for dynamic interoperability of heterogeneous PI resolution systems, seamlessly federating individual naming technologies. Although this kind of interoperability will primarily aim at resolution of independent PI schemata, it will also foster ontology-based metadata translation among different bodies. The basic idea is providing an evolvable set of trusted service interfaces rather than standardizing metadata formats or mappings. Upon finalization of our infrastructure, these interfaces will define a complete service-oriented framework for PI resolution and management addressing the following issues:

[2] http://www.lib.helsinki.fi/meta/

[3] http://www.dspace.org/

[4] http://www.fedora.info/

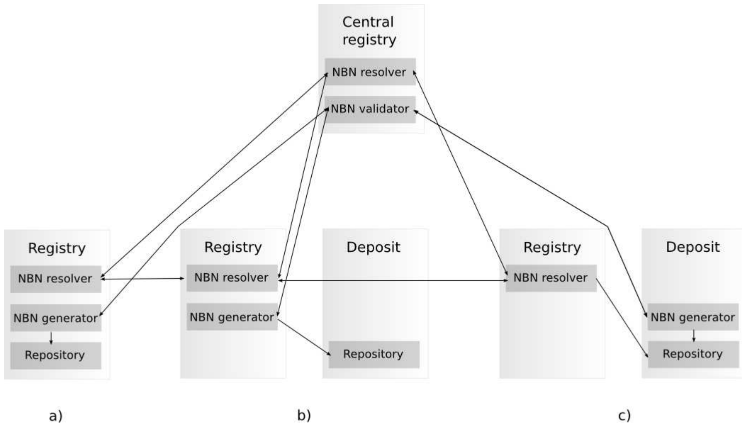


Fig. 1. The three deployment configurations implemented in the NBN system

- Provide a reference PI schema (the NBN namespace) and integrate the former with a heterogeneous set of PI schemata (e.g., DOI). As a consequence, a given resource can be made available according to the options made available by the different systems (e.g., with regard to access control, rights clearance, etc.).
- Metadata associated with individual PI systems are mapped one onto the other, thus allowing a broad range of functionalities aimed at keeping PI descriptions interoperable and consistent with each other.
- In order to address granularity of data items, PIs can be associated with collections of resources, described as an extension to the Object Reuse and Exchange (ORE) specification [6] proposed by OAI.
- Finally, we provide a means to navigate these complex structures by using the Protocol for Metadata Harvesting (PMH)[5], proposed by OAI as well. We do so by allowing a subset of the XPath syntax[5] in the definition of resumption tokens.

Fig. 1 displays the three distinct configurations according to which the current prototype can be deployed. More specifically, a registry may be a consistent system providing both the resolution facilities and the actual resources (a), it may assign and resolve PIs pointing to remote resources made available over the Internet (b), and also may delegate PI assignment to third parties and participate in the resolution infrastructure only (c). The central registry is the only entity that checks for PI uniqueness with regard to individual digital items; instead, resolution requests may be handled either by the central registry or, if the former is offline for some reasons, by second-level nodes in a peer-to-peer fashion.

The infrastructure supports different topologies of namespace hierarchies and can be queried from a diverse set of technological platforms, from individual browsers to intelligent software agents. In our approach, namespaces are organized

[5] http://www.w3.org/TR/xpath

similarly to DNS Autonomous Systems[6] in order to enable communication among different domains by means of a signaling protocol that is implemented by first level nodes. Then, this signaling protocol may be developed towards other technologies (DOI, PURL, ARK, etc.).

The resolution infrastructure allows any set of enabled nodes to assign NBN each other (horizontal delegation) and to execute the translation in a cooperative way. Our schema prevents duplications by computing MD5 hashes[7] of resources associated with PIs. Each NBN assignment must me acknowledged by the central node, in order to verify that the MD5 hash value corresponding to the resource does not already have an identifier associated with it. The current implementation supports PI creation, resolution, and update by delegated authorities according to various delegation schemes; PI generation and resolution supports techniques for automatic PI generation, both as opaque identifiers and also according to prefixed generation schemes, for instance according to versioning.

3.1 PI Assignment and Resolution

The central node manages the register of sub-namespaces. This register is necessary to the harvesting of metadata from II level nodes and for the redirection of translation requests to them. The central node can initiate the harvesting process on peripheral registers to receive the updated data and metadata associated with every sub-namespace. The hash checking that is required during PI assignment occurs only after the harvesting at the central level. In particular, if there are two different NBNs with the same hash, an appropriate signaling is sent to the registers responsible for them. The system will take care of associating the further URL to the already registered NBN. The details on the life cycle of NBN identifiers are rendered in Fig. 2 as a finite state automa. The distinct states can be singled out by using three variables:

– Flag F, whose value is either 'inconsistent' or 'consistent', determines whether or not the central register should harvest the record associated with the NBN because it has changed.
– Status S, whose value is either 'active' or 'inactive', indicates whether registers should resolve the NBN, that is, if the resource associated with the NBN is currently available.
– Action A is an additional variable indicating to the central register, during metadata harvesting, the particular operation that has been carried out (allowed values are 'created', 'enabled', 'disabled', and 'modified').

The resolution strategy adopted by our infrastructure is twofold. On the one-hand, when the central registry is up and running, it answers redirection requests by local registries that need to resolve NBN identifiers in the whole network of servers, each managing one or more sub-namespaces. On the other

[6] http://tools.ietf.org/html/draft-ietf-dnssec-as-map-05
[7] http://en.wikipedia.org/wiki/MD5

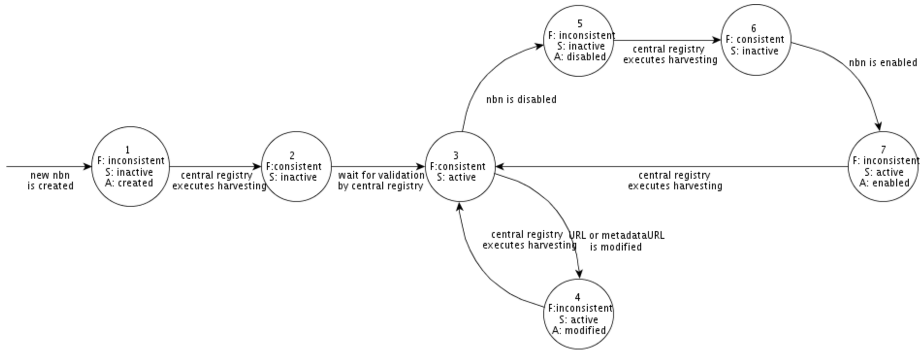


Fig. 2. The life-cycle of NBN identifiers, as seen from the local register's standpoint

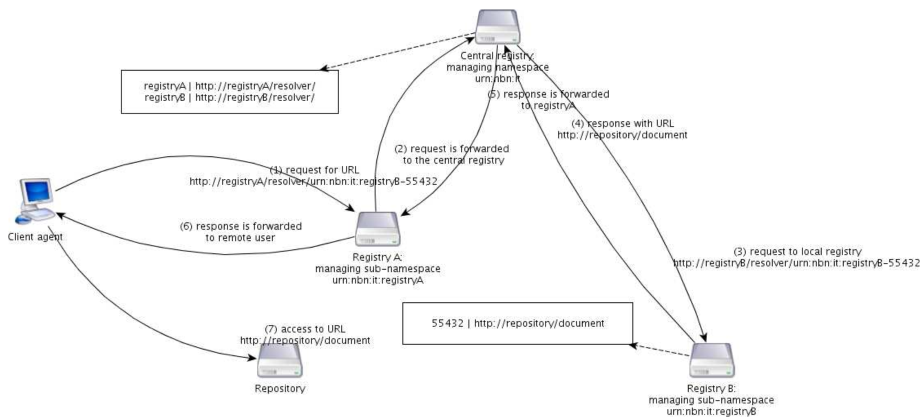


Fig. 3. The diagram showing the interaction between the central registry and local repositories when resolving NBNs

hand, local registries are internally mirroring a (partial and not necessarily updated) copy of the references to local registries stored by the central registry. On the basis of these data, local registries may communicate with each other in peer-to-peer mode when no responses are received from the central registry. Consequently, network problems affecting the latter do not necessarily impact on the resolution capabilities of the overall infrasctructure. Fig. 3 shows the typical interaction between registries that is triggered by a resolution request directed to a local registry (registryA) which does not manage the intended sub-namespace (urn:nbn:it:registryB). The central registry stores the correspondences between sub-namespaces and local registries, so that it can redirect requests to the intended local registry. In turn, the latter provides the actual URL corresponding to the PI, that is sent back to the client along the same chain to enable caching by both the central and local registry participating in the PI resolution.

4 Resolving Complex Objects

Our infrastructure enables extended resolution of names by traversing aggregation and composition relationships, e.g., resolving the PIs that are aggregated by a given resource. As an example, Fig. 4 depicts a categorization of resources that are ascribed to the novel "I Promessi Sposi" by Alessandro Manzoni. More specifically, the multimedia presentation associated with the PI urn:nbn:it-01 is categorized as an instance (an ellipse with empty background) of concept CompositeMedia that, in our extension ontology, represents a specialization of concept Aggregation in the ORE vocabulary. Resource urn:nbn:it-01 may have a tangible digital counterpart, such as a SMIL multimedia presentation arranging the distinct media into a coherent framework, but may also be a purely logic entity that only provides a pointer to multiple resources. In this case, interactive applications consuming the XML descriptor associated with the PI should take care of presentation issues. Resource urn:nbn:it-01 is aggregating resource-01, that is an atomic resource with a resolvable URL and a media type associated with it. It also aggregates resource urn:nbn:it-02, which is itself a composite entity categorized as instance of concept AlternativeFormat, meant to indicate alternative media formats (e.g., aural vs. textual). Among the resources aggregated by urn:nbn:it-02, Fig. 4 is showing one of the possible options, identified as urn:nbn:it-04, expressing multiple mirrors for the same digital resource. Instances of concept MultipleDeposit, such as urn:nbn:it-04, may only aggregate resources that share the same MD5 hash value, guaranteeing that the distinct URLs specified by the aggregated resources, resource-03 and resource-04 in Fig, 4, point to the same digital item. Finally, urn:nbn:it-04 is also aggregated by composite entity urn:nbn:it-03, typed as instance of concept RevisionList and serving the purpose of linking the two versions of the novel that Alessandro Manzoni wrote on the same subject.

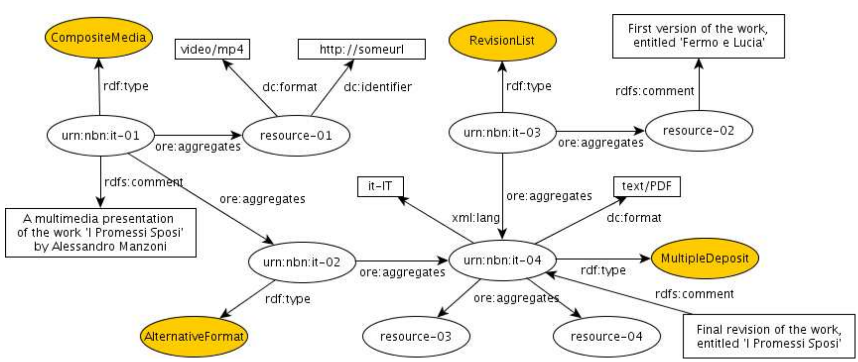


Fig. 4. The resource map populated with the extension to the ORE vocabulary

4.1 Navigating Part-of Hierarchies

Making composite resources accessible over the Internet may be a daunting task when considering automated agents among the possible audience. As an example, distinct software agents may "speak" different dialects of the XML language; consequently, resolution infrastructures aiming at the integration of heterogeneous metadata should seamlessly adapt to the requirements by the client w.r.t. metadata formats. Moreover, the protocol should allow for an efficient navigation of the complex data structures that unfold when resolving a *Resource Map* (ReM). This Section illustrates how these requirements have been tackled in accordance with existing standards for interrogating repositories and, at a finer granularity level, identify fragments of more complex resources.

At protocol level, we rely on the OAI-PMH infrastructure for interrogating repositories. Unfortunately, the protocol is not directly suitable for allowing clients to navigate composite resources; more specifically, it only provides a set-oriented abstraction for categorizing resources. In fact, the integration of OAI-ORE data structures into the protocol is only at representation level, that is, ORE data structures can be integrated into PMH responses but no hint on how to further navigate them is given. Particularly, the query format for handling incomplete lists of resources is left open to implementation. Clearly, the ReM depicted in Fig. 4, fully expanded and annotated with metadata, can not be efficiently exchanged all at once; consequently, navigation criteria has to be set in order to enable browsing of data structures.

User experience has proven tree-shaped sitemaps as the most perceptively intelligible navigation means, while ReMs describe more general data structures, directed graphs. Consequently, among the implementation choices, we do not allow graph-wide navigation of aggregated resources; rather, tree-shaped projections of the former are derived and made accessible through XPointers[8]. Moreover, the human agent is accustomed to navigate resources by filtering them according to a single criterion, that is, specificity; on the contrary, navitating ReMs may take advantage of a broad range of 'axis' for refining a search, made by the different properties annotating nodes. To reduce complexity of the query format, we adopt the following conventions:

– Restrict navigation steps to the relations between nodes that describe aggregations, that is, the inverse properties ore:aggregates and ore:isAggregatedBy.
– Allow the specification of concepts from the ORE and NBN-ORE vocabularies to indicate the specific category of aggregated resource that should be retrieved.
– Specify conditions on data items according to datatype properties (i.e., text-based attributes) annotating nodes in the ReM.

In order to build on existing formalisms for document fragment identification, we rely on the XPointer syntax for specifying the local jargon that the client can interpret (e.g., Dublin Core terms [1]) and the specific XPath pattern describing the intended resources. As an example, the resumption token that follows,

[8] http://www.w3.org/TR/WD-xptr

when applied to the aggregated resource identified as urn:nbn:it-01, will return the descriptor associated with the PI urn:nbn:it-04.

```
xmlns(dc=http://purl.org/dc/terms/)
xpointer(./AlternativeFormat/*[dc:format='text/PDF'])
```

It should be noted that, in the internal representation of data structures describing resource urn:nbn:it-04, there may be no dc:format metadata attribute describing it. Instead, it may be the mapping between the specific metadata format processable by the client (in this case, DC terms) and the proprietary format adopted by the register to draw this correspondence. We are currently investigating the service interfaces that are required in order to bring a heterogenous set of metadata formats under the same umbrella. The dual issue that has to be considered is the translation of internal descriptors from and to external data formats in a customizable way. For this purpose, the OAI-PMH compliance enables integration with conversion tools, such as the OAI2LOD Server[3], exposing OAI-PMH Metadata as Linked Data[9]. Instead, when integrating less expressive XML output formats, XSLT transformations still constitute the most scalable solution. Consequently, we are evaluating off-line compilation of the mappings between the proprietary data structures and individual XML formats, so as to produce stylesheets that can be used in the actual enactment of the translation.

5 Conclusions and Outlook

In this work, we outlined the achievements of the NBN project w.r.t. persistent identification in the context of federated repositories. We outlined the approach adopted for PI assignment and resolution in the twofold modality of hierarchical and peer-to-peer request forwarding. We also described the advanced capabilities of the infrastructure for the retrieval of complex objects by automated agents, combining the PMH interaction protocol with ORE data structures extended as to suit the purpose of digital preservation. An example of complex resource map is detailed, toghether with a standards-based interrogation technique that can be wrapped in PHM requests, whose parameters can be tailored onto the specific metadata format that is intelligible by the client application.

The resolution infrastructure will enable each PI domain to communicate with other domains by using the same resolution interface. It will also provide a set of complementary interoperability services, aimed at supporting the translation of both structural and descriptive metadata among different platforms. In fact, populating the repositories' knowledge bases from heterogeneous metadata implies that the correct mappings and data normalization techniques are set in advance. Moreover, enabling the specification of these mappings with little effort by the actors that are creating and maintaining repositories is by no means a straightforward task. For this purpose, we are currently evaluating a series of architectural options to enable the seamless integration of formats and PMH-compliant applications.

[9] http://linkeddata.org/

Another key aspect under current development is the one dealing with privacy and trust issues, including all emerging aspects of data security, access management, and privacy. Finally, a research group involving several academic institutions and companies is planning to complete the infrastructure with a framework for metadata interoperability and exchange.

References

1. Dublin Core Metadata Initiative. Dublin Core Metadata Element Set, Version 1.1, http://dublincore.org/documents/dces/
2. Hakala, J.: Using national bibliography numbers as uniform resource names (2001), http://www.ietf.org/rfc/rfc3188.txt
3. Haslhofer, B., Schandl, B.: The OAI2LOD Server: Exposing OAI-PMH Metadata as Linked Data. In: International Workshop on Linked Data on the Web, Beijing, China (2008)
4. Kunze, J.: The ARK Persistent Identifier Scheme. Internet Draft (2007), http://tools.ietf.org/html/draft-kunze-ark-14
5. Lagoze, C., de Sompel, H.V.: The Open Archives Initiative Protocol for Metadata Harvesting, version 2.0. Technical report, Open Archives Initative (2002), http://www.openarchives.org/OAI/openarchivesprotocol.html
6. Lagoze, C., Van de Sompel, H., Johnston, P., Nelson, M.L., Sanderson, R., Warner, S.: Open Archives Initative Object Reuse and Exchange (OAI-ORE). Technical report, Open Archives Initative (2007), http://www.openarchives.org/ore/0.1/toc
7. Network Development MARC Standards Office, Library of Congress. Library of Congress Control Number (1999), http://www.loc.gov/marc/lccn.html
8. Object Management Group. Life Sciences Identifiers final adopted specification (2004), http://www.omg.org/cgi-bin/doc?dtc/04-05-01
9. Online Computer Library Center. Persistent URL (PURL), http://purl.org/
10. Paskin, N.: Digital Object Identifiers. Inf. Serv. Use 22(2-3), 97–112 (2002)
11. Schroeder, K.: Persistent Identification for the Permanent Referencing of Digital Resources - The Activities of the EPICUR Project Enhanced Uniform Resource Name URN Management at Die Deutsche Bibliothek. The Serials Librarian 49, 75–87 (2006)
12. Sollins, K.: Architectural Principles of Uniform Resource Name Resolution (1998), http://www.cis.ohiostate.edu/htbin/rfc/rfc2276.html
13. Sun, S.X.: Internationalization of the Handle System - A persistent Global Name Service (1998), http://citeseer.ist.psu.edu/sun98internationalization.html

The Impact of Readability on the Usefulness of Online Product Reviews: A Case Study on an Online Bookstore

N. Korfiatis[1], D. Rodríguez[1], and M.A. Sicilia[2]

[1] Department of Informatics
Copenhagen Business School (CBS)
DK-2000, Frederiksberg, Copenhagen, Denmark
nk.inf@cbs.dk
[2] Department of Computer Science
University of Alcalá
28805 Alcalá de Henares Madrid, Spain
{daniel.rodriguezg,msicilia}@uah.es

Abstract. Online product reviews is an important advantage for consumers of experience goods in online marketplaces and act as a useful source of information during the purchase of a good. Furthermore in some online marketplaces consumers have the opportunity to evaluate how helpful a review was by using a binary evaluation interface provided by the online marketplace. This results to the usefulness score of a review which is calculated as a fraction of helpful votes over the total votes that this review has received. Our early results indicate that the usefulness score of a particular review is affected in a significant way by the qualitative characteristics of the review as measured by readability tests applied to a large dataset of reviews collected from the UK section of the popular online marketplace *Amazon*.

Keywords: Readbility tests, Online services.

1 Introduction

One of the most profound advantages of online marketplaces and electronic commerce to the product choice process and purchase is the ability to encapsulate and promote the opinions of their customers for the products that they have purchased. This has led to a massive amount of product reviews accessible online, which a consumer may use for an informed decision about the product or the service that is considering to purchase.

The importance of online reviews on the choice process of a certain product by an individual on the internet has been a subject of several recent studies in the literature [1,2,3]. Due to the digital nature of delivery, most of the goods available for purchase online are experience goods [4]. An experience good is a product or a service which quality and utility for a consumer can only be determined upon consumption. This provides that in order for a consumer to

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 423–432, 2008.

make a decision for the purchase of this good or service, she/he has to rely on previous experiences which will provide an indicator whether this good or service is worthy for purchase or not. One example of an experience good can be the case of a book where the utility that the consumer perceives by reading such a book can be extracted only after reading it. Therefore, in experience goods such as books, the producers (e.g. publishers) often use the reviews by authoritative sources such as literature experts to provide an opinion and endorse the book, so that consumers trusting these sources will continue to the purchase of this good.

However the inclusion of a prior experience to the promotion of an experience good can actually pose a problem for the consumer mainly due to following factors:

- The cost for the producers of publishing experiences by previous consumers and especially in cases where negative views might reach new customers. Such a cost makes the producers not willing to do so [5].
- The obvious search costs that arise for a consumer in order to search acquire and evaluate the prior experiences.
- The variance between the different versions of the same good which may confuse a consumer (e.g. an mp3 player with a large set of characteristics vs. a simpler mp3 player).

The development of Internet marketplaces where consumers can establish interaction has undoubtedly has affected the way a review –as an expression of prior experience– influences the way consumers make a choice about a product or a service based on prior experiences [6,7]. First and foremost, the use of online mechanisms for the reporting and categorization of reviews by a product or a service in conjunction with the development of modern search engines has eliminated the search costs for the consumers. Online marketplaces such as the popular bookstores *Amazon.com*[1] and *Barnes and Noble*[2] provide the ability for a consumer to read a series of reviews about the product that a consumer is interested in purchasing. Furthermore, apart from the description of the experience deriving by the purchase of the reviewed product a consumer is able also to rate the usefulness of the product usually by rating on a standard Likert scale.

The later comes into connection with an important field in marketing literature, which has to do with the referral value of a specific product. In particular in "word of mouth" scenarios consumers refer to a product or a service to fellow consumers usually by enthusiasm (if they are satisfied, or regret if they are unsatisfied). The extent to which the referral value of a specific customer might affect another one still remains an issue to identify.

In this study we assume that a review submitted by an individual reflects his/her experience from the product usage. Furthermore the review text acts as a "justification" of the rating so the potential buyer can evaluate if the review was fair or not. In addition, most online marketplaces use a way of meta-rating on

[1] `http://www.amazon.com/`

[2] `http://www.barnesandnoble.com/`

Fig. 1. The interface of the review evaluation mechanism that we use in this study

unfair reviews where interested buyers can evaluate how helpful was this review during the decision-making process of purchasing a good. Again on that case, the review acts as the main source of evaluation of the usefulness of this specific review by other consumers. Reviews by individual consumers often express a personal view of their experience with the product and might differ in such from the expectations of the interested buyer. For example it might be that someone expected a book to contain more action elements; however, an interested buyer might is not be interested in that specific characteristic. Nevertheless in order to evaluate the usefulness of the review someone has to read it first. Therefore the style and the readiness of a review might actually play a role on how its usefulness is evaluated.

In this paper, we evaluate how the style and the comprehension of a review as depicted by a readability test, might affect the usefulness of a review –the number of people that found this review useful out of the total number of people that read and evaluated this review. In order to investigate this issue, we employ the use of readability metrics applied on a dataset of reviews with their meta-evaluations collected by the bookstore section of the website of Amazon in UK[3].

The major objective of this study is the evaluation of the impact that the qualitative characteristics of a review might have to consumers that are interested in buying a product or a service from an online Web store. Early results indicate that apart from the review score of a particular review, a consumer also evaluates its importance by how this review is close to his/her communication code which is denoted by the way the review has been written.

2 A Background on Readability Tests

The concept of readability describes in general terms the cognitive effort that is needed by an individual to understand and comprehend a piece of text [8]. In a more formalized way, a readability test consists of a formula which is the result of a linear regression applied to subjects regarding the reading ease of different pieces of text that were asked to comprehend using specific instruments. The objective of a readability test is to provide an indication on a scale of how difficult is the comprehension of a piece of the text by readers in conjunction with the linguistic characteristics of a text. In that case a readability test can

[3] `http://www.amazon.co.uk/`

only provide us with an indication on how understandable is this piece of text based on its syntactical elements and style.

As such we assume that the attention that a review might receive by the interested buyers of the particular product, can in a large extend be associated with its readability. On our case the assessment of a review by a readability test provides us with an indication whether someone who evaluated how useful a particular review was, actually comprehended this piece of text. On the other hand we might expect that the fact that some reviews were not considered helpful might have been affected by the readability of the content as well.

However the use of a readability test has some weaknesses which we should take into consideration during the analysis of the results in this study. In particular the result of a readability formula cannot tell us whether the content of the review expresses personal views on the product and/or contains some gender, social class or even cultural bias. In order to avoid the case of a selection effect due to the cultural background we collected the reviews only from the U.K. store of the online marketplace in order to maximize the number of native English speakers and as much cultural homogeneity of the population as possible.

Table 1. Readability Tests Used

Readability Measure	***Score Range***	***Measurement Implications***
Gunning-Fog Index	1-12	Indicates the grade level of the education scale. The lower the grade the more readable the text
Flesch Reading Ease Index	0-100	Scores above 80% make the text understandable by literally everyone. As the value of the index decreases the comprehensiveness of the text becomes more difficult.

Table 1 lists the two readability texts that we selected for our analysis. The tests - Gunning's Fog index and the Flesch Reading Ease Index - evaluate the readability of a text by consistently decomposing the text into its basic structural elements which then combine using the empirical regression formula. An important issue of a readability test is that it can be used to evaluate texts of certain length since the comprehension of a text by a reader has also other cognitive properties which are beyond the scope of this study. The logic behind the calculation and the norms of these instruments is described in the sections bellow.

2.1 The Gunning Fog Index

Gunning's Fog index [9] literally produces a measure of how comprehensible is a piece of text by an individual with a high school education. In order to calculate the Fog score for our data we followed the following steps:

For each review we calculated the average number of words per review sentence on a 100+ word review passage. This gives as the average sentence length (L).

We then obtained the number of the difficult words (D) that is words that have more than three letters by excluding proper nouns, compound words and common suffixes. We finally added the average sentence length to the number of the difficult words. The following equation describes the empirical relation in the Fog Index:

$$Fog = 0.4 \times \left(\frac{Words}{Sentence} + 100 \times \left(\frac{N(complex\_words)}{N(words)} \right) \right)$$

An obvious difficulty on measuring the Fog index for a given text is the evaluation of the number of complex words. In our analysis we considered a word as complex when it has more than two syllables.

2.2 The Flesch Reading Ease

The Flesch Reading Ease index [10] is a readability test which uses as a core linguistic measure that is based on syllables per word and words per sentence in a given text. The Flesch test is used to evaluate the complexity of the text to determine the number of years of education which are needed for someone to understand the examined text. The following equation describes the calculation of the Flesch score for a given text:

$$FK = 0.39 \times \left(\frac{total\_words}{total\_sentences} \right) + 11.8 \times \left(\frac{total\_syllables}{total\_words} \right) - 15.59$$

The variables *total_words*, *total_sentences* and *total_syllables* denote the total number of words, sentences and syllables found in a text respectively. For calculating the Flesch score of a particular review we decomposed the text into sentences, then words and finally into syllables which were combined using the constants presented in the formula above. It can be easily be implied from the mathematical expression that the sorter is the number of words per sentence is, the better the readability score that the Flesch test will give.

3 Analysis and Results

Having provided a background on the readability tests used, we analyzed the reviews stored in our dataset to test whether the readability tests can actually provide us with an indication on how the qualitative characteristics of a review influence its usefulness for a consumer.

3.1 Data Collection and Definition of Variables

In order to apply the readability tests presented in Section 2, we developed a Web crawler to capture the content of the book section of Amazon UK. The crawler consisted of two parts: (i) a Web client to randomly pick items from the frontpage of the bookstore; and (ii) a client to the Web service interface provided by Amazon (AWS) where data from the particular item was collected.

Table 2. Main Components of the Initial Dataset Collected by Using the Web Crawler

Variable Code	**Variable description**
productid	The id of the product that this review is written for. It is used to control for the publication date and other product characteristics
summary	The summary / title of the review
content	The actual content of the review. To be used for content analysis
revieworder	The order that the review appears on the product review page.
reviewpage	The page that the review appears (default setting is five reviews per page)
rating	The rating that this review justifies, measured in a Likert scale.
totalvotes	The number of total votes that have been given to this review
helpfulvotes	The number of votes that consider this review helpful.
reviewerid	The id of the customer used to control if the customer is a professional reviewer or not

The list of books was stored in a relational database which we used for further processing of the reviews expressed in each individual book page. We omitted from the database those books that the publication date was older than 6 months or had no rating. We also excluded books at special offers or discounts to control for price effects.

As aforementioned, the reason for selecting Amazon U.K. to obtain the dataset used in this study is the case of language homogeneity among reviewers and consumers which might play a role in the comprehension of a text. In addition this is important because readability tests are useless in case a reader is not a native speaker of the language that the text is written. This is due to the fact that many languages differ in syntactical form and the style of the language is written in the review might be totally different from the reader's native language.

Another issue with the dataset that we had collected was the case of bypassing promotion backed items such as bestsellers. Since these items are more accessible to the visitors of the online bookstore/future customers there is always the case of a selection bias towards the more visible items. This may result to a high exposure of the product reviews that are more recent in contrast with those that are older. In order to avoid that the web crawler was keeping a list of the frequency of the items that were displayed in the frontpage and randomly chose items listed by categories.

Our dataset contains in total seven variables and two identifiers. The *reviewerid* provides the identifier of the customer in the online bookstore's central database in order to group reviews performed by customer (a customer may have submitted reviews for more than one book). The *productid* is the unique product identifier provided for this product. With this identifier we can group the reviews by product and check for variances between products of different categories.

We define the usefulness ratio of a review (UR) as the fraction of the votes that considered this review helpful *(helpfulvotes)* divided with the total number of readers that evaluated the usefulness of the review *(totalvotes)*.

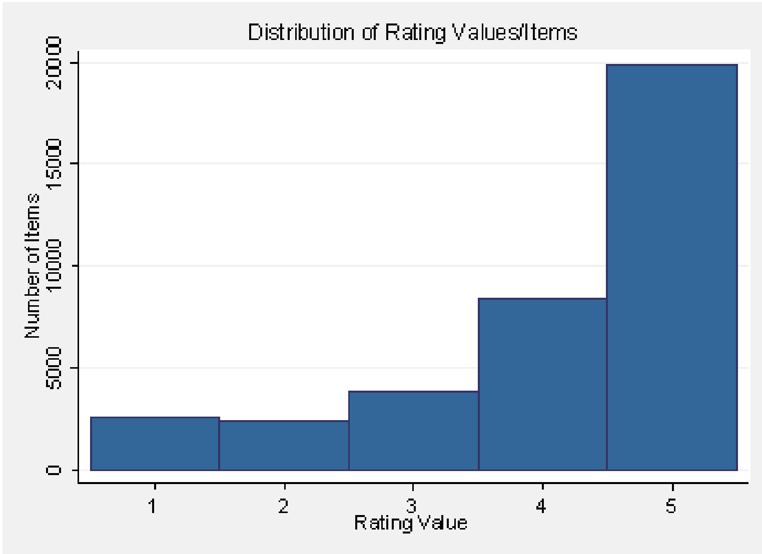


Fig. 2. Distribution of rating values among items in our dataset

Thus we have the main unit of analysis for our study defined as $UR = helpfulvotes/totalvotes$. However since the number of total votes that a review had (that is the minimum amount of readers) may affect the consistency of the metric we need to keep control of the exposure of this review since some reviews at a certain period of time receive more exposure than others. Typically the system displays first the most recent reviews that were submitted for the book under review).

In our study the particular exposure of a Review was measured by keeping a set of two variables for the pagination results. In particular the variable *reviewpage* is informative on whether this review was at the first, second or third page at the time the review was retrieved. Subsequently the same case was for the *revieworder* which controls the display order for a particular review in a particular page. Combining the two variables (*reviewpage, revieworder*) into a new compositional variable we are able to control for the review exposure on the website during time. For example if a review appears in page 2 and was ordered as third in the page then the order number is 23 and so forth. It is generally assumed that reviews which appear on the top of a page obtain a much higher exposure than a review that appears at the bottom since visitors' attention get to be captured by elements that are displayed in the beginning of the space under the product description.

On the other hand, regarding the actual exposure of a review and in particular the amount of people that read the review we don't have a variable that justifies that. However in order to hold our analysis in an acceptable level we make the assumption that the total number of people that evaluated the usefulness of this

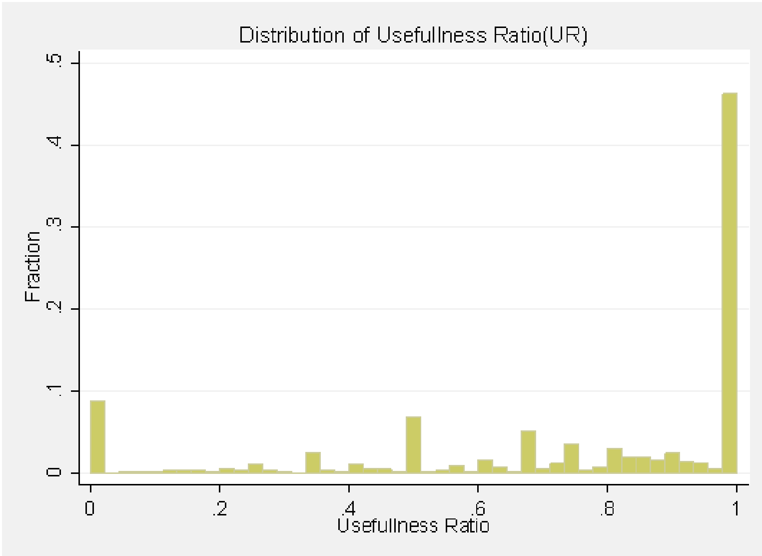


Fig. 3. Distribution of Usefulness Scores Plotted by Density ($N = 37,221$)

particular review is the minimum number of the readers that this review had. With that way we get an indication whether this review has been read by a high amount of visitors since it is assumed that those two numbers are positively correlated.

Our dataset consists of 38,366 reviews where the total votes (*totalvotes*) were greater than zero which means that the reviews on our dataset have been evaluated for their usefulness at least once.

Fig. 3 provides an overview of the distribution of usefulness scores on our dataset by rating. It is interesting to note that around 47% (total of: 17,695) of the reviews have received a perfect score by the readers which provides that around half of the reviews were very highly acclaimed by their readers resulting for this group of particular reviews, the number of helpful votes to be the same with the potential buyers that have read it. On the other hand we find that approximately 9% of the votes (total of: 3,292) of the reviews were found totally non-useful for their readers receiving an absolute zero (0) of helpful votes. As it can be observed in Fig. 3 much of the variance on the usefulness score happens between the 0.8 and perfect (1).

3.2 Results

Table 3 presents the inter-correlation matrix obtained from running inter-item correlations between the items in our dataset. The scores were obtained by doing a pair- wise correlation between the variables and asking for a confidence interval of 1% ($p < 0.01$). By looking the sign of the coefficients in the first column we obtained some interesting information. In particular the higher is the exposure of the review (*reviewexposure*); the lower is the usefulness of the review. In fact by looking more carefully at the relation between the usefulness ratio and the exposure of a review we observe that the more exposed is the review, the less helpful votes the review will take where at the same time, the coefficient of total votes is positive.

Table 3. The Inter-correlation Matrix between Elements in our Dataset (*$p < 0.01$)

	ur	***revieworder***	***rating***	***fogscore***	***fleschscore***
ur	1.0000				
reviewexposure	-0.1210*	1.0000			
rating	0.2717*	-0.0449*	1.0000		
wordcount	0.1585*	0.0248*	0.0040		
fogscore	0.1158*	-0.0348*	-0.0148*	1.0000	
fleschscore	0.0982*	-0.0368*	-0.0317*	0.9621*	1.0000

All three variables that are connected with the qualitative characteristics of an online product review have been found positively correlated and significant (*$p < 0.01$). The coefficients received for the simplest qualitative characteristic which indicates the review length *(wordcount)* actually provides that the perceived usefulleness of a review is affected by almost 16% while the performance of the review text affects a review by 11% and 9% respectively. As can be seen from table 2 the three factors account for almost 35% of the usefulness score of a review providing that the qualititative characteristics indeed might play a role to the perceived usefulness of a review by a consumer.

4 Conclusions and Further Research

The early results presented in this paper indicate that qualitative characteristics of online product reviews indeed play a role on the evaluation of the usefulness of a particular review by a consumer. The use of tools such as readability tests provided a way to evaluate the importance of these characteristics by employing simple statistical analysis methods which however need to be evaluated more for robustness. One of the limitations of this study is to assess whether the review was written in a way that was expressing a personal opinion about a product or a service. Consumers tend to associate themselves with other consumers that express a more personal experience about the product which might influence the consumers' choice process of the good. In addition a further limitation of this study is to check the actual reliability of the readability tests by cross validating whether the tests actually measures the readability of a review written on a website since the readability tests do not take into account usability factors (e.g. the position of the text on the screen etc).

Acknowledgements

We would like to thank the Copenhagen Business School, University of Alcal and the autonomic community of Madrid (CCG07-UAH-TIC-1588) for their financial support.

References

1. Pavlou, P., Dimoka, A.: The nature and role of feedback text comments in online marketplaces: Implications for trust building, price premiums, and seller differentiation. Information Systems Research 17(4), 392–414 (2006)
2. Chevalier, J., Mayzlin, D.: The effect of word of mouth on sales: Online book reviews. Journal of Marketing Research 43(3), 345–354 (2006)
3. Hu, N., Pavlou, P., Zhang, J.: Can online reviews reveal a product's true quality? empirical findings and analytical modeling of online word-of-mouth communication. In: Proceedings of the 7th ACM conference on Electronic Commerce, pp. 324–330 (2006)
4. Nelson, P.: Information and consumer behavior. Journal of Political Economy 78(2), 311 (1970)
5. Richins, M.: Negative word-of-mouth by dissatisfied consumers: A pilot study. Journal of Marketing 47(1), 68–78 (1983)
6. Clemons, E., Gao, G., Hitt, L.: When online reviews meet hyperdifferentiation: A study of the craft beer industry. Journal of Management Information Systems 23(2), 149–171 (2006)
7. Dellarocas, C.: The digitization of word-of-mouth: Promise and challenges of online reputation mechanisms. Management Science 49(10), 1407–1424 (2003)
8. Zakaluk, B., Samuels, S.: Readability: Its past, present, and future. International Reading Association, New Yark (1988)
9. Gunning, R.: The fog index after twenty years. Journal of Business Communication 6(2), 3 (1969)
10. Flesch, R.: How to Test Readability. Harper (1951)

An on Demand Business Context to Improve Software Development Process Based on Business Knowledge

Miguel Ángel Sánchez[1], Ana Fermoso[1], and Luís Joyanes[2]

[1] Pontifical University of Salamanca, Compañía, 2, 37002 Salamanca, Spain
[2] Pontifical University of Salamanca (Madrid campus), Juan XXIII, 23, 28080 Madrid, Spain

Abstract. On Demand Business concept, from IBM, shows how to coordinate the transformation of the enterprise organization and its technological infrastructure to bridge the gap between business and technology. This problem appears in most of information systems. This concept is based on Service Oriented Architecture (SOA) to improve the connection between business services and software services.

If companies can reach this On Demand Business context they could improve the software development process by applying standards like Model Driven Architecture (MDA), to separate business logic from software and technological platforms, and Business Process Management (BPM) to define business processes. In this article we propose a new approach that combines On Demand Business with MDA, BPM and SOA to improve software development process starting on business knowledge.

The most important contribution of this approach to Knowledge Society is the method used to connect business knowledge with technological resources using a well defined architecture.

1 Introduction

To define a valid separation between business, software and technological platforms in the information systems, Model Driven Architecture (MDA) uses different kind of models. The most abstract models are called Computation Independent Models (CIM) and according to the MDA official guide [1], they must be associated to business domain. Software models in MDA are classified in Platform Independent Models (PIM), which include the software logic without technological details, and Platform Specific Model (PSM), associated to specific software models of technological platforms. According to MDA, using the adequate steps and transformations between these models, we could generate software starting on business models.

In the scope of business modeling, Business Process Management (BPM) discipline [2] [3] is very important. It makes reference to the set of activities of analysis, design, development, execution, monitoring and optimization of business processes.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 433–440, 2008.

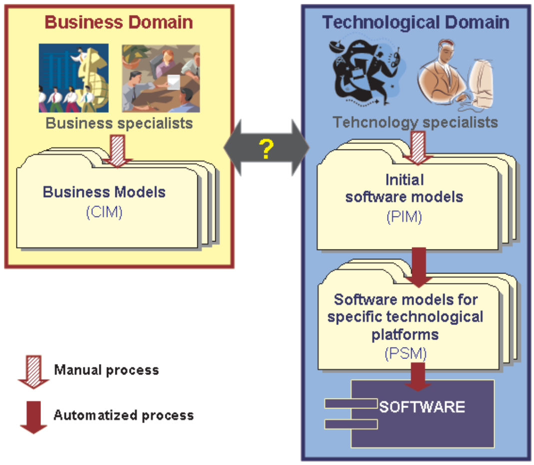


Fig. 1. Some MDA interpretations are focused on software models (PIM and PSM) and do not manage an adequate business perspective

In the last years has grown the number of projects based on software services to improve flexibility and integration [4]. In relation to software services, Service Oriented Architecture (SOA) [5] [6] allows to access and to execute these software components with independence of its location. SOA can also integrate software implemented with different technologies and it is independent of platforms, operating systems and middleware.

Using SOA as a basic foundation, IBM proposes the On Demand Business [7] concept. From a business perspective, the main objective of it is to integrate strategic processes to be able to respond, in a flexible and fast way, to any change in customers demand or new business opportunities.

Because MDA guide does not specify how business models (CIM) must be handled, many MDA interpretations are focused on software models. For this reason, as we can see in figure 1, in some MDA interpretations it is not solved the gap between the business domain and the technological one. On Demand Business concept shows how to coordinate the transformation of enterprise organization and its technological infrastructure to bridge the gap between business and technology.

Considering advantages, disadvantages and deficiencies of MDA, BPM, On Demand Business and SOA, in this article we present a recommendation that combines all these concepts to improve software development and associate them to business processes. To make it possible, is necessary to establish a special On Demand Business context, specific for each company. In this environment, it will be possible to create CIM models based on business processes, and then transform them to PIM models based on a Service Oriented Architecture. In this context, software is strategic for business, and business knowledge must be the first and basic aspect to manage in the software development process. In next sections we expose progressively our proposed recommendation.

2 Basic Foundations

This section describes, in a brief form, the fundamental aspects on which this proposal is based, that is to say, MDA, BPM, SOA and the On Demand Business.

2.1 Model Driven Architecture (MDA)

MDA represents a new Model Driven Development (MDD) choice for software development that uses three different types of models, exposed in figure 1, each of them for very different abstraction levels: CIM, PIM and PSM. Specific content of each MDA model can be interpreted in diverse ways. For this reason, different MDA interpretations could have very different visions of the elements and objectives associated to each type of MDA model.

2.2 Business Process Management (BPM) and Service Oriented Architecture (SOA)

Business Process Management [8] describes the set of activities of analysis, modeling, design, development, execution, monitoring and optimization of business processes. BPM is an interesting concept for companies because it can improve business processes integration, productivity and cost. BPM helps companies to manage strategic business processes that, in many cases, are associated to many people, different departments, non integrated information systems, shared data and documents, etc. In our recommendation BPM is applied to analyze and to model the business level (CIM) including the main elements of business processes, like people, resources, tasks and information. This will help to develop software that will satisfy the business goals and requirements.

Another basic concept is the Service Oriented Architecture. SOA makes possible the connection between business domain, that includes the definition of business processes, and IT domain with technologies that implement those business processes. In this sense, David Sprott exposes in [9] the advantages to use this architecture to make flexible the business. Nevertheless, he alerts about the problems of considering SOA from a merely technological point of view.

SOA represents an important change in software development because it allows constructing applications from a perspective that will not depend on technologies. Now it is possible to define the functionality of each service from a business perspective and we can associate it to software without concerning the technology required for its implementation and execution.

All these BPM and SOA features [10], related to the objectives of our recommendation, suggest that the combination of SOA, BPM and MDA could be adequate for a software development that can start on business knowledge.

2.3 On Demand Business

According to IBM, this concept represents a new approach of business management. IBM CEO Sam Palmisano defines an On Demand Business as: *"An enterprise whose business processes –integrated end-to-end across the company and* *with key partners, suppliers and customers– can respond with speed to any customer demand, market opportunity or external threat"*. This idea has important benefits for the enterprise but it is difficult to apply due to the next two aspects:

1. *Companies must change their business organization.* Technology and software are important but they will not be useful if the company is not prepared to integrate them as a basic part of their business processes.
2. *Success depends on integration.* Strategic business processes must be integrated and must use the main information systems. This critical software must be accessible for many people in the required departments and locations.

To connect the business domain with IT in an On Demand Business scenario is necessary to coordinate important transformations in the enterprise organization and in the technological infrastructure. Those changes must cause a better relationship between both domains. In this context technology has an important influence on business and business guides the technology that must be used.

3 Definition of an On Demand Business Context Based on BPM, MDA and SOA

This section describes a method that can be applied to obtain an enterprise context based on the use of software and technology associated to business processes. The objective is to reach a flexible scenario in which it would be easier and faster to react when changes in demand or business appear.

But this method can be hard and difficult to apply because many changes are needed and much people must modify their perspective of business and technology. In the initial context, that is to say, the enterprise and technological environment previous to the On Demand Business adoption, business domain is not integrated with the technological infrastructure.

Typically, business processes are not integrated and each department uses their own information systems. To solve this problem we recommend to follow the main steps, exposed in figure 2:

Step 1. Analyze business in the initial context. It is necessary to obtain business information and knowledge before changing to an On Demand Business context. This is what we call the initial business context. This information is basic to know how to connect business processes with technological resources and how to transform both to reach the future On Demand Business context. For example, strategic goals, business rules, important business processes, resources, profiles, relationship with customers and suppliers, etc.

Step 2. Define a plan to reach an On Demand Business context. The main objective of this step is to reach a flexible scenario which allows a quick adaptation to changes. Each company must realize a coordinated transformation between its business organization and its technological infrastructure because the

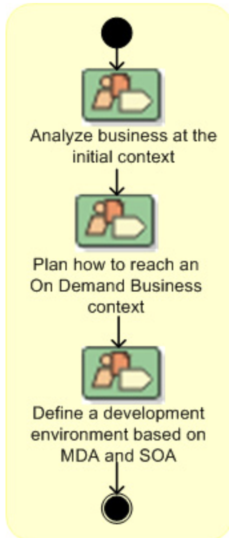


Fig. 2. Main steps to create an On Demand Business context based on BPM, MDA and SOA

On Demand Business requires the use of adequate software and technology in their business processes. To make that possible, it is necessary to use a progressive strategy, based on iterations. This approach is useful for many types of companies. In some of them the number of iterations required will be low because in their initial context they use, for example, adequate methodologies or technologies like Web services [11]. In each iteration, specific transformations must be detailed with well defined objectives and results. As described in figure 3, in these cycles important activities must be repeated.

Step 3. Define a development environment based on MDA and SOA. Each company must define its own development environment, according to MDA specification and SOA architecture. The main activities of this step are exposed in figure 3. After these activities are executed, the company will have transformed its organization and its technological infrastructure to an On Demand Business context. In addition, this new scenario will help to develop software applying MDA and starting on business knowledge.

4 Contribution to Knowledge Society

The proposal exposed in this article can be applied in Knowledge Management [12] in many ways. It can improve business knowledge representation and modeling using BPM. Using adequate tools, business processes can be easily associated to different kind of resources like people, information, capital or other processes in other companies, suppliers or public administration. This facility can improve

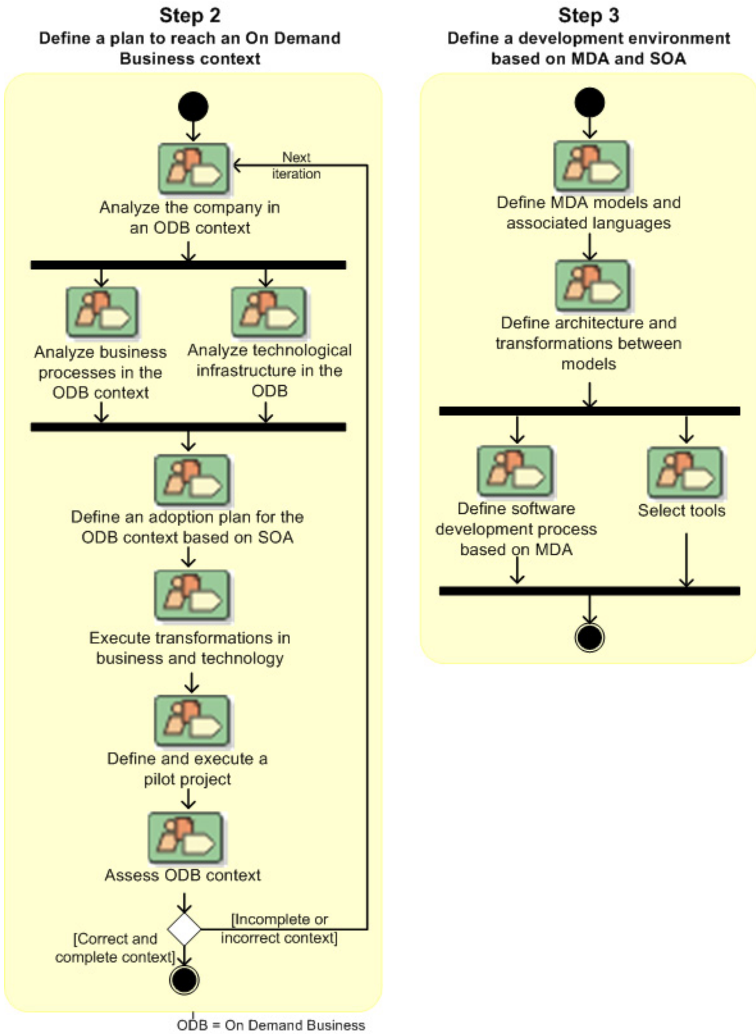


Fig. 3. Workflow diagrams with main activities of steps 2 and 3

the management of Intellectual Capital in some cases [13] because it can link easily business information, people and resources with the main processes of each company, that is, the core of what they do.

The most important contribution of our approach is the method used to connect business knowledge with technological resources using a well defined architecture founded on MDA and software services. Nowadays, the most popular solution is based on SOA and Web services from a business perspective [11]. This is more important in modern societies that use advanced technologies and software.

In addition, the On Demand Business concept supports the creation and maintenance of this connection between business knowledge and technology and reduces the time necessary to adjust business processes to changes in market, resources, people, etc.

5 Conclusions

This article represents an approach to show how is possible to combine the On Demand Business concept with BPM, SOA and MDA. We have described briefly how this special combination can improve the software development in some companies starting on business processes descriptions. In summary, these are the general conclusions and main concepts of this recommendation:

- *The software development process starts on business models associated to business processes.* We propose to start the software development process modeling the main elements involved in a business process.
- *BPM helps to model business knowledge.* Business models are based on the description of business processes. These models can describe business knowledge and simplify the vision of the problem for technical specialist.
- *SOA simplifies the connection between business processes and software services.* Creating small pieces of software, configured like services, it will be easier to link business tasks to software functions.
- *The most important contribution of this approach to Knowledge Society is the method used to connect business knowledge with technological resources.* This is possible using a well defined architecture based on MDA and software services, for example a solution founded on SOA and Web services from a business perspective. This is more important in modern societies that use advanced technologies and software.

Although this article describes a theoretical approach, at the present time this recommendation is beginning to be applied in the Pontifical University of Salamanca [15] [16] to improve academic processes and their adaptation capacity to face changes implied in the new European Space of Superior Education. The experiences and results of this project will be exposed in further articles.

References

1. OMG: MDA Guide Version 1.0.1. Object Management Group. Document omg/03-06-01 edn. (2003)
2. Harmon, P.: Business Process Change, Second Edition: A Guide for Business Managers and BPM and Six Sigma Professionals, 2nd edn. Morgan Kaufmann, San Francisco (2007)
3. Kelly, D., Ashton, H.: Changing Business for Better: A Practical Guide to BPM. An Introduction to BPM. Technical report, Upside Research (2005)
4. Papazoglou, M.: Web Services: Principles and Technology. Prentice-Hall, Englewood Cliffs (2007)

5. Bell, M.: Service-Oriented Modeling (SOA): Service Analysis, Design, and Architecture. Wiley, Chichester (2008)
6. Sprott, D.: Service Oriented Architecture: An Introduction for Managers. CBDI Journal (2004)
7. West, M.: Why Software Development Matters: Competitive Advantage and the On Demand Enterprise. Technical report, Saugatuck Technology (2004)
8. Pyke, J.: BPM in Context: Now and in the Future. In: Fischer, L. (ed.) Workflow Handbook 2006, Workflow Management Coalition, pp. 17–28 (2006)
9. Sprott, D.: The Business Case for Service Oriented Architecture. An Introduction to SOA for Business Managers. CBDI Journal (2004)
10. Noel, J.: BPM and SOA: Better Together. Technical report, IBM (2005)
11. Maamar, Z., Benslimane, D.: A Context-Based and Policy-Driven Method to Design and Develop Composite Web Services. International Journal of E-Business Research (IJEBR) 4, 77–95 (2008)
12. Cepeda, G.: Understanding the link between knowledge management and firm performance: articulating and codifying critical knowledge areas. International Journal of Knowledge and Learning 2, 238–262 (2006)
13. Tome, E.: IC and KM in a macroeconomic perspective: the Portuguese case. International Journal of Learning and Intellectual Capital 5, 7–19 (2008)
14. Georgopoulos, N.B.: Knowledge Management as an integral part of strategic management in e-business era. International Journal of Knowledge and Learning 1, 373–387 (2005)
15. Fraile, J.A., Delgado, M., Sánchez, M.A.: The UPSA Mobile Information System - MoviUPSA. In: Proceedings of VI International Workshop on Practical Applications on Agents and Multi-agents Systems (IWPAAMS 2007), IWPAAMS 2007 (2007)
16. Sánchez, M.A., Joyanes, L., Fermoso, A., Beato, M.E., Berjón, R., Mateos, M.: Recommendation for software development based on MDA, SOA and BPM applied to create a mobile platform associated to Virtual Campus project. In: Proceedings of 6th International Workshop on Practical Applications on Agents and Multi-agents Systems (IWPAAMS 2007), IWPAAMS 2007 (2007)

Organizational Knowledge Sources Integration through an Ontology-Based Approach: The Onto-DOM Architecture

Mariel Alejandra Ale[1], Cristian Gerarduzzi[1], Omar Chiotti[2], and Maria Rosa Galli[2]

[1] CIDISI – UTN – FRSF, Lavaise 610, Santa Fe, Argentina
male@frsf.utn.edu.ar
[2] INGAR – CONICET, Avellaneda 3657, Santa Fe, Argentina
{chiotti,mrgalli}@santafe-conicet.gov.ar

Abstract. Nowadays, there is a large number of Knowledge Management (KM) initiatives implemented in organizations, which often fail to manage the natural heterogeneity of organizational knowledge sources. To address heterogeneity, documentation overload and lack of context we propose Onto-DOM, a question-answering ontology-based strategy implemented within a Distributed Organizational Memory. Onto-DOM is a portable question-answering system that accepts natural language queries and, using a domain ontology, transforms and contextualizes the query eliminating the inherent natural language ambiguity. At the same time, it recovers those knowledge objects that are most likely to contain the answer.

Keywords: Knowledge Management, Distributed Organizational Memory, Ontologies.

1 Introduction

There is already a large number of Knowledge Management (KM) initiatives implemented in organizations, which often fail to manage the natural heterogeneity of organizational knowledge sources. Instead, many approaches to KM have been only based on new information system technologies to capture all the possible knowledge of an organization into databases that would make it easily accessible to all employees [8]. The philosophy of regarding knowledge as a “thing” that can be managed like other physical assets has not been quite successful for several reasons related to tacit knowledge capture and tacit-to-explicit knowledge conversion. Therefore, we believe that an approach with a new conceptual basis is needed that emphasizes the semantics of organizational knowledge objects.

Our contributions are the following:

- We present a three-layer architecture for a Distributed Organizational Memory (Onto-DOM) that addresses two common problems in implementations with these characteristics: the documentation overload that implies for workers the knowledge elicitation to feed an Organizational Memory and the lack of context associated to tacit-to-explicit knowledge conversion.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 441–450, 2008.

- We propose a question-answering ontology-based strategy implemented within the Organizational Memory that allows an automatic semantic treatment of heterogeneous organizational knowledge sources.
- By means of a real world scenario using documents related to the tourism area we describe the most important tasks of the strategy: document annotation in the Knowledge Representation Layer and query semantic treatment in the Information Retrieval and Processing Layer.

Onto-DOM employs domain ontologies in a number of key processes. The domain ontology is used as the core of the representation strategy of knowledge objects. This strategy selects ontological concepts as descriptors obtaining a homogeneous representation of objects structurally heterogeneous. The domain ontology is also used in query refinement, in the reasoning process (a process of generalization/specialization using ontology classes and subclasses) and in the similarity resolution. Experimental evaluation for the Tourism domain indicates that our strategy can automatically annotate documents with high precision and recall while is useful to eliminate natural language query ambiguity. We say that Onto-DOM is portable because the time needed to implement it in a new domain is minimum, requiring just a change of the associate domain ontology.

In section 2, we present our Onto-DOM architecture. In section 3, we discuss the knowledge representation strategy for semantic document treatment within Onto-DOM. In section 4, we present the question treatment strategy. In section 5 we discuss the propagation layer. Finally, remarks and future works are presented in section 6.

2 The Onto-DOM Architecture

In their daily activity, organizations generate huge amounts of textual information along with less traditional non-textual information (audio, video and images). Making all this knowledge available requires a mechanism that retrieves a minimum of irrelevant information (high precision) while assuring that no relevant information is missed (high recall). A traditional solution was a keyword-based search where only those documents containing the keywords were retrieved. Nevertheless, documents often convey the required information without containing the exact keywords. This problem is normally addressed by expanding the query terms using co-occurrence techniques. As a consequence, recall is increased, but at the same time, precision is lost. A different approach to this problem is to classify documents using a semantic-based technique rather than doing it with a word-based or statistical technique.

Some organizational KM systems proposals focus on the application of information technologies for the capture, storage, and retrieval of organizational knowledge. In our approach we propose Organizational Memories (OMs) to support knowledge effective representation, use, handling and conservation over time and space, whenever possible - without human intervention [1].

Croasdell et al. define OMs as the means by which knowledge from the past is brought to bear on present activities resulting in higher organizational effectiveness [5]. Knowledge is naturally distributed across the organization and it is necessary to represent and retrieve knowledge objects in the same way. To this aim we propose to divide the organization in several knowledge domains and associate every domain

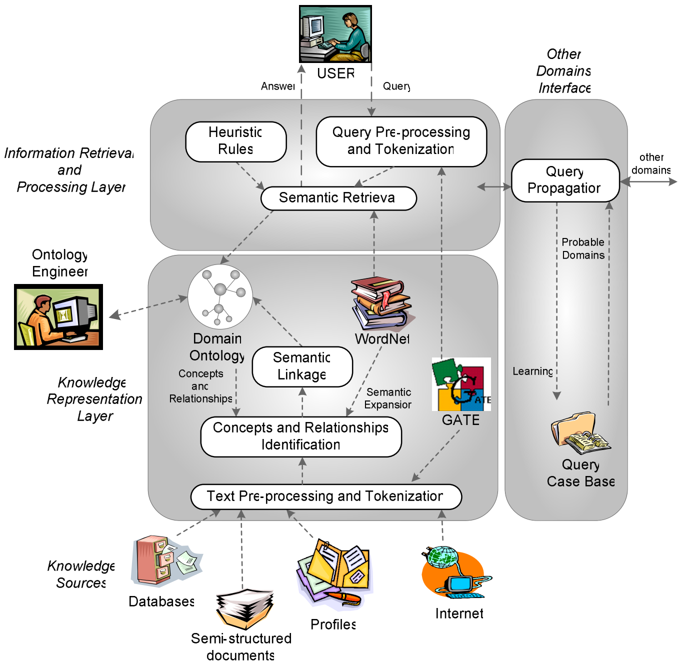


Fig. 1. Onto-DOM architecture

with its own OM. Every OM has an interface that enables knowledge retrieval from other domain OM if necessary. Allowing connection between individual OMs creates a Knowledge Network that fosters knowledge sharing and reuse within the organization [2][3].

In this particular type of OM, the characteristics, attributes, and semantics of the knowledge objects, as well as the relationships among them are represented through a domain ontology. Ontologies aim to capture domain knowledge in a generic way and provide a commonly agreed understanding of a domain, which may be reused, shared, and operationalized across applications and groups [6].

An additional benefit of ontology modeling is context representation. Ontologies provide a domain model that allows knowledge objects to be seen in their context and this can be crucial for subsequent reinterpretation or use in a new task or project. As shown in Figure 1, our Onto-DOM architecture has three main components implemented in Java:

- Information Retrieval and Processing Layer: it is responsible for user query analysis, query transformation into a matching format and information retrieval.
- Knowledge Representation Layer: this component is responsible for the knowledge extraction and representation from heterogeneous sources.
- Other Domains Interface: It is responsible for propagating the user query to OMs in different domains that can provide an answer. In order to accomplish this task the module implements a learning mechanism based on user´s feedback to propose possible target domains.

Another important advantage provided by ontologies can be seen in the Information Retrieval area, where the availability of an ontology allows for replacing the traditional keyword-based retrieval approaches by more sophisticated ontology-based retrieval mechanisms [7][9].

3 Knowledge Representation Layer

As we said before, our goal is to represent in a homogenous way knowledge sources that are heterogeneous in nature (more specifically we began our experiments with natural language documents).

We propose a strategy for semantic document representation where ontologies are used as the main structure for the classification process. Our proposal relies on the hypothesis that domain ontologies contain all the relevant concepts and relationships in a given domain even though the way in which ontologies are built up in the domain is out of the scope of this paper. To illustrate our strategy, we present an example using an extended version of the Travel[1] ontology that contains more than 120 concepts from the tourism area and an extract of a web page[2] of the same domain.

The process begins with the tokenization of the text and, the lexical-morphological analysis of each token. Tokenization consists of dividing the text into single lexical tokens and involves activities such as sentence boundary detection, simple white space identification, proper name recognition, among others. After tokenization, a lexical-morphological analysis has to be done using a POS (Part-of-Speech) tool. In our case, we use the POS tagger provided by GATE[3] (General Architecture for Text Engineering) which specifies if a term is a verb, an adjective, an adverb, or a noun.

Usually, the decision on whether a particular word will be used as a representative term is related to the syntactic nature of the word. In fact, nouns frequently carry more semantics than adjectives, adverbs, and verbs [4]. As, in our case, representative terms will be determined by ontological concepts, which are nouns, we will focus on this syntactic category within the tagged text.

In this sense, ontological concepts can be seen as possible classifying categories. At this stage, if the noun is not directly found in the ontology, using the synonyms set and hyperonymic/hyponymic structure provided by WordNet[4], we semantically expand every noun identified in the text and perform a new search in the domain ontology. By doing this, we do not only identify exact ontological concepts occurrences but also derivations of the same word or even a synonym. Up to this point, we are not interested in the meaning of each possible concept and that is why the presence of more than one sense for each noun in WordNet is not a problem.

For example, the concept "food" has been found with WordNet assistance. In this particular case, by using WorldNet's hypernym relationship we found out that "meal" (a concept present in the text) is a kind of "food", which is a concept in the ontology. In other cases, this tool helps us to mark as ontological concept occurrences the

---

[1] Available at http://protege.stanford.edu/plugins/owl/owl-library/index.html (for the extended version send a request to male@frsf.utn.edu.ar).

[2] Available at http://www.vacationidea.com

[3] Available at http://gate.ac.uk

[4] Available at http://wordnet.princeton.edu

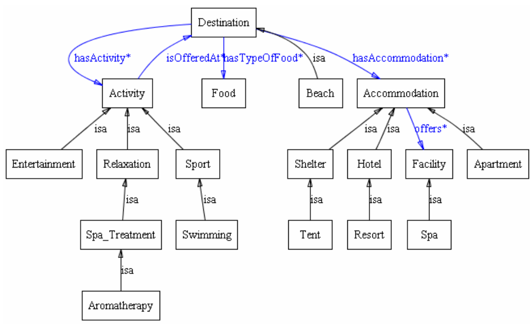


Fig. 2. Ontology representation

presence of synonyms, and in this way, if the noun is not found directly in the ontology, WordNet allows us to expand the matching possibilities taking advantage of related concepts (synonyms, hypernyms, etc.).

At this point, we navigate through the domain ontology using the properties structure in order to find relationships among previously identified concepts. By doing this, we expand the possible document descriptors using intermediate ontology levels and contextualizing those concepts that, in another way, could not be related to other concept among those that were identified in the previous step.

As a result, we finally obtain the subset of the domain ontology that best models the document semantic content (Figure 2). Figure 3, shows the knowledge representation prototype from where ontology engineers can choose the descriptors for each

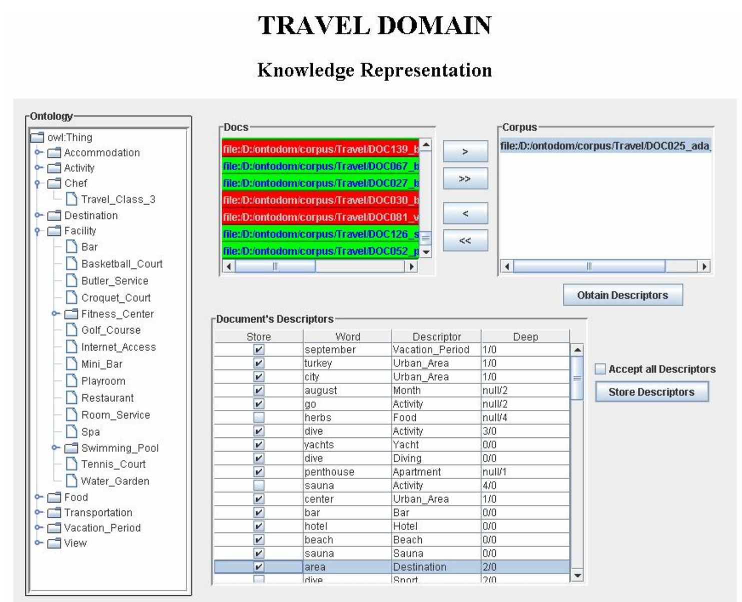


Fig. 3. Knowledge Representation Prototype Interface

document along with the methodology used to obtain each descriptor (straight finding, synonyms, hypernyms, etc.). This semantic document classification will enable new, semantically enhanced, access methods.

3.1 Representation Evaluation

As a first step in the implementation process, we estimate the representation strategy performance applying the following metrics according to Yang´s [10] definitions: recall, precision, fallout, and accuracy[5].

Recall	Precision	Fallout	Accuracy
87%	70%	14%	86%

Recall is a measure of strategy performance in finding relevant concepts. Recall is 100% when every relevant concept is annotated. In theory, it is easy to achieve good recall simply annotating every noun in the text. Therefore, recall for itself is not a good measure of strategy quality. Precision, on the other hand, is a measure of strategy performance in not annotating non relevant nouns. Finally, fallout is the measure of how fast precision is reduced as recall is increased, in other words, it represents the portion of non-relevant concepts that were annotated. We analyzed the reason for the relative low value of recall measure and found that 82% of the not annotated relevant concepts correspond to names of vacation destinations that were either places not recognized by WordNet (i.e. Caicos) or types of destinations that were not taken into account in the domain ontology (i.e. islands, archipelago). We believe that recall can be improved by using common vocabulary domain lists and enriching the domain ontology.

4 Information Retrieval and Processing Layer

Most works on ontology-based question-answering tends to focus on simple query expansion or on exploiting the availability of a knowledge base linked to the ontology to provide a precise answer. In the first case, we believe that this is a limited use of ontology potential and, in the second case, a vast knowledge base must be learnt in order to provide adequate answers. The effort required to feed all organizational knowledge in a knowledge base is prohibitive. Moreover, if precise answers are required this process cannot be fully automated.

Ontologies ensure an efficient retrieval of knowledge resources by enabling inferences based on domain knowledge. This vision relies on the assumption that an ontology designed to describe a domain can both annotate and retrieve knowledge sources. In fact, this is not always the case because domain specialists usually build the ontologies and users do not always share or understand their viewpoints. Users might not use the right concepts – from an ontologist´s viewpoint – when writing a query, leading to missed answers. For example, a user might use "student lodging" instead of "hostel". Or, perhaps a user asking for a "hotel" might also appreciate the retrieval of

[5] Performed over 150 documents with 35.091 words.

documents about “resorts”. Consequently we partially use the same strategy applied to document descriptors determination in the semantic query treatment.

In this case, Onto-DOM accepts natural language queries and, using the domain ontology, transforms the query by eliminating natural language ambiguity and recovering those knowledge objects that are most likely to contain the answer. In a sense, this layer tries to find similarity between the query and the ontological concepts.

Our strategy to determine similarity includes both conceptual and relationship similarity. The first step is to transform the query in a format that facilitates ulterior evaluations and, to this aim, we apply part of the same strategy for document representation. After this stage, we have not only nouns that match ontological concepts but we also keep the verbs in order to evaluate relationship similarity and wh-words that give us an idea of the type of answer expected (time, location, person, etc.).

We go beyond taxonomic relationships (is-a) making use of semantic relationships to sharpen query comprehension. Essentially, we are trying to “understand” the question lying on the codified knowledge in the domain ontology, lexical resources as WordNet and GATE and the heuristics associated to the treatments of wh-words. For example: in the query “Where can I eat Vegetarian dishes?, after the first analysis we obtain the following useful information:

eat(Vegetarian, Food) (where, location)

In this case, the concept Food is derived from Dishes with the help of WordNet`s hyperonymy structure. Nevertheless, as we said before, our main objective is to go beyond a keyword search or the use of the domain ontology as a query expansion tool. To this aim, on the one hand, we will use the verbs detected in the query to look for semantic similarity related to relationships, and on the other hand, we will analyze the concepts related to those relationships to see if they belong to the expected type according to the wh-word.

Following the previous example we recover the ontological concepts identified in the query along with their neighbors, Restaurant and Chef (Figure 4). To decide if one of these neighbors is useful to represent the query (and not search only by Food and Vegetarian) we evaluate similarity between the verb in the query (eat) and the verbs in the relationships attached to the identified concepts (serve, specialize) using the synonym and correlate sets of WordNet.

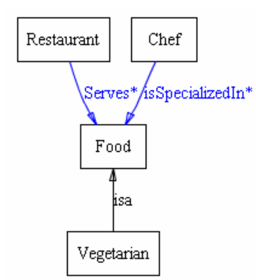


Fig. 4. Ontological concepts identified in the query (with their neighbors)

This analysis shows that "serve" has a higher semantic similarity with "eat" than "specialize".

To confirm this result, or as an alternative in case we are not able to obtain a conclusive result in the verbs comparison, we analyze the concepts at each end of the relationships (Restaurant, Chef) to see if they match with the expected type according to the wh-word. In this particular case, WordNet tells us that Restaurant is a Location (expected type according to the wh-word Where in the query) and Chef is a Person confirming that the portion of the domain ontology that best represents the query contains the concepts: Food, Vegetarian and Restaurant.

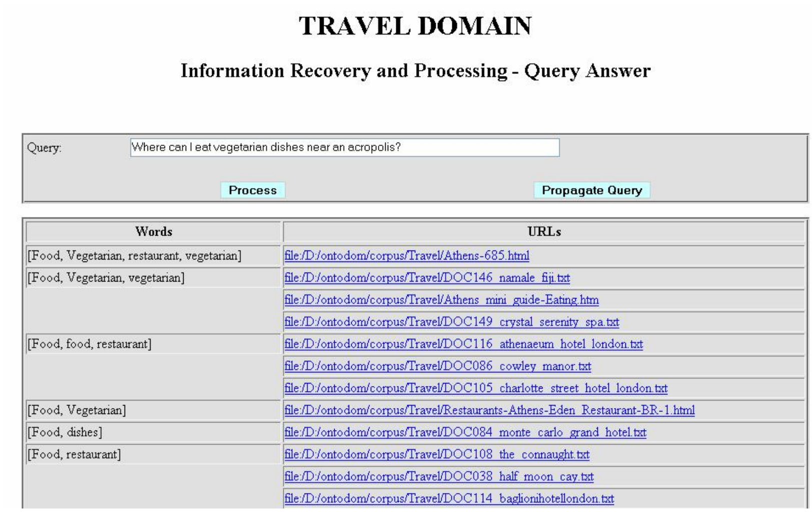


Fig. 5. Information Recovery and Processing Interface

As regards to query evaluation the same results as those for document annotation are expected since the strategy being used is almost the same, adding in this particular case verbs treatment and the use of the ontological relationships (Figure 5). In this sense, our analyses have demonstrated that the queries, due to their short length, are much more sensible to the errors of the strategy. In these cases, a concept detection error attributable to the POS-tagging tool or the annotation strategy has a much greater impact than the same error in a document. To address this problem we are working in a domain independent heuristics set to improve query treatment.

5 Other Domains Interface

This layer implements a case-based reasoning strategy to obtain those domains that have a higher probability of providing an adequate answer to the query. Given a query propagation request, Onto-DOM searches in the case base associated with the domain for those records containing at least one matching descriptor with the current query. This similarity is calculated based on the amount of matching descriptors and their

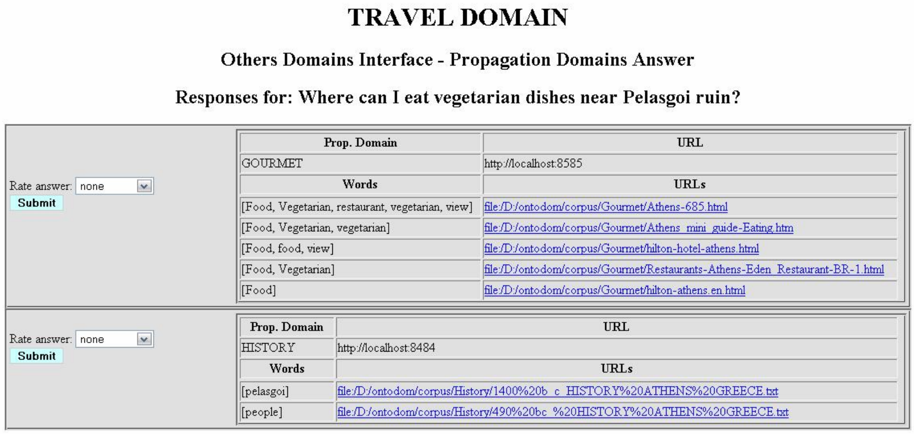


Fig. 6. Other Domain Interface

depths (semantic and ontological). These depths represent how far we had to move in the domain ontology or WordNet structure to mark that noun as a descriptor. The results obtained after the propagation are presented to the user who ranks the usefulness of the answers provided by each domain (Figure 6). The domains with the higher ranks are stored along the query as a new case in the case base.

6 Final Remarks and Future Work

Our goal is the implementation of a Distributed Organizational Memory system to support KM activities, representing in a homogenous way knowledge sources that are heterogeneous in nature (more specifically documents). To this aim, we propose a strategy for semantic document representation where ontologies are used as the main structure for the classification process. Our proposal relies on the hypothesis that domain ontologies contain all the relevant concepts and relationships in the domain. Onto-DOM combines, in a novel way, a series of techniques to "understand" the natural language query and map it to the semantic annotation done in the organizational knowledge sources.

Our initial experiments have yielded reasonable results. These show that it is possible to automatically perform operations such us document integration to an Organizational Memory by semantic annotation and a richer information retrieval. During our experiments with the annotation strategy we have identified several factors that may contribute to uncertainty. One of the reasons for errors in ontology concept identification has to do with text preprocessing. This preprocessing includes a fully automatic noun markup that has an error rate that influence the effectiveness of the subsequent steps. These results could be improved using more sophisticated Natural Language Processing techniques. The domain ontology definition, which is currently restricted to a relatively small number of concepts, also contributes to a low recall rate.

Other identified problems are related to words association. For example, we found some documents that describe what things a place does not have (bars, theaters, cars, etc.) but the strategy classified these documents as describing places with those characteristics. We are currently seeking more advanced techniques to improve the analysis of negative expressions. In relation to query treatment we are currently developing a heuristics set to lower the impact of error rate in short sentences.

Finally, we have assumed the availability of a predefined domain ontology. This means that all documents will be treated according to that particular view of the world. However, in any realistic application scenario, new documents that have to be classified will generate the need for new concepts and relationships. The meanings of terms evolve or take on new meanings as organizational knowledge evolves. It is clear that we will have to find solutions to problems regarding the addition, change or elimination of ontological concepts. Further research would be directed towards the use of the annotation strategy to suggest ontology improvements.

Despite the issues to be solved as future work, our semantic representation and query treatment strategy has proved to be a useful approach to address two major problems in KM initiatives: documentation overload and lack of context. Our strategy is automatic and does not have a learning phase that has to be redone every time we move to a different domain; only a change of the domain ontology is needed. We believe that these characteristics make this strategy suitable for a DOM implementation where a large and variable number of domains are presented and where Knowledge Intensive Tasks´ knowledge needs are continuously changing. Finally, the query treatment strategy allows us to make further use of ontology advantages beyond query expansion.

References

[1] Ale, M., Chiotti, O., Galli, M.: A Distributed Knowledge Management Conceptual Model for Knowledge Organizations. ICFAI Journal of Knowledge Management, 27–39 (2005)

[2] Ale, M., Gerarduzzi, C., Chiotti, O., Galli, M.: Onto-DOM: A Question-Answering Ontology-based Strategy for Heterogeneous Knowledge Sources. ICFAI Journal of Knowledge Management, 54–68 (2007)

[3] Ale, M., Chiotti, O., Galli, M.: Enterprise Knowledge Management for Emergent Organizations: An Ontology-Driven Approach. In: Knowledge Management Strategies: A Handbook of Applied Technologies, pp. 218–249. IDEA Group Publishing (2008)

[4] Baeza-Yates, R., Ribeiro-Neto, B.: Modern Information Retrieval. Addison-Wesley, Wokingham (1999)

[5] Croasdell, D., Jennex, M., Yu, Z., Christianson, T.: A Meta-Analysis of Methodologies for Research. In: Knowledge Management Organizational Learning and Organizational Memory: Five Years at HICSS, p. 110 (2003)

[6] Fensel, D.: Ontologies: Silver Bullet for Knowledge Management and Electronic Commerce. Springer, Berlín (2001)

[7] Guarino, N., Masolo, C., Vetere, G.: Ontoseek: Content-based access to the web. IEEE Intelligent Systems 14(3), 70–80 (1999)

[8] Levine, L.: Integrating Knowledge and Processes in a Learning Organization. Information System Management, 21–32 (2001)

[9] Richard-Benjamins, V., Fensel, D., Decker, S., Gómez-Pérez, A.: (KA)2: building ontologies for the internet: a mid-term report. International Journal of Human-Computer Studies 51(3), 687–712 (1999)

[10] Yang, Y.: An evaluation of statistical approaches to text categorization. Journal of Information Retrieval (1999)

A Capability Assessment Framework for the Adoption of B2B Integration Systems*

Spyros Mouzakitis and Dimitris Askounis

National Technical University of Athens, Athens, Greece
{smouzakitis,askous}@epu.ntua.gr

Abstract. In today's information intensive business world it is critical that decision-makers across the entire supply chain have access to knowledge that is crucial in helping them make more informed business decisions for the adoption of B2B integration (B2Bi) systems. This paper presents a practical capability assessment framework that aims to provide knowledge and in-focus guidance to the enterprises in their effort to adopt B2Bi systems. Our methodology and findings can assist enterprises and public bodies to utilize, share and enrich a knowledge base about B2Bi organizational readiness, throughout their evolution as part of the Knowledge Society.

Keywords: B2B integration, knowledge society, adoption, capability model, organizational readiness, indicators.

1 Introduction

In today's information intensive business world it is critical that decision-makers across the entire supply chain have access to knowledge that is crucial in helping them make more informed business decisions for the adoption of B2B integration (B2Bi) systems. The urgent demands of global competitiveness, however, drive corporations to make blind investments in implementing enterprise systems so as to streamline internal business processes and to exchange data electronically with their business partners. These applications enable corporations to gain high business performance and operational efficiency [21], and thus more and more organizations tend to adopt B2B systems in order to obtain significant competitive advantages [20] and to respond to increasing demands for improved security and compliance. In this hasty attempt to embrace a B2B solution, enterprises are burdened with a proliferating collection of disadvantageous or abandoned B2Bi projects that lack centralized control, service quality and business alignment, since technical and non-technical prerequisites are ignored.

* This work has been funded by the project PENED 2003. The project is cofinanced 75% of public expenditure through EC - European Social Fund, 25% of public expenditure through Ministry of Development - General Secretariat of Research and Technology and through private sector, under measure 8.3 of OPERATIONAL PROGRAMME "COMPETITIVENESS" in the 3rd Community Support Programme. Special thanks to Vasileia Kantarou.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 451–459, 2008.

Modern B2B technologies, such as XML-based middleware, web services, integration brokers and ESBs have solved major technical issues of traditional EDI, especially in terms of interoperability, but due to the vast number of non-technical adoption barriers, the efforts for B2Bi are still enormous [17]. Most companies, however, especially the SMEs, fail to recognize the necessary required business culture, technical and non-technical infrastructure and economic flexibility in order to efficiently adjust to the environment of a B2B integration framework Organizational readiness has long been identified as a critical success factor for a healthy adoption of EDI or any other inter-organizational system, in terms of profitability and service quality. Therefore the preliminary evaluation of organizational readiness is essential in view of the adoption of a B2Bi solution.

Nonetheless, the specifications and conditions of such an evaluation constitute a substantial issue. In fact, the need for a capability model from a business perspective has been considered as one of the grand challenges in enterprise interoperability by relevant research roadmaps and reports [29,28] as well as by a number of related studies [24,7,1]. One of the main problems in the evaluation is that many factors influence one another, and it is therefore essential to know what to look for and to be able to isolate these factors. Moreover, another critical issue is how we can capture and quantify measurable indicators out of these factors in a well-grounded manner. Lastly, relevant evaluation adoption efforts and research studies usually have limited scope and implications without making a conscious effort to abstract and share practical information for the prosperity of Knowledge Society.

The purpose of this paper is to present a methodological approach for constructing B2B integration capability models that assess organizational readiness. The term B2B integration encompasses many inter-organizational systems such as extranets, EDI, internet based B2B applications, e-SCM and B2B e-commerce. What they differ are the technologies used, scope of application and stakeholders [19]. The evaluation approach has mostly a business scope and focuses exclusively on the enterprise's internal environment. The next section describes the theoretical background, followed by our research framework. The paper concludes with a discussion on the major results and implications.

2 Theoretical Perspectives on the Adoption of B2B Integration

Our research work is based on an extensive literature analysis of studies on the adoption of inter-organizational systems, including B2B e-Commerce, enterprise application integration (EAI) systems and electronic marketplaces. Giachetti, R. has defined five levels of enterprise integration (organization, process, application, data, and network) in order to identify the barriers encountered at each level [8]. C. Ranganathan addresses key business issues to which IT managers have to pay just as close attention as to technical ones before adopting a B2B exchange environment [26]. Yu Chung William Wang presents different levels of information technology adoption that a company can achieve depending on internal and external business factors. The highest, most demanding level is B2B integration/collaborative e-commerce [35]. Furthermore, a number of studies examine the effects of B2B integration adoption at a firm level [34,33,6] as well as in global business economics [25]. On application level, Themistocleous [34] extends the perception of EAI from the traditional intra-organization to B2B integration approaches and presents common and best practices for evaluating and adopting application integration.

There has been an extensive research investigating determinants, business drivers and critical success factors (CSF) on IT and B2B technology adoption. For instance, Xiang-Hua Lu at al. [19] reveals seven critical success factors (CSF) for the IOS, including shared vision, high integration with internal information systems, advanced legacy information systems and infrastructure and shared industry standards. Wing Lam proposed a comprehensive and useful CSF model for EAI projects that can be applied to inter-organizational settings [15]. Although these studies deal with different business integration approaches, such as EDI, B2B e-commerce and internet based inter-organizational systems, they usually share common theoretical background and features, including the validated factors and factor categories [19, 7, 4]. In most cases, organizational readiness is explicitly or implicitly addressed among these factors.

These studies provide valuable insight for the B2Bi adoption phase. Nonetheless, the abstraction level of the identified determinants is in most cases too high to be practically translated into measurable value for the stakeholders. In other words, there is a lack of empirical research on assessable factors regarding B2B integration adoption. This limitation has been addressed by a number of relevant studies [7, 9, 32]. Whereas instances of measurable factors can be spotted in many cases [11, 15, 4, 27], there is no clear demarcation of them in the literature. Some studies mention that the independent variables were "measured by multiple indicators" [11] but no further description or reference on their systematic construction and role is available. This distance between theory and measures stumbles evaluators or other stakeholders in their attempt to make practical use of research results from relevant literature.

Even typically envisaged and commonly used variables, such as "firm size", usually fail to deliver an objective physical interpretation in terms and measures of the real world [14]. Variables describing more intangible concepts, such as "management support", are even less likely to be translated to meaningful measures. Khalid Hafeez et al. [10] present an e-business capabilities model based on a noteworthy literature review that addresses the lack of indicators measuring the "readiness" of an organization. His proposed framework, however, still remains fairly in a conceptual level.

This paper, aims to address this gap in literature by proposing a theoretical framework for shaping indicators for the assessment of an enterprise's capability to successfully delve into a B2B integration business model environment. Our work is based on the methodology and results of the previous studies but it follows a more practical approach by giving emphasis on the usability of the final results and by using quantitative data for the validation of the assessment instrument.

3 Methodology

3.1 Introduction - Towards the Knowledge Society

The main goal of our work was to provide a B2B evaluation methodology that conforms to the principles of the Knowledge Society [30]. First of all, rather than giving emphasis on the scientific or technological excellence of the produced methodology, the main priority was the construction of an evaluation framework in a way that promotes the creation, the sharing and the practical utilization of knowledge. Therefore, the capability model is built upon common research results of relevant studies but in a manner that the involved knowledge-based components and methods can be employed and reproduced in an efficient and practical manner by the decision-makers. Moreover, the indicators and indicator categories of the assessment instrument represent not only pure financial factors but also intangible aspects of an enterprise. According to our proposed framework knowledge and awareness of these indicators is essential for the successful adoption of B2Bi systems. Lastly, one of our main concerns was to articulate and clarify components of the assessment instruments in order to permit the codification of the involved knowledge (e.g. homogeneous measurable factors expressed as indicators with clearly defined units of measure that can realistically be used for the evaluation). Codification consists in translating knowledge into symbolic representations so that it can be implemented thereafter as an advanced information system (e.g. web-based evaluation software) for the Knowledge Society [13]. The following sections describe the steps of our methodology.

3.2 Purpose / Goals of the Assessment

The first and most significant step in any evaluation is to define its goals. The outcome of an assessment sets the strategic direction of an enterprise. Consequently, tactical decisions about what the business will do, how, and what gets measured must relate to this strategic statement. In the context of our work, the main goal of the evaluation is to identify organizational weaknesses that will determine the success of a B2B integration effort. The multidimensional nature of the key term "success", however, must be first addressed in a well-organized manner in order to deduce clear assessment objectives.

The majority of studies illustrate the term "success" of inter-organizational systems by presenting examples of the benefits that a successful system offers, but usually a clear and common taxonomy of success metrics among relevant literature is missing and the term is expressed as a single dependent variable [34, 15, 19]. Khalid Hafeez et al. on the other hand [50] propose three types of perceived success metrics: Financial Measures, Efficiency Measures and coordination with business partners. Other studies examine success only from a financial performance perspective [16].

Instead of proposing our own new model, our approach aims to contribute to a more coherent body of knowledge by using an existing IS success model for producing success metrics. SERVQUAL [23] measurement instrument in a B2B context was initially considered as an option. However, since service quality is merely a subset of success, the updated DeLone and McLean Model of Information Systems Success [5] was preferred.Therefore, the first step in our framework is to define the appropriate success metrics that are based on the DeLone and McLean E-commerce Model in a B2Bi context. The goals of the evaluation must be expressed in relation to these items. These objective statements are a driving force for the selection of the performance measures.

3.3 Specification of the Assessment Indicators

Evaluation indicators should be created on a well-grounded manner in order to be effective. To create our framework, a review of the literature on IT/E-commerce/EDI/Inter-organizational systems adoption factors was conducted. From these studies,

Table 1. Integrated theoretical framework for indicator categories describing organizational readiness for B2Bi adoption

Indicators Category	Indicators Subcategory	Sources
Leadership and Strategy	Top Management Support	[24,15,31,19,2,27,35,1,22]
	Innovativeness	[24,31,7]
	Strategy	[15,31,27,35]
	Compliance & Legislation	[27]
Finance	Economic Health	[24,,31,7,27,1]
	IT Investment	[11,31,7,27]
Human Resources	ICT skills	[24,15,2,4]
	Training	[15,27,4,18]
	IT Staff	[15,27]
	Business Confluence	[11,27]
	Slack Staff	[12]
Infrastructure	Network Reliabilty	[31]
	Network Speed	[31]
	Security	[31,27]
	Applications Interoperability	[11,15,3,19,27]
	Data Flexibility	[15,3,19,27]

constructs relevant to the B2B integration were examined. Factors that address to internal organizational characteristics and that were found to have significant correlation with the dependent variable(s) were selected and duplicates were eliminated. These factors were organized in order to synthesize an integrated framework of indicator categories affecting the success of a B2Bi adoption. These factors were then classified into four categories as seen in Table 1.

Description for each indicator category can be found in the corresponding study.

According to our framework, assessment indicators for measuring organizational readiness for B2Bi adoption should derive from the indicator categories defined in Table 1. Also, assessment indicators of high quality should implicitly or explicitly be related to goals. That is, in the context of our methodology, that they must represent domains of the DeLone and McLean E-commerce Model [5] for which B2B integration can be beneficial. Furthermore, as in general, a set of carefully crafted assessment indicators should also conform to other requirements. First of all, indicators should be measurable and answerable. Additionally, direct and easily understood indicators are more likely to produce unbiased results. Further requirements can be found in relevant literature.

On this basis, a vast number of indicators can emerge through discourse and negotiation with representative enterprises, managers, experts and stakeholders. Thereafter, Exploratory Factor Analysis can be used in order to identify a smaller number of indicators that explain most of the variance that is observed in the complete set. Then, Confirmatory factor analysis can be applied to verify the indicator structure.

Finally, the evaluation results are expected to have different meaning for firms of different type and size and thus the evaluation instrument should employ proper control variables.

A summary of our proposed framework is depicted in figure 1.

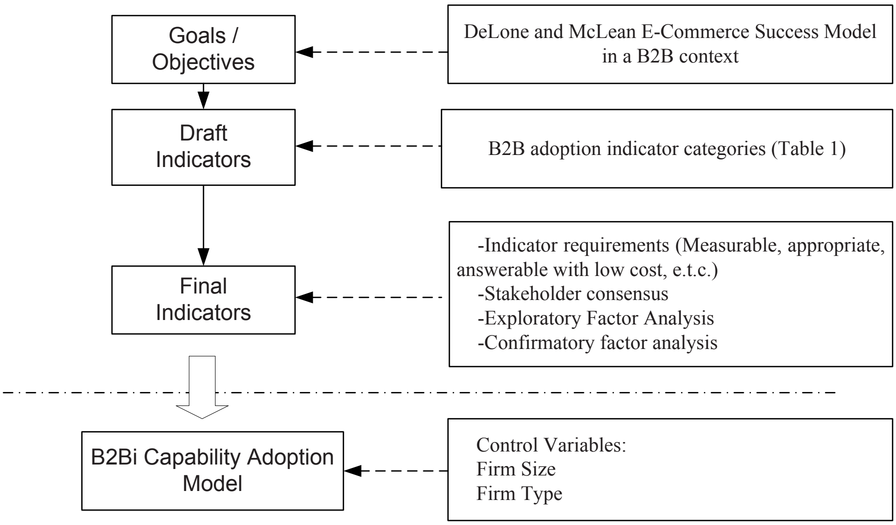


Fig. 1. Conceptual framework for constructing B2Bi capability models

The validity of our capability model framework was tested using empirical evidence from firms in Greece.

4 Data Analysis and Results from Firms in Greece

4.1 Methodology Application

The application and validation of our methodology was based on a field study with the help of a professional IT-consulting firm that specializes in conducting IT-related research and providing ISO certifications. The sample frame was obtained from the consulting firm's database that contained representative firms that had experience with B2B integration projects. Our research methodology has two phases. The first phase involved the initial creation of the measurement instrument and the second phase examined its validation.

For the first phase two of the most B2B experienced firms belonging to wholesale traders industry were selected from the consulting firm's customer database. Discussions and one-to-one interviews with the senior managers of these firms ensured a more focused creation and adjustment of the capability measurement instrument. For each indicator subcategories (Table 1) 39 indicators were conceived on the basis that they reflect these success metrics.

The second phase involved the validation of the assessment instrument model with input data from wholesale trading firms in Greece. Exploratory factor analysis was used to examine whether there was significant overlap among the subgroups of the indicators and to determine their structure. After that, confirmatory factory analysis was conducted to test the hypothesis of the indicator structure. Lastly, multiple regression analysis was performed in order to address the strength of the relationship between the instrument model and the dependent variables.

5 Implications

5.1 Implications

The main purpose of the survey conducted was to examine the validity and efficiency of a capability model for B2Bi adoption, constructed according to our methodology. By following the methodical approach proposed, a valid and reliable assessment instrument was created which can provide a basis for evaluating organizational readiness of firms in Greece and comparable countries for multi-enterprise integration. Our methodology proposes a systematic approach for constructing assessment instruments that can be used to measure organizational readiness with a view to adopting a B2B integration solution. Our work is based on prior adoption research but gives much more emphasis on the usability of the final results, and uses quantitative research for its validation. Constructing a capability model that is exclusively based on measurable items, contributes to a more clear and efficient evaluation. But even more importantly, in this case, the link to practical measures/strategies for overcoming the exposed barriers is more obvious and direct.

Our framework can be used by experts, consultants and analysts as a common groundwork for designing and conducting relevant evaluations. The findings of the application in Greek firms can be used as a concrete example for a helpful starting point. The application of the methodology provides researchers and practitioners an initial set of indicators that are perceived to reflect a successful B2Bi solution adoption. Moreover, our results have major implications for firm owners and managers who examine the option of conducting B2B automated transactions in the future. Our methodology and findings can assist them in identifying their strengths and weaknesses in a practical manner and thus, serve as a guide for establishing an effective integration strategy (e.g. in which domain should available resources be allocated).Furthermore, B2B technology vendors and standardization bodies can benefit from the knowledge base that is developed around such a framework, by focusing more on the alignment to the organizations' business needs, rather than technological excellence.

Lastly, an efficient knowledge-based framework for detecting and thereafter overcoming B2Bi adoption barriers is expected to have a significant social and economic impact in Greece and comparable countries in the long-term. Such framework can freely provide valuable knowledge to enterprises in their effort to expand their markets and increase their global competitiveness. The geographic diversion of potential partners is a much less painful and costly matter and this fact can contribute to dealing with many social issues such as the major problem of urbanism. Governments and public bodies can use our framework in the form of an advanced web-based information system in order to examine enterprises' B2B readiness in a national or international level. Enterprises that need help can receive financial or consultation support. Moreover, governmental bodies or neutral third parties can identify areas of co-operation, including establishment of links with potential partners, based on the knowledge of the readiness level of companies offered by the evaluation framework. These possibilities enable Governments to monitor the business development and prosperity of their country in its evolution as a Knowledge Society.

References

1. Al-Qirim, N.: An empirical investigation of an e-commerce adoption-capability model in small businesses in New Zealand. Electronic Markets 15(4), 418–437 (2005)
2. Amoroso, D.L., Vannoy, S.: Translating the adoption of b2b e-business into measurable value for organizations. In: Proceedings of the 39th Hawaii International Conference on System Sciences, vol. 6 (2006)
3. Claycomb, C., Lyer, K., Germain, R.: Predicting the level of b2b e-commerce in industrial organizations. Industrial Marketing Management 34(3), 221–234 (2005)
4. Debra, Z., Handfield, R.B.: The role of learning and technical capabilities in predicting adoption of b2b technologies. Industrial Marketing Management 33(7), 627–641 (2004)
5. DeLone, W.H., McLean, E.R.: The DeLone and McLean model of information systems success: A ten-year update. Journal of Management Information Systems 19(4), 9–30 (2003)
6. Garicano, L., Kaplan, S.N.: The effects of business-to-business e-commerce on transaction costs. Journal of Industrial Economics 49(4), 463–485 (2001)
7. Gengatharen, D.E., Standing, C.: A framework to assess the factors affecting success or failure of the implementation of government- supported regional e-marketplaces for smes. European Journal of Information Systems 14(4), 417–433 (2005)
8. Giachetti, R.E.: Enterprise integration: An information integration perspective. International Journal of Production Research 42(6), 1147–1166 (2004)
9. Giachetti, R.E., Hernandez, P., Nunez, A., Truex, D.P.: A research framework for operationalizing measures of enterprise integration. Knowledge Sharing in the Integrated Enterprise 183, 237–247 (2005)
10. Hafeez, K., Keoy, K.H., Hanneman, R.: E-business capabilities model: Validation and comparison between adopter and non-adopter of e-business companies in UK. Journal of Manufacturing Technology Management 17(6), 806–828 (2006)
11. Hong, W., Zhu, K.: Migrating to internet-based e-commerce: Factors affecting e-commerce adoption and migration at the firm level. Information and Management 43(2), 204–221 (2006)
12. Joo, Y., Kim, Y.: Determinants of corporate adoption of e-marketplace: An Innovation theory perspective. Journal of Purchasing and Supply Management 10(2), 89–101 (2004)
13. Kalfoglou, Y.: Knowledge society arguments revisited in the semantic technologies era. International Journal of Knowledge and Learning 3(2/3), 225–244 (2007)
14. Kumar K., Rajan R., Zingales L.: What determines firrm size? NBER Working Paper No.7208
15. Lam, W.: Investigating success factors in enterprise application integration: A case-driven analysis. European Journal of Information Systems 14(2), 175–187 (2005)
16. Laseter, T.M., Bodily, S.E.: Strategic indicators of b2b e-marketplace financial performance. Electronic Markets 14(4), 322–332 (2004)

17. Lheureux, B.J.: Hot questions for multienterprise (B2B) integration. Gartner Research Group (2007)
18. Lopez, S.P., Montes Peon, J.M., Vazquez Ordas, C.J.: Measuring organisational learning: proposal of a multidimensional scale. International Journal of Learning and Intellectual Capital 4(3), 276–293 (2007)
19. Lu, X., Huang, L., Heng, M.S.H.: Critical success factors of interorganizational information systems - A case study of Cisco and Xiao tong in china. Information and Management 43(3), 395–408 (2006)
20. Middel, H.G.A., Fisscher, O., Groen, A.: Managing and organising collaborative improvement: a system integrator perspective. Int. J. Technology Management 37(3/4), 221–236 (2007)
21. Mukhopadhyay, T., Kekre, S.: Strategic and operational benefits of electronic integration in B2B procurement processes. Management Science 48(10), 1301–1313 (2002)
22. Nah, F., Islam, Z., Mathew, T.: Empirical Assessment of Factors Influencing Success of Enterprise Resource Planning Implementations. Journal of Database Management 18(4), 26–50 (2007)
23. Pitt, L.F., Watson, R.T., Kavan, C.B.: Service quality: A measure of information systems effectiveness. MIS Quarterly 19(2), 173–187 (1995)
24. Quaddus, M., Hofmeyer, G.: An investigation into the factors influencing the adoption of B2B trading exchanges in small businesses. European Journal of Information Systems 16(3), 202–215 (2007)
25. Qureshi, K.A., Dawood, M.: Improving global business economics by seamless business integration framework. Human Systems Management 26(4), 247–255 (2007)
26. Ranganathan, C.: Evaluating the options for business-to-business e- exchanges. Information Systems Management 20(3), 22–28 (2003)
27. Ranganathan, C., Teo, T.S.H., Dhaliwal, J.S., Ang, J.S.K., Hyde, M.: Facilitators and inhibitors for deploying business-to-business e-commerce applications: A multi-method, cross-cultural study. In: Twenty second International Conference on Information Systems, 2001, pp. 593–600 (2001)
28. Report from Information Society Technologies Enterprise interoperability research roadmap (version 4 - 2008)
29. Report from Information Society Technologies, Unleashing the potential of the european knowledge Economy,Value proposition for enterprise interoperability (version 4 – 2008)
30. Stehr, N.: Societal transformations, globalisation and the knowledge society. International Journal of Knowledge and Learning 3(2/3), 139–153 (2007)
31. Soliman, K.S., Janz, B.D.: An exploratory study to identify the critical factors affecting the decision to establish internet-based interorganizational information systems. Information and Management 41(6), 697–706 (2004)
32. Straub, D.W., Steinfield, C.: Measuring e-commerce in netenabled organisations. Information Systems Research 13(2-3), 115–124 (2002)
33. Subramaniam, C., Shaw, M.J.: A study of the value and impact of B2B e-commerce: The case of web-based procurement. International Journal of Electronic Commerce 6(4), 19–40 (2002)
34. Themistocleous, M.: Justifying the decisions for EAI implementations: A validated proposition of influential factors. The Journal of Enterprise Information Management 17(2), 85–104 (2004)
35. Wang, Y., Chang, C.-W., Heng, M.: The levels of information technology adoption, business network, and a strategic position model for evaluating supply chain integration. Journal of Electronic Commerce Research 5(2), 85–98 (2004)

Inclusion in the Information Society for the "Excluded" Women in Greek Thrace

Keratso Georgiadou, Gerassimos Kekkeris, and Mary Kalantzis

Mathematician, Professor at the Department of Primary Education DUTH Greece, Dean at the Department of Education University of Illinois Urbana-Champaign, USA
kgeorgia@eled.duth.gr, kekkeris@eled.duth.gr, marykalantzis@uiuc.edu

Abstract. This article is based on a research conducted in Thrace, a Greek region in the North, bordering Turkey and Bulgaria. It aims to describe the efforts women, belonging to socially excluded communities i.e. Muslim women, Pontian women immigrants from the former Soviet Union and Roma women, make to adapt to the demands of today's world and to detect whether these women have access to and use of ICTs.

Keywords: ICTs, Muslims of Turkish origin, Greek-Pontian immigrants from FSU, Roma, Greek Thrace.

1 Introduction

During the last century and at the outset of the new one, people are experiencing a major shift in human civilisation – the information revolution that is transforming social, economic, cultural and political interactions the world over and creating a new concept of the society of human beings. This society, known as the "Information Society", combined with the economy makes the best possible use of new Information and Communication Technologies (ICTs).

Rampant poverty, unemployment, wage and labour discrimination, lack of access to education and resources(women represent 2/3 of world's illiterates), cultural stereotypes and gender bias towards women and ICTs, racial background, less time than men to visit public access facilities, poor access to communication infrastructures, lack of computer literacy and language barriers are among the socio-cultural factors impeding access to the ICT infrastructure, and use of it, especially in developing countries and rural areas (Marcelle, 2000; Hafkin and Huyer, 2006). Although new technologies can offer to women opportunities in order to gain skills and substantially improve their lives and increase their income (Huyer, 2005), in developing countries most women are in the deepest part of the digital divide- further removed from the information age than the men whose poverty they share (Hafkin, 2006). Nevertheless, even when women do have access to basic education, few women pursue careers in ICT professions, a phenomenon probably based on employers' sexist stereotypical prejudices (women are incapable of managing or of rational thought, etc.) or even on economical business criteria (women leaving for pregnancy) (Vitsilaki, 2004).

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 460–468, 2008.

According to Latimer (2001) social gaps in society cause the digital divide, but the digital divide, in turn, may intensify existing social gaps and create new ones. Family income shows an important correlation with ICT use and adoption, but racial background and especially educational attainment are much stronger indicators (Lizie et al, 2004). Because members of minority groups and people from lower socioeconomic groups have less access to technology, they are likely to be further disadvantaged from attaining some of the higher positions in tomorrow’s economy, widening the economic divisions that already exist (Cooper and Weaver, 2003).

2 Populations of the Research

The research is carried out during the last two years, among three different populations of women living in Greek Thrace (Georgiadou et al, 2007). All members of these populations are Greek citizens, but a proportion of them are Muslims of Turkish origin, some are immigrants from countries of former Soviet Union of Greek-Pontian origin, and some are Roma (Gypsy).

Presently, the Muslim minority in Greek Thrace, recognised by the Treaty of Lausanne in 1923, consists of approximately 100.000-120.000 individuals, the one third of the total population of Greek Thrace (Aarbakke, 2000). Muslim minority women may be dressed in different ways, covered with scarves or feretze (black gowns) for the older ones or uncovered according to the place they live, their educational level, their marital status, employment status and cultural level. In the area of Thrace, the Muslim family structure mainly oppresses women and relegates them to a low-level of educational achievement and to confinement to the home sphere. The rate of employment for Muslim women is rather low.

Greek-Pontian immigrants are descended from Greek populations which colonized the Caucasus Mountain and the Black Sea regions during various historical periods (the first settlement began in the 7th and 8th centuries B.C.). In the 1990s, a population of almost 2000.000 Pontians migrated to Greece in order to avoid the consequences of social and economic disruption in the ex-Soviet countries. According to a census by the General Secretariat of Repatriated Greeks, 23.000 Pontians have settled in Greek Thrace and 7.800 of them at the province of Rodopi. Of those 7.800, nearly 2.000-2.500 are women (Data derived from their local associations). Immigrants’ general status is characterized by a high percentage of unemployment and lack of contentment with their situation in Greece (Tressou-Milona, 1998).

Today in all Greek Thrace, Roma population is estimated to be around 18.000-25.000 people (Mavrommatis, 2005) most of them Muslims. In Greece, the Roma frequently experience forced evictions from their settlements, police violence, and exclusion from the educational system or a very high drop-out rate from schools, barriers to access to health care and other social support services, high rates of infant mortality, life expectancy 20 years less than the average. The illiteracy rate among the Roma women is extremely high, since they are the first to leave school at marriage, usually getting married at the age of 12-15(GHM, 2003).

The study is accordingly qualititative in nature; a case study survey using an ethnographical approach, which aims to obtain an in-depth understanding of the relationship between women, who belong to the communities described above, and ICTs. The research was conducted with the structured interview method for the Muslim women and the Greek Pontian immigrants, one-on-one, using a questionnaire with a total of 59 questions, (both open- and closed-ended questions as well as scale items). All interviews were tape-recorded and subsequently transcribed in full. More specifically, for the Roma women the body of data was also semi-structured interview-based. While interviewing the Roma women we chose the "vacuum-cleaner" technique and did not interrupt them even when they deviated from the main theme, as interviews and narrations from such individuals and on such topics are rare (Goldstein, 1964).

The research took place in the province of Rodopi (Xanthi and Evros provinces are the two other parts of Greek Thrace). It involves a non-probability sample of a total of 74 individuals, (32 Muslim women of Turkish origin, 35 Greek Pontian immigrants and 7 Roma). The first two populations were identified and recruited by the snowballing method and by the convenience sampling the third as it was simply available to the researcher by virtue of its accessibility. The sample was guided by the principle of maximum variation in terms of age, educational background, occupational background, parents' educational and occupational background, marital status, and native country.

Their age ranges for the Muslim women were: 18-29 (12), 30-39 (16) and 40-49 (4). It was not possible to find women in the age of fifties involved with ICTs. While conducting the group of Pontian women in the survey, we had to deal with a cultural group concentrated in a particular area of the city, known as the "Russian neighbourhood". Their age ranges were: 18-29 (11), 30-39 (11), 40-49(11) and 50-59 (2). Few women in their fifties involved with ICTs could be found. The 7 Roma interviewees live in a district of Komotini, called "Alan-Koyu" or "Tin Neighbourhood", in 50 sheds or other impromptu structures with communal toilets, with no land ownership; with electricity, running water, and sewage provided; not easily accessible but with satellite antennas over all the roofs. Their age ranges were: 18-29 (2), 30-39 (4), and 40-49 (1).

3 Results

3.1 Background Details

In order to achieve an understanding of the role of their culture in the use and adoption of ICT by the interviewees, in this exploratory study phase we investigated demographic data, women's education and professions and their parents' education and professions.

Most of the Muslim women are graduates from Turkish universities, but an increasing interest in Greek universities is mentioned. Collected data evidences that young women of the minority show a great interest in receiving education, improving their skills, becoming more fluent in speaking the Greek language and being equally prepared for their future entrance to the labour market. Almost no minority students enrolled in a Greek university prior to the positive discrimination measure of 1996 for entering Greek Universities (Dragonas & Fragoudaki, 2006). Approximately 700 students of the Muslim minority of Rodopi area have been given the chance to enter Greek universities with the quota (0,5%) in a ten year period.

As for the Pontian immigrants of the sample, most of them at the age of 18-29 had graduated from Greek high schools and were thus able to receive the same qualifications and skills as members of the local community. The great majority of women over 30, 40 and 50 years of age had graduated from high schools in the former Soviet Union. All had received secondary education, and twenty-six of them had received tertiary education, either in Greece or in the former Soviet Union. Although from data collected we have evidence that more of the interviewees over 30, who grew up in countries of former Soviet Union, were educated in the hard sciences, after their settlement in Greece they had to work in low-profile jobs unrelated to their initial studies, in order to survive, as Russian University degrees were not recognized or did not readily correspond to diplomas from Greek Universities.

Finally it has to be mentioned that none of the seven Roma women interviewed has received any education and were totally illiterate. All of them spoke the Romani, most of them Turkish and some Greek, although unable to read or write it. Only one of them, the eldest, whose family was travelling around Greece, was able to read Greek newspapers. Consequently, they could not compete with their classmates.

3.2 Learning and Communication Experiences

A small number of open-ended questions asked participants to explain where or how they first learned the computer use; how they felt and feel in front of a computer; if the family encouraged them to use the computers, how many hours they use the computer every week and for what reason. It is observed that most of the Muslim women at the age of 18-29 learned the use of computers at the Greek state High school or Lyceum, where the lesson of computing science has been taught since 1994, while in Minority schools started almost a decade later.

Most of the Pontian women in the 18-29 age range learned to use computers in the Greek state middle or high schools, where computer science classes have been taught since 1994. Following their settlement in Thrace, nineteen of the interviewees had attended E.U.-funded seminars provided either by the prefecture of East Macedonia and Thrace, the Municipality of Komotini, or the Greek Ministry of Labour, and conducted in private occupational education centres.

For the Roma women, the 400 hour E.U.-funded seminar for computer use they attended was their first experience with computers. They had never found themselves before in a schoolyard and had never attended lessons in a classroom. Even the keys on the keyboard were recognised as an image and not with the sense of the letters.

Most of the Muslim women, who possess a PC, have Internet connection, have email accounts and all of them own mobile phones. Among the group of Pontians, the majority of the interviewees possesses a computer but have no Internet connection as they rarely have land phone connections due to the cost. Nearly all of them however, own a mobile phone. Almost half of them have an email account. According to the data collected, most of the Muslim women do not frequent Internet cafes due to social reasons and structures of their society. At the age of 18-29 the Pontians did not frequent Internet cafes as they own a computer at home or it is provided in their working area. The older Pontian women did not frequent Internet cafes due to their age, for social reasons and their community structures; and some of them accessed the Internet at their workplaces.

Telecommuting is a more flexible way of work for women with domestic and family duties, and thus is more preferable for at least half of both Muslims and Pontians. As for the long working hours demanded by the ICT sector, half of the women from both groups felt positively. About on-line studies, most of the women felt positively, thinking that in this way family, marriage, domestic duties, dropping out of school, relations with family could be combined, affording them the opportunity for a "second chance" in their lives to improve their skills, abilities and prospects. They believed that in this way they would find jobs, become more educated and cultivated, and have a comfortable life with the ability to establish better relations with others. Also commendable is the fact that, both Muslim and Pontian women in the age of 30-39, and 40-49, felt more comfortable than the youngest ones to function with men in groups for computer lessons. The Roma as well of all age ranges did not have any problem being in groups with men. All of them had cell phones. They did not know what telecommuting is but when it was explained to them they were positive in finding a job through this procedure, as finding a job was their main problem mentioned several times during the interviews. One of the things observed during the seminar attended by the seven Roma women, was the good relations developed among members of the whole group. All the Roma women mentioned the fact that they were treated politely by their classmates-all members of the Christian majority.

For the question detecting the reasons for computer use, it is clear that most preference was given by the Muslim women to the Internet, Microsoft Office applications and communication with friends, followed by email and web surfing. Studies, games and telemarketing were not high-priorities for these women. As for the Pontian immigrant women, most preference was given to the Internet, email and web surfing, followed by Microsoft Office and communication with friends. On-line studies and tele-marketing are not high-priorities, also for these women.

3.3 Learning and Communication Needs and Attitudes

According to all interviewees, the use of ICTs is not only the realm of men. Most of the interviewees agreed that computer knowledge is a necessity in today's world. Half of the Muslim women and most of the Pontian women responded positively when asked if computer illiteracy corresponded to non-computer use thus affirming the importance of being technologically literate today, and the rest were negative claiming that literacy was connected to education, university study or reading books. Nevertheless, most of the interviewees prefer reading from printed material than electronic. Among the most commonly used ICT appliances, the Muslim women prefer traditional mass media such as mobile phones, television and computers and the Pontians mostly prefer television, followed by mobile phones and computers. All the Roma interviewed, as mentioned above, owned cell phones and watched satellite TV. All Muslim interviewees and Pontian interviewees believe computer can facilitate their lives; ICTs can help in acquiring new knowledge and allow easier and faster communication and exchange of opinions but on the other hand do not believe that one must have particularly high qualifications in order to learn to use a computer. For the Roma women, the material selected suggests that at the end of the seminar they recognized that the computer could facilitate their lives as they could see that things were done in an easier and quicker way. As visualisation of information through images, demonstration and simulation is offered by computers in high quality, knowledge can be acquired in a better way (Kárpáti, 2004). This opened their eyes to positive changes. "Is this a mouse? You should see the mice I have in my house!" it was the first thing said when the tutor was demonstrating the hardware of the computer. But if the start they have made ends after receiving the 2000 Euros subsidy, everything will have been in vain. Provided that the Roma women during the seminar day by day showed increasing excitement for the computer, that could be their first step towards climbing the stairs of literacy or facilitation of their everyday life as reading and writing, computer lessons for driving license, developing communication skills, etc. Their willingness to learn seemed obvious; when they understood what they were taught, they demanded more knowledge. If someone willing to help them was showing something new, they could understand easily and apply it on the computer. They would no longer be afraid to press the buttons of the keyboard.

Feelings of fear, stress and anxiety towards first computer use were reported by a small number of the interviewees. Most of them expressed feelings of interest, creativity and pleasure. Even women in their 30s, 40s or even 50s were positive towards new technologies, interested in learning how to use computers, and aware of their usefulness, though they were aware of the difficulty of learning something new, or the isolation that its use might bring.

4 Conclusions

This research constitutes a first approach to the subject. Due to the small sample, it cannot provide in-depth answers to all the aspects of the questions that were raised and need more thorough investigation. However, by presenting preliminary findings on Muslim women of Turkish origin, immigrants from fSU, Roma and their relation to ICTs, it contributes to the dialogue on the subject. Although the sample is situated only in the province of Rodopi and not in all Greek Thrace, it was estimated that the results of the research should be announced so that some general comments will contribute toward identifying the problem more clearly, and support the further studies of the questions that arise. Also the themes that have emerged from the above qualitative data shed light on some of the many problems that these women, living in this specific area of Greece, face.

For the Muslim women of Turkish origin, our initial hypothesis whether Muslim women of the minority use the ICTs, the answer is positive, although we cannot assume that all women of the Muslim minority in general relate to technology in the same way. The women interviewed expressed their intention to be or become computer literate, to improve their knowledge of the Greek language, to continue their studies and become qualified in order to be able to find a job. A continuous worry on this matter was expressed several times during the interviews by the women of different ages. The marital status of the participants was not an obstacle to the use of new technologies, as many of them were supported and encouraged by their husbands to learn how to use a computer. Participants of the research showed a preference for mobile phones, TV, and thirdly to computers. When asked, they were negative to the mobility demanded by the ICT labour sector, but long working hours, telecommuting and online studies are accepted and generally welcomed. Women with domestic responsibilities particularly welcomed this flexibility. Influenced by the way Internet cafes functions in the particular area, women of the Muslim minority are not comfortable with visiting them, although they exist in their neighbourhoods and villages. However they do visit them when they are in Turkey, where anonymity is afforded. From the interviews it has been cleared that relation with, and access to, technology depends on education, income, and to some extent on the personality of the person who tries to become digitally literate.

Secondly, for the immigrants from FSU the interview results indicate that an overwhelming majority of the interviewees, both younger and older, consider ICTs to be of rapidly increasing importance. ICTs and the Internet offer obvious benefits as a means of communication. Immigrants have begun to use ICTs, especially email, cell-phone connections and cell phone text messages, as valuable means of sustained contact with relatives in the former Soviet Union, with the distinct advantages of low costs and immediacy of connection. Online newspapers greatly improve the immigrants' access to the traditional media in their former homelands. Findings suggest that nearly two thirds of the participants welcome the mobility demanded by the ICT labor sector; and long working hours, telecommuting and online studies are accepted and generally welcomed as new lifestyles. Particularly women with domestic responsibilities welcome this flexibility. The interviews indicated that immigrant women from the former Soviet Union, having made the decision to move to a higher-wage economy, are likely to wish to gain access to the earnings and lifestyle available here. Most of them being highly educated, they generate a positive feedback effect. According to interviewees, there is a problem in obtaining information concerning seminars on computer use. Furthermore, it is a necessity of our times to hold seminars according to the age, past ICT experience and specific needs of the participants. These seminars should also provide a broad range of computer knowledge, from computer literacy to more specific programmes on demand in the labor market, so that trainees may become more specialized. The results of past seminars on computer literacy should be disseminated in order to attract new trainees. The benefits of past computer literacy training programs should be evaluated. In order to pursue the goal of spreading the benefits of the Information Society to all residents of Greece, members or representatives of immigrant communities must be included in the Information Society implementation organs. This would assure that the views of these groups would be more effectively incorporated into policy formulation and implementation. The living conditions, problems and social exclusion faced by women immigrants from the former Soviet Union and other countries, as well as refugees, have barely been studied. The study and research of women's migration issues have gained new priority, in efforts to decide upon new political and strategic targets with the aim of confronting the problems faced by migrant women, the amelioration of their living conditions, and their social and economical inclusion in the receiving country.

Thirdly, for the Roma women the interviews have indicated that their language skills must be improved as their oral and written comprehension is poor and insufficient for efficient learning. For this, we suggest that learning methods for seminars approaching the Roma and generally illiterate people must be improved and specialized, and the knowledge processing strategies must be more diversified. Seminars with useful services driven by the real needs of the community must be materialized according to age, education level, and even gender of the participants by instructors prepared to teach people of special cultural groups and the educationally disadvantaged. For the above characteristics of the under-served areas in Greek Thrace must be identified. Women's associations or channels that interact with their way of living must be the informants for the benefits of the information society. Reducing the digital inequality must be an on-going process of education and support, with a concrete target. Their literacy may be achieved through digital literacy. Helping them acquire this skill may enable them to avoid unemployment and poverty, which is their common fate.

References

1. Aarbakke, V.: The Muslim minority in Greek Thrace, PhD dissertation. The University of Bergen, Norway (2000)
2. Cooper, J., Weaver, K.D.: Gender and Computer: Understanding the digital divide, pp. 3–4. Lawrence Erlbaum Associates, Mahwah (2003)
3. Dragonas, T., Frangoudaki, A.: Educating the Muslim minority in Greek Thrace. Islam and Christian–Muslim Relation 17(1), 21–41 (2006)
4. Georgiadou, K., Kalantzis, M., Kekkeris, G.: Gender and ICT: The case of Muslim women in Greek Thrace. International Journal of Interdisciplinary Social Sciences 1(4), 181–188 (2007)
5. Georgiadou, K., Kekkeris, G., Kalantzis, M.: Immigrant Women from Former Soviet Republics at Greek Thrace: Becoming computer literate. International Journal on Technology, Knowledge, Society 3(4), 28–36 (2007)
6. Georgiadou, K., Kekkeris, G., Kalantzis, M.: Gender and ICT: The case of Roma women in Greek Thrace. International Journal of Interdisciplinary Social Sciences 2(4), 543–550 (2007)
7. Goldstein, K.S.: A guide for fieldworkers in folklore, pp. 133–138. Folklore Associates, Hatboro (1964)
8. Greek Helsinki Monitor (GHM) Country Report Series No 12, Cleaning Operations: Excluding Roma in Greece (2003), `http://lists.errc.org/publications/reports/greeceE_2003.pdf`
9. Hafkin, N.J.: Why the world isn't flat enough: bringing more women contributors and beneficiaries into information technology. EMC Women's Leadership Forum, Pleasanton (2006)
10. Hafkin, N.J., Huyer, S.: Cinderella or Cyberella?, p. 11. Kumarian Press, USA (2006)
11. Huyer, S.: Women, ICT and the Information Society: Global Perspectives and Initiatives. In: The conference Women and ICT, Baltimore, MD, June12-14 (2005)
12. Kárpáti, A.: Travellers in Cyberspace: ICT In Hungarian Romani (Gypsy) Schools. In: Kárpáti, A. (ed.) Promoting Equity Through ICT in Education, pp. 141–156. OECD, Paris (2004)
13. Latimer, C.P.: The digital divide: Understanding and addressing the challenge. New York State Forum for Information Resource Management, New York (2001)

14. Lizie, A., Stewart, C., Avila, G.: Cultural Dimensions of the Digital Divide: ICT and Brockton's Cape Verdean. In: International Assocation for Media and Communication Research and Confernce, Porto Alegre, Brazil, July 24-30 (2004), http://www.media.uio.no/prosjekter/ctp/papers/IAMCR-CTP04_S2-2_Lizie.pdf
15. Marcelle, G.: Getting Gender into African ICT Policy: A Strategic Vie. In: Rathgeber, E.M., Adera, E.O. (eds.) Gender and the Information Revolution in Africa. IDRC, Ottawa (2000)
16. Mavrommatis, G.: Ta paidia tis Kalkantzas. Metaixmio, Athens (2000)
17. Tressou-Milona, E.: Exclusion of least privilege groups from education Social Inequalities and Social Exclusion, pp. 639–655. Karagiorgas Foundation, Athens (1998)
18. Vitsilaki, C.: New figures of employment and the dimension of gender (2004)
19. Zenginis, E.: I Mousoulmani Athinganoi tis Thrakis. Hemus Peninsula Institute of Studies, Thessaloniki (1994)

On Significance of Ontology Quality in Ontology-Driven Web Search

Darijus Strasunskas[1] and Stein L. Tomassen[2]

[1] Dept. of Industrial Economics and Technology Management
[2] Dept. of Computer and Information Science
Norwegian University of Science and Technology,
NO-7491, Trondheim, Norway
darijuss@gmail.com, stein.l.tomassen@idi.ntnu.no

Abstract. Web search performance and efficiency is critical for many people and organizations in knowledge society. Nowadays, ontologies are being applied in a number of ontology-based information retrieval systems in order to improve the performance of these systems. However, quality of ontology plays an important role in these applications. In order to feasibly assess the impact, evaluation criteria need to be connected to scenarios of use with a purpose to enhance particular search tasks. In this article discussed preliminary results of the experiment showing how different ontology quality aspect can improve ontology-driven Web search performance.

1 Introduction

The Web is becoming a dominant information source for learning and acquiring new knowledge. Consequently, web search is becoming one of the main means to access the required information, while the task of improving the web search performance is one of the most relevant for knowledge society. Some approaches are relying on semantic annotations (e.g., [33]); some are enhancing clustering of retrieved documents according to topic (e.g., [22]). Therefore, there are a lot of efforts devoted to research on improvement of information retrieval (IR) by the help of ontologies that encode domain knowledge (e.g., [10, 11, 12, 29]), i.e. by so called advanced knowledge technologies [18].

The literature reports on improvement of web search using ontology-based information retrieval tools (e.g., [1, 29]). However, there is no investigation on what ontology features enhance or impair search engine performance.

Therefore, the objective of this paper is to analyze ontology quality role in ontology-driven web search application. Web search could be characterized by having a focus on retrieving documents rather than browsing knowledge or answering a question. This ontology application restriction limits ontology quality aspects that we are considering and analysing here. Typically, subclass hierarchies are considered to be sufficient for document retrieval and any further ontology specification (properties and axioms) are required only for knowledge browsing and question answering [17]. However, here we show that ontology quality improvement (by specifying equivalent and disjoint classes, adding instances and properties) can significantly improve web search results.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 469–478, 2008.

The rest of the paper is structured as follows. First we briefly review related work that comes from two main areas, ontology-driven information retrieval and ontology quality. Second, we discuss a framework for Evaluation of Ontology Quality for Search (EvOQS) [28] in a few words. Then we elaborate on an experiment and evaluation of ontology quality aspects and their role in search performance. The main results are presented and discussed. Finally, we conclude the paper and outline future work.

2 Related Work

An increasing number of recent information retrieval systems make use of ontologies to help the users clarify their information needs and expand users' queries. First, we summarize ontology-driven information retrieval (OdIR) methods, taking a closer look what role ontology plays in the methods proposed. Second, we recapitulate the state-of-the-art in ontology quality evaluation.

2.1 Ontology-Driven Information Retrieval

The basic assumption of OdIR systems is as follows. If a person is interested in information about *B*, its likely that she will find information about *A* interesting, with a condition that *A* and *B* are closely related terms/concepts in an ontology. I.e. OdIR exploits semantic relationships. In the simplest way, user's query is expanded by hypernyms (superclasses) - i.e. generalization [5], or hyponyms (subclasses) - i.e. focalization (more detailed knowledge) [5] or other related concepts (e.g., sibling concept and other neighbourhood concepts). In this way ontologies are used in the process of enriching queries [6, 12]. There ontology typically serves as thesaurus containing synonyms, hypernyms/hyponyms.

However, there are more sophisticated approaches to OdIR. We classify them into two non-orthogonal categories as follows.

Knowledge Base based OdIR – functioning on top of Knowledge base (KB). These approaches use reasoning mechanism and ontology querying languages to retrieve instances from KB. There, documents are treated either as instances or are annotated using ontology instances [19, 24, 25, 26], i.e. there focus is on retrieving instances rather than documents.

Integrated with vector space model – functioning on top of existing search engines and indices. These approaches combine OdIR with already traditional vector space model. Some start with semantic querying using ontology query languages (e.g. SPARQL, RDQL, OWL-QL) and use resulting instances to retrieve relevant documents using vector space model [11, 19, 21, 31].

2.2 Evaluation of Ontology Quality

An important body of work exists in ontology quality assessment area (e.g., [2, 10, 14, 15, 20]). Most of them aim at defining a generic quality evaluation framework and, therefore, do not take into account specific application of ontologies.

Analysis of the literature shows that ontologies are typically examined according to five aspects: syntax, vocabulary, structure, population of classes and usage statistics. Where *evaluation of syntax* checks whether an ontology is syntactically correct. This quality aspect is most important in any ontology-based application, since syntactic correctness is a prerequisite to be able to process an ontology. Syntactic quality is a central quality aspect in most quality frameworks (e.g., [10, 20]). *Cohesion to domain and vocabulary*. Congruence between an ontology and a domain is another important aspect in ontology quality evaluation. There ontology concepts (including taxonomical relations and properties) are checked against terminology used in the domain. *Structural evaluation* deals with assessment of taxonomical relations vs. other semantic relations, i.e. the ratio of IsA relationships and other semantic relationships in ontology is evaluated. Presence of various semantic relationships would identify the richness of ontology. *Population of classes* is based on instance related metrics. *Usage statistics and metadata*. Evaluation of this aspect focuses on the level of annotation of ontologies, i.e. the metadata about an ontology and its elements.

Table 1. Summary of existing approaches to ontology evaluation

Quality framework	Syntax evaluation	Domain cohesion	Structural evaluation	Population of classes	Usage statistics
AKTiveRank [3]		X	X		
OntoClean [16]			X		
OntoKhoj [23]		X			X
Ontometric [20]	X				
OntoQA [30]			X	X	
OntoSelect [9]			X		
oqval [14]		X			X
Semiotic metrics [10]	X	X			X
Swoogle [13]					X
Other		[8, 27]			

Table 1 summarizes ontology evaluation approaches with respect to the five aspects discussed above. In evaluation of cohesion to domain terminology, a direct match of the vocabulary used to denote concepts in the ontology with a terminology used in text corpora has positive impact on overall OdIR performance. Lexical fit allows better adoption of an ontology, both from user and document collection perspectives. However, that is not vital for every single approach to OdIR. For instance, an approach [31] aligns terminologies by the help of a feature vector constructed for each of the concepts in the ontology based on terms collocation in a document collection. Evaluation of a structural aspect determines richness of ontology, therefore it is important for KB and vector-space model based OdIR.

Consequently, some metrics of the above discussed ontology evaluation approaches are applicable and feasible to assess capability of ontologies to enhance information retrieval. However, there is a lack of a systematic framework to assess fitness of ontologies for a particular search strategy and/or OdIR approach. Adequate optimality criteria should be selected to enable quality estimation of OdIR. These measures should be related to the users' information needs.

3 The EvOQS Framework

In this section we briefly overview the EvOQS (Evaluation of Ontology Quality for Searching) framework [28] for evaluation of ontology quality in search applications. The framework defines a stepwise ontology selection procedure and metrics. Ontology quality aspects are defined with respect to the search tasks and search enhancement requirements. There it is adopted classification of search tasks into three categories, such as *fact-finding*, *exploratory*, and *comprehensive* search tasks [4]. In fact-finding, a precise set of results is important, while the amount of retrieved documents is less important. In exploratory search task, the user wants to obtain a general understanding about the search topic, consequently, high precision of the result set is not necessarily the most important thing, nor is high level of recall [4]. Finally, a concern of comprehensive search task is to find as many documents as possible on a given topic, therefore the recall and precision should be as high as possible.

The EvOQS framework consists of three functional steps as follows.

Step 1. Generic quality evaluation. This initial step concerns filtering out poor quality (i.e. syntactically incorrect) and irrelevant ontologies. For more detailed account on this and other steps the keen reader is directed to [28].

Step 2. Search task fitness. This step concerns evaluation of ontology fitness for a particular search task. For instance, ratio of taxonomic vs. non-taxonomic relationships is important when selecting an appropriate ontology for exploratory and comprehensive search tasks.

For instance, in *fact-finding,* a high precision can be achieved by using precise terms or phrases in the query, and typically, by formulating a query consisting of several terms. In order to enhance results in fact-finding search task, provided concepts need to be extended by their instances, datatype properties. Consequently, concepts, their instances and properties are essential here. *Exploratory search*. Here, the user may find topic-related documents by extending simple keyword-based search with parent- and child-concepts. *Comprehensive search*. In order to cover broader-topic in addition to hypernyms and hyponyms, sibling concepts and semantic relationships are included in the query, to cover the most important aspects of the search topic.

Table 2. Search tasks and ontology support

Search tasks	Ontology support
Fact-finding	Concepts, their instances, object and datatype properties
Exploratory	Sub-concepts
Comprehensive	Super-, sub- and siblings- concepts, object properties

In Table 2 we summarize ontology support necessary to support search tasks as discussed.

Step 3. Search enhancement capability. This final step in our framework concerns evaluating vocabulary of ontologies. Here we account for availability of internal lexical resources in ontologies, i.e. presence of specified synonyms, alternative labels that might potentially be used for a query expansion [32].

Table 3. OWL language constructs and relevance for search performance

Search enhancement	Ontology elements	OWL constructs
Precision	Sub- and related concepts	`rdfs:subClassOf`, `owl:intersectionOf`, `owl:unionOf`
	Disjoint concepts (to be used with Boolean operator NOT)	`owl:complementOf`, `owl:disjointWith`
	Properties	`owl:ObjectProperty`, `owl:DatatypeProperty`
	Instance (w/ Boolean operator NOT)	`owl:differentFrom`
Recall	Super-, sub- and sibling concepts	`rdfs:subClassOf`
	Instances	`owl:sameAs`
	Synonyms	`owl:equivalenClass`, `rdfs:lable`
	Closely related concepts	`owl:intersectionOf`, `owl:unionOf`

In order to improve the result of search, query expansion is typically used, where a query is refined to improve both, recall and precision. Table 3 summarizes a role of main ontology elements (and corresponding OWL constructs) in query expansion. Our aim is to define metrics to assess capability of ontologies to provide lexical resources for enhancement of precision and recall. For instance, ontology lexicon (a set of lexical entries for the concepts of ontology (synonyms)) can improve recall [1, 7].

4 Experiment, Settings, Materials and Used Ontology-Driven Web Information Search Tool

For the assessment of ontology quality role in an ontology-driven search application we have conducted an experiment with four different ontologies (different domains) and two different versions of each of the ontologies. The experimental settings are detailed as follows.

For the experiment we have used the WebOdIR system[1] that is an ontology-driven information retrieval system for the Web [31]. There users can specify one or more concepts related to a domain of interest when formulating a query. In addition, it is possible to specify a set of keywords to narrow the search even further. A Web user interface is meant to be as simple as possible to use for the end user.

The prototype used the Yahoo! Web Search API as the backend search engine. Consequently, we compared the search results from WebOdIR with similar results from Yahoo! Web search.

In WebOdIR ontologies are used extensively in the search process. Each concept specified in an ontology is extended with a feature vector (*fv*) that relates the concept to a terminology used on a particular domain. The feature vectors are constructed as follows. Documents for each concept and its neighbours are retrieved, and then the documents are clustered to group those documents having high similarity. For each

[1] WebOdIR prototype available at:http://129.241.110.220

Table 4. Search tasks given to participants of the experiment

Search topic id	Search task classification and task description
Food & Wine domain (http://www.w3.org/2001/sw/WebOnt/guide-src/wine.owl and integrated with http://www.w3.org/ 2001/sw/WebOnt/guide-src/food.owl)	
1.	Explorative search task. Imagine that you are going to prepare a dinner for tonight. You plan to make beef curry and would like some wine to drink with this meal. Find out what grapes are used for suitable wines to this meal.
2.	Fact-Finding search task. Imagine that you are going to prepare a dessert as well. The main component of this dessert is chocolate but also contains some sweet fruits. You would like to find the perfect dessert wine but don't know which, try to find it.
Travel domain (http://protege.cim3.net/file/pub/ontologies/travel/travel.owl)	
3.	Comprehensive search task. Imagine that you are going on a vacation and would like to try a safari. You don't know yet which country or what kind of safaris you would like. Try to get an overview of the kind of safaris that are available.
4.	Fact-Finding search task. Suppose that you would like to see leopards and have decided to go on a leopard safari but don't know where. Explore the possibilities for a leopard safari.
Animal domain (http://nlp.shef.ac.uk/abraxas/ontologies/animals.owl)	
5.	Explorative search task. Imagine that you should write an article about jaguars but don't know very much about jaguars. Try to find some facts about jaguars.
6.	Comprehensive search task. Imagine that you would also like to write an article about jaguars and leopards and similar kind of cats. Try to get an overview of the cat family.
Autos domain (http://gaia.isti.cnr.it/~straccia/download/teaching/SI/2006/Autos.owl)	
7.	Fact-Finding search task. Imagine that you have heard that the neighbor has bought a new car of the brand Saturn. Further, imagine that you have never heard of this brand before. Try to find some facts about this brand.
8.	Comprehensive search task. Suppose your neighbor has recently bought a beautiful new car. Therefore, you would like to impress your neighbor as well buy getting a bigger car, an SUV. However, you don't know much about cars; try to get an overview of what SUVs are.

cluster a set of candidate terms are created, terms are ranked and finally feature vectors are associated with the concept (for more details see [31]).

The participants in our experiment were mainly 4th year students. There were 21 subjects that participated; they were offered payment for used time after full completion of the experiment.

The experiment consisted of two parts. The first part included formulating search queries for both WebOdIR and Yahoo! The participants were presented four domains with two topics of interest for each domain (see Table 4). They had to formulate in total 16 queries, eight to be submitted to WebOdIR and eight to Yahoo. The participants were divided into two groups that used different ontologies for the same domain. The first group used the original ontology while the second group used a modified version of the original ontology. The original ontology was modified to include more relations and/or instances to see how this enhancement will influence on the search results. Different feature vectors were generated as the result of modifications in ontologies.

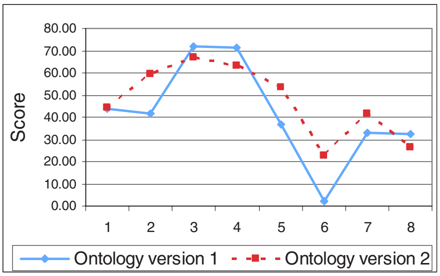
The participants needed to mark each of top 10 retrieved documents according to perceived relevance. The relevance score for each query has been calculated using the following equation:

$$\mathrm{Score}_q = \frac{1}{2}\sum_{i=1}^{10} P_{D_i} \times P_{P_i} \tag{1}$$

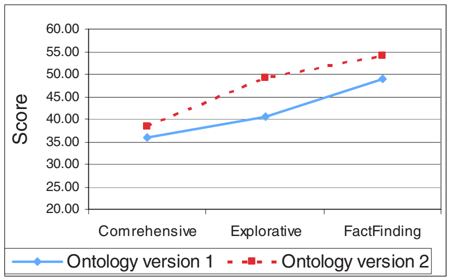
where P_{Di}[2] is an individual score for document D_i, and P_{Pi} - the weighting factor for position P_i[3].

5 Results

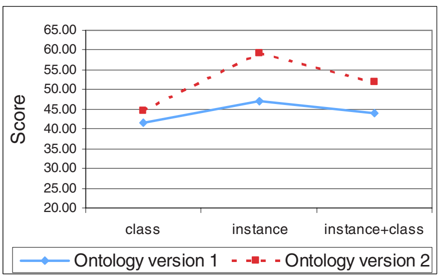
All four ontologies were modified by adding instances (all ontologies), specifying additional object properties (travel, animal and wine ontologies) and introducing equivalent classes (animal and autos ontologies). As a result, comparing relevance



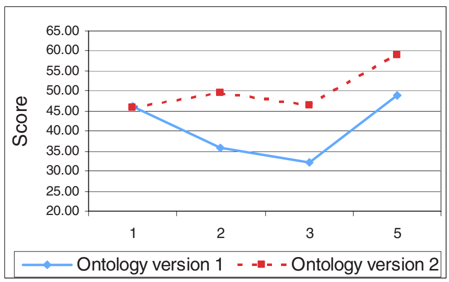
a) Mean score per topic



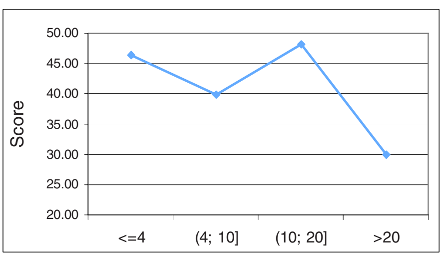
b) Mean score per search type



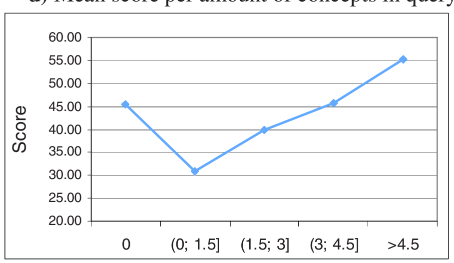
c) Mean score concept-based query type



d) Mean score per amount of concepts in query



e) Mean score based on concept richness ranges



f) Mean score based on path length among concepts specified in queries

Fig. 1. Main results of ontology quality impact on search performance

---

[2] Score for document is as follows: -1 for trash; 0 for non-relevant or duplicate; 1 – related; and 2 - good document.

[3] Document ranking position has weights as follows: 1st – 20; 2nd – 15; 3rd – 13; 4th – 11; 5th – 9; 6th & 7th – 8; 8th & 9th – 6; 10th – 4. Consequently, the final score falls in a range [-50, 100].

scores for the original ontologies vs. the modified ones, we have found an improvement in mean score that equals to 10.6% (overall mean relevance for original ontologies score 42.1 vs. 46.6 for modified ontologies), see Figure 1 a) for comparison per search topic.

Addition of more instances and object properties has improved the mean relevance score of fact-finding search tasks, while addition of subclass and equivalent concepts resulted in better performance of exploratory and comprehensive tasks (see Figure 1 b)). Further, the b) chart can be related to c) chart that shows the performance based on what type ontological information has been used in query, i.e. instance, concept or both. Since the specified individuals in ontologies are concrete object and have datatype properties, that resulted in better document selection. Chart d) visualized results based on amount of concepts/instances used in queries. The concepts in the modified ontologies contained more precise knowledge specified about them (e.g. disjoint subclass relations), that helped to better discriminate the retrieved documents and improve the mean of relevance scores.

Concept-cluster richness has been calculated as a score based on available information specified in ontology. The score included amount of object and datatype properties, instances, sub- and super-concepts associated with used concept/instance in a query. As well an average path length measure was used to compute the distance between the concepts specified in queries (counting edges between concepts) in order to measure semantic difference between concepts provided in queries and its impact on the result. Here the hypothesis is that closer located concepts have overlapping feature vectors. From Figure 1 e) chart we can see that "richer" concepts (i.e. those having a lot of subclasses, properties and instances specified) results in a noisy feature vector and consequently in a lower relevance score. f) chart shows that a longer distance between concepts better discriminates retrieved documents, since the feature vectors for the closely related concepts are overlapping.

6 Conclusions and Future Work

The Web is a constantly increasing repository of knowledge that is vital for the evolving knowledge society. Therefore, in this article we have focused on improvement of access to this repository through search, namely we have investigated what properties of ontology can enhance performance of ontology-driven Web search. Furthermore, in this article we have briefly discussed the EvOQS framework [28] to assess ontology fitness and capability to improve ontology-based search. In the framework evaluation criteria are connected to scenarios of use with a purpose to enhance particular search tasks.

Moreover, in this article we have discussed preliminary results of the experiment showing how different ontology quality aspects improve ontology-driven Web search performance. However, the results of the experiment need to be further analysed and a more controlled experiment should be conducted, since in the current experiment we have allowed the participants to interpret the task and freely construct the query and once again to interpret the relevance of retrieved documents. Consequently, we have found a significant variance between users' assessments.

References

1. Aitken, S., Reid, S.: Evaluation of an ontology-based information retrieval tool. In: Gomez-Perez, A., Benjamins, V., Guarino, N., Uschold, M. (eds.) Workshop on the Applications of Ontologies and Problem-Solving Methods, ECAI 2000, Berlin (2000)
2. Alani, H., Brewster, C.: Ontology ranking based on the analysis of concept structures. In: 3rd Int. Conf. on Knowledge Capture (K-CAP 2005), Banff, Canada, pp. 51–58. ACM Press, New York (2005)
3. Alani, H., Brewster, C., Shadbolt, N.: Ranking ontologies with AKTiveRank. In: Cruz, I., Decker, S., Allemang, D., Preist, C., Schwabe, D., Mika, P., Uschold, M., Aroyo, L.M. (eds.) ISWC 2006. LNCS, vol. 4273, pp. 1–15. Springer, Heidelberg (2006)
4. Aula, A.: Query formulation in web information search. In: IADIS International Conference WWW/Internet (ICWI 2003), Algarve, Portugal, pp. 403–410. IADIS (2003)
5. Bonino, D., Corno, F., Farinetti, L., Bosca, A.: Ontology driven semantic search. WSEAS Transaction on Information Science and Application 1(6), 1597–1605 (2004)
6. Braga, R., Werner, C., Mattoso, M.: Using ontologies for domain information retrieval. In: Proceedings of the 11th International Workshop on Database and Expert Systems Applications, pp. 836–840. IEEE Computer Society Press, Los Alamitos (2000)
7. Brasethvik, T.: Conceptual modelling for domain specific document description and retrieval: An approach to semantic document modelling. PhD thesis, NTNU, Trondheim, Norway (2004)
8. Brewster, C., Alani, H., Dasmahapatra, S., Wilks, Y.: Data driven ontology evaluation. In: Proceedings of Int. Conf. on Language Resources and Evaluation, Lisbon, Portugal (2004)
9. Buitelaar, P., Eigner, T., Declerck, T.: OntoSelect: A dynamic ontology library with support for ontology selection. In: Proceedings of the Demo Session at the International Semantic Web Conference, Hiroshima, Japan (2004)
10. Burton-Jones, A., Storey, V., Sugumaran, V., Ahluwalia, P.: A semiotic metrics suite for assessing the quality of ontologies. Data and Knowledge Engineering 55(1), 84–102 (2005)
11. Castells, P., Fernandez, M., Vallet, D.: An adaptation of the vector-space model for ontology-based information retrieval. IEEE Transactions on Knowledge and Data Engineering 19(2), 261–272 (2007)
12. Ciorascu, C., Ciorascu, I., Stoffel, K.: knOWLer - ontological support for information retrieval systems. In: SIGIR 2003 Conference, Workshop on Semantic Web, Toronto, Canada (2003)
13. Ding, L., Finin, T., Joshi, A., Pan, R., Cost, R.S., Peng, Y., Reddivari, P., Doshi, V., Sachs, J.: Swoogle: A search and metadata engine for the semantic web. In: Proceedings of the 13th ACM Conference on Information and Knowledge Management (CIKM), pp. 652–659. ACM Press, New York (2004)
14. Gangemi, A., Catenacci, C., Ciaramita, M., Lehmann, J.: Ontology evaluation and validation. An integrated formal model for the quality diagnostic task. Technical report, ISTC-CNR, Trento, Italy (2005)
15. Giboin, A., Gandon, F., Corby, O., Dieng, R.: Assessment of ontology-based tools: a step towards systemizing the scenario approach. In: EON 2002 workshop (2002)
16. Guarino, N., Welty, C.: An Overview of OntoClean. In: Handbook on Ontologies, pp. 151–172. Springer, Heidelberg (2004)
17. Gulla, J.A., Borch, H.O., Ingvaldsen, J.E.: Ontology Learning for Search Applications. In: Meersman, R., Tari, Z. (eds.) OTM 2007, Part I. LNCS, vol. 4803, pp. 1050–1062. Springer, Heidelberg (2007)

18. Kalfoglou, Y.: Knowledge society arguments revisited in the semantic technologies era. Int. J. of Knowledge and Learning 3(2/3), 225–244 (2007)
19. Kiryakov, A., Popov, B., Terziev, I., Manov, D.: Ognyanoff: Semantic annotation, indexing, and retrieval. Journal of Web Semantics 2(1), 49–79 (2004)
20. Lozano-Tello, A., Gomez-Perez, A.: Ontometric: A method to choose appropriate ontology. Journal of Database Management 15(2), 1–18 (2004)
21. Nagypal, G.: Improving information retrieval effectiveness by using domain knowledge stored in ontologies. In: Meersman, R., Tari, Z., Herrero, P. (eds.) OTM-WS 2005. LNCS, vol. 3762, pp. 780–789. Springer, Heidelberg (2005)
22. Panagis, Y., Sakkopoulos, E., Garofalakis, J., Tsakalidis, A.: Optimisation mechanism for web search results using topic knowledge. Int. J. Knowledge and Learning 2(1/2), 140–153 (2006)
23. Patel, C., Supekar, K., Lee, Y., Park, E.: OntoKhoj: A semantic web portal for ontology searching, ranking and classification. In: Proceedings of the Workshop on Web Information and Data Management, pp. 58–61. ACM Press, New York (2003)
24. Paralic, J., Kostial, I.: Ontology-based information retrieval. In: Proceedings of the 14th International Conference on Information and Intelligent systems (IIS 2003), Varazdin, Croatia, pp. 23–28 (2003)
25. Rocha, C., Schwabe, D., de Aragao, M.: A hybrid approach for searching in the semantic web. In: Proceedings of WWW 2004, pp. 374–383. ACM Press, New York (2004)
26. Song, J.F., Zhang, W.M., Xiao, W., Li, G.H., Xu, Z.N.: Ontology-based information retrieval model for the semantic web. In: Proceedings of EEE 2005, pp. 152–155. IEEE Computer Society, Los Alamitos (2005)
27. Spyns, P., Reinberger, M.L.: Lexically evaluating ontology triples generated automatically from texts. In: Gómez-Pérez, A., Euzenat, J. (eds.) ESWC 2005. LNCS, vol. 3532, pp. 563–577. Springer, Heidelberg (2005)
28. Strasunskas, D., Tomassen, S.L.: Web Search Tailored Ontology Evaluation Framework. In: Chang, K.C.-C., Wang, W., Chen, L., Ellis, C.A., Hsu, C.-H., Tsoi, A.C., Wang, H. (eds.) APWeb/WAIM 2007. LNCS, vol. 4537, pp. 372–383. Springer, Heidelberg (2007)
29. Suomela, S., Kekalainen, J.: Ontology as a search-tool: A study of real user's query formulation with and without conceptual support. In: Losada, D.E., Fernández-Luna, J.M. (eds.) ECIR 2005. LNCS, vol. 3408, pp. 315–329. Springer, Heidelberg (2005)
30. Tartir, S., Arpinar, I., Moore, M., Sheth, A., Aleman-Meza, B.: OntoQA: Metric-based ontology quality analysis. In: IEEE Workshop on Knowledge Acquisition from Distributed, Autonomous, Semantically Heterogeneous Data and Knowledge Sources, Houston, TX, USA, pp. 45–53. IEEE Computer Society, Los Alamitos (2005)
31. Tomassen, S.: Automatic construction of ontology concept feature vectors and evaluation (in press)
32. Tomassen, S., Strasunskas, D.: Query terms abstraction layers. In: Meersman, R., Tari, Z., Herrero, P. (eds.) OTM 2006 Workshops. LNCS, vol. 4278, pp. 1786–1795. Springer, Heidelberg (2006)
33. Yang, H.-C.: A method for automatic construction of learning contents in semantic web by a text mining approach. Int. J. Knowledge and Learning 2(1/2), 89–105 (2006)

Biggest Barriers to Effectiveness in CIO Role in Large Portuguese Companies

João Varajão[1], António Trigo[2], José Bulas-Cruz[3], and João Barroso[4]

[1] Departamento de Engenharias, Universidade de Trás-os-Montes e Alto Douro, Apartado 1013, 5001-801 Vila Real, Portugal
jvarajao@utad.pt

[2] Escola Superior de Tecnologia e Gestão de Mirandela, Instituto Politécnico de Bragança, Rua João Maria Sarmento Pimentel, Apartado 128, 5370-326 Mirandela, Portugal
trigo@ipb.pt

[3] Centro de Investigação e de Tecnologias Agroambientais e Biológicas, Apartado 1013, 5001-801 Vila Real, Portugal
jcruz@utad.pt

[4] Grupo de Investigação em Engenharia do Conhecimento e Apoio à Decisão, Instituto Superior de Engenharia do Porto, Rua Dr. António Bernardino de Almeida, 431, 4200-072 Porto, Portugal
jbarroso@utad.pt

Abstract. This study provides some empirical insight on the barriers that chief information officers face in their Job. The findings of the survey we conducted directed to the chief information officers of the 500 large Portuguese companies by gross revenue, suggest three main barriers: the lack of time to think and define strategies, the overwhelming backlog of requests and projects and inadequate budgets. The knowledge and understanding of the identified barriers contributes to the characterization of chief information officer role state of the art and should be useful for practitioners, who may use it as a basis for developing solutions in order to overcome these barriers.

1 Introduction

The enormous dissemination of Information Technologies (IT) in the organizations came to confer to the Chief Information Officer (CIO) an absolutely central role in the development of business strategies. While in the past CIO's responsibilities were practically circumscribed to the operational functions, exerting a essentially technician role in its nature and with a limited importance for the organization, she/he is nowadays responsible for all the IS department on which depends the good functioning, success and survival of practically any organization [1]. The IT manager is, thus, the maximum responsible for the Information System Function (ISF), normally materialized in the IS department, which consists of the set of activities that in an organization aims the optimization of the organization's IS, namely, Information Systems Planning (ISP), Information Systems Development (ISD), Information Systems Exploitation (ISE) and

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 479–488, 2008.

Information Systems Management (ISM) [2]. The position that the CIO has conquered in the organization implies that the disturbances that appear in the fulfillment of its role, have today a much more significant impact in the organizations of that one that would have in the past, being the CIO success of critical importance not only for the present of the organization, as well as for its future. To identify and understand the main difficulties that the CIO encounter in the development of their activities is crucial, so that they can develop and implement the appropriate measures to overcome these barriers.

This paper discusses the results of a survey conducted to determine the biggest barriers to effectiveness in CIO role in large Portuguese companies. It also presents a comparison of the results from this study with results from a study developed in US.

2 Literature Review

Today's CIO have assumed many influential roles and responsibilities, such as overseeing new product development, facilitating knowledge management activities, prescribing business process reengineering efforts, assuming regulatory compliance, and administrating the company's IT maintenance. The CIO of today are reported to see themselves as business executives with responsibilities for harnessing the potential of IT in the interest of their company business [1,3,4].

The analysis of diverse works [5,6,7,8] devoted to the study of managerial work of IS managers reveal a set of eight basic roles [1]: leader; liaison; monitor; spokesman; entrepreneur; resource allocator; change architect; and technology strategist. The importance of the CIO's roles depends on the context where the organization is inserted, namely the nature of the business, the dimension of the organization, the country, etc. [6,7,8,9]. So, the cited roles will have a relative importance in accordance with the organizational conjuncture to which the CIO belongs.

CIO accomplishes her/his role in the organization trough a set of activities:

- Interacting with the TMT is a crucial activity since both the CIO and TMT have as one of the top concerns the IS strategic alignment. CIO and TMT need to have a shared language and a shared understanding regarding the role of IT/IS and ISF within a company [10]. The lack of language and understanding is one of the most cited reasons for the poor IS strategic alignment [11,12].
- Making strategic decisions involve formulating IS objectives, defining strategies, policies and detailed plans to achieve them.
- Managing projects and application development faces new challenges since most of today's projects and applications are not built in-house. Inclusively, they tend to be partially or totally outsourced to countries with inferior costs like India [13,14,15];
- The IT activity of designing and optimizing business processes of the organization is the activity where the CIO can prove the value of IT by defining and adjusting IT standards and technologies to business processes;

– Hiring of staff, development of systems and managing the IT function is the CIO responsibility. The CIO needs to guarantee the current and future shortage of qualified IS personnel that threatens the IS department ability to keep up with the information needs of the company [16,17];
– Outsourcing of IT started in the 90s and did not stop growing. Many companies even see it as the holy grail for all the problems within an organization and the way to achieve all the organization goals [18]. Therefore, the has to interact with IT vendors, outsourcers and service providers.
– Managing crises is an activity that most CIO should not need to perform if everything went well and there were not any surprises in the way. The truth is that a large number of CIO, mainly in small medium companies end up performing this activity more than they would like [19];
– Budgeting is the process of predicting and controlling the spending of money. It consists of a periodic negotiation cycle to set budgets and a day-to-day monitoring of the current budgets [20].
– Interacting with clients and business partners effectively is very important due to the fact that many of the IT projects are developed for external client use and not only in-house use.

For the above activities the following barriers were identified [21,22]:

– Inadequate budgets;
– Shortage of time for strategic thinking and planning;
– Unrealistic expectations from the TMT;
– Lack of technical skill sets within the IT department;
– High degree of technology obsolescence;
– Difficulty proving the value of IT;
– Lack of alignment between business goals and IT efforts;
– Overwhelming backlog of requests and projects.

The great diversity of incumbencies for which the CIO is responsible clearly illustrates the importance that CIO has for the good functioning and development of the organizations to which they belong. So, it is of great importance to identify and understand the main barriers that exist in the exercise of the CIO activities to find solutions to overcome those barriers and thus minimize the impact of those barriers in the overall performance of the CIO, and of the entire company.

3 Research Focus, Design and Method

A survey was conducted to investigate several aspects of IS department's reality in large Portuguese organizations. Specifically for this study, the survey aimed to determine the biggest barriers to effectiveness in CIO role. The general methodology involved a questionnaire that was sent in 2006 July to 500 large Portuguese organizations by gross revenue. Three months later, after two rounds, 54 usable questionnaires were received and the data collection process was concluded. The data analysis and results presentation occurred in the next nine weeks. These usable surveys were coded and entered into SPSS.

3.1 Subjects

The survey, undertaken from July to October 2006, focused on Portugal's large companies. The subjects in this study consisted of CIO of the 500 largest Portuguese companies by gross revenue listed in the 2003 issue of Exame Magazine [23]. This particular audience was preferred because the firms are generally leaders in technology use and application [24,25], and need to have a well structured IT department to deal and manage the overall information system architecture. Therefore, the use of the "Exame 500 companies" as the target group seemed most appropriate. A database with the list of the 500 large Portuguese companies was prepared and the survey questionnaire was sent to each CIO.

3.2 Questionnaire

A survey instrument was formulated to obtain feedback from the CIO. The structure of the questionnaire, partly based on earlier surveys conducted by CIO magazine [21], addressed several key aspects of the CIO role with different types of questions. The questionnaire was divided into several sections, each one with well defined objectives. The proposed questionnaire was pre-tested several times to validate its content and readability and to improve some aspects of the questions. The necessary changes were made to the final questionnaire, which was delivered to all Exame 500 CIO by post. With the questionnaire was sent a letter briefing the subjects about the scope and goals of the study, including a link to an Internet home page that allowed the questionnaire to be filled out online.

3.3 Data Representativeness

The survey was mailed to 500 CIO of "Exame 500 companies". The number of undelivered and return questionnaires were 11 so, 489 total questionnaires were mailed. This mailing received 55 responses. Of these, one was rejected because many items were left blank, yielding a final usable response rate of 11%. This response rate did not come as a surprise as it is comparable with the response rates of others studies conducted in the last few years [24,25,26,27,28,29]. This may be due to the fact that the subjects are unwilling to respond to unsolicited survey [24], or simply had insufficient time [28] or because many more companies set a policy of rejecting survey questionnaires [24,28]. It is interesting to note that, although a paper version of the questionnaire was sent by post, unlike others studies in the past [26], the overwhelming majority of CIO (82%) replied electronically online.

Before the data analysis, the data representativeness of the sample was examined. As others studies [24,25], non-response bias was examined by comparing industry type of the respondents to entire sample. The Chi-square goodness-of-fit (Chi-square=14.39, $p<0.085$) test showed that industry type of respondents were not significantly different from the "Exame 500 companies" as a whole. Table 1 shows the characteristics of the respondents.

Table 1. Size of respondents' companies

Size of company	Survey population
Total number of employees	
<200	14
201-500	19
501-2000	16
>2000	5
Annual sales(euros)	
5 million to below 50 million	12
50 million to below 500 million	29
Greater than 500 million	8
No answer	5
International presence (number of countries)	
1	20
2	4
3-4	11
5-20	5
>20	9
No answer	5

The majority of CIOs that answer the survey were male (94%) with a Bachelor's degree (65%). They have an average tenure with in their organization of 10,6 years and an average tenure in their current position of 7,6 years.

4 Analysis and Results

The great diversity of incumbencies for which the CIO is responsible clearly illustrates the importance that CIO has for the good functioning and development of the organizations to which they belong. The identification and understanding of the main barriers that exist in the exercise of the CIO activities is essential to find solutions that can overcome those barriers and thus minimize the impact of those barriers in the overall performance of the CIO.

In the questionnaire used in this study, for data collection, we requested the participants to classify the importance of the barriers in the CIO's work in Likert scale varying from one to five, where one is the least important and five the most important.

The barriers identified as the most important, occupying the top three positions, were: Shortage of time for strategic thinking and planning, overwhelming backlog of requests and projects and inadequate budgets. These three barriers have an average importance of 3. To notice that these had been motivations very frequent pointed in the past and that they continue to have extreme importance in the present, as studies carried disclose [21,22,30].

A recent study [31] conducted with the goal of identifying the activities performed by CIOs shows that they spend most of their time solving operational problems, interacting with the TMT and managing projects. The activity of solving operational problems appears as the responsible for the barrier shortage of time for strategic thinking and planning. When asked "What are the five biggest hurdles or barriers to your effectiveness in your role right now?" [22], US CIOs, answered that the biggest three were, shortage of time for strategic thinking/planning (54%); overwhelming backlog of request/projects (54%); inadequate budgets (51%). To notice that these main barriers identified by US CIOs were coincident with the study conducted by us, from which we can take two results: First, these three barriers deserve to be carefully study in order to find solutions to overcome them; Secondly the difficulties felt by CIOs of Portuguese large companies are similar to their US counterparts.

To analyze the relation between the barriers, we calculated, with SPSS, the existent correlation coefficients, which are presented in Table 2.

Correlation is significant at the .01 level between:

A1 Inadequate budgets and overwhelming backlog of requests and projects;

B1 Shortage of time for strategic thinking and planning and unrealistic expectations from the TMT;

C1 Unrealistic expectations from the TMT and difficulty proving the value of IT;

Table 2. Correlation between barriers

	1	2	3	4	5	6	7	8
Inadequate budgets	1							
Shortage of time for strat- -egic thinking and planning	.095	1						
Unrealistic expectations from the TMT	.327*	.398**	1					
Lack of technical skill sets within the IT department	-.177	.061	.088	1				
High degree of technology obsolescence	.094	.275*	.317*	.106	1			
Difficulty proving the value of IT	-.033	.225	.391**	.097	.283*	1		
Lack of alignment between business goals and IT efforts	-.014	.088	.291*	.144	.4**	0.431**	1	
Overwhelming backlog of requests and projects	.420**	.333*	.224	-.034	.164	.03	-.147	1

**Correlation is significant at the .01 level.

*Correlation is significant at the .05 level.

D1 High degree of technology obsolescence and lack of alignment between the business and IT;

E1 Difficulty to prove IT value and lack of alignment between business goals and IT efforts.

Correlation is significant at the .05 level between:

A2 Inadequate budgets and unrealistic expectations from the TMT;

B2 Shortage of time for strategic thinking and planning and high degree of technology obsolescence;

C2 Shortage of time for strategic thinking and planning and overwhelming backlog of requests and projects;

D2 Unrealistic expectations from the TMT and high degree of technology obsolescence;

E2 Unrealistic expectations from the TMT and lack of alignment between business goals and IT efforts;

F2 High degree of technology obsolescence and difficulty proving the value of IT.

B1, C1, A2, D2 and E2 correlations indicate that the barrier unrealistic expectations from the TMT is significantly related to the barriers shortage of time for strategic thinking and planning, difficulty proving the value of IT, inadequate budgets, high degree of technology obsolescence and lack of alignment between business goals and IT efforts". This existing barrier to the development of the activities of the CIO seems to be the source of many of the faced difficulties. The unrealistic expectations from the TMT might be the reason why CIOs do not obtain adequate budgets to face the necessities derived from the huge number of requests and projects, as it is suggested by A1.

On the other hand, the C1, E2 and B1 correlations, suggest lack of communication, or of an effective communication, between TMT and the CIO what clearly harms the understanding of the importance of the initiatives carry out by IT and consequently the miss alignment between business and IT. If the TMT perceives the ISF and the role of the IT/IS in the company well, then it will be capable of, together with the CIO, work with sight to the alignment of the business goals and IT/IS efforts, granting to the CIO the time necessary to think and to define strategies, building this way realistic expectations about what it is possible to reach and, in last instance, to confer budgets adjusted for the development of the ISF. This will also contribute to demonstrate the IT value.

B2 and C2 correlations point out that the shortage of time for strategic thinking and planning is related with the existence of an overwhelming backlog of requests and projects and with the high degree of technology obsolescence. The huge number of requests and projects placed to the CIO leads many times to spend most of her/his time to solve problems of operational nature, not leaving much time to the activity of thinking and planning of strategies for IT/IS initiatives. This shortage of time can be in the origin of CIOs feeling as an important barrier the high degree of obsolescence of the technology, due to the fact that the adoption of IT/IS solutions might not be as well evaluated, as it should be. Consequently, if the IT/IS solutions adoption is strongly affected by the obsolescence of the technology, it becomes difficult to prove the IT value as it is suggested by F2.

This idea is reinforced by D1 and E1 correlations, which suggest that the lack of alignment between business goals and IT/IS is related to the high degree of obsolescence of the technology and with the difficulty to prove IT value. Case the IT/IS are adopted according to the real needs of the business it will be much easier to evaluate the gains from the use of IT/IS and to prove the value of IT/IS.

The analysis of the existing barriers clearly suggests that the solution for most of the difficulties, which appear to the CIO while performing her/his job, is to communicate effectively with the TMT, in order to understand what the TMT wants from IT and helping them to understand the limitations and potentials of the IT/IS. Traditional difficulties like the lack of alignment between business goals and IT efforts are still present in the CIO agenda and deserve all her/his attention.

5 Knowledge Society

Economic productivity in 21st century will depend on enhanced application of information and knowledge to economic activity [32]. In this new emerging society, knowledge society, organizations are becoming increasingly dependent on their IT/IS. Today, IT/IS is present at almost all the organizational activities [33] and few are the organizations that try to conduct their businesses without seeking to exploit the advantages of IT/IS solutions [34].

Being the CIO the maximum responsible for the organization IT/IS it is important to identify disturbances in the execution of its work that can jeopardize the IT/IS of the organization in the current global knowledge society in which we live.

The results obtained are particularly pertinent for the construction of solutions, such as frameworks to access the impact of the barriers, for the difficulties that the CIO face in the development of theirs activities, thus contributing for better performance of the CIO and of the organizations they are part of.

6 Limitations

The primary limitation of this research, as other studies that use a similar research sample [24,25,28], is that the results cannot be generalized to all business. It is true that large organizations generally provide leadership in using information technology, but differences do exist between small and large business [25]. Therefore, careful use of the results should be made, especially as to their applicability to small businesses.

7 Conclusions

Today, the CIO is not only responsible for managing the different existing technologies in the organization but also responsible for defining the IT/IS strategies, which will have to be duly lined up with the directives of the TMT. It is demanded to the CIO to match its capacities and knowledge at the IT/IS level with a deep knowledge of the business of the organization [1,35].

This paper identifies and discusses the current main barriers to effectiveness in CIO role. The findings of this study, lead next to the 500 largest Portuguese companies, suggest as main difficulties in the execution of the CIO activities, the lack of time to think and to define strategies, the overwhelming backlog of requests and projects and the inadequate budgets.

References

1. Trigo, A., Varajão, J., Barroso, J.: Os papéis do gestor de Sistemas de Informação. CONTECSI 2007– 4º Congresso Internacional de Gestão de Tecnologia e Sistemas de Informação, São Paulo, Brasil (2007)
2. Varajão, J.E.Q.: Contributos para a melhoria do sucesso da adopção de tecnologias de informação e desenvolvimento de sistemas de informação nas organizações. Departamento de Sistemas de Informação, Phd. Thesis. Universidade do Minho, Guimarães, p. 439 (2002)
3. Polansky, M., Inuganti, T., Wiggins, S.: The 21st Century CIO. Business Strategy Review 15, 29–33 (2004)
4. Philip, G.: IS Strategic Planning for Operational Efficiency. Information Systems Management 24, 247–264 (2007)
5. McCall, M.W., Segrist, C.A. In: Pursuit of the Manager's Job: Building on Mintzberg. Center for Creative Leadership, Greensboro, N.C (1980)
6. Grover, V., Seung-Ryul, J., William, J.K., Lee, C.C.: The Chief Information Officer: A study of managerial roles. Journal of Management Information Systems 10, 107–130 (1993)
7. Gottschalk, P., Taylor, N.: Strategic Management of IS/IT functions: The role of the CIO. In: 33rd Hawaii International Conference on System Sciences (2000)
8. Gottschalk, P.: The Chief Information Officer: A Study of Managerial Roles in Norway. In: 35th Hawaii International Conference on Systems Science, Hawaii (2002)
9. Stephens, C., Ledbetter, W., Mitra, A., Ford, F.: Executive or functional? The nature of the CIO's job. MIS Quarterly, 449–467 (1992)
10. Johnson, A.M., Lederer, A.L.: The Impact of Communication between CEOs and CIOs on their Shared Views of the Current and Future Role of IT. Information Systems Management 24, 85–90 (2007)
11. Preston, D.: Shared Mental Models Between the CIO and CEO: Towards Information Systems Strategic Alignment. In: Ninth Americas Conference of Information Systems, Tampa, FL (2003)
12. Vedder, R.G., Guynes, C.S.: Cios' Perspectives on Competitive Intelligence. Information Systems Management 19, 49–55 (2002)
13. Iijima, T.: Auditing your offshore outsource. Journal of Corporate Accounting & Finance 18, 11–18 (2007)
14. Hirschheim, R., George, B., Wong, S.F.: Information Technology Outsourcing: The Move Towards Offshoring. Indian Journal of Economics & Businees 3 (2004)

15. Heeks, R., Krishna, S., Nicholsen, B., Sahay, S.: Synching or sinking: global software outsourcing relationships. Software IEEE 18, 54–60 (2001)
16. Nelson, R.R.: Educational needs as perceived by IS and end-user personnel: A survey of knowledge and skill requirements. MIS Quarterly 15, 503–525 (1991)
17. Hoving, R.: Information Technology Leadership Challenges - Past, Present, and Future. Information Systems Management 24, 147–153 (2007)
18. Dibbern, J., Goles, T., Hirschheim, R., Jayatilaka, B.: Information Systems Outsourcing: A Survey and Analysis of the Literature. The DATA BASE for Advances in Information Systems 35, 6–102 (2004)
19. CIOMAG: State of the CIO: Challenges Differ in SMBs, large Organizations. CIO Magazine (2004)
20. Sutter, J.d.: The Power of IT: Survival Guide for the CIO. BookSurge, LLC (2004)
21. CIOMAG: The State of the CIO 2006. CIO Magazine's (2006)
22. CIOMAG: The State of the CIO 2007. CIO Magazine's (2007)
23. Exame: Ranking das 500 Maiores & Melhores. Revista Exame (2003)
24. Li, E.Y., McLeod, R., Rogers, J.C.: Marketing information systems in Fortune 500 companies: a longitudinal analysis of 1980, 1990, and 2000. Information & Management 38, 307–322 (2001)
25. Liu, C., Arnett, K.P.: Exploring the factors associated with Web site success in the context of electronic commerce. Information & Management 38 (2000)
26. Kendall, J.D., Tung, L.L., Chua, K.H., Hong, C., Ng, D., Tan, S.M.: Receptivity of Singapore's SMEs to electronic commerce adoption. Journal of Strategic Information Systems 10, 223–242 (2001)
27. Enns, H.G., Huff, S.L., Golden, B.R.: How CIOs obtain peer commitment to strategic IS proposals: barriers and facilitators. Journal of Strategic Information Systems 10, 3–14 (2001)
28. Lin, C., Pervan, G.: The practice of IS/IT benefits management in large Australian organizations. Information & Management 41, 13–24 (2003)
29. Sohal, A.S., Ng, L.: The role and impact of information technology in Australian business. Journal of Information Technology 13, 201–217 (1998)
30. Smaltz, D.H., Sambamurthy, V., Agarwal, R.: The Antecedents of CIO Role Effectiveness in Organizations: An Empirical Study in the Healthcare Sector. IEEE Transactions on Engineering Management 53 (2006)
31. Varajão, J., Trigo, A., Figueiredo, N., Barroso, J.: TI nas empresas nacionais. Revista CXO 2, 19–23 (2007)
32. Information Society Comission: Building the Knowledge Society. Dublin 2 (2002)
33. Varajão, J., Ribeiro, A.T., Figueiredo, N., Barroso, J.: Motivações inerentes á adopção de Tecnologias e Sistemas de Informação nas grandes empresas portuguesas. In: 6^a CISCI, Orlando, EUA, vol. 1, pp. 287–292 (2007)
34. Trigo, A., Varajão, J., Figueiredo, N., Barroso, J.: Information systems and technology adoption by the Portuguese large companies: EMCIS, Valence, Spain, vol. 15, pp. 1–7 (2007)
35. Karahanna, E., Watsin, R.T.: Information Systems Leadership. IEEE Transactions on Engineering Management 53, 171–176 (2006)

A Computational Experiment to Describe Opinion Formation Using a Master Equation and Monte Carlo Simulations

Sarantos Psycharis[1], Evi Makri-Botsari[2], Gregorios Mouladidis[3], Fotini Paraskeva[4], and Vassilis Tatsis[5]

[1] University of the Aegean-Department of Education and Advanced School of Pedagogy and Technology ASPETE-Athens
sarpsy@otenet.gr
[2] School of Pedagogy and Technology ASPETE
maeducation@aspete.gr
[3] School of Pedagogy and Technology ASPETE
bm-clwrzc@otenet.gr
[4] University of Piraeus
paraskeva@bfm.co.hol.gr
[5] University of the Aegean
premnt06024@rhodes.aegean.gr

Abstract. We propose a computer simulation model aiming to describe the interaction of students in a learning environment composed of the teacher, the students in a collaborative project and the educational material. Our aim is to investigate the change of the opinion of students when they interact with an agent with different opinion. This model can apply to all levels of education in order to explore the reconciliation or not of different opinions during the teaching and learning sequence as well as to examine the resistance of students to new challenges and concepts. The idea is based on the social impact theory and uses methods of Computational Physics, mainly the Monte Carlo techniques and the notion of master equation. Results from simulations indicate that opinion formation is established for different values of the populations when the temperature is below the critical temperature.

Keywords: Master equation, ICT, Monte Carlo, Computational Physics.

1 Introduction

According to Landau (2008) Computational Physics is a subfield of computational science and is a multidisciplinary subject combining aspects of physics, applied mathematics and computer science.

In the last 30 years there has been a lot of interest in implementing methods of Computational Physics for a quantitative description of teaching-learning as well as social and economic processes (see for example Weidlich, 1991; Vallacher & Nowak 1994; Cowan et.al 1994; Gilbert & Doran, 1994; Clelia et.al 2001). The development also of the interdisciplinary field-known as science of complexity-explores complex dynamic processes using methods of Computational Physics (Holyst et.al 2001).

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 489–500, 2008.

The multidisciplinary approach to study complex systems links psychological and sociological theories of impact, education psychology, mathematics, computer science statistical physics e.t.c(Berliner & Calfee 1996; Binder 1987;Epstein, 2006; Helbing ,1995; Helbing, 1993;Latane,1996;Latane,2000;Mantegna & Stanley ,2000; Stauffer,2002;Meadows et.al,1974;Prietula et.al,1998; Janssen et.al,1999; Weidlich & Haag, 1983). It is also well-known that Markovian stochastic processes are clearly connected to diffusion equations and thus are described by a master equation. Types of master equations had been applied to Physics in Molecular Dynamics, Thermodynamics, Laser Physics e.t.c. but Haag & Weidlich (1983,1988) 25-30 years ago used these in order to investigate and describe successfully social processes ,opinion formation ,migration agglomeration and settlement processes (Weidlich,1991; Weidlich & Haag,1987).

Many Physicists also used techniques from the physics of collective disorder and statistical physics in order to study a variety of problems outside the usual field of physics such as social behavior (see for example Kohring,1998; Glance, & Huberman, 1993; Bonabeau et.al 1995, decision making (Galam 1997) multinational organizations (Galam, 1996; Oliveira et.al 1996).

More specifically, many researchers have applied methods of Computational Physics (Monte Carlo, Ising Model e.t.c.) to describe opinion formation in terms of the social impact theory (see for example (Latane,1981; Lewenstein, Nowak & Latane, 1992). It is worthwhile to report that there is a branch of Science called Sociophysics which focus in interdisciplinary research (Weidlich, 2000).

Kohring also (1998) developed a model of opinion formation which parameters are in the form of time dependent interaction functions between members of the social group and correspond to a learning procedure. His model is based on the social impact theory, developed by Latane (1981). Latane considered that the impact exerted on an individual by a group of people is a multiplicative function of their social immediacy, strength and number while large empirical support for this statement has been gathered (Vallacher & Nowak 1994).

2 The Physics Background

The mathematical model is based on the Ising model where N individuals, each of which can share one of two opposite "opinions" on a given subject, denoted as $\sigma_i = \pm 1$, i = 1, ...,N. ± 1 and every individual is characterized by another couple of strength parameters, namely the persuasiveness p and the supportiveness s. These parameters are assumed to be random numbers and in this way disorder is introduced into the system allowing a complex process. In Physics, using Ising model spins σ are placed at the sites of the lattice and take the values ± 1. The values ± 1 could stand for the orientation of the magnetic moment in a ferromagnetic material, the presence or absence of an atom in a solid e.t.c. In our model we use the Ising model in a two dimensional lattice of dimensions L_1, L_2.

In stochastic systems, numerical methods that are known as Monte Carlo methods, can be loosely described as statistical simulation methods, where statistical simulation is defined to be any method that utilizes sequences of random numbers to perform the simulation. A central algorithm in Monte Carlo methods is the Metropolis algorithm, ranked as one of the top ten algorithms in the last century. The Monte Carlo method (i.e. random sampling) is a fundamental numerical tool in the analysis of stochastic systems and Metropolis algorithm is the most common numerical algorithm used to compute probabilities and expectation values. (Dongarra &, Sullivan 2000; Liu,2001). To apply Monte Carlo the only requirement is that the system is described by probability distribution functions (PDF's). Once the PDF's are known, the Monte Carlo simulation can proceed by random sampling from the PDF's. Next, many simulations are performed –characterized as trials- and the desired result is taken as an average over the number of observations (which may be a single observation or millions of observations by generating random numbers uniformly distributed in an interval).

All Monte Carlo schemes used are based on Markov processes in order to generate new random states. A Markov process is a random walk with a selected probability for making a move. The new move is independent of the previous history of the system and the Markov process is used repeatedly in Monte Carlo simulations in order to generate new random states. The reason for choosing a Markov process is that when it is run for a long enough time starting with a random state, we will eventually reach the most likely state of the system. To achieve this Markov process needs to obey two important conditions, that of ergodicity and detailed balance. These conditions impose then constraints on our algorithms for accepting or rejecting new random states. The Metropolis algorithm abides to both these constraints.

The main features of Markov are:

The time development of PDF w(t), after one time-step from t = 0 is given by

$$w_i(t=\varepsilon) = W(j \to i).w_j(t=0) \text{ where } W(j \to i) \equiv Wji \text{ is a matrix} \tag{1}$$

An important condition we require for Markov chain is that of detailed balance. In statistical physics this condition ensures that Boltzmann distribution is reached at equilibrium.

The definition for being in equilibrium is that the rates at which a system makes a transition to or from a given state i have to be equal, that is

$$\Sigma W_{ji}.w_i = \Sigma W_{ij}.w_j \tag{2}$$

However, the condition that the rates should equal each other is in general not sufficient to guarantee that we, after many simulations, generate the correct distribution. We therefore introduce an additional stronger condition, namely that of detailed balance, i.e.

$$W_{ji}.w_i = W_{ij}.w_j \tag{3}$$

We introduce the Boltzmann distribution

$$w_i = \frac{e^{-\beta.\mathrm{E}_i}}{\mathrm{Z}}, \beta = \frac{1}{K\mathrm{T}} \text{ (T the temperature of the system).} \tag{4}$$

The denominator Z is a normalization constant which ensures that the sum of all probabilities is normalized to one. It is defined as the sum of probabilities over all microstates of the system.

To implement the work we are using the Ising Model (Anderson 1997). Ising model consists of a lattice and spins $\sigma_i = \pm 1$ are placed on the sites of the lattice. The Hamiltonian of the system has the form

$$H = -J \sum_{ij} \sigma_i \sigma_j \tag{5}$$

(in the absence of the external magnetic field and for nearest neighbours).

The interaction energy is –J , for aligned spins, +J for antiparallel spins.

Below the critical temperature there is a net magnetization in the different domains formed, while this magnetization is lost above the critical temperature.

3 The Mathematical Model

Let N the number of individuals divided in different classes a, where the different classes of individuals classify students according to their interest for some aspect, or according to a psychological structure (for example people with internal/external locus of control) e.t.c. Let a takes the values a=1 to A where A denotes the number of different values-classes of attitudes/interests/characteristics and obviously

$$\sum_{\alpha=1}^{\mathrm{A}} \mathrm{N}_{\alpha} = \mathrm{N} \tag{6}$$

We consider that every class a is described at time t by a vector $\vec{x} = \{x_1, x_2,,........x_{Sa}\}$ where the different x_i represent a "microstate" corresponding to the particular state a, and $_{Sa}$ is the maximum number of microstates belonging to state a, where

$$\sum_{s=1}^{Sa} \eta_{x_s}^{a} = N_a \tag{7}$$

The state of the system is fully described by the vector $\vec{n} = \{n_{x_1}^{1}, n_{x_2}^{1}, ...n_{x_{S_1}}^{1}, ..., n_{x_1}^{A}, n_{x_2}^{A}, ...n_{x_{S_A}}^{A}\}$ and corresponds to a configuration of the system.

The notation states that when individuals are for example in state a=1 they are distributed in the possible microstates is $n_{x_1}^{1}, n_{x_2}^{1}, ...n_{x_{S_1}}^{1}$.

Relative transition rates from one configuration n to another $\vec{n}'$ are defined through the relation

$$w(\vec{n}', \vec{n}; t) = \lim_{\Delta t \to 0} \frac{P(\vec{n}', t + \Delta t, \vec{n}; t)}{\Delta t} \tag{8}$$

while the absolute transition rates are given by

$$w(\vec{n}', \vec{n}; t).P(\vec{n}, t) \tag{9}$$

From the Chapman-Kolomogrov equation, which sums over the probability of being in a particular state at the current step and the transition probability from that state into state ,we derive the master equation which describes the input-output between the states $\vec{n}, \vec{n}'$ and is given by:

$$\frac{dP(\vec{n},,t)}{dt} = \sum_{n'} w(n, n^{'}; t) P(\vec{n}^{'}, t) - \sum_{n} w(n', n; t) P(\vec{n},,t) \text{ (Helbing 1991)} \tag{10}$$

=inflow into n –outflow from n.

Suppose now that we have two different attitudes a,b. We can accept that:

$$w(\vec{n}', \vec{n}; t) = \eta^{\alpha}_{\bar{x}} \eta^{b}_{\bar{y}} \tilde{w}_{ab}(\vec{x}', \vec{y}' : \vec{x}, \vec{y} : t) \tag{11}$$

where $\eta^{\alpha}_{\bar{x}}, \eta^{b}_{\bar{y}}$ represent the populations in a,b classes at particular configurations (microstates) x,y. The vector

$$\vec{n}' = \vec{\eta}^{\alpha b\, \alpha b}_{\bar{x}'\bar{y}'\bar{x}\,\bar{y}} = (...(\eta^{\alpha}_{\bar{x}'} + 1), ...(\eta^{\alpha}_{\bar{x}} - 1), ...(\eta^{b}_{\bar{y}'} + 1), ...(\eta^{b}_{\bar{y}} - 1), ...) \tag{12}$$

represents the new configuration where some people in state a have decided to move from $\eta^{\alpha}_{\bar{x}}$ to $\eta^{\alpha}_{\bar{x}'}$ (but still in state a) and some people from $\eta^{b}_{\bar{y}}$ to $\eta^{b}_{\bar{y}'}$ and $\tilde{w}_{ab}(\vec{x}', \vec{y}' : \vec{x}, \vec{y} : t)$ is the transition rate between $\vec{x}, \vec{y} \rightarrow \vec{x}', \vec{y}'$ during the interaction between states a, b.

Finally after some more manipulations we end up with the master equation:

$$\frac{dP_a(i,t)}{dt} = \sum_{b}\sum_{i'}\sum_{j} [\tilde{w}_{ab}(i, i', j : t) P_a(i', t) P_b(j, t) - \tilde{w}_{ab}(i', i, j : t) P_a(i, t) P_b(j, t)] \tag{13}$$

where $\tilde{w}_{ab}(i', i, j : t)$ represents the transition rate of change from class a in the state i to the class b in the state j. The transformation $i \rightarrow i'$ declares that people from class a in a state i could change to state i' when they interact with people from class b, be at state j (j not necessarily the same as i'). The elements $\tilde{w}_{ab}$ can be determined empirically during an experiment, for example by considering students within classes a, b and examining the change of their attitudes during an intervention by for example a teaching learning sequence using Information and Communication Technologies (ICT). Elements $\tilde{w}_{ab}$ can be also determined by Monte Carlo simulations.

In the theory of social impact, the variable i could be the opinion of a student at time t about the learning process, or a psychological characteristic, or an attitude towards an intervention e.t.c which could be changed at another time.

A logical ansatz is to assume that:

$$\widetilde{w}_{ab}(i',i,j:t) \sim e^{\beta \cdot I(t)} \text{, } \beta\sim 1/\text{T} . \tag{14}$$

Temperature T can be interpreted as the "social" temperature" which is linked to the degree of randomness in the system regarding the stochastic behaviour of the trainees.(erratic effects). In our model we have to investigate the factors which contribute to I (social impact factor).

Researchers have suggested that (Clelia et.al 2001):

$$I = CI^{TS}(t) + CI^{ss}(t) + CI^{SM}(t) \tag{15}$$

The coefficients in the equation of I have the following meaning:
the cognitive impact (CI) acting on an individual is the overall result of interactions of the following forms:

- interaction -persuasiveness of the teacher T to student S (TS), denoted by $CI^{TS}(i,t)$ (student has the opinion i).
- persuasiveness, *Pji* which describes the degree to which the with opinion I persuade the individual with opinion j and support, *Sij* which describes the degree to which the individual with opinion I supports the statements of the individual with opinion j (for example in a collaborative environment using or not ICT) , denoted by $CI^{ss}(i,t)$
- interaction –critical reading of the material of training and quality of the material M provided, denoted by $CI^{SM}(i,t)$

We also suppose that:

$$CI^{TS}(i,t) = P_{iT}(1 - \sigma_i(t).\sigma_{\text{T}}) \tag{16}$$

where P_{iT} is the ability of teacher T to persuade the student with opinion i

$$CI^{SS}(t) = \sum_{\iota,i\neq j}^{N} P_{ij}(t)(1-\sigma_i(t).\sigma_j(t)) - S_{ij}(t)(1-\sigma_i(t).\sigma_j(t)) \tag{17}$$

$$CI^{SM}(i,t) = \text{A}(1-\sigma_i(t) \tag{18}$$

A a coefficient which represent the readiness, the quality of the educational material e.t.c.

The quantity $\sigma_i(t)$ -opinion I at time t- is the one to be measured.

According to Monte Carlo method we create random numbers with Boltzmann distribution $P_a \sim e^{-Ea/kT}$ at a given temperature (index a corresponds to class a). The acceptance of the configuration is governed by the Metropolis criterion .In this case we used the criterion

$$P_j = \frac{\tau_j}{1+\tau_j} \text{ (Binder 1987) } \tau_j = e^{\beta_{TS}.CI^{TS}} + e^{\beta ss.CI^{SS}} + e^{\beta Ms.CI^{MS}} \tag{19}$$

4 Methodology of Measuerments

To study numerically our model we start with a population of $L_1 \times L_2$ spins in a two dimensional (lattice) with sides L_1, L_2 .All spins initially have the value -1 and represent configurations where all the trainees have the opinion i (class a). Next we create Monte Carlo Lattice configurations using Markov chains and apply the importance sampling method. We change (flip) the spins with probability r from -1 to +1. In this way there are configurations of type a whose number is (1-r. $L_1 \times L_2$) sharing opinion i and configurations of number r. $L_1 \times L_2$ with opinion j (from class b). The development of the system starts for different values of r and temperatures. We

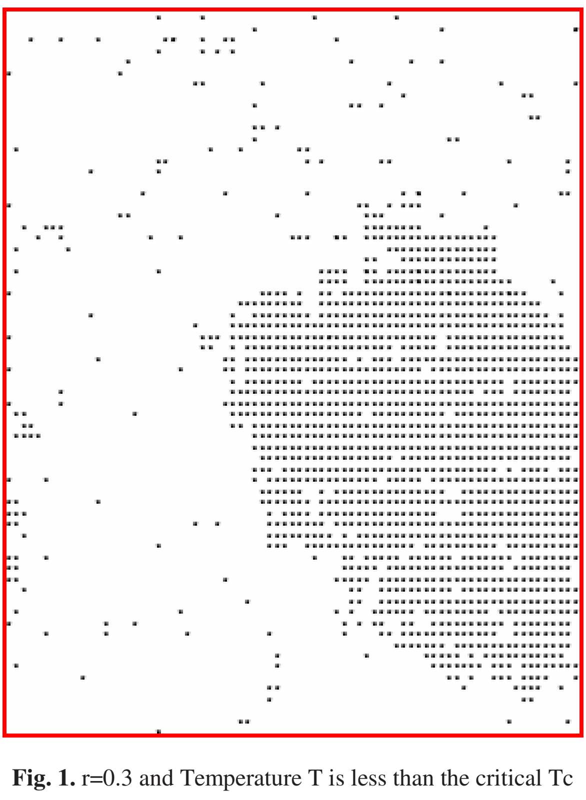


Fig. 1. r=0.3 and Temperature T is less than the critical Tc

consider also different number of Monte Carlo step N as well as different populations sharing the same opinion (a,b)($\eta_{\bar{x}}^{\alpha}, \eta_{\bar{y}}^{b}$).

5 Results

We present our results for temperatures below and above the critical, different Monte Carlo steps , different values of r and different ratio of $\frac{\eta_{\bar{x}}^{\alpha}}{\eta_{\bar{y}}^{b}}$.

From figure we conclude that after 10^6 number of sweeps that a cluster of opinion b is formed independently of the ratio of $\eta_{\bar{x}}^{\alpha}, \eta_{\bar{y}}^{b}$ (the dots stand for opinion b).

Increasing the temperature T so that T>Tc (such case should correspond to a strong leader in class b, an excellent software educational material, a very good teacher

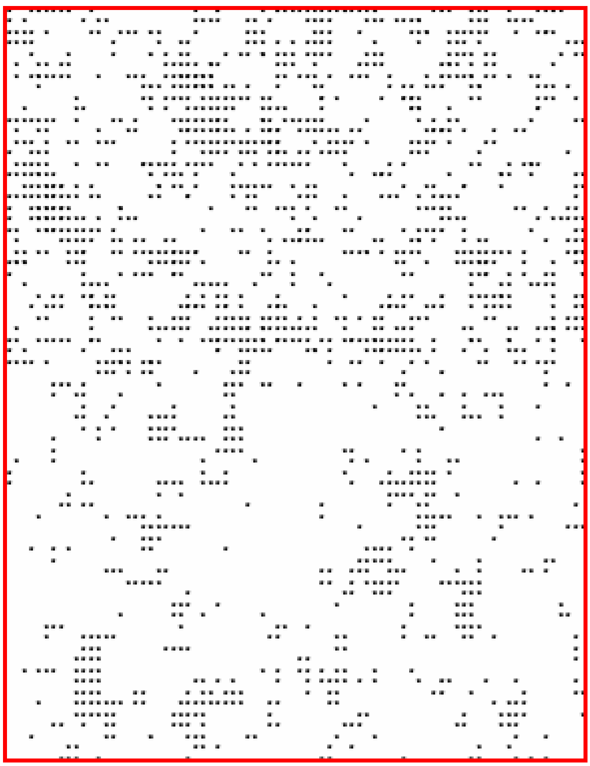


Fig. 2. r=0.3 ,T=1.3* Tc , $\frac{\eta_{\bar{x}}^{\alpha}}{\eta_{\bar{y}}^{b}}$ =1

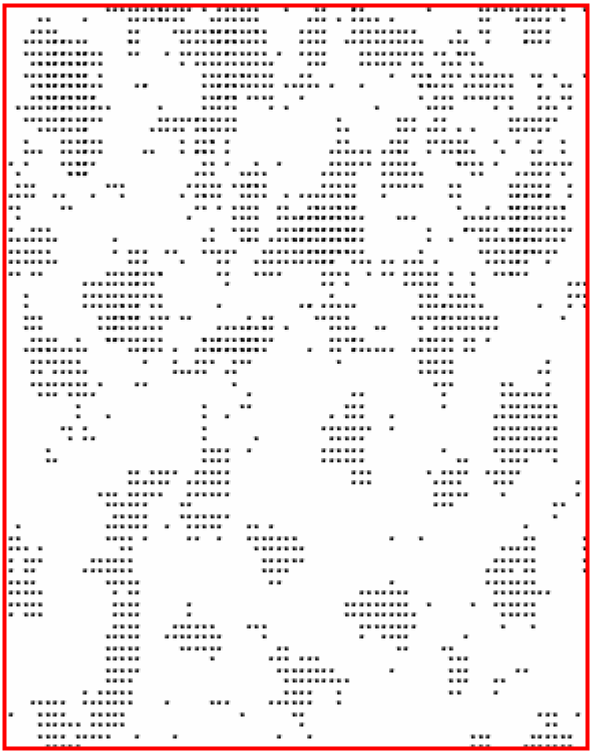


Fig. 3. r=0.3 T=1.7* Tc when $\dfrac{\eta_{\bar{x}}^{\alpha}}{\eta_{\bar{y}}^{b}}$ =0.7

e.t.c.) we observe that opinion b formation dissolves when T=1.3* Tc, when $\dfrac{\eta_{\bar{x}}^{\alpha}}{\eta_{\bar{y}}^{b}}$ =1(Fig. 2) while opinion b formation dissolves at T=1.7* Tc when $\dfrac{\eta_{\bar{x}}^{\alpha}}{\eta_{\bar{y}}^{b}}$ =0.7 (Fig. 3).

6 Conclusions

In our work we presented a model implemented using the Fortran Language in order to study the opinion formation in a collaborative environment. The model studies the interaction between members of the same group as well as from different groups. It is a model that is complete regarding its mathematical structure but further extensions are necessary in order to take into account other parameters involved in the learning-teaching sequence.

Results show that we could have different opinion formation(or resistance) when temperature is below the critical. Further investigation is necessary to examine the opinion formation under certain values of r as well as explicit forms of interactive agents (specific forms of the education material, the type of teacher e.t.c.) so we should apply our model in a teaching-learning sequence.

The Extension will be bases on the use of a 4-dimensional plaquette instead of the 2 dimensional Ising model (Barbour & Psycharis 1990).

References

1. Anderson, P.W.: Basic Notions of Condensed Matter Physics. Addison-Wesley, Reading (1997)
2. Barbour, I., Psycharis, S.: SU(2) and SU(3) Gauge Theories on a Lattice with Twisted Boundary Conditions. Nuclear Physics B 334, 302–308 (1990)
3. Berliner, D.C., Calfee, R.C.: Handbook of Educational Psychology. MacMillan, New York (1996)
4. Binder, K.: Application of the Monte Carlo Method in Statistical Physics. Springer, Heidelberg (1987)
5. Bonabeau, E.G., Theraulaz, G., Deneubourg, J.L.: Phase diagram of a model of self-organizing hierachies. Physica A 217, 373 (1995)
6. Clelia, M., Ezequiel, V.: Theoretical Description of Teaching-Learning Processes: A Multidisciplinary Approach. Physical Review Letters 87(11) (2001)
7. Cohen, J.: Statistical power analysis for the behavioural sciences. Lawrence Erlbaum, Hillsdale (1988)
8. Coombs, S., Smith, I.: Designing a self-organized conversational learning environment. Educational Technology 38(3), 17–28 (1998)
9. Cowan, G.A., Pines, D., Meltzer, D.: Complexity: Metaphors, Models and Reality. Addison-Wesley, Santa Fe (1994)
10. Dongarra, J., Sullivan, F.: Computing in Science and Engineering 2.2, 2(1), 22–23 (2000) ISSN: 1521-9615
11. Epstein, J.M.: Remarks on the Foundations of Agent-Based, Generative Social Science. In: Tesfatsion, L., Judd, K. (eds.) Handbook of Computational Economics II. Elsevier, Amsterdam (2006)
12. Galam, S.: Fragmentation versus stability in bimodal coalitions. Physica A 230, 174–188 (1996)
13. Galam, S.: Rational group decision making: A random field ising model at t = 0. Physica A 238, 66–80 (1997)
14. Gilbert, N., Doran, J.: Simulating Societies: The Computer Simulation of Social Processes. University College, London (1994)
15. Glance, N.S., Huberman, B.A.: The outbreak of cooperation. J. Math. Sociology 17(4), 281 (1993)
16. Glasersfeldt, E.: Constructivism in education. In: Husén, T.T., Postlethwaite, T.L. (eds.) The international encyclopedia of education, pp. 11–12. Pergamon, Oxford (1989)
17. Haag, G., Weidlich, W.: A dynamic phase transition model for spatial agglomeration processes. Journal of Regional Science 27(4), 529–569 (1987)
18. Haag, G., Weidlich, W.: Concepts and Models of a Quantitative Sociology. The Dynamics of Interacting Populations. Springer, Berlin (1983)
19. Haag, G., Weidlich, W.: Interregional Migration. Springer, Berlin (1988)

20. Hake, R.R.: Interactive-engagement versus traditional method: A six-thousand-student survey of mechanics test data for introductory physics courses. American Journal of Physics 66(1), 64–74 (1998)
21. Helbing, D.: A mathematical model for the behavior of pedestrians. Behavioral Science 36, 298–310 (1991)
22. Helbing, D.: Quantitative Sociodynamics. Kluwer Academic, Dordrecht (1995)
23. Helbing, D.: Stochastic and Boltzmann-like models for behavioral changes and their relation to game theory. Physica A 193, 241–258 (1993)
24. Heller, J.I., Reif, F.: Prescribing effective human problem solving processes: Problem descriptions in physics. Cognition and Instruction 1(2), 177–216 (1984)
25. Holyst, J., Krzystzof, K., Schweitzer, F.: Social Impact Models Of Opinion Dynamics. In: Stauffer, D. (ed.) Annual Reviews of Computational Physics IX, pp. 253–273. World Scientific Publishing Company, Singapore (2001)
26. Janssen, M., Jager, W.: An Integrated Approach to Simulating Behavioural Processes: A Case Study of the Lock-In of Consumption Patterns. JASSS - Journal of Artificial Societies and Social Simulation 2(2) (1999)
27. Kohring, G.A.: Ising models of social impact: the role of cumulative advantage. J. Phys. I. France 6, 301 (1998)
28. Latane, B.: Am. Psychologist 36, 343 (1981)
29. Latané, B.: Dynamic Social Impact: Robust Predictions from Simple Theory. In: Hegselmann, R., Mueller, U., Troitzsch, K. (eds.) Modeling and Simulation in the Social Sciences from a Philosophy of Science Point of View. Kluwer, Dorderecht (1996)
30. Latané, B.: Pressures to Uniformity and the Evolution of Cultural Norms. Modeling Dynamics Social Impact. In: Hulin, C., Ilgen, D. (eds.) Computational Modeling of Behavior in Organizations. The Third Scientific Discipline, pp. 189–215. American Psychological Association, Washington (2000)
31. Lewenstein, M., Nowak, A., Latane, B.: Phys. Rev. A 45, 763 (1992)
32. Liu, J.: Monte Carlo Techniques in Scientific Computing. Springer, New York (2001)
33. Lorenz, H.W.: Nonlinear Dynamical Equations and Chaotic Economy. Springer, Berlin (1993)
34. Mantegna, R.N., Stanley, H.E.: An Introduction to Econophysics. Cambridge University Press, Cambridge (2000)
35. Meadows, D.L., Behrens, W.W., Meadows, D.H., Naill, R.F., Randers, J., Zahn, E.K.: The Dynamics of Growth in a Finite World. MIT Press, Cambridge (1974)
36. Metropolis, N., Arianna, W., Rosenbluth, A., Teller, E.: Equation of state calculations by fast computing machines. The Journal of Chemical Physics 21(6), 1087–1092 (1953)
37. Oliveira, P.M., Stauffer, D., Oliveira, M.S., Zorzenon, R.M.: Monte Carlo Simulations of Sexual Reproduction. Physica, A 231, 504 (1996)
38. Prietula, M., Carley, K., Gasser, L.: Simulating Organizations: Computational Models of Institutions and Groups. MIT Press, Cambridge (1998)
39. Reif, F., Heller, J.I.: Knowledge structure and problem solving in physics. Educational psychologist 17(2), 102–127 (1982)
40. Stauffer, D.: Journal of Arificial Societies and Social Simulation 5 (2002)
41. Sweller, J.: Cognitive load during problem solving: Effects on learning. Cognitive Science 12, 257–285 (1988)
42. Vallacher, R., Nowak, A.: Dynamical Systems in Social Psychology. Academic, New York (1995)
43. Vallacher, R.R., Nowak, A.: Dynamical Systems in Social Psychology. Academic, San Diego (1994)

44. Weidlich, W., Haag, G.: Concepts and Models of Quantitative Sociology. Springer, Berlin (1983)
45. Weidlich, W.: Physics and social science - The approach of synergetics. Physics Reports 204, 1–163 (1991)
46. Weidlich, W.: Physics and social science | the approach of synergetics. Phys. Rep. 204 (1991)
47. Weidlich, W.: Sociodynamics: A Systematic Approach to Mathematical Modelling in the Social Sciences. Harwood Academic Publishers (2000)
48. Psycharis,S.: Is there a spontaneous symmetry breaking during the learning process? The use of Monte Carlo Simulation and the Metropolis Algorithm in order to determine the time evolution of the learning effects. Journal Mentoras (2008) (in Greek)

A UML Model of the Client Tracking System at the Learning Enrichment Foundation in Toronto, Canada: A Study of Class, Object, and State Diagrams

Lan Anh Tran

Lecturer in Information Systems
School of Information Management
Victoria University of Wellington
lan.anh.tran@vuw.ac.nz

Abstract. This paper represents a part of the case studies of the UML model for designing the Client Tracking System (CTS) at the Learning Enrichment Foundation (LEF) in Toronto, Canada by Tran [1]. It attempts to apply UML concepts to design UML diagrams that reflect the functional processes within the Client Tracking System. In addition it investigates the task of constructing the design elements for CTS that can be used to manage the client information within LEF. Specifically, this paper investigates class, object, and state diagrams of CTS. Through a study of how the CTS has been structured and how it operates, we may learn lessons that may be useful in other community networks serving significant immigrant communities.

Keywords: UML Model, Class diagram, Object Diagram, State diagram, Client Tracking System.

1 Introduction

The CTS was developed within LEF and has been in operation since 1998. At the beginning this system was designed to support LEF in managing client information and contacting clients. Over the years, CTS has been upgraded to offer a job matching services to LEF clients. Presently, CTS provides a series of information services to the internal users within LEF and its partners, such as accessing client information, internal and external programs, staff information, program schedules, job matches, statistics and report generation, and so on. As the services have improved and increased, the CTS has accumulated more clients successfully [2].

This study attempts to apply UML concepts to design UML diagrams that reflect the functional processes within the CTS. It is a part of the case studies of the UML model for designing the Client Tracking System (CTS) by Tran [1]. It investigates the task of constructing the design elements for CTS that can be used to manage the client information within LEF. Specifically, this paper investigates the class, object, and state diagrams based on the UML model of the existing CTS at LEF.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 501–512, 2008.

2 Significance of the Study

Relying on Unified Modelling Language, this study provides useful knowledge and detailed discussion of the concepts of the class, object, and state diagrams. Such discussion can serve the interests of students, researchers, system designers and practitioners in software development and engineering. The class, object, and state diagrams are one of essential steps for building a structural model of a system based on UML. In summary, this case study attempts to achieve the following benefits and outcomes:

- It will contribute to our knowledge base in the fields of system design and UML diagrams.
- It demonstrates step-by-step practical diagramming for class, object, and object diagrams using UML in system design.
- It contributes to the improvement of information and service delivery to local communities through an internal information system, such as the CTS at LEF.
- It increases awareness among system designers working in community organizations of the benefits and significance of system design. Such awareness can help these organizations become more responsive to their clients and stakeholders.

3 Methodology

This research employs a combination of methods to collect the best possible data and to understand the meaning of the data as clearly as possible.

- It begins with a review of the literature on UML models plus initial fieldwork involving visits to LEF in order to gain an understanding of the organization, its activities and services. Additionally, such visits allow the researcher to observe the development and use of the existing CTS within LEF. This initial step is the grounding for the research – a combination of literature review and collection of observational data on the development of CTS. It should be noted note that description of the existing CTS is partly dependent on a number of unpublished resources within LEF.
- The next step is to communicate (verbally and by email) with the managers and system designer, who have been involved with the development and implementation of the CTS, for their explanations and clarification about what is observed.
- In the final step the research, based on the preceding analysis, designs a series of detailed UML diagrams in order to derive a design model of CTS based on the existing literature in the field of UML models for system design.

4 Research Objectives and Research Questions

This research is undertaken to fill a gap in our knowledge of system design for community services within community organizations, and to further our understanding of the class, object, and state diagrams through design processes. To achieve this aim the research is designed in two parts. The first part focuses on observation of the existing

CTS within LEF. It explores the users, components, structure and operation of the system for tracking client information and making job matches. The second part analyses and develops the class, object, and state diagrams for designing the CTS.

To focus this investigation, the key issues can be stated as the research question - What class, object, and state diagrams, as part of the UML model, make up a client information system that can support LEF in meeting the needs of its clients in the local community?

5 Definitions of Terms

- **Unified Modelling Language (UML)** is used for object modelling in designing software or application programs. UML 'includes a graphical notation used to create an abstract model of a system, referred to as a ***UML model***' [3]. The ***UML tool*** allows software designers to draw use cases and design system diagrams, such as class, object, sequence, activity, state, collaboration, and component and deployment diagrams. The concepts of class, object, and state diagram will be explained in the next sections.
- **Design model** of a computerised system describes a sequential process that begins with the analysis of system requirements, followed by a collection of specific diagrams for depicting system structure, its components and operation; it ends with the deployment diagram to achieve system requirements.
- **Client information** contains client demographic characteristics, such as gender, age, employment history, education, etc. Such characteristics allow LEF staff to provide relevant community services to their clients.
- **Client Tracking System** is a computerised system employed by internal users within an organization for storing and managing client information, for searching job matches, and for sharing information between the organization and its partners.

6 Statement of the Modelled System – CTS

> The purpose of the CTS will be to facilitate the internal management of clients within an organization (Operations Module), and enable the sharing of client information and cross-referral between members of the collaborative (Referral Module). (Page 12 in [2])

This case study explores the tasks involved in creating the design elements for the CTS that can be used to manage clients within LEF. According to the Executive Director, LEF provides over 300 graduates each year with specific job skills and practical experience that employers require [4]. LEF has offered a variety of training programs to its clients, such as early childhood assistance, industrial skills, budgeting workshops, IT project management, enhanced language training and cookery training. There are some user groups within LEF who expect to use the client information in CTS to design and manage training programs for their clients. Such users include organizational managers and directors, program managers, counsellors and administrators.

7 Designing Class Diagrams

The class diagram represents a set of interrelated classes based on the identified actors and use cases in the use case diagram (*refer to* [1]), and interfaces that reflect important entities of the business domain of the modelled system. Additionally, the class diagram describes the relationships between such classes and interfaces. Each of classes always has certain functionalities within a system. Class diagrams are considered the static diagrams that show the interactions among classes, but do not show what happens from those interactions.

There are three elements in each UML class diagram, including:

- *Class* represents class name, attribute(s) and operation(s) of the class
- *Associations* represent the interactions between classes
- *Multiplicity* of an association end represents the number of possible instances of the class associated with a single instance of the other end

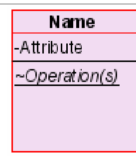


Table 1. Mapping Multiplicity for Class Diagrams

Type of multiplicity	Description
0	Zero instance
0..1	Zero or one instances
0..*	Zero or more instances
1	Exactly one instance
1..*	One or more instances
*	Unlimited number of instances

This section explores the class diagram which describes in detail every use case scenario and actors as the foundation of functionalities of the modelled CTS.

Relying on Tran [1] the actors specified in the use case diagram are considered as potential classes because they reflect the active entities of the business domain of CTS. It is similar to the use case diagram; the organizational managers and programme managers are grouped in the manager group because these managers have similar functionalities within the system. These potential classes include:

- Administrator
- Counsellors
- Manager group (including the organizational and programme managers).

In addition the use cases identified in the use case diagram are also considered as potential classes, because these use cases reflect passive entities of the business domain of CTS. These additional potential classes include:

- Employers
- Contacts
- External programmes
- Internal programmes
- Jobs and positions

- Reports
- Clients
- Schedules
- Job matchers
- Database
- Staff.

The identification of potential classes above suggests a promising outcome: these classes will be consistent with essential elements of the interface of the modelled system. Figure 1 represents the class diagram of CTS, including three elements: classes with their attributes and operations in detail, associations between classes, and multiplicities of associations among classes.

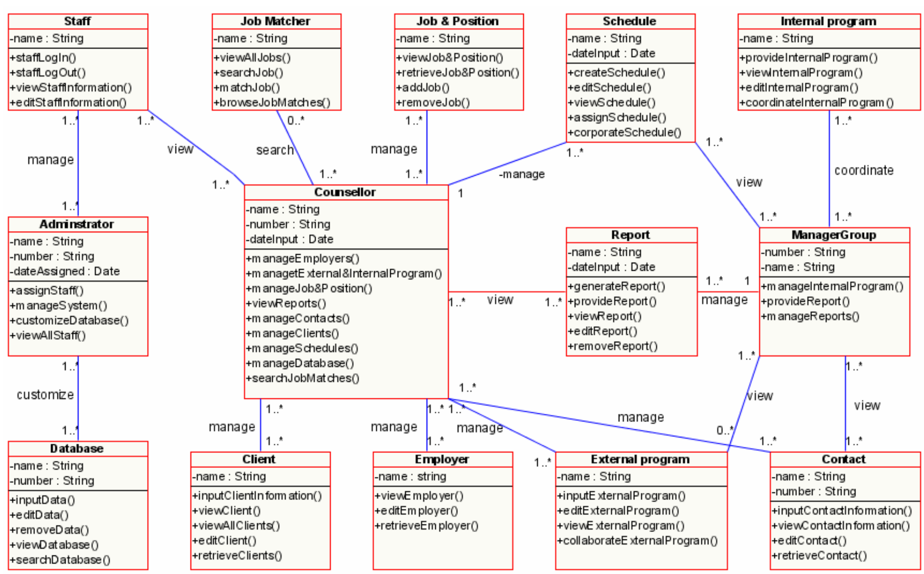


Fig. 1. Class Diagram for the CTS

Most classes encapsulate functionality in association with use cases and system requirements. The functional operations among classes, such as *counsellors*, *administrator* and *manager group* are distinct within the diagram. For instance, the *counsellors* class should provide client information to the manager group in order to design internal programmes and opportunities, the availability of external programmes for collaboration between LEF and its partners and local organizations, updated schedules for coordinating training and internal programmes, contact information for communication needs. More important, the *counsellors* class will provide results of job matches in order to support clients in locating relevant jobs. As a result (see Figure 1), the *counsellors* class should provide a series of operations within the system; each of these operations is described specifically in the associated classes. For example, the 'manageClient' operation in the *counsellors* class is described in detail by the *client* class. Therefore this class is an associated class with the *counsellors* class.

The *manager group* class show the main operations of creating reports, providing reports and providing internal programmes. Details of such operations of the *manager group* class are described by the *report* and *internal program* classes. Consequently, every such a class provides business functionality in association with system requirements.

The association between two classes is presented in a manner that contains the association name and multiplicities of instances of both ends of an association. For example, the association between administrator and staff classes is to manage the staff log in, staff log out, view all staff information, and edit staff information. The multiplicity shows that the administrator can assign from one to many (1..*) users at his end, and there are from one to many (1..*) users at the other end of the association.

The class diagram (Figure 1) defines the essential classes in the design of CTS. This class diagram is essential for representing the system structure and interface. In other words, this diagram has shown how the system and its interface should look and what essential elements should be available on the system interface.

8 Designing Object Diagrams

The object diagram represents the structure of a modelled system at a certain time while the system is running. This diagram includes a group of objects that can act on each other within a system. ‘An object is an individual unit of run-time data storage that is used as the basic building block of programs’ [3] in object-oriented programming. Object diagrams are considered a specific kind of class diagrams with some distinctions as follows: 1) they are more concrete than class diagrams; 2) they show instances of the objects at a runtime of the system; and 3) they can represent small pieces with specific relationships within a system.

The elements of an object diagram represent a set of classes, object instances and their attributes, and associations between instances. Each instance reflects a specific object in a certain time of the class when the system is running. It is different from the class diagram, and names of the instances are underlined in the object diagram.

For example, the object diagram in Figure 2 explores the search methods that a job matcher can carry out in order to find the job matches. Thus with a particular job the matcher can search for language, skills, job choices, and qualifications in order to retrieve a list of clients who can match this job. The object diagram in this case explores some queries:

- Who has the language this job requires?
- Who has skills this job requires?
- Who has qualifications this job requires?
- Who has job choices that match this job? (job choices may include preferred area, time period, expected salary).

Figure 2 indicates that all four specific instances of a class *job matcher* can be carried at runtime, and the *client retrieval* is a general instance in this object diagram. This diagram creates the four relationships between the job matcher and each of language, qualification, skill, and job choices search. These relationships are much more explicit compared with relationships between classes in the class diagram. And these relationships indicate that two objects always act on each other within the modelled system. For instance, the *matcher* and *skill search* instances work on each other and are associated with one another.

When the job matcher is working, instances of the job matcher and specific search (language, job choice, skills, etc.) will be created, with values of the attributes initialised. The object diagram for this situation is represented in the object diagram (Figure 2). It takes the job *matcher class* in Figure 2 and replaces this class with a concrete example. As can be seen from Figure 2, client retrieval, language, skill, qualification and job choice are names of the instances; and job matcher is the name of class in this object diagram.

This section has analysed and created an object diagram for the scenario of job matches for clients within the CTS. The next section will investigate the state diagram within CTS.

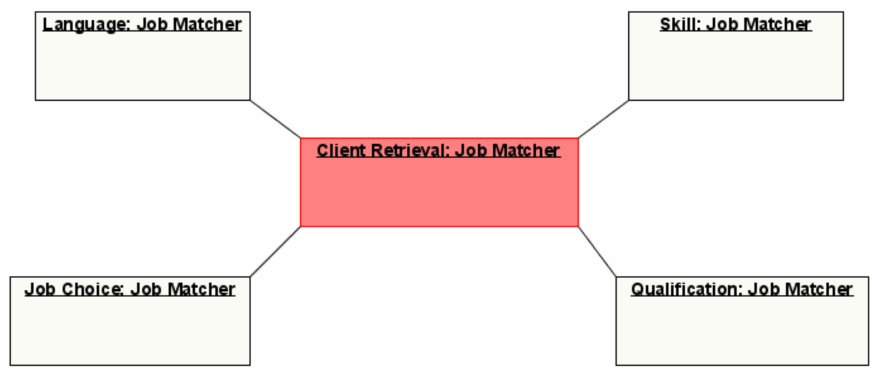


Fig. 2. Example of the Object Diagram for Job Matches within CTS

9 State Diagrams

The state diagram describes the changes of an object from start to finish based on events that occur during the system's life cycle. State diagrams can be used for drawing a single class to exhibit the lifetime behaviours of a single object in most object-oriented techniques. Top-level state diagrams always have initial and final states.

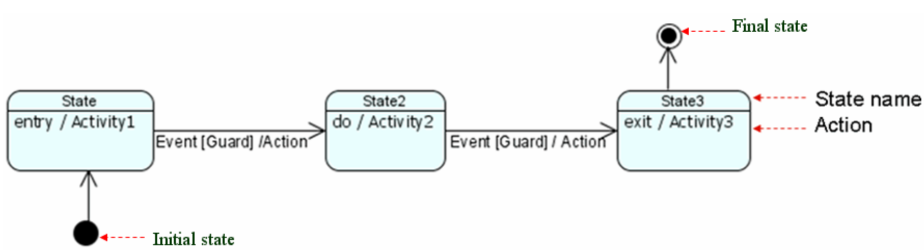


Fig. 3. Outline of Basic Elements of a State Diagram

Figure 3 represents basic elements of a state diagram. In detail each element is as follows:

- A *state* is a condition or situation in the life of an object during which it performs some activities, satisfies some conditions or waits for some events.
- An *action state* is a short-hand for a state with an entry action and at least one outgoing transition involving the implicit event of completing the entry action (there may be several such transitions if they have guard conditions).
- *Start or initial state* describes the starting point; it is also called *pseudo state* or *first activity* of the state diagram.
- *End or final state* describes the ending point of the state diagram; it is also called *pseudo state* because it does not have any variable or action described.
- *Transitions* describe the connections between states. Such connections show the movement of an object from one state to another.
- *Events* cause transitions between states. An event is something that occurs to an object during the transition from a state to another.
- A *guard* is a condition of a transition. There are preconditions and post-conditions.

According to Tran [1] the use case, class, and object diagrams only describe a static representation of the modelled system. Such diagrams only describe the way a system should look and define the architecture and essential elements of interface design. The investigation of the state diagram in this section is approaching a high-level design of behavioural elements in the modelled system.

Chitnis, Tiwari and Ananthamurthy suggest that designing a state diagram for a system is optional. While the state diagram is not a compulsory, it must be defined on a need basis [6]. Within the modelled system clients are an important object that affects most other business functionalities of the CTS operation. Therefore, this section focuses the investigation on the state diagram for *client* object in the modelled system.

Initially the researcher should identify basic elements of the *client* object in order to create a state diagram. Replying on the concepts and definitions of state diagrams above, the *client* object experiences various states from the initial to the end during its lifecycle. As can be seen from Figure 3, there are a number of states involved.

Initially, the counsellors must do data entry and record client information (state 1 - *recorded*) in the spreadsheets. Then they should process such data and client information within the database (state 2 - *processed*). This state covers some activities including sort, classify, refine and organise client information. Moving to the next state - *analysed* (state 3), the counsellors and programme managers should assess clients for different purposes. There are two possibilities in this *analysed* state:

1. Some clients, who require neither job training nor attendance at support programmes, are ready for job searching and following up by the *job matchers* (state 4). The counsellors can inform the client once a matched job has been found for him/her (state 5 - *found job*). Finally, a successful result of client job matches can be stored in the database prior to closing this client request within the system (state 6 - *client database*).
2. Other clients, who required job skills, training and qualifications, can be *admitted* (state 7) and *offered* (state 8) training courses and other programmes. Some of the subsequent states are the client's decision. A few clients may not accept the admission and offer; then their records in the database are closed. For clients who accept the offer, they then participate in (state 9 - *participated*), and complete (state

10 - *completed*) such training courses and programmes as are available. Consequently, these clients (who have completed training courses and programmes) can be sent to the job matcher in order to find job matches for them. Thus they will have experience states 4 - 6 until job matches have been found, as discussed above.

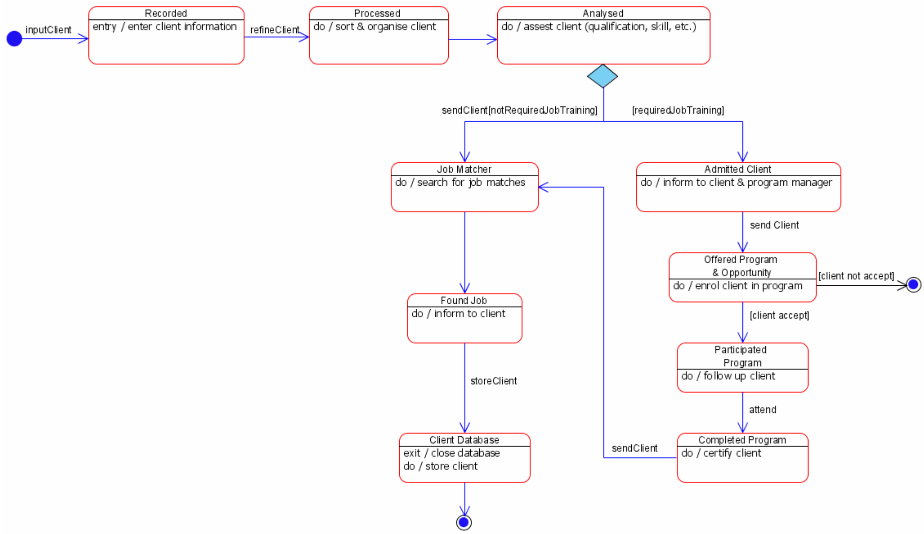


Fig. 4. State Diagram of the Client Object within CTS

This section has designed a state diagram (Figure 4), the inital dynamic UML diagram for the modelled system. This diagram depicts the possible states, transitions and events occurring among those states for the *client* object. Specifically, this diagram represents the lifecycle of the *client* object within the modelled system.

10 UML Model of CTS

> It is very important to distinguish between the UML model and the set of diagrams of a system. A diagram is a partial graphical representation of a system's model. The model also contains a "semantic backplane" - documentation such as written use cases that drive the model elements and diagrams [3].

The UML model of the CTS in this case study can be considered an organised collection of diagrams carried out through CTS implementation. UML is used for modelling a system because it is a standard language for designing detailed diagrams at different points of time in the software life cycle of a system. Such diagrams can be used on an incremental basis as the need arises of a system [6].

Based on the analysis of system specifications and the creation of use case diagrams as above, and a set of further UML diagrams in Tran [1], we have devised a UML model for designing the CTS that contains four parts. These parts can be visualised in Figure 5, and are summarised as follows:

- **Functional model** - This part describes the system specifications. It analyses the essential requirements around which the system has been built. Such requirements include the business needs and user requirements, and the specification of system requirements (refer to [1]). The use case diagram depicts essential actors and use cases that can meet the functionalities of the modelled system in association with business and user needs, and system requirements.
- **Structural model** - This part describes the way that system should look. It analyses the structure and substructure of the modelled system based on objects, attributes, operations and relationships. The class diagram depicts the structure of CTS by representing a series of system classes, their attributes and the associations among classes. Additionally, the object diagrams also represent the structural aspects of the CTS.

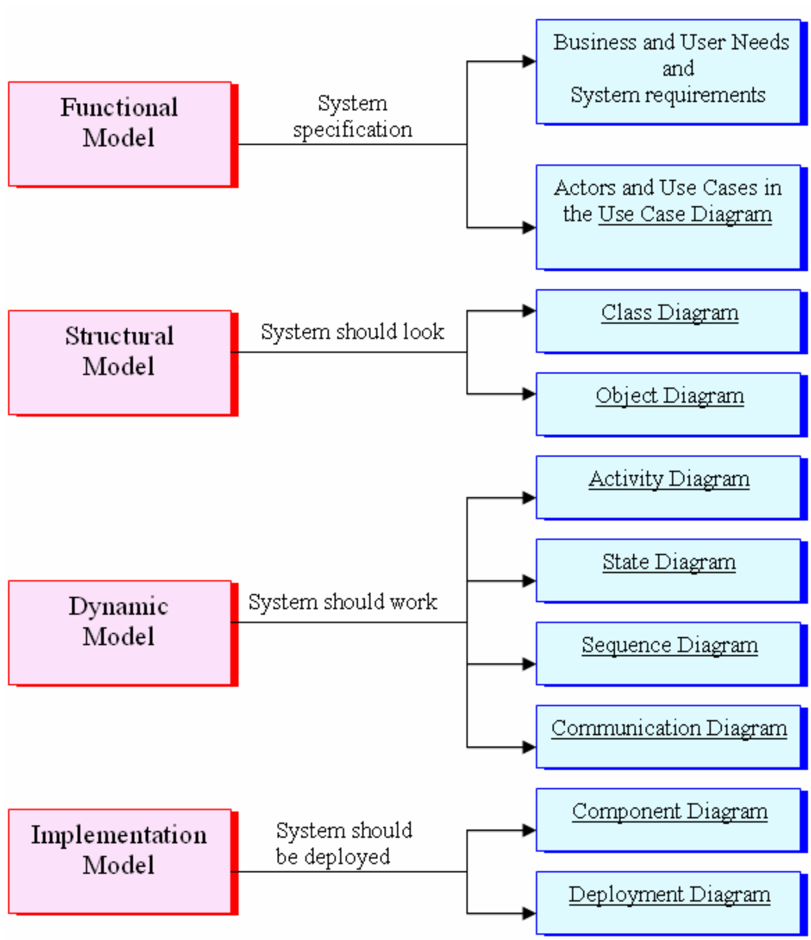


Fig. 5. UML Model of Client Tracking System

- **Dynamic model** - This part describes the way that the system should work. It analyses the system behaviour, including sequence and communication diagrams, activity diagram, and state diagram.
- **Implementation model** - This part describes the way that the system should be deployed. It integrates Parts 1-3 to depict the implementation of CTS. The component and deployment diagrams show the integration of system components and the interactions among them for deploying the modelled system.

11 Conclusion

This case study has investigated the class, object, and state diagrams, part of the UML model of the Client Tracking System. Such diagrams were designed to support the system designers and developers, to help customers in observing a software system from various perspectives, and to improve their understanding of cohesion and abstraction in designing a system or software. Diagramming techniques are based on the Unified Modelling Language (UML) v2.0.

This study of the CTS has shown positive results in designing a client information system in association with community services, training and programmes, and related events to residents of local communities in Toronto. One such positive results is the increased volume of client information related to LEF plans, training, programmes and activities. According to LEF Reports for 2005 and 2006 (refer to [2] and [5]), the CTS has been shown to serve as a powerful tool for internal users in managing their clients, supporting them, providing them with relevant training and programs, and job matching services in particular.

Acknowledgements. I wish to express my thanks to Peter Frampton (Executive Director) and Margarida Almeida (Coordinator, Community ICT Innovation) of LEF for facilitating this case study. I would also like to give special thanks to Shawn McArthur, the Help Desk Manager, who collaborated with me during this case study**.**I would also like to thank the CRACIN Group at the Faculty of Information Studies, University of Toronto, who provided office facilities to support my research, and Victoria University of Wellington for providing time and funds for me to undertake this research.

References

1. Tran, L.A.: A UML Model of the Client Tracking System in Association with Community Services at the Learning Enrichment Foundation in Toronto, Canada: A Case Study, report prepared for the Learning Enrichment Foundation in Toronto (unpublished, 2007)
2. Learning Enrichment Foundation: Report on Client Tracking System: Business Requirements, Prepared by Outset Consulting, following consultations with staff members from LEF and its partner organizations (unpublished, 2006)
3. WikiPedia: Unified Modeling Language (2007), `http://en.wikipedia.org/wiki/Unified_Modeling_Language`

4. Learning Enrichment Foundation: Report on LEF Programs, Contact Person: Peter Frampton, Executive Director of LEF (unpublished, 2007)
5. Learning Enrichment Foundation: Report on Client Tracking System: User Requirements and Use Case Analysis, Prepared by Outset Consulting, following consultations with staff members from LEF and its partner organizations (unpublished, 2005)
6. Chitnis, M., Tiwari, P., Ananthamurthy, L.: UML Tools (2002), http://www.developer.com/design/article.php/1593811

Searching with Document Space Adapted Ontologies

Stein L. Tomassen

Department of Computer and Information Science,
Norwegian University of Science and Technology,
Sem Saelandsvei 7-9, NO-7491 Trondheim, Norway
stein.l.tomassen@idi.ntnu.no

Abstract. An increasing number of recent information retrieval systems make use of ontologies to help the users clarify their information needs and come up with semantic representations of documents. In this paper, we present an approach that utilizes ontologies to enhance the effectiveness of large-scale search systems for the Web. We describe how these systems can be enriched with adapted ontologies to provide an in-depth understanding of the user's needs. The ontology concepts are adapted to the domain terminology by computing a feature vector for each concept. We explain how these feature vectors are constructed and finally evaluate the approach.

Keywords: architecture, evaluation, feature vector construction, information retrieval, ontology, web search.

1 Introduction

Query interpretation is the first phase of an information retrieval (IR) session and the only part of the session that receives clear inputs from the user. Traditional vector space retrieval systems typically retrieve information without explicitly defined domain of interest to the user. As a result, the system presents a lot of information that can be of little relevance to the user. Consequently, the retrieval and ranking process is very important, though the result crucially hinges on the user's ability to specify unambiguously his/her information needs. Ideally, the queries' *real intentions* should be exposed and reflected in the way the underlying retrieval machinery can deal with them. In this paper, we present an approach that utilizes ontologies that are adapted to the corpus terminology by computing a feature vector (*fv*) for each of the ontology concepts. We present the architecture of the approach and explain how these *fv*s are constructed. Finally, we present a small experiment conducted and the evaluation.

Typical IR systems work in word-space while we humans deal with information in concept-space [3]. Since typical IR systems work in word-space to retrieve documents written by humans thinking in concept-space the result is often not satisfying. A promising approach is concept-based search [7]. With this approach, the burden of knowing how the documents are written is taken off the user and hence the user can focus on searching on a conceptual level instead. However, a problem with this approach is finding good concepts.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 513–522, 2008.

As part of the globalization, more and more enterprises have faced the benefit of information sharing. Therefore, an increased usage of ontologies in information and communication technology (ICT) has emerged. However, creating and maintaining ontologies is both time-consuming and costly. Therefore, it is important to use the ontologies for many different tasks to increase return on investment (ROI). It is also assumed that the success of the Semantic Web depends strongly on ontologies [15]. The focus of this paper is an approach for reuse of ontologies for traditional vector-space information retrieval (IR) systems by adapting to the document space within multi-disciplinary domains where different terminology is used.

Ontologies can define concepts and the relationships among them for any domain of interest [8]. In our approach [9], we use ontologies to define concepts for a domain. The approach uses contextually enriched ontologies to bring the queries closer to the user's preferences and the characteristics of the document collection. The idea is to associate every concept (classes and instances) of the ontology with a feature vector to tailor these concepts to the specific terminology used in the document collection. Synonyms and conjugations would naturally go into such a vector, but we would also like to include related terms that tend to be used in connection with the concept and to provide a contextual definition of it. The *fv*s are later used to post process the search results by filtering and presentation of the final results.

This paper is organized as follows. In section 2, related work is discussed. In section 3, the architecture of the approach is presented. In section 4, we describe how the *fv*s are constructed and provide a little example. While in section 5, we describe how these *fv*s are used in a concept-based search. In section 6, we present a small experiment conducted and some of the evaluation results. Finally, in section 7 we conclude this paper.

2 Related Work

The related work to our approach comes mainly from two areas. Ontology based IR, in general, and approaches to conceptual query expansion, in particular. General approaches to ontology based IR can further be sub-divided into Knowledge Base (KB) and vector space model driven approaches. KB approaches typically use reasoning mechanism and ontological query languages to retrieve instances. Documents are treated either as instances or are annotated using ontology instances [10, 11, 13]. These approaches focus on retrieving instances rather than documents. Some of these approaches are often combined with ontological filtering [14, 16].

There are approaches combining both ontology based IR and vector space model. For instance, some start with semantic querying using ontology query languages and use resulting instances to retrieve relevant documents [13, 17]. Vallet et al. [17] use weighted annotation when associating documents with ontology instances. The weights are based on the frequency of occurrence of the instances in each document. Nagypal [18] combines ontology usage with vector-space model by extending a non-ontological query. There, ontology is used to disambiguate queries. Simple text search is run on the concepts' labels and users are asked to choose the proper term interpretation. A similar approach is described by Paralic et al. [19] where documents are associated with the concepts in the ontology. The concepts in the query are matched to the concepts of the ontology in order to retrieve terms and then used for calculation of document similarity.

Braga et al. [14] is using ontologies for retrieval and filtering of domain information across multiple domains. There each ontology concept is defined as a domain feature with detailed information relevant to the domain including relationships with other features. The relationships used are hypernyms (super class), hyponyms (sub class), and synonyms. Unfortunately, there are no details provided by Braga et al. [14] on how a domain feature is created.

Most query enrichment approaches are not using ontologies like [7]. Query expansion is typically done by extending the provided query terms with synonyms or hyponyms (cf. [21]). Some approaches are focusing on using ontologies in the process of enriching queries [14, 19]. However, ontology in such case typically serves as thesaurus containing synonyms, hypernyms/hyponyms, and do not consider the context of each term, i.e. every term is equally weighted.

The approaches presented in [3, 7] are most similar to ours. However, Chang et al. [7] is not using ontologies but is reliant on query concepts. Two techniques are used to create the feature vectors of the query concepts, i.e. based on document set and result set of a user query. While the approach presented by Ozcan et al. [3] is using ontologies for the representation of concepts. The concepts are extended with similar words using a combination pf Latent Semantic Analysis (LSA) and WordNet[1]. Both approaches get promising results for short or poorly formulated queries.

3 Architecture

WebOdIR[2] is an ontology-driven information retrieval system for the Web. Figure 1 depicts the overall architecture of the ontology-driven information retrieval system. In this section we will briefly describe the architecture and its components.

The system has both offline and online components. The offline components are in general used to add and populate new ontologies (Section 4). The online components are used when searching, using the available and already populated ontologies (Section 5). The underlying query and indexing system is both used offline and online. Next, we will be briefly described the individual components.

Feature vector miner (offline): This component takes an ontology, from the *ontology repository*, and automatically creates *fv*s with keyphrases that are associated with the concepts. The keyphrases are extracted from documents found relevant to the concepts of the ontology (more details is found in Section 4). The *fv*s are stored in the *feature vector repository*.

Ontology-driven retrieval engine (online): This component performs both the search and post-processing (Section 5). The component handles the query specified by the user. The query can initially consist of concepts that are mapped to a domain (ontology) and/or ordinary terms (keywords) (more information is found in Tomassen et al. [12]). The ontologies, from the *ontology repository*, and their corresponding *fv*s, from the *feature vector repository*, are used when post-processing the retrieved documents before presented to the user.

---

[1] WordNet, http://wordnet.princeton.edu/

[2] WebOdIR prototype (16.05.2008), http://129.241.110.220

Query and indexing system wrappers (offline and online): This component creates a common interface to the various query and indexing systems.

Ontology Repository (offline and online): This repository contains the OWL[3] ontologies that are made available to the system.

Feature Vector Repository (offline and online): Contains the feature vectors of the corresponding ontology concepts found in the *ontology repository*.

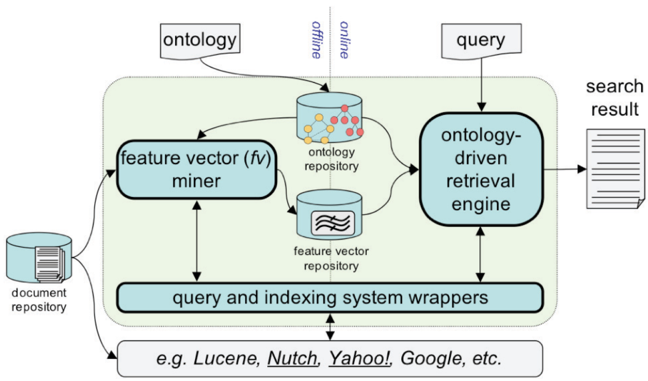


Fig. 1. The overall architecture of the ontology-driven information retrieval system. The outlined components illustrate those components being the contribution of this work to typically existing IR systems. Currently, only wrappers for Nutch and Yahoo are implemented.

4 Feature Vector Construction

Recall that every ontology concept has an associated feature vector with a set of relevant terms extracted from the document collection. In this section, we will describe the process of how these *fv*s are constructed.

The process of constructing feature vectors constitutes three main steps. The aim of the first step is to do some preparation to optimize the construction of the feature vectors for each of the ontology concepts. The concepts are ranked according to considered ontology relevancy. This ranked list is the input to the next step.

The main aim of the second step is to extract and group sets of candidate terms being relevant to each concept. For each concept a query is formulated based on how the concepts relate to other concepts of the current ontology. The queries are submitted to the underlying search engine that retrieves a set of documents for each concept. Then the individual documents of each concept are clustered to group those documents having high similarity. For each cluster a set of candidate terms are extracted based on the documents of each cluster. These candidate terms are the input to the next and final step, which is to identify the relevant documents and construct a corresponding feature vector for each of the ontology concepts.

[3] OWL, Web Ontology Language by W3C.

At this stage the grouped candidate terms are not necessarily relevant to the domain defined by the ontology. Consequently, the aim of the third and last step is to identify those candidate terms being relevant to both the corresponding concepts and the current ontology. To find those domain relevant candidate terms we calculate the similarity between for each of the grouped candidate terms of the current concept and the grouped candidate terms of the neighboring concepts. Weighting is used to differentiate on the importance of the ontology relation types when calculating these similarity measure scores. Finally, the set of grouped candidate terms with the highest similarity to the neighboring concepts is selected and next used when creating the *fv* of the corresponding concept.

Step one is done prior to step two and three. While step two and three are repeated until there are no more concepts to process in the ranked list created in step one. The result of these steps is a set of concepts with corresponding feature vectors that consist of terms from the document collection associated both to the concepts and the domain defined by the ontology.

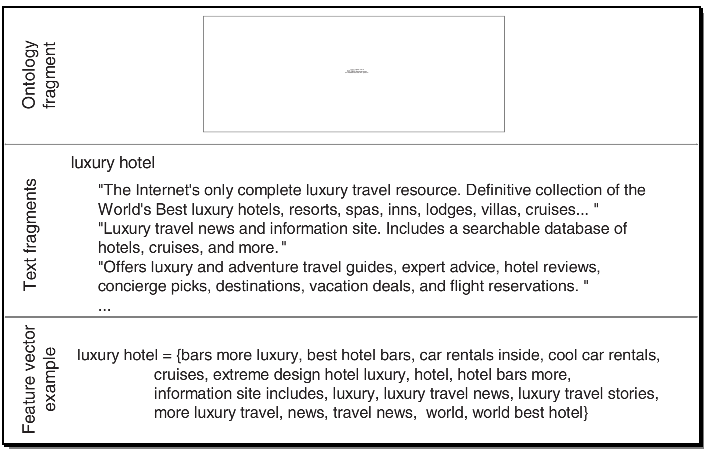


Fig. 2. An illustration of a feature vector, without weights, created for the concept `LuxuryHotel`. A fragment of the Travel[4] ontology is depicted at the top of the figure. In the middle some of the summary snippets of the potentially related pages are shown. At the bottom is the resulting feature vector for the `LuxuryHotel` concept.

Figure 2 depicts an illustrative example. The ontology fragment (shown at the top of the figure) shows the concept `LuxuryHotel` and how it relates to other neighboring concepts. In the middle of the figure some of the text fragments used in the process are shown. Note that in this example only the summary snippets by Yahoo! are shown. The content of each individual page can also be used when constructing the feature vectors. All the fragments are analyzed and only those considered relevant to the concept defined in the ontology are used in the final process of creating the concept feature vector. The *fv*, without the weightings, for the concept `LuxuryHotel` is shown at the bottom of Figure 2.

[4] Travel ontology, http://protege.cim3.net/file/pub/ontologies/travel/travel.owl

5 Ontology-Driven Search

WebOdIR is an ontology-driven information retrieval system for the Web that uses ontologies to bring the query closer to the real intention of the user's query. In this section we will briefly describe how ontology-driven search is done with WebOdIR.

Users tend to use very few terms (3 or less) in their search queries [1, 2]. In addition, only about 10% of the users are using the advanced features of a Web search engine [1]. This makes it difficult for the system to understand the context of the user's query and a lot of non-relevant documents are presented. Therefore, we believe there is a need to differentiate on the query terms to increase the precision of search. For an explorative search [5], using only concepts when defining the query gives satisfactory results. However, for more precise search (fact-finding), using only concepts does not give the same acceptable results. Consequently, the user should be able to use a mixed approach being able to use both terms and concepts. In our approach, the user can specify one or more concepts related to a domain of interest when formulating a query. In addition, the user can specify a set of keywords to narrow the search even further. By differentiating on concepts and keywords the real intention of the user's query can better be understood by the underlying machinery and thus present more relevant results. Figure 3 depicts a small example.

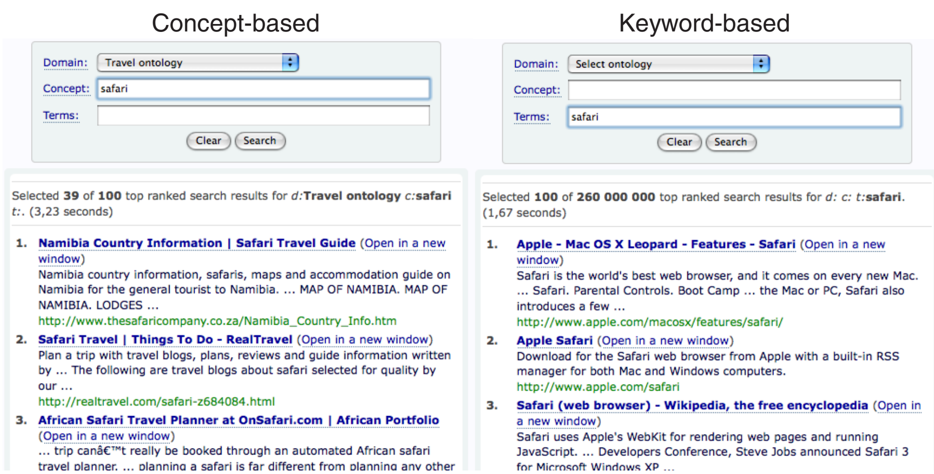


Fig. 3. An example of a concept-based versus a keyword-based search with WebOdIR where the same query term, `safari`, is used. On the left hand side it is treated as a concept of the travel[4] domain while on the right hand side as a keyword with no relation to any domain.

WebOdIR is ontology-driven, which means that ontologies are used extensively in the search process. Firstly, an ontology is used to help a user formulating a query. Then the specified query concepts are used by the system to formulate one or more new queries, which are sent to the underlying search engine. The new query is based on how the current concept relates to other neighboring concepts. Finally, the concepts are used to re-rank and filter out those documents retrieved by the underlying search engine, which are considered to be of no or little relevance to the current domain.

6 Experiment and Evaluation

In this section, we present an experiment performed in May 2008. We present the prototype and some of the evaluation results of the experiment.

A prototype called WebOdIR[5] was implemented in Java that were run on a Tomcat server. In this first prototype, a simplified version, because of limited time, of the Feature Vector Construction algorithm was used. All the clusters of a concept were compared to all the neighboring clusters and all the relations were weighted equally when creating a concept's *fv*. It is assumed that the result of this simplification is *fv*s with more noise (i.e. words of no relevance to the domain) compared to the correct implementation of the algorithm. However, if this is the case is still to be tested and verified.

The prototype used the Yahoo! Web Search API[6] as the backend search engine. Consequently, we compared the search results with similar results from Yahoo! Web search.

6.1 Experiment

The users in our user base were mainly student at the Norwegian University of Science and Technology (NTNU). There were 27 subjects that participated while 21 performed the experiment correctly.

The experiment consisted of two parts. The first part included formulating search queries for both WebOdIR and Yahoo!. Four domains (wine[7], travel[4], animals[8], and autos[9] respectively) with two topics of interest for each domain, which makes 16 queries in total, eight to be submitted to WebOdIR and eight to Yahoo!. The second part of the experiment was a survey of 29 questions.

The participants were divided into two groups that used different ontologies for the same domain. The first group used the original ontology while the second group used an altered more advanced version of the original ontology to see if this would influence on the search results.

The two groups were further divided into two sub-groups. The first sub-group formulated ordinary keyword-based queries first then concept-based queries next, while the second sub-group did vice versa of the first sub-group. This was done to see if the process of formulating keyword-based queries would influence on how the concept-based queries were formulated later and vice versa.

The query scoring and calculation strategy presented by Brasethvik [20] was adopted. The user scored the top-ten ranked documents as *trash*, *non-relevant or duplicate*, *related*, or *good* respectively. The maximum search result score with this scheme is 100 while the minimum is -50 (see [20] for further details).

6.2 Evaluation

Figure 4 depicts a graph showing how the different ontologies versions influence on the search result relevance score and how they perform versus Yahoo! Web search.

---

[5] WebOdIR prototype (16.05.2008), http://129.241.110.220

[6] Yahoo! Developer Network, http://developer.yahoo.com/search/web/

[7] Wine ontology, http://www.w3.org/2001/sw/WebOnt/guide-src/wine.owl

[8] Animals ontology, http://nlp.shef.ac.uk/abraxas/ontologies/animals.owl

[9] Autos ontology, http://gaia.isti.cnr.it/~straccia/download/teaching/SI/2006/Autos.owl

The graph shows that WebOdIR performs in general well especially for topic 3 and 4 (travel). The graph also shows that in general a more advanced ontology in the sense of having more relations, properties and individuals does perform better than a similar simpler ontology. A reason for this can be that for the more advanced ontologies more knowledge is available in the process of creating the concept *fv*s and hence will contain less noise compared to those of a simpler ontology. This observation matches well with one of our hypothesis regarding these issues.

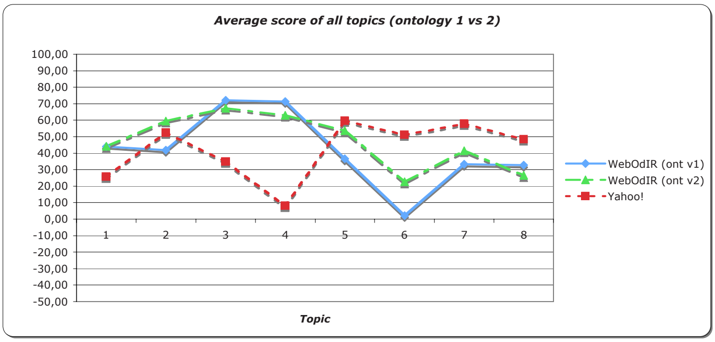


Fig. 4. The average score of all the eight topics. The score is in the range of -50 to 100. The graph shows effectiveness of ontology 1 versus ontology 2 but also how they perform versus a similar search done with Yahoo! Web search.

When observing the length of the queries, it also seems to be a trend that WebOdIR performs better for short queries compared to keyword-based queries which is also observed for other concept-based approaches (e.g. [3, 7]). The concept-based queries were also in general shorter than keyword-based queries.

Another observed pattern is how the users formulate their queries. Recall that the groups were divided into sub-groups where the first group was to formulate the keyword-based queries prior to the concept-based queries and the other sub-group vice versa. The group formulating the concept-based queries first did in average use 13% less keywords and 14% fewer concepts compared to the group formulating the concept-based queries last. Note that a query must contain one or more concepts in combination with zero or more keywords to be classified as a concept-based query. However, the group formulating the keyword-based queries first did have a tendency to use most of the keywords in the concept-based search as well, consequently having in general longer concept-based queries than the other group. The keyword-based queries for both groups were almost equal in length with a difference of only 2%.

7 Conclusion

In this paper, we have presented an approach that utilizes ontologies to enhance the effectiveness of large-scale search systems for the Web. We have described how such systems can be enriched with adapted ontologies by computing a feature vector with associated terms for each of the concepts. We have shortly described how these feature vectors are automatically constructed by utilizing the knowledge represented in the ontology. Finally, we have evaluated the approach.

Preliminary analysis of the experiment shows that the approach performs well, especially for shorter queries. The experiment also showed that users tended to formulate shorter queries for the concept-based approach versus the traditional keyword-based approach. In a survey the participants were asked to rate the quality of the results compared to the base system in a scale from 1 (very bad) to 5 (very good), and the average score was 3.5. This score indicates that the approach for automatic construction of concept feature vectors based on an ontology works quite well. However, the evaluation results are preliminary and more analysis is needed to figure out when and why this approach performs better or worse than traditional keyword-based search. More analysis is also needed to state what aspects of an ontology is important for the process of generating good concept feature vectors.

As the research reported here is still in progress [4], we have not been able to fully implement the algorithm and formally evaluate the approach. Therefore, in future work we are planning to inspect and tackle a set of issues as follows. We will investigate alternative methods for assigning relevant terms to the ontology concepts (i.e. word distribution [6]). Alternative user interfaces for this system will also be investigated (i.e automatic identification of ontology and concepts based on the query terms). We will also look into alternative methods for post-processing of the retrieved documents utilizing the semantic relations in the ontology for better ranking and navigation. We will also need to look into how this approach fits into different search task strategies (e.g. fact-finding vs. exploratory vs. browsing [5]).

Acknowledgements. This research work is funded by the Integrated Information Platform for reservoir and subsea production systems (IIP) project, which is supported by the Norwegian Research Council (NFR). NFR project number 163457/S30. In addition, I would like to thank Darijus Strasunskas (NTNU), Jon Atle Gulla (NTNU), Per Gunnar Auran (Yahoo!), and Robert Engels (ESIS) for their support and help.

References

1. Gulla, J.A., Auran, P.G., Risvik, K.M.: Linguistic Techniques in Large-Scale Search Engines. Fast Search & Transfer, 15 p. (2002)
2. Spink, A., Wolfram, D., Jansen, M.B.J., Saracevic, T.: Searching the Web: the public and their queries. J. Am. Soc. Inf. Sci. Technol. 52, 226–234 (2001)
3. Ozcan, R., Aslangdogan, Y.A.: Concept Based Information Access Using Ontologies and Latent Semantic Analysis. Technical Report CSE-2004-8. University of Texas at Arlington, p. 16 (2004)
4. Tomassen, S.L.: Research on Ontology-Driven Information Retrieval. In: Meersman, R., Tari, Z., Herrero, P., et al. (eds.) OTM 2006 Workshops. Springer, Montpellier (2006)
5. Strasunskas, D., Tomassen, S.L.: Web Search Tailored Ontology Evaluation Framework. In: Chang, K.C.-C., Wang, W., Chen, L., Ellis, C.A., Hsu, C.-H., Tsoi, A.C., Wang, H. (eds.) APWeb/WAIM 2007. LNCS, vol. 4537, pp. 372–383. Springer, Heidelberg (2007)
6. Galeas, P., Freisleben, B.: Word Distribution Analysis for Relevance Ranking and Query Expansion. Computational Linguistics and Intelligent Text Processing, pp. 500–511 (2008)

7. Chang, Y., Ounis, I., Kim, M.: Query reformulation using automatically generated query concepts from a document space. Information Processing and Management 42, 453–468 (2006)
8. Gruber, T.R.: A translation approach to portable ontology specifications. Knowledge Acquisition 5, 199–220 (1993)
9. Tomassen, S.L., Gulla, J.A., Strasunskas, D.: Document Space Adapted Ontology: Application in Query Enrichment. In: Kop, C., Fliedl, G., Mayr, H.C., Métais, E. (eds.) NLDB 2006. LNCS, vol. 3999, pp. 46–57. Springer, Heidelberg (2006)
10. Song, J.-F., Zhang, W.-M., Xiao, W., Li, G.-H., Xu, Z.-N.: Ontology-Based Information Retrieval Model for the Semantic Web. In: Proceedings of EEE 2005, pp. 152–155. IEEE Computer Society, Los Alamitos (2005)
11. Rocha, C., Schwabe, D., de Aragao, M.P.: A hybrid approach for searching in the semantic web. In: Proceeding of WWW 2004, pp. 374–383. ACM, New York (2004)
12. Tomassen, S.L., Strasunskas, D.: Query Terms Abstraction Layers. In: Meersman, R., Tari, Z., Herrero, P., et al. (eds.) OTM 2006 Workshops. LNCS, vol. 4278, pp. 1786–1795. Springer, Heidelberg (2006)
13. Kiryakov, A., Popov, B., Terziev, I., Manov, D., Ognyanoff, D.: Semantic Annotation, Indexing, and Retrieval. Journal of Web Semantics 2(1) (2005)
14. Braga, R.M.M., Werner, C.M.L., Mattoso, M.: Using Ontologies for Domain Information Retrieval. In: Proceedings of the 11th International Workshop on Database and Expert Systems Applications, pp. 836–840. IEEE Computer Society, Los Alamitos (2000)
15. Maedche, A., Staab, S.: Ontology learning for the Semantic Web. IEEE Intelligent Systems and Their Applications 16, 72–79 (2001)
16. Shah, U., Finin, T., Joshi, A., Cost, R.S., Mayfield, J.: Information Retrieval On The Semantic Web. In: Proceedings of Conference on Information and Knowledge Management, pp. 461–468. ACM Press, McLean (2002)
17. Vallet, D., Fernández, M., Castells, P.: An Ontology-Based Information Retrieval Model. In: Gómez-Pérez, A., Euzenat, J. (eds.) ESWC 2005. LNCS, vol. 3532, pp. 455–470. Springer, Heidelberg (2005)
18. Nagypal, G.: Improving Information Retrieval Effectiveness by Using Domain Knowledge Stored in Ontologies. In: Meersman, R., Tari, Z., Herrero, P. (eds.) OTM-WS 2005. LNCS, vol. 3762, pp. 780–789. Springer, Heidelberg (2005)
19. Paralic, J., Kostial, I.: Ontology-based Information Retrieval. Information and Intelligent Systems, Croatia, pp. 23–28 (2003)
20. Brasethvik, T.: Conceptual modelling for domain specific document description and retrieval - An approach to semantic document modelling. IDI, Vol. PhD. NTNU, Trondheim, p. 257 (2004)
21. Chenggang, W., Wenpin, J., Qijia, T., et al.: An information retrieval server based on ontology and multiagent. Journal of computer research & development 38(6), 641–647 (2001)

Knowledge-Intensive Interactive Systems Design in Cultural Context

Stefano Valtolina

Department of Computer Science and Communication, University "degli Studi" of Milano, via Comelico 39, Milano, Italy
valtolin@dico.unimi.it

Abstract. The innovations promoted by the knowledge society highlight the central role that the e-culture has to play as a privileged means for disseminating cultural heritage. This paper addresses the issues of knowledge representation, management, distribution and sharing in the field of the Cultural Heritage (CH) valorization and dissemination. The proposed approach is based on the definition of relationships between the information cultural domain fitting the conceptual model of the cultural experts (represented by an appropriate knowledge base) and an information domain understandable by the machine (modeled by a domain ontology). The final system's infrastructure filters the richness of the data-sources to comply the users' needs tailoring the information according to their contexts of use. In this way the user can properly navigate through the heritage and create their own personalized thematic tour through a large number of information trails.

Keywords: Knowledge-based management; User-centered Design; Cultural Heritage; CH Ontology; Data/Information Integration Systems; Narrations.

1 Introduction

The rapid development of the Information and Communication Technologies (ICT) is deeply influencing today's society. The use of new technologies is of increasing interest in several fields of human society where the information is becoming a strategic resource in the cultural development, growth and enrichment of the society. In particular, these innovations promoted by the knowledge society highlight the central role that the e-culture has to play as a privileged means for disseminating cultural heritage. E-culture is understood as the mediation of cultural expressions, knowledge and experiences across digital media. In this area, the dissemination of the information in a flexible way and according to a specific context requires an organization of the knowledge that meets the domain experts' requirements. This because only the domain experts have the necessary experience and knowledge to highlight real and proper historical and anthropological meanings of cultural data under which prospective the information have to be disseminated [1]. The knowledge society must be constructed upon the synergies of individual, teams, organizations, social networks, and communities that exploit in effective way knowledge and learning flow [2].

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 523–530, 2008.

Under this perspective domain experts as well as all people who think to have something to say about a set of cultural artefacts, should be able to participate in the e-culture making process by specifying their own contributions. The cultural experts' contribution regards how they can participate in the knowledge design and management process in order to enhance the semantic of the cultural data and to tailor the information according to the user's needs.

Nowadays many organizations have to comply with new users' needs in terms of content and services that have to be integrated and delivered in a flexible and effective way. Because of the increasing number of the available information resources (web-pages, sites, blogs, forums) the organizations have to be able to provide fast and effective strategies for locating, accessing and retrieving information relevant to specific users' interests. This growth of information can lead to a data overload that sometimes causes confusion rather that knowledge and dramatically reduces the benefits of a rich knowledge system. Methodologies for locating, accessing and retrieving knowledge need thus to be appropriately personalized in order for user not to be taken aback by the huge amount of available data.

Starting from these considerations, this paper proposes a methodology for knowledge representation, management, distribution and sharing in order to design and develop user centered systems in the context of the cultural heritage valorization and dissemination. This methodology is based on the contribution cultural expert's contribution. Such contribution is addressed on two different levels. The first one regards how concepts, expressions, reasoning paths, terminologies of a specific cultural knowledge base can be transformed in an information domain understandable by the machine (modeled by a domain ontology). Instead, the second one regards how the domain experts can participate in the knowledge design and management process in order to enhance the semantic of the cultural data and to tailor the information according to the user's needs. Target of this last task is the definition of the "narration" concept, which basically define the portions of data-sources to be materialized on each context of use. The narrations are texts, short essays, written by domain experts, useful to contextualize the single artifacts retrieved from different archives, through their connection with specific topics and spheres of knowledge. By means of the narrations it is possible to tailor the CH information according to specifications defined by domain experts. In this way the user can properly navigate through the heritage and create their own personalized thematic tour through a large number of information trails.

In summary, in the chapter 2 it is described how, by means of a knowledge integration model, it is possible to create an holistic view of the CH of interest integrating different and heterogeneous knowledge sources. Whereas, the chapter 3 presents how to create an knowledge system reflecting the mental model of the domain experts levering on ontology-based knowledge representation. Chapter 4 presents services able to disseminate proper information according to the end user's interests and to support the domain experts research activities. And finally chapter 5 outlines some conclusions.

2 An Integrated Access to the CH

Several times in the museums the artifacts are de-contextualized and are often juxtaposed to other objects on the base of properties such as chronology, typology, taxonomy, shape, stylistic schools and so on. This kind of exhibitions emphasizes the formal aspects of objects rather than their thematic contents which are useful to promote a better understanding of the life, the behaviors, the culture of ancient people, in relation with cultural models of the past and of the present. Therefore an innovative notion of CH display would see the museum as both a physically flexible place and a virtual space where visitors could find, close to each other, and compared, physically-distant objects, texts and artifacts from different countries but belonging to similar cultural horizons (history, style, society). Although many institutions and museums have well organized digital archives, these communities still lack effective and efficient technological supports for collaborative knowledge networks. The most outstanding innovative feature of the such a network is its ability to bring together information, which is normally distant, because of geographical constraints and/or institutional background. In the data integration context a lot of proposals have been introduced, for example OBSERVER [3] and MOMIX [4] adopt multiple ontologies to map the domain information, INFOMIX [5] proposes the integration of different databases (DBs) using data-source wrappers and a global schema, whereas SEMEX [6], offers personal data integration capabilities supported by a domain and user model.

Basing on these studies, it is possible to affirm that the use of an ontologies for the explication of the common knowledge seems to be a promising method for addressing the integration problem. In particular the integration model presented in this paper is based on a use of an ontology as knowledge base representation where data residing at the sources are accessed during query execution. This approach called virtual approach [7] uses the ontology as a sort of semantic access point of the information that can be retrieved from databases. Databases owned by different institutions are mapped and related independently from their number, location and typology. In this way, the information are not recreated, but extracted automatically from the existing sources through the ontology schema. Nevertheless, creating a new ontology from scratch is a time consuming task and, therefore, it is better to exploit a general ontology from which customized cultural ontologies can be derived. In the proposed solution this ontology has been derived from a well-known CH ontology, that is, the CIDOC Conceptual Reference Model (CRM) [8]. The CIDOC-CRM provides definitions and a formal structure for describing the implicit and explicit concepts and relationships used in CH documentation and it is a well formalized, well supported and widely-accepted standard in the CH area. This ontology is suitable to create a common language and it is usable as the basis for a good practice conceptual modeling in each cultural contexts. In particular it is necessary to design a proper ontology considering only the classes and properties of the CIDOC-CRM relevant to the given information domain. Once modeled and filtered the CIDOC ontology, it is necessary to establish a correspondence between the database schemas and the classes and properties themselves. In this way, the system can determine how the ontology classes are represented in the databases and how to access them. The result of this process, iterated for each federated database, is a semantic network able to translate the DB schemas onto classes and properties of the CIDOC-CRM. The information defining the mappings are used by the final system to generate SQL code for querying each DB schema. In this way the query can be expressed using semantic queries independently from the query languages of the underlying databases. Further information about the definition of this semantic network are available in [9,10].

3 Interaction Knowledge Patterns

The methodology presented in the previous section is the result of empirical studies carried out during the T.Arc.H.N.A. project. This project aims to support a community of heritage professionals to develop a comprehensive system on the Etruscan civilization. The overall goal of the T.Arc.H.N.A project is to design interactive systems supporting information professionals and other knowledge workers to play a key role in making CH materials accessible to a broad array of audiences.

These empirical studies have highlighted that only the domain experts have the proper experience to filter and model the CIDOC-CRM in order to establish the portion of ontology relevant to the given cultural information domain. During this tailoring process the domain experts have complained about the inefficiency of the CIDOC-CRM to express the information domain in a right way. Even though the CIDOC_CRM is a well defined and used ontology for CH it is not adapted for designing a proper knowledge representation understandable by the domain experts. CIDOC-CRM is adapted to represent a machine understandable knowledge base, but domain experts are not able to use it to explicate their capabilities of expression and communication. In [11] V. Devedžić states that "there is no tool that will provide the terminology exactly the same with what the users expect it to be". This because such tools offer a representation of the knowledge that does not fit the domain experts' mental model. According to these considerations, the approach adopted in the T.Arc.H.N.A project levers on a representation of the information domain and of data-source contents able to comply with proper concepts and terminology of the given CH as defined by domain experts.

Much researches have been devoted to the definition of methods for knowledge representation by domain experts [12,13]. The T.arcH.N.A approach uses a mind map [13] how graphical diagram by means of which to represent ideas, concepts and terminology for a specific CH. In the remaining part of this paper, this knowledge representation, expressed using a mind map, is referred to as Cultural Knowledge Base (CKB). Once a CKB is defined for a specific CH, it is necessary to translate it in a form understandable by the machine. As said in the previous section, the T.Arc.H.N.A system adopts the CIDOC-CRM to represent such machine understandable knowledge base. During this translation process two groups of experts have to collaborate: cultural experts and computer science experts. These two teams through a process of progressive semantization [14] have to define a ontology that on one hand reflects the portion of CIDOC-CRM relevant for a given CH and on the other hand maps the CKB concepts and relations on the CIDOC-CRM classes and properties. Through the CKB, domain experts explain their view about the current organization of their data. Exploiting this view they can clearly express to computer scientists what are the real-world entities that they describe, their relationship and what kind of informative requirements they expect fulfill. Following this process the two groups analyze each concept and relation and map them onto the proper CIDOC-CRM classes and properties. The final result is the development of the ontology carried out through an iterative process. For example in the figure 1 is presented an archaeological context in which this iterative process brings to map an archaeological mind map with a portion of the CIDOC-CRM. In this example, the CKB relation "material" (linking the CKB concepts "FindingMaterial" and "Finding") is modeled using the

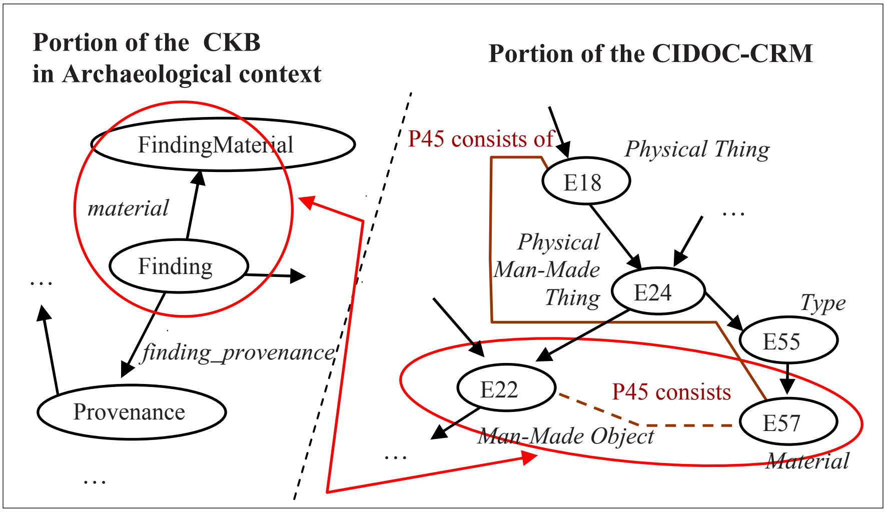


Fig. 1. An example of the mapping process between the a CKB in archaeological context and the CIDOC ontology

CIDOC-CRM property "P45.consists_of". This property is inherited from the class "E18 Physical_Thing" father of the class "E57.Material" in the CIDOC-CRM hierarchy.

The information describing the mapping are memorized in the ontology itself. In order to store such information, the CIDOC-CRM has been extended by adding two classes: *DB_Class_Mapping* and *DB_Property_Mapping*. Since these classes do not model any domain concept, they have been placed outside the original CIDOC-CRM classes hierarchy. The two classes are endowed with a set of properties which refer the information related to the mapping between the CIDOC-CRM and the CKB. Further discussion about the knowledge integration model is out of the paper's goal and is omitted for lack of space.

4 Semantic Tailoring and Filtering of Cultural Information

Although advances in digital media have provided us with exciting and pioneering ways of exploring and relating to media content, stories and narratology are still recognized as a principle means of knowledge transfer within a range of ad hoc disciplines. Under this perspective, narration can be served as a means of disseminating knowledge throughout communities and society as a whole. Its role in preserving historical memory, firstly as spoken word and later in written form is of distinct importance and as a consequence, it is uniquely placed within the realm of CH. Technological advancements, however, particularly in semantic enabled technologies, have paved the way for new possibilities in developing more intuitive and human centered information systems. Within this context, this section describes an approach, developed as part of the T.Arc.H.N.A. project, which aims to support a community of heritage professionals in the development of a comprehensive narrations system. Therefore, this approach advocates the use of narration as a vehicle for knowledge transfer and as a tool for context aware tailoring. Starting from these considerations it is possible to define the narration as a document written by domain experts and able to contextualize cultural data in a novel way by relating different types of artifacts. These artifacts acquire new value according to the context defined in the narration. In this way a narration becomes a medium used by domain experts for defining the portions of the data-sources to be materialized according to their historical and anthropological meanings. To integrate the narration concept into the knowledge system, it is necessary to extend the ontology's schema by means of a new class called "Narration". In the adopted knowledge system a narration is composed of multiple components: a text and a context. For instance in the archaeological field, a possible narration can deal with the theme of devotional practices or the music in ancient Etruria. In these cases the context expresses the network of relations that connect the text with the set of artifacts related to it. The figure 2 shows a narration about Etruscan music as it appears to a visitor. The text (frame A) describes the social role of music and features, roles and functions of musical instruments in the Etruscan age. The context (frame B) is a set of three documents displayed on the right side of the text: the top document shows and describes a lute, a musical instrument, the second document displays a vase on which a playing musician is represented and the third document presents a fresco from the Leopard Tomb, displaying musicians playing musical instruments. The three documents have been retrieved from different databases, and illustrate artifacts (instrument, frescos and vase) which can be seen in several institutions, geographically dispersed in Europe. It is important to note that each archive in the federation of databases connected by means of the ontology can be updated, for example because the institution maintaining it acquires some new exhibits. In these cases the set of artifacts collected as the result of the interpretation of a context is different from the previous sets. Hence the context and the narration itself are document systems varying in time. The proposed method aims to retrieve a huge amount of available data to support users in easily navigating filtering the cultural information according to their real interests. Through these access strategies rich, complex, and meaningful questions can be formed. In the case of use presented in figure 2 the user has begun his/her thematic tour selecting the topic: "music and musicians". The frame A of the figure 2 shows a set of narrations related to this argument (only the narration titled "Music and Etruscans" is open). In this case, the narrations are used to filter the amount of available artifacts, findings, monuments, documents related to this theme. For example the narration titled "Music and Etruscans" recollects all findings and monuments (in the frame B) relevant for the theme explained in the text (shown in the frame A). The piece of knowledge presented in the frame B is retrieved from different databases by means of a semantic query expressed using a terminology as defined by the domain experts through the CKB. This semantic query is then transformed in a query based on CIDOC-CRM terms exploiting a first layer of the information mapping defined to put in relation the CKB with the CIDOC-CRM. Finally exploiting the second layer of the information mapping between the ontology and the DB schemas, the query is translated into a set of SQL statements for each database integrated in the system.

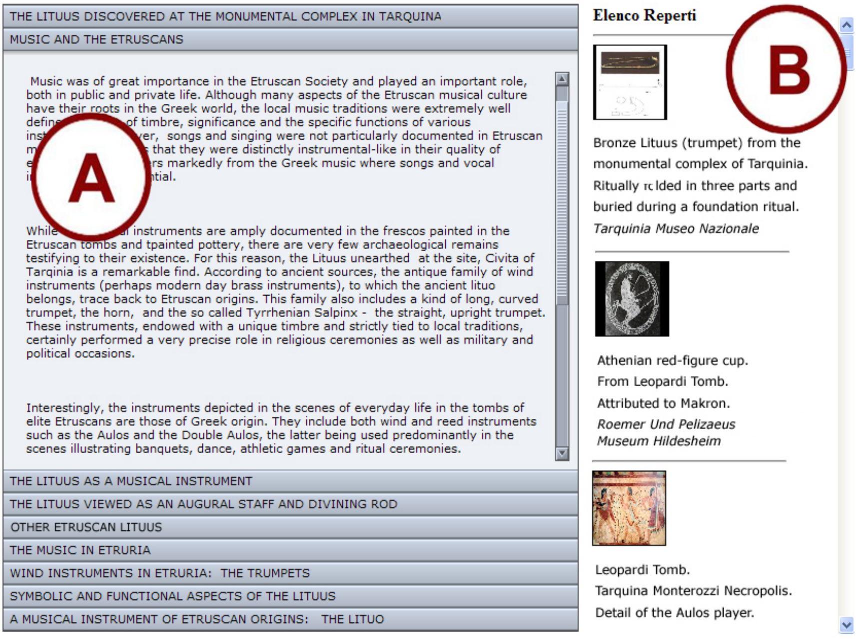


Fig. 2. A screenshot of an application used to present narrations to the large public

5 Conclusions

The fruitful meeting between domain experts and computer science experts has led to the definition of a methodology for supporting the design of interactive and participatory systems where different actors cooperate to create and disseminate cultural knowledge. This methodology allows to deal with CH as dynamically evolving over the time through the discovery of cultural objects and the development of new theories. The added value of the cultural issue produced overtakes limits of space and time and can be presented to a large public under its proper context oriented light. The presented approach is addressed to the definition of a comprehensive knowledge base according to a specific CH able to integrate heterogeneous data-sources, contextualize their information with the active participation of domain experts, and finally disseminate them using specific interactive tools. Data-sources are integrated using a knowledge system reflecting the mental model of the domain experts. The paper also introduces a methodology based on the concepts of narration. Through the use of narrations, the cultural information retrieved from different digital archives are tailored and contextualized according to the real users' interests and domain experts can actively participate in the dissemination process of the CH information to the public. The system is today used to disseminate information about the Etruscan civilization in the context of the T.Arc.H.N.A. project. However, the solution proposed is built to be flexibly applied to many domains, even outside of the heritage scenarios.

Acknowledgments. This work has been partially founded by the European Community under the T.Arc.H.N.A. project (Towards Archaeological Heritage New Accessibility) under the EC-grant No 2004-1488/001-001, CLT-CA22 (CULTURE2000 2004-2007).

References

1. Bagnasco Gianni, G. (ed.): Cerveteri. Importazioni e contesti nelle necropoli, Quaderni di Acme, 52. Bologna (2002)
2. Lytras, M.D., Sicilia, M.A.: The Knowledge Society: a manifesto for knowledge and learning. International Journal of Knowledge and Learning 1(1-2), 1–11 (2005)
3. Mena, E., Illarramendi, A.: Ontology-Based Query Processing for Global Information Systems, p. 215. Kluwer Academic Publishers, Dordrecht (2001)
4. Bergamaschi, S., Castano, S., Vincini, M., Beneventano, D.: Semantic integration of heterogeneous information sources. Data Knowl. Eng. 36(3), 215–249 (2001)
5. Leone, N., Eiter, T., Faber, W., Fink, M., Gottlob, G., Greco, G.: Boosting information integration: The infomix system. In: Proc. Italian Symposium on Advanced Database Systems (SEBD), pp. 55–66 (2005)
6. Dong, X.L., Halevy, A.: A platform for personal information management and integration. In: CIDR 2005 Second Biennial Conference on Innovative Data Systems Research, pp. 119–130 (2005)
7. Lenzerini, M.: Data integration: a theoretical perspective. In: ACM Intl. Conference on Management of Data (SIGMOD), pp. 233–246 (2002)
8. Crofts, N., Doerr, M., Gill, T., Stead, S., Stiff, M.: Current Official Version of the CIDOC CRM version 4.2 of the reference document. Definition of the CIDOC Conceptual Reference Model (2005)
9. Valtolina, S., Mussio, P., Mazzoleni, P., Franzoni, S., Bagnasco, G., Geroli, M., Ridi, C.: Media for Knowledge Creation and Dissemination: Semantic Model and Narrations for a New Accessibility to Cultural Heritage. In: Krishnamurthi, S., Odersky, M. (eds.) CC 2007. LNCS, vol. 4420. Springer, Heidelberg (2007)
10. Valtolina, S., Franzoni, S., Mazzoleni, P.: Building knowledge networks using panoramic images. System and Information Sciences Notes, vol. 2(1) (2007) ISSN 1753-2310 (Print) ISSN 1753-2329 (CD-ROM)
11. Devedzic, V.: Research community knowledge portals. International Journal of Knowledge and Learning 1(1-2), 96–112 (2005)
12. Novak, J.D.: Learning, Creating, and Using Knowledge: Concept Maps (tm) As Facilitative Tools in Schools and Corporations, 1 edn., February 1, 240 pages. Lawrence Erlbaum, Mahwah (1998)
13. Buzan, T., Buzan, B.: The Mind Map Book: How to Use Radiant Thinking to Maximize Your Brain's Untapped Potential, Plume, March 1, 320 pages (1996) ISBN: 0452273226
14. Tondl, L.: Problems of Semantic. Reidel Publishing Company, Dordrecht (1981)

Mobile and Accessible ICTs for Museography

Belén Ruiz[1,3], Jaime Solano[2,3], Lourdes Moreno[1,3], and José Luis Pajares[3]

[1] Computer Science Department, Universidad Carlos III de Madrid,
Avda. Universidad 30, 28911 Leganés, Madrid, Spain
[2] Audiovisual Communication and Journalism, Universidad Carlos III de Madrid,
C/ Madrid 133, 28903 Getafe, Madrid, Spain
[3] The Spanish Centre of Captioning and Audio Description (CESyA)
Avda del Mar Mediterráneo, 22, 28914 Leganés Madrid
+34 91 624 9015
bruiz@inf.uc3m.es, jsolano@hum.uc3m.es, lmoreno@inf.uc3m.es,
jpajares@cesya.es

Abstract. Technology can be an integrative tool with which to facilitate universal access to museums via multimedia and portable guides, making it more inclusive. In this way, this article describes the main findings in the design and use of our MGA (Multimedia Guides for All) approach. This approach involves a series of recommendations for the selection, application, preparation of content, maintenance, etc., of this type of computerized device, in order to achieve the "design for all" principles, giving everyone, with or without disabilities, equal access to the cultural heritage. Following MGA approach, a real study case is presented, in this study several prototypes were developed with the continues support and testing of different disability users associations. The MGA approach can be applied to other domains. Many of the conclusions in this article have been drawn from an R&D Project financed by the Spanish Ministry of Industry, Science and Technology within the National Innovation and Development Plan 2005-2008.

Keywords: Mobile media, audiovisual accessibility, Universal Design, museums, cultural heritage, education, guides.

1 Introduction

Different electronic guides with sign language videos and audiodescriptions are beginning to be introduced in museums [10][12] with the aim of allowing disabled visitors to explore them in a more independent and adaptable way, encouraging the inclusion of citizenship in the information society [5].

Like related work, many museums have set up initiatives to create portable devices which make museum visits accessible to visitors with different types of needs. These devices are of a diverse nature and they enrich the visitor's experience, some of them are referenced in this work.

The approach MGA is designed to universalise access to mobile contents by including sufficient configuration and adaptation features, enabling people with or

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 531–539, 2008.

without disabilities to make equal use of them. Thanks to this features, the applications in museums have the potential of becoming an essential tool in museographics.

Section 2 discusses about museographics in relation to use of multimedia guides. The approach, MGA (Multimedia Guides for All) is showed in Section 3. Section 4 describes the case study, GVAM (Virtual Accessibility Museum Guides). Finally, we offer some conclusions and areas for future research.

2 Museographics and Virtual Guides

Museography is the science that studies the construction of museums, and the exhibition acquires a very special importance as a system for presenting pieces and the way they are arranged for the public [8]. This involves the application of the museological requirements of the project, taking into account the architecture, the collection, the financial and human resources, and other factors limiting "how" the museum is presented to its visitors. In this context, traditional guides are a resource in short supply. They are employees who are experts in the content and narration of the pieces on display, their social or human historical context. They give life and vigour to the museum and even entertain visitors, making their visits stimulating rather than boring, and of course, educational, who are capable of responding to any situation, question, type of audience, emergency, etc.

This need for training in content, social skills, language, etc. and the growing number of ever-increasingly demanding visitors mean that museums must find educational resources to complement the services of this traditional guide.

What's more, visitors' behaviour has changed and they now avoid from forced human contact and predefined routes. Faced with the linear nature imposed on the experiences and social interactions taking place in museums and in other cultural exchange areas, many visitors prefer to be free to explore the depths of the museum on their own, and place great value on the ability to participate in the experience of scientific discovery, whether it is archaeological, biological or technological, etc.

2.1 New Technologies as Tools at the Service of the Visitor

It is true that the use of new reference and exhibition media based on information technology has been very helpful to museums when it comes to attracting and satisfying large numbers of visitors. However, it is less certain that they have become part of the actual educational process resulting from the contact and the participation in the cultural item in its pure, proximal state (the piece on display), and which should be intensified by this type of system.

The traditional purpose of museums has been to acquire, preserve, communicate and exhibit the pieces and contents of their collections or the field of knowledge in which they specialise. Although the focus is on people and their interests and preferences, the obvious solutions of the modes always need to be avoided in favour of an approach supported by the orderly, balanced development of these functions [2].

Therefore, these new technologies must be applied from the perspective of the value they contribute to these traditional functions and, lastly, to developing new ones, taking into account the three basic characteristics of new museums (Santacana, 2005, p. 640) [9]: "The inexistence of any earlier requisites for understanding any type of exhibition, the educational factor applied to all types of audiences and the preference for open visits as opposed to closed circuits. Only then will real innovations be possible that do not pervert the essence of the museological project itself".

2.2 Virtual and Personal Guides

There have always been guides in museums. These are the people who act as a bridge between the visitor and the knowledge hidden in the pieces, impenetrable for many without the help of the friendly, personalized explanations of these employees.

About 35 million audio guides are distributed daily in several cultural centres [12]. Interactive guide devices are no substitute for these specialists; however, they do complement their activities by:

- Serving a large number of visitors at a reasonable, affordable price.
- Giving explanations in several languages.
- Adapting to the needs of single individuals rather than group.
- Encouraging and facilitating exploration of the museum by personalising the explanations, depending on the facilities, according to needs for accessibility, time available, itineraries based on specific pieces of interest, themed itineraries, preferences, etc.
- To facilitate, depending on its configuration, the work to modify its contents and therefore the explanations given by the institution.
- To enable the visitors to contribute in situ to the museum contents.
- To have greater control over and precise statistics about the use visitors make of the museum.

3 MGA (Multimedia Guides for All)

Our approach born in the context of an R&D project called GVAM (Spanish acronym of Accessible Virtual Guides for Museums) detailed in section 4. It's the result of research, and conclusions after putting them into practice in real experiments. The objective of this project is to provide design guidelines for any mobile or portable device showing multimedia and audiovisual contents, so they can be accessed by people with sensory and cognitive disabilities.

The application of MGA in tour guides defines a portable, interactive device that helps and guides visitors through a place of cultural interest such as a museum, transmitting information through different media (which could be text, images, video, audio, etc.), being their use adaptable to the visitors' different sensorial and cognitive conditions.

After reviewing issues concerning museography that affect direct user interaction in a museum, and seeing how these can be transferred to a virtual interaction within the field of multimedia guides, is presented as proposal in this paper a series of basic recommendations with the hope that such guides will offer a universal and accessible design.

In the museum setting with application of MGA approach, GVAMs are revolutionary in the way they present and give access to their content to people with disabilities, and all other visitors, meaning that museums do not fall into the digital gap, but instead strengthen everyone's inclusion in the knowledge society.

3.1 Accessibility Mechanism

Any MGA device should be based on a usable, accessible design, which defines all its characteristics from inception, leading to the availability of the advantages described in 2.2. To do this it must include menus or assistants that enable multi-language configuration and audiovisual accessibility resources adapted to times and interests, as well as the possibility of freely obtaining more information about each element, etc.

In this approach, a proposal of accessibility requirements to consider in the design of a multimedia guide based on standards, regulations and solid studies [6]. On the one hand, guaranteeing the accessibility and usability requires the extrapolation of concepts included in legislation, standards and other recommendations regarding the standardization of requirements, adapting them to the context and specific domain of museums. Regarding international regulations, the design takes into account the “ISO TS 16071-2003 for Software Accessibility” [4] and the technical standards in Spain about requirements for software and hardware accessibility and the application of alternative contents for predicting accessibility such as subtitling, audio descriptions and Sign Language, etc [1]. Usability criteria and principles of Universal Design were considered. For standardization documents, the W3C as Web Content Accessibility Guidelines (WCAG 1.0 and 2.0) [14] from WAI, and MWBP flip cards of best practices for mobile Webs [13]. Relevant documents from the NCAM (National Centre for Accessible Media) were also reviewed as to their relation with multimedia accessibility in multimedia and self-navigation menus, among others works.

In order to undertake such a diverse type of study always keeping accessibility in mind, an approach was adopted to prepare the mechanisms for accessibility.

In the context of MGA we are interpreting the term “accessibility mechanisms" to mean a tool that makes the contents available to specific users. There are several audiovisual accessibility resources according to the needs of the users that can be integrated in portable devices, and in the future these will be improved upon and will increase in number.

Thus, it was considered [6] in the case of those who do not have access to the soundtrack, the resources available should be subtitling and a signing window. In the case of people who do not have access to the images, they will be provided with audio descriptions, audio navigation, magnification and a contrast modifier. It must be possible to configure these resources freely so that, regardless of the person's physical and sensorial condition, they can be used at any time they are considered useful tools that improve the usefulness of the device or the application itself.

Every device following MGA approach must give a single access with configuration options rather than offering different accesses according to the type of user. This principle is subject not only to commented regulations and standards, but is also supported by the international principles of “Design for all”, which have an evident impact on this approach:

- The layout of the reference interface.
- The layout of the units of content - navigation.
- The layout of the physical control elements.

- The ergonomics (weight, size, transport aids, battery life, etc.).
- The solution for updating contents
- The question of accessibility.

3.2 Integration and Compatibility of Audiovisual Accessibility Resources in Portable and Mobile Devices

Whenever designing the behaviour, the placement of the different accessibility resources on the screen and audio must be taken into consideration, and its synchronization must be arranged in a manner that users can operate them logically according to their needs.

The areas reserved for accessibility resources must be equivalent to those occupied by first level content in the textual information, graphical or audiovisual context for people without disabilities. In order to orchestrate this, the following matters are taken into consideration:

- Regarding the placement of subtitles, it is recommended that these be placed in a box at the bottom of the screen, which will be permanent and may be hidden by the user. This box may also be hidden automatically in the event that no subtitled content is being shown.
- Due to the small size of the PDA and UMPC devices, it is reasonable that a sign language video would be provided as an element separate from the layout of the other content, appearing in a floating window which can be dragged and hidden by the user. This will prevent considerable space being wasted, which is better occupied by the actual museum contents. If, on the other hand, a fixed position is chosen, if possible, this will be placed on the top right hand side of the screen so that it follows the direction of reading.

All the accessibility resources will be synchronised at all times with the corresponding audiovisual elements, in such a manner that the associated play functions for audiovisual content also affect these resources, as well as possible automatic pauses due to the user's interaction with the application, such as, for example, a menu.

4 GVAM: Our First MGA Prototype

The GVAM is an R&D project[1] of the Spanish Ministry of Industry carried out by Dos de Mayo Ltd., the firm that leads the team integrated by The Spanish Centre of Captioning and Audio Description (CESyA)[2], in collaboration with Carlos III University of Madrid[3], CNSE Foundation[4], The ONCE Foundation[5] and the General Directorate of Museums and Cultural Heritage under the Ministry of Culture of Spain. As a

[1] FIT-350300-2007-45 Spanish Ministry of Science and Technology.

[2] www.cesya.es

[3] www.uc3m.es

[4] www.cnse.es

[5] www.fundaciononce.es

specific application domain the Spanish Museo del Traje (The Costume Museum)[6], was used, but the aim is to obtain solutions which are easily adaptable to different types of museums. The National Dress Museum of Madrid is a pioneering space in museology approaches, both in management exhibition, and artworks presentation through the use of new technologies as an information and training resource.

4.1 Hardware

The GVAM application meets at the current stage of development, with most of the design specifications defined in this document for MGA, representing the only solution to truly provide universal and adaptable museum contents at the international level.

The hardware relies on the UMPC (Ultra Mobile Personal Computer) category and is also consistent with the MGA specifications, the needs of the R&D project and with the configuration of most museums. These are, broadly real time positioning, with 1 meter error and without cable installation needed, meaning no visual impact in the museum walls. The Portable Device weights less than 500g, works over Windows XP and Adobe Flash, offers connectivity via WIFI and RJ45 and gets 3 hours of battery operation. It has physical navigation buttons and joystick, as well as a touch screen, desirable alternative for users without visual disabilities. The screen is 7 inches widescreen and 1024x600 px. An optional belt at the waist, as a device stand for people in wheelchairs and for another physical disabilities, is also available. The actual working prototype is planned for 2009 and has already established an action plan for promotion by the end of 2008.

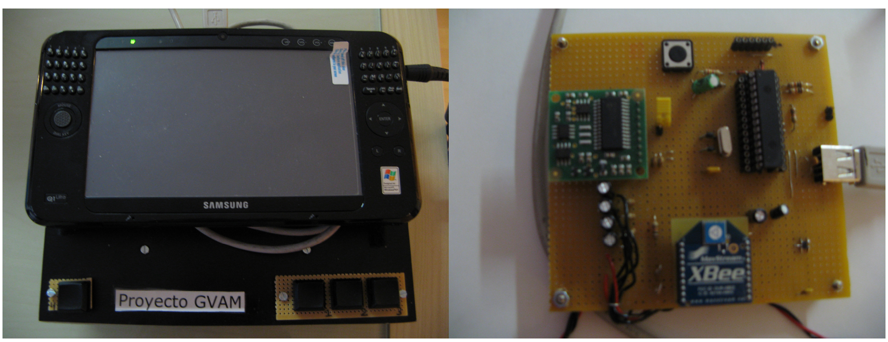


Fig. 1. Hardware components of the GVAM 1.0 prototype

4.2 Structure and Content

The organisation and nature of the contents are very much predefined but each museum, and it has its own peculiarities to which the content of the guides must be adapted.

[6] http://museodeltraje.mcu.es/

Likewise, titles comprise a first level within the description of each piece, the second is the formal description and the third is the contextual information.

The content included in the GVAM is placed in these last two levels. Although the GVAM can also be used to identify the piece using photographs, the user would have to confirm this with the corresponding title, which is why the information presented on the screen must be organized in the same way as that provided in the titles and panels adjacent to the works.

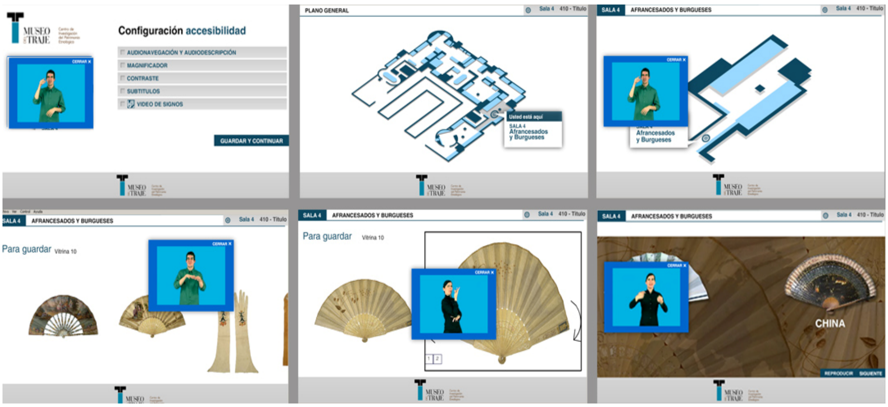


Fig. 2. Screenshots of the GVAM 1.0 prototype application

With regard to the drafting of the content, reference can be made here to WCAG 1.0, 2.2. "Content developers must make the content comprehensible and navigable. (…) Not all users are able to use the visual clues such as maps, navigation bars, continuous frames and graphics that guide sighted users around the desktop"[14].

In the context of the museum, the semantic labelling of the content must also help guide the visitor, particularly when searching, if this function is activated and make the interoperability of contents possible [3]. Semantic labelling is also essential to give consistency to the database, beyond the taxonomies the museum may have established.

When the user starts using a GVAM, and once the language and accessibility resources have been configured, the user will be able to use it. The user is presented with the basic content that will provide the following basic information:

1. Welcome and introduction to the museum. The structure of the content in the application will be presented to the user for information purposes.
2. Information about the guide itself. Explanations of its features, as well as a list of contents and the type of contents.
3. Information about where the user is at the time of listening to the introduction and the physical layout of the building.

Among the additional tools, it is recommended that a corresponding glossary of terms in the chosen language be included, which will also affect the sign language. The sign language glossary will comprise a series of terms and their corresponding videos, in which the signer shows the sign and explains its meaning. In this respect the FCNSE (The Spanish Confederation of the Deaf), in its experience with this type of resource in the development of the sign language guides for the Reina Sofia National Art Museum, suggests that the entire application of subtitles should show the words included in the glossary in a different word or underlined to show they are available.

5 Conclusions

Museums are part of this new connected knowledge society. The museum solutions must be sensitive to this situation and take advantage of new ICTs. In this evolution, one should not repeat past mistakes or obviate main problems such as universal accessibility. We have presented some of the main requirements that the final MGA guidelines will include. While user testing is still ongoing in order to ensure its full validation, the experiments already done and the good feedback from users and affected collectives associations push us to continue our work. We believe their benefits affect not only to disabled visitors but also to the whole public of a museum, which ensures profitability at any exhibition, in terms of entertainment, education, knowledge transfer and overall satisfaction of the people.

6 Future Lines

Our approach was initially conceived for a GVAM like device, but we concluded our recommendations will be also applicable to other mobile devices. Nevertheless, in order to test the GVAM prototype and to validate our approach in this context, more user testing and comparison analysis of the main tourist audio and multimedia guides currently available in the market and through out several museums is still necessary and it will be done.

As we are part of a public centre, the aim of our group is to make progress in the establishment of regulations in the European and Spanish contexts, regarding audiovisual and multimedia accessibility over mobile contexts, firstly those requires access to information over physical media, like museums, natural and historical heritage wholes and even urban environments with a high density of communication media. In next stages, any kind of mobile media will be taken into consideration.

While this testing is finished, a publication with an informative character, with the collaboration of the organizations representing the disabled, will be published before the end of the year to introduce the museum educators departments and boards to this topic. Keeping the character of similar accessibility studies [7][11], publication would be presented as a guide with recommendations and best practices for including requirements in GVAM like devices.

References

[1] AENOR, Spanish technical standards: Standard UNE 153010:2003: Subtitled through tele-text, Standard UNE 153020:2005: Requirements for audio description and Standard UNE 139804:2007 Requirements for the use of Spanish Sign Language on computer networks (2007), `http://www.aenor.es`

[2] Chinchilla, M.: El Papel De Los Museos En La Conservación Y Difusión Del Patrimonio Histórico. Sociedad Estatal España Nuevo Milenio (2002)
[3] Colazzo, S., Garzotto, F., Paolini, P.: Let's Go Mobile! Design Issues in Multichannel 'Accessible' Applications for Cultural Heritage. In: Trant, J., Bearman, D. (eds.) Museums and the Web 2005: Proceedings, Toronto (2005) (ref. de March 26, 2008), http://www.archimuse.com/mw2005/papers/colazzo/colazzo.html
[4] International Organization for Standardization: ISO TS 16071-2003 refer to software accessibility (2003)
[5] Jónsdottir, B.: Nordic strategies of design for all. In: Making Cultural Heritage Truly Inclusive Conference. National Museum of Finland, Helsinki (2007)
[6] Moreno, L.: Inclusion of accessibility requirements in the design of electronic guides for museums. In: 11th International Conference on Computers Helping People with Special Needs (ICCHP 2008), Special Thematic Sessions: Portable and Mobile Systems in Assistive Technology, Linz, Austria, July 9-11 (2008)
[7] Moreno, L., Gálvez, Ma.C., Ruiz, B., Martínez, P.: Providing Deaf and Hard-Of-Hearing Visitors With On-Demand, Independent Access To Museum Information and Interpretation Through Handheld Computers. In: Trant, J., Bearman, D. (eds.) Museums and the Web 2005: Proceedings. Archives & Museum Informatics, Toronto (2005), http://www.archimuse.com/mw2005/papers/proctor/proctor.html
[8] Salas López, F.: El Museo, Cultura Para Todos. Ministerio de Cultura, Madrid (1980)
[9] Santacana, J., Serrat, N.: (coord.): Museografía Didáctica. Ariel, Barcelona (2005)
[10] Santoro, C., Paternò, F., Ricci, G., Leporini, B.: A Multimodal Mobile Museum Guide for All. In: Mobile Interaction with the Real World (MIRW 2007) (2007) (ref. March 24, 2008), http://www.medien.ifi.lmu.de/mirw2007/papers/MGuides2007_Santoro.pdf
[11] Solano, R., Utray, F., Gálvez de la Cuesta, M.C., Pajares, J.L.: Multimedia and Accessible Museum Guides: The GVAM Prototype for the Dress Museum of Madrid. In: International Conference of Inclusive Museum, Leiden, Holland, June 9-11 (2008)
[12] Tellis, C.: Multimedia Handhelds: One Device, Many Audiences. In: Bearman, D., Trant, J. (eds.) Museums and the Web 2004, International Conference Proceedings, Archives and Museum Informatics (2004) (ref. March 24, 2008), http://www.archimuse.com/mw2004/papers/tellis/tellis.html
[13] W3C: Mobile Web Best Practices and MWBP Flip Cards (2006), http://www.w3.org/Mobile
[14] W3C: Web Content Accessibility Guidelines 2.0 (WCAG 2.0) (2008), http://www.w3.org/WAI/intro/wcag.php

CallimachusDL: Using Semantics to Enhance Search and Retrieval in a Digital Library

Juan Miguel Gómez-Berbís* , Ricardo Colomo-Palacios, and Ángel García-Crespo

Universidad Carlos III de Madrid, Computer Science Department
Av. Universidad 30, Leganés, 28911, Madrid, Spain
{juanmiguel.gomez,ricardo.colomo,angelgarcia}@uc3m.es

Abstract. Among the challenges of classifying, locating and accessing knowledge in Digital Libraries tackling with the huge amount of resources the Web provides, improving Digital Libraries by means of different strategies, particularly, using semantics remains a promising and interesting approach. In this paper, we present CallimachusDL, a semantics-based Digital Library which provides faceted search, enhanced access possibilities and a proof-of-concept implementation.

Keywords: Digital Library, Semantic Web, Ontologies, Faceted Search.

1 Introduction

Digital Libraries represent a new breed of software applications whose aim encompasses categorizing, classifying, archiving and providing access to the vast constellation of Web resources. Currently, Digital Libraries (DL for short) are facing a new paradigm shift coping with various challenges which include overcoming traditional browsing or keyword-based strategies. Fundamentally, DL infrastructure improvement attempts have been trying to increase the quality of information retrieval, from query expansion to the collaborative filtering or multi-faceted browsing [1]. However, current approaches are still not fulfilling expectations, leading the user in many cases to frustration.

On the other hand, semantic technologies are evolving to a more mature state in which ontologies [2], its backbone technology, provide a formal representation of a domain. The use of semantics in DL can outperform the current endeavors that require finding data spread out across the DL structure and dynamically drawing inferences, something continually hampered by their reliance on ad-hoc, task specific frameworks in present DL technologies.

In this paper, we present CallimachusDL, a semantics-based DL which uses semantic information gathering and browsing to enhance search and retrieval.

The remainder of the paper is organized as follows. In section 2, we present the related work on DL and the state of the art. In section 3, we discuss a number of

* Please note that the LNCS Editorial assumes that all authors have used the western naming convention, with given names preceding surnames. This determines the structure of the names in the running heads and the author index.

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 540–548, 2008.

requirements and the benefits of tackling them with our semantically-enhanced approach. Section 4, we describe CallimachusDL in detail, its architecture and proof-of-concept implementation. Finally, section 5 concludes the paper providing a number of conclusions and section 6 summarizes our future work.

2 Digital Libraries: Been There, Done That

Digital libraries provide high quality and well-organized information. Many of the powerful characteristics of Digital Libraries rely on Metadata. Librarians describe the resources of catalogues and other collections trough metadata in order to facilitate efficiently the delivery of information. The use of metadata in its formats and functionalities has been an object of study in the past in the field of Digital Libraries: ej. XML [3] and RDF [4], [5]. The use of ontologies in the context of Digital Libraries could be interesting in order to incorporate new functionalities by describing the relationships between elements. The concept of ontology introduced by the Semantic Web is a promising path to extend Digital Library formalisms with the meaningful annotations [6]. Several authors have proposed ontologies for describing the relationships between all the elements which take part in a digital library scenario [7], [8] that goes beyond different standards of digital libraries description formats like MARC21, Dublin Core and BibTeX.

The new and promising digital libraries content management tool generation comes from the joint of the Semantic Web and the new social aspects of the so called Social Web. Here we find several initiatives such as the ambitious JeromeDL project [1] or DLibra [9]. Jerome DL uses MarcOnt Ontology [8] mediates with several legacy metadata standards (MARC21, BibTeX & Dublin Core) and offers a number of search and retrieval services based on Semantic technology.

Fundamentally, our approach is radically different to the ones detailed before since we propose semantic navigation, faceted search and browsing, metadata representation format and usability as the main building principles and cornerstones of the whole approach. Those features are detailed in the next section.

3 Using Semantic Information Gathering and Browsing to Enhance Search and Retrieval

Since its inception, Digital Libraries on the Web had to strive for classifying, locating and accessing resources. However, the advantage of the simplicity in Digital Libraries leads to its great drawback, the increasing number of information being stored without a clear structure. Actually, most current DL cannot be used as fully-fledged environments to create and search knowledge in an efficient way, since the information collected through these systems lays unused by computers, mainly due to the human language in which the resources are written. As further processing is needed, new formal approaches are used to make computers "understand" the Web content [10] or, more precisely, applying semantics.

The Semantic Technologies paradigm is based on this statement, where the traditional Web is enhanced with formal knowledge placed below the current information.

This is possible thanks to the extensibility of the Web with metadata and metadata processing, which allows computational reasoning and intelligent capabilities. In the following, we analyze the problems raised in the way to reach a semantically-enhanced DL environment, including technical and social factors:

- Metadata representation format: Metadata support for the actual information on DL resources must be explicitly declared. In some of the current social tools such as the emerging Web 2.0 applications like Flickr (http://www.flickr.com) or del.icio.us (http://del.icio.us/) apply the so called "folksonomies" to add meta-information in form of tags chosen by the user [11]. In this case, tags are different among different users, because they are chosen freely, so they cannot be fully exploited in a community. Besides, its storage has nothing to do with Semantic Web.
- Navigation. Ordinary DL base the relationship between pages in explicit hyperlinks. This links relate one page to another basically by user considerations. If the relation between DL resources were represented by means of semantics, the application would be able to provide mechanisms to semantically navigate between related resources with real meaning.
- Search. Given a set of resources, the basic type of querying in current DL is the keyword-based search. Structured requests for more advanced information retrieval are needed to make a DL a really useful knowledge repository. In addition to simple full-text searches, users would recover information by querying or selecting the semantic knowledge.
- Usability. Communities need a critical mass of users. Not only the number of users is crucial, but also their participation in the communities. Without his mass, the systems underlying communities will be abandoned by the users [12]. Semantic Web community has to grasp this principle and make it their own. For that purpose, applications enhanced with semantic functionalities have to be designed with maximum usability and minimum cognitive load for every user, including both Semantic Web experts and Internet users with no knowledge about semantics.

The gist of this work is providing an answer to these requirements. In CallimachusDL, we focus on the aforementioned requirements, solve them and propose an integrated solution that uses semantic information gathering and browsing to enhance search and retrieval. In the next section, our approach for CallimachusDL will be discussed.

4 CallimachusDL: Bringing the Library Mess into Order

4.1 The CallimachusDL Description

Given the aforementioned problems that traditional DL cope with, we explain here our approach, based on several design principles to avoid these drawbacks, and built as the kernel to develop a fully-fledged semantic working environment for the final users. These design principles are as follows:

- Metadata Representation Format: Bearing in mind that metadata processing requires a controlled and well-defined vocabulary, the Semantic Web saw in the ontologies the best mechanism to represent, share and reuse the knowledge behind. One of the most well-known definitions of an ontology is the one stated by Borst [13], extending Gruber's one [14], define it as a formal specification of a shared conceptualization. Since semantic knowledge must be represent in form of well-designed ontologies, it is time then to choose the models and languages in which this representation will be brought to life. For that, we recommend the selection of the different World Wide Web Consortium (W3C) proposed standards. Resource Description Framework (RDF, http://www.w3.org/TR/rdf-primer/) and RDF Schema (RDFS, http://www.w3.org/TR/rdf-schema/) can be perfectly suitable for defining the semantic information needed. Other languages such as the Web Ontology language (OWL) can also be suitable, but its further inference mechanism can be too much for the real necessities of the application.
- Multi-ontology approach for defining DL resources: Once ontologies representation has been defined, the scope of the used ontologies must be explicitly declared. Since DL resources are basically resources in the Web, they should be described this way first. For this, Dublin Core initiative (DC, http://dublincore.org/) fits perfectly as the main ontology for describing the whole wiki pages. Once identified, the DL resources must be described as far as its content is concerned. Therefore, a second ontology or several ontologies must be used for formalizing the real domain of the DL resources content.
- Semantic Navigation: As ordinary hyperlinks are not enough to show the related information in a DL, another approach is needed to offer the user all the information semantically similar to the one they are viewing. This is mainly due to the fact that the user interface must enable navigation to semantically related items [15]. For that, we propose semantic links, semalinks, which are ordinary hyperlinks in appearance but built upon semantic information. This semantic information, consisting both on the ontology concept which a certain part of the content is referring and its value, will lead to the user to pages with a semantic similar content as the semalink indicates. That is, if a set of words have been used to form a semalink, with a property x and a value, when mouse over this link, the nodes appearing will make reference to other pages with same property x and value, and as many more references as properties directly related with property x exists in the repositories, with same value.
- Usability: Authoring a semantic wiki must be made just as easy as authoring a traditional wiki. For that purpose, editing the semantic links must be done at the same time and in the same view as editing the rest of the page. Semantic annotations are the answer to fill this gap. Annotate a document means adding semantic data to these documents [16]. Users will be provided with semantic information to add; therefore, while editing a page, they will be able to annotate a word or a set of words with semantic data, just as easy as marking the selected words and associate them to a

property or vocabulary concept from the ontology domain. Usability is also reflected in the functionalities of browsing and searching seen in the previous subsections.

- Faceted Search: As keyword-based searches or other different syntactical queries are not an efficient retrieval mechanism, and providing that semantic information is underlying our system, a more advanced search is required. A facets-based search is the solution. With faceted metadata [17], the information space is partitioned using orthogonal conceptual dimensions of the data. These dimensions are called facets, and represent the characteristics of the information elements. These facets are used then to select or filter the relevant elements in a certain information space, leading users to the exact information needed. These facets are the properties defined in the domain ontologies.

Once we have described CallimachusDL and its main features, we will describe the CallimachusDL architecture in the next section.

4.2 The CallimachusDL Description

The CallimachusDL architecture is heavily based on the SWAN architecture [18]. Having into account these apparently different levels of knowledge (ontologies, resources and semantic information), we explicitly divide this knowledge into three layers:

- Resource layer: This layer stores the DL resources and all the objects related to those resources.
- Domain layer: This layer deals with the ontologies used for formalized the semantic information for both the DL pages (DC vocabulary) and contents (RDFS vocabulary or vocabularies).
- Application layer: This layer is supported on top of the previous one and will be built with the domain ontologies the CallimachusDL system requires, and applied to the resources in the first layer.

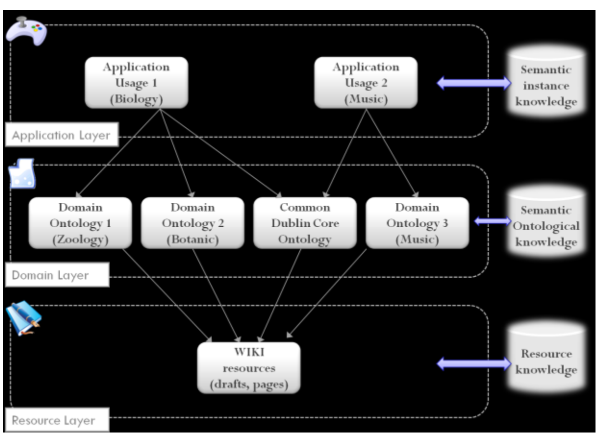


Fig. 1. The SWAN architecture as a basis for the CallimachusDL architecture

Keeping these knowledge layers conceptually separated, implementation will guarantee the flexibility and reusability of the CallimachusDL application for every sort of domain. [Fig. 1] shows the framework of this approach, along with named examples for better understanding.

Domain layer keeps the different domain ontologies that can be used. The Application layer will use one or more domain ontologies depending on the sort of topics the DL application is going to deal with. The Dublin Core Ontology will be always used to represent the basic metadata concepts of every resource.

4.3 Using CallimachusDL

The CallimachusDL implementation is based on the SWAN architecture successfully SWAN architecture has been successfully deployed on CoolWikiNews, a Semantically-enhanced Wiki devoted to online news publishing [18]. CallimachusDL implements the MVC pattern by means of Ruby on Rails (RoR, http://www.rubyonrails.org) [19], a MVC-based framework which eases the task of building this architectural pattern. The common ontology used for describing the resources is Dublin Core. Its terms allow defining the metadata related to the whole page. The MarcOnt ontology is used for the annotation of more complex data. Both ontologies are developed with RDF Schema, and serialized in N-Triple syntax (http://www.w3.org/TR/rdf-testcases/#ntriples). The DL pages are presented to the user in XHTML 1.0 syntax (http://www.w3.org/TR/xhtml1/), and visual graphics for navigation are made with JavaScript libraries such as CoolTip (http://www.acooltip.com). Persistence repositories are MySQL server for resources information and SQLite- based RDFLite for semantic information. Finally, CoolWikNews uses ActiveRDF [20], a library for abstracting the queries for RDFLite within the implementation in RoR. Finally, we will show how CallimachusDL is used with a motivating scenario. Recently, a new breed of user generated content aware technologies which have been encompassed by the “Web 2.0” buzzword umbrella have turned up to provide a huge amount of metadata and information about the user as a particular entity. Web 2.0 technologies as outlined in [11] are exemplified by blogs, namely easy to update websites about a particular subject where entries are written in chronological order, picture-sharing environments such as Flickr or Photobucket, social bookmarking sites such as Del.icio.us, video-sharing such as YouTube or music preferences such as Last FM. A number of common features of Web 2.0 applications have been identified in [21]. This Web 2.0 user generated content is a perfect battlefield for our example.

For example, a user called John Smith has uploaded a number of videos in YouTube about his staying in Norway. Particularly, those videos are about the Norwegian fjords so he tags them with the “fjord” and “Norway” tags. However, tags are freely chosen keywords describing a particular resource. They offer a simple way of retrieving content but they are subjective conceptualizations, being potentially aggregated to a flat bottom-up categorization or folksonomy. In [22], folksonomies have been claimed to be an interesting emergent attempt for information retrieval but serve different purposes to ontologies, the latter are attempts to more carefully define parts of the data world and to allow mappings and interactions between data held in different formats. In this scenario folskonomies had been used for creating semantic metadata

[23] or as a support to learning [24]. Hence, ontologies are defined through a careful, explicit process that attempts to remove ambiguity, whereas the definition of a tag is a loose and implicit process where ambiguity might well remain. Finally, the inferential process applied to ontologies is logic based and uses operations such as join. The inferential process used on tags is statistical in nature and employs techniques such as clustering.

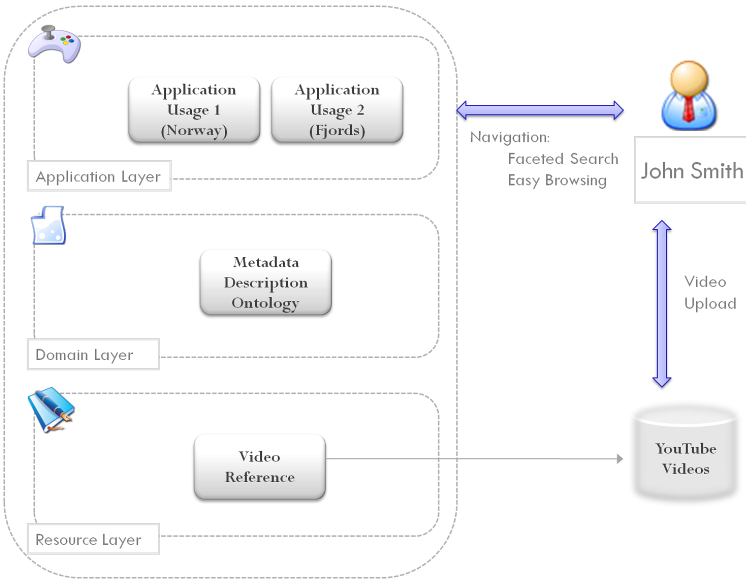


Fig. 2. John Smith videos in CallimachusDL

If John Smith chooses any traditional DL, he will face a number of problems, as we have shown in section 3. First of all, there is no metadata description, no chance of faceted browsing and problems to locate and retrieve its YouTube videos. Nevertheless, CallimachusDL offers a completely different situation. Using the three-layered architecture described in section 4.2, the Resource Layer would store references to the videos in YouTube or the videos as such. In the Domain Layer, there are metadata formally describing the videos by means of ontologies, mostly DC and the MarcOnt ontology. Finally, the Application Layer will use domain ontologies (for example, those referred to Norway and Fjords).

Finally, Faceted Search and Browsing would make very easy the life of John Smith when retrieving his videos, since he can navigate through the categories and also see related videos thanks to the semalinks, as explained in section 3.

5 Conclusions and Future Work BibTeX Entries

Callimachus (c.305-c.240 B.C.) was an ancient Greek poet, librarian, and scholar, famous representative of the Alexandrian school of poetry. Following the works of

Zenodotus of Ephesus, Alexandria Library first library director that began an inventory of the scrolls acquired by the Ptolemies, Callimachus created for the first time a subject catalog in 120,000 scrolls of the Library's holdings, called the Pinakes or Tables [25]. Following the Callimachus efforts, the man that improved subject search in Alexandria, we have presented a novel approach to improve browsing and searching in DL by adding semantics to the definition of resources. In a larger context, the problem of DL scaling may be multiplied by thousands of data structures located in hundreds of incompatible databases and message formats.

Hence, our future work will consist of evaluating our implementation and approach more carefully, validating CallimachusDL with a number of quality-aware case studies and using big-sized DL resources where pooling out of results can determine more accurately if the effectiveness of the breakthroughs of our approach detailed in section 3 take place. In a more general view, future work should further integrate social networks full potential into Digital Libraries. The unlimited potential of the Web 2.0 is an open field for technology investigators around the globe, and it is also a great opportunity for Digital Libraries researchers to put together social features and limitless content into a single package.

References

1. Kruk, S.R., Decker, S.: JeromeDL - the Semantic Digital Library. In: Proceedings Semantic Technology Conference 2007, San José, California (2007)
2. Fensel, D.: Ontologies: A Silver Bullet for Knowledge Management and Electronic Commerce. Springer, Berlin (2002)
3. Kim, H., Choi, C.: XML how it will be applied to digital library systems. The Electronic Library 18(3), 183–189 (2000)
4. Xing, W., Dikaiakos, M.D., Yang, H., Sphyris, A.S., Eftichidis, G.: Building a distributed digital library for natural disasters metadata with grid services and RDF. Library Management 26(4/5), 230–245 (2005)
5. Han, Y.: ARDF-based digital library system. Library Hi Tech. 24(2), 234–240 (2006)
6. Kruk, S.R., Decker, S., Zieborak, L.: JeromeDL - Adding Semantic Web Technologies to Digital Libraries. In: Proceedings of the 16 th International conference on database and expert systems applications, Copenhagen, Denmark (2005)
7. Ferrán, N., Mor, E., Minguillón, J.: Towards personalization in digital libraries through ontologies. Library Management 26(4/5), 206–217 (2005)
8. Kruk, S.R., Synak, M., Zimmermann, K.: MarcOnt - Integration Ontology for Bibliographic Description Formats. In: Proceedings of the International Conference on Dublin Core and Metadata Applications, Madrid (2005)
9. Mazurek, C., Werla, M.: Distributed services architecture in dLibra digital library framework. In: 8th International Workshop of the DELOS Network of Excellence on Digital Libraries on Future Digital Library Management Systems (2005)
10. Berners-Lee, T., Hendler, J., Lassila, O.: The semantic web. Scientific American 284(5), 34–44 (2001)
11. O'Reilly, T.: What is web 2.0? O'Reilly Network Retrieved (July 10, 2008) (2005), `http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html`
12. Ignacimuthu, S.: Basic bioinformatics. Alpha Science International, Harrow (2004)
13. Borst, W. N.: Construction of engineering ontologies for knowledge sharing and reuse. Doctoral Dissertation, University of Twente (1997)

14. Gruber, T.R.: A translation approach to portable ontology specifications. Knowledge Acquisition 5(2), 199–220 (1992)
15. Teevan, J., Alvarado, C., Ackerman, M.S., Karger, D.R.: The perfect search engine is not enough: A study of orienteering behaviour in directed search. In: Proceedings of the ACM Conference on Human Factors in Computing Systems, Vienna, Austria, pp. 415–422 (2004)
16. McEnery, T., Wilson, A.: Corpus linguistics. Edinburgh University Press, Edinburgh (2001)
17. Ranganathan, S.R.: Elements of library classification. Asia Publishing House, New York (1962)
18. Fuentes-Lorenzo, D., Gómez-Berbís, J.M., García-Crespo, Á.: CoolWikNews: More than meets the eye in the XXI century journalism. In: Rech, J., Decker, B., Ras, E. (eds.) Emerging technologies for semantic work environments: Techniques, methods, and applications. Idea Group, Germany (2007)
19. Thomas, D., Heinemeier-Hansson, D., Breedt, L.: Agile web development with rails: A pragmatic guide. The Pragmatic Bookshelf, Raleigh, NorthCarolina (2005)
20. Oren, E., Delbru, R., Decker, S.: Extending faceted navigation for RDF data. In: Proceedings of the International Semantic Web Conference. LNCS, pp. 559–572. Springer, Berlin (2006)
21. Ankolekar, A., Krötzsch, M., Tran, T., Vrandecic, D.: The two cultures: mashing up web 2.0 and the semantic web. In: Proceedings of the 16th international Conference on World Wide Web, pp. 825–834. ACM Press, New York (2007)
22. Shadbolt, N., Hall, W., Berners-Lee, T.: The Semantic Web Revisited. IEEE Intelligent Systems 21(3), 96–101 (2006)
23. Al-Khalifa, H.S., Davis, H.C.: Exploring the value of folksonomies for creating semantic metadata. International Journal on Semantic Web and Information Systems 3(1), 13–39 (2007)
24. Lux, M., Dosinger, G.: From folksonomies to ontologies: employing wisdom of the crowds to serve learning purposes. International Journal of Knowledge and Learning 3(4/5), 515–528 (2007)
25. Bevan, E.: The House of Ptolemy. Argonaut Inc., Chicago (1968)

Spatial Information Retrieval from Images Using Ontologies and Semantic Maps

Stavros Christodoulakis[1], Michalis Foukarakis[1], and Lemonia Ragia[2]

[1] Laboratory of Distributed Multimedia Information Systems and Applications
Technical University of Crete (MUSIC/TUC)
Chania, Crete, Greece, 73100
{stavros,foukas}@ced.tuc.gr
[2] Advanced Systems Group, Centre Universitaire d'Informatique
University of Geneva
24 rue General-Dufour, 1211 Geneva 4, Switzerland
lemonia.ragia@cui.unige.ch

Abstract. Cameras provide integrated GPS technology which makes them a powerful sensor for geographical context related images. They allow wireless connection to computers and the images can be automatically transferred to a PC or can be integrated into a GIS system. In this paper we propose an approach for spatial information retrieval from images using the concept of ontologies and semantic maps. The term of ontology is used in our case to describe spatial domain knowledge to enhance the search capability and image annotation. The objects are represented by their location in semantic maps. We describe a developed prototype system with a database design for ontologies and semantic maps. We demonstrate the automatic image annotation and the visualization of the spatial queries. The system is oriented to the area of culture and tourism and provides a user friendly interface.

Keywords: ontology, semantic, image retrieval, spatial search, database design, automatic image annotation, tourism application.

1 Introduction

Images are a powerful visual aid for displaying different kinds of information. With the use of digital cameras, a huge amount of images are produced. The development of powerful digital cameras has lead to the connection of the cameras with other devices like GPS receivers. The cameras have new capabilities like Wi Fi connection to remote computers and the images can be directly transferred. The users can also save in the cameras during pre-processing some information about the images, the environment that will be photographed, or about some interesting objects. The modern cameras produce images of high resolution with great quality and provide powerful tools for performance enhancement.

The images with their GPS information can serve as a useful tool for spatial information extraction. With an appropriate framework, the users can achieve an automatic

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 549–556, 2008.

spatial information retrieval. The semantic context of the images can be extracted and saved and, in principle, every user can have access to it and display it. This challenges the users to find new ways to use the above information for professional and personal reasons in a flexible and easy-to-use process.

Spatial information retrieval is concerned with the selection of geo-related information. It is the aspect of information retrieval that emphasizes the spatial context. The goal of this paper is to describe an approach for spatial information retrieval using the semantics and the location of information objects. Our approach is based on the assumption that the objects with their locations are represented on the basis of exact coordinates. There are spatial relations between objects which are metric (distance) or ordinal relation (direction). We use ontologies to overcome the problem of semantic heterogeneity and semantic maps in order to identify objects that have semantic meaning in a specific location. We describe a prototype for spatial information retrieval by integrating the images with semantic information. The current prototype is demonstrated for culture and tourism purposes.

1.1 Related Work

Spatial information retrieval is widely used in different kind of applications, like environment protection, urban transportation, etc. [10]. In general, it is related to spatial queries that refer to location, interesting objects, features of objects, or historical information. There are different approaches for spatial information retrieval depending on the data sources. In the area of Digital Libraries, a system for automatic processing is introduced for geospatial information [11]. It is based on the place names, their attributes and some spatial relationships between the objects. The indexing and retrieval methods for geo-referenced information in Digital Libraries to provide efficient access has also been examined [12].

The use of ontologies for image annotation is proposed in different approaches [6, 7, 8]. The main goal of using an ontology is to use the background knowledge in terms of assigning words for improving the automatic image annotation, indexing, searching and retrieval. In the Geographic Information Systems society, the ontological modeling of spatial objects and relationships is a useful method for search and analysis of spatial data [13]. An upper level ontological modeling is also proposed for thematic, temporal and spatial queries in the spatial domain [14]. Another approach proposes the use of ontology of place which combines coordinate data with spatial relationships between places [3]. For spatial information retrieval on the web, the ontological modeling with machine learning techniques for the extraction of geographic information of web documents has been introduced [2]. For the same purpose, the domain and geographical ontologies are supposed to enrich the web documents with well defined meaning and to expand the spatial query techniques [9].

In the application of culture and tourism there are tools that provide geographic information functionalities by combining the location and topological relationships of spatial objects and use maps to present them [15]. There are also systems which use the GPS information to provide multimedia tourist information [4].

2 An Approach for Spatial Information Retrieval

A very big problem with annotation and indexing of (multimedia) information is the inconsistency of the names used for the annotation. If text words are used for annotation of an image there will be problems of different spellings, problems of synonyms, problems of knowing or remembering a word that has been used for annotation. In addition, different people will use different words to index the same object or different words to search for it. The result is that the search very often fails giving small recall and precision.

2.1 Ontologies

Ontologies have the advantage that they are “common conceptualizations of a knowledge domain”, which means that they are accepted terms by a community for describing the knowledge of a domain. If an ontology is known and used by everybody for annotating information and searching for information, then all the above problems of search are eliminated. Thus the use of ontologies for annotation and search is very important for the community of users.

2.2 Semantic Maps

Semantic maps are digital maps which have the capability to associate for each pixel of the map its coordinates. These objects have their location based on the two dimensional coordinates of GPS positions associated with their spatial footprints and a common conceptual meaning. They are important because they give semantic information about objects. This information typically includes the type of the object and the name of the object. Both the type and the name exist in an ontology of objects which is of a particular kind.

In particular the semantic map is essentially a database of important objects in a geographic space which have representations on maps. With each important object the GPS coordinates of its footprint which gives the location are recorded in the database along with the name of the object (and possibly additional information about it). At the time of image taking the GPS coordinates of the user are recorded also in the camera.

Semantic maps use the concepts of one or more ontologies to annotate important objects of the real world that have a map representation. In addition to the names that they use (which are taken from the ontologies), they also register their location of those concepts. The advantages of the semantic maps are:

- they can be searched using ontology terms,
- they can visually show on the top of a map the location of important objects of the area (allowing interaction with them),
- they can visually show on the top of a map image the location of the important artifacts of an area,
- they can inform the user about the existence of an important artifact near his current location and
- they can also provide to the user all the information about the artifact, like its kind (ontology name), its type and information about the specific instance.

They are used later on for the detection of the nearest to the user object of the Semantic map, and the transfer of its attributes (name, descriptions, etc.) to the image attributes of a database.

3 The Developed Prototype System

The objective of the prototype developed is to show the use of ontologies and semantic maps in the automatic annotation of images taken by a user while traveling as a tourist.

In this approach we consider the Entity Relationship Model (ER) [1] as a basis for a successful use of a powerful ontology and semantic map server. The ontology database contains a number of ontologies (fig. 1). Each ontology is composed of a hierarchy of semantic types. A semantic type has a name and a set of semantic attributes. The semantic attributes may be different for each type and they may have a name and a value. It can accommodate ontologies of different kinds. Each ontology has a unique identifier and an ontology name and a number of semantic types. Each semantic type may have instances, usually called individuals in the semantic language terminology. Since there may be more that one objects with the same name the system should guarantee unique identification. The location of the object can be used to uniquely identify the particular object.

The semantic map database has a number of semantic maps (fig. 1). Each semantic map has a number of pixels of the map that correspond to GPS coordinates. Each semantic map also has a transformation matrix associated with it for transforming pixels

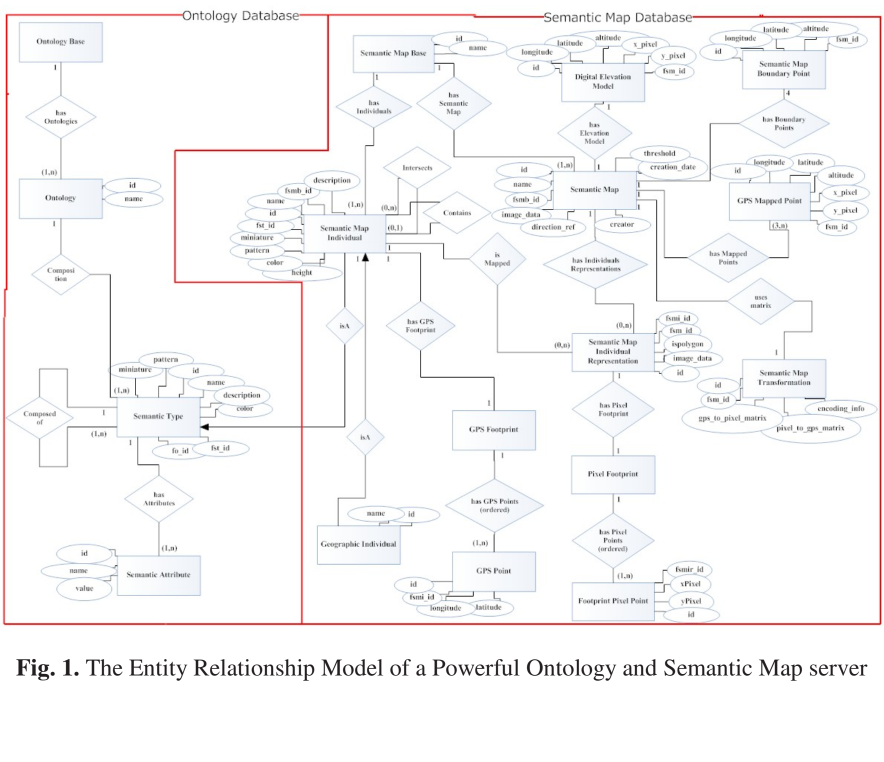


Fig. 1. The Entity Relationship Model of a Powerful Ontology and Semantic Map server

to GPS points. It has information about semantic map individuals. A semantic map individual is an important object with a spatial location which is described by its GPS footprint which is actually the GPS locations of the polygon of its footprint on the map.

Interfaces that are based on semantic map information can support spatial queries such as "*show the location of all the semantic objects on a map*", "*show the location of all the semantic objects of a particular kind on a map*", "*show me the nearest semantic object of a particular kind*", "*show me the name of the object nearest to my current GPS position*", "*give me all the images of a specific object*", etc.

Design and Implementation of the Prototype

The prototype considers a user of a Ricoh camera equipped with a GPS receiver. The user walks around in a city and takes images of near-by buildings. Together with each image the GPS location is recorded. When all the images are downloaded from the camera to a laptop the software developed finds the GPS location from where the image was taken, it has access to a semantic map and calculates the distance to the nearest semantic object and uses the information about this in order to annotate the image.

We have applied this prototype in the city of Chania, Crete. The map of Chania was downloaded from Google Earth, as a platform for spatial information presentation [5]. Important semantic entities were recorded together with their location. An overlay layer was implemented to show the location and shape of every semantic entity on top of the map. As the mouse of the laptop moves on top of the map, the location of the mouse is also shown, and the nearest objects of the map to the mouse position are highlighted. Images taken while walking on the city can be automatically annotated when transferred to the laptop.

Another function of the implemented system allows to browse through the images that exist in the laptop and see their location, as well as all the semantic information that has been associated with them through the access of the semantic map. The screen below shows a demonstration of semantic maps (fig. 2). A Google map of the city of Chania has been downloaded and used as a basic image for creating a semantic map. With the image we associate GPS coordinates.

The ontology database contains an ontology of geographic locations (simple ontology constructed by us for demonstration purposes, but any formal ontology can replace it), and an ontology on archeology. The screen (fig. 2) shows the objects of the database shown projected with a red color on the semantic map.

The demonstrator allows the user to select with the mouse one of those semantic objects and see the images associated with it. In this screen shot (fig. 2) one semantic object has been selected and its object has been turned to green. When a semantic object is selected, the images that have been taken with the Ricoh camera become available. In the screen shot shown, the semantic object that has been selected from the map is an object from the ontology "geography" which has a type "public garden", and the name of the individual is "public garden of Chania". All this information is information that has automatically been extracted from the ontology and semantic map database based on the GPS coordinates of the camera.

This screen (fig. 2) shows some of the functionalities offered: the capability to have more than one ontologies in the database (like geography), each ontology has types (like Public Garden), and types have individuals (like public garden of Chania).

It demonstrates the capability to create semantic maps that show all the individuals of all the ontologies as active objects that can be selected on top of the map. In this semantic map of Chania we can demonstrate semantic types from the ontologies geography and archeology at the same time. Alternatively it is easy to generate a semantic map (fig. 2) that will be personalized so that it only contains types (active objects) from the ontology geography. It demonstrates the capability to associate images taken with the Ricoh camera with semantic objects, and access all the images related to a semantic object with a simple interface. It also displays the capability to annotate the images taken with information that has been extracted from the ontology and the semantic maps.

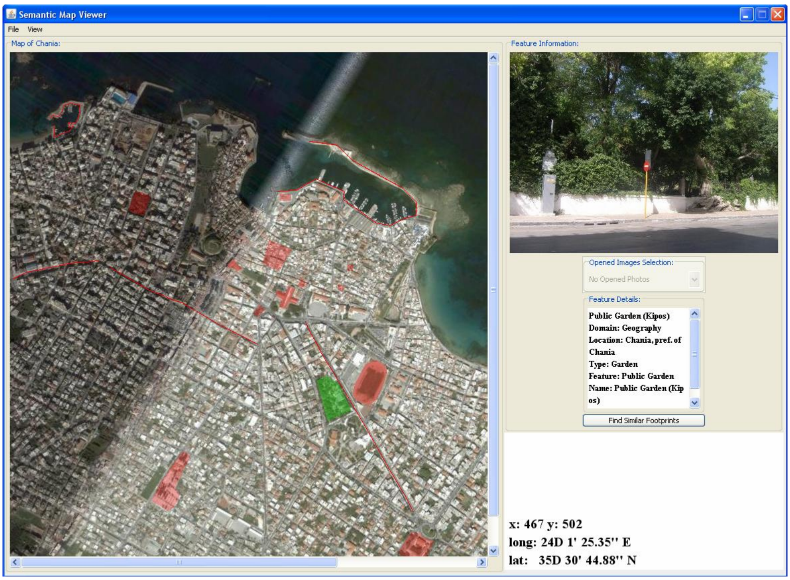


Fig. 2. A screen shot of a semantic map. The semantic objects belong to an ontology, they have a type and a name. They also have a location that is used to display the semantic objects of the ontologies on top of any map. The semantic objects are shown in red.

The same ontology browsing interface could allow the user to select certain types (like Byzantine churches and Venetian Forts) and ask the system to automatically create a semantic map with this information for the user. It's very important that the system can accommodate any number of ontologies with their types. There is no dependence from the specific ontologies used.

4 Conclusions

We presented an approach for spatial information retrieval from images in an open and user friendly environment. It provides the users the possibility to search and find spatial related information about interesting objects. The approach is based on the use of ontologies to overcome the semantic heterogeneity and semantic maps to better visualize and handle the extracted spatial information. For the implementation of the system we used a digital camera integrated with GPS location information. The demonstration is done for tourism and culture purposes. We experimented with the usage of the Ricoh 500SE camera with GPS capability to automate the information retrieval of the images.

We have also developed a complete database design for the server of ontologies and semantic maps. The prototypes demonstrate the automation in the assignment of annotation information related to important objects. The prototype has the capability to present the information of the semantic map database on top of maps, as well as to show the current GPS position of the user on top of the same maps. In addition, the user can select an object and see all the images.

We believe that the developed prototype can be used for more advanced applications in the future. It could be also an information system for tourisms. We are currently investigating more functionalities for spatial information retrieval and the improvement of the visualization to provide the user a better access and understanding of the results.

References

1. Chen, P.P.-S.: The Entity-Relationship Model-Toward a Unified View of Data. ACM Transactions on Database Systems (TODS) 1(1), 9–36 (1976)
2. Jones, C.B., Purves, R., Ruas, A., Sanderson, M., Sester, M., Van Kreveld, M., Weibel, R.: Spatial Information Retrieval and Geographical Ontologies An Overview of the SPIRIT Project. In: SIGIR 2002: Proceedings of the 25th Annual International ACM SIGIR Conference on Research and Development in Information, Tampere, Finland, August 11-15, pp. 387–388. ACM Press, New York (2002)
3. Jones, C.B., Alani, H., Tudhope, D.: Geographical Information Retrieval with Ontologies of Place. In: Montello, D.R. (ed.) COSIT 2001. LNCS, vol. 2205, pp. 322–335. Springer, Heidelberg (2001)
4. Christodoulakis, S., Kontogiannis, P., Petridis, P., Moumoutzis, N., Anastasiadis, M., Margazas, T.: A Distributed Multimedia Tourism Information System. In: Information and Communication Technologies in Tourism 1997. Proceedings of the International Conference in Edinburgh, Scotland (ENTER 1997), pp. 295–306 (1997)
5. Google Earth 2008. Google Earth virtual globe (2008), `http://earth.google.com`
6. Hollink, L., Schreiber, A.T., Wielemaker, J., Wielinga, B.: Semantic Annotation of Image Collections. In: Proceedings of the KCAP 2003 Workshop on Knowledge Capture and Semantic Annotation, Florida (October 2003)
7. Schreiber, A.T., Dubbeldam, B., Wielemaker, J., Wielinga, B.: Ontology-Based Photo Annotation. IEEE Intelligent Systems 16(3), 66–74 (2001)
8. Srikanth, M., Varner, J., Bowden, M., Moldovan, D.: Exploiting ontologies for automatic image annotation. In: Proceedings of the 28th annual international ACM SIGIR conference on Research and development in information retrieval, pp. 552–558 (2005)
9. Fu, G., Jones, C.B., Abdelmoty, A.I.: Ontology-Based Spatial Query Expansion in Information Retrieval. In: Meersman, R., Tari, Z. (eds.) OTM 2005. LNCS, vol. 3761, pp. 1466–1482. Springer, Heidelberg (2005)
10. Li, W., Yang, P., Zhou, B.: Spatial Information Retrieval (2007)
11. Woodruff, A.G., Plaunt, C.: GIPSY: Geo-referenced Information Processing System. Journal of the American Society for Information Science 45(9), 645–655 (1994)

12. Larson, R.R.: Geographic Information Retrieval and Spatial Browsing. In: Smith, L.C., Gluck, M. (eds.) Geographic information systems and libraries: patrons, maps and spatial information, pp. 81–124 (1996)
13. Agarwal, P.: Ontological consideration in GIScience. International Journal of Geographical Information Science 19(5), 501–536 (2005)
14. Perry, M., Hakimpour, F., Sheth, A.: Analysing Theme, Space, and Time: An Ontology based Approach. In: 14th International ACM Symposium on Advances in Geographic Information Systems, pp. 147–154. Arlington, VA (2006)
15. Christodoulakis, S., Anastasiadis, M., Margazas, T., Moumoutzis, N., Kontogiannnis, P., Terezakis, G., Tsinaraki, C.: A modular Approach to Support GIS Functionality in Tourism Applications, Enter Conference, Istanbul (1998)

Pattern Matching Techniques to Identify Syntactic Variations of Tags in Folksonomies

F. Echarte, J.J. Astrain, A. Córdoba, and J. Villadangos

Dpt. de Ingeniería Matemática e Informática
Universidad Pública de Navarra
Campus de Arrosadía. 31006 Pamplona (Spain)
patxi@eslomas.com, {josej.astrain,alberto.cordoba,
jesusv}@unavarra.es

Abstract. Folksonomies offer an easy method to organize information in the current Web. This fact and their collaborative features have derived in an extensive involvement in many Social Web projects. However they present important drawbacks regarding their limited exploring and searching capabilities, in contrast with other methods as taxonomies, thesauruses and ontologies. One of these drawbacks is an effect of its flexibility for tagging, producing frequently multiple syntactic variations of a same tag. In this paper we study the application of two classical pattern matching techniques, Levenshtein distance for the imperfect string matching and Hamming distance for the perfect string matching, to identify syntactic variations of tags.

Keywords: Folksonomies, Semantic Web, Annotations, Pattern Matching.

1 Introduction

Folksonomies [1] are based in the assignation of text tags to different resources, such as photos, web pages, documents, etc. Users use these tags to annotate resources defining collaboratively the meaning of the annotated resources, and the used tags. New search and exploration approaches are possible with Folksnomies, based on the use of the tags [2,3]. Users can search for tags, or use navigation systems such as clouds of words, to locate resources tagged by other users and to find information. Though folksonomies have a great success in current web, mainly due to their simplicity of use, they have also important disadvantages. The fact of users creating tags and assigning them freely to resources produces the inexistence of any structure among these tags. As folksomonies become larger, more problems appear regarding the use of synonyms, syntactic tag variations and different granularity levels [4]. All these problems make more and more difficult the exploration and retrieval of information [5,6] decreasing the quality of folksonomies Thus, the reduction of syntactic tag variations aids to improve the quality of folksonomies.

There exist different types of syntactic variations of tags: typographical misspellings in the annotation process (*semanticweb*/*semnticwev*/*zemantcweb*); grammatical number (singular or plural) of the same word (*semanticweb*/ *semanticwebs*);

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 557–564, 2008.

separators (*semantic-web/semanticweb*); or a combination of them (*semntic-web/smanticweb*, *semntic-webs*, etc.). The existence of these variations causes the classification of the resources under different tags, when they should be classified under just one. This fact makes more confusing the clouds of words, the location of information and the navigation on the folksonomy. However, by identifying all of them as variations of the same label "*semantic web*" and grouping them under the same tag, a user can access this tag obtaining all the information concerning the resources associated with it and its syntactic variations.

In this paper we focus on the application of pattern matching techniques to identify syntactic tag variations. As contribution of this paper, we propose the utilization of pattern matching techniques to identify syntactic variations of tags. We study two classical pattern matching techniques as Levenshtein [7] and Hamming [8] distances on a large real dataset, evaluating how these techniques perform the identification of both variations of known tags and new (non-existing) tags.

We present the results of syntactical variations identification achieved for each distance considered. Only in [9] there is a related work, where a pre-filtering of the tags is performed before applying an algorithm for tag clustering. This is used to minimize the effects of syntactic variations and to increase the quality of tag clustering. Authors identify similar tags using the Levenshtein similarity metric to determine morphological variations, although over a reduced experimental data set. Another way to represent these variations is presented in [4] where an ontology with three properties associated to tags (*prefLabel*, *altLabel* and *hiddenLabel*) is used.

The use of pattern matching techniques designed to automatically recognize syntactic variations of tags provides mechanisms to improve the quality of folksonomies. Approximate string matching techniques allow dealing with the problem introduced by syntactic variations on folksonomies. The problem consists on the comparison of a candidate input string called α, maybe containing errors, and a pattern string ω in order to transform α in ω [10]. The Hamming distance [8] between two strings of equal length indicates the number of positions for which the corresponding symbols are different. It measures the minimum number of substitutions required to transform the candidate string into the pattern string. The Hamming distance can be shown as the number of errors that transform one string into the other. The Hamming distance is commonly used to perform perfect matching between pairs of strings but in our case we deal with pairs of strings with different length strings by padding white spaces at the end of the shortest string. However, for these situations and for those cases where not just substitutions but also insertions or deletions have to be expected, a more sophisticated metric like the Levenshtein distance is more appropriate.

Probably, the most relevant contribution in the field of imperfect string matching is the Generalized Levenshtein Distance [7]. The main drawback of these techniques is the limited number of errors that can be considered due to the finite number of rules introduced in the grammar to model edit operations.

The rest of the paper is organized as follows: section 2 describes the experimental scenario and section 3 presents and analyzes the experimental results obtained; finally, conclusions and references end the paper.

2 Workbench

This section describes the experimental scenario we have used to evaluate Levenshtein and Hamming distances, paying special attention to the datasets and the methodology followed. This workbench is available on the web[1].

Datasets – We have collected data from the social web CiteULike (which contains bibliographic cites) in order to evaluate our proposal, collecting a total number of 2,290,740 annotations. Each annotation consists on a tag assigned by a user to a resource, at a given date.

After a first analysis of the resulting data set, we can appreciate the existence of two tags with a significantly larger number of annotations than the rest, which correspond to some automatic procedure. We eliminate them. The resulting data set has the following characteristics: (1) 2,038,172 annotations (one record per user-tag-resource), (2) 494,206 resources, (3) 21,480 users, and (4) 151,522 tags.

In order to evaluate Levenshtein and Hamming distances, we have created two data sets: one with the aim of checking the correct identification of variations (DS1) and another (DS2) to check the recognition of new tags.

DS1 is obtained from the 10,000 most often used tags. These tags are used in 1,557,198 annotations, representing the 76.4 % of the total amount of annotations. DS1 consists of a set of tuples <*pattern tag-candidate tag*>: *pattern* is one of the 10,000 related tags, and *candidate* is a syntactic variation of the *pattern*. These variations are created automatically. These syntactic variations consider different cases: (i) the singular or plural, (ii) simulation of a typographical error, (iii) simulation of transposition of adjacent symbols, (iv) removal and replacement of separators, and (v) the own pattern tag in order to verify that the used distances recognize the correct pattern when both tags fit. In the creation process, if a syntactic variation of a pattern tag *t* fits another pattern tag *t'*, the candidate tags obtained from *t'* are addressed to *t* and *t'* is deleted. After the whole process, DS1 contains 8,806 different pattern tags and 39,255 tuples (*pattern, candidate*) to check. DS2 contains 5,000 tags not included as pattern tags in DS1. These tags are used in 122,394 annotations representing the 6% of the total amount of annotations. We create a dictionary with the 8,806 pattern tags contained in DS1. This dictionary is used to perform the Levenshtein and Hamming distances over DS1 and DS2 datasets. We use a trie structure to store the dictionary when computing the distances.

Methodology - The identification of syntactic variations of tags becomes useful whenever: (1) the pattern matching techniques used ensure a high recognition rate of tags, which are variations of an existing one; and (2) identify, with a high degree of success, new tags that do not fit any existing one. The goal is to maximize the number of syntactic tag variations identified without conditioning the recognition of new tags. In our experimental scenario, the goal is to maximize the number of correctly identified tuples <*pattern, candidate*> on DS1; and to maximize the number of tags identified as new tags on DS2.

To perform this evaluations a discriminator is used. This discriminator consists of the dictionary created from DS1 and a distance (Hamming or Levenshtein). The discriminator accepts as input one tag and checks it against the tags defined in the

[1] http://www.eslomas.com/index.php/publicaciones/tagspatternmatching

dictionary. As output the discriminator provides two values, (1) the most similar tag in the dictionary to the provided one, and (2) the distance value. We denote in the following by *candidate* the input at the discriminator, and by *pattern'* its output as depicted in Fig. 1.

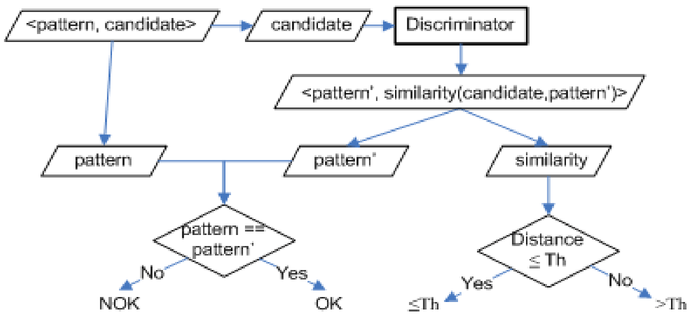


Fig. 1. Methodology schema for DS1 data set evaluation

We take the *candidate* tag from each tuple in DS1 and we apply Levenshtein and Hamming distances over the dictionary at the discriminator. As output we get a corresponding *pattern'* and its distance to the *candidate*. Note that the algorithm could select a pattern tag (*pattern'*) different to the correct pattern (the associated to the *candidate* tag in DS1). We denote by *OK* the case when the tag selected by the algorithm (*pattern'*) is the *pattern* associated to *candidate* tag in DS1. That is, the algorithm selects the expected pattern tag. We use *NOK* to describe the case when *pattern'* and *pattern* do not fit.

A threshold level, called *Th*, determines the accuracy of the discriminator. The *candidate* tag is classified as a syntactic variation of the *pattern'* tag if the discriminator provides a distance less than or equal to this threshold (see Fig.1). Thus, for example *NOK & ≤TH* indicates that *candidate* and *pattern'* tags match with a low distance between them, but *candidate* derives from *pattern* tag (in DS1) which is different to *pattern'*. Dealing with the problem of new tags identification, when the distance values obtained for the tags contained in DS2 (*candidates*) are greater than *Th*, tags are considered as new pattern tags (*New*). In other case tags will be considered as syntactic variations (*Not New*) of the *pattern'* provided by the discriminator.

3 Experimental Results

Table 1 shows the results of processing data sets DS1 and DS2 with the Levenshtein and Hamming distances, using the dictionary with the 8,806 distinct tags of DS1. Results on DS1 are shown in four different columns, representing if the correct pattern has been identified for each candidate string (*OK*) or not (*NOK*), and if the distance is less than or equal to a determined threshold (*≤Th*). Threshold values for each distance have been set to 1.0 experimentally, so only one edit operation by string is considered. Table 1 shows that Hamming distance is more restrictive at the recognition of pattern variations in DS1 (*OK & ≤Th*) and that it does not overcome distance threshold in more cases than the Levenshtein distance. This shows that Hamming distance trends to identify less variations and therefore to identify them as new tags. It corresponds with the results on DS2, where we can appreciate a greater identification ratio than the obtained for the Levenshtein distance.

Table 1. Process results on datasets DS1 and DS2

	DS1				DS2	
	NOK & >Th	NOK & ≤Th	OK & >Th	OK & ≤Th	> TH (New)	≤TH (Not New)
Hamming	3,095	2,152	8,127	25,881	4,162	838
Levenshtein	1,641	2,516	7,767	27,331	4,016	984

A breakdown of these results based on the different variation types is presented in Table 2. The variation labelled as *Self,* represents that both pattern and candidate are the same strings, so the distance is null and both Hamming and Levenshtein distances should identify them always correctly. Table 2 shows that both distances identify correctly the pattern and candidate strings when they match (*Self / OK & ≤TH*).

Table 2. Breakdown of the results of Hamming and Levenshtein distances by variation type

	NOK & >Th		NOK & ≤Th		OK & >Th		OK & ≤Th	
	Ham.	Lev.	Ham.	Lev.	Ham.	Lev.	Ham.	Lev.
Self	0	0	0	0	0	0	8,788	8,788
Plural/Singular	233	253	523	617	928	896	7,291	7,209
Typo error	65	21	669	762	24	60	8,195	8,110
Transposition	1,022	1,358	934	1,108	6,807	6,280	6	23
Separators	1,775	9	26	29	368	531	1,601	3,201
Total (#)	3,095	1,641	2,152	2,516	8,127	7,767	25,881	27,331
Total (%)	7.88%	4.18%	5.48%	6.41%	20.70%	19.79%	65.93%	69.62%

Regarding the failures, both distances provide similar results for the other syntactical variations considered, except for substitution/deletion of separator, where Levenshtein-distance performs better.

Transposition variations imply the existence of two edit operations, so a threshold value of 1.0 avoids the identification of this kind of variation. The greater number of results corresponds to *OK&>Th*, representing that they are able to identify correctly the original pattern, but with a high distance.

One way to deal with this situation is increasing the threshold, however this implies the acceptance of a higher number of edit operations, and this would produce an increase in the incorrect identification of variations among short tags. For example, a threshold value of 2.0, would allow to identify as variations many of the transposition cases, but would affect negatively in the identification of new tags on DS2 for both distances. In the case of Hamming distances, identifications as new tags (>*Th*) decreases from 4,162 to 3,281 and in the case of Levenshtein, from 4,016 to 2,957.

Another way is to consider transposition operations as a unique and atomic edit operation, assigning a unitary cost as occurs in [11].

Both distances provide good results identifying variations originated by typographic errors in which one letter has been replaced by another, providing a distance lower or equal than the threshold value. Results differ when separators are changed by other characters. Hamming distance is negatively affected when separators inside tags are deleted. In addition, both perform well in case of plural/singular syntactic variations. Both distances also provide similar results for more complex plurals, as (*library* and *libraries*). In these cases the distance values are greater than the threshold value.

Regarding the lengths of candidate strings, Fig. 2 shows the identification errors between *candidate* and *pattern* strings (*pattern'* ≠ *pattern*), attending to the candidates string length. It shows that in both cases (Hamming and Levenshtein) the greater number of errors happens for tags with lengths of 3 and 4 characters. The reason is that any variation in short length strings can produce the resultant strings will be more similar to other patterns distinct to the original. It can be also seen that Hamming distance has lightly less identification errors for lengths in the range between 4 and 7, and worse results from this point.

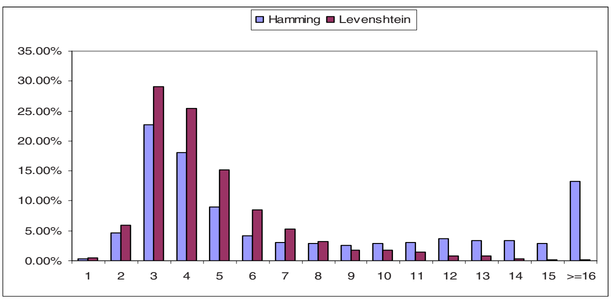


Fig. 2. Failures of Hamming and Levenshtein distances on DS1 per candidate string length

Regarding identification errors for string lengths between 4 and 7, Levenshtein distance get lightly worse results because it is not so much affected by the deletion or insertion of new characters as Hamming distance. For instance, the candidate string *vace*, generated from pattern *face* with a typographic error changing the first character. Hamming distance gets the correct original pattern *face*, but Levenshtein distance gets *ace* as the nearest pattern.

However, Hamming distances starts to increase the number of incorrect identifications in comparison with Levenshtein distance, from the pattern length 8. The reason is due to the fact that from these length is more frequent the use of separators in tags, and Hamming is more affected by the elimination of characters in the middle of patterns. So for instance, for the candidate string *websearch*, generated from the pattern *web_search*, Levenshtein identifies correctly the original pattern, but Hamming distance gets as results the pattern *substance*.

With the objective of ignoring strings with lengths less than or equal to 3, information about the amount of tags in the initial dataset of CiteULike has been obtained.

Based on these data, trying to identify variations only for lengths greater than 3, the distances would be used for a 95.37% of the tags in the initial CiteULike data set, (91.07% of the total number of annotations). Table 3 summarizes the results obtained for DS1 and DS2 data sets, and ignoring tags with length less than or equal to 3.

Table 3. Process results on DS1 and DS2 ignoring lenghts <=3

	DS1				DS2	
	NOK & >Th	NOK & ≤Th	OK & >Th	OK & ≤Th	>Th (New)	≤Th (Not New)
Hamming	2,966	587	8,111	24,431	4,171	418
Levenshtein	1,539	871	7,751	25,934	4,076	513

It shows that the number of incorrectly identified patterns with distance less than or equal to the threshold (*NOK&≤Th*) has been reduced: from 2,152 to 587 (72.73%) in the case of Hamming distance, and from 2,516 to 871 (65.38%) in the case of Levenshtein. Regarding results on DS2, it shows that both distances keep the number of correctly tags identified as new, while they reduce the number of tags identified as known tags (*Not New*): from 838 to 418 in the case of Hamming distance and from 984 to 513 in the case of Levenshtein. This shows that both distances were detecting tags with lengths less than or equal to 3 as variations of some known tag. Table 4 shows a breakdown of the results on DS1 based on the different variations.

Table 4. Results of Hamming and Levenshtein distances by variation type ignoring lengths ≤3

	NOK & >Th		NOK & ≤Th		OK & >Th		OK & ≤Th	
	Ham.	Lev.	Ham.	Lev.	Ham.	Lev.	Ham.	Lev.
Self	0	0	0	0	0	0	8,088	8,088
Plural/Singular	172	201	180	220	916	884	6,827	6,790
Typo error	54	13	175	248	24	59	7,918	7,851
Transposition	970	1,318	216	381	6,805	6,279	1	14
Separators	1,770	7	16	22	366	529	1,597	3,191
Total (#)	2,966	1,539	587	871	8,111	7,751	24,431	25,934
Total (%)	8.22%	4.26%	1.63%	2.41%	22.47%	21.47%	67.69%	71.85%

It can be seen that the number of identification errors has been reduced in the three types of variations where we get more errors previously: plurals/singulars, typographic errors and transpositions. The greater reduction in associated to transposition variations: from 934 errors to 216 in the case of Hamming distance and from 1,108 to 281 in the case of Levenshtein. The reason is that any transposition in short patterns has high probability to generate another different pattern with less distance.

6 Conclusions

In this work we have analyzed the performance of two pattern matching techniques to identify syntactic variations in folksonomies. We have performed the analysis over a large dataset in two different ways: identifying (i) pattern-candidate combinations and (ii) new tags. Experiments show that both techniques provide similar results for some syntactic variation types as typographic errors and simple plurals/singulars, but Levenshtein gets significantly better results than Hamming identifying variations based in the insertion/deletion of characters. However both techniques do not perform as well as desired when identifying variations based in the transposition of adjacent characters or some kind of singulars/plurals (*library/libraries*). Moreover, both techniques improve their results ignoring candidate tags with lengths less than four.

These results show that this techniques can be used to identify syntactic variations of tags, though they should be adapted to perform better with some variation types as plurals/singulars and transpositions of adjacent characters.

Acknowledgements

Research supported by the Spanish Research Council TIN2006-14738-C02-02.

References

[1] Vander Wal, T.: Folksonomy, `http://vanderwal.net/folksonomy.html`
[2] Millen, D.R., Feinberg, J.: Using Social Tagging to Improve Social Navigation. In: Workshop on the Social Navigation and Community based Adaptation Technologies, Dublin, Ireland (June 2006)
[3] Golder, S.A., Huberman, B.A.: The Structure of Collaborative Tagging Systems. Journal of Information Science 32(2), 198–208 (2005)
[4] Gruber, T.: A Translation Approach to Portable Ontology Specifications. Knowledge Acquisition 5(2), 199–220 (1993)
[5] Echarte, F., Astrain, J.J., Córdoba, A., Villadangos, J.: Ontology of Folksonomy: A New Modeling Method. In: Semantic Authoring, Annotation and Knowledge Markup (SAAKM 2007), Whistler, British Columbia, Canada, October 28-31 (2007)
[6] Mathes, A.: Folksonomies - Cooperative Classification and Communication Through Shared Metadata. Computer Mediated Communication (December 2004)
[7] Guy, M., Tonkin, E.: Folksonomies - Tidying up Tags? DLib Magazine 12(1) (2006)
[8] Levenshtein, V.I.: Binary codes capable of correcting deletions, insertions, and reversals. Soviet Physics Doklady 10(8), 707–710 (1966)
[9] Hamming, R.W.: Error Detecting and Error Correcting Codes. Bell System Technical Journal 26(2), 147–160 (1950)
[10] Specia, L., Motta, E.: Integrating Folksonomies with the Semantic Web. In: Franconi, E., Kifer, M., May, W. (eds.) ESWC 2007. LNCS, vol. 4519, pp. 503–517. Springer, Heidelberg (2007)
[11] Navarro, G.: A Guided Tour to Approximate String Matching. ACM Computing Surveys 33(1), 31–88 (2001)
[12] Oommen, B.J., Loke, R.K.S.: Pattern recognition of strings with substitutions, insertions, deletions, and generalized transpositions. Pattern Recognition 30(5), 789–800 (1997)

Accessible Tourism for the Disabled: Long Tail Theory

Yen-Chun Jim Wu[1] and Ming Jen Cheng[2]

[1] Professor, Dept. of Business Management, National Sun Yat-Sen University, 70 Lianhai Rd., Kaohsiung, 804, Taiwan
yenchun@email.com
[2] Ph.D. Program Student, Dept. of Business Management, National Sun Yat-Sen University, 70 Lianhai Rd., Kaohsiung, 804, Taiwan
u9528903@ccms.nkfust.edu.tw

Abstract. The purpose of this study is to propose a completely barrier-less, or "accessible," tourism platform and makes suggestions to facilitate the current travel information for the disabled persons. It then applies Long Tail theory's three forces and nine "rules" in making assessments and creating an accessible tourism communication network to connect upstream and downstream travel agency. After collating the opinions of scholars specialized in the tourism sector and travel agents interviewed through semi-open questions, the study investigates the Long Tail theory's suitability and applicability to the tourism industry. This study then thoroughly explores the topic of accessible tourism and proposes concrete suggestions and frameworks for such travel need. It also sets up an accessible tourism communications network, contributing a real platform that travel agents can refer to as they take their first steps to provide travel packages that accommodate the needs of the disabled.

Keywords: Accessible Tourism; Long Tail theory, Travel, Web 2.0.

1 Introduction

According to a World Travel and Tourism Council's 2008 survey of Tourism Satellite Accounts (TSAs) from 2000-2007 [1], Taiwan's average annual consumer spending on tourism was US$21 billion, with rises in local incomes and the improving quality of life, travel has already become one of the major focal points of the lives of local residents. The disabled are no different from the average consumer and have the same leisure, travel and accommodation needs.

Thus, helping the disabled obtain better service and greater protection of their rights when they travel to ensure their trips are barrier-free, while at the same time encouraging the enhancement of social welfare and the fulfillment of corporations' social responsibility, will become important issues [2]. Brey et al. [3] found that Internet information is an important tool for the promotion of the travel market, but noted that Taiwan lacks online sites that serve the disabled and provide travel information and packages that cater to them. This study looks at the travel industry from the perspective of niche markets, and, through tourism models that satisfy people with disabilities, it applies new supply-side concepts advanced in "The Long Tail" [4] to spark latent

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 565–572, 2008.

demand and build a complete tourism plan that is suitable for the disabled. To satisfy an important focus of this study, this research first assesses the suitability and accessibility of Long Tail Theory to the tourism industry and then builds the framework for a barrier-free travel Internet platform and offers planning suggestions.

2 Literature Review

Over the past 30 years, the travel and tourism industry has experienced rapid growth in every corner of the globe and has become the key engine of economic growth in many nations [5]. Governments everywhere see tourism as a key engine of development in the future [6]. It is therefore safe to say that tourism is the largest-scale industry in the world today, and it contributes considerably to the economies of both developed and developing countries [7]. Regardless of whether a place is a small area, a large area or a country, tourism has already become a tool for economic development and diversification and something economic development policy cannot afford to overlook [8]. In 2006 alone, people in Taiwan took more than 150 million trips, and more than 78 percent of them said the purpose of their travel was for sightseeing, rest and relaxation, or going on their annual vacation [9].

Unlike other industries that have limited life cycles, tourism is sustainable and cannot be outsourced, meaning that any investment in the sector will benefit local economic development over the long term. They need instead to put a premium on nurturing long-term high quality operating and management approaches [10] that will enable Taiwan to unleash its inherent competitive advantages in the sector. Looking at the development of tourism from a historical perspective, one discovers that the domestic social structure and the people's living conditions have a mutually interdependent relationship with the scale of population, economic conditions and overseas tourist destinations [11]. As a result, satisfying the travel needs of the disabled has been given greater urgency. Traveling can have therapeutic value for people with disabilities if properly planned, stimulating physical and mental growth and increasing their interaction with society while alleviating the level of their disability [12]. In Europe, there are approximately 37 million people with disabilities in the EU, indicating that future demand for barrier-free, or "accessible," travel will rise [8]. If one can provide good service to a small group of consumers, a substantial niche can be created [13].

The newly fashionable management term "Long Tail" described by Anderson [4], that asserts the development of the Internet has created a large volume market for hard-to-find or niche market products. "Recessive" buyers in various corners of the globe with access to the Internet see "recessive" products in other corners of the globe, and if the price is acceptable, the transaction is completed. The striking viewpoint advanced by Long Tail theory is currently being put into practice in commercial circles, leading to niche Long Tail markets, but no matter whether big or small, they all must achieve a minimum scale to prop up sales and income. There is no doubt, however, that the formation of Long Tail markets has created many new commercial opportunities [13].

Another principle of the Long Tail is that no one product can satisfy everybody. Not every consumer, for example, likes the same kind of food. It's the same in the tourism industry, where one kind of package can satisfy the average traveler but cannot meet with the approval of all disabled individuals [1]. The disabled also have the right to enjoy travel and leisure experiences [14]. In popularizing travel, the Internet is a tool that can transcend culture, graphically and informatively promoting specific travel companies and places of interest around the world. Internet has the potential to improve the chances of survival and the profitability of small players in the travel business amid fierce competition. Thus, using Web 2.0 concepts to build a consultative, shared, learning platform for accessible tourism can fulfill the special needs of the public and businesses [15].

3 Methodology

Hoping to explore the ways in which Long Tail theory influences the tourism industry, this study interviewed experts and collated and analyzed the information obtained to make the theory more suitable for and accessible to the travel sector. Using Web 2.0 concepts, this study built a complete accessible tourism Internet structure catering to the disabled and provided integrated planning advice.

Direct fieldwork was used in doing research for this study, based on a strict sampling design to search for facts. In exploring the relationship between variables affecting social phenomena, this type of methodology relies on both big and small clusters, through which samples are chosen for further investigation. Those samples help understand the circumstances, distribution and interrelationship of the influences that many social and psychological variables have on each other. Thus, the method is called the “sample survey method” [16]. Because the travel planning of disabled persons requires a specific sampling, and ethnic groups in Taiwan have their own special characteristics, building a structure involved integrating the opinions and viewpoints of industry, government and academia. Thus, this study interviewed experts as its main research methodology.

3.1 Data Source

This study’s investigation focused on disabled persons in Taiwan, with the large majority of them physically challenged individuals. It integrated and analyzed the opinions obtained from wide-ranging interviews with the above-mentioned travel agents and scholars. The expert interviews conducted for this study relied on semi-open questions to ensure that the survey research method could resolve the issues being studied. During the interviews, we asked permission from those being interviewed to record the conversation, which enabled us to better gather related information to analyze and understand their views on the applicability of Long Tail theory to the tourism industry. Gaining a thorough understanding of their actual experiences and cognizance helped better explain the gap between printed data and the real world.

4 Analysis

4.1 Use of Long Tail Theory in Establishing Accessible Tourism Network

Long Tail theory is a new business model that gained prominence as the Internet matured, and its influence continues to expand. In practical terms, it has subverted traditional operational models. The emergence of Long Tail theory can be attributed to three main forces — the democratization of the tools of production, cutting the costs of consumption by democratizing distribution, and connecting supply and demand [4] — resulting from the development of Internet information technology, especially Web 2.0 technology. Once the three forces are apparent, the Long Tail concept will naturally materialize within the sector. To enable these three forces to take shape naturally in the tourism industry, this study has developed an Internet platform that will facilitate their rise.

Positioned as an information provider, this Web site has used the Web 2.0 framework to build an accessible tourism information platform that allows people with disabilities to submit articles and provides a forum in which they can share and exchange their own travel experiences. Such a forum can encourage the disabled to participate in more activities [17]. This study's introduction of the Web site's structure is divided into the following general categories: fixed itineraries, accessible tourism reviews, accessible tourism knowledge sharing, accessible tourism audio video area, accessible tourism news, and accessible tourism blogs (see Figure 1).

Fig. 1. The Accessible Tourism Network Website

(1) Fixed Itineraries: After becoming a member of the Web site, travel agents can post complete accessible tourism itineraries that people with disabilities can refer to plan a trip. By proposing different itineraries with diverse sights and tours, browsers can choose packages that they like, and suit their needs and interests. The site gives the disabled excursion options and reinforces their willingness to go on a trip.
(2) Accessible Tourism Evaluation: This page clearly classifies and segments tourism-related businesses and attractions and enhances the convenience of choosing packages. The descriptions provided lay out the accessible tourism features and targets of each company or attraction, and note those features that have passed accessible tourism evaluations. This page fully exploits Web 2.0's advantages. Anyone who has become a member of the Web site can enter the rating system and post their experiences and appraisals of their trips, as well as add or revise travel operator information. The use of an interactive Internet platform enables every user to freely express his or her opinion, resulting in more objective content and speeding up the updating and gathering of information. At present, the Web site provides a chat room where customers can express opinions, and through the personal evaluations of travel destinations submitted by site members, other users will select products that suit

them, putting into practice the Long Tail concepts "let the customers do the work" and "share information".

(3) Accessible Tourism Knowledge Sharing: This page clearly and systematically imparts important knowledge about food, clothing, accommodation, tours, and other details. Relying on related accessible tourism information contributed by disabled persons, the site describes things people should know or watch out for in every category of activity, building greater confidence among the disabled to get out and travel. Thus, the information provided can help disabled individuals or those who would accompany them gain a clearer picture of what they need to be prepared for before they leave home and enable them to take steps to prevent problems that might arise during the trip.

(4) Accessible Tourism Audio Video Area: The video content features films that guide those involved in accessible tourism through simple educational tools to achieve an accessible tourism environment in areas such as food, clothing, accommodation and tours. These educational films can raise awareness of accessible tourism concepts among even more people and make them more universally accepted.

(5) Accessible Tourism News: This page is constantly updated to provide the latest news related to accessible tourism, and, in browsing the page, users can also obtain the freshest information, whether related to the government or to the private sector. The integrated functions of this section of the Web site will help individuals browsing the site obtain information quickly and save them the time they would normally spend on mass market sites searching for the news or information they need.

(6) Accessible Tourism Blogs: In this blog updated by Eden Social Welfare Foundation staffers, bloggers can post their thoughts on travel experiences or upcoming accessible tourism related information. They also frequently post insights based on their own travel experiences. The blogs serve as encouragement for the site's users who read them and enhance the enthusiasm among the disabled to travel. Fully capitalizing on this virtual channel to increase marketing appeal, the blogs serve a market segment that brick-and-mortar outlets have no way of handling. In the future, this proposed Web site can include even more advanced functions, such as ranking the most popular search requests and using browser hits to screen the most popular products, to help customers get a feel for existing levels of participation.

4.2 Insights of Scholars and Travel Agents

This study uses interviews of travel agents and scholars involved in the tourism sector and summarizes their views in this section (see Table 1).

Table 1. The Perspectives of Travel Agents and Scholars

	Regular Travel Agency	Tourism-related Scholars	Travel Agency for the Disabled
Commercial Interest	Disagree	Agree	Agree
Reasons	●Based on their economic capacity disabled cannot afford it. ●Personnel costs are high. ●The uncertainty of a new market is too high. ●Accessible tourism value-added is low. ●Taiwan has poor accessible tourism environment.	●Already successful overseas. ●Accessible tourism demand expected to rise. ●Elevates Taiwan's international image. ●Strengthens Taiwan's tourism competitiveness. ●Mature Internet allows information to be transmitted quickly.	●It meets the travel needs of the disabled. ●Accessible tourism demand expected to rise. ●Attracts overseas tourists.

Regular Travel Agency

Regular travel agents believe that most disabled persons do not have the economic leverage of the average consumer and lack the income needed to participate in this kind of leisure activity. Because of their limited spending power, fewer disabled persons travel for pleasure than other individuals, and the trips they take are characterized by few shopping stops, low value-added and low profits, which reduced the interest among travel agents interviewed to get involved in accessible tourism. Also, more staffers are usually needed to accompany accessible tourism excursions to safeguard the safety of those on the trip, pushing personnel costs higher than for regular groups. In a fiercely competitive environment that has left travel businesses struggling to survive, agents said they don't have the deep financial pockets needed to develop the new emerging accessible tourism market. In addition, businessmen contended that with Taiwan's accessible tourism environment not fully developed, it would be hard to promote the concept. There will be many problems in a number of areas if the transportation network is not improved.

Tourism-related Scholars

Scholars suggested that the promotion of accessible tourism has met with success overseas and brought significant economic benefits to the tourism sector in those countries. With Taiwan's society aging and the demand for travel among the disabled increasing, this market has the potential for rapid growth in Taiwan and at present does not have any competitive pressure. If agents adopt a flexible strategy and operate their businesses well, not only will they benefit, but Taiwan's international image will be enhanced, and its tourist sector will become more competitive in the international arena. In this era when information can be transmitted quickly and Internet technology is highly developed, the technical barriers to promoting this new concept have been largely removed.

Travel Service Providers for the Disabled

Because travel agents offering accessible tourism services may be people with disabilities or those that understand them, they are fully aware of the demand for travel among their disabled peers and don't believe it's as weak as outside estimates suggest. With Taiwan quickly becoming an aging society and demand growing for tour packages among disabled individuals, this segment of the tourism market has significant growth potential. By offering excellent accessible tourism opportunities, tour companies not only can provide Taiwan's disabled community with chances to sightsee but also attract disabled persons from abroad to visit Taiwan, stimulating local tourism development and helping meet targets for visitor arrivals.

4.3 Using Long Tail Theory for the Tourism Industry

This study took Long Tail theory perspectives [18] to identify strategies used by the travel industry in developing accessible tourism, including: integrating the virtual and real worlds to expand the scope of services; creating new supply to attract potential customers; listening more closely to customers to discover Long Tail niches; and using an information screening platform to create new demand by molding new tastes and extending a product’s value. In operating accessible tourism ventures in the future, this study suggests businesses develop in diverse directions targeting different customer segments. Agents should not limit themselves to targeting people with physical disabilities, but can serve many other tour groups with limitations, including, for example, the visually impaired.

In managing accessible tourism, businesses should remember that people with disabilities are not the only ones who can participate in accessible tourism itineraries. Diversified customer groups, including individuals with different kinds of disabilities, can ensure that every disabled individual can participate by eliminating environmental barriers and providing specialized service assistants. Only then can the tail of the Long Tail be big and long enough to make these niches in the tourism industry profitable.

5 Conclusion

This study examined the accessible tourism segment within the tourism industry, and through interviews with experts discovered that the pleasure travel requirements of disabled persons are not as complicated as is widely portrayed. As long as a complete barrier-free environment exists and specialized personnel are provided, people with disabilities can experience the same joy from pleasure travel as the average tourist. After interviewing academic experts and tourism professionals, this study found that accessible tourism was a niche worth pursuing and had plenty of room for growth in the future.

This study focused primarily on people with disabilities, just one niche market among many. In fact, accessible tourism is not the only niche in the tourism market, and accessible facilities can also be of benefit to non-disabled individuals, including the elderly, young children and pregnant women. With the blossoming of the Internet and the rise of Web 2.0 Web sites [19], we also suggests that travel agents set up sites to improve people's access to information. This study used Web 2.0 concepts proposed in Long Tail theory to design a Web site specifically geared to people with disabilities. Using the Web 2.0 model, the site provides travel agents and customers a transparent platform that empowers people from around the world to post accessible attractions and even allows the disabled to share their own experiences, in the process increasing the willingness of potential customers to travel for pleasure [17]. Ultimately, it can become a platform where information is shared and quickly links upstream and downstream actors, as well as successfully proving the feasibility of applying Long Tail theory to the tourism industry.

Implications for Government

Tourism is seen as having the greatest potential of any industry in the economic development of many countries, but before a viable tourism industry can be developed, each country must identify its own strengths and weaknesses, and should upgrade its strengths while resolving any lingering problems. In the fiercely competitive tourism industry, products should be built to satisfy different niches, maintain a market's novelty and create a unique appeal to generate profit.

The two most important factors in accessible tourism are service personnel and the overall tourism infrastructure for the disabled. Scholars interviewed contended that the government should make a concerted effort to promote and maintain a welcoming travel environment for people with disabilities and strengthen the construction of accessible facilities to provide barrier-free space. In terms of service personnel, more people are needed to push for a barrier-free environment and spread the concept among local residents. That way, everybody can join together in preserving accessible facilities and ensure that these facilities can fulfill their true functions in helping the people they are intended for. With the integrated development of these two factors, accessible tourism is a market worth pursuing that has considerable profit potential [1].

Acknowledgements

This study was supported by National Science Council of Taiwan, Republic of China, under Grant No. NSC 96-2815-C-327-019-H.

References

1. WTTC (2008), http://www.wttc.trave/eng/Research/Tourism_Satellite_Accounting_Tool/index.php
2. Williams, R., Rattray, R., Grimes, A.: Meeting the On-line Needs of Disabled Tourists: An Assessment of UK-based Hotel Websites. International Journal of Tourism Research 8(1), 59–73 (2006)
3. Brey, E.T., So, S.I.A., Kim, D.Y., Morrison, A.M.: Web-based Permission Marketing: Segmentation for the Lodging Industry. Tourism Management 28(6), 1408–1416 (2007)
4. Anderson, C.: The Long Tail: Why the Future of Business is Selling Less of More, 1st edn. Hyperion, New York (2006)
5. Sharpley, R., Telfer, D.J.: Tourism and Development Concepts and Issues. Aspects of Tourism 5 Clevendon. Channel View Publications (2002)
6. Clarke, J., Denman, R., Hickman, G., Slovak, J.: Rural Tourism in Ronnava Okres: A Slovak Case Study. Tourism Management 22(2), 193–202 (2001)
7. Jones, E., Haven-Tang, C.: Tourism SMEs, Service Quality and Destination Competitiveness. CABI Publishing, MA (2006)
8. Westcott, J.: Improving Information on Accessible Tourism for Disabled People: European Commission (2004)
9. TBMTC: Annual Report on Tourism 2006. Tourism Bureau Ministry of Transportation and Communication, Republic of China Taipei City (2006)
10. Kalisch, A.: Corporate Futures: Consultation on Good Practice. Tourism Concern, London (2002)
11. Eadington, W.R., Smith, V.L.: Introduction: The Emergence of Alternative Forms of Tourism. Wiley, Chichester (1992)
12. Kraus, R.: Recreation and Leisure in Modern Society. Harper, New York (1990)
13. Brynjolfsson, E., Hu, J.Y., Smith, M.D.: From Niches to Riches: The Anatomy of the Long Tail. Sloan Management Review 47(4), 67–71 (2006)
14. Cameron, B., Darcy, S., Foggin, E.: Barrier-free Tourism for People with Disabilities in the Asian and Pacific Region. United Nations, New York (2003)
15. Craig, E.M.: Changing Paradigms: Managed Learning Environments and Web 2.0. Campus-Wide Information Systems 24(3), 152–161 (2007)
16. Lucas, H.C.J.: Methodological Issues in Information Systems Survey Research. In: Kraemer, K.L. (ed.) The Information Systems Research Challenge: Survey Research Methods, vol. 3, pp. 273–285. Harvard Business School, Boston (1991)
17. Oberhelman, D.D.: Coming to Terms with Web 2.0. Reference Reviews 21(7), 5–6 (2007)
18. Curran, K., McCartney, D., Elder, K.: The Power of Long Tail. Journal of Information Technology Impact 6(3), 129–134 (2006)
19. Eijkman, H.: Web 2.0 as a Non-foundational Network-centric Learning Space. Campus-Wide Information Systems 25(2), 93–104 (2008)

A Social Networking Exploration of Political Blogging in Greece

Kostas Zafiropoulos[1] and Vasiliki Vrana[2]

[1] Department of International and European Studies,
University of Macedonia, Egnatia 156, 54006, Thessaloniki, Greece
kz@uom.gr
[2] Department of Business Administration, Technological Education Institute of Serres,
Terma Magnisias, 62124, Serres, Greece
v_vrana@otenet.gr

Abstract. The paper considers the recent Web debate relatively to the election of Pan-Hellenic Socialist Movement (PASOK) new President. PASOK was defeated on the national election of September 2007, and this defeat brought up a major leadership crisis. Election for a new leader was held on November 2007. The paper examines the posts of blogs linking to the two main candidates. Using social networking theory and statistical analysis, it measures blogs' connectivity, conversational patterns, and variations over time. It examines the skewdeness of incoming blog links and finds the core blog groups that serve as focal points for political bloggers.

Keywords: blogs, Greece, political blogs, PASOK, links distribution, skewedness, connectivity, patterns, social networking, closeness, focal points, core groups, blog authority.

1 Introduction

Drezner and Farrell [1, p. 5] defined weblogs as "A web page with minimal to no external editing, providing on-line commentary, periodically updated and presented in reverse chronological order, with hyperlinks to other online sources". Blogs can take a number of forms and tend to have a number of characteristics in common, such as: being set up to display blog postings in reverse-chronological order or with their content arranged by subject; each entry has a timestamp so that the reader knows when it was posted; being updated regularly with new material; providing a personal viewpoint; give their readers an opportunity to comment on blog postings, or to contact the author directly [2]. Journalists regard blogs as alternative sources of news and public opinion [3]. Kosonen et al. [4]. claimed that blogs give organizations a unique opportunity for informal knowledge sharing, Fuchs [5] highlighted blogs potential to advance cooperation and participation in social systems and Hoogenboom et al. [6] their support to social learning processes. In the political context, Walker [7] called blogs "a soapbox" and highlighted their attractiveness for voicing political messages. And according to Herring et al.[8], blogs are also possessing a "social-transformative, democratizing potential".

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 573–582, 2008.

Nowadays, blogging tools provide enhanced features for between-blog interactivity; thus promoting the creation of social networks among bloggers [9]. Williams & Jacobs [10] recognized interactivity as the key to the success of social network systems such as blogs. Interactivity between blogs takes two forms. The first form is that of a "blogroll" that many bloggers maintain. It is a list of blogs that bloggers frequently read or especially admire. The second form, is achieved by expressing their thoughts by posting comments to entries [1,11]. Posts commenting on posts are a key form of information exchange in the blogosphere. Drezner and Farrell [1] highlighted the fact that links and page views are the currency of the blogoshpere.

Forty percent of the Greek population uses Internet. Percentages are higher among young people and men. Search for information, sending emails, downloading, playing games, chatting, and online buying are the reasons for using internet. Using a sample of 1367 bloggers[12], found out that blogging started to expand during 2002-2003 in Greece. There exist 9510 blogs written in Greek, but only 4639 of them are active. The average Greek blogger is around 30, with college education. S(he) uses DSL connection. Blogs receive less than 100 visits daily, while they do not have any advertisements and they discuss multiple subjects. Bloggers are 64% male. 65% of the bloggers live in Athens (53.1%) and Thessaloniki (12.4%). Eleven percent is residents of abroad. Motives for blogging are keeping a diary, experimenting, taking action while being anonymous, creation of a community. Personal interests, art and culture, and entertainment are the main subjects throughout Greek blogs. News and politics blogs are rarer. Thirty eight percent of the bloggers consider blogging to be a form of journalism, while 51% does not.

The paper aims to describe basic characteristics of political blogging in Greece using at large their quantitative properties. It examines the posts of blogs that were pros or cons the two main candidates of the election for presidency of Pan-Hellenic Socialist Movement (PASOK) for the period from September 16 to November 13. Blogs connectivity, closeness, variations over time and skewedness of the blog incoming links distribution are the main characteristics of this investigation.

2 Web 2.0 in the Knowledge Society

Knowledge Management (KM) aims at connecting people to quality knowledge and people to people in order to peak performance [13]. Lytras [14, p.40] claimed that our "daily life is a continuous knowledge management process". Even thought, knowledge management is not a matter of technology, digital environment is central to the financing of KM strategies and mechanisms [15]. Chatti et al. [13] mentioned that Web 2.0 technologies can leverage knowledge sharing, Osimo [16] that they are particularly effective in enabling the sharing of informal and tacit knowledge and Lee and Lan [17] that they have the ability to facilitate collaborative knowledge management.

Information is now more available than ever and that is key to democracy. E-democracy has given people a means to become educated, organize and therefore be heard, where they weren't before [18]. Parliaments and legislatures play a central KM role within existing democratic governing architectures, and widened KM infrastructures are required for more participative forms of democratic governance

[15]. Web 2.0 technologies can offer these forms, can help people participation into political processes and can produce well-informed public. According to Chadwick [19] primary and presidential campaigns in the United States "saw the emergence of campaigning model based on online venues loosely meshed together through automated linking technologies, particularly blogs". Moreover there is a recent shift towards online social networking on platforms like Facebook and MySpace, and social media sites like YouTube such as the announcement of candidacies of John Edwards and Barack Obama for the Democratic presidential nomination via informal video postings on YouTube [19].

3 Political Blogging

Blogs have been seen a good way of circulating new ideas [20] and featured in articles regarding their political activism and influence [21]. "The interest within the political sphere on bloggers is that they are a potential alternative to the traditional media as gatekeepers of information and news" mentioned Pedley [2, p.295]. Johnson and Kaye [22] claimed that weblogs were viewed, by web users, as a credible source which provided depth and thoughtful analysis and based on this Jackson [23 , p.295] suggest that "during an election campaign a weblog is a mean for a party to promulgate its policies through a virtual network of political bloggers". Talking more generally, Trammell et al. [24] noted that blogs are a popular tool for politicians to campaign and reach out to their constituency and [25] that blogs appear to play an increasingly important role as a forum of public debate, with knock-on consequences for the media and for politics.

Commenting on political blogs into American politics Graf [26] wrote: "In just a few years they have become a finger in the eye of the mainstream media and a closely watched forum of political debate. Political blogs have exposed lapses in mainstream media coverage, chastened reporters with the fear of an angry online response to sensitive stories, and at times set the media agenda. Political blogs have also been influential in raising money for political candidates and pushing select races into the national spotlight". Investigating political blogs for campaigns, Garrett [27] (in [24]) mentioned that bloggers write posts in a personal voice, update the blogs several times a day, encourage and moderate comments, offer hyperlinks to internal and external sources, and other blogs, and call the readers into action. As far as, visitors of political blogs in USA, is concerned, Bloom [28] mentioned that a high percentage are political reporters, politicians and policy makers: key opinion formers. Taking this in to consideration Jackson [23, p.296] mentioned: "This can give political bloggers a disproportionate influence, based on the type of blog visitor, and not just the number of blog visitors. Therefore, elite bloggers can act as a "focal point" encouraging influential visitors to congregate around them. To influence the news, political and policy agenda, political actors need to attract an "A" list audience to their weblog". It was, Drezner and Farrell [1] who found out that even though there are over a million bloggers, posting thousands of new items daily, the median blogger has almost no political influence as measured by traffic or hyperlinks and they highlighted "This is because the distribution of weblinks and traffic is heavily skewed, with a few bloggers commanding most of the attention. This distribution parallels the one observed for political websites in general. Because of this distribution, a few “elite” blogs can operate as both an information aggregator and as a “summary statistic” for the blogoshpere” (p. 4).

The most reliable way to gain traffic to a blog is through a link on another weblog [29]. In that way “blogs with large numbers of incoming links offer both a means of filtering interesting blog posts from less interesting ones, and a focal point at which bloggers with interesting posts, and potential readers of these posts can coordinate” [1, p.13]. Less prominent bloggers contact one of the large ‘focal point’ blogs, to publicize their post when they have an interesting piece of information or point of view that is relevant to a political controversy. On the one hand this lead the readers to ‘focal point’ blogs, as they know that they will find links to many interesting stories, and on the other hand bloggers to send posts to focal point blogs as they know that they are likely to find more readers. Based on this and the lognormal distribution of weblogs, in a given a political issue, the media only needs to look at the top blogs to obtain a “summary statistic” about the distribution of opinions [1]. In this vein Adamic and Glance [30, p.2] noted: “Because of bloggers’ ability to identify and frame breaking news, many mainstream media sources keep a close eye on the best known political blogs”.

4 Methodology

The paper aims to describe basic characteristics of political blogging in Greece using at large their quantitative properties. It uses technorati.com to track Greek political blogs and provide indicators of their popularity and interconnections. As a case study, the paper considers the recent debate that took place on the Web relatively to the election of PASOK’s new President. Pan-Hellenic Socialist Movement (PASOK) (one of the two major parties in Greece), under Georgos Papandreou’s leadership, was defeated on the national election of September 16 2007, and this defeat brought up a major leadership crisis. Election for a new leader was held on November 11 2007. The paper examines the posts of blogs that were pros or cons the two main candidates for presidency for the period from September 16 to November 13. Technorati.com search engine is used to search for all blog posts that link to the sites or blogs of the two main candidates for presidency of PASOK, G. Papandreou and E. Venizelos, for the period 16/9 – 13/11/2007. It presents and measures blogs’ connectivity, conversational patterns and variations over time. The paper adds to the study of political blogs by reporting patterns of blogging and making one of the few contributions to the study of political blogging in Greece. The study uses Social Networking theory to present and study blogs. Blogs connectivity, closeness and variations over time are the main characteristics of this investigation. In addition, the paper discusses skewedness of the blog incoming links distribution and how this is affecting the formation of central or core blog groups, which serve as “focal point” blogs [5]. Multidimensional scaling and Hierarchical Cluster Analysis are used to explore blog patterns regarding connectivity. Also, the paper uses measures of closeness of core groups in order to examine whether blog groups political affiliation is reflected to blogs interconnections

5 Findings

Through the search via technorati.com, 142 blogs were found. Figure 1, on the left, presents the variations over time for blog posts linking to Papandreou's (the former, and current, president of the party) site/blog, and on the right presents the variations over time for blog posts linking to Venizelos' site/blog. Posts linking to Papandreou are more uniformly distributed. However, the distribution of blog posts linking to Venizelos is more interesting. The discussion about the new contender attracted more attention from bloggers and Venizelos was criticised and discussed widely. This is the reason that the blog posts present a higher density in the left side of their distribution, reflecting the discussion at the beginning of the re-election period.

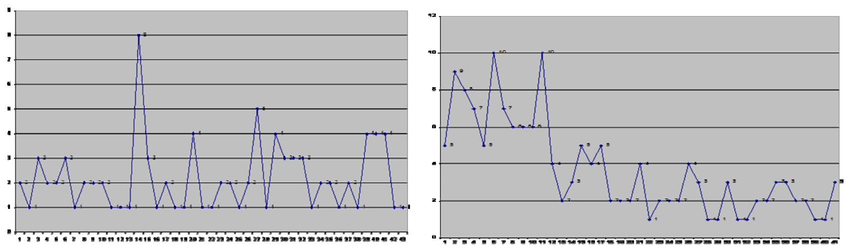


Fig. 1. Variations over time for blog posts linking to Papandreou site/blog (left), to Venizelos site/blog (right)

In order to explore the connectivity patterns of political blogs, the paper uses the social networking theory. The next step involves the presentation of the 142 blogs using a graph. UCINET 6.0 for Windows is used for this presentation. Figure 2 presents the interconnections of the 142 blogs. As Drezner and Farrell [5, p.13] mention "Blogs with large numbers of incoming links offer both a means of filtering interesting blog posts from less interesting ones, and a focal point at which bloggers with interesting posts, and potential readers of these posts can coordinate. When less prominent bloggers have an interesting piece of information or point of view that is relevant to a political controversy, they will usually post this on their own blogs. However, they will also often have an incentive to contact one of the large 'focal point' blogs, to publicize their post. The latter may post on the issue with a hyperlink back to the original blog, if the story or point of view is interesting enough, so that the originator of the piece of information receives more readers. In this manner, bloggers with fewer links function as "fire alarms" for focal point blogs, providing new information and links". Also they mention that: "We note that this implies that even while focal point blogs play a crucial mediating role, smaller blogs may sometimes have very substantial political impact by bringing information to the attention of focal blogs" [1, p.13]. This paper argues that "focal point" blogs are recognized as authority blogs by the bloggers community and they may serve as the blogs cores where the interesting and informational discussion is taking place. This property can be used to limit the analysis only to these blogs, excluding in this way other blogs which might be considered to have limited interconnections with other blogs or they are isolated.

This property is a consequence of the skewed distribution of links, also mentioned by Drezner and Farrell [1]; only few blogs have a very big number of incoming links while the rest, the majority of blogs, have only a small number of incoming links.

To test whether this hypothesis holds for political blogging in Greece, this paper examines the distribution of incoming links to the 142 blogs of the study. To measure incoming links for a blog, the paper calculates the percentage of the 142 blogs that link to it. For example, a percentage of 10% for a specific blog means that nearly 14 out of 142 blogs link to it. Figure 2 also presents the histogram of incoming links for the 142 blogs. Most of the blogs have a very small number of incoming links, while only a few blogs have a big number of incoming links. In any case, the percentage of incoming links does not exceed 17%. Blogs have a very low degree of interconnectivity and this is due mainly to the fact that most blogs are constructed in an “amateur” fashion or they were built just for the campaigns of two main candidates. Figure 2(on the right) presents similar findings. It presents blog ranks according to incoming links (1 being the highest linked blog) versus the percentage of incoming links. From these figures it is obvious that there exist a skewed distribution, which implies that only a few blogs gather the highest number of incoming links. This finding provides evidence that Drezner and Farrell’s [5] argument about the skewedness of incoming links distribution holds true.

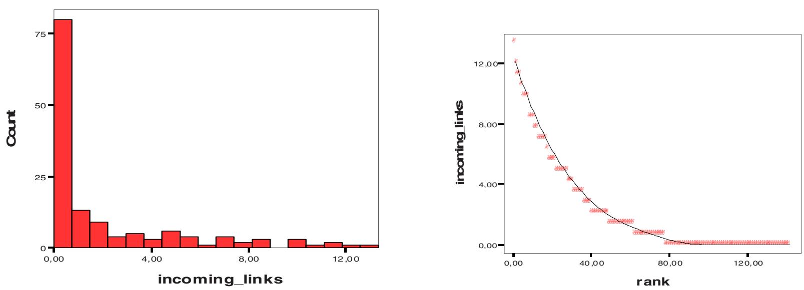


Fig. 2. Histogram of percentages of incoming links for the 142 blogs (on the left) and ranks of these blogs vs. percentages of incoming links (% out of 142)

The next step involves the construction of a blog interconnection graph. It is a directed graph where blogs are noted as nodes and incoming links as directed arrows (Figure 3). One can notice that there exist a central area of the graph where it seems that two core networks are formed, which they gather most of the incoming links. To describe this situation explicitly, statistical analysis using Multidimensional Scaling (Stress=0.03039), followed by Hierarchical Cluster Analysis is performed. It results to the formation of three groups (clusters) of blogs regarding incoming links. These groups of blogs are described in Table 1.

From Table 1 it is clear that Group 1 contains blogs, which are pro Papandreou. Their administrator is mainly a member of PASOK. The average percentage of blogs (in 142 total) linking to this Group is 10%. Group 2 consists of non political, non PASOK though political, or critical blogs to both candidates. The average percentage

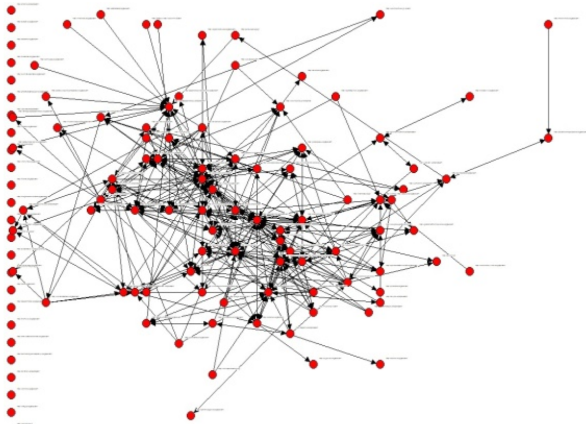


Fig. 3. Blogs interconnections according to incoming links from blog rolls

Table 1. Blog groups description

	Affiliation	Mean percentage of incoming links
Group 1 (6 blogs)	Pro Papandreou	10%
Group 2 (17 blogs)	Non political, political but with no PASOK affiliation, critical to both candidates and especially to Venizelos	7%
Group 3 (119 blogs)	All the rest of the blogs	1%

of incoming links is 7%. In conclusion, the average percentage of incoming links is relatively low to both groups. The large number of non-political blogs, or the temporary character by means that they were constructed for campaign reasons, or the "amateur" fashion of constructing a blog may serve as reasons for this. Groups 3 contain all the rest of the blogs. They have a very small number of incoming links (1%) and they are distinguished from the two core Groups. Formation of groups is a finding, which is also compatible with those founded by Drezner and Farrell [1].

Further, the analysis searches for "closeness" of the core groups (Groups 1 and 2). "Closeness" describes the property of a group of blogs where on the one hand, there exist a large number of interconnections of blogs within the group, and on the other hand, there exists only a small number of links between blogs of this particular group and any other group of blogs. In the present study, this means that there exists a large number of interconnections within Group 1 and Group 2, but only a small number of links between blogs of Group 1 linking to blogs of Group 2 and vice versa. Table 2 presents the mean percentages of links within each core group linking to Group 1 or Group 2. For each blog, the percentage of incoming links is calculated. Then the average percentage for each core group is obtained. Table 2 shows that the average blog of Group 1 is linked by 55.6% of the blogs of Group 1, while the average blog of Group 2 is linked by only 11.76% of the blogs of Group 1. On the other hand, the average blog in Group 2 is linked by 25% of the blogs of Group 2 and by 16.7% of

Group 1. Group1 exhibits a higher degree of closeness, while Group 2 presents low degrees of linkage to both groups of blogs.

Table 3 goes a step further since it presents the percentages of degree of connection within each core group and between them as well. Two groups are in "connection" if any blog of one group links to any blog of the other. Degree of connection for a group can be calculated as the percentage of blogs linking to any blog of it. From Table 3 it is clear that 83.3% of blogs in Group 1 are linked by at least one blog of Group 1. Half of the blogs of Group 2 are linked by at least one of the blogs of Group 1 and half of the blogs from both Group 1 and 2 are linked by at least one blog from Group 1. On the other hand, 76.5% of the blogs of Group 2 are linked by blogs of Group 2, 23.5% of the blogs of Group 2 are linked by blogs from Group 1 and 23.5% of blogs from both groups are linked by blogs from Group 2.

In conclusion, the two core groups are characterized by a high degree of closeness, yet there exist enough interconnections between the two groups. Closeness is significant but not absolute.

Table 2. Mean percentages of links within each group linking to blogs of Groups 1 and 2

	Group 1 (6 blogs)	Group 2 (17 blogs)
Group 1 (6 blogs)	55.6%	11.76
Group 2 (17 blogs)	16.7%	25%
Group 3 (119 blogs)	7.5%	4%

Table 3. Degrees of "connections" to Groups 1 and 2

	Group 1	Group 2	Both Groups 1 and 2
Group 1 (6 blogs)	83.3%	50%	50%
Group 2 (17 blogs)	23.5%	76.5%	23.5%
Group 3 (119 blogs)	19.5%	27.1%	11%

6 Conclusions

Political blogging in Greece, although limited, conforms to the characteristics described in the literature regarding political blogging. Political discussion through blogs is influencing media but also they influence it as well. As Drezner and Farrell [1] conclude that blogs may frame political debates and create "focal points" for the media as a whole. In this way, blogs sometimes have real political consequences, given the relatively low number of blog readers in the overall population. Skewedness of incoming links distribution and the formation of core blog groups may be used to explain the importance that some blogs have on the provision of information and discussion. Empirical evidence from Drezner and Farrell [1] is also reproduced in the present analysis. Greek political blogs act within a social network of blogs, which form authority core groups where the discussion is taking place. These core blog groups provide citizens' opinions and attitudes, which are taken into consideration by media. Recently, for example, there are plenty of published articles in Greek newspapers, referring blog posts.

Political affiliation is partly reflected on the formation of blog core groups. Because of this, it is easier for citizens to coordinate and find out were the interesting debate is taking place.

This paper made an effort to describe the mathematical properties of political blogging in Greece, by means of connectivity and closeness. It strived to apply recent advances in political blogging research, being one of the few relative studies in Greece.

References

1. Drezner, D., Farrell, H.: The power and politics of blogs. The Annual Meeting of the American Political Science Association, Washington, DC (August 2004), http://www.utsc.utoronto.ca/~farrell/blogpaperfinal.pdf
2. Pedley, P.: International phenomenon? Amateur journalism? Legal minefield? Why information professionals cannot afford to ignore weblogs. Business Information Review 22(2), 95–100
3. Lasica, J.D.: Blogging as a form of journalism. USC Annenberg Online Journalism Review (2001), http://www.ojr.org/ojr/workplace/1017958873.php
4. Kosonen, M., Henttonen, K., Ellonen, H.-K.: Weblogs and internal communication in a corporate environment: a case from the ICT industry. International Journal of Knowledge and Learning 3(4/5), 437–449 (2007)
5. Fuchs, C.: Towards a dynamic theory of virtual communities. International Journal of Knowledge and Learning 3(4/5), 372–403 (2007)
6. Hoogenboom, T., Kloos, M., Bouman, W., Jansen, R.: Sociality and learning in social software. International Journal of Knowledge and Learning 3(4/5), 501–514 (2007)
7. Walker, J.: Weblog, Definition for the Routledge Encyclopedia of Narrative Theory (2007)
8. Herring, S.C., Scheidt, L.A., Bonus, S., Wright, E.: Bridging the gap: A genre analysis of weblogs. In: Proceedings 37th Annual HICSS Conference 2004, Big Island, Hawaii (2004)
9. Du, H., Wagner, C.: Weblog success: Exploring the role of technology. International Journal of Human-Computer Studies 64, 789–798 (2006)
10. Williams, J.B., Jacobs, J.: Exploring the use of blogs as learning spaces in the higher education sector. Australasian Journal of Educational Technology 20, 232–247 (2004)
11. Mishne, G., Glance, N.: Leave a reply: An analysis of weblog comments. In: WWW 2006, pp. 22–26 (2006)
12. Karampasis, Z.: Greek-speaking bloggers (2007) (in Greek), http://ereuna. wordpress.com/
13. Chatti, M.A., Jarke, M., Frosch-Wilke, D.: The future of e-learning: a shift to knowledge networking and social software. International Journal of Knowledge and Learning 3(4/5), 404–420 (2007)
14. Lytras, M., Pouloudi, A., Poulymenakou, A.: Knowledge Management convergence – expanding learning frontiers. Journal of Knowledge Management 6(1), 40–51 (2002)
15. Roy, J.: e-government, good governance and knowledge management. In: 7th Global Forum on Reinventing Government: Building Trust in Government, Vienna, Austria, June 26-29 (2007)
16. Osimo, D.: Web 2.0 in Government: Why and How. JRC Scientific and technical reports (2008)
17. Lee, M., Lan, Y.-C.: From Web 2.0 to Conversational KnowledgeManagement: Towards Collaborative Intelligence. Journal of Entrepreneurship Research 2(2), 47–62, http://www.cme.org.tw/journal/search/JournalFile/v02n02/V02N2-3.pdf

18. McInerney, S.: Information Technology Discussion Paper Number 1, September 23 (2006), http://shulman.ucsur.pitt.edu/doc/itpapers/sarah1.pdf
19. Chadwick, A.: Web 2.0: New Challenges for the Study of E-Democracy in an Era of Informational Exuberance. I/S: A Journal of Law and Policy for the Information Society 4(3) (forthcoming, 2008)
20. Baker, S., Green, H.: Blogs will change your business. Business Week 3931, 56–65 (2005)
21. Su, N.-M., Wang, Y., Mark, G.: Politics as Usual in the Blogosphere. In: Proceedings of the 4th International Workshop on Social Intelligence Design (2005)
22. Johnson, T., Kaye, B.: Wag the blog: how reliance on traditional media and the internet influence credibility perceptions of weblogs among web users. J&MC Quarterly 81(3), 622–642 (2004)
23. Jackson, N.: Dipping their big toe into the blogoshpere. The use of weblogs by the political parties in the 2005 general election. Aslib Proceedings: New Information Perspectives 58(4), 292–303 (2006)
24. Trammell, K., Williams, A., Postelnicu, M., Landreville, K.: Evolution of Online Campaigning: Increasing Interactivity in Candidate Web Sites and Blogs Through Text and Technical Features. Mass Communication and Society 9(1), 21–44
25. Graf, J.: The Audience for Political Blogs. New research on Blog Readership. GW's Institute for Politics, Democracy & the Internet (2006), http://www.ipdi.org/uploadedfiles/audience%20for%20political%20blogs.pdf
26. Graf, J., Darr, C.: Political Influentials Online in the 2004 Presidential Campaign, Institute for Politics, Democracy and the Internet, George Washington University, Washington, DC (February 2004), http://www.ipdi.org/UploadedFiles/political%20influentials.pdf
27. Garrett, J.J.: User experience analysis: Presidential campaign sites. Report prepared for Adaptive Path (2004)
28. Bloom, J.: The blogosphere: how a once-humble medium came to drive elite media discourse and influence public policy and elections. In: American Political Science Association, Philadelphia, PA (August 2003)
29. Blood, R.: The Weblog Handbook: Practical Advice on Creating and Maintaining Your Blog. Perseus Publishing, Cambridge (2002)
30. Adamic, L., Glance, N.: The Political Blogosphere and the 2004 U.S. Election: Divided They Blog. In: Proceedings of the WWW-2005, workshop on the Weblogging Ecosystem (2005), http://www.blogpulse.com/papers/2005/AdamicGlanceBlogWWW.pdf

Implementing an e-Government Observatory for Rural SMEs

Nikos Manouselis[1,2], Kostas Kastrantas[2], Argiris Tzikopoulos[2], Constantina Costopoulou[2], and Alexander Sideridis[2]

[1] Greek Research & Technology Network (GRNET) S.A., 56 Mesogion Av., 115 27, Athens, Greece
nikosm@ieee.org

[2] Informatics Laboratory, Div. of Informatics, Mathematics & Statistics, Dept. of Science, Agricultural University of Athens, 75 Iera Odos Str., 11855, Athens, Greece
{kkastrad,tzikopoulos,tina,as}@aua.gr

Abstract. ICT training activities for rural areas can be complemented by online points of reference that SMEs can access to find relevant information and educational resources. To this direction, we present the design and implementation of the Rural-eGov Observatory, which aims to serve as an online reference point for SMEs in five European regions. The Observatory collects, describes and categorizes training resources and e-government services that may prove useful to rural SMEs.

Keywords: E-government, SMEs, design, Web portal.

1 Introduction

Away from the central public authorities, regional (also called rural) enterprises do not have direct, physical access to a variety of services that governmental or public agencies offer [2]. Very often, these services are essential in order for the enterprises, mostly small and medium ones (SMEs) in such areas, to perform their business operations. They include services offered by several types of governmental agencies/authorities, ranging from taxation offices, legislative authorities, local authorities, or chambers of commerce. Information & Communication Technologies (ICT) aim to address such problems: first, by providing the means for public authorities to deploy and offer e-government services; second, by facilitating rural SMEs in accessing these services from a distance. On the other hand, many times professionals and citizens are not aware of electronically available public services, or do not know how to effectively use them so that they may reap benefits in their everyday business activities [4].

In this paper, we report results from an ongoing initiative of the European Leonardo da Vinci (LdV) programme that aims to familiarize rural SMEs with the use of e-government services. This project, called 'Rural-eGov: Training SMEs of Rural Areas in using e-Government Services', has started on October 2006 and will run for 24 months. It builds on the experience from national initiatives that partners had from training SMEs in rural areas, such as the 'Go-Online Training Support' project in Greece (http://www.go-online.gr/) and the 'Opportunity Wales' project in UK

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 583–592, 2008.

(http://www.opportunitywales.co.uk/). It will provide rural SMEs from Wales, Germany, Greece, Slovenia and Poland with the following:

- a specially designed training curriculum that can demonstrate how SMEs may use existing e-government services to support their business;
- a series of training scenarios that will combine traditional forms of learning with e-learning forms (based on blended learning models) in order to train rural SMEs on the use of e-government services;
- the 'Rural-eGov Observatory', an online point of reference which SMEs can continuously access for relevant information and digital training resources.

In this paper we particularly focus on the last output: the Rural-eGov Observatory. This is an online environment that will collect and provide access to the digital training content that will be developed to support the vocational training curriculum on how to prepare rural SMEs to use and exploit e-government services. In addition, it will collect, describe and categorize e-government services that can prove useful to SMEs in the rural areas to be considered.

2 Rationale

In the context of Rural-eGov, two types of information resources (or objects) are examined: Digital Training Objects (DTOs) and e-Government Resource Objects (eGROs). A number of DTOs will be developed to support the training scenarios of the project, including different types of educational material (such as lectures, best practice guides, self-assessment forms, etc.). These are expected to be stored as electronic files in the form of Powerpoint presentations, Word documents, PDF documents, short demo videos, and others. They will be developed to support the training scenarios of all participating rural areas, and will therefore be available in English, Greek, German, Polish and Slovenian. All these digital resources will be uploaded in the databases of the Rural-eGov Observatory, and will be made available to all interested users. To facilitate searching, locating and downloading appropriate resources, the characteristics of the DTOs have to be briefly reflected in their descriptions. In this way, users can simply go through the various descriptions, and select the most appropriate resources for their needs, instead of downloading each file and checking for their appropriateness. Apart from reflecting the most important characteristics, descriptions have to also be available in the language of the users (that is, multilingual descriptions will be necessary). An example of a Rural-eGov DTO is the best practice guide presented in Figure 1. It is a guide that explains step-by-step with an illustrative example, how a particular Greek e-government service is used.

Apart from the training resources, the Rural-eGov Observatory aims to list a number of e-government services (i.e. eGROs) for each participating country that may be useful for the SMEs in the corresponding regions. The eGROs to be listed will be mainly the ones to be examined in the context of the project (i.e. the case studies to be used in the training scenarios). Descriptions of the e-government services will be included in the Observatory, in order to allow users search through the listings of

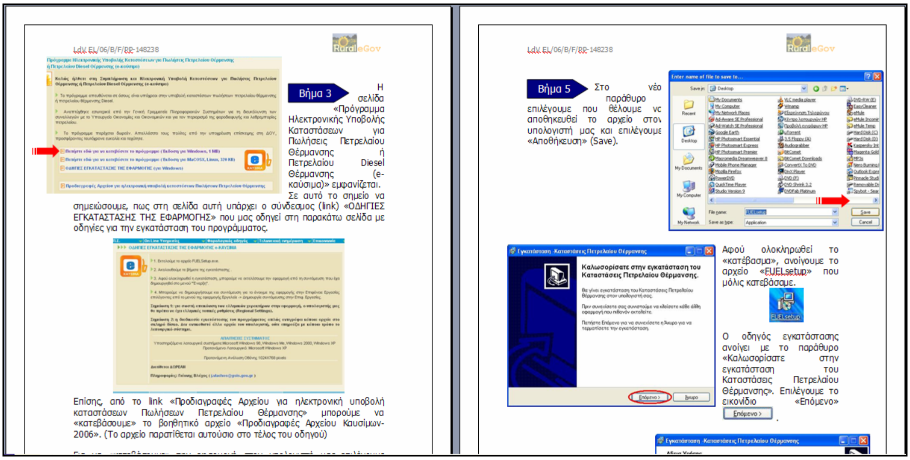


Fig. 1. Screenshot of a best practice guide for using a Greek e-government resource

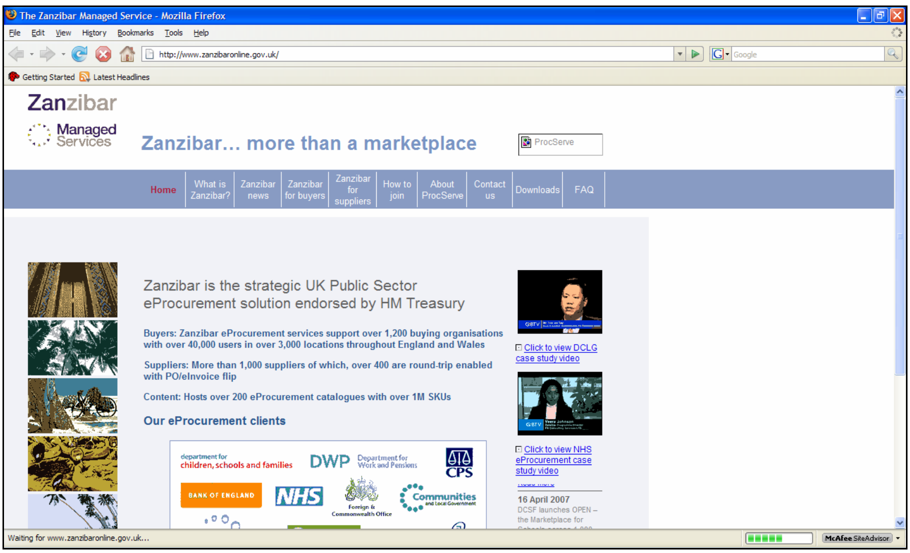


Fig. 2. Screenshot of an e-government service for UK suppliers

services and identify ones that may be useful for their needs. For this reason, these descriptions will have to be structured in such a way that will allow searching and browsing according to various properties such as their geographical coverage, their business sectors, and others. Again, apart from reflecting the most important characteristics, descriptions have to be available in the language of the users (that is, multilingual descriptions will be necessary). An example of a Rural-eGov eGRO is the Zanzibar e-procurement marketplace that is presented in Figure 2. It is an e-market providing catalogues of buyers and procurement opportunities for UK-based suppliers.

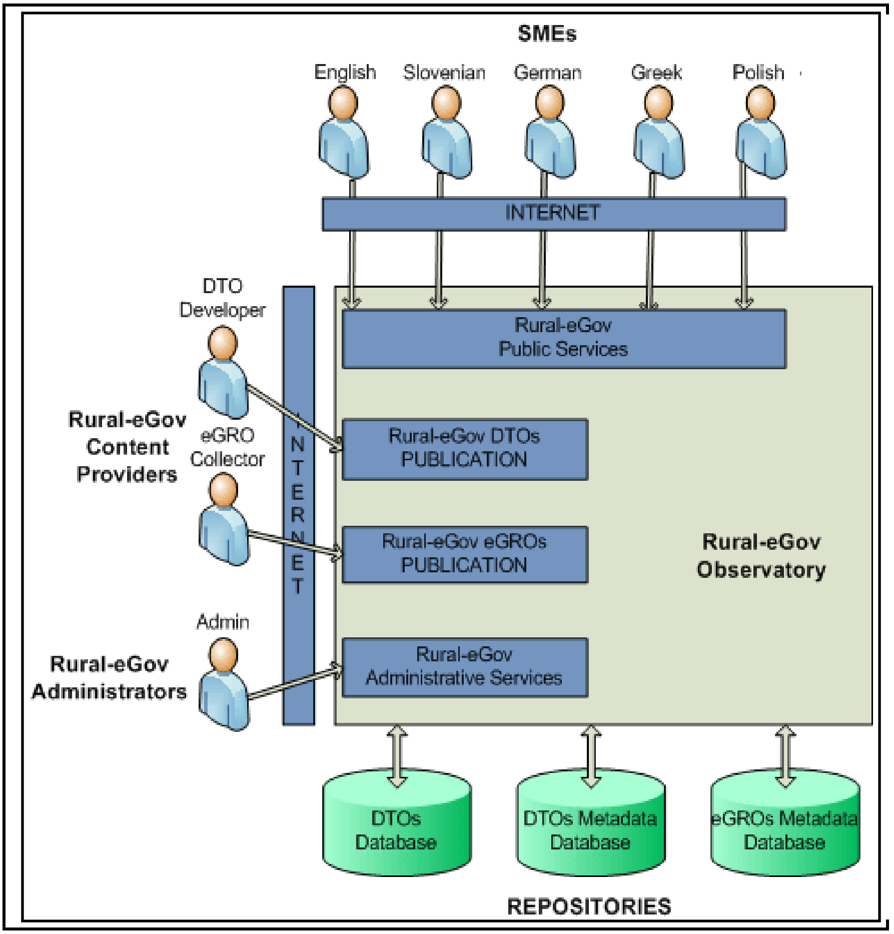


Fig. 3. Overall Architecture of the Rural-eGov Observatory

3 Analysis of User Roles and Interactions

Figure 3 illustrates the main architecture of the Rural-eGov Observatory. The users accessing the portal, the corresponding services, as well as the repositories involved are depicted. There are three kinds of users, each one accessing the Observatory in a different fashion:

- *Visitors*, who can use the Public Services of the Portal such as browsing or searching for DTOs. Visitors can be either registered or unregistered, with the registered ones having access to a wider set of the portal's functionalities such as adding annotations or rating to DTOs and evaluating eGROs.
- *Content Providers (CPs)*, who can insert DTOs or reference to eGROs and their corresponding Metadata. CPs comprise of DTO Developers, which have the ability

to upload DTOs and DTO Metadata and eGRO Collectors which insert into the portal reference to eGROs as well as the corresponding Metadata.

- *Administrators*, who perform all the administrative functions related to Visitors, Content Providers, DTOs and eGROs. Those include Viewing/Deleting/Deactivating DTOs/eGROs and the corresponding Metadata, Accepting or Declining Requests for Registration from CPs, Viewing/Activating/Deactivating Registered Visitors or CPs etc.

In Figure 4, the users of the Rural-eGov Observatory Portal and their categorization are illustrated.

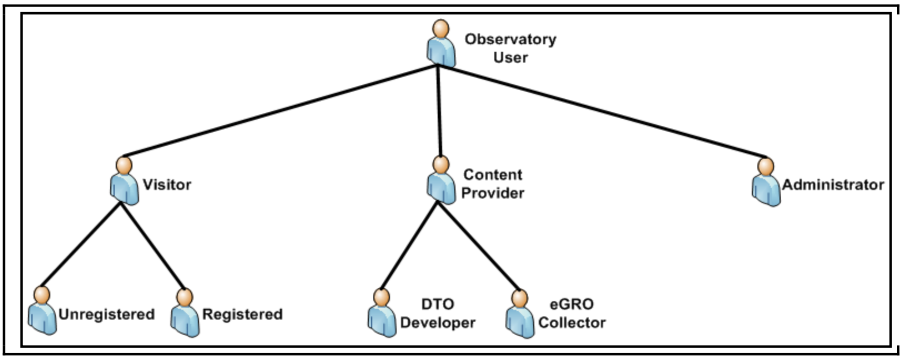


Fig. 4. Overall Architecture of the Rural-eGov Observatory Portal

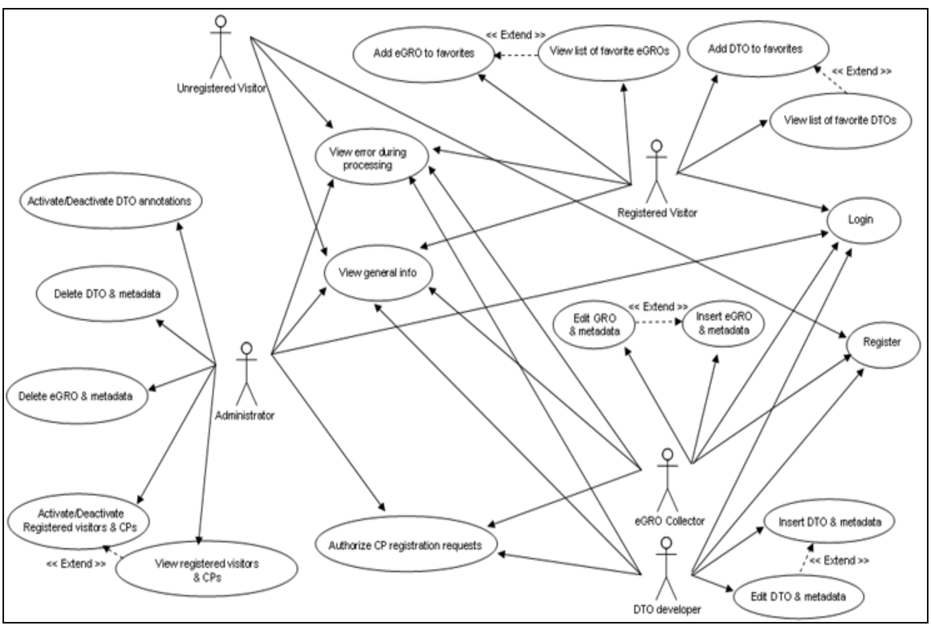


Fig. 5. Part 1 of the Use Case model

To further analyze the system and its expected operations, we have engaged the Unified Modeling Language (UML, http://www.uml.org), which is the de-facto software industry standard modeling language for visualizing, specifying, constructing and documenting the elements of systems in general, and software systems in particular. UML provides a rich set of graphical artifacts to help in the elicitation and top-down refinement of software systems from requirements capture to the deployment of software components [1].

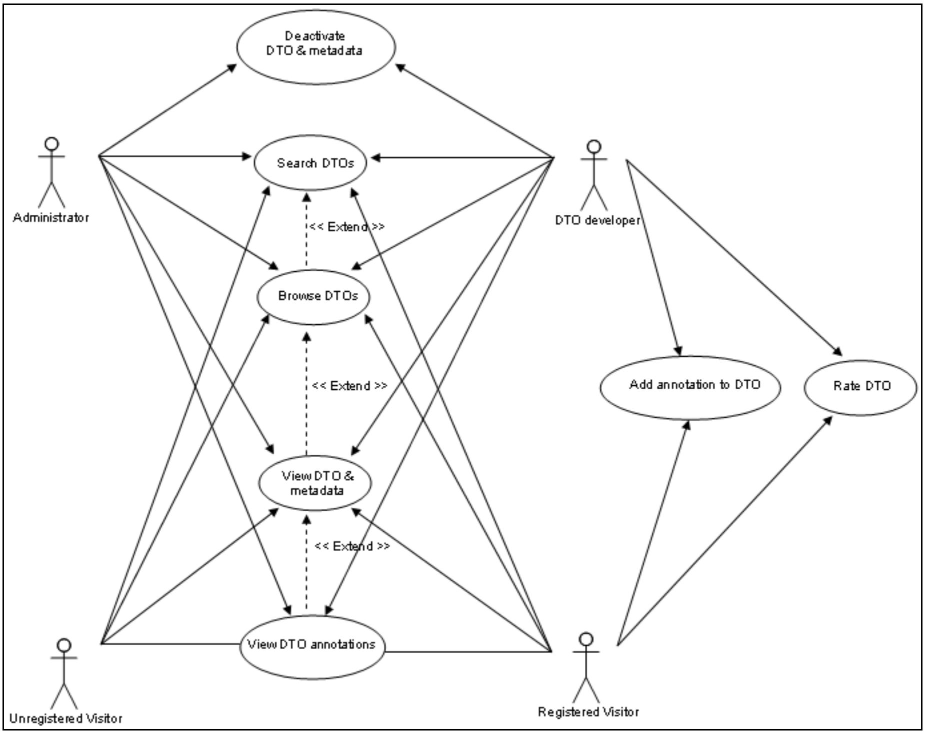


Fig. 6. Part 1 of the Use Case model

In UML, a system is described using different levels of abstraction and considering various views (i.e. Business view, Use Case view, Design and Process view, Implementation view). Each view is realized using different UML modelling tools (diagrams), such as Use Case Diagrams, Activity Diagrams, Sequence Diagrams, Collaboration Diagrams, Statechart Diagrams, Class Diagrams, Component Diagrams, and Deployment Diagrams. UML is largely process-independent, meaning that it can be used with a number of software development processes. Due to space restrictions, we only present the Use Cases in which the identified users are engaged (Figures 5, 6 and 7). The detailed analysis is included in the technical documentation of the project.

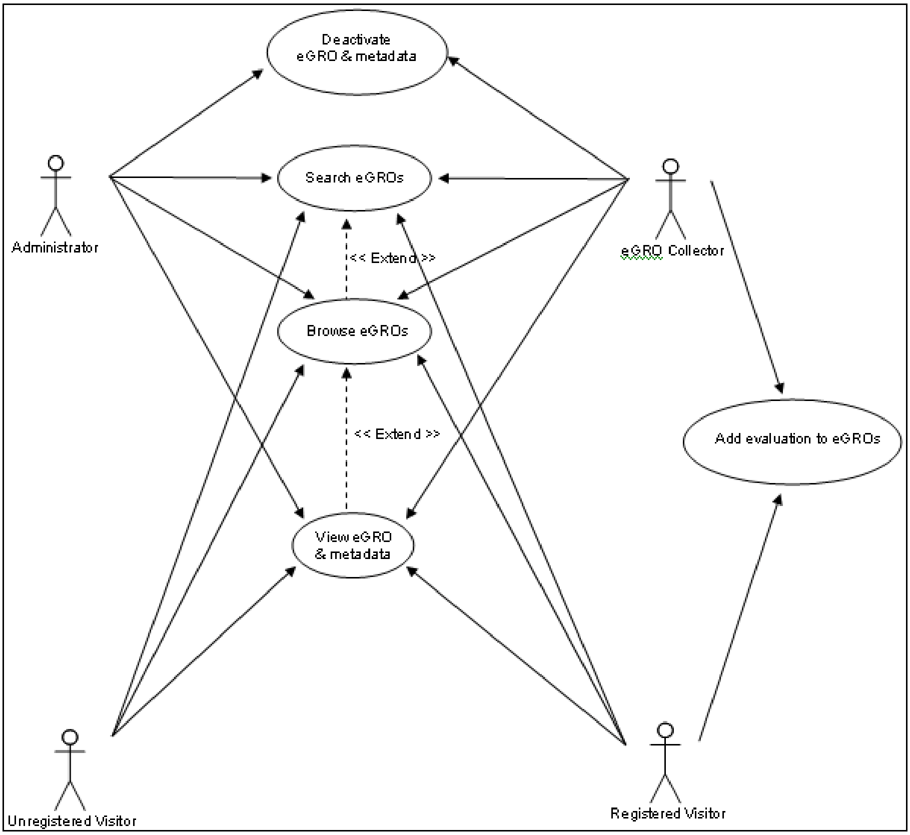


Fig. 7. Part 3 of the Use Case model

4 Database Design

The UML-based analysis that led to the identification of the user roles and interactions, and therefore to the identification of required functionalities and components to support them. Furthermore, the design and specification of the Observatory also called for the design of the system's repositories: that is, of the databases that would store information about DTOs and eGROs. The stored information, referred to also as *metadata* ([7],[8],[10],[11],[12]), has been represented according to two selected metadata standards. More specifically, for the description and classification of the eGROs for rural SMEs, the Observatory used a specialization of the e-Government Metadata Standard [3]. In addition, for the description and classification of the DTOs, a specialization of the IEEE Learning Object Metadata (LOM) standard [5] has been used [13]. These specializations [6] have been used as a basis for the specification of the Observatory's databases. An example specification is presented in Figure 8 – similar ones are included in the project's technical documentation.

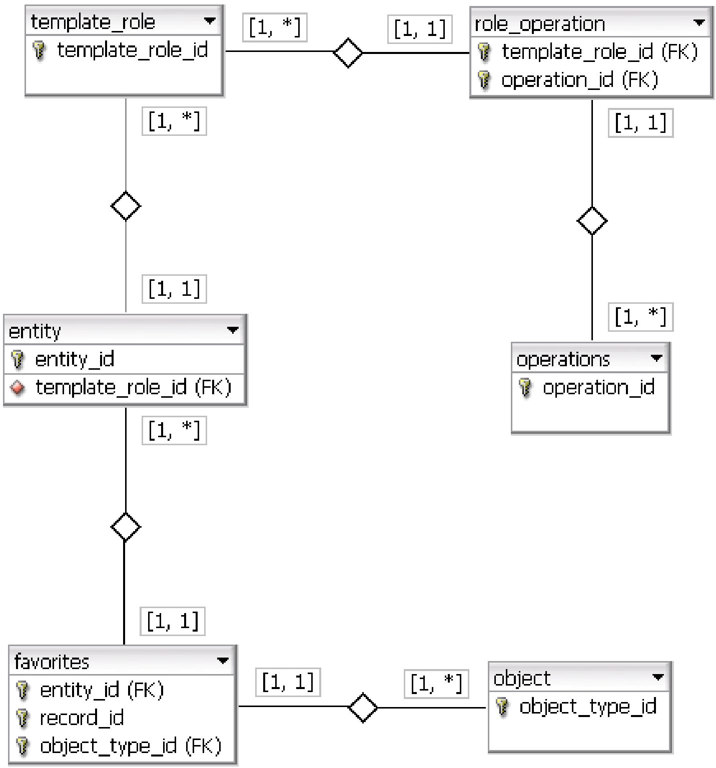


Fig. 8. Example of database specification: storing information about user entities

5 Interface Design and Prototype

The final stage in the design and specification of the Rural-eGov Observatory has been the design of its interfaces, and the implementation its prototype version.

Interface design took place having in mind the structure of information to be presented through the Observatory. This structure should be consistent in any Web application (from a single web site to an advanced web portal), therefore the process consisted on the generation of typical page descriptions where major information blocks were identified. The final layout of the implemented interface could differ at the end, but the components that have been identified should be present on all pages. As soon as the interface design process was completed, the development of the initial prototype of the Observatory started taking place. This led to the deployment of a first English version of the system, which has been provided to the users for testing and debugging. The implemented prototype version of the Observatory is presented in Figure 9. This version is currently tested and revised. Moreover, additional language version are produced (i.e. the German, Greek, Slovenian and Polish versions). During 2008, the Observatory will be populated with descriptions of both training resources and e-government services. In addition, pilot testing trials will take place with actual users, in order to assess their satisfaction from the Observatory.

Fig. 9. Implemented version of Observatory's Home Page

6 Conclusions

In this paper we presented one of the main results of the LdV Rural-eGov initiative: the Rural-eGov Observatory. This is an online environment that collects, categorizes and provides access to the digital training resources and e-government services that may help rural SMEs to use and exploit e-government services that are relevant to their needs. We presented the design and prototype implementation of the Observatory. In future work, the final, public version of the system, and results from its pilot testing with real users will be presented.

Acknowledgments. The work presented in this paper has been funded with support by the European Commission, and more specifically the project No EL/06/B/F/PP-148238 "Rural e-Gov: Training SMEs of Rural Areas in using e-Government Services" of the Leonardo da Vinci (LdV) Programme. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein. The authors would like to thank all the consortium partners for their contribution in the design and implementation of this initiative.

References

1. Boggs, W., Boggs, M.: Mastering UML with Rational Rose. SYBEX Inc. (2002)
2. EC: i2010 – A European Information Society for growth and employment, European Commission (2005)
3. e-GMS: E-Government Metadata Standard version 3.0, Technical Report (2004), `http://www.govtalk.gov.uk/schemasstandards/metadata_document.asp?docnum=872`

4. Gelb, E., Offer, A.: ICT in Agriculture: Perspectives of Technological Innovation. European Federation for Information Technologies in Agriculture. Food and the Environment (2005)
5. IEEE LOM: Draft Standard for Learning Object Metadata. IEEE Learning Technology Standards Committee, IEEE 1484.12.1 (2002).
6. Kraan, W.: No one standard will suit all. The Centre for Educational Technology Interoperability Standards (2003), `http://www.cetis.ac.uk/content/20030513175232`
7. Miller, P.: Metadata for the Masses, vol. 5. Ariadne (1996)
8. NISO: Understanding Metadata. National Information Standards Organisation. NISO Press (2004)
9. Roberts, A.: Metaphysics of Metadata. Presentation (2003), `http://www.edusource.ca/english/resources/MetadataNB.ppt`
10. Sen, A.: Metadata Management: past, present and future. Decision Support Systems 37, 151–173 (2004)
11. Steinacker, A., Ghavam, A., Steinmetz, R.: Metadata Standards for Web-Based Resources. IEEE Multimedia, pp. 70–76 (January-March 2001)
12. Taylor, C.: An Introduction to Metadata. University of Queensland Library (2003), `http://www.library.uq.edu.au/iad/ctmeta4.html`
13. Tzikopoulos, A., Manouselis, N., Yialouris, C.P., Sideridis, A.B.: Using educational metadata in a learning repository that supports lifelong learning needs of rural SMEs. In: EFITA/WCCA 2007 Conference on Environmental and rural sustainability through ICT, Glaskow, UK (July 2007)

A Semantic Based Collaborative System for the Interoperability of XBRL Accounting Information

Sheila Méndez Núñez, Javier de Andrés Suárez, Jose Emilio Labra Gayo, and Patricia Ordóñez de Pablos[1]

[1] University of Oviedo, C/Calvo Sotelo, S/N, 33007, Oviedo, Spain
{jdandres,labra,patriop}@uniovi.es

Abstract. The annual accounts and other financial information of big companies is being worldwide standardized. The open standard that allows this standardization is XBRL, an XML vocabulary for exchanging financial information. In return for this initiative, the existence of different accounting standards in each country makes necessary to define specific XBRL taxonomies for each kind of accounting report, making the extraction of homogeneous information from different taxonomies difficult. This project seeks to incorporate a new level of abstraction through OWL ontologies, allowing the users of accounting reports to compare and exchange financial reports drawn up according to different standards. In addition, we propose a collaborative web environment through which experts in the Accounting domain will update the knowledge base of the system.

1 Introduction

XBRL (eXtensible Business Reporting Language) is an XML vocabulary designed to simplify the automation of exchanging financial information. It offers great benefits in the preparation, analysis and communication of financial information and is a very useful tool for accountants. It offers cost savings, greater efficiency and improves the accuracy and reliability to all those involved in the supply or use of accounting information.

Currently, XBRL is being developed by XBRL International, which is an international non-profit consortium (http://www.xbrl.org) which consists of approximately 550 large companies, organizations and government agencies (dated May 2008). The worldwide diffusion of XBRL is being carried out through the formation in different countries of local jurisdictions of the XBRL consortium.

This project proposes an approach to extract information from sets of documents compliant with different XBRL taxonomies in different formats (RDF, Excel, PDF, etc.). This is done by classifying accounting information into one ontology of financial concepts designed for this purpose. The automated processing of information, which is possible due to the use of XML, gives the users maximum flexibility on their queries.

Furthermore, we also seek to develop a collaborative web environment where users are responsible for recalibrating the relations defined in the system and creating a repository of information that can be freely accessed. This will result in a constantly

M.D. Lytras et al. (Eds.): WSKS 2008, LNAI 5288, pp. 593– 599, 2008.

evolving project, where users incorporate the new documents requested by the released XBRL taxonomies and are responsible for establishing relations between the concepts identified in the ontology and the items in the specific taxonomies.

2 Related Work

There are a scarce number of software applications which permit produce/analyze XBRL reports. This limited range of resources is due to the recent standardization of financial reports using XBRL, which makes it an interesting area of study and a source of research opportunities. The existing tools which are related to the XBRL standard can be grouped into two main categories. First, we can mention the software applications for the validation, editing and in some cases generation of accounting reports. Almost all the applications of this kind are private and have high licensing costs.

Second, there are a number of tools which help the users of XBRL reports to assess the future solvency and profitability of the firms under study. These applications are closely related with the model we propose, as our system will also ease the process of financial benchmarking.

From January 2008 onwards, the website of the Spanish Securities Commission[1] includes a tool that lets investors to download and view the IPP (*Información Pública Periódica* – Public Periodic Information) reports submitted by listed companies.

The interim financial statements (balance sheet and profit and loss account) can be viewed, as well as certain data which are calculated on a quarterly basis (shareholders' equity, revenues, earnings before taxes, net results and the number of employees). The system provides information both on an individual and a consolidated basis. Graphics showing the evolution of the different financial items can also be designed using this tool.

Also, the U.S. Securities and Exchange Commission developed the system EDGAR (Electronic Data Gathering, Analysis, and Retrieval system). Its role is to collect and analyze information from public companies. This information should be published at EDGAR by companies following the format specification established by the SEC. Two formats are officially considered: the first one is a plain text format and the second one uses HTML. In addition, the same information must be provided in PDF format. The XBRL documents are accepted at EDGAR, but are not recognized as official documents, so their contribution is voluntary and is considered a supplement to official information, but not a valid information by itself. EDGAR is a search engine and a tool for the comparison of information widely used and known, but is not standard. It seeks to standardise financial reporting and provide useful services to investors, shareholders, etc.

3 Semantic Web and XBRL

When XBRL was developed, the authors used XLink [10] as the basis for describing and linking semantic information expressed in taxonomies. However, that was not the main main purpose of XLink, which had been developed as a language to define links between resources [1]. We think that describing semantic information could be better accomplished using the technologies that are being developed in the semantic web field.

[1] Spanish securities comisión (Comisión Nacional del Mercado de Valores):http://www.cnmv.es

The semantic web is a long-term project which aims at the development of technologies which will facilitate the integration between data published in the Web. Currently, most of the data available in the web is published in HTML for human consumption. Although it may seem good at first, when there are vast quantities of data, it becomes a problem to automatically manage that data. One step was the appearance of XML and web services. In this way, applications could publish domain specific data in XML vocabularies which could be handled by some particular applications. Although this approach solved the interoperability problem between applications, it can be seen as a syntactic level of interoperability, where the applications know in advance which data formats are going to exchange. However, there remained to be solved a more difficult problem: the semantic interoperability, in which the applications can integrate data from different heterogeneous sources.

RDF (Resource Description Framework) [6] was designed as a language that enabled the description of resources identified by URIs by means of global properties, also identified by URIs. The compositional graph model of RDF makes it easy to integrate descriptions from heterogeneous sources. Recently, SPARQL [7] has been developed as a graph matching query language over RDF repositories, offering new perspectives for application developers to easily consult semantic web data.

One of the key aspects of semantic web will be the development of ontologies which enable the users to formally describe specific domain. OWL (Web Ontology Language) [5] has been developed as a standard language based on description logics. In OWL, it is possible to include definitions of concepts and relations between them, which are useful for processing and for semantic analysis.

4 Analysis of XBRL through Semantic Web Technologies

In [4], we presented a project that was developed at the School of Computer Engineering of Oviedo (University of Oviedo) as part of the Final Year Project of the first author of this paper. The project developed one ontology of financial concepts in OWL, which allowed the users to export the information contained in XBRL documents using the RDF format. It enabled the users to calculate a series of ratios providing additional information on the financial health of the analyzed companies.

Through the use of semantic web technologies and the query language SPARQL, the system allows financial analysts to make logical inferences on the basis of accounting data. The information is gathered and provided in a flexible way, as several formats can be used. However, a drawback of this project is that only the information which is compliant with the IPP-XBRL taxonomy can be analyzed. IPP comprises the data that Spanish listed firms must submit to the Spanish Securities Commission (*Comisión Nacional del Mercado de Valores [CNMV]*). This information consists of the main items of the quarterly and half-yearly accounting reports.

These reports are drawn up according to the International Accounting Standards Board (IASB) standards and the Spanish standards issued by the Ministry of Economy of Spain. Nevertheless, it could be used as a starting point for the development of the model proposed in the present paper, as both are intended to process XBRL reports and transform them using XSLT. Another limitation is that this project is a desktop mono user application, although we are studying the feasibility of a migration to a web environment.

Figure 1 presents the architecture of the system which extracted semantic information from XBRL reports. The main components of the system were:

- **Translator:** It takes XBRL reports produced by listed firms which are available at the CNMV website and converts them to RDF reports. We used XSLT to carry on the conversion. Each XBRL concept is transformed into an OWL class or property, which belong to the OWL ontology that we have developed.
- **Merger:** It combines the RDF reports obtained from the translator with a domain specific OWL ontology. The ontology defines over 100 concepts from the IFRS/IAS. The results of the merger are stored in the knowledge base of the system.
- **Query Manager:** This module executes SPARQL queries over the knowledge base and generates HTML reports of the results. The queries can be defined by the end user or they can also be stored and retrieved from a query store.

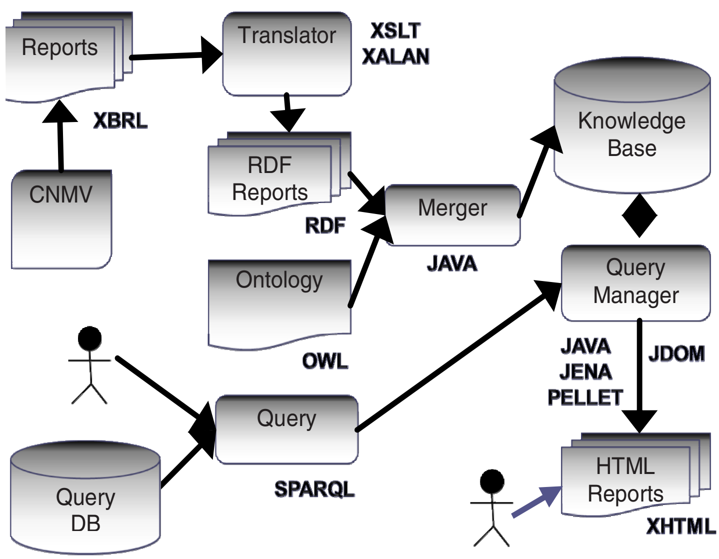


Fig. 1. Architecture of the a System for Semantic Analysis of XBRL reports

The system has been implemented as a standalone Java application, although we are planning to develop a web based interface.

5 Semantic Interoperability of XBRL Accounting Information

When we analyze the tools which process XBRL reports, we can extract a common factor: the comparisons between reports which are compliant with different taxonomies are difficult. This project seeks to add a new level of abstraction, allowing you to work with XBRL instances regardless of their origin.

The goal is to design an OWL ontology, which on the one hand defines groups of elements from different taxonomies which are common (or at least very close) and on the other hand is extensible, so the experts in the Accounting domain can add new knowledge to the system, by adding an element from a certain taxonomy to one of the existing groups or creating a new one.

As a basis for the definition of the OWL ontology, the IFRS (International Financial Reporting Standards) will be used. IFRS are a set of Accounting standards which are issued by the IASB. The IASB is an independent foundation whose aim is the standardization of financial information. IFRS are compulsory in a number of countries (i.e. in the EU countries for listed consolidated groups of companies).

The IASB has a task force on XBRL, which has developed a taxonomy that standardizes the financial statements drawn up according to the IFRS. This taxonomy is known as IFRS-GP (General Purpose). IFRS-GP is a complex taxonomy (approximately 4,000 items). Despite this, and given that IFRS are in continuous review, it should face a regular and continuous updating. The latest draft of IFRS-GP was issued by the IASB on May 2, 2008. Some parts of IFRS-GP are currently being used as subsets of other taxonomies (i.e. the taxonomy for the information submitted by non-financial companies to the Central Balance Sheet Data Office maintained by the Bank of Spain).

As each XBRL jurisdiction has defined its own set of taxonomies, according to the financial reporting requirements in each country, the number of financial items is too high to be manually translated into the ontology. As a solution for this problem, we propose a collaborative environment, where users (experts in the domain of the problem) will define the relationship between an item which is specific for a certain taxonomy and the corresponding concept in the ontology. Once this relation is defined, it will be incorporated into the knowledge base of the project, allowing the rest of the users to take benefit from it.

For the definition of such relationships, we must bear in mind that the differences in the reporting requirements across countries and sectors of activity imply that in many cases users can not establish a relationship of equivalence between an item belonging to a certain taxonomy and the concept defined in the ontology. To model and represent these relationships we intend to use fuzzy sets. Applying the properties of fuzzy numbers, the relationship between an item of a given taxonomy and the corresponding element of the ontology will be represented using a value which belongs to the range [0, 1]. As different users may assign different values to the degree of relationship between the items and the concept, statistic (i.e. weighted averages) and Artificial Intelligence (i.e. self-organizing maps) procedures will be used for knowledge representation.

Figure 2 shows an abstraction of the architecture and design of the project described above.

Lastly, we consider important to provide end-user information in different formats to ease its analysis. So, we intend to allow the export of the data in several formats using multiple sheets. Specifically, we will use XSLT (XSL Transformations) to export the required information to the most common formats: PDF, Excel, etc.

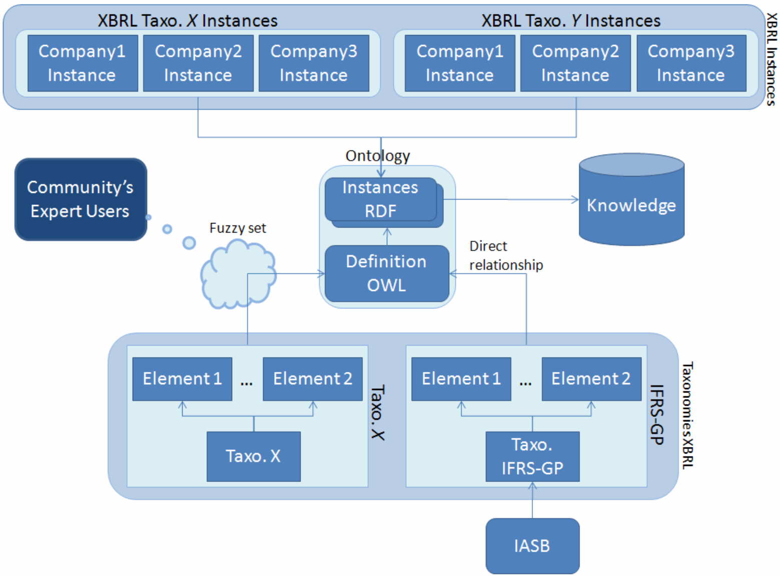


Fig. 2. Architecture of the System

6 Conclusions

The transformation of the data contained in XBRL reports compliant with different taxonomies into comparable information is a huge breakthrough for the analysis of financial information at the global level. It would be very important for potential investors to have access to global databases which contain financial information which has a high level of homogeneity. This would increase the efficiency of the decision making processes. As issues which would take benefit from this approach, we can mention the bankruptcy prediction problem and other tasks which are closely related to the assessment of the solvency of the firm, such as for example the bond rating problem and the issuance of the auditor's going concern opinion.

In the present paper we present a project that, through the use of Semantic Web technologies, will ease the formation of reliable financial databases, as it will let the providers of market and financial information to gather financial statements drawn up according to different standards, and therefore, represented using different XBRL taxonomies. In order to do this, we define an ontology of financial concepts, and then the relationship between the items in the specific taxonomies and the corresponding concepts in the ontology will be established. For the modelling of such relationships we will use fuzzy sets and other statistical and Artificial Intelligence tools.

One of the fundamental aspects of the present project is that we are planning to develop a collaborative environment. This environment will maintain and update the knowledge base of the system, the repository of XBRL documents and the taxonomies related to the ontology. Otherwise, the definition of the relationships between the items in the taxonomies and the concepts in the ontology would not be cost-effective, because of the large number of taxonomies and the high number of items contained in each one of them.

References

[1] Ducharne, Bob, XLink, Who Cares? O'Reilly XML.com (March 2002)

[2] Hodge, F.D., Kennedy, S.J., Maines, L.A.: Does search-facilitating technology improve transparency? Accounting Review 79(3), 687–704 (2004)

[3] Lara, R., Cantador, I., Castells, P.: XBRL Taxonomies and OWL Ontologies for investment funds. In: Roddick, J.F., Benjamins, V.R., Si-said Cherfi, S., Chiang, R., Claramunt, C., Elmasri, R.A., Grandi, F., Han, H., Hepp, M., Lytras, M., Mišić, V.B., Poels, G., Song, I.-Y., Trujillo, J., Vangenot, C. (eds.) ER Workshops 2006. LNCS, vol. 4231, pp. 271–280. Springer, Heidelberg (2006)

[4] Méndez Núñez, S., Labra, G.: Analysis of XBRL documents representing financial statements using Semantic Web Technologies. In: 2nd International Conference on Metadata and Semantic Web Research, Corfu, Greece (October 2007)

[5] OWL – Web Ontology Language (2004), `http://www.w3.org/2004/OWL`

[6] RDF – Resource Description Framework (1999), `http://www.w3.org/RDF/`

[7] SPARQL – SPARQL Query Language for RDF (2008), `http://www.w3.org/TR/rdf-sparql-query/`

[8] Roos, N., Vervoort, A., Tijhof, M., van Wingerden, D.: Transforming XBRL into an OWL On-tology, Seminar Economics and ICT, FEW1904-06, Erasmus University Rotterdam (2007)

[9] XBRL International, `http://www.xbrl.org/`

[10] XML Linking Language (XLink) Version 1.0. DeRose, S., Maler, E., Orchard, D. (eds.) World Wide Web Consortium (2001), `http://www.w3.org/TR/xlink/`

Author Index