

New Trends in Databases and Information Systems: Contributions from ADBIS 2017 Workshops

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Abstract. In the last few years, research on database and information system technologies has been rapidly evolving thanks to the new paradigms of software and hardware adopted by modern scientific and more invasive applications. A huge and heterogeneous amount of data should be efficiently stored, managed, and analyzed exploiting proper technologies for such novel and more interesting data-driven applications. New and cutting-edge research challenges arise that have been attracting great attention from both academia and industry. The 21st European Conference on Advances in Databases and Information Systems (ADBIS 2017), held on September 24–27, 2017 in Nicosia, Cyprus includes four thematic workshops covering some emerging issues concerning such new trends in database and information system research. The aim of this paper is to present such events, their motivations and topics of interest, as well as briefly outline their programs including interesting keynotes, invited papers and a wide range of research, application, and industrial contributions selected for presentations. The selected papers have been included in this volume.

1 Introduction

The ADBIS conferences aim at providing a forum for the dissemination of research accomplishments and promoting interaction and collaboration between the database and information system research communities from European countries and the rest of the world. The ADBIS conferences provide an international platform for the presentation of research on database theory, development of advanced DBMS technologies, and their applications. The 21st edition of ADBIS, held on September 24–27, 2017 in Nicosia, Cyprus includes four thematic workshops covering emerging and cutting-edge research topics concerning new trends

in database and information system research. Papers accepted at the ADBIS main conference span a wide range of topics in the field of databases and information systems ranging from innovative platforms for data handling to emerging hardware and software technologies for database and information systems, from data management on novel architectures (cloud and MapReduce environments) to interesting and novel machine learning algorithms for effectively supporting decision-making process. Meanwhile, the general idea behind each workshop event was to collect contributions from various domains representing new trends in the broad research areas of databases and information systems. Specifically, the following workshop events have been organized:

- The 1st Workshop on Novel Techniques for Integrating Big Data (BigNovelTI 2017)
- The 1st International Workshop on Data Science: Methodologies and Use-Cases (DaS 2017)
- The 2nd International Workshop on Semantic Web for Cultural Heritage (SW4CH 2017)
- The 1st Workshop on Data-Driven Approaches for Analyzing and Managing Scholarly Data (AMSD 2017)

Each workshop had its own international program committee, whose members served as the reviewers of papers included in the rest of this volume. In the following, for each workshop, a brief introduction of its main motivations and topics of interest is presented, as well as its program including interesting keynotes, invited papers and the selected papers for presentations. These papers have been included in this volume. Finally, some acknowledgements from the workshop organizers are provided.

2 The 1st Workshop on Novel Techniques for Integrating Big Data (BigNovelTI 2017)

Introduction. The 1st Workshop on Novel Techniques for Integrating Big Data (BigNovelTI 2017) has been organised by Diego Calvanese (Free University of Bozen-Bolzano, Italy) and Oscar Romero (Universitat Politècnica de Catalunya, Spain).

The challenges posed by Big Data require novel data integration techniques beyond Data Warehousing (DW), which has been the in-company de-facto standard for data integration. On the one hand, bottom-up data integration approaches, performing a virtual integration, are a good fit for integrating disparate autonomous and heterogeneous data sources in large-scale distributed decision support systems, a current trend to contextualise the in-house data. Virtual data integration however tends to suffer from poor performance, which hinders the right-time analysis approach, and needs to be adapted and combined with materialisation to meet the new requirements brought by Big Data. On the other hand, variety and the need to deal with external non-controlled sources

in an automatic way require to look at this problem from a broader perspective than the one of traditional data management, and semantics need to be included in the data integration processes. In such setting, domain knowledge is represented in an ontology, and inference over such knowledge is used to support data integration. However, this approach poses significant computational challenges that still need to be overcome, and hence its potential has not been fully exploited yet in real world applications. For these reasons, (i) providing different degrees of coupling of the integrated data sources based on their heterogeneity and autonomy, and (ii) dealing with and integrating semantics as a first-class citizen are open questions for novel scenarios.

Program. The workshop included a panel session and four selected research papers. The panel session sought to promote the interaction and collaboration between the data management and knowledge representation communities, which tackle data integration from different perspectives. As main outcome, promising research lines in this research area were presented and discussed.

The four selected papers address different interesting research issues related to data integration for Big Data. Brandt et al. presented a framework for temporal ontology-based data access (OBDA). In particular, compared to the standard OBDA, the framework envisions the addition of static and temporal rules, where the latter are based on *datalog_{nr}MTL*. Ibáñez et al. introduced a collaborative approach that stores queries in a multidimensional-aware (based on an extension of the QB4OLAP RDF vocabulary) knowledge base that is then analysed to help users assessing semantic consistency of aggregation queries in self-service BI contexts. Theodorou et al. presented an adaptive Big Data reference architecture, named *Theta*, thought to introduce flexibility in the data analytics part of the system enabling optimization at runtime to meet the level of data quality required by the data analyst. Finally, Trajcevski et al. introduced the concept of knowledge-evolution trajectory as a model to formalise the spatial, temporal, and content-based aspects of scientific publications and enable novel querying techniques based on these three aspects.

Acknowledgements. The BigNovelTI chairs would like to acknowledge the help of all PC members. The alphabetically ordered list of PC members contains: Alberto Abelló (Universitat Politècnica de Catalunya, Spain), Andrea Cali (Birkbeck College London, U.K.), Theodoros Chondrogiannis (Free University of Bozen-Bolzano, Italy), Martin Giese (University of Oslo, Norway), Gianluigi Greco (University of Calabria, Italy), Katja Hose (Aalborg University, Denmark), Petar Jovanovic (Universitat Politècnica de Catalunya, Spain), Maria C. Keet (University of Cape Town, South Africa), Roman Kontchakov (Birkbeck College London, U.K.), Antonella Poggi (Sapienza University of Rome, Italy), Mantas Simkus (TU Vienna, Austria), Sergio Tessaris (Free University of Bozen-Bolzano, Italy), Christian Thomsen (Aalborg University, Denmark), Stefano Rizzi (University of Bologna, Italy), Alejandro Vaisman (Instituto Tecnológico de Buenos Aires, Argentina), Stijn Vansummeren (Université Libre de

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3 The 1st International Workshop on Data Science: Methodologies and Use-Cases (DaS 2017)

Introduction. The 1st International Workshop on Data Science: Methodologies and Use-Cases (DaS 2017) has been organized by Tania Cerquitelli (Politecnico di Torino, Italy), Silvia Chiusano (Politecnico di Torino, Italy), and Natalija Kozmina (University of Latvia, Latvia).

Data science is an interdisciplinary field about scientific processes, methodologies, and systems to extract useful knowledge or insights from data in various forms. Data can be analyzed using data mining, machine learning, data analysis and statistics, optimizing processes and maximizing the knowledge exploitation in real-life settings. DaS 2017 is a workshop aimed at fostering and sharing research and innovation on data science. The workshop allows researchers and practitioners to exchange their ideas and experiences on designing and developing data science applications, discuss the main open issues, and share novel solutions for data management and analytics.

The DaS topics of interest include methodologies, models, algorithms, and architectures for data science, scalable and/or descriptive data mining and machine learning techniques for knowledge discovery, data warehouses and large-scale databases, and experiences with data-driven project development and deployment in various application scenarios.

Keynote Presentation. Rossano Schifanella (computer scientist at the University of Turin) gave a talk entitled *Combined Effect of Content Quality and Social Ties on User Engagement*. He is a visiting scientist at Nokia Bell Labs, Cambridge, UK, and a former visiting scientist at Yahoo Labs and at Indiana University School of Informatics and Computing where he was applying computational methods to model social behavior in online platforms. His research mainly focuses on a data-driven analysis of the behavior of (groups of) individuals and their interactions on social media platforms.

In his talk, Rossano presented a large scale study on the complex intertwinement between quality, popularity, and social ties in an online photo sharing platform, proposing a methodology to democratize exposure and foster long term users engagement.

Invited Paper. Genoveva Vargas-Solar contributed to DaS with an invited paper entitled *Efficient Data Management for Putting forward Data-centric Sciences*. She is a senior scientist of the French Council of Scientific Research (CNRS) and since 2008, Genoveva is deputy director of the Franco-Mexican Laboratory of Informatics and Automatic Control (LAFMIA) an international

research unit established at CINVESTAV. Her research interests concern distributed and heterogeneous databases, reflexive systems and service based database systems. She conducts fundamental and applied research activities for addressing these challenges on different architectures ARM, raspberry, cluster, cloud, and HPC.

The novel and multidisciplinary data-centric and scientific movement promises new and not yet imagined applications that rely on massive amounts of evolving data that need to be cleaned, integrated, and analysed for modelling, prediction, and critical decision making purposes. In her paper, Genoveva explains the key challenges and opportunities for data management in this new scientific context, and discusses how data management can best contribute to data-centric sciences applications through clever data science strategies.

Selected Papers. The DaS workshop is composed of 11 papers discussing a variety of interesting research issues, application domains, and experience reports in the area of data science. Specifically, the workshop is composed of three sections covering different aspects in the area of *data analytics for data science* (4 papers authored by Datta et al., Cagliero et al., Saleh and El-Tazi, and Podapati et al.), *data management for data analytics* (3 papers authored by Galkin et al., Bobrov et al., and Borzovs et al.), and *data science use cases* (4 papers authored by Haq and Wilk, Quemy, Gončarovs and Grabis, and Hernandez-Mendez et al.). In the following we present the research papers for each of the three areas above.

In the *Data analytics for data science* section, the paper entitled *Parallel Subspace Clustering using Multi-core and Many-core Architectures* (Datta et al.) presents a multi-core approach exploiting CPU computation to parallelize the SUBSCALE algorithm. The authors report results over performances and discuss the concurrency problems that effect the parallelization of the SUBSCALE algorithm. A novel pattern, named Generalized High-Utility Itemset (GHUI), has been proposed in the paper entitled *Discovering High-utility Itemsets at Multiple Abstraction Levels* (Cagliero et al.) to represent sets of item groups, each one characterized by a high total profit. The GHUI pattern exploits the available data taxonomies to model high-utility itemsets at different abstraction levels. The significance of the proposed pattern and the performance of the GHUI mining algorithm have been evaluated on retail data with the aim of planning advertising campaigns of retail products. Aimed at grouping tags associated with the StackOverflow posts in semantically coherent clusters, a technique based on the Latent Dirichlet Allocation (LDA) has been proposed in the paper entitled *Automatic Organization of Semantically Related Tags using Topic Modelling* (Saleh and El-Tazi). First, by analyzing post texts through LDA, topics are discovered and associated with the posts. Then, groups of tags associated with the topics are built. A measure to evaluate the quality of the extracted groups is presented. The approach has been experimentally validated on a real dataset extracted from StackOverflow. The paper entitled *Fuzzy Recommendations in Marketing Campaigns* (Podapati et al.) proposes a technique based on fuzzy logic to put in relationship the proneness of the customers of

telecommunication companies to be infrastructure-stressing (i.e., operating in zones of high demand that might produce network service failures) with geodemographic customer segments. The aim is to shape the marketing campaigns understanding whether there are segments of users that are too infrastructure-stressing and should be avoided.

In the *Data management for data analytics* section, the paper entitled *Towards a Multi-way Similarity Join Operator* (Galkin et al.) puts forward an approach to overcome limitations of most of the existing query engines that rely on binary join-based query planners and execution methods with complexity depending on the number of data sources involved. The authors propose a multi-way similarity join operator (MSimJoin) that accepts more than two inputs and is able to identify duplicates corresponding to similar entities. In the paper titled *Workload-Independent Data-driven Vertical Partitioning*, Bobrov et al. introduce a new class of vertical partitioning algorithms that don't exploit workload information and are data-driven. The proposed algorithm relies on the database logical schema to extract functional dependencies from tables and perform partitioning accordingly. The authors experimentally compared their algorithm with two existing workload-dependent algorithms. Borzovs et al. in the paper entitled *Can SQ and EQ Values and their Difference Indicate Programming Aptitude to Reduce Dropout Rate?* discuss the inadequacy of metrics and models available in the reviewed literature when predicting the potential dropouts among students of Computer Science study programs. Gained results in their empirical evaluation disprove the hypothesis that students' programming aptitude would correlate with the systemizing quotient (SQ), empathy quotient (EQ), and its difference.

Four interesting experience reports respectively in health care, law and justice, financial, and business domains are discussed in the *Data science use cases* section. A critical issue in health care domain is the ability to predict the proper treatment for patients affected by a certain pathology. The paper entitled *Fusion of Clinical Data: A Case Study to Predict the Type of Treatment of Bone Fractures* (Haq and Wilk) presents the application of data fusion techniques, such as combination of data (COD) and interpretation (COI) approaches, in building a decision model for patients with bone fractures to distinguish between those who have to undergo a surgery and those who should be treated non-surgically. An extensive and critical review of the current state-of-the-art research in data science techniques for law and justice is presented in the paper *Data Science Techniques for Law and Justice: Current State of Research and Open Problems* (Quemy). The author describes the difficulties of analyzing legal environments, identifies four fundamental problems, and discusses how they are covered by the current top approaches available in the literature. In the paper entitled *Using Data Analytics for Continuous Improvement of CRM Processes: Case of Financial Institution*, Gončarovs and Grabis present a case study where data mining strategies have been exploited to identify the Next Best Offer (NBO) for selling financial products to bank's customers. Based on the experience gained on this case study, the authors eventually point out that the interaction between

business owners and data analysts is necessary to improve the models. Aimed at supporting the business ecosystems modeling (BEM) management process, the Business Ecosystem Explorer (BEEEx) tool is introduced in the paper entitled *Towards a Data Science Environment for Modeling Business Ecosystems: The Connected Mobility Case* (Hernandez-Mendez et al.). BEEEx empowers end-users to adapt not only the BEM but also the visualizations. The authors describe their experience on modeling the Connected Mobility Ecosystem in the context of the project TUM Living Lab Connected Mobility (TUM LLCM).

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4 The 2nd International Workshop on Semantic Web for Cultural Heritage (SW4CH 2017)

Introduction. The 2nd International Workshop on Semantic Web for Cultural Heritage (SW4CH 2017) has been organized by Béatrice Markhoff (University of Tours, France) and Stéphane Jean (ENSMA, Poitiers, France). The aim of this workshop is to bring together interdisciplinary research teams involved in Semantic Web solutions for Cultural Heritage. Interdisciplinarity is a key point in this field, as Software Engineers, Data Scientists, and various Humanity and Social Scientists have to work together for inventing, devising and implementing novel ways of digital engagement with heritage based on the semantic web principles, data, and services. It is crucial to have a place to exchange experiences, present states of the art, and discuss challenges. The University of Tours, ISAE-ENSMA Engineering School, and University of Poitiers are involved in such interdisciplinary projects, within the scope of the Intelligence des Patrimoines (I-Pat) programme, funded by the Région Centre Val de Loire, and led by the CESR (Centre d'études Supérieur de la Renaissance), a DARIAH laboratory and one of the principal European laboratories in the field of the Renaissance.

Invited Paper. An invited talk has been given by Carlo Meghini, prime researcher at CNR-ISTI and the head of the Digital Libraries group in the NeMIS Lab of ISTI. His presentation was about *Narratives in Digital Libraries*. One of the main problems of the current Digital Libraries (DLs) is the limitation of the discovery services offered to the users, which typically boil down to returning a ranked list of objects in response to a natural language query. No semantic relation among the returned objects is usually reported, which could help the user in obtaining a more complete knowledge on the subject of the search. The introduction of the Semantic Web, and in particular of the Linked Data, has the potential of improving the search functionalities of DLs. In order to address this problem, Carlo Meghini introduced narratives as new first-class objects in DLs, and presented preliminary results on this endeavor.

Selected Papers. The workshop selected 6 papers addressing interesting research issues in the context of Semantic Web for Cultural Heritage. In this field, research teams work in knowledge engineering for building, extending and using ontologies, for representing their data. Ontologies are clearly identified as an integration means, a base for interconnecting projects and datasets. In this context, the CIDOC-CRM plays a central role, as shown in the number of projects that use it.

The first presented paper, *Introducing Narratives in Europeana: Preliminary Steps* (C. Meghini et al.), reports on a particular case of the work introduced in the invited talk, namely using a tool developed to enrich the Europeana content. A narrative is here defined as a semantic network that consists of linked events, their spatio-temporal properties, participating entities, and objects included in the digital collection, which can be represented using the CIDOC-CRM.

The second paper, *Evaluation of Semantic Web Ontologies for Modelling Art Collections* (D. Liu et al.), presents an evaluation of three existing ontologies used in the Cultural Heritage field, CIDOC-CRM, the Europeana Data Model, and VRA (Core), with respect to the representation of Art Collections. The comparison is based on the concrete modelling of four different artworks.

The third paper, *The CrossCult Knowledge Base: a co-inhabitant of cultural heritage ontology and vocabulary classification* (A. Vlachidis et al.), discusses design rationales of the CrossCult Knowledge Base, devised to support a cross-cultural public access to European History, fully compliant with the CIDOC-CRM ontology and equipped with specific thesauri. Several choices made during the design process which involved inter-disciplinary teams are discussed.

The fourth paper, *The Port History Ontology* (B. Rohou et al.), describes the first results of a multidisciplinary research project on an extension of the CIDOC-CRM dedicated to the history of ports. The Port History Ontology is mainly based on a pre-defined model representing the spatio-temporal evolution of ports.

The fifth paper, *A WordNet ontology in advancing search digital dialect dictionary* (M. Mladenović et al.), introduces an ontology-based method for connecting a standard language (Serbian) and a dialect in Serbian to improve the

search over the dialect dictionary using keywords entered in the standard language. The proposal defines SWRL rules to infer new synonyms.

The last presented paper, *When it comes to Querying Semantic Cultural Heritage Data* (B. Markhoff et al.), provides an overview of projects and approaches for querying semantic web data, including ontology-based mediation, federated query systems and full web querying, with a focus on solutions already used for semantic Cultural Heritage data.

All in all, on the one hand this second edition of SW4CH clearly reflects the increasing number of CIDOC-CRM uses, for modeling a variety of CH domains, and, on the other hand, it highlights the development of ontology-based methods for connecting, integrating and querying several Digital Cultural Heritage resources.

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5 The 1st Workshop on Data-Driven Approaches for Analyzing and Managing Scholarly Data (AMSD 2017)

Introduction. The 1st Workshop on Data-Driven Approaches for Analyzing and Managing Scholarly Data (AMSD 2017) was organized by Andreas Behrend (University of Bonn, Germany) and Christiane Engels (University of Bonn, Germany).

Supporting new forms of scholarly data publication and analysis has become a crucial issue for scientific institutions worldwide. Even though there are already several search engines, bibliography websites and digital libraries (e.g., Google Scholar, CiteSeerX, Microsoft Academic Search, DBLP) supporting the search and analysis of publication data, the offered functionality is still rather limited. For example, the provided keyword-based search does not employ the full opportunities an advanced semantic search engine could offer. In addition,

a comprehensive content analysis beyond title and abstract as well as the capability to take the quality and relevance of the publications into account is not provided so far.

International community forums such as FORCE11 and Research Data Alliance (RDA) already engage for open and semantic publishing which enable various opportunities for new analytics on scholarly data. The global vision is a uniform system combining all forms of scholarly data offering a comprehensive semantic search and advanced analytics including:

- Knowledge extraction and reasoning about scientific publications and events,
- Quality assessment of scientific publications and events, e.g. via rankings or quality metrics,
- Recommender systems for conferences and workshops, and
- Identification of research schools and key papers or key researcher within a field using citation analysis.

In this first edition of the AMSD workshop, we want to encourage especially researchers from the database community (but also from the fields information retrieval, digital libraries, graph databases, machine learning, recommender systems, visualization, etc.) to combine their resources in order to exploit the possibilities of scholarly data analysis. The main goals of the AMSD workshop are to facilitate the access of scholarly data, to enhance the ability to assess the quality of scholarly data and to foster the development of analysis tools for scholarly data. The following topics will be addressed:

- Managing scholarly data, i.e. representation, categorization, connection and integration of scholarly data in order to foster reusability, knowledge sharing, and analysis,
- Analyzing scholarly data, i.e. designing and implementing novel and scalable algorithms for knowledge extraction and reasoning about and assessing the quality of scientific publications and events with the aim of forecasting research trends, establishing recommender systems, and fostering connections between groups of researchers,
- Applications on scholarly data, i.e. providing novel user interfaces and applications for navigating and making sense of scholarly data and highlighting their patterns and peculiarities.

Program. The workshop consists of 3 accepted papers addressing interesting research challenges to support new forms of scholarly data publication and analysis. In the paper entitled *Publication Data Integration As a Tool for Excellence-Based Research Analysis at the University of Latvia* a publication data integration tool is presented designed and used at the University of Latvia for excellence-based research analysis. Besides the usual bibliographic data about authors (name, affiliation) and publications, quantity, quality and structural bibliometric indicators are included for a excellence-based analysis. In the paper *Evaluating Reference String Extraction Using Line-Based Conditional Random*

Fields: A Case Study with German Language Publications the authors address the problem of extracting individual reference strings from the reference section of scientific publications. They propose an approach named RefExt that apply a line-based conditional random fields rather than constructing the graphical model based on the individual words, dependencies and patterns that are typical in reference sections provide strong features while the overall complexity of the model is reduced.

Finally, in the paper *CEUR Make GUI A usable web frontend supporting the workflow of publishing proceedings of scientific workshops* a new GUI web front end for facilitating the generation of proceedings in CEUR-WS is described. A previously developed command line tool has proven to be not feasible for this purpose. The performed user evaluation shows a 40% less execution time of the GUI variant compared to the command line version and rather positive usability scores.

Keynote Presentations. This year, two keynote presentations were offered at AMSD. The first talk was provided by Johann Gamper from the University of Bozen-Bolzano who is an expert in temporal data management. In his talk he discussed key requirements for managing temporal data in current database systems. In particular, he showed how the requirements can be mapped to simple and powerful primitives for the relational model, and identifies a range of open problems when dealing with so-called long data.

The second talk was given by Andreas Behrend from the University of Bonn who works on a cloud-based tool for managing and analyzing publication data. In his talk he presented the OpenResearch project in which a semantic wiki is developed for storing and querying information about scientific events, research projects, publishers, journals, and articles.

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6 Conclusions

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as to the external reviewers of the ADBIS 2017 workshops, for their support in evaluating the submitted papers, providing comprehensive, critical, and constructive comments and ensuring the quality of the scientific program and of this volume.

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We all hope you will find the volume content an useful contribution to promote novel ideas for further research and developments in the areas of databases and information systems. Enjoy the reading!