Chapter 1
Advances in Intelligent Decision-Making Technology Support

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Abstract A succession of data-bases, Advanced Information Processing (AIP) and Intelligent Decision-Making Technologies (IDT) have evolved rapidly over the past five decades. This cumulative evolution of Intelligent Decision Support Systems (IDSSs) has served to stimulate industrial activity and enhanced the lives of most people that the modern world. This publication highlights a series of current contributions to enhance the collective body of knowledge. Artificial Intelligence (AI) and Computational Intelligence (CI) techniques continue to be successfully employed to generate human-like decision-making, while simultaneously providing greater access to information to solve data intensive problems. This book documents innovative contributions that represent advances in Knowledge-Based and Intelligent Information and Engineering Systems. New research recognises that society is familiar with modern AIP and increasingly expect richer IDT systems. Today there is a growing reliance on automatically processing information into knowledge with less human input. Society has already digitised its past and continues to progressively automate knowledge management for the future and increasingly expect to access this information using mobile devices. This book seeks to inform and enhance the exposure of research on intelligent systems and intelligence technologies that utilize

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novel and leading-edge techniques to improve decision-making. Each chapter concentrates on the theory, design, development, implementation, testing or evaluation of IDT techniques or applications. These approaches have the potential to support decision making in the areas of management, international business, finance, accounting, marketing, healthcare, production, networks, traffic management, crisis response, human interfaces and, military applications. All fourteen chapters represent a broad spread of topics across the domain and highlight how research is being realised to benefit society. Students, professionals and interested observers within the knowledge-based and intelligent information management domain will benefit from the diversity and richness of the content.

Keywords Artificial intelligence · Computational intelligence · Data · Decision-making · Decision support · Information · Intelligence · Knowledge · Wisdom

1.1 Introduction

When McCarthy developed LISP, it enabled Bachman to create the first information data storage system [1]. Although this research stimulated the creation of the first Database Management System (DMS), Feigenbaum quickly exploited the technique to apply constraints within a prescribed search space. This Decision Support System (DSS) employed Heuristic techniques to explain experimental data in organic chemistry. Buchhanan and Lederberg reported the benefits of this Heuristic DENDRAL program in 1971 [2].[1] DMSs were used to collect, fuse and analyze data in order to aggregate information and ultimately generate knowledge. The context influences the technique used. These typically included: communication-driven, data-driven, document-driven, knowledge-driven and model-driven architecture. This era was accompanied with an expansion in research into a variety of intelligent decision support systems that where created to derive greater confidence in the decision being generated [3].

After the introduction of desktop computers in the mid-eighties, most Intelligent Decision-Making Technologies (IDT) research involved the progressive use of technology to collect and interpret data, prior to translating this into information based on 'folk law' or 'symbology'. The wealth of data continues to become unwieldy, forcing researchers to explore data-mining, warehousing and Knowledge Based Systems (KBS), however the key research domains remained focused on problem solving using formal/structured or reasoning systems [4]. This era was accompanied with an expansion in research into a variety of intelligent decision support systems that were created to derive greater confidence in the decision being generated [3]. The growing

[1]The term DENDRAL originally stood for 'DENDRitic ALgorithm'. This invoked a procedure engaged in exhaustive topologically search used to arrange any given set of atoms into a consistent configuration based on their chemical valence.

density of data had an overall effect on the efficiency of these systems. Conversely a series of measures were created to report on the performance of DSS. Factors such as; accuracy, response time and explain-ability were raised as constraints to be considered before specifying courses of action [8]. Since the eighties, Artificial Intelligence (AI) applications have concentrated on problem solving, machine vision, speech, natural language processing/translation, common-sense reasoning and robot control [6]. In the nineties there was a flurry of activity using 'firmware' solutions to overcome speed and compiler complexities, however around the turn of the century, a return to distributed computing techniques has prevailed [7]. Researchers continue to explore the interaction between *Intelligence and Decision-Making* [8]. Hence, the next generation of applications began to focus on new IDT techniques, such as those described in this volume.

The field of IDT has evolved into an interdisciplinary domain of research, bridging concepts from computer science, AI, DSS, and systems engineering. Support for IDT within the Knowledge-Based Intelligent Information and Engineering Systems (KES) community continued to dominate conferences until the first KES International Symposium on IDT in 2009. This symposium series now hosts an annual conference, with the 7th aiming to bridge soft computer science techniques with innovative AI developments to enhance DSS, and Intelligent Decision Support System (IDSS). The conference provides an excellent opportunity for the novice, experts and professionals in the field to present interesting new research, results and discussions about leading edge knowledge management ideation [9, 10]. KES still promotes IDT through its parent conference,[2] the International Journal of Intelligent Decision Technologies[3] and numerous books [11–15]. These success stories include the 5th KES International Conference on Intelligent Decision Technologies, held in Sesimbra, Portugal. This conference supports a mixed-discipline society, who contribute significant skills and knowledge into current applications and theory relating to IDT.

1.2 Decision Support System

A DSS is a set of technologies that aims to improve individual or group decision making by combining knowledge from the decision maker(s) with relevant data from identified sources and applying mathematical and statistical methods and models to suggest preferred decisions. IDSS utilize advanced intelligent methods from the computer science and engineering fields to extend the applicability of DSS to complex problems and enable sophisticated capabilities such as distributed computing. These systems, then add value to the data being collected or promulgated using a knowledge-base to create an inference. For example, clinical DSS combine patient or healthcare data with professional knowledge to assist physicians and other healthcare professionals to diagnose or treat patients. By contrast, a DSS is not a

[2] See http://idt-15.kesinternational.org.

[3] See http://www.iospress.nl/journal/intelligent-decision-technologies/.

Table 1.1 Decision Support System domains categorised

Category	Domain	Example
Data mining	Data driven	Lists, data bases and data management systems
Evolutionary	Genetic algorithms	Optimisation and search spaces
Thought	Neural networks	Learning and pattern matching
Constraints	Rule based systems	Expert and knowledge based systems
Symbolic	Fuzzy logic	Transforming the ambiguity into fuzzy sets
Temporal	Case based systems	Reasoning and analogy based systems
Inductive	Machine learning	Iterative creation of dynamic rule sets

decision making system. Hence, techniques that use control systems in which no human judgement is needed are not considered DSS, although the underlying set of intelligent technologies may be similar.

DSS have matured over a number of data-based eras that can be categorised based on the degree of intelligence provided as shown in Table 1.1. This shows the method listed against each category as interpreted by Dharl and Stein [5].

1.2.1 Data-Driven

Data-driven methodologies were based on data mining techniques. They evolved with lists, databases and data warehousing, which developed into a domain of research that is still titled data mining. The inputs are based on a list of related facts (even when held in databases) that need to be associated and queried prior to being interpreted. For example, On-line Analytical Processing (OLAP), Executive Information Systems (EIS) and Geographic Information Systems (GIS) are types of data-driven DSS.

1.2.2 Genetic Algorithms

This style of data processing originated as a result of an excessive number of parameters. The exponential growth of combinatorial statistics called for a new approach to deriving answers. The use of *Darwinian theory* relating to *survival of the fittest* concept was proven to efficiently find the optimal or best solution of a given probable subset and has been adopted to solve many search space problems.

1.2.3 Neural Networks

A neural network simulates cognitive approach to learning using trial and error. It involves the creator maintaining a prediction loop from which comparisons and an adjustment process can be used to reconcile transfer functions, internal weightings and swagging functions. Forward and backward chaining neural networks have been created to minimise overall network errors.

1.2.4 Rule Based Systems

Systems like *Internist*[4] and *XCON*,[5] use a combination of knowledge management tools (ultimately termed KBS), working memory and rule interpreters[6] to discriminate between a collection of facts represented as evidence in knowledge bases and queries input by operators. Forward chaining (branching down the tree) and backward chaining (evidence matching up through working memory).

1.2.5 Fuzzy Logic

The problem with many of the existing systems is that they do not approximate information the way humans interpret their surroundings (especially RBS). Fuzzy logic introduces natural language membership functions, based on underlying truth statements represented by the Boolean values of '0' or '1'. For example, a numerical temperature reading can be expressed as gradations between 'hot' and 'cold'. This scale could also be expanded to include 'warm' or 'cool'. This enables humans to accept information (measure against a range, without being burdened with the need to process minor errors or fluctuations). The membership is transformed from *crisp sets* into *fuzzy sets*.

1.2.6 Case Based Reasoning

A Case Based Reasoning (CBR) system takes advantage of previous attempts to solve a problem or improve the accuracy of the system. Training is gained using a predefined data set and matured using new patterns as time passes. Reasoning is generated using a series of measures that are used to describe the situation within a scenario. Cases are determined using a pattern matching approach of analysis.

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[4] Internal Medicine.

[5] A Rule-Based Systems (RBS) created by DEC to manage computing customers needs.

[6] Logic source used as the control strategy.

1.2.7 Machine Learning

Rules are recursively created and connected using trees to represent possible outcomes, based on statistical patterns and algorithms. Tic-tac-toe and chess are good examples of branching and pruning to derive a number of possible results (end-means).

1.3 Intelligent Decision Support System

As intelligent technologies have matured, IDSS have incorporated new capabilities that mimic and extend human cognitive abilities in some manner. Artificial intelligence tools within a DSS can be used to reason to solve problems, plan toward a goal, remember past events, learn from experience, make sense out of ambiguous data, infer based on disparate information, and analyze to predict or optimize outcomes. For example, relevant information to a decision problem from widely distributed data can be surveyed, selected and retrieved; generalized models can be constructed from uncertain data and applied to new problems; associations can be inferred from multiple data sources; unstructured data can be analyzed and incorporated into decision making. This domain is growing rapidly to service the global enterprise and Internet enabled applications that provide access to distributed information and mobile devices.

In todays environment, information needed for decision-making tends to be distributed [16]. Networks exist within and outside of enterprises, homes, the military, government, and national boundaries. Information is segmented for logistical and security reasons onto different machines, different databases, and different systems. Informed decisions may require integration of information from various internal and/or external sources. As enterprises become multi-national, information tends to be distributed geographically across national boundaries and yet collectively required for decision making. The speed of communication in the 21st century requires fast response to be competitive, so the integration of information for decision-making needs to be fast and accurate. Technology can aid decisions that are complex and semi-structured by integrating information flow with analysis using both conventional and artificial intelligence techniques. Agents can assist these efforts by such actions as anticipating the needed information, using the Internet to collect data, and assisting the user in analysis [9].

As an example, intelligent agents can facilitate information processing and user interaction. Agents may serve as task assistants to the user, consultants, or as global assistants that collect information. Agents as task assistants may, for example, retrieve specific data requested by the user, schedule meetings, or work with other Agents on behalf of the user. Agents as consultants could be used for such operations as querying the user, presenting personalised views of data, or ascertaining the information needed for a decision. Agents as global assistants may access distributed information

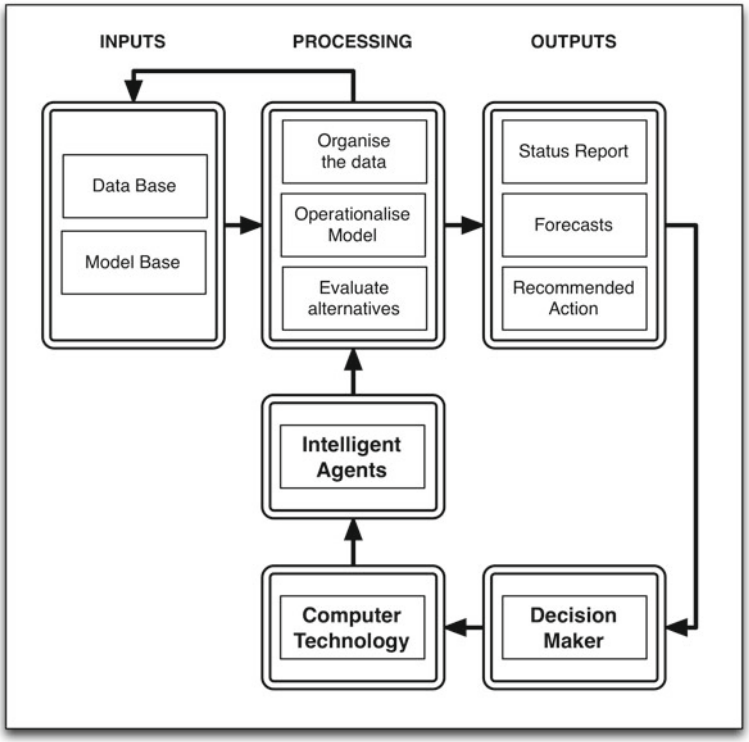

Fig. 1.1 Components of an IDDS enabled by agents [17]

in the enterprise, maintain a current status for the system by updating information in real-time, or use the Internet to bring external information to the decision problem. The major components of an agent-mediated IDSS are are shown in Fig. 1.1 with agents as integral components of the IDSS.

The IDSS has inputs that include the database(s) needed for the decision problem and a model base that includes, for example, the statistical techniques needed for the analysis [18]. Agents may be used to interact with the user or to learn what types of data are needed and assemble them. The processing component permits analysis of the data, including what-if scenarios that the user may desire. During processing, agents may acquire the needed models or consult with the user. The feedback loop indicates interaction between the processing and input components such as real-time updating or user requirements for additional information. The output component provides the result of the analysis to the user and possibly recommendations about the decision. In this component agents may, for example, personalise the output to particular user so that it is presented in a desired way or so that drill-down information is available. The decision maker and the computer technology are components of the overall system and are recognised explicitly in the diagram. The decision maker is

usually a human user, although robotic applications increasingly utilise automated decisions that may be implemented with agents [17].

IDSS use a variety of intelligent techniques to meet the demands of the decision problem. For example, Artificial Neural Network (ANN) are useful for their universal approximation capabilities. A major advantage of ANN compared to other methods is their ability to approximate any bounded continuous function to any arbitrarily small approximation error [19]. Thus, ANN are universal approximators and do not make any assumption about the underlying structure or association between a set of inputs and outputs. In addition, ANN learn as they encounter new input-output data so they can be updated and modified in near real-time to incorporate new information. In cases in which data cannot be described as either binary (0 or 1) or with a specific value, fuzzy logic provides the ability to deal with uncertainty. Decision makers are also interested in future states that are not based on past knowledge. In these case, genetic algorithms offer the opportunity to optimize an output for a decision problem by comprehensively exploring the search space to find the global maximum [19]. New intelligent techniques have also shown the ability to discover patterns or associations in big data, automatically apply that knowledge to new situations, and provide decisional guidance. Indeed, the many exciting and useful applications of IDSS demonstrate the rich potential of this field of research.

1.4 Contributions

All contributions in this book were sourced from authors supporting the series of activities associated with Intelligent Decision Technologies (IDT) conference under the auspices of Knowledge Engineering Systems International (KES). A call for chapters was issued following the 5th Conference on Intelligent Decision Technologies, held at Sesimbra, Portugal on 26–28 June 2013. Based on the submissions received, selected authors were invited to enter a competitive process prior to acceptance and extend their papers into a book chapter. Following an iterative review process, an innovative subset of topics and techniques are included in this volume. A full list of chapters is show in Table 1.2.

This book seeks to inform and enhance the exposure of research on intelligent systems and intelligent technologies that utilize novel and leading-edge techniques to improve decision-making. Each chapter concentrates on the theory, design, development, implementation, testing or evaluation of IDT techniques or applications. These approaches have the potential to support decision making in the areas of management, international business, finance, accounting, marketing, healthcare, production, networks, traffic management, crisis response, human interfaces and, military applications. A guide to understand some of these trends and future directions intelligent decision-making technology is provided by Multi-agent Systems (MAS) [9]. Several of the editors also highlighted their thoughts about future directions of IDT in 2008 [10]. Although the 2008 article focuses on building a decision-support framework using MAS to operate as teams, these trends have been realised around the world.

Table 1.2 List of topics within this contribution

Chapters	Title
2	Asset Management Strategies: Risk and Transaction Costs in Simulation
3	Decision Support System for Energy Savings and Emissions Trading in Industrial Scenarios
4	A Parsimonious Radial Basis Function-Based Neural Network for Data Classification
5	Personalized Intelligent Mobility Platform: An Enrichment Approach using Social Media
6	Exploiting Alternative Knowledge Visualizations and Reasoning Mechanisms to Enhance Collaborative Decision Making
7	Decision-Making in a Distributed and Dynamically Scalable Environments
8	Enhancing the Tactical Data Link Decision Support System
9	AC^3M: The Agent Coordination and Cooperation Cognitive Model
10	Wind Rendering in 3D Modeling Landscape Scenes
11	Extending the Service Oriented Architecture to include a decisional aspect
12	An extended dependability case to share responsibility knowledge
13	Designing a Hybrid Recommendation System for TV Content
14	Incompleteness and fragmentation: Possible Formal Cues to cognitive processes behind Spoken Utterances

Several examples provided in this volume include: 'assessing Asset Management Strategies' in Chap. 2 and 'Knowledge Visualization Decision-Making in a Distributed and Dynamically Scalable Environments' in Chap. 6.

Computational social science involves the use of agent-based modeling and simulation to study complex issues [20]. It is related to a variety of techniques, methodologies and approaches. There are two accepted approaches, these include 'synthesis' and 'analysis'. Simulation generally involves stochastic (deterministic), continuous (discrete) and dynamic (event-based) simulation. The later typically involves MAS, incorporated in distributed artificial intelligence components. Chapter 2 provide background knowledge on MAS, Mathematical modelling, an extension of the transaction costs, its implementation using JADE.[7] This shows that the probability of an agent switching from a fundamental to technical behavior depends on the historic trend of assets prices. Šperka et al. hypothesis for this research was based previous simulation results and focused on the fundamental rules [21]. Future effort extends to investigating risk and parameterization of the model in order to prove that the Tobin tax has a positive impact on the stability of financial market.

[7] See http://jade.tilab.com.

Emission Trading System (ETS) have been subject to significant rigor over the past decade. The volume of data being collected has increased dramatically. Government policy continues to influence industrial compliance and legislation, forcing companies to collect data to measure both energy savings and carbon emissions. Chapter 3 proposes a decision support approach to determine societal reactions and any adjustments required to the ETS. Marques and Neves-Silva [22] implement a multi-criteria decision analysis using MACBETH. They use a CBR approach that is stimulated via probabilistic analysis and describe multiple case studies used to analyse their concepts. The results obtained provide excellent correlation which is encouraging the utilization of this technique in future applications.

ANN have been used to conduct supervised learning in AI application to solve problems where regression, classification and time series prediction are required. Radial Basis Function (RBF) algorithms were introduced as a simplified approach to support approximation functionality to interpret forward selection [23]. Chapter 4 introduced a RBF neural network that incorporates greedy insertion behavior with a dynamic decay adjustment. Tan et al. [24] incorporate this algorithm in an application they call Radial Basis Function Network with the Dynamic Decay Adjustment (RBFNDDA). Hidden nodes of RBFNDDA are re-organized through a supervised Fuzzy ArtMAP (FAM) classifier, and those parameters are adapted using the Harmonic Means (HM) algorithm. They discuss FAM, the experiment, the comparative performance against other classifiers prior to summarising their results. They indicate that the proposed model is able to produce a compact structure network with high performance when classifying subject data.

Intelligent Transportation Systems (ITS) refer to a variety of mechanisms used to support safe and coordinated use of transport networks. Some countries are experimenting with innovative services that deliver ‘smarter’ transport and traffic management systems. These include: infrastructure, platforms, monitoring, rescue, evacuation, mobility and management. Europe is leading this innovation under EU Directive 2010/40/EU (7 July 2010). Chapter 5 present a technical approach for developing a personalized mobility knowledge base. This is supported by mechanisms for extracting and processing tweets related with traffic events by commuters. Costa et al. use a step-wise approach to enrich their knowledge model using heterogeneous data sources derived from commuter Personal Digital Assistants (PDAs) [25]. They progressively introduce their concept and objectives, which are supported using existing literature. The methodology discusses base graphs, smart graphs and personalized smart graphs. Using a formalized vocabulary, the authors apply real-time traffic events from twitter prior to making their comparison. At present, their results do not address the final conclusion, but do form the basis for the formalization of the domain knowledge being acquired. Ongoing effort is being funded under EU FP7 MobiS project.

Engaging in collaborative decision making in today’s knowledge intensive and complex environments is a challenging task. The diversity of these environments and the associated plurality of decision makers perceptions require multi-disciplined support. Chapter 6 reports on an innovative approach that offers a number of interrelated visualization tools to facilitate the knowledge exchange and during a collabora-

tive decision making process. The authors define the concept of multi-criteria decision making, the dicode approach, and scenarios to explain its use. Christodoulou et al. believe that the major benefit of this work is the implementation of a number of mechanisms capable of displaying the result of the decision making process with a user-friendly what-if analysis [26]. These visualizations incorporate suitable reasoning mechanisms that exploit human to machine understandable knowledge and aid stakeholders towards reaching consensus and collective decision.

Chapter 7 discusses interoperability within and across ubiquitous platforms. Modern computing operations have evolved to a level where plug 'n' play protocols can be used to invoke common interfaces. Designers are able to create dynamic interfaces using reflectance to effective and efficient conduct distributed decision-making. Many applications now use mobile agents to support web-centric activities. This capability enables decentralised data mining and supports IDSS. Tweedale provides a brief description relating to the evolution of data processing, from Lisp to IDSS, prior to discussing methodologies used to support dynamic environments [27]. This chapter seeds many ideas for researchers who are increasingly being asked to provide more adaptive intelligent services.

Defence employs Tactical Data Links (TDLs) to maintain situation awareness of assets during a mission and to convey the intent of command and control information. Network Managers are use to optimise the link. A DSS is already used to enhance their ability to process the vast amount of information generated in real-time. The introduction of a DSS to support an Network Management System (NMS) is expected to reduce the burdens on the TDL Network Manager (TDLNM) and also mitigate the effects of operators who may have reduced experience. Sioutis and Dominish use Cognitive Work Analysis (CWA) to acquire subject knowledge that will ultimately be incorporated into a DSS to compliment the experience required to efficiently operate the network effectively [28]. Chapter 8 discusses the TDL network, the process of managing the network, the decision processes used, design patterns and a suitable agent architecture to be used to design a DSS service. Although, this research is time consuming, four modules have already been identified for future implementation.

To promote IDT within industry it will be necessary to emulate the human ability to coordinate and cooperate. Here coordination is referred to as the management of the interdependencies of activities and cooperation as voluntary relationship of two parties to share resources used to achieve a common goal. Chapter 9 describes the evolution of the Agent Coordination and Cooperation Cognitive Model (AC^3M) and its successful application in team automation when operating within dynamic environments. The aim of AC^3M is to emphasise how Coordination and Cooperation ($CO–O^2$) models improve an agent's autonomy and decision-making capabilities. The AC^3M's $CO–O^2$ model ensures that a decision to act can be made quickly and effectively. Consoli uses a Stimulus/Perceptor framework to envoke coordination and cooperation on two levels: Intelligence, surveillance and reconnaissance, and command and control. The author highlights the importance of identifying the link between an agent's belief, desires and intentions with coordination and cooperation [29]. She also believes she has proven that AC^3M can enhance the automation of a team and their situational awareness. This was demonstrated in an application to

coordinate multiple flight mission systems and promote cooperation between components of individual Unmanned Aerial Vehicles (UAVs).

A space colonization algorithm was applied to make compact and realistic tree models. Wind rendering is a necessary procedure in modeling realistic scenes with minimal computational costs. Chapter 10 uses various tree shapes and wind parameters to simulate three levels of wind conditions (weak, mild and storm-force). Favorskaya and Tkacheva describes the process of transforming a 3D cloud of laser scanned scenery points into digital models [30]. They explain the rendering process for each wind strength and the experiments used to verify the process. This OpenGL tool successfully restores a view of the earths surface and the natural objects within scenes landscape. There experiments show the new architecture accurately delivers decisional needs to the enterprise providing greater agility. Future plans indicate this research will integrate the decisional aspects in cloud-base computing applications.

The emergence of Service-Oriented Architecture (SOA) components within organisational applications is increasingly being used to provide decision processes with support systems. Boumahdi and Chalal introduce a meta-model called Decisional Model of Service (DMoS) using three views to each concept (business, information and decision) [31]. Chapter 11 provides a case study that illustrates an inventory management system using the proposed architecture. The authors provide background on current decision-making processes within an organization, prior to linking each concpet to their architectural dimensions. In the future works, the integration of decisional aspect in cloud computing is envisaged.

Information related to dependability is important knowledge that must be shared among stakeholders. Existing methods cannot clearly describe dependability cases using relationship between a claim and a responsibility. Chapter 12 introduces a proposal that uses the d* framework to define relationship between attributes for sharing knowledge and those for achieving agreements among stakeholders. Saruwatari et al. use three example applications to deomonstrate the effectiveness of the d* framework. They use a meta-model to map responsibility attributes [32]. The case studies use a simple graphical notation to mapan elevator, AP download and LAN device management systems. Future plans include evaluating the effectiveness of the proposed concept using ‘practical’ dependability cases.

Traditional TV recommendation systems are based on an individual’s viewing activity and at present, only recommend program choices. These systems have not be modified to include Smart TV capabilities. Given access to the internet, applications on Smart TV’s can be used to provide a hybridised recommendation system. This would include, personal preferences, other users viewing habits and information related to additional content, such as; TV programs, movies, and even music. Chapter 13 includes a detailed history of existing systems, prior to describing the proposed framework for component analysis and learning system. Chang et al. discuss how these components can be used to identify diversity, novelty, explanation and recommendations [33]. The three components presented will be incorporated into a physical recommendation system and additional research conducted to verify the process.

Spontaneous communication is an essential element of social speech. Natural Language Programming (NLP) is difficult because the sounds you hear and words you read are often hard to identify using speech. Currently synthesised speech is often fragmented and not considered to be real unless grammatically correct. Chapter 14 presents numerous forms of generating dialogue using their syntax, prosody and overall multi-modality for the Hungarian corpus. The research aims at improving the robustness of the spoken form of natural language technology. Hunyadi discuss a generative model of human to human communication followed by a schema supporting a generative Theoretical-Technological speech model [34]. They identify the minimum requirements (building blocks) required to create structured speech non-verbal modalities of Prosody in Hungarian speech. They then explore duration, intonation and intensity before creating a temporal alignment of gestures and clauses. Further work is required to gain complete insight into the real nature of multimodal communication. This understanding is considered essential prior to researchers successfully generating human to machine interactions.

1.5 Conclusion

The editors believe that this book represents a valuable resource to the novice, students, professionals and anyone seeking further information about knowledge management and innovative methods of employing Intelligent Decision-Making Technologies to deliver sound knowledge management to consumers. The editors recommend that the reader uses both the table of contents, list of acronyms and index to help navigate each topic. For those focusing on specific topics, it is recommended that the reader also explores the surrounding chapters for associated tools, techniques or methodologies. We hope you enjoy the content and are as inspired as much as the editors and subject matter experts with the potential of IDT to improve our world. All authors would be delighted to field questions or discuss their research with you. Their contact details are provided in the 'List of Contributors' and at the bottom of the first page of each chapter.

References

1. Bachman, C.W.: Integrated data store: the information processing machine the we need! In: General Electric Computer Users Symposium, General Electric, New York (1962)
2. Buchanan, B.G., Lederberg, J.: The Heuristic DENDRAL program for explaining empirical data. In: Technical Report, Stanford University, Stanford, CA, USA (1971)
3. Yen, J., Fan, X., Sun, S., Hanratty, T., Dumer, J.: Agents with shared mental models for enhancing team decision makings. Decis. Support Syst. **41**(3), 634–653 (2006)
4. Bigus, J.P., Bigus, J.: Constructing Intelligent Agents Using Java. Professional Developer's Guide Series. Wiley, New York (2001)
5. Dhar, V., Stein, R.: Intelligent Decision Support Methods: The Science of Knowledge Work. Prentice-Hall Inc, Upper Saddle River (1997)

6. Rich, E., Knight, K.: Artificial Intelligence. McGraw-Hill College, New York (1991)
7. Jain, L., Tweedale, J.: Research directions in the KES centre. In: Chan, C.C., Grzymala-Busse, J., Ziarko, W. (eds.) Rough Sets and Current Trends in Computing. Lecture Notes in Computer Science, vol. 5306, pp. 13–20. Springer, Berlin (2008)
8. Tweedale, J.W., Jain, L.C. (eds.): Recent Advances in Knowledge-based Paradigms and Applications: Enhanced Applications Using Hybrid Artificial Intelligence Techniques. Advances in Intelligent Systems and Computing, vol. 234. Springer, Berlin (2013)
9. Tweedale, J., Ichalkaranje, N., Sioutis, C., Jarvis, B., Consoli, A., Phillips-Wren, G.: Innovations in multi-agent systems. J. Netw. Comput. Appl. **30**(3), 1089–1115 (2006)
10. Tweedale, J., Sioutis, C., Phillips-Wren, G.E., Ichalkaranje, N., Urlings, P., Jain, L.C.: Future directions: building a decision making framework using agent teams. In: Phillips-Wren, G.E., Ichalkaranje, N., Jain, L.C. (eds.) Intelligent Decision Making: An AI-Based Approach. Studies in Computational Intelligence, vol. 97, pp. 387–408. Springer, New York (2008)
11. Nakamatsu, K., Phillips-Wren, G., Jain, L.C., Howlett, R.J. (eds.): New Advances in Intelligent Decision Technologies: Results of the First KES International Symposium IDT, Studies in Computational Intelligence, vol. 199. Springer, Heidelberg (2009)
12. Phillips-Wren, G. (ed.): Advances in Intelligent Decision Technologies: Proceedings of the 2nd KES International Symposium IDT, in Smart Innovation, Systems and Technologies, vol. 4. Springer, Heidelberg (2010)
13. Watada, J., Phillips-Wren, G., Jain, L., Howlett, R. (eds.): Proceedings of the 3rd International Conference on Intelligent Decision Technologies: Smart Innovation, Systems and Technologies, vol. 10. Springer, Heidelberg (2011)
14. Watada, J., Watanabe, T., Phillips-Wren, G., Howlett, R.J., Jain, L.C. (eds.): Intelligent Decision Technologies: Proceedings of the 4th International Conference on Intelligent Decision Technologies, in Smart Innovation, Systems and Technologies, vol. 16. Springer, Heidelberg (2012)
15. Neves-Silva, R., Watada, J., Phillips-Wren, G. (eds.): Intelligent Decision Technologies: Proceedings of the 5th KES International Conference on Intelligent Decision Technologies. IOS Press, Amsterdam (2013)
16. Du, H., Jia, X.: A framework for web-based intelligent decision support enterprise. In: 23rd IEEE International Conference on Distributed Computing Systems Workshops, pp. 958–961. IEEE Press, New York (2003)
17. Phillips-Wren, G., Forgionne, G.: Advanced decision-making support using intelligent agent technology. J. Decis. Syst. **11**, 165–184 (2002)
18. Phillips-Wren, G.: AI tools in decision making support systems: a review. Int. J. Artif. Intell. Tools **21**(2), 1–13, 1240005 (2012)
19. Pedrycz, W., Gomide, F.: Fuzzy Systems Engineering: Toward Human-Centric Computing. Wiley, Hoboken (2007)
20. Tweedale, J.W., Jain, L.C. (eds.): Advanced Techniques for Knowledge Engineering and Innovative Applications: 16th International Conference, KES 2012, San Sebastian, Spain, 10–12 Sept 2012. Revised Selected Papers. Communications in Computer and Information Science, vol. 246. Springer, Berlin (2013)
21. Šperka, R., Spišák, M., Górecki, J.: Stability of financial market: the introduction to the java simulation of agent-based model. In: Neves-Silva, R., Watada, J., Phillips-Wren, G., Jain, L.C., Howlett, R.J. (eds.) Intelligent Decision Technologies. Frontiers in Artificial Intelligence and Applications, vol. 241, pp. 380–389. IOS Press, Amsterdam (2013)
22. Marques, M., Neves-Silva, R.: Approach for decision support for energy savings and emissions trading based on industrial requirements. In: Neves-Silva, R., Watada, J., Phillips-Wren, G., Jain, L.C., Howlett, R.J. (eds.) Intelligent Decision Technologies. Frontiers in Artificial Intelligence and Applications, vol. 255, pp. 74–83. IOS Press, Amsterdam (2013)
23. Broomhead, D., Lowe, D.: Multivariate functional interpolation and adaptive networks. Complex Syst. **2**, 321–355 (1988)
24. Tan, S.C., Lim, C.P., Watada, J.: A hybrid rbf-art model and its application to medical data classification. In: Neves-Silva, R., Watada, J., Phillips-Wren, G., Jain, L.C., Howlett, R.J.

(eds.) Intelligent Decision Technologies. Frontiers in Artificial Intelligence and Applications, vol. 255, pp. 21–30. IOS Press, Amsterdam (2013)
25. Costa, R., Figueiras, P., Maló, P., Jermol, M., Kalaboukas, K.: Mobis—personalized mobility services for energy efficiency and security through advanced artificial intelligence techniques. In: Neves-Silva, R., Watada, J., Phillips-Wren, G., Jain, L.C., Howlett, R.J. (eds.) Intelligent Decision Technologies. Frontiers in Artificial Intelligence and Applications, vol. 241, pp. 296–306. IOS Press, Amsterdam (2013)
26. Christodoulou, S., Karacapilidis, N., Tzagarakis, M.: Advancing collaborative decision making through alternative visualizations and reasoning mechanisms. In: Neves-Silva, R., Watada, J., Phillips-Wren, G., Jain, L.C., Howlett, R.J. (eds.) Intelligent Decision Technologies. Frontiers in Artificial Intelligence and Applications, vol. 241, pp. 38–47. IOS Press, Amsterdam (2013)
27. Tweedale, J., Jain, L.: Multilingual agents in a dynamic environment. In: Nakamatsu, K., Phillips-Wren, G., Jain, L., Howlett, R. (eds.) New Advances in Intelligent Decision Technologies. Studies in Computational Intelligence, vol. 199, pp. 193–202. Springer, Berlin (2009)
28. Sioutis, C., Dominish, D.: Developing intelligent agents with distributed computing middleware. In: Watada, J., Phillips-Wren, G., Jain, L., Howlett, R. (eds.) Intelligent Decision Technologies. Smart Innovation, Systems and Technologies, vol. 10, pp. 863–872. Springer, Berlin (2011)
29. Consoli, A., Tweedale, J., Jain, L.: Defining a decision-support framework in AC^3M. In: Nakamatsu, K., Phillips-Wren, G., Jain, L., Howlett, R. (eds.): IDT'09: First KES International Symposium in Intelligent Decision Technologies, pp. 203–212 (2009)
30. Favorskaya, M., Tkacheva, A.: Rendering of wind effects in 3D landscape scenes, 17th international conference in knowledge based and intelligent information and engineering systems. Proc. Comput. Sci. **22**, 1229–1238 (2013)
31. Boumahdi, F., Chalal, R.: Soada: service oriented architecture with a decision aspect, 17th international conference in knowledge based and intelligent information and engineering systems. Proc. Comput. Sci. **22**, 340–348 (2013)
32. Saruwatari, T., Hoshino, T., Yamamoto, S.: Method to share responsibility knowledge of dependability cases, 17th international conference in knowledge based and intelligent information and engineering systems. Proc. Comput. Sci. **22**, 1073–1082 (2013)
33. Chang, N., Irvan, M., Terano, T.: A TV program recommender framework, 17th international conference in knowledge based and intelligent information and engineering systems. Proc. Comput. Sci. **22**, 561–570 (2013)
34. Hunyadi, L.: Incompleteness and fragmentation in spoken language syntax and its relation to prosody and gesturing: cognitive processes versus possible formal cues. In: 2013 IEEE 4th International Conference on Cognitive Infocommunications (CogInfoCom), Dec 2013, pp. 211–218