In the last few years, we have not only experienced a tremendous explosion in the complexity of technical systems, enterprise structures, supply chains, and customer demands, but also market challenges, balance (and its dynamics) of power between the different stakeholders of companies, environmental and political systems. These trends require us to implement the optimization, adaptation (learning), and the overall behavior of socio-economic systems in a much more decentralized and networked manner, which will encompass more bottom-line oriented approaches than we usually employ today. Besides the necessary cultural changes in our economies (and societies), this will also require new construction principles, architectures, and behaviors for our information technology-based systems.

Intelligent agents are software entities that perform a set of tasks on behalf of a user with some degree of autonomy. They find applications in a variety of domains including: Internet-based information systems, adaptive (customizable) software systems, autonomous mobile and immobile robots, data mining and knowledge discovery, smart systems (smart homes, smart automobiles, etc.), decision support systems, and intelligent design and manufacturing systems. Current research on intelligent agents and multi-agent systems builds on developments in several areas of computer science including: artificial intelligence (especially agent architectures, machine learning, planning, distributed problem-solving), information retrieval, database and knowledge-based systems, and distributed computing.

A multi-agent system (MAS) is defined as a loosely coupled network of problem solvers that work together to solve problems that are beyond the individual capabilities or knowledge of each problem solver. The increasing interest in MAS research is due to significant advantages inherent in such systems, including their ability to solve problems that may be too large for a centralized single agent, provide enhanced speed and reliability and tolerate uncertain data and knowledge. Some of the key research issues related to problem-solving activities of agents in a MAS are in the areas of coordination, negotiation and communication. Coordination is the process by which an agent allocates tasks to other agents and synthesizes the results from these agents to generate an overall output. Negotiation is the process by which agents solve their conflicts and reach a compromise. For coordination and negotiation, they need to communicate with one another and hence the system should provide a general communication mechanism.
Multi-agent technology is one of the enabling technologies that provides appropriate concepts, architectures and protocols for applications with challenging flexibility demands. Based upon the results of the last twenty years of research, a MAS flexibility framework has identified and formalized with six dimensions: qualitative flexibility, quantitative flexibility, problem solving flexibility, economic flexibility, time flexibility and configuration flexibility. These flexibility concepts support the systematic description, analysis, and explanation of MAS flexibility, and they support the design of flexibility profiles into multi-agent system-based applications.

Considerable research has been carried out in the area of intelligent agents and multi-agent systems and a myriad of applications have been built using agents. This book discusses a number of agent-based applications developed in a variety of domains such as e-learning, online auction, Web services, and semantic technologies. The following sections briefly outline the different applications discussed in various chapters of this book.

**Book Organization**

**Section I: Agents and E-Learning**

This section presents four chapters that discuss how intelligent agents can be used in e-Learning. Chapter I by Schwingel, Vossen, and Westerkamp titled “Securing the Infrastructure for Service-Based E-Learning Environment” discusses e-learning environments and their system functionalities. The LearnServe system under development at the University of Muenster builds on the assumption that a typical learning system is a collection of activities or processes that interact with learners and suitably chosen content, the latter in the form of Learning Objects. It divides the main functionality of an e-learning system into a number of stand-alone applications or services, thereby giving learners a higher flexibility of choosing content and functionalities to be included in their learning environment. It maintains user identity and data across service and server boundaries. This chapter presents an architecture for implementing user authentication and the manipulation of user data across several Web services. In particular, it demonstrates how to exploit the SPML and SAML standards so that cross-domain single sign-on can be offered to the users of a service-based learning environment.

In Chapter II titled “Intelligent Agents for E-Learning,” Bruns and Dunkel propose a software architecture for a new generation of advisory systems using Intelligent Agent and Semantic Web technologies. In the proposed architecture the domain knowledge is semantically modeled by means of XML-based ontology languages such as OWL. Using an inference engine the agents reason on the basis of their knowledge to make decisions or proposals. The agent knowledge consists of different types of data: private data, which has to be protected against unauthorized access, and publicly accessible data spread over different Web sites. Comparable to a real consultancy situation, an agent only reveals sensitive private data if it is indispensable for finding a solution. In addition, depending on the actual consultancy situation each agent dynamically expands its knowledge base by accessing OWL knowledge sources from the Internet. The usefulness of the approach is demonstrated through the implementation of an advisory system whose objective is to develop virtual student advisers
that render support to university students in order to successfully organize and perform their studies.

Chapter III titled “Assisting Learners to Dynamically Adjust Learning Processes by Software Agents” by Pan and Hawryszkiewycz, focuses on the application of software agents in assisting learners to dynamically adjust learning processes. Unlike pedagogical agents, the agents in this application do not hold domain knowledge but simply assist learners to get through the learning process by a variety of supportive services. They assist learners to develop personalized preferred learning plans and guide them to dynamically align learning towards their goals. In this chapter, the online learning process is first investigated and an approach to assisting learners to dynamically adjust learning processes is outlined. Then the structure of the UOL (Unit of Learning) database that provides links between a practical learning scenario and the required services is explored. A multi-agent architecture for realizing the services is configured and the roles of the involved agents are described. After that, the related agent algorithms for guiding learners to dynamically adjust learning processes are described.

In Chapter IV by Hamdi, titled “Combating Information Overload by Means of Information Customization Systems,” the author argues that the evolution of the Internet into the Global Information Infrastructure has led to an explosion in the amount of available information. The result is the “information overload” of the user, i.e., users have too much information to make a decision or remain informed about a topic. Information customization systems allow users to narrowcast what they are looking for and get information matching their needs. The value proposition of such systems is reducing the time spent looking for information. Hamdi points out that information customization could be best done by combining various artificial intelligence technologies such as collaborative filtering, intelligent interfaces, agents, bots, Web mining, and intermediaries. MASACAD, the system described in this chapter, is an example of an information customization system that combines many of the technologies already mentioned and others to approach information customization and combat information overload.

Section II: Agents and Online Auction

This section contains two chapters that discuss how agents can be implemented within online auctions and another chapter that describes the characteristics of user interface agents. Chapter V titled “An Agent-Oriented Perspective on E-Bidding Systems” by Jureta, Kolp, and Faulkner indicates that a high volume of goods and services is being traded using online auction systems and that the growth in size and complexity of architectures to support online auctions requires the use of distributed and cooperative software techniques. They argue that in this context, the agent software development paradigm is appropriate both for their modeling, development and implementation. This chapter proposes an agent-oriented patterns analysis of best practices for online auction. The patterns are intended to help both IT managers and software engineers during the requirement specification of an online auction system while integrating the benefits of agent software engineering.

Chapter VI titled “Implementing Seller Agent in Multiple Online Auctions” by Anthony points out that very little work has been done on the seller’s strategy for online auctions. In any online auction, the final selling price of the item is dependent on several factors such as the number of bidders participating in the auction, how much each bidder is will-
ing to pay for the product, how many online auctions are selling the same item as well as the duration of each auction. Each item to be auctioned off has a reserved price set by the seller. Setting the reserved price too high for the item will result in the item not being sold and setting the price too low may result in profit reduction or even loss. Deciding on the reserved price of an item to be auctioned off is not a straightforward decision. This chapter reports on a preliminary implementation of a seller agent that recommends a reserved price for a given item to be auctioned off by the seller. The seller agent’s objective is to suggest a reservation price that guarantees the sale of the item within a given period (as required by the seller) with a profit.

Serenko discusses interface agents in Chapter VII titled “The Importance of Interface Agent Characteristics from the End-User Perspective.” Specifically, this chapter reports on an empirical investigation of user perceptions of the importance of several characteristics of interface agents. Interface agents are software entities that are incorporated in various computer applications including electronic mail systems. There are several characteristics of interface agents that require special attention from agent developers. In order to identify the significance of these characteristics, a group of the actual users of an e-mail interface agent was surveyed. The results indicate that information accuracy and the degree of the usefulness of an agent are the most salient factors, followed by user comfort with an agent, the extent of user enjoyment, and visual attractiveness of an agent.

Section III: Agents and Web services

This section discusses intelligent agents and Web services. Chapter VIII by Ramírez and Brena is titled “Multiagent Systems and Web services in Enterprise Environments.” It discusses the general aspects related to utilization of multi-agent systems in Enterprise environments with special emphasis on the integration architectures enabled by Web Service technologies. The authors present a decoupled architectural approach that allows Software Agents to interoperate with enterprise systems using Web services. The proposed solution leverages existing technologies and standards in order to reduce time-to-market and increase the adoption of agent-based applications. The authors discuss some case studies of knowledge-oriented Web services that have been designed using their approach and outline some current research and business concerns for the field.

Chapter IX titled “A Service Discovery Model for Mobile-Agent Based Distributed Data Mining” by Li and Song proposes a new model for solving the database service location problem in the domain of mobile agents by implementing a Service Discovery Module based on Search Engine techniques. As a typical interface provided by a mobile agent server, the Service Discovery Module improves the decision ability of mobile agents with respect to information retrieval. This research is part of the IMAGO system—an infrastructure for mobile agent-based data mining applications. This chapter focuses on the design of an independent search engine, IMAGOSearch and discusses how to integrate service discovery into the IMAGO system, thus providing a global scope service location tool for intelligent mobile agents.

In Chapter X, Serhani, Badidi, Benharref, Dssouli and Sahraoui discuss service quality. This chapter titled “Integration of Management of Quality of Web services in Service Oriented Architecture,” emphasizes that quality of Web services (QoWS) management has witnessed considerable interest in recent years and that most of the existing works regarding this is-
sue do not provide support for the overall QoWS management operations. Some of these works propose QoWS solutions for only basic Web services while others propose solutions for composite Web services. In this chapter, the authors extend the service oriented architecture (SOA) with a framework for QoWS management in which services may be basic or composite Web services. The framework uses a layered approach to provide support for the most common QoWS management operations, which include QoWS specification, QoWS verification, QoWS negotiation, and QoWS monitoring.

Section IV: Semantic Technologies

This section discusses semantic technologies, Semantic Web, and privacy preserving data mining algorithms. In Chapter XI, titled “Using Semantic Technologies for the Support of Engineering Design Processes,” Brandt, Schlüter, and Jarke present a new integrated approach to design process guidance based on capturing the process traces in a Process Data Warehouse (PDW). Both the products to be designed and the corresponding process steps are structured and stored as extended method traces. This trace capture facilitates the processing and subsequent reuse of the information through a process-integrated development environment. The concept of the PDW has been evaluated in several engineering design case studies. One of those, which focuses on the conceptual design of a chemical production plant, is described in detail.

Chapter XII by Cardoso, Fonseca de Souza, and Salgado titled “Using Semantic Web Concepts to Retrieve Specific Domain Information from the Web,” points out that the Semantic Web can be described as the Web’s future once it introduces a set of new concepts and tools. For instance, ontology is used to insert knowledge into contents of the current WWW to give meaning to such contents. This allows software agents to better understand the Web’s content meaning so that such agents can execute more complex and useful tasks to users. This chapter introduces an architecture that uses some Semantic Web concepts allied to Regular Expressions (REGEX) in order to develop a system that retrieves/extracts specific domain information from the Web. A prototype, based on the architecture, has been developed to find information about offers announced on supermarket Web sites.

In Chapter XIII titled “On the Problem of Mining Phrase Definition from Item Descriptions,” Nguyen and Davulcu discuss a system for improving the “findability” of products. Most search engines perform their text query and retrieval using keywords. However, vendors cannot anticipate all possible ways in which shoppers search for their products. In fact, many times, there may be no direct keyword match between a search phrase and descriptions of products that are perfect “hits” for the search. A highly automated solution to the problem of bridging the semantic gap between product descriptions and search phrases used by Web shoppers is developed. By using scalable information extraction techniques from Web sources and a frequent item-set mining algorithm, their system can learn how meanings can be ascribed to popular search phrases with dynamic connotations. By annotating the product databases based on the meanings of search phrases mined by our system, catalog owners can boost the findability of their products.

Finally, Chapter XIV discusses privacy preserving data mining algorithms. This chapter is titled “Improved Privacy: Preserving Techniques in Large Databases,” and authored by Abumani and Nedunchezhian. They argue that while data mining may help in strategic decision-making as well as many other applications, it also has a few demerits apart from
its usefulness. Sensitive information contained in the database may be brought out by the
data mining tools. Different approaches are being utilized to hide the sensitive information.
The work presented in this chapter applies a novel method to access the generating transac-
tions with minimum effort from the transactional database. It helps in reducing the time
complexity of any hiding algorithm. The theoretical and empirical analysis of the algorithm
shows that hiding of data using this approach performs association rule hiding quicker than
other algorithms.
Effective use of intelligent information technologies becomes a necessary goal for all, and
an outstanding collection of latest research associated with intelligent agent applications
and Web services is presented in this book. Use of intelligent information technologies will
greatly improve productivity and change how we view computing.

Vijayan Sugumaran

Editor-in-Chief