Preface

Many complex problems, such as financial investment planning, involve many different components or sub-tasks, each of which requires different types of processing. To solve such complex problems, a great diversity of intelligent techniques, including traditional hard computing techniques (e.g., expert systems) and soft computing techniques (e.g., fuzzy logic, neural networks, and genetic algorithms), are required. These techniques are complementary rather than competitive, and thus must be used in combination and not exclusively. This results in systems called *hybrid intelligent systems*. In other words, hybrid solutions are crucial for complex problem solving and decision-making. However, the design and development of hybrid intelligent systems is difficult because they have a large number of parts or components that have many interactions. Existing software development techniques cannot manage these complex interactions efficiently as these interactions may occur at unpredictable times, for unpredictable reasons, and between unpredictable components.

An *agent* is an encapsulated computer system that is situated in a certain environment and that is capable of flexible, autonomous action in that environment in order to meet its design objectives. A multi-agent system (MAS) can be defined as a loosely coupled network of entities that work together to make decisions or solve problems that are beyond the individual capabilities or knowledge of each entity. These entities, or agents, are autonomous and may be heterogeneous in nature. Thus, from a multi-agent perspective, agents in MASs are autonomous and can engage in flexible, high-level interactions. The flexible nature of interactions means that agents can make decisions about the nature and scope of interactions at run-time rather than design time. Such agents are good at dealing with complex, dynamic interactions. They offer a new and often more appropriate route to the development of complex systems, especially in open and dynamic environments. It is now widely recognized that *interaction* is probably the single most important characteristic of complex software. It is evident that hybrid intelligent systems are typical complex systems, as they have a large number of parts or components with

many interactions. Thus agent perspectives are well suited to hybrid intelligent system construction, especially where loosely coupled hybrid intelligent systems are concerned.

This book presents an agent-based framework that can greatly facilitate the building of hybrid intelligent systems, as well as two agent-based hybrid intelligent systems based on that framework. These two systems, one for financial investment planning and one for data mining, are based on real-life applications and are used here to demonstrate how to analyze, design and implement such systems from the viewpoints of agents.

This book strongly advocates the construction of hybrid intelligent systems from an agent's point of view. Each intelligent technique/model is treated as one building block of a hybrid intelligent system in the form of an agent. Different intelligent techniques can easily be integrated into one loosely coupled hybrid intelligent system under a unifying agent framework. Because of this, many complex problems can be solved within a shorter timeframe. Also, due to a variety of complementary problem-solving techniques/approaches being combined together, higher-quality solutions can be produced with such systems.

The book consists of nine chapters, which are divided into four major parts.

Part I comprises an introduction. Chapter 1 discusses the importance of hybrid intelligent systems for complex problem solving and decision-making, and explains why agent perspectives are suitable for modeling, designing and constructing hybrid intelligent systems.

Chapter 2 briefly presents some basic concepts and existing knowledge on hybrid intelligent systems. The advantages and disadvantages of different intelligent techniques are summarized. The drawbacks in the current practice of hybrid intelligent system development are identified. In Chap. 3, the fundamentals of agents and multi-agent systems are introduced. The distinctions between agents and objects, as well as agents and expert systems, are presented. A brief survey of typical agent-based hybrid intelligent systems and some approaches to incorporating intelligent techniques into agents are provided. Typical approaches to converting legacy intelligent-technique software packages into agents are also given. State-of-the-art agent-based hybrid intelligent systems are summarized.

Part II presents the methodologies and framework for hybrid intelligent system construction from an agent perspective. Chapter 4 first discusses some typical agent-oriented methodologies. A methodology suitable for analysis and design of agent-based hybrid intelligent systems is then extracted and tailored from the current practice of agent-oriented software engineering, which is mainly based on the *Gaia* methodology.

In Chap. 5, a unifying agent-based framework for building hybrid intelligent systems is proposed. The ontology issue, which is important for application system development, is addressed. Chapter 6 discusses matchmaking in middle agents, which is crucial for the success of agent-based hybrid intelli-

gent systems. This chapter also addresses some improvements to matchmaking algorithms which are currently used.

Part III presents two agent-based hybrid intelligent systems, one for financial investment planning, the other for data mining. Both are built based upon the framework proposed in Chap. 5. Chapter 7 discusses the analysis, design and implementation of an agent-based hybrid intelligent system for financial investment planning. This system consists of 13 different agents. Many techniques/packages, including fuzzy logic, neural networks, genetic algorithms, expert systems, an operations research software package, a matrix operation software package, portfolio selection models based on standard probability theory, fuzzy probability theory, and possibility distribution theory, are integrated under the unifying agent framework.

Chapter 8 presents another application system–agent-based hybrid intelligent system for data mining. The *Weka* system is reimplemented from agent perspectives. Different data mining techniques/algorithms can be easily integrated into a data mining system in the form of agents for a specific mining task.

Part IV contains concluding remarks, in which Chap. 9 summarizes this book. The future work of the proposed agent-based framework is pointed out.

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