Chapter 3
Electronic Markets and Multiagent Systems

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ABSTRACT

As the Internet helps mediate millions of transactions in electronic markets, research work on automated trading agents is helping humans improve their trading objectives (e.g., finding lower prices and improving delivery options). This chapter presents an overview of the research work on trading agents in the context of the Trading Agent Competition. The Trading Agent Competition is an annual event where researchers are interested in the following research questions: (i) how to design trading agents, (ii) how to evaluate these trading agents, and (iii) how do trading agents affect electronic markets. This research community has produced many research results that are based on state-of-the-art techniques from artificial intelligence, operations research, statistics, and other relevant fields.

INTRODUCTION

Agents (Wooldrige, 1999) are software programs that are capable of making decisions autonomously in order to achieve goals (normally defined at design time). The term “Multi-agent System” is generally used for a group of agents in an environment with resources, which have to collaborate or compete to achieve a common goal. Trading agents are software agents that pursue trading objectives and have to abide by the rules defined by the electronic markets.

As the Internet helps mediate an increasing number of electronic transactions, there is a growing interest in investigating the benefits of developing automated trading systems for electronic markets. Effective trading systems depend not only on services with reliable interfaces but also on decision making processes (such as which goods to buy, when to purchase such goods, and at
what price). One of the main concerns of Artificial Intelligence (AI) (Russell & Norvig, 1995) is to develop techniques for decision making processes by autonomous agents. Hence, agent-based systems are probably one of the best paradigms for effectively automating the decision making processes of trading systems.

The Trading Agent Competition (TAC) (Arunachalam & Sadeh, 2005; Wellman et al., 2001) is an annual event that was created to promote and foster high quality research into the trading agent problem. The trading agent problem is a complex decision making problem where autonomous software agents have to negotiate goods to achieve trading objectives. Since 2000, the event has attracted over 120 entries from universities and research institutes, such as Carnegie Mellon University, Harvard University, University of Michigan, University of Texas at Austin, Southampton University and SICS.

This chapter is organized as follows. Firstly, we introduce the main objectives of the Trading Agent Competition and short description of the top two scenarios. Secondly, we present an overview of the different architectures used by the trading agent developers. Finally, this section discusses some lessons learned and presents some concluding remarks.

**TRADING AGENT COMPETITION**

The Trading Agent Competition (TAC) (TAC, 2011) is an annual event that has been held since 2000. The main goal of this event is to encourage high quality research into the trading agent problem. The trading agent problem is a complex decision making problem where autonomous software agents have to negotiate goods to achieve trading goals. For example, a trading agent might have a trading goal to buy components in order to build a computer. Not only does the agent have to try to minimize the purchasing cost but also guarantee that all components are procured (since a computer with a missing component, such as memory or motherboard, is not ready to be assembled).

In the TAC community, the researchers are generally interested in the following research questions (TAC Association, 2011):

1. **How to design a trading agent?** Given an electronic market specification, a trading agent developer normally starts the design process with the identification of key modules that are going to help the agent pursue the trading goals. For example, almost every trading agent has a forecast module where future prices of goods are predicted. This module might help other modules such as a bidding module in order to buy goods and minimize procurement costs.

2. **How to evaluate a trading agent?** The evaluation of a trading agent is a key aspect of the development process of a successful agent. The primary motivation for organizing TAC was to create a common electronic market where developers can compare and evaluate their agents.

3. **How do trading agents affect electronic markets?** Another important goal of TAC is to evaluate how the competing agents affect an electronic market.

Since 2000, the competition has attracted research groups from around the world to put forth their best efforts at developing automated trading agents for a specific market scenario. The market scenarios in TAC are:

- **TAC Travel** (Wellman et al., 2001): Trading agents have to assemble travel packages for customers, which express their preferences for various aspects of the trip. In order to assemble these travel packages, the agents bid on flight tickets, hotel reservations and entertainment tickets from simultaneous auctions. The agent