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Autonomous agent negotiation strategies in complex environments

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Autonomous Agent Negotiation Strategies in Complex Environments

A thesis submitted in fulfillment of the
requirements for the award of the degree

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from

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by

Fenghui Ren

School of Computer Science and Software Engineering

April 2010

Dedicated to
My family and friends

Declaration

This is to certify that the work reported in this thesis was done by the author, unless specified otherwise, and that no part of it has been submitted in a thesis to any other university or similar institution.

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Fenghui Ren

April 30, 2010

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Abstract

Autonomous agents are software agents that are self-contained, capable of making independent decisions, and taking actions to satisfy internal goals based upon their perceived environment. Agent negotiation is a means for autonomous agents to communicate and compromise to reach mutually beneficial agreements. By considering the complexity of negotiation environments, agent negotiation can be classified into three levels, which are the *Bilateral Negotiation Level*, the *Multilateral Negotiation Level*, and the *Multiple Related Negotiation Level*.

In the *Bilateral Negotiation Level*, negotiations are performed between only two agents. The challenges on this level are how to predict an opponent's negotiation behavior, and how to reach the optimal negotiation outcome when the negotiation environment becomes open and dynamic. The contribution of this thesis on this level is (1) to propose a regression-based approach to learn, analyze and predict the opponent negotiation behaviors in open and dynamic environments based on the historical records of the current negotiation; and (2) to propose a multi-issue negotiation approach to estimate the opponent's negotiation preference, and to search for the bi-beneficial negotiation outcome when the opponent changes its negotiation strategies dynamically.

In the *Multilateral Negotiation Level*, negotiations are performed among more than two agents. Agents need more efficient negotiation protocols, strategies and approaches to handle outside options as well as competitions. Especially when negotiation environments become open and dynamic, future possible upcoming outside options still need to be considered. The challenge in this level is how to guide agents to efficiently and effectively reach agreements in highly open and dynamic negotiation environments, such as e-marketplaces. The contribution of this thesis on this level is (1) to propose a negotiation partner selection approach to filter out unexpected negotiation opponents before a multilateral negotiation starts; (2) to extend

a market-driven strategy for multilateral single issue negotiation in dynamic environments by considering upcoming changes of the environment; and (3) to propose a market-based strategy for multilateral multi-issue negotiation by considering both markets situations and agents specifications.

In the *Multiple Related Negotiation Level*, several negotiations are processed together by agents in order to achieve a global goal. These negotiations are not absolutely independent, but some how related. In order to ensure the global goal can be efficiently achieved, factors such as the negotiation procedure, the success rate, and the expected utility for each of these related negotiations should be considered. The contribution of this thesis on this level is to introduce a Multi-Negotiation Network (MNN) and a Multi-Negotiation Influence Diagram (MNID) to search for the optimal policy to concurrently conduct the multiple related negotiation by considering both the joint success rate and the joint utility.

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Publications

The following is a list of my research papers that have been already published during my PhD study that ends with the completion of this thesis.

Scholarly Book Chapters

1 **Fenghui Ren** and Minjie Zhang, Desire-Based Negotiation in Electronic Marketplaces. In *Post-Proceedings of the Second International Workshop on Agent-based Complex Automated Negotiations (ACAN09), Innovations of Agent-based Complex Automated Negotiations*, (accepted in Jan. 2010), in press.

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