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Coordination mechanisms for self-interested multi-agent systems

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Coordination Mechanisms for Self-interested Multi-agent Systems

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

Doctor of Philosophy

from

UNIVERSITY OF WOLLONGONG

by

Quan Bai
Dedicated to

my parents and wife
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.

__________________________________________
Quan Bai
April 30, 2007
A multi-agent system (MAS) is a collection of agents that interact with each other. Multi-agent systems (MASs) can be classified as self-interested MASs and cooperative MASs according to the features of agent goals. Coordination is one of the major issues of MAS research. It plays a central role in MASs to ensure agents achieve interactions properly. Today, the remarkable growth of MAS applications brings higher requirements and more challenges to agent coordinations. Many complex applications require a MAS to include various agents to work together under an open and dynamic environment.

Toward some challenges in current agent coordination research, this thesis deeply investigates agent coordination problems in self-interested MASs, and proposes three coordination mechanisms based on three different methodologies. Firstly, this thesis investigates the use of Coloured Petri Net techniques in agent coordinations. As one of the best modelling tools, Coloured Petri Nets can express a great range of concurrent systems and interactions in graphical representations and well-defined semantics, and allow formal analysis and transformations. In the thesis, a coordination mechanism that uses Coloured Petri Nets to model interaction protocols of agents is proposed and implemented. This mechanism allows interaction protocols to be separated from hard-coded agents. The separation of agents and interaction protocols makes it possible to allow agents to evaluate and select protocols before they operate interactions. Furthermore, a Coloured Petri
Net based approach that allows agents to propose, exchange and evaluate interaction protocols is also introduced in this thesis. By citing Coloured Petri Net techniques in agent coordinations, agents have more flexible and rational interactions. Secondly, this thesis proposes a flexible team formation mechanism for self-interested agents. In this mechanism, agents can evaluate the performance and importance of other agents in the system, and select team members with reasonable terms and costs according to the evaluation result automatically. Comparing with some traditional team formation mechanisms, the flexible team formation mechanism makes agent team compositions more reasonable, and avoids some potential benefit conflicts among self-interested team members (more suitable for self-interested agents). Finally, a knowledge level coordination mechanism that uses of ontologies to describe and manage MAS knowledge is introduced in this thesis. By using ontologies, MAS knowledge can be described and organised in hierarchies, and the dynamic features of independent knowledge sources are captured.
Ph.D study is a long journey that could never have been completed without the help of many people.

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On the personal front, I would express my deepest gratitude and love to my parents. I owned them too much in the years of my Ph.D study. I also want to thank my sister and her daughter. If they have not been taking care of my parents, I would never concentrate on my studies. Most important of all, I would like to thank my wife, Wenwei Yan, for her unquestionable support and understanding throughout the years. Her unreserved love makes it possible for me to finish this thesis.
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Finally, my thanks also go to my examiners, for their valuable suggestions and comments which have been most helpful for improving the quality of this thesis.
The followings are a list of my research papers that have been published or accepted during my Ph.D study that is to end by the completion of this thesis.


• Quan Bai and Minjie Zhang, Agent Coordination Through Ontology Managements. In Proceedings of International Conference on Artificial Intelligence and Their Applications, pages 141-146, Innsbruck, Austria, 2004.


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