UNIVERSITI PUTRA MALAYSIA

NEURAL NETWORK PREFERENCE LEARNING APPROACHES FOR IMPROVING AGENT-BASED MEETING SCHEDULING PROBLEMS

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By

TANG EN LAI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

August 2007

DEDICATION

Dedicated to my wife, my parents,
my brothers and sisters.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

NEURAL NETWORK PREFERENCE LEARNING APPROACHES FOR IMPROVING AGENT-BASED MEETING SCHEDULING PROBLEMS

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August 2007

Chairman : Associate Professor Md. Nasir Sulaiman, PhD

Faculty : Computer Science and Information Technology

Meeting scheduling is a distributed, tedious and time-consuming task in an organization which involves several individual in different location. The preferences and calendar availability of each individual are vary and treated as private information that unlikely to share with other individuals. Application of software agent is one of the solutions to automate this tedious task. Agent-Based Meeting Scheduling (ABMS) consists of several autonomous Secretary Agent (SA) that perform meeting scheduling task on behalf of their respective user through negotiation among them. Searching strategy is the negotiation technique that performed by SA in searching a suitable meeting timeslot. This study is interested in investigating the efficiency of searching strategy in term of communication cost, optimality of solution found and proposal successful rate during negotiation. Preliminary study of searching strategy use relaxation process

to allow agents negotiate by relaxes their preference when conflicts arise. This strategy was extended with “preference estimation” technique to optimize the user preference level of negotiation outcome. However, this will increase the cost of searching process. As the result, an improvement of relaxation searching strategy by adapting artificial neural network (ANN) learning mechanism into SA is proposed in this study. ANN is used in this study because of its popularity in predicting. Unfortunately, ANN has never been used to improve the searching strategy in meeting scheduling. The back-propagation neural network (BPNN) is applied in this research to intelligently predict of participants’ preferences and guide the host in selecting proposals that are more likely to get accepted by participants. Hence, increase the accuracy of negotiation outcome and reduce the communication cost. A computer simulation is conducted to compare the proposed searching strategy with the two existing strategies namely “relaxation”, and “relaxation with preference estimation”. It is carried out by performing scheduling tasks on a set of meeting in difference calendar density. Some measurement such as, the average preference level for committed meeting, optimality of the solution, the communication cost, and rate of successful proposals are defined to evaluate the performance of these three strategies. Finally, the result of the simulation shows the ability of proposed searching strategy to find the timeslot that close to optimal solution and achieves higher average preference level. Besides, proposed searching strategy requires less communication cost to achieve optimal solution. In conclusion, the use of ANN in relaxation searching strategy successfully improves the performance of timeslot searching process in ABMS. In future works, the existing system may be extended

to deal with more complex and dynamic scheduling situation such as synchronize scheduling, meeting rescheduling and user preference elicitation technique.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENDEKATAN RANGKAIAN NEURAL UNTUK PEMBELAJARAN KEUTAMAAN BAGI MEMPERBAIKI MASALAH EJEN PENJADUALAN MESYUARAT

Oleh

TANG EN LAI

Ogos 2007

Pengerusi : Profesor Madya Md. Nasir Sulaiman, PhD

Fakulti : Sains Komputer dan Teknologi Maklumat

Penjadualan mesyuarat adalah tugasan harian yang teragih, meletihkan, dan memakan masa di sesebuah organisasi di mana melibatkan beberapa individu yang berada di tempat yang berbeza. Keutamaan dan kebebasan kalendar bagi setiap individu adalah berbeza dan dianggap sebagai maklumat sulit yang tidak suka dikongsi antara individu dengan individu yang lain. Penggunaan ejen perisian adalah salah satu penyelesaian untuk mengautomasikan tugas yang meletihkan ini. Ejen Penjadualan Mesyuarat (ABMS) mengandungi beberapa Ejen Urusetia (SA) berautonomi yang berfungsi sebagai wakil pengguna masing-masing untuk menjalankan tugas penjadualan mesyuarat melalui perundingan sesama mereka. Strategi pencarian ialah teknik perundingan yang dilakukan oleh SA untuk mencari satu masa mesyuarat yang sesuai. Penyelidikan ini bertujuan untuk mengkaji keberkesanan strategi pencarian dari segi kos komunikasi, tahap

optimum hasil pencarian dan kadar cadangan yang diterima dalam sesuatu perundingan tersebut. Penyelidikan awal bagi strategi pencarian menggunakan proses “pengenduran” untuk membenarkan ejen berunding dengan mengendurkan keutamaan mereka apabila pertembungan berlaku. Strategi ini telah ditambah dengan teknik “penganggaran keutamaan” untuk mengoptimumkan kepuasan pengguna terhadap hasil perundingan. Walau bagaimanapun, teknik ini telah menybabkan kos proses pencarian meningkat. Oleh sebab itu, satu peningkatan bagi strategi pengenduran dengan menggunakan pembelajaran rangkaian neural (ANN) di dalam Ejen Urusetia telah dicadangkan dalam penyelidikan ini. ANN digunakan dalam penyelidikan ini kerana ia popular dalam peramalan. Akan tetapi, ANN belum digunakan untuk meningkatkan prestasi strategi pencarian dalam penjadualan mesyuarat. Rangkaian neural jenis perambatan balik telah digunakan dalam penyelidikan ini untuk meramal keutamaan peserta dan membimbing ketua mesyuarat dalam memilih cadangan-cadangan yang lebih mungkin diterima. Dengan itu, ia dapat meningkatkan ketepatan bagi hasil rundingan dan mengurangkan kos komunikasi. Satu simulasi komputer telah dijalankan untuk membandingkan strategi pencarian yang dicadangkan dengan dua strategi sedia ada yang bernama “pengenduran” dan “pengenduran dengan penganggaran keutamaan”. Simulasi ini dijalankan dengan menjadualkan satu set mesyuarat dalam ketumpatan kalendar yang berbeza. Ukuran-ukuran seperti purata tahap keutamaan bagi mesyuarat yang telah dipersetujui, tahap optimum bagi hasil perundingan, kos komunikasi dan kadar cadangan yang diterima telah ditakrifkan untuk menilai prestasi bagi ketiga-tiga strategi tersebut. Akhirnya, keputusan simulasi menunjukkan kebolehan strategi yang dicadangkan untuk mencari slot

masa mesyuarat yang lebih mengoptimumkan dan mencapai purata tahap keutamaan yang lebih tinggi. Selain itu, strategi ini juga memerlukan kos komunikasi yang lebih rendah untuk mencapai keputusan sedemikian. Sebagai kesimpulan, penggunaan ANN dalam strategi pencarian berdasarkan teknik "pengenduran" berjaya meningkatkan prestasi proses pencarian slot masa mesyuarat dalam ABMS. Sebagai kerja masa akan datang, sistem ini perlu diperkembangkan lagi untuk melayan situasi penjadualan yang lebih rumit dan dinamik seperti penjadualan secara serentak, penjadualan semula mesyuarat dan teknik pembelajaran keutamaan pengguna.

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Finally, I would like to thank my parents, my wife and my family members for their love, motivation and supports.

I certify that an Examination Committee has met on _____ to conduct the final examination of Tang En Lai on his Master of Science thesis entitled "Neural Network Preference Learning Approach for Agent-Based Meeting Scheduling Problem" in accordance with Universiti Petanian Malaysia (Higher Degree) Act 1980 and Universiti Petanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date: 21 February 2008

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

TANG EN LAI

Date: 16 January 2008

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LIST OF ABBREVIATIONS

ABMS	Agent-Based Meeting Scheduling
ACL	Agent Communication Language
AI	Artificial Intelligence
ANN	Artificial neural network
APL	Average Preference Level
BPNN	Back-Propagation Neural Network
CAP	Calendar Apprentice
DRAC	Distributed Reinforcement of Arc Consistency
FIPA	Foundation for Intelligent Physical Agent
GA	Genetic Algorithm
JADE	Java Agent DEvelopment Framework
LPL	Lowest Preference List
MAFOA	Mobile Agent for Office Automation
MAMS	Multi-Agent Meeting Scheduling
MSA	Meeting Scheduling Agent
MSCA	Meeting Scheduling Client Agent
MSSA	Meeting Scheduling Server Agent
MSDSS	Meeting Scheduling Decision Support System
OA	Office Automation
PL	Preference Level
PPV	Predicted Preference Vector
RMSE	Root of Mean Square Error

SA	Secretary Agent

CHAPTER 1

INTRODUCTION

1.1 Introduction

Meeting scheduling is a routine task that needs to be performed quite regularly and frequently within an organization. This task can be tedious and time-consuming when there are many individuals involved in a meeting. Each individual has different availability and constraints. This makes the process of finding a meeting date, time and place that satisfy every individual becomes more difficult. They need to negotiate with each other to schedule a meeting.

To find a meeting time that satisfies every individual is not merely considering the availability of the participant, but also their preferable time and date. Usually, individuals hide their personal calendar, preference and constraint from others for privacy. In addition, meeting scheduling becomes a distributed task when organizations structure is more likely to transform to distributed structure. This makes the meeting scheduling task more difficult.

Office automation (OA) refers to integration of hardware and software that needed to accomplish the basic task in office and supports cooperative activities between office workers. The goal of OA is to optimize and automate the tedious and repetitive tasks (such as meeting scheduling) among office workers and make

them more productive. Study in automating the meeting scheduling task provides essential contribution in OA.

Agent can be defined as an autonomous software program which is capable to operate in dynamic and open environment. Wooldridge and Jennings (1995) define an agent as a software system or system component that is situated in some environment and that is capable of autonomous action in this environment in order to meet its design objective. Wooldridge (1995) define that agent should have properties of autonomy, social ability, reactivity and pro-activeness. The emphasis of consumer-based computing and the rapidly spread of internet are two main catalysts behind the growth of agent technology (Shoham, 1999). Recently, many researchers are interested in application of agent technology in various problem domains. In literature, software agent have been proposed and implemented in number of research areas. In e-commerce for example, agent technology is applied to automate the online business process (Maes, Guttman and Moukas, 1999). Maller (1997) uses agent to automate network task and improve network security. In the field of office automation (OA), agent is applied in email filtering (Boone, 1998) and meeting scheduling task.

The application of agent technology in meeting scheduling becomes a serious consideration in recent research. This causes the emergence of agent-based meeting scheduling (ABMS) or close relative name, multi-agent meeting scheduling (MAMS). Several theories and models have been proposed by many researchers. Some most remarkable research studies in this domain include Sen