UNIVERSITI PUTRA MALAYSIA

ADAPTIVE GENETIC ALGORITHM TO IMPROVE NEGOTIATION PROCESS BY AGENTS IN E-COMMERCE

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By

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To

Whom made me think

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

ADAPTIVE GENETIC ALGORITHM TO IMPROVE NEGOTIATION PROCESS BY AGENTS IN E-COMMERCE

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In the past decade we have witnessed the rapid growth of negotiation agent systems in electronic commerce (e-commerce). A huge number of works have been done in order to develop adaptive negotiation agent systems. However, existing models are weak in supporting real world e-commerce conditions since most of them assume static conditions for environment and complete information about opponent agent's preferences. E-commerce platforms are dynamic and flexible environments which require adaptive negotiation models to survive. In this situation, non-adaptability of models results into non-optimal or sub-optimal performance which is an obvious problem for previous models. One-to-many negotiations are the most common types of negotiations in e-commerce platforms. Also, many-to-many negotiations are a form of parallel one-to-many negotiations. Therefore, in this study we focus on improving one-to-many negotiation model, so that later we will be able to expand it to many-to-many negotiation. E-CN one-to-many negotiation model has been

chosen as our benchmark. E-CN model is a popular one-to-many negotiation model which is currently being used by British Telecommunication. This model has later been improved by ODC. This study is using the same data set and performance measurements explained in e-CN model.

The objective of this study is to improve an adaptable version of e-CN model which is able to adapt according to the opponents' preferences and environmental condition while tackling with local optimum answers. This adaptability property improves the performance of the proposed one-to-many negotiation model by producing high quality and mutually acceptable offers. The proposed adaptive negotiation model is named Aspirated Genetic Algorithm (AGA) negotiation model which is a hybrid negotiation system composed of different negotiation strategies, Aspiration concept, genetic algorithm and Bayesian learning. The proposed adaptive AGA negotiation model is a hybrid negotiation system that is composed of different negotiation strategies, Aspiration concept, genetic algorithm and Bayesian learning. In order to reach a high quality solution and guarantee the success of negotiation model two contributions have been made. The first contribution is to improve the decision policy of e-CN negotiation model using Aspiration concept. This contribution is made in order to tackle the local optimum offers and heightening the risky attitude of agents. Second contribution is made by applying an improved genetic algorithm in offer generation mechanism and producing high quality, mutually acceptable offers. This improved genetic algorithm considers an economic encounter where both parties (sellers and buyer) preferences are considered when generating new offers. The proposed negotiation algorithm employs Bayesian learning and similarity functions in order to predict opponent agent's type and preferences. The results of this study showed that the proposed negotiation model improved agent's learning

ability and decision policy in order to adapt to the changes of the environment and tackle the local optimum answers. In addition, proposed negotiation model generated mutual acceptable offers that reduced the number of negotiation rounds before reaching agreement; this resulted in faster agreement while reducing the negotiation cost in comparison with ODC model. The proposed negotiation model has been studied over different dynamic conditions using the same data set and measurement metrics as e-CN. Experimental studies demonstrate that the final utility value, joint utility value, negotiation time and success rate of proposed negotiation model has significantly improved in comparison with e-CN model as our original benchmark and with ODC as a recent negotiation model. Finally, this thesis provided an improved adaptable negotiation model which guarantees reaching agreements while supporting the real world B2B scenarios in e-commerce. Further studies needs to be undertaken in order to evaluate qualitative issues as well as quantitative issues. Also, there is an open direction to accelerate the speed of proposed genetic algorithm in order to reduce the cost and time of negotiation. Also a possible further study is to evaluate the performance of this model on a many-to-many system architecture.

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

ADAPTIVE ALGORITMA GENETIK MENINGKATKAN PROSES PERUNDINGAN OLEH EJEN DI E-COMMERCE

Oleh

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Pada dekad kebelakangan ini, kita telah menyaksikan pertumbuhan pesat sistem agen perundingan dalam perdagangan elektronik. Sejumlah besar kerja telah dilakukan bagi membangunkan sistem agen perundingan yang adaptif. Namun demikian, model-model sedia ada mempunyai kelemahan dalam menyokong keadaan dunia nyata e-pasaran kerana kebanyakan mereka menganggap keadaan statik dalam persekitaran dan maklumat lengkap mengenai keutamaan agen berlawanan. Persekitaran e-pasaran yang dinamik dan fleksibel memerlukan model perundingan penyesuaian untuk terus bertahan. Dalam situasi begini, model yang tidak menyesuaikan diri akan menghasilkan keputusan yang tidak adaptif atau separa optimum dan ini merupakan masalah utama dalam model-model sebelum ini. Banyak kajian telah dilakukan bagi mengadaptif model perundingan satu-ke-banyak. Memandangkan perundingan banyak-ke-banyak adalah bentuk yang selari dengan perundingan satu-ke-banyak, di sini kita akan memberi tumpuan dalam

mengadaptifkan model satu-ke-banyak, supaya kemudian kita akan dapat menperluaskannya dalam perundingan banyak-ke-banyak. Model perundingan satu-ke-banyak e-CN telah dipilih sebagai tolok ukur kami. Model e-CN ialah satu model perundingan satu-ke-banyak yang popular dan kini sedang digunakan oleh Telekomunikasi British. Kajian ini menggunakan set data dan pengukuran prestasi yang sama seperti dijelaskan dalam model e-CN.

Objektif kajian ini adalah untuk memperbaikkan satu versi penyesuaian model e-CN yang mampu menyesuaikan diri berdasarkan keutamaan pihak berlawanan dan keadaan persekitaran sambil menangani jawapan adaptif tempatan. Sifat penyesuaian ini meningkatkan prestasi model perundingan satu-ke-banyak yang dicadangkan dengan menghasilkan tawaran yang berkualiti tinggi dan diterima bersama. Model perundingan yang dicadangkan ini dinamakan Algoritma Beraspirasi Genetik (AGA) rundingan model yang merupakan sistem perundingan kacukan yang terdiri daripada pelbagai strategi perundingan, konsep Aspirasi, Algoritma Genetik, dan *Bayesian Learning*. Bagi mencapai penyelesaian yang berkualiti tinggi dan menjamin kejayaan model perundingan ini, dua sumbangan telah dibuat. Sumbangan pertama ialah meningkatkan polisi keputusan model perundingan e-CN menggunakan konsep Aspirasi. Sumbangan ini dilakukan bagi menangani tawaran adaptif tempatan dan meninggikan sikap berisiko agen-agen. Sumbangan kedua dilakukan dengan menggunakan algoritma genetik yang baru dalam mekanisme penghasilan tawaran dan memberi tawaran yang berkualiti tinggi serta diterima bersama. Algoritma genetik baru ini menganggap pertumbuhan ekonomi di mana keutamaan kedua-dua pihak (penjual dan pembeli) dipertimbangkan semasa penghasilan tawaran baru. Algoritma perundingan yang

dicadangkan menggunakan *Bayesian learning* dan fungsi persamaan bagi meramal jenis dan keutamaan agen berlawanan. Keputusan kajian ini menunjukkan model AGA meningkatkan keupayaan belajar agen dan polisi keputusan bagi menyesuaikan diri kepada perubahan persekitaran dan menangani jawapan adaptif tempatan. Tambahan lagi, AGA menghasilkan tawaran yang diterima bersama dan ini mengurangkan jumlah pusingan perundingan sebelum mencapai kesepakatan; ini menghasilkan kesepakatan yan lebih cepat di samping mengurangkan kos perundingan. AGA telah dikaji dalam pelbagai keadaan dinamik menggunakan set data dan metrik pengukuran yang sama seperti e-CN. Kajian eksperimen menunjukkan bahawa nilai akhir utiliti, masa perundingan dan tahap kejayaan model AGA telah meningkat berbanding dengan model tolok ukur kami e-CN dan dengan model kebelakangan ini ODC. Akhirnya, tesis ini memberikan satu model perundingan yang sesuai dan adaptif, di mana ia menjamin pencapaian kesepakatan yang menyokong senario dunia nyata B2B dalam e-perdagangan. Kajian lanjut perlu dilakukan bagi menilai isu-isu kualitatif serta isu-isu kuantitatif. Selain itu, masih terdapat ruang untuk mempercepatkan algoritma genetik yang dicadangkan bagi mengurangkan kos dan masa perundingan. Di samping itu, terdapat kemungkinan untuk melanjutkan kajian ini untuk menilai prestasi model dicadangkan dalam senibina sistem banyak-ke-banyak.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirements for the degree of Master of Science. Members of the Supervisory Committee were as follows:

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DECLARATION

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

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Date: 7 October 2011

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