UNIVERSITI PUTRA MALAYSIA

UTILISATION OF EXPONENTIAL-BASED RESOURCE ALLOCATION AND COMPETITION IN ARTIFICIAL IMMUNE RECOGNITION SYSTEM

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DOCTOR OF PHILOSOPHY
UNIVERSITI PUTRA MALAYSIA

2011

UTILISATION OF EXPONENTIAL-BASED RESOURCE ALLOCATION AND COMPETITION IN ARTIFICIAL IMMUNE RECOGNITION SYSTEM

By

SHAHRAM GOLZARI HORMOZI

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

February 2011

DEDICATION

I would like to dedicate my work to my mother, who passed away during my graduate study, and my father.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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February 2011

Chairman: **Shyamala A/p c. Doraisamy, PhD**

Faculty: **Computer Science and Information Technology**

There has been a rapid growth in using Artificial Immune Systems for applications in data mining and computational intelligence recently. There are extensive computational aspects with the natural immune system. Several algorithms have been developed by exploiting these computational capabilities for a wide range of applications.

Artificial Immune Recognition System is one of the several immune inspired algorithms that can be used to perform classification, a data mining task. The results achieved by Artificial Immune Recognition Systems have shown the potential of Artificial Immune Systems to perform classification. Artificial Immune Recognition System is a relatively new classifier and has some advantages such as self regularity, parameter stability and data reduction capability. However, the Artificial Immune Recognition System uses a linear resource allocation method. This linearity increases the processing time of

generating memory cells from antigens and causes an increase in the training time of the Artificial Immune Recognition System. Another problem with the Artificial Immune Recognition System is related to the resource competition phase which generates premature memory cells and decreases the classification accuracy of system.

This thesis proposes new algorithms based on Artificial Immune Recognition System to address the mentioned weaknesses and improve the performance of the Artificial Immune Recognition System. Firstly, exponential-based resource allocation methods are utilized instead of the existing linear resource allocation method. Next, the Real World Tournament Selection method is adapted and incorporated into the resource competition of Artificial Immune Recognition System.

The proposed algorithms have been tested on a variety of datasets from the UCI machine learning repository. The experimental results show that utilizing exponential-based resource allocation methods decreases the training time and increases the data reduction capability of Artificial Immune Recognition System. In addition, incorporating an adapted Real World Tournament Selection technique increases the accuracy of the Artificial Immune Recognition System up to 4%. The difference between the performances of the proposed algorithms and Artificial Immune Recognition System are significant in majority of cases.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGGUNAAN PERUNTUKAN SUMBER BERDASARKAN-EKPONENSIAL DAN PERTANDINGAN DALAM SISTEM PENGECAMAN PELALIAN BUATAN

Oleh

SHAHRAM GOLZARI HORMOZI

Februari 2011

Pengerusi:　　　　**Shyamala A/p c. Doraisamy, PhD**

Fakulti:　　　　**Sains Komputer dan Teknologi Maklumat**

Dewasa ini pertumbuhan pesat degan menggunakan Sistem Pelalian Buatan untuk aplikasi perlombongan data dan kepintaran komputeran. Terdapat aspek pengiraan meluas dengan Sistem Pelalian Semula Jadi. Beberapa algoritma telah dibangunkan dengan menggunakan keupayaan komputasi ini untuk berbagai jenis aplikasi.

Sistem Pengecaman Pelalian Buatan ialah salah satu daripada beberapa algoritma berinspirasikan pelalian yang boleh digunakan untuk menjalankan klasifikasi, suatu tugas perlombongan data. Keputusan yang dicapai oleh Sistem Pengecaman Pelalian Buatan telah menunjukkan potensi bagi Sistem Pelalian Buatan untuk menjalankan klasifikasi. Sistem Pengecaman Pelalian Buatan ialah secara relatifnya satu pengelas baru dan mempunyai beberapa kelebihan seperti ketetapan diri, kestabilan parameter dan keupayaan pengurangan data. Walaubagaimanapun, Sistem Pengecaman Pelalian Buatan menggunakan kaedah peruntukan sumber linear. Kelinearan ini meningkatkan masa

pemprosesan menjana sel memori dari antigen dan menyebabkan satu peningkatan dalam masa latihan dalam Sistem Pengecaman Pelalian Buatan. Satu masalah lagi dengan Sistem Pengecaman Pelalian Buatan ialah berkaitan dengan fasa pertandingan sumber yang menghasilkan sel memori pramatang dan mengurangkan ketepatan pengklasifikasian sistem.

Tesis ini mencadangkan algoritma baru berdasarkan Sistem Pengecaman Pelalian Buatan untuk menyelesaikan kelemahan dan meningkatkan prestasi Sistem Pengecaman Pelalian Buatan yang disebutakn. Pertama sekali, kaedah peruntukan sumber berdasarkan-exponensial digunakan berbanding deagan kaedah peruntukan sumber linear yang sedia ada. Berikutnya, kaedah Pemilihan Pertandingan Dunia Nyata diubahsuaikan dan digabungkan ke dalam pertandingan sumber bagi Sistem Pengecaman Pelalian Buatan.

Algoritma yang dicadangkan telah diuji pada pelbagai jenis set data dari pangkalan data pembelajaran mesin UCI. Hasil experimen menunjukkan penggunaan kaedah peruntukan sumber berdasarkan-exponensial mengurangkan masa latihan dan meningkatkan keupayaan pengurangan data bagi Sistem Pengecaman Pelalian Buatan. Sebagai tambahan, teknik menggabungkan penyesuaikan bagi Pemilihan Pertandingan Dunia Nyata yang diubahsuai telah meningkatkan ketepatan Sistem Pengecaman Pelalian Buatan sampai 4%. Perbezaan antara prestasi bagi algoritma algorithma cadangan dan Sistem Pengecaman Pelalian Buatan adalah nyata dalam kebanyakan kes.

ACKNOWLEDGEMENTS

First and foremost I would like to express my deepest praise to Allah that has given me the strength, faith, confidence and patience to complete this project within the required time frame despite all the challenges.

First and foremost, I would like to express my sincere gratitude to my supervisor Dr. Shyamala Doraisamy for giving me an opportunity to start off this project. Through the course of my study, I have had the great fortune to get to know and interact with her. Her comments and suggestions for further development as well as her assistance during writing this thesis are invaluable to me. Her talent, diverse background, interest, teaching and research style has provided for me an exceptional opportunity to learn and made me become a better student.

I would like to express my sincere thanks and appreciation to the supervisory committee members Associate Professor Dr. Md Nasir Sulaiman and Dr. Nur Izura Udzir for their guidance, valuable suggestions and advice throughout this work in making this a success.

Last but not least, a very deepest gratitude to my family for their patient and encouragement during my postgraduate study.

APPROVAL

I certify that an Examination Committee met on 11th February 2011 to conduct the final examination of **Shahram Golzari Hormozi** on his **Doctor of Philosophy** thesis entitled "**Utilisation of Exponential-based Resource Allocation and Competition in Artificial Immune Recognition System**" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee were as follows:

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Date:

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

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Date:

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 institution.

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SHAHRAM GOLZARI HORMOZI

Date: 11 February 2011

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