UNIVERSITI PUTRA MALAYSIA

OPTIMISED CROSSOVER GENETIC ALGORITHMS FOR COMBINATORIAL OPTIMISATION PROBLEMS

HABIBEH NAZIF

FS 2010 53

OPTIMISED CROSSOVER GENETIC ALGORITHMS FOR COMBINATORIAL OPTIMISATION PROBLEMS

By

HABIBEH NAZIF

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

July 2010

DEDICATION

To

My Sweetheart, Akbar

and

My Lovely Son, Kiarash

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

OPTIMISED CROSSOVER GENETIC ALGORITHMS FOR COMBINATORIAL OPTIMISATION PROBLEMS

By

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A Genetic Algorithm is successful in generating near-optimal solutions if it is able to produce offspring during crossover that is better than the parent solutions. Most of the current methods of crossover determine offspring by using a stochastic approach and without reference to the objective function with the result being that a potentially optimal solution could be lost through incorrect choices being made in the randomisation process.

This thesis focuses on the development of a new stream of crossover within genetic algorithms, called Optimised Crossover Genetic Algorithm (OCGA) for solving combinatorial optimisation problems, which takes into account the objective function in finding the best offspring solution among an exponentially large number of potential offspring. Using the optimised crossover scheme, the two parents produce the two new children: the O-child (Optimum child) and the E-child (Exploratory child). The O-child is constructed in a way so as to have the best objective function value from the feasible set of children, while the E-child is constructed so as to maintain the diversity of the search space.

In this thesis, the OCGA is applied to some combinatorial optimisation problems, specifically on single machine scheduling problems and vehicle routing problems. We particularly focus on four problems: single machine family scheduling problem with maximum lateness, single machine family scheduling problem with total weighted completion time, capacitated vehicle routing problem and vehicle routing problem with time windows. These problems are motivated by the manufacturing organisations where decisions involve a trade-off between the manufacturer's efficiency and customers' satisfaction.

Extensive computational experiments are carried out to assess the effectiveness of the OCGA compared to other local search methods proposed in the literature. The results shown the OCGA is competitive and capable of generating near optimal solutions.

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

ALGORITMA GENETIK LINTASAN TEROPTIMUM UNTUK MASALAH PENGOPTIMUMAN KOMBINATORIK

Oleh

HABIBEH NAZIF

Jun 2010

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Algoritma Genetik telah berjaya dalam menjana penyelesaian hampir optimum sekiranya ia mampu menghasilkan zuriat yang lebih baik semasa lintasan dari penyelesaian ibubapa. Kebanyakkan kaedah-kaedah lintasan terkini menentukan zuriat dengan menggunakan pendekatan stokastik dan tanpa rujukan kepada fungsi objektif dengan keputusan yang berpotensi untuk penyelesaian optimum akan gagal menerusi pilihan tidak tepat yang telah dibuat dalam proses perawakan.

Tesis ini memfokuskan pembangunan strim lintasan yang baru di dalam algoritma genetik, dipanggil Algoritma Genetik Lintasan Teroptimum (OCGA) untuk menyelesaikan masalah pengoptimuman kombinatorik, yang mengambil kira fungsi objektif dalam mencari penyelesaian zuriat terbaik diantara zuriat berpotensi yang berjumlah besar secara eksponen. Dengan menggunakan skim

lintasan teroptimum, kedua-dua ibubapa menghasilkan dua kanak-kanak baru: anak-O (anak optimum) dan anak-E (anak jelajahan). Anak-O dibina sedemikian rupa untuk mendapatkan nilai fungsi objektif terbaik dari set tersaur bagi kanak-kanak, sementara anak-E dibina untuk mengekalkan perbezaan ruang gelintaran.

Dalam tesis ini, OCGA digunakan untuk masalah pengoptimuman kombinatorik, secara spesifiknya dalam masalah penjadualan mesin tunggal dan masalah perjalanan kenderaan. Kami secara khususnya memfokuskan empat masalah: masalah penjadualan keluarga mesin tunggal dengan kelewatan maksimum, masalah penjadualan keluarga mesin tunggal dengan masa siap berpemberat keseluruhan, masalah perjalanan kenderaan yang berkapasiti tetap dan masalah perjalanan kenderaan dengan tetingkap masa. Masalah dimotiuasikan oleh organisasi pembuatan di mana keputusan membabitkan keseimbangan diantara kecekapan pengeluar dan kepuasan pelanggan.

Eksperimen berkomputer telah dijalankan dengan meluas untuk menilai keberkesanan OCGA berbanding kaedah carian lain yang dicadangkan dalam literatur. Keputusannya menunjukkan OCGA adalah kompetitif dan berupaya menjanakan penyelesaian yang hampir optimum.

ACKNOWLEDGEMENTS

First of all, praise is for almighty Allah for giving me the strength, guidance and patience to complete this thesis.

This thesis is the result of almost three years of work where I have been accompanied by some people. I now have the pleasant opportunity to express my gratitude to all of them.

I am sincerely grateful to my supervisor, Dr. Lee Lai Soon for his excellent supervision, valuable guidance, helpful discussion and continuous encouragement. I am grateful for having the opportunity to work under his supervision. His precious assistance and comments in the preparation and completion of this thesis are also highly appreciated. I would like to thank the members of supervisory committee, Prof. Malik Bin Hj. Abu Hassan and Dr. Leong Wah June.

I also wish to express my thanks to all my friends during my study in University Putra Malaysia, especially to my roommate Suzan. Their continuous help, encouragement and support are highly appreciated.

My deepest gratitude and love is to my parents, brother and sisters, specifically for their supports, encouragements, and prayers towards my success.

Last but not least, I am especially grateful to my beloved husband, Akbar, and my lovely son, Kiarash, who are my constant inspiration for their patience, love, unwavering support and understanding during this study. My sincere appreciation and love is for you both always.

I certify that an Thesis Examination Committee has met on **18 June 2010** to conduct the final examination of **Habibeh Nazif** on her thesis entitled "**Optimised Crossover Genetic Algorithms For Combinatorial Optimisation Problems**" in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the **Doctor of Philosophy**.

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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 Universiti Putra Malaysia or at any other institution.

HABIBEH NAZIF

Date: 23 July 2010

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