



UNIVERSITI PUTRA MALAYSIA

***FUZZY GENETIC ALGORITHMS FOR
COMBINATORIAL OPTIMISATION PROBLEMS***

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**FUZZY GENETIC ALGORITHMS FOR
COMBINATORIAL OPTIMISATION PROBLEMS**

By

MOHAMMAD JALALI VARNAMKHASTI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
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of Philosophy**

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DEDICATION

This thesis is dedicated to my parents for their endless love and encouragement. Also I lovingly dedicate this thesis to my wife, who supported me each step of my way, and my lovely kids, Mahdi and Mohaddeseh.



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

**FUZZY GENETIC ALGORITHMS FOR COMBINATORIAL
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March 2012

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The Genetic Algorithms (GAs) have been very successful in handling optimization problems which are difficult. However, the fundamental problem in GAs is premature convergence and it is strongly related to the loss of genetic diversity of the population. This thesis aims at proposing some technique to tackle the premature convergence of GAs by controlling the population diversity.

Firstly, a new sexual selection mechanism which utilizing mate chromosome during selection is proposed. The female chromosome is selected by standard tournament selection while the male chromosome is selected based on the hamming distance from the selected female chromosome, fitness value or the active genes.

Fuzzy Logic Controllers (FLCs) are considered as knowledge-based systems, incorporating human knowledge. The second technique focuses on controlling the GA parameters by applying the FLC, thus creating a new variant of GA called Fuzzy Genetic Algorithm (FGA). In each generation, the diversity of studied population is measured in terms of the phenotype and genotype properties. Then the selection of crossover and mutation operators together with their probabilities are achieved by running the FLCs based on the diversity of the population.

The proposed sexual selection and the FGAs are applied to combinatorial optimization problems specifically to those involving selection problems. We particularly focus on two problems: multidimensional 0/1 knapsack problems and p -median facility location problems. The goal of a multidimensional 0/1 knapsack is to boost the sum values of the items to be chosen from some specified set by means of taking multiple-resource restrains into consideration. In the p -median problem, the aim is to choose the positions of the p facilities in order to cover n demand points such that the summation of distances from each facility to each corresponding demand point is brought to a minimum.

Extensive computational experiments are carried out to assess the effectiveness of the proposed algorithms compared to other metaheuristic proposed in the literature.

The computational results shown that, the proposed sexual selection and FGAs are competitive and capable of generating near optimal solutions.

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

ALGORIMA GENETIK KABUR UNTUK MASALAH PENGOPTIMUMAN KOMBINATORIK

Oleh

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Algoritma Genetik (AGs) telah berjaya mengendalikan masalah pengoptimuman yang sukar. Walau bagaimanapun, masalah asas dalam AG ialah penumpuan pramasa dan ia amat berkaitan dengan kehilangan kepelbagaian genetik populasi. Tesis ini bertujuan untuk mencadangkan beberapa teknik untuk menangani penumpuan pramasa AG dengan mengawal kepelbagaian populasi.

Pertama sekali, mekanisme pemilihan seksual baharu yang menggunakan kromosom teman semasa pemilihan dicadangkan. Kromosom betina dipilih melalui pemilihan pertandingan klasik sementara kromosom jantan dipilih berdasarkan

jarak Hamming daripada kromosom betina yang dipilih, nilai kesesuaian atau gen aktif.

Pengawal Logik Kabur (PLK) dianggap sebagai sistem berasaskan pengetahuan, menggabungkan pengetahuan manusia. Teknik kedua memberi tumpuan terhadap pengawalan parameter AG dengan menggunakan PLK, dengan itu mewujudkan varian AG baharu yang dipanggil Algoritma Genetik Kabur (AGK). Dalam setiap generasi, kepelbagaian populasi yang dikaji diukur dari segi sifat fenotip dan genotip. Kemudian pemilihan operator mutasi dan bersilang bersama-sama dengan kebarangkaliannya akan dicapai dengan menjalankan PLK berdasarkan kepelbagaian populasi.

Pemilihan seksual yang dicadangkan dan AGK telah digunakan pada masalah pengoptimuman kombinatorik secara khususnya yang melibatkan masalah pemilihan. Kami secara khususnya memberi tumpuan terhadap dua masalah: masalah knapsack 0/1 berbilang dimensi dan masalah lokasi kemudahan p -median. Matlamat knapsack 0/1 berbilang dimensi adalah untuk merangsang nilai hasil tambah item untuk dipilih daripada beberapa set yang dinyatakan dengan mengambil kira pengekangan berbilang sumber. Dalam masalah p -median, tujuan untuk memilih kedudukan kemudahan p bagi meliputi titik tuntutan sehingga perjumlahan jarak dari setiap kemudahan ke setiap titik tuntutan yang sepadan diminimumkan.

Ujikaji berkomputasi yang menyeluruh dijalankan untuk menilai keberkesanan algoritma yang dicadangkan berbanding dengan metaheuristik yang dicadangkan di dalam ilmiah. Hasil berkomputasi menunjukkan bahawa, pemilihan seksual yang dicadangkan dan AGK adalah kompetitif dan mampu menjana penyelesaian hampir optimum.



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I certify that an Thesis Examination Committee has met on **08 March 2012** to conduct the final examination of **MOHAMMAD JALALI VARNAMKHASTI** on his thesis entitled **“Fuzzy Genetic Algorithms For Combinatorial Optimisation Problems”** in accordance with Universities and University Colleges 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 1989 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 the sources cited have been used in this thesis. 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.



Mohammad Jalali Varnamkhasti

Date: 8 March 2012

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