



UNIVERSITI PUTRA MALAYSIA

***GENETIC ALGORITHMS FOR URBAN TRANSIT
ROUTING PROBLEMS***

JOANNE CHEW SUK CHUN

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By

JOANNE CHEW SUK CHUN

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By

JOANNE CHEW SUK CHUN

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Chairman: Lee Lai Soon, PhD

Faculty: Science

The problem of road congestion occurs in most of the urban cities in the world. An efficient public transportation system is vitae in helping to reduce the overall traffic on the road. The urban transit routing problem (UTRP) is involved in searching for a set of routes for the urban public transportation system, which proved to be a highly complex multi-constrained problem. UTRP is a NP-hard problem where a lot of criteria need to be met in order to generate a feasible solution. Metaheuristic algorithm is suitable for the difficulties of this problem. Thus in this study, one such metaheuristic algorithm, genetic algorithm (GA) is developed to solve the UTRP.

The objective of this study is to design a GA to solve the UTRP. Due to the complexity of the UTRP, there is always a possibility of getting an infeasible chromosome. Thus, each chromosome is tested by a set of feasible criteria and modification is made for the infeasible chromosomes. The genetic operations of crossover

and mutation are also introduced to help the GA in exploring new characteristics for the chromosome and to maintain the diversity of the population as the GA evolves in each generation. The proposed algorithm is first applied to the single objective of UTRP which involves only the passengers' cost. It is later expanded to the bi-objective of UTRP which looks into the operator's cost as well. Due to the contradicting objective functions of the bi-objective UTRP, a trade-off between the two objective functions is needed. Our proposed GA will search the Pareto Frontier and Pareto-optimal solutions are returned as the non-dominated solutions. The results obtained from the single and bi-objective of UTRP show that our proposed GA significantly improves the results compared to other published results in the literature for the Mandl's Swiss road network benchmark problem.

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

ALGORITMA GENETIK BAGI MASALAH PERSINGGAHAN LALUAN DI BANDAR

Oleh

JOANNE CHEW SUK CHUN

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Pengerusi: Lee Lai Soon, PhD

Fakulti: Sains

Masalah kesesakan jalan raya berlaku di kebanyakan bandar di dunia. Sistem pengangkutan awam yang cekap adalah penting dalam membantu mengurangkan kesesakan lalu lintas di jalan raya secara keseluruhannya. Masalah persinggaan laluan di bandar (UTRP) melibatkan dalam mencari satu set laluan untuk sistem pengangkutan awam di bandar dan UTRP terbukti adalah masalah yang sangat kompleks disebabkan oleh banyak kekangan yang wujud. UTRP adalah masalah *NP-hard* di mana banyak kriteria perlu dipenuhi untuk menjana satu penyelesaian yang tersaur. Algoritma metaheuristik adalah sesuai bagi tahap kesukaran masalah ini. Oleh itu, dalam kajian ini, satu algoritma metaheuristik, iaitu algoritma genetik (GA) digunakan untuk menyelesaikan UTRP.

Objektif kajian ini adalah untuk merekabentuk GA untuk menyelesaikan UTRP. Disebabkan oleh kerumitan UTRP, kemungkinan wujud dimana kromosom adalah tidak tersaur. Oleh itu, setiap kromosom akan diuji oleh satu set kriteria dan pengubahsuaian akan dibuat bagi kromosom yang tidak tersaur. Operasi genetic

silang dan mutasi juga diperkenalkan untuk membantu GA dalam meneroka ciri-ciri kromosom baru dan mengekalkan kepelbagaian populasi apabila GA berevolusi dalam setiap generasi. Algoritma yang dicadangkan akan digunakan untuk menyelesaikan masalah objektif UTRP berfungsi tunggal yang melibatkan kos penumpang sahaja. Algoritma tersebut kemudiannya berkembang kepada objektif UTRP dua fungsi yang melibat kos penumpang dan juga kos operator. Disebabkan oleh fungsi-fungsi objektif yang bercanggahan dalam masalah dua objektif UTRP, keseimbangan antara kedua-dua fungsi objektif adalah diperlukan. GA yang dicadangkan akan mencari Patasan Frontier dan keputusan optimum Patasan akan dikembalikan sebagai penyelesaian yang tidak dikuasai. Keputusan yang diperoleh daripada objektif tunggal dan dua objektif dalam UTRP menunjukkan bahawa GA yang dicadangkan telah memberbaiki keputusan secara ketara berbanding dengan keputusan lain yang diterbitkan dalam literatur. Dengan menggunakan rangkaian jalan *Swiss Mandl* adalah *benchmark* dalam menyelesaikan masalah UTRP.

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I certify that a Thesis Examination Committee has met on **6 April 2012** to conduct the final examination of **Joanne Chew Suk Chun** on her thesis entitled “**Genetic Algorithms for Urban Transit Routing Problems**” in accordance with the 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 **Master of Science**. Members of the Thesis Examination Committee were as follows:

Jayanthi A/P Arasan, PhD

Senior Lecturer
Faculty of Science
Universiti Putra Malaysia
(Chairperson)

Leong Wah June, PhD

Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Mansor Bin Monsi, PhD

Senior Lecturer
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Mustafa Bin Mamat, PhD

Associate Professor
Department of Mathematics
Faculty of Science and Technology
Universiti Malaysia Terengganu
Malaysia
(External Examiner)

SEOW HENG FONG, Ph.D.

Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

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 **Master of Science**. The members of the Supervisory Committee were as follows:

Lee Lai Soon, PhD

Senior Lecturer
Faculty of Science
Universiti Putra Malaysia
(Chairperson)

Zanariah Binti Abdul Majid, PhD

Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

Mohd Rizam Bin Abu Bakar, PhD

Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

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 Universiti Putra Malaysia or at any other institution.

JOANNE CHEW SUK CHUN

Date: 6 April 2012

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