UNIVERSITI TEKNOLOGI MARA

HYBRIDIZING HARMONY SEARCH WITH LOCAL SEARCH BASED METAHEURISTIC FOR SOLVING CURRICULUM BASED UNIVERSITY COURSE TIMETABLING

JULIANA BINTI WAHID

Thesis submitted in fulfillment
of the requirement for the degree of
Doctor of Philosophy

Faculty of Computer and Mathematical Sciences

January 2017

ABSTRACT

Harmony search algorithm (HSA) is a population-based metaheuristic optimization algorithm that imitates the music improvisation process where musicians improvise their instruments' pitch by searching for a perfect state of harmony. Previous studies have shown that HSA has been successfully adapted for solving combinatorial optimization problems such as university course timetabling problem (UCTP). However, HSA encountered a setback in which the convergence rate and accuracy of the obtained results are reduced because of the solutions in the population are eventually about the same during the final iterations. Thus, this thesis proposed hybrid algorithms between HSA and local search based methods (simulated annealing (SA) and/or great deluge (GD)) to enhance the HSA performance for solving curriculum-based course timetabling (CBCTT) problem which is the variant of UCTP. SA is chosen to be hybridize with HSA for solving CBCTT because in literature, SA was successfully hybridize with HSA to solve other domain of problems. GD is chosen to be hybridize with HSA for solving CBCTT because GD has the related procedure with SA. The result of this approach was compared to other approaches in the literature applied to the same domain and best known solution available in the CBCTT website. The approach produced solutions that are at par quality with the previous published results. Moreover, this approach is able to obtain optimal penalty cost for two problem instances. In this thesis, a CBCTT problem from College of Art and Sciences, Universiti Utara Malaysia (UUM CAS) is also introduced and solved. The real data of UUM CAS timetable was analyzed and processed using the proposed algorithms. The result shows that the quality cost of UUM CAS course timetabling produced by the proposed algorithms is better compared to the course timetable produced by the ready-made software package. The main contributions of this thesis are: a well-defined lecture assignment procedures, with comprehensive comparison of heuristic orderings (with single or combinations) that are able to produce a diverse population of feasible solutions for all problem instances, a comprehensive hybridization settings between population and local search based framework, as well as the formulation and solution of a new curriculum based course timetabling dataset.

ACKNOWLEDGEMENT

In the name of Allah, the beneficent, the Merciful,

I would like to express my gratitude to my supervisor, Associate Professor Dr Naimah Mohd Hussin, for her expertise, encouragement, support, and valuable advice during my research.

I would also like to thank the Ministry of Higher Education (MOHE) of Malaysia and the Universiti Utara Malaysia (UUM) for the doctoral scholarship and other financial support throughout the course of my PhD study.

Special thanks to my lovely husband Mohamad Yazid Bin Ismail, my children; Muhammad Afham, ‘Ain Roshad, Muhammad Aqwam, Muhammad Althaf and Muhammad Al Fatih, my parents, my brothers and sisters for their love, patience and understanding throughout the study.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

University course timetabling problem (UCTP) is an administrative task that allocates the set of courses offered by the university to particular rooms and time slots. The allocation process needs to satisfy several constraints so that the timetable can actually be carried out (feasible). The UCTP as described in the International Timetabling Competition 2007 (ITC2007) website (www.cs.qub.ac.uk/itc2007/) falls into two versions. The first version is the post-enrolment course timetabling (PECTT), where the timetable is constructed based on student enrolments, i.e. after students have selected which lectures they wish to attend. The second version is the curriculum-based course timetabling (CBCTT), in which the timetable will be constructed according to the curricula published by the university.

The UCTP can be formulated as a combinatorial optimization problem (COP) (Colorni et al., 1996; Blum & Roli, 2003). A COP can be defined by a set of variables X ($x_1 \ldots x_n$), variable domain $D_1 \ldots D_n$, constraints among variables, objective function f to be minimized, and a set of all possible feasible assignments (solution). To solve a COP, the solution with minimum or maximum objective function value should be found. For UCTP, the aim is to find the solution (timetable) with minimum objective function value.

A COP such as UCTP needs heuristic or metaheuristic algorithms which have the ability to solve it in a reasonable time. Metaheuristic algorithms are categorized into local search-based (use single solution at each optimization process) and population-based methods (use several solutions at the same time at each optimization process) (Blum & Roli, 2003). Local search-based metaheuristic such as simulated annealing (SA) algorithm, are implemented for UCTP (Bellio, Ceschia, Di Gaspero, Schaerf, & Urli, 2013, 2015; Bellio, Di Gaspero, & Schaerf, 2012; Tarawneh, Ayob, & Ahmad, 2013). However, SA needs substantial running time to reach a good quality solution (Henderson, Jacobson, Johnson, & Hillier, 2003; Nikolaev & Jacobson, 2010;