A HYBRID CLONAL SELECTION ALGORITHM WITH CONFLICT BASED STATISTICS FOR UNIVERSITY COURSE TIMETABLING

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A HYBRID CLONAL SELECTION ALGORITHM WITH CONFLICT BASED STATISTICS FOR UNIVERSITY COURSE TIMETABLING

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This dissertation is dedicated to my parents Prof M. M. Borodo and Hajia Bilkisu.

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ABSTRACT

The University course timetabling pr· ·blem involves the allocation of courses to rooms and timeslots subject to satisfaction of hard and soft constraints. The hard constraints must be satisfied, while the soft constraints are desired to be satisfied. The problem also has an objectice function that need to be maximised. Several methodologies have been used for solving timetabling problem such as the sequential methods, graph coloring, cluster methods, constraint based and meta heuristic methods. The Hybrid Clonal Selection Algorithm with Conflict Based Statistics (Hybrid CLONALG-CBS) was chosen based on CLONALGs' positive track record in optimization tasks and the ability of CBS in avoiding conflicting value assignments to a variable. The Hybrid CLONALG-CBS start with an initial solution, the initialized solution then undergo selection, cloning and mutation; the mutated solutions are used for the generation of improved solutions. The dataset is from Faculty of Computer Science and Information System, Universiti Teknologi Malaysia. The experimental results showed the Hybrid CLONALG-CBS fared better than the manual method and CLONALG algorithm in timeslot utilization, room utilization, Lecture spread and objective function.

ABSTRAK

Masalah penjadualan kursus univesiti melibatkan pengagihan kursus kepada bilik dan slot masa subjek, bergantung kepada kekangan kasar dan lembut. Kekangan kasar mesti dipenuhi, manakala kekangan lembut boleh dipenuhi mengikut keadaan. Masalah ini juga mempunya fungsi objektif yang perlu diminimumkan. Beberapa kaedah telah digunakan untuk menyelesaikan masalah penjadualan seperti kaedah penjajaran, pewarnaan graf, kaedah pengagihan, kaedah berasaskan kekangan, dan kaedah metaheuristics. Kaedah Penggabungan Algorithma Pemilihan Klon dengan Statistic Berasaskan Konflik (Hybrid CLONALG-CBS) telah dipilih berdasarkan rekod pengesanan positif CLONAG dalam kerja-kerja pengoptimuman dan keupayaan CBS dalam menghindari nilai umpukan berkonflik kepada sesuatu pembolehubah. Kaedah Hybrid CLONALG-CBS bermula dengan penyelesaian permulaan yang melalui proses pemilihan, pengklonan, dan permutasian; di mana penyelesaian yang termutasi digunakan untuk generasi kepada penyelesaian yang telah diperbaik. Data yang digunakan adalah daripada Fakulti Sains Komputer dan Sistem Maklumat, Universiti Teknologi Malaysia. Keputusan eksperimen menunjukkan kaedah Hybrid CLONALG-CBS adalah lebih baik berbanding kaedah manual dan algorithma CLONALG dalam penggunaan slot masa, bilik, lembaran kuliah dan fungsi objektif.

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LIST OF ABBREVIATIONS

AIS	=	Artificial Immune System
CBS	=	Conflict Based Statistics
CSP	=	Constraint Satisfaction Problem
CLONALG	=	Clonal Selection Algorithm
FSKSM	=	Faculty of Computer Science and Information System
UCTP	=	University Course Timetabling Problem
UTM	=	Universiti Teknologi Malaysia

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CHAPTER 1

INTRODUCTION

1.0 Introduction

The University Course Timetabling Problem (UCTP) is a type of timetabling problem, there are numerous other timetabling problems such as the transport timetabling problem (i.e. train and bus timetabling), healthcare institutions timetabling problem (i.e. surgeon and nurse timetabling) and sport timetabling problem (i.e. timetabling of matches between pairs of team). The UCTP involves assigning Lectures to a number of rooms and timeslots based on some constraints that must be satisfied (Hard constraints) and other constraints that are desired to be satisfied (soft constraints) in the allocation of the timetable subjects. The problem also has an objective function that needs to be maximized in order for the time table solution to be of higher quality. The objective function usually involves assigning points to each soft constraints of the problem; the more soft constraints are satisfied by the timetabling solution, the higher the value of the objective function.

1.1 Problem Background

The UCTP which is a subset of scheduling is a recurring challenge faced by academic institutions at the inception of each semester. The problem involves assigning courses to be offered in the semester to the available rooms and timeslots while satisfying all the hard constraints. The hard constraints are usually similar across board in different academic institutions. Hard constraints involves not assigning a course to more than one room at the same timeslot, courses offered by students of the same group (students with courses in common) should not be assigned at the same timeslot, the lecturer taking a course should also not be allocated more than a single course at the same timeslot, the number of students offering a course should not exceed the room capacity of the allocated room. There are also the soft constraints of the UCTP that need to be satisfied as much as possible; there are usually different across separate institutions, there are based on the need of each particular academic institution. The soft constraints can involve a specific course to be allocated to a certain timeslot, students should not be assigned more than a certain number of courses in a day, Professors' may prefer to teach in a particular room or on a particular time of a day and a course may need to be scheduled ahead or before another course.

The university course timetabling problem is known to be a NP complete problem because it is a cumbersome problem with many

constraints to be solved and a huge search space to be explored if the problem size increases (Deris et al., 2000).

1.2 Problem Statement

The timetabling process at FSKSM is carried out manually, it takes a number of days for designing and several other days for fine tuning. Mistakes also take place in the timetabling process because a human is involved. Due to these problems, an automated timetabling solution is needed to overcome the shortcomings of the manual method

The prime question for this research study is:

"Could the Hybrid Clonal selection algorithm with conflict based statistics be used for producing a feasible and a higher quality solution for the University Course Timetabling problem?"

For the above prime question of the research to be answered some salient questions needed to be pondered over

- How would the UCTP be modeled with the Hybrid Clonal Selection Algorithm with Conflict Based Statistics?

- How would the Clonal Selection Algorithm be integrated with all the UCTP constraints?
- How would the Conflict Based Statistics complement the Clonal Selection Algorithm functionality
- How can a feasible timetable be generated?
- What is the objective function of the problem which would be a guide for producing better and higher quality solutions?
- What parameters would guide the execution of the designed system because the UCTP is a NP complete problem with unknown bounded polynomial time for its execution?
- How would the generated timetable solution be measured for its quality?

The hypothesis of the this research study can be formulated as follows

"By using the Hybrid clonal selection algorithm with conflict based statistics it can achieve a feasible as well as a higher quality of the University course timetabling Problem."

1.3 Aim and Objectives of the Study

The aim of this research is to develop a Hybrid Clonal Selection Algorithm with Conflict Based Statistics for finding a feasible and better

quality University course timetable solution that satisfies all the constraints of the problem. The objectives of the study are

a) To model the Clonal Selection Algorithm
b) To model and develop a Hybrid Clonal Selection Algorithm with Conflict Based Statistics for University Course Timetabling
c) To evaluate the Performance of the Hybrid Clonal Selection Algorithm with Conflict Based Statistics in terms of the Timetabling solution quality

1.4 Scope of the Study

The thesis would focus on designing a Hybrid Clonal Selection Algorithm with Conflict Based Statistics for University course timetabling problem based on the following:

- The Semester 1 2012/2013 academic session timetable of Faculty of Computer Science and Information System is the Dataset.
- The Hybrid Clonal Selection Algorithm with Conflict Based Statistics would be applicable to the intended domain only.
- The study will design an offline running system (stand alone application) rather than online application (web page).

- The Java 1.7 programming language would be used for designing the application
- The ECLIPSE software development kit would be used for the application development
- The computer system used for the experiment has the following specification: 4GB RAM, Dual core 2.27 GHZ processor, 64 Bit Windows 7 operating system.

1.5 Significance of the study

a) The timetabling problem of FSKSM,UTM is solved using the Hybrid Clonal Selection Algorithm with Conflict Based Statistics

b) The Hybrid Clonal Selection Algorithm with Conflict Based Statistics designed can be tweaked and used for other scheduling problems

1.6 Summary

The chapter started with an introduction of timetabling and also provided the problem statement. Subsequently the objective, scope as

well as significance of the research study were provided at the end of the chapter.

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