AN INVESTIGATION OF GENETIC ALGORITHM APPROACH TO SOLVE UNIVERSITY EXAMINATION TIMETABLING PROBLEMS

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THIS THESIS IS SUBMITTED TO FULFILL THE REQUIREMENTS FOR BACHELOR OF INFORMATION TECHNOLOGY MAJOR IN E-COMMERCE

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DECLARATION

The materials in this thesis are original expect for quotations, excerpts, summaries and references, which have been duly acknowledged.

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ABSTRACT

AN INVESTIGATION OF GENETIC ALGORITHM APPROACH TO SOLVE UNIVERSITY EXAMINATION TIMETABLING PROBLEMS

This research paper discuss on producing a clash free examination timetabling system using Artificial Intelligence (AI). Currently the university is using the CELCAT Timetabling Software to generate examination schedule. CELCAT system is used to generate timetable based on the course that is offered by the university each semester. However, this method yields some unfavourable circumstances. Those are, the number of each set of examination should be spread as evenly as possible over the exam period and the ability to fulfil certain preferences of the examination. Collectively they are known as soft constraints. Therefore, this paper proposes a method to solve the soft constraints by using the genetic Algorithm to generate examination timetabling. Apart from that, by using this algorithm the system is able to produce high quality solutions for the constraints that are above all more essential to the solution produced by the current system.

ABSTRAK

Kertas kajian ini membincangkan tentang penghasilan jadual peperiksaan yang mempunyai pertembugan bebas mengunakan Kecerdasan Buatan (AI). Pada masa ini, Universiti Malaysia Sabah menggunakan CELCAT untuk menghasilkan jadual peperiksaan. Sistem CELCAT menghasilkan jadual pepriksaan berdasarkan kuliah yang ditawarkan pada setiap semester. Namun , sistem ini tidak menhasilkan jadual yang optimum. Sebagai contoh setiap peperiksaan perlu disusun supaya ruang masa yang mencukupi dapat diwujudkan serta beberapa kriteria yang perlu diambil kira dalam penghasilan jadual peperiksaan. Selain itu, Kecerdasan Buatan (AI) ini boleh menghasilkan jadual peperiksaan yang berkualiti denagan mengambil kira semua kengkangan yang telah dinyatakan. Ini merupakan elemen penting dalam penghasilan jadual yang membezakannya dari sistem semasa.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Throughout 20th century our view towards the technology has eventually evolved. The technology has gone through many changes and still going through changes even as we speak. Many methods have been developed to solve complex combinatorial optimization problems. One of those methods will be genetic algorithm. Genetic algorithm has been used to solve problems in the field of bioinformatics, engineering, economics, chemistry and many more related fields. As such category will be exam timetabling (Heitkoetter et al., 1995).

The advantages of using genetic algorithm include the ability to solve every optimization problem with chromosome encoding and solve it by using multiple solutions. Not only that, genetic algorithm is very easy to understand, does not demand knowledge of mathematics and can be easily transferable to existing simulation (Solomon.J et al., 2013). We believe that through this genetic algorithm we would able to produce an efficient clash free exam timetabling system.

Not only that, currently the university is using CELCAT system to generate exam timetables. This system is a semi-automated that requires the administrator man-power to generate the timetable. The genetic algorithm approach can eliminate the human errors as the system will generate through all possible traits to produce high quality results. Last but not least, by using genetic algorithm we would like to solve the hard constraint and at the same time try to minimize the soft constraints as much as we can in order to improve the quality of the final solution of the timetable.

1.2 Project Title

An Investigation of Genetic Algorithm Approach to Solve University Examination Timetabling Problems

1.3 Project Nature

The focus of the project is to develop exam timetabling system by using the current state of art of genetic algorithm in order to solve the complex exam timetabling constraints. During the construction of the timetable, the hard constraints need to be solved in any circumstances, while the soft constraints can be violated, however, these constraints worth taking into consideration to produce a high quality of final solution of timetable.

Through this project we are able to understand the uses of genetic algorithm to solve many complex problems especially in timetabling domain. The model is developed based on the engine that is encoded by us. This encoding is developed based on object oriented programming approach that is written on Java code. Through this research we would like to develop more efficient algorithm that able to generate clash free timetable that is less time constraint.

There are three major decision making process that we take into consideration along this research, namely technical decision, managerial decision and lastly execution decision. In technical decision we create a high quality interface that is user friendly. The objective of this process is to deliver designs that enhance the relevance, effectiveness, efficiency, robustness and sustainability of the genetic algorithm. Next will be managerial decision. We are always aware of the due dates and keep track on the task to ensure that it is completed within the timeframe scheduled; this is because any delay on the task execution will reflect on our time management skill. Lastly keeping track on all project activities. This includes getting

approval from higher authority regarding our project and constant inspection by our supervisor. All this phases should be bond together to produce a high quality result.

There are crucial key values in this project. Firstly, will be collaboration. Our success is dependent on each other. We treat each other with respect and the task has to be inclusive in both our thinking and activities. Secondly, we are confident in our process and in the quality of our work. We encourage independent thinking as a demonstration of freedom of expression. The third value will be diligent. We are thorough and perseverant in our process and bring a methodology, logical, and disciplined approach. Lastly, we always seek the right cause of action in all circumstances. All our deliverables rest on a foundation of both honest and trustworthy.

1.4 Target Users

Firstly, our target user will be the administrator of the examination division. They will use the graphical user interface to input data to produce the examination timetable. Our secondary target users will be lecturers and students. After the schedule is generated, it will be published or revealed to each lecturer personally with their names stated on it. The students can search online for the schedule of the subject that they have registered.

The Information Technology (IT) administrator of the examination department are trained with basic technique of data handling using graphical user interface, therefore this can ease them while using this application to input data. On the other hand, lecturers and students can only read the published information. This can be done easily by just clicking the subjects and the time, date and venue will be displayed.

1.5 Problem Statement

- The AS-IN system used in University Malaysia Sabah is time consuming. This is because the system is semi-automated that requires manual handling by the technical support to develop the timetable.
- The current system used is also expensive. The university is currently spending more than RM100, 000 for this system which is paid yearly.
- Though this current system produces a clash free exam timetable but it is neither efficient nor convenient. This is because when each time a timetable is constructed it is distributed to the lecturers to seek judgment and their opinion on whether or the timetable produced is the best solution which consumes a longer time to publish the final timetable.

1.6 Project Objective

- To solve the hard constraint and minimize the soft constraints.
- To reduce time taken in generating exam timetable
- To reduce man power in generating exam timetable
- To eliminate human errors while generating exam time table

Hence, the hard constraints for the exam timetabling problem in UMSKAL are:

H1: All exams must be assigned and every exam must be assigned in exactly one timeslot.

H2: No student can sit more than one exam scheduled at the same timeslot.

H3: Exams that need to be scheduled together must be assigned to the same timeslot.

H4: More than one exam can take place in the same room if the capacity of the involved room is sufficient. However, there must be sufficient seats in each timeslot for all exams scheduled.

The soft constraints that meant to enhance the quality of the solution in the exam timetabling system are:

S1: Each set of examinations should be spread as evenly as possible over the exam period.

S2: The utilization of resources should be optimized in prevention of wastage in terms of room utilities.

1.7 Scope Statement

The scope of the proposed project is focused mainly on the exam timetabling problem of both schools in UMSKAL which are FCI and FKAL. The areas of concern are examinations offered, timeslots allocated, rooms available and also the quality of examination timetabling schedule in UMSKAL. Besides, the users of this system included in the scope area would be focused intensively.

1.8 Project Timeline

Project timeline is a schedule of activities or events undertaken in completion of tasks that done chronically. Timeline is an essential component of the project seeing that it is constructed around temporal goals and milestones that keep track on the project toward eventual success. Datelines are basic units of project timeline and it is the stepping stone in achieving milestones of the project. Generally, the line drawn upon a suitable scale (days or weeks) in which the planned or projected events are marked to be completed within the certain duration of time. Hence, the project timeline is being represented in a Gantt chart (Please refer Appendix C) that illustrated the project schedule upon completion. The implementation of the optimization solution in

exam timetabling system would be completed as accordance to the time scheduled in prevention of halting or failure in completing the complete research on genetic algorithm.

1.9 Project Methodology

The methodology or the guideline being applied in solving the problems in developing the system involved different specifics components that are carried out in a systematically way. The term Methodology refers to the methods we intend to use to collect data for a project. The methodology is an essential tool to study the project and its particular concept and methods. There are many different ways to approach the system in term of fulfil the user requirements. It is important that to consider the expectations and possibilities in our research paper. Our research paper underlines some research methods to carry out to be use in the system development phase.

Table 1.1 Research Methodology Approach

Method	Procedure
Observation	• Observing the AS-IN system of the University Examination Procedure. • Observing by looking at the procedure and steps taken by the admin [examination division of University Malaysia Sabah Labuan International Campus] • Collecting information on the steps required and time taken to develop the examination timetable.
Survey	• Conducted a quick and simple survey among 30 students of University Malaysia Sabah Labuan International Campus. • These students are from 2nd year and 3th year of school of Informatics Science and Labuan School of International

	Finance • This survey is conducted to know the students feedback on the current exam-timetabling system of UMSKAL as they are the secondary target user for this application.
Interview	• An interview is conducted among the admin and lecturer of UMSKAL to obtain their feedback on the current system and how it works.
Research	• A research done by reading through research articles based on timetabling problems and approaches towards solving timetabling problems using genetic algorithm as a solution. • Five application reviews done on different types of applications that might use any of the algorithm method to solve timetabling problem.

1.10 Data Analysis Overview

Data analysis is a process where analytical and logical reasoning is applied to examine each component of the data. This process is essential and must be completed during a research experiment. The data is gathered, analysed and reviewed from various reliable resources to develop a finding or conclusion.

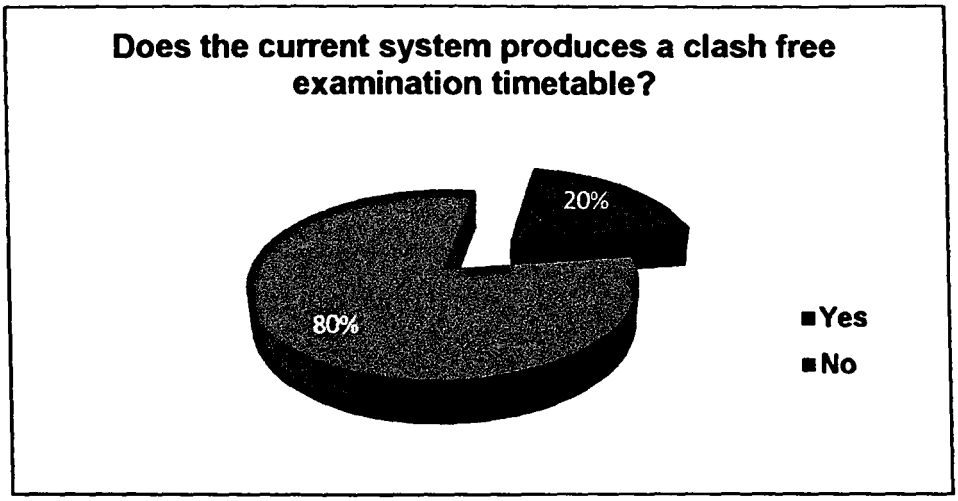
1.10.1 Questionnaire

We have used the Google drive to create the survey form. The form is distributed via email, Google+ and Facebook page. We have asked every respondent to answer 50 questions. We have randomly distributed it to over 100 potential respondents. Unfortunately only 60 students responded to our survey. The rest of the responses were discarded as they were being too late

to be included in our final results. To view questionnaire please refer Appendix A.

1.10.1.1 Timetabling problem

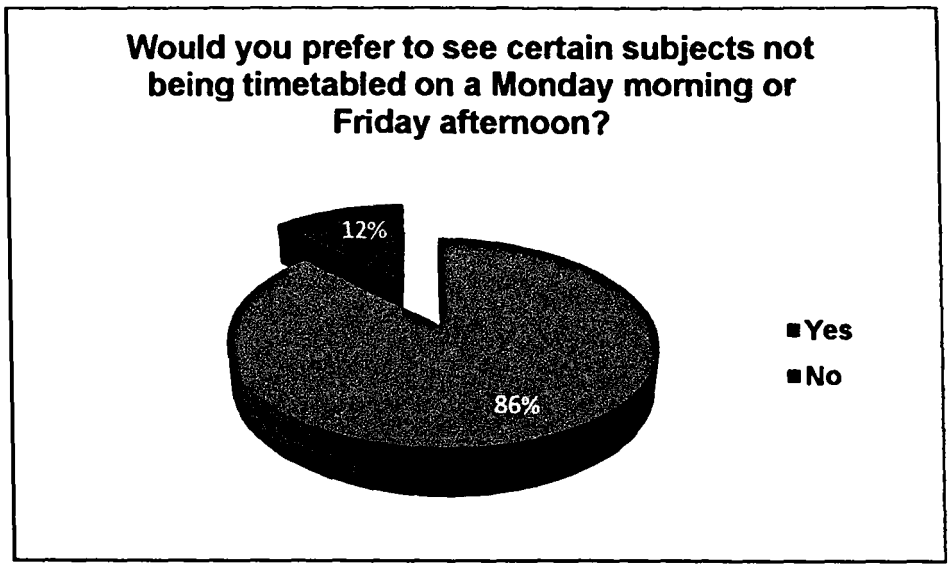
The main conundrum of examination timetabling is to solve the hard constraint. One of those hard constraints will be to produce a clash free exam timetabling system. The current system does not always produce a clash free timetabling system. Regarding this matter we have asked the students "Does the current system produces a clash free examination timetable?" 48 students or a total of 80% disagree to this statement. This is due to the reason that sometimes this system does not produce a reliable output that causes the subjects to clash.

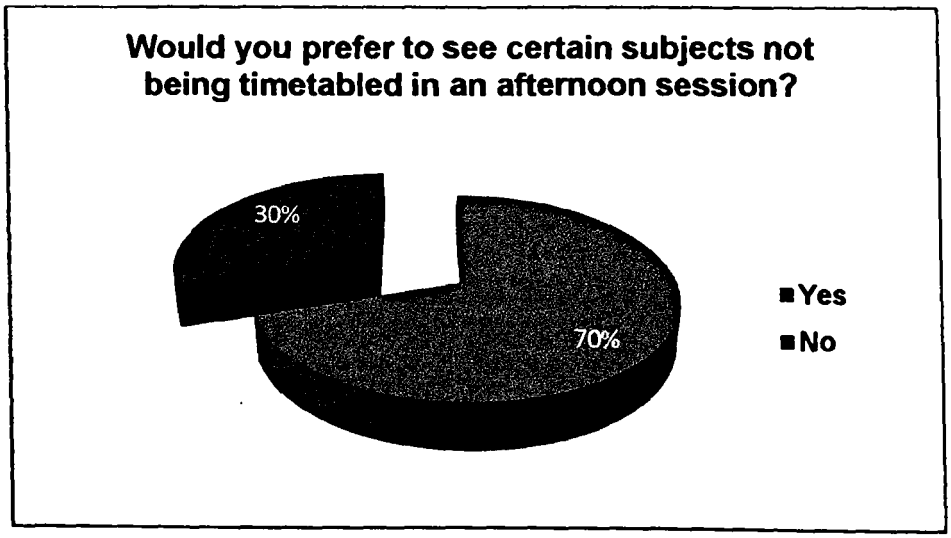


1.10.1.2 Exams and Students

We also asked if the students "Would you prefer to see certain subjects not being timetabled on a Monday morning or Friday afternoon?" 53 students answered yes where else 12% students disagree. This is because majority of the students prefer to use their weekends to concentrate on factual subjects. On the other hand many

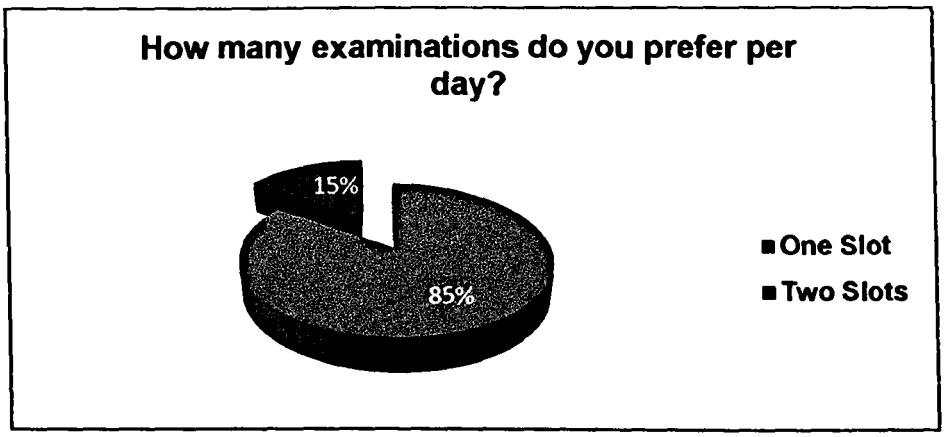
of the students prefer to sit for more relaxing exams on Friday afternoon due to the fact that they had exams the whole weekdays. Another similar question is also asked among the student which is "Would you prefer to see certain subjects not being timetabled in an afternoon session?" Over 70% of the students agreed that they do not prefer factual exam to be scheduled on afternoon session. This is because they are exhausted from the morning examination paper and the environment is not conducive. They prefer mathematical or calculation based subject to be placed during this session.





1.10.1.3 Exams and Departments

The academic department decides the amount of examinations that students need to sit for a day. When we asked the students "How many examinations do you prefer a day". Only 15% of the students answered 2 while 85% responded they only want to sit a paper a day. This is because they do not want to burden themselves by preparing for two different subjects on a single day.



1.10.1.4 Exam Lengths

In this session we asked two questions to them. The first part was "How many days of gaps do you prefer in between examinations?". For this questions 3 options were given, majority of the students which accounted for 45% answered 1 day gap followed by 35% for 2 day gap. The least favoured option was more than 2 days. The following question was "How many weeks do you prefer your exam to be held?" 55% of the students answered within 2 weeks where else the 35% of the respondent answered between 2 to 3 weeks and the rest answered between 3 weeks to 4 weeks. This session shows the eagerness of the students to complete their examination. They do not want to in a stressful situation for a long period of time.

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