SOLVING AN APPLICATION OF UNIVERSITY COURSE TIMETABLING PROBLEM BY USING GENETIC ALGORITHM

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Abstract

Generating timetables for academic institutions is a complex problem. This is due to many constraints involved whether they are vital or desirable, which are known as hard and soft constraints. The problem becomes more complicated and difficult to solve as the number of courses increase. Moreover, generating manual timetables is challenging and time-consuming, particularly to meet lecturers' preferences. Thus, it is crucial to establish an automated course timetable system. Many efforts have been made using various computational heuristic methods to acquire the best solutions. Among the approaches, genetic algorithm (GA), constructed based on Darwin's theory of evolution, becomes the renowned approach to solve various types of timetabling problems. Therefore, this study produces the best timetable using GA to solve clashed courses, optimize room utilization and maximize lecturers' preferences. Data of 41 course sections from 17 courses offered in semester A172 were taken from Decision Science Department, School of Quantitative Sciences (SQS). The phases in GA involves a number of main operators which are population initialization, crossover and mutation. The best parameter setting for GA was determined through combination of different mutation rate, population and iteration. The simulation results of GA show that this method is able to produce the best fitness value that satisfied all hard and soft constraints. There are no clashes either between lecturers or lecture rooms, and lecturers' preferences were satisfied. The system can help SQS or any other academic schools or institutions to easily develop course timetabling in the coming semesters.

Keywords: Course timetabling problem, Lecturers' preferences, Genetic algorithm, Population-based metaheuristic

Abstrak

Penjanaan jadual waktu kursus untuk institusi akademik merupakan masalah yang kompleks. Ini disebabkan oleh banyak kekangan yang terlibat sama ada ia penting atau wajar, yang dikenali sebagai kekangan keras dan lembut. Masalah menjadi lebih rumit dan sukar untuk diselesaikan apabila jumlah kursus meningkat. Tambahan pula, penjanaan jadual waktu secara manual adalah mencabar dan memakan masa, terutamanya untuk memenuhi keinginan pensyarah. Maka, adalah penting untuk membangunkan satu sistem jadual kursus automatik. Pelbagai usaha telah dilakukan menggunakan pelbagai kaedah pengiraan heuristik untuk memperoleh penyelesaian terbaik. Di antara pendekatan tersebut, algoritma genetik (GA), yang dibina berdasarkan teori evolusi Darwin, menjadi pendekatan yang terkenal untuk menyelesaikan pelbagai jenis masalah jadual waktu. Oleh itu, kajian ini menghasilkan jadual waktu terbaik menggunakan GA untuk menyelesaikan pertindihan kursus, mengoptimumkan penggunaan bilik dan memaksimumkan keinginan pensyarah. Data 41 seksyen kursus daripada 17 kursus yang ditawarkan pada semester A172 diambil dari Jabatan Sains Pemutusan, Pusat Pengajian Sains Kuantitatif (SQS). Fasa-fasa GA melibatkan beberapa operator utama iaitu pemulaan populasi, persilangan dan mutasi. Tetapan parameter terbaik untuk GA ditentukan melalui gabungan kadar mutasi, populasi dan lelaran yang berbeza. Hasil simulasi GA menunjukkan bahawa kaedah ini mampu menghasilkan nilai kecergasan terbaik yang memenuhi semua kekangan keras dan lembut. Tiada pertindihan sama ada di antara pensyarah atau bilik kuliah, dan keinginan pensyarah dipenuhi. Sistem ini boleh membantu SQS atau mana-mana pusat pengajian atau institusi lain dalam membangunkan jadual waktu kursus untuk kuliah pada semester yang akan datang dengan mudah.

Kata kunci: Masalah jadual waktu kursus, Keinginan pensyarah, Algoritma genetik, Metaheuristik berasaskan populasi

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Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Resource allocation exists in a wide variety of domain including healthcare institution, transportation, sport, industrial environments, and education. It is the matter how the resources are being allocated to perform a collection of tasks over time. In education domain such as school and university, resource allocation is always being referred as timetabling (Wong, Goh & Likoh, 2022; Petrovic & Burke, 2004).

Diaz-Parra et al. (2022) and Wren (1996) defined timetabling as the allocation of resources to objects placed in space time, depending on constraints, to fulfil a set of desirable objectives the nearest likely. Nuntasen and Innet (2017) stated that university timetabling problem is the arrangement to fulfil compliance and relation of courses, lecturers, classrooms, students, day, and time.

A general university timetabling can comprise of sub-problems such as lecturer assignment, course timetabling, student timetabling and classroom assignment (Gunawan, Ng & Poh, 2012; Bashab et al., 2020). According to Tan et. al. (2021), and Adewumi, Sawyer and Montaz Ali (2009), these problems are categorized under NP-hard problem that concerns with the allocation of certain resources, based on constraints with the goal of achieving a set of stated objectives to the best possible level, which is very difficult to solve exactly or optimally.

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