Sequential Constructive Algorithm incorporate with Fuzzy Logic for Solving Real World Course Timetabling Problem

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Abstract. Sequential constructive algorithm is one of the popular methods for solving timetabling problems. The concept of the algorithm is to assign event based on their difficulty value by using different sequential heuristic. The most common sequential heuristics are largest enrolment, largest degree and saturation degree. Each sequential heuristic has its own criteria to obtain events' difficulty value. Instead of single sequential heuristic, this paper presents to use fuzzy logic to consider multiple sequential heuristics in order to obtain the difficulty value of the events. The proposed method will be used to generate feasible solution as well as improve the quality of the solution. Another objective of this paper is to tackle a real world course timetabling problem from Universiti Malaysia Sabah Labuan International Campus (UMSLIC). Currently, UMSLIC generates course timetable manually which is very time consuming and ineffective.The experimental results show that the proposed method is able to produce better quality of solution less than one minute. In terms of quality of timetable and efficiency, the proposed method is outperforming UMSLIC's manual method.

Keywords: Sequential Constructive Algorithm, Fuzzy Methodology, Course Timetabling Problem.

1 Introduction

A general definition of course timetabling problem is known as scheduling of a given set of courses to a limited number of timeslots and room under certain criteria and requirements [1]. Every institution has its own set of criteria and requirements and they are often known as a set of constraints in timetabling problem. Basically, constraints can be categorized into two groups: hard and soft constraints. A feasible solution must not involve in hard constraint violation. Although different institutions have different sets of constraints, however there are some hard constraints that commonly used in course timetabling problem. For instance, no student is assigned to attend

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more than one lecture concurrently. On the other hand, soft constraints are not necessary to be solved but it is highly desirable when soft constraints violation can be reduced in order to improve the quality of the solution. For instance, a student should not be assigned to only attend a lecture a day. Normally, the feasibility and quality of a timetable is measured by using cost function which indicates the degree of hard and soft constraints violation.

An enormous number of studied have been done with different approaches to solve course timetabling problems since the early of 1960's. For example, methods that are used to generate feasible solution such as sequential constructive algorithm [1], [2] and constraint programming [3], [4]. While metaheuristic algorithms are popular in improving solution such as Great Deluge [5], [6], Simulated Annealing [7], [8], Tabu Search [9], [10] and so forth.

This paper aims to solve course timetabling problems of Universiti Malaysia Sabah Labuan International Campus (UMSLIC). In UMSLIC, the course timetable is generated by timetabling officer manually. The timetabling process is time consuming as it needs to go through several times of amendments in order to produce a feasible timetable. Therefore, this paper proposes to develop an algorithm which integrates sequential constructive algorithm with fuzzy logic [11] to solve UMSLIC course timetabling problems. In this paper, there are two different phases of experiments: construction and improvement phase. The development of algorithm will be further discussed in Section 4.

2 Related Work

2.1 Sequential Constructive Algorithm

Sequential constructive algorithm was first introduced by [12] to solve examination timetabling problems. The idea of the algorithm is to assign those "difficult" events into timetable first. It is very difficult for those difficult events to fit themselves in the timetable when most of the timeslots and rooms are occupied by other events. There are some common sequential heuristics used to generate feasible solution such as Largest Degree (LD), Largest Enrolment (LE), Least Saturation Degree (SD), Largest Colored Degree (LCD) and Weighted Largest Degree (WLD).

However, in [13], the algorithm was unable to produce feasible solution for large instance from benchmark dataset by [14]. Therefore, many researches introduced modified version of sequential constructive algorithms in order to improve the performance of the algorithms.

In [15], a hyper-heuristic framework which employed Tabu search to search for permutations of graph heuristic to solve both examination and course timetabling problems. The framework utilized the Tabu search to store all the possible permutations and select the most suitable heuristic to construct timetable. Any move that is not able to assign course into feasible slot and room will be stored in a Tabu list.

While paper [16] proposed a framework to hybridize sequential heuristics with local search and Tabu search. The framework is composed by three processes which each of them has different objective to achieve. The experimental results showed that