Guided Genetic Algorithm to Solve University Course Timetabling with Dynamic Time Slot

ABSTRACT

This work discussed about one of the most popular technique in Evolutionary Computation, i.e., Genetic Algorithm to solve the UCTP that has dynamic teaching time slot. Duration of a lecture is determined by the course's credit which means that the structure of course timetable can be different between one day to the others. This kind of timetable structure is more complex since the flexible time slot could produce high number of schedules possibility. Hence, a flexible chromosome is developed to deal with dynamic time slot and enhanced the efficiency of the system by eliminating the crossover process which usually time consumed. A Guided Creep Mutation is proposed to act as an evolutionary operator that guides the chromosomes to find global optimum by changing certain gene value gradually in every generation. Our system successfully generated optimum schedule for 878 and 1140 courses in odd and even semester with zero collision in rooms, time, lecturers, also satisfied all soft constraints given. Based on our experiments, the system needs relatively small number of generations with few chromosomes to generate an optimum schedule.

INTRODUCTION

- Previous works in University Course Timetabling Problem (UCTP) deal with static time slot.
- Standard Genetic Algorithm has inefficient computation and tends to be trapped in local maxima, esp. for complex combinatorial optimization such as UCTP.

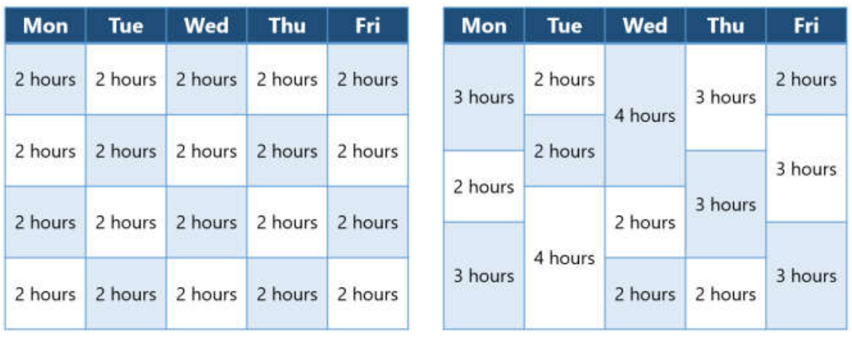

Figure 1. Static vs dynamic time slot in UCTP.

METHODS

In general, our timetabling system only consist of three main process, i.e., **chromosome initialization**, **fitness calculation**, and **guided creep mutation**. Guided Creep Mutation is a customized mutation procedure that is conducted by changing the value of a gene (allele) to the next close value. This mutation is controlled by certain rule to satisfy the timetable policies.

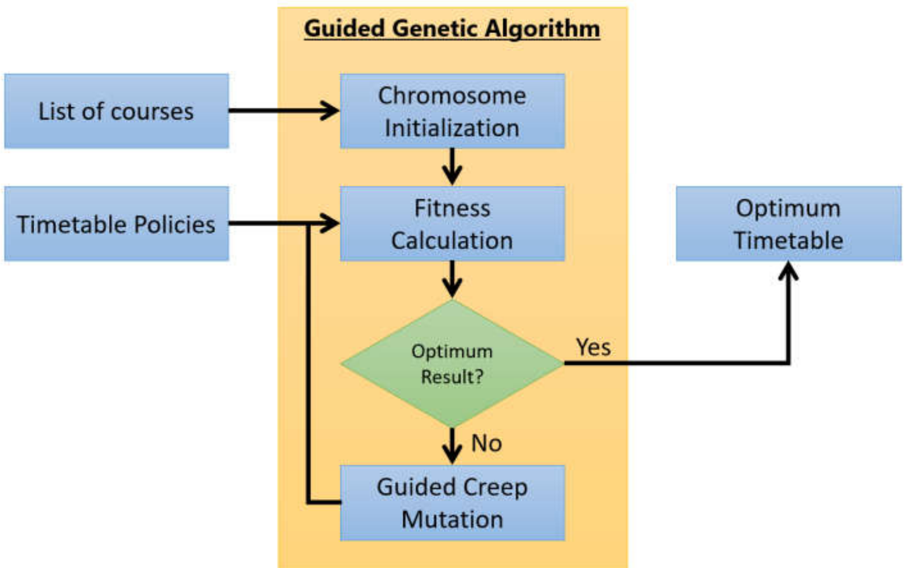

Figure 2. Proposed timetabling system architecture.

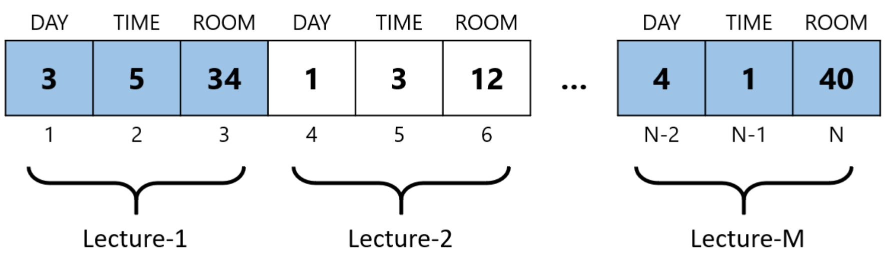

Figure 3. Chromosome design to optimize optimization.

RESULTS AND ANALYSIS

Our timetable system works under a set of constraints that lead the algorithm to find the optimum timetable. There are Hard Constraints (HC) and Soft Constraints (SC). A good timetable must satisfy all HC and, if possible, all SC.

Table 1. Set of HC and SC that is obtained from university's policies.

Constraints	Type	Penalty
No lecturer conflict	HC1	100
No students group (class) conflict	HC2	100
No room conflict	HC3	100
Practical course must be held in laboratory	HC4	100
Every course meeting must be held in room with enough capacity	HC5	100
Lecturer with structural position may not teach before 10.30	HC6	100
A lecturer should not teach more than 6 credits in a day	SC1	10
Lecturer should not teach after 12.00 PM on Saturday	SC2	10
Lecturer should not teach in the first time slot if the day before he taught in the last time slot	SC3	10
Lecturer should not teach more than 7 hours in a day	SC4	10
The number of lectures on Saturday should be less than on other days	SC5	10
Students should not attend the class more than 6 credits in a day	SC6	5

Compared to other works that used much less lecture meetings, our proposed system works more efficiently with smaller number of chromosome and generation. To be noticed, there is no violation to all HC and SC in this work, while other mentioned works still have violation on some SC.

Table 2. Set of HC and SC that is obtained from university's policies.

References	Lectures	Chromosomes	Generations
Ref. 1	100	100	200
Ref. 2	300	20	1000
Ref. 3	166	-	900
This work	1140	10	**410**
This work	878	10	**137**

CONCLUSION

In this research, we designed a chromosome where a lecture meeting is encoded in three different genes to represent 'day', 'time', and 'room' for each lecture meeting. We also proposed the Guided Creep Mutation which works by changing the gene value in a small step size based on certain rules. This mutation mechanism successfully helps GA to avoid local maxima and finally finding the best solution in feasible time. All in all, our system enables to find the optimum timetable that satisfies all hard and soft constraints specified by Universitas Teknologi Yogyakarta.

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