Time Table Generation using Constraint Programming Approach

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***Abstract*—**Every college in today's era has number of different courses and each course has a number of subjects. Since there are limited resources to allocate such as faculties, labs, class rooms, the time table is needed to schedule and conduct different courses which do not have any overlapping of resources at a given time. The time table generation algorithm should make the optimum use of available resources.

General terms: *Algorithm, Constraint Programming.*

Keywords:*Automatic timetable generator, Scheduling, Constraint Programming***.**

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I. Introduction

A schedule [1] or a timetable[1], as a basic time-management tool, consists of a list of time slots at which possible tasks, events, or actions are intended to take place. The process of creating a schedule - deciding how to order these tasks and how to commit resources between the varieties of possible tasks - is called scheduling [1**]**.

The class timetabling [1] problem is a scheduling algorithm with great interest and inference in the fields of operational research and artificial intelligence. The problem was first studied by Gotlieb**[**2][3], who formulated a class-teacher timetabling problem by considering that each lecture contained one group of students and one teacher, such that the combination of teacher and students can be chosen freely. The timetabling problem can be solved using a heuristic [2] search algorithm to find the optimal solution.

II. BACKGROUND KNOWLEDGE

The class timetabling problem is a classic scheduling problem. The direct heuristics [3] technique used for scheduling problem are based on successive augmentation [3]. When class schedule is made the resources such as number of faculties, students, sections, classrooms, size of classroom and laboratories are considered. There have been a large number of approaches made in the past decades to the problem of constructing timetables for colleges and schools. Timetabling problems may be solved by different methods that are inherited from operation research such as graph coloring [4] and mathematical programming [4], from local search procedures[4] such as "taboo"[4] search and simulated annealing[4], from genetic algorithms to back-tracking Based Constraint Programming[5].

In recent years two main approaches are widely used. The first approach is based on Local Search Procedures. The second approach is based on Constraint Programming (CP).

The Local Search Procedures [4]

The local search procedures such as Simulated Annealing, Taboo Search and Genetic Algorithms. These methods express constraints as some cost functions, which are minimized by a heuristic Search of better solutions in a neighborhood of some initial feasible solution. To solve the course scheduling first the basic Local Search entities should be defined, namely the cost function, the search space and the strategy for generating the initial solution.

The Constraint Programming (CP) [5]

The main advantage of constraint programming is declaring a straightforward statement of the constraints in the algorithm. This makes ease in modification, which is crucial in timetabling problems. The constraints are handled through a system of constraint propagation.

Genetic algorithms [6] are general search and optimization algorithms inspired by processes and normally associated with natural world. Unlike many heuristic schemes, which have only one optimal solution at any time, Genetic algorithms maintain many individual solutions in the form of population. A genetic algorithm contains population of chromosomes, selection according to fitness, crossover to produce new offspring, and random mutation of new offspring.

III. LITERATURE SURVEY

Time tabling problem is said to be one the non-polynomial(NP) complete problems. The most striking feature of NP–complete is that no best solution the problem is that no best solution is known. Only

T Murata, in [7], presented hybrid algorithm for finding a set of non-dominated solutions of a multi-objective [7] optimization problem operations. The algorithm uses a weighted sum of multiple objectives as a fitness function.

Edmund Bruke et al. in [8] introduced two variants of local search where the search time can be set as an input parameter. These two approaches are: a time-pre-defined variant of simulated annealing and an adaptation of the "great deluge" method which improved previous results for exam timetabling problems.

D M Ryan et al., in [9], introduced constraint programming minimum cost matching model which is useful to overcome the problems of computational complexity in scheduling set partition programs.

Ana Cerdeir et al., in [10], presented the random non ascendant method (RNA) and genetic algorithm variants(GAT4C) for school timetabling problem. RNA and genetic algorithm variants more precisely called GAT4C have been used for obtaining feasible timetables in a judicious computing time.it has reduced the hard constraints drastically.

M. Nandhini et al., in [11], presented class timetabling with multi agents by steepest ascent hill climbing algorithm. It has agent procedure named Combination-Generator which generates the maximum possible combinations for the inputting timetable as well as the agent Min-Finder which finds a combination with minimum evaluation function value for further successive examination thus over all reducing the search space for solution.

Table I LITERATURE SUMMARY

Author	Techniques	Findings
T Murata[7]	Local Search Algorithm using weighted sum of multiple objectives	The fitness function is utilized when a pair of parent solutions is selected for generating a new solution by crossover and mutation operations. A local search procedure is applied to the new solution to maximize its fitness value.
Edmund burke et al. [8]	Local Search Method “great deluge algorithm” Time-pre-define simulated annealing.	Performance of a local search algorithm can be significantly improved by incorporating a controlled management of the processing time into the approach.
D M Ryan et al.[9]	Constraint Programming minimum cost matching model	The use of this model in search process is an economical and efficient mechanism for the creation of effective search strategies
Ana Cerdeir et al.[10]	The random non ascendant method (RNA) and genetic algorithm variants(GAT4C)	The use of this method is to satisfy both hard constraints and soft constraints to some extent.
M. Nandhini et al.[11]	Multi agents by Steepest ascent hill climbing algorithm	Handle and generate combinations of input and find combination of minimum evaluation function value to reduce the Search space.

IV. PROBLEM SPECIFICATION FOR AN ENGINEERING INSTITUTE

An engineering college offers courses for students in daytime. There are two academic sessions annually in any engineering college such as even semester and odd semester. Even semester is in winter while odd semester is in summer. Each semester class has two divisions, ’A’ and ‘B’. These are further divided into six Laboratory batches. Class-structures of both the semester are very complex, which include different types of classes, such as single-slot, multi-slot, split, combined, open, and group classes. The types of lectures are: 1.Theory 2. Tutorial 3.Practical
The class group size of theory lectures is from 40 to 60 students. The group size for practical hours is from 15 to 25 students. A minimum timeslot is 60 minutes that is 1 hour for theory classes and 2 hours for practical and tutorial. Two breaks are provided daily for Monday to Friday.

In one day 6 slots are allocated to lectures and labs that is in one week 36 slots for lectures, practical and tutorial according to the subject scheme.
A constraint [9], in project management, is any restriction that defines a project's limitations; the scope, for example, is the limit of what the project is expected to accomplish.
Different constraints in timetabling algorihtm needs that are madatory are :

1 A class room must be assigned only to one lecture at a time

2 A lecturer must be allotted on lecture or lab

3 The labs and classrooms must have the predefined capacity for students.

The following Constraint may be satisfied as per the needs of the user:

1 Lecturer’s daily lectures must be within the allowed maximum hours.

2 Practical courses must be assigned in afternoon classes

and theory courses must be scheduled in morning classes

3 As far as possible, classes should be scheduled in their respective classrooms

4 Lunch breaks must be scheduled

Proposed system will be able to generate timetable for all the lectures and faculties, maintaining the availability of teachers, availability and capacity of physical resources, and set of rules applicable at different levels. The algorithm will take various inputs as variables like number of subjects, teachers, maximum number of lectures a teacher can conduct, subject scheme. The proposed system will be able to generate possible time table for working days of the week with optimal use of all resources.

V. PROPOSED SYSTEM ARCHITECTURE

The proposed system is to design and develop a consistent and real-time time-table generator, which would be able to facilitate faculties, students and administration people to effectively manage the teaching hours.. It will generate timetable for each class and teacher, in keeping with the availability calendar of teachers, availability and capacity of physical resources (such as classrooms, laboratories and computer room) and rules applicable at different classes, semesters, teachers and subjects level.

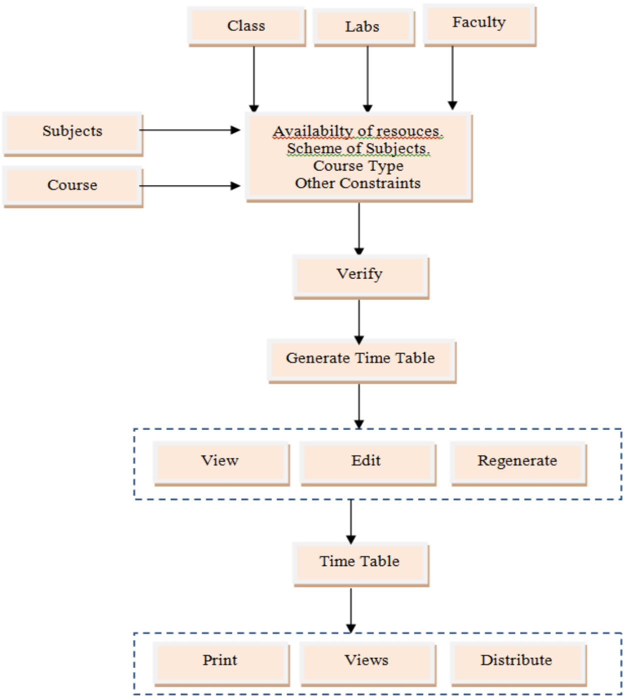

Figure 1. Proposed System Architecture

The proposed system generates multiple useful views from time table. It will detect clashes of same faculty allocation at same class or slot with different subject as well as allocation of same class rooms to different classes.

Pseudo code for generating a schedule will be as follows:

Variables used:
C: - Class
C_i: - Class selected
L: - Lectures per subject
L_j: - Lecture selected
S: - Subjects
S_k: - Subject Selected
F: - Faculty
TS: - Time Slot
TS_m: - Time Slot m
D: - Day
D_n: - Day Selected
Max_Day:- 5 Monday-Friday
Steps:

```
1.  Select $C_i$ class, start loop from Ci=1 and display list of subjects S.
2.  Select Subject $S_k$ from S and start loop with $S_k$ .
3.  Start Loop with  $L=L_I$ and allot lecture Li of subject selected $S_k$ from S and
4.  Allocate in time slot $TS_m$ of the day $D_{n.}$
5.  Calculate DayFreeSlotn = $DayTotalSlot_n$ – $DayAllocatedSlot_m$.
6.  If lecture Li allotted is 2 then,
      i.  $SubjectSchemeLab_k$ = TotalSubjectLab $_k$ – $AllocatedLab_k$ and
      ii. AvailableLab = TotalLab – $AllocatedLab_k$
7.  Else
      i.  $SubjectSchemeLecture_k$= $TotalSubjectLecture_k$ - $AllocatedLecture_k$ and
      ii. AvailableRoom = TotalRoom – $AllocatedRoom_k$ .
8.  $FacultyLoad_x$= TotalLoadx – $AllocatedLoad_x$.
9.  Repeat steps 3 through 7 till Lecture Selected $L_i$ = $MaxLectureOnDay_n$ and DaySelected$D_n$ =MaxDay.
10. Repeat steps till Subject Selected $S_k$ = MaxSubject.
11. Repeat loop till Class Selected Ci $_=$ MaxClass.
```

VI. CONCLUSION

The proposed system generates time table based on the available resources such as faculties, class rooms and subjects. The proposed system performs constraint based allocation of available resources. The application will make the procedure of time table generation easier consistently which may otherwise need to be done using spread sheet manually which might lead to constraints problem

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