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Timetable Management System for an Academic Institution

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Introduction: The intricate task of scheduling lectures by assigning teachers and students classes based on multiple interdependent and closely related factors such as time slots, class venues and course subjects is a problem faced by every educational institution. Although this task seems to be very common, the rules and regulations pertaining to particular institutions generate several 'constraints' that must be kept in mind while arriving at a largely generalized technique of generating timetables for all the departments and semesters. Computerizing the process of generating such a timetable saves a lot of time, provides clarity and avoids repetition as well as ambiguity.

Project Overview: The project focuses on developing a timetable management system for a university. It requires the optimal configuration of a given set of variables- namely the students, the faculty, the courses and semester within each department in a university. The project makes use of a database for the storage of data. On the successful completion of this project, the system will be able to accomodate the creation of a systematic schedule for students and for faculty, who handle classes across semesters and branches. It aims to automate the creation of timetables, which would otherwise be a very tedious and cumbersome process.

Objectives:

1. To identify the requirements for a university timetable generation system by analyzing the existing systems.
2. To design the system by adhering to the constraints hereto provided and developed based on need.
3. To create a database with information regarding courses offered in each semester by each Department and the total hours per week, the faculty teaching these courses for each section and the classrooms and labs available
4. To develop the system to provide a structured, well-organized timetable for all sections in all semesters across all Departments at both the Undergraduate and Postgraduate levels, as well as a timetable for faculty, which can be accessed with the help of a smooth and comprehensible user interface.

5. To test and validate the system to avoid misallocation of course units, clashing of lecture times, and double-booking of lecture halls and practical labs.

Problem Statement

The given problem of generating a timetable for an academic institution can be classified as a scheduling problem. The problem essentially requires the process of allocation of a variety of courses in a stipulated time period based on the availability of resources such as teacher, student and lecture halls while satisfying a set of constraints.

1. The following criteria have been identified as inputs to be obtained for the generation of a timetable: the degree (UG/PG), semester, department and the section, classroom, lab sessions and their slots, names of the courses and the number of hours required per week, the names of the faculty members, and the courses that they handle.
2. A solution to the problem also depends on the constraints that have been imposed on the system, in terms of time constraints and constraints on faculty. The academic institution must be considered as a whole, while formulating the solution.
3. A need for two levels of accessibility has been identified:
    - At the student level- To view the timetable of their section in their department.
    - At the faculty level- To add courses, the number of sessions and its venue, to add a lecturer and the course taught and to assign lab slots.
4. The output would be a timetable corresponding to the inputs entered, for students and faculty.

Constraints

Basic Constraints

1. A student can attend only one lecture at a time.
2. The timetabling should be done department wise, with eight departments in all.
3. There are two sections per department.
4. The timetabling should be done for 2nd, 3rd and 4th year students along with PG students.
5. The number of subjects for each course in each semester must be taken into account.
6. Timetables must be suitably allocated for both teachers and students without any overlap.

Time Specific Constraints

1. Each day consists of six hours of classes, and there are classes for five days a week.
2. There are four hours of classes in the forenoon session and two hours of classes in the afternoon session.
3. The day starts at 8:15 am and ends at 3:30 pm. Each lecture is 60 minutes long.

Course Specific Constraints

1. Math courses must preferably have 4-5 hours of classes per week. Other subjects should have 3 hours per week.
2. Faculty belonging to the student’s department must be allotted at least one first hour.

3. The first hour must not be handled by faculty from the math department or any other department, other than the student's department.
4. Apart from academic courses, there are courses common to all branches, like Environmental Science and Humanities Electives, and certain mandatory courses like Mentor, Sports and Library.

Faculty Specific Constraints

1. A maximum of 2 hours can be allocated for a faculty per day.
2. Faculty must not have two classes in a row.
3. A lecturer should not meet a class twice in any half day, but they may meet a class in both the morning and afternoon of one day.

Techniques:

1. It is initially required to procure a dataset with information on the number and names of the courses offered, and details of the faculty handling different courses in each department, for each semester.
2. An efficient method to store and organize the records of an academic institution would be in the form of tables. Student records pertaining to their department, semester, courses and section could be maintained in a table. Similar tables containing information about the faculty and the courses that they teach could also be organized in separate tables. Relationships between these tables can be established to develop the scheduling system.
3. The initial development of the timetable would be done by taking into account the total number of hours available, forenoon and afternoon.
4. The process of allocation of courses would be an iterative process:
   a. A subject can initially be arbitrarily assigned, taking into account some of the course specific constraints.
   b. There must be a decrementation in the concerned resources: namely a reduction of the number of class hours utilized, and also the availability of the faculty member.
   c. Subsequent classes are allocated based on whether a lecturer and a slot is available.
   d. Before allocation, there must be checks to ensure that faculty and course constraints are also satisfied.
   e. In the case of laboratory classes, three hours must be allocated in bulk, and preferably the lab courses can be fixed on the timetable first.
   f. In case of failure to generate a solution, these steps must be repeated, until fruition.
   g. Vacant hours in the timetable can be filled by allocating Sports, Mentor and Library hours.
5. The database is organized in such a manner that the basic constraints, such as avoiding the overlap of classes is adhered to. Data redundancy is eliminated and the integrity of the data is maintained.
6. Ease of accessibility can be achieved by implementing a user friendly Graphical User Interface.

Literature Survey

1. Mary Almond in "An Algorithm for Constructing University Timetables", suggests a simple heuristic approach to develop a timetable for different departments. The resources are represented

in the form of a 3-dimensional array. When an allocation is made for a class, there is a decrementation made in a Requirements matrix and a Lecturer Availability matrix. The solution generated may not be unique, and different variations can be obtained by scanning the Requirements matrix in different directions.

2. Samson Oluwasuen Fadiya et al. emphasize on the effective usage of relational databases to store and retrieve data in an organized manner for the development of a scheduling system in "University Time-table Scheduling System: Databases Design". It elaborates on the required tables, and the interconnectivity that has to be established between them, such as the relationships between the faculty table and the course table.
3. Mei Ching Chen et al. in "A Survey of University Course Timetabling Problem: Perspectives, Trends and Opportunities" discuss different approaches to solving this problem. One proposed solution is using graph colouring, wherein the courses are the nodes of the graph, and the time slots and possible clashes are the edges. Lectures are assigned based on factors like largest and weighted degree. Another possible solution is arrived at through genetic algorithms, which uses the concept of biological evolution, selecting the fittest solutions, based on predefined constraints. Yet another approach is Ant Colony Optimization, modeled after the foraging behaviour of ants, involving the identification of the shortest path. This approach divides students into mutually exclusive groups, and then assigns each group into time slots and venues accordingly.

Timeline

Activities	29.05.22-02.06.22	03.06.22-23.06.22	24.06.22-07.07.22	08.07.22-11.08.22
Problem Definition				
Literature Survey				
Formulating the Algorithm				
Acquiring records and establishing relations				
Catering to basic constraints				
Incorporating Time Specific Constraints				
Integrate Faculty Specific Constraints				
Including Course Specific Constraints				
Implementing the model				
Debugging and Testing				

References

1. Educational Timetabling: Problems, Benchmarks and State of the Art Results
   DOI: https://doi.org/10.48550/arXiv.2201.07525
2. Mary Almond- An Algorithm for constructing University Timetables
   DOI: https://doi.org/10.1093/comjnl/8.4.331
3. A Survey of University Course Timetabling Problem: Perspectives, Trends and Opportunities
   DOI: 10.1109/ACCESS.2021.3100613
4. University Time Table Scheduling System: Databases Design
   https://oaji.net/articles/2016/2985-1455546839.pdf