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Timetable Scheduling using Bipartite Graph

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Abstract: ***In any educational institution, the two most common academic scheduling problems are course timetabling and exam timetabling. A schedule is desirable which combines resources like teachers, subjects, students, classrooms in a way to avoid conflicts satisfying various essential and preferential constraints. The timetable scheduling problem is known to be NP Complete but the corresponding optimization problem is NP Hard. This problem is solved using bipartite graph. Hence a heuristic approach ispreferred to find a nearest optimal solution within reasonable running time.***
Keywords: course time table scheduling

I. INTRODUCTION

In the year 1736,graph theory originated from the Konigsberg bridge problem pointed out by mathematician Euler which later led to the concept of Eulerian graph[4]. In the same decade, Gustav Kirchh off established the concept of a tree, a connected graph without cycles which was used in the calculation of currents in electrical networks or circuit and later to enumerate chemical molecules.In1840.

While constructing schedule of courses at a college or university, it is obvious that courses taught by the same professor and courses that require same classroom must be scheduled at different time slots.Further more,a particular student or group of students may be required by a curriculum to take two different but related courses(e.g., physics and Mathematics) concurrently during a semester. In such cases too,courses need to be scheduled in away to avoid conflicts.

A. Basic Concepts of Graph Theory

A graph G is an ordered triplet (V(G), E(G), ϕ) consisting of a non-empty set V of vertices or nodes, E is the set of edges and ϕ is the mapping from the set of edges E and the set of vertices V.

In a bipartite graph (or bigraph) (Fig. 1) the set of vertices V can be partitioned into two disjoint sets *V1* and *V2* such that every edge of the graph connects a vertex in *V1* to one in*V2*, i.e.*V1* and*V2* are independent sets.

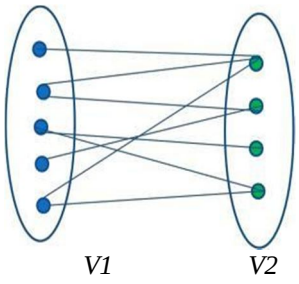

Fig.1Bipartitegraph

II. SCHEDULING PROBLEM

The general idea of a scheduling problem is defined by allocation of related resources among a number of time-slots satisfying various types of essential and preferential constraints aiming at creating optimized conflict-free schedule.

Some of the typical scheduling problems include-

A. Timetable Scheduling

1) CourseTimetableScheduling-coursessharingcommonresourcestobescheduledin conflict-freetime-slots.
2) ExamTimetableScheduling–examssharingcommonresourcestobescheduledin conflict-freetime-slots.
3) Aircraft Scheduling-aircrafts need to be assigned to flights.

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B. Motivation Towards Timetable Scheduling

Effective timetable is vital to the performance of any educational institute. It impacts their ability to meet changing and evolving subject demands and their combinations in a cost-effective manner satisfying various constraints. In this paper, we have focused our work into CourseTimetable Scheduling.

C. Course Timetable Scheduling

Course Timetabling is the scheduling of a set of related courses in a minimal number of time-slots such that no resource is required simultaneously by more than one event.In a typical educational institute resources,which may be required by courses simultaneously can be students, classrooms and teachers.

III. TEACHER-SUBJECT PROBLEM

A. Problem Definition

For a given 'T' number of teachers, 'N' number of subjects and available 'P' number of periods, a timetable should be prepared. The number of classes for each subject needed by a particular teacher is given in Table2.This problem is mentioned earlier in some papers[25][26]but only a partial solution was provided in both.

B. Input Dataset

Number of teachers -3
Number of subjects-5
List of subjects are following

N1- Calculus
N2- Classical Mechanics
N3- Phython Programming
N4- Trigonometry
N5- MS office

Teacher-Subject Requirement Matrix

Periods P	N1	N2	N3	N4	N5
T1	2	1	0	1	0
T2	1	1	1	0	2
T3	0	1	1	1	1

C. List of Constraints

1) Hard Constraints

a) At any one period, each subject can be taught by maximum one teacher.
b) At any one period, each teacher can teach at most one subject.

2) Soft Constraints

a) Teacher taking two classes of same subject to be scheduled in consecutive periods.
b) No more than two consecutive theory classes can be assigned to same teacher for teaching same subject.

D. Solution

This problem is solved using bipartite graph which acts as the conflicts graph. The set of teachers and subjects are the two disjoint independent sets . edges are drawn connecting a vertex from teacher set to a vertex in subject set, indicating that the subject requirement matrix given table .
The solution to the problem is obtained by proper edge coloring of the bipartite graph as shown the following figure. The chromatic number acts as the minimum number of periods.

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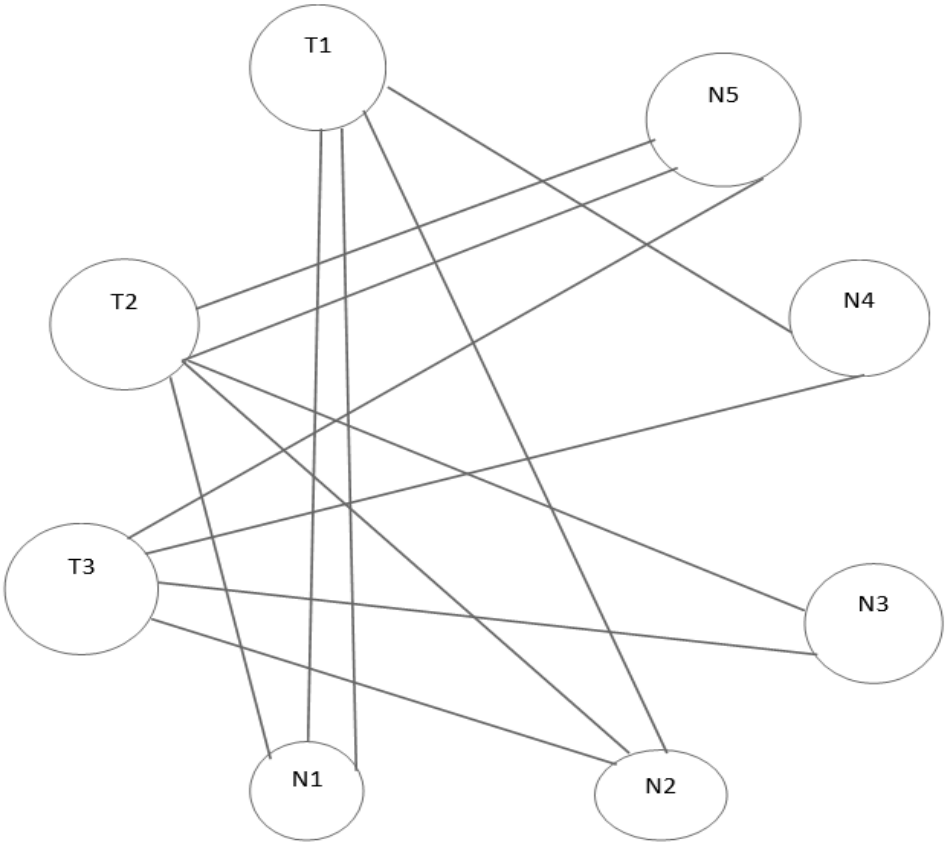

Bipartite Graph G

Thus the final complete schedule is obtained
Final Teacher -Subject Allotment Table

Period 1	Period 2	Period 3
T1N2	T1N1	T1T4
T3N3	T2N1	T2N5
	T3N2	T1N5

IV.CONCLUSION

This paper focus our works into course Time Scheduling using bipartite graph .which helps the educational institute to construct effective time table.

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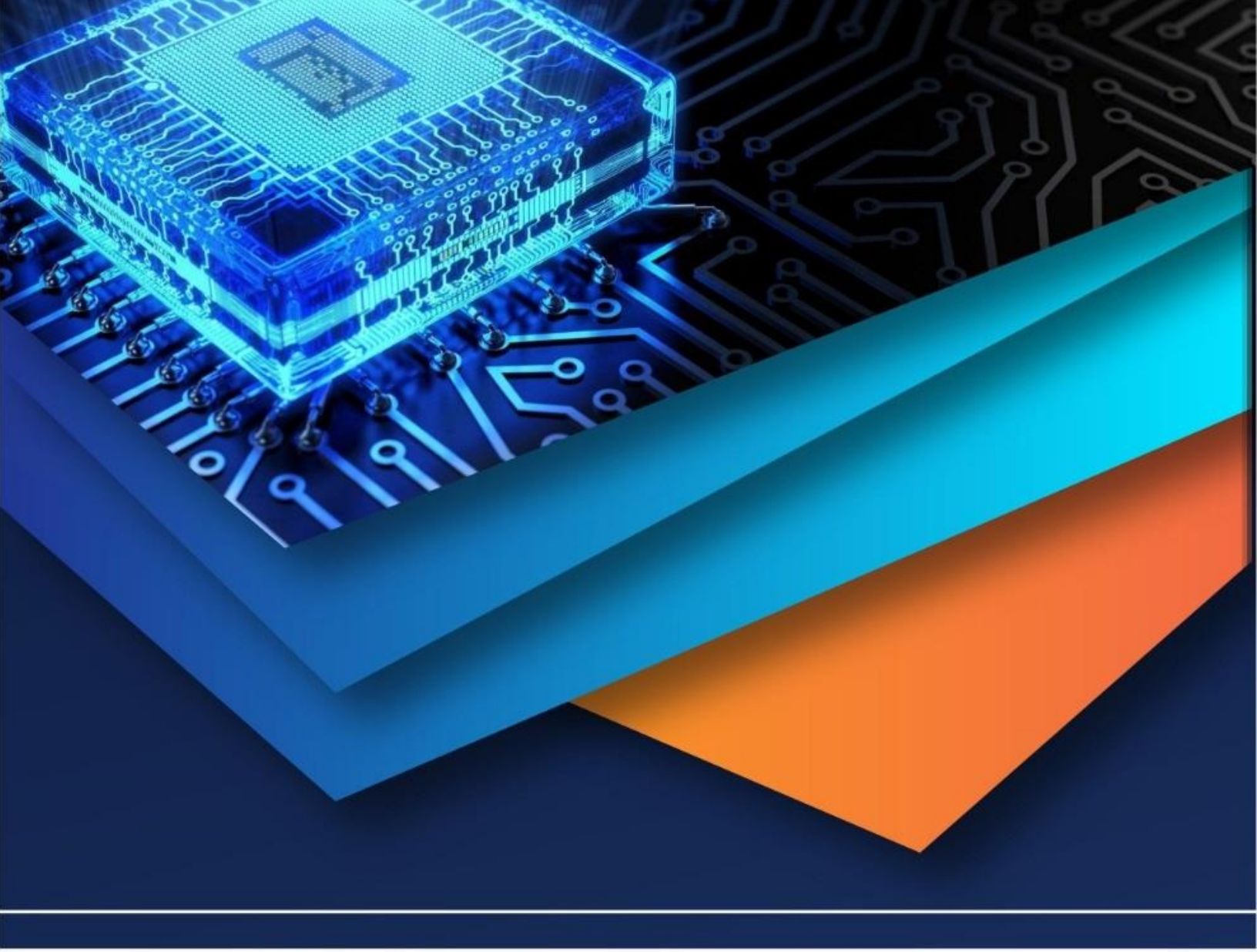

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