Lecture Scheduling System Using Welch Powell Graph Coloring Algorithm in Informatics Engineering Department of Universitas Malikussaleh

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Abstract. Scheduling lectures is a routine work in the academic system in higher education every time to facing a new semester. In the implementation, often the schedule that has been issued has not been fixed so it requires rescheduling. For this reason, a new lecture scheduling system is needed using the Welch Powell Graph Coloring Algorithm. This study was done in the Informatics Engineering Department of Universitas Malikussaleh using the subjects schedule during 2013, 2014 and 2015. Based on the results of this study it can be concluded that the Welch Powell Graph Coloring Algorithm can solve properly the problem of scheduling lectures, in this case there are no clashes between scheduled components.

1. Introduction

Scheduling lectures is a routine work in the academic system in higher education which is conducted every time to facing a new semester. In the implementation, often the schedule that has been issued has not been fixed so it is need to rescheduling. This results in the lecture at the beginning of the semester was ineffective because it has to adjust the schedule to real conditions after the schedule is issued. In addition, difficulties in finding empty slots also become a problem, especially when looking for a substitute lecture schedule or additional lectures.

Lecture scheduling problems are closely related to optimization problems. Therefore, the development of lecture scheduling systems is done through several iterations of improvement. The objective function
is to fill a number of scheduling constraints, such as avoiding clashes of schedules. In Discrete Mathematics study, the graph theory provides solutions to these problems through discussion of graph coloring. The development of a lecture scheduling system that applies this theory is expected to be able to answer this problem accurately so it can be implemented for scheduling lectures.

Graph theory is one of the chapter in discrete mathematics that is interesting to discuss because it deals with problems that are commonly encountered in everyday life [1]. Graph is a complex mathematical model and completely difficult, but it can also be the best solution for certain problems. Currently graph theory is growing and interesting because of its uniqueness and its many applications. One of reason for the rapid development of graph theory is its vast application in everyday life and in various area of science [2]. The uniqueness of graph theory is the simplicity of the subjects it learns, because it can be presented as a point (vertex) and edge. One chapter of graph theory commonly used in modeling problems is graph colouring [3]. Graph coloring is giving a color to the graph element that will be used as a subject in understanding the problem constraints. There are three various of coloring graph problems, which are point coloring (vertex), edge coloring, and region coloring. For example a problem can be modeled with graph coloring is the problem of arranging a course schedule on college, especially in each department [4].

In everyday life, the problem of arranging lecture schedules on campus is related to the time allocation (conformity with the Semester Credit Unit of each subject), the availability of lecturers in each department and the availability of lecture halls. One of the departments have experienced problems to preparing the schedule was the Department of Informatics Engineering, Universitas Malikussaleh. The allocation of lecture time, the determination of lecturers and the determination of lecture halls is an important element in preparing lecture schedules in each department.

Scheduling problems that often occur, class schedules for several semesters, lecture halls used or overlapping / collision. In addition, the existing lecture schedule exceeds the time or lecture hours that have been determined in accordance with the Semester Credit Unit of each subject. Therefore, an efficient lecture scheduling system is needed so that learning on campus can be done more optimally and efficiently.

2. Related Works
The graph was used to represent discrete objects and relationships between these objects. The visual representation of the graph is to state that the object is expressed as a dot, circle, or point, while the relationship between objects is decribed by lines. The graph coloring is a special case of graph labeling. Labeling means to give color to points at a certain limit. There are three types of graph coloring, like node coloring, side coloring, and region coloring. Algorithms in graph coloring are: Welch-Powell Algorithm and Coloration in Bipartite Graph [5].

3. Research Methodology
3.1 Previous System
In the current system, the data processing process the existing lecture schedule is still implemented using the welch powell graph coloring method, where the application of this method functions to distinguish the lecture schedule that can be done at the same time or at different times by coloring each schedule arranged in every semester.

3.2 Systems that will be Developed
Lecture scheduling application using a graph coloring algorithm welch powell with case study in Informatics Engineering Departement Universitas Malikussaleh is a system that processes data and processes lecturer class schedules, involving lecturers, teaching hours and room. This system is designed to share lecturers' schedules with the same room and different hours. It is seen like to determine accurate and precise data so that errors in data duplication do not occur.
3.3 System Design
The system design in this study was designed with an algorithm method with details of room, hours, name of the lecturer. In the design process, the author will explain about the Context Diagram of data flow diagrams (DFD) that are used to describe the process in the lecture scheduling application using Welch Powel graph coloring algorithm [6] case study of Informatics Engineering Departement of Universitas Malikussaleh. This chapter will also present program specifications, entity relationship diagrams (ERD). The following is the process of the sequence of systems that the author did in this study:

![Sequence of System Processes](image)

**Figure 1.** Sequence of System Processes

4. Result and Discussion
4.1 Database Design
Database is a collection of information stored on a computer systematically so it can be checked by a computer program to obtain the database information. The design of database files is required attributes for the data input process so the program is made accordingly. The design of this database includes the tables that build a database, in the scheduling application using the ant algorithm case study Informatics Engineering Departement of Universitas Malikussaleh.

4.2 System Stages
In this application about scheduling, the solution will be generated to determine the time and room for lectures, where all events (events are representatives of classes, semesters, lecturers, and courses) will be scheduled for times (timeslot) and placed in rooms (room assigning), will be solved by using the welch powel graph coloring algorithm to produce scheduling lectures with a good solution. Following is the implementation of the scheduling of selected courses in tables 1 and 2.

The Welch-Powell algorithm is stated as follows:

a. Sort the vertices in graph G in decreasing degrees.
b. Use one color to color the first node (which has the highest degree) and other nodes (according to the order) that are not side by side with the first node.

c. Start again with the next node highest degree in the ordered list which is still not colored. Repeat this process using the second color.

d. Repeat the addition of colors until all the nodes have been colored.

From a graph made with side coloring, of the side color, two things can be discovered are, first if the sides are in the same color, it is indicating if those sides can be made at the same time. But if the colors are different, the schedule is not at the same time. Then the second, the number of colors used illustrates the number of courses scheduled for each class each day. The following is a report of all the results of scheduling courses obtained from the Welch Powell Algorithm Coloring Graph process:

| Day     | NO | Time     | Subject Code | Subject       | Room | Lecturer |
|---------|----|----------|--------------|---------------|------|----------|
| Monday  | 1  | 08:00-09:00 | TIF001       | AlproII       | TIF-1 | Abdul    |
| Monday  | 2  | 08:15-09:15 | TIF002       | Prak.AlproII  | TIF-2 | Intan    |
| Monday  | 3  | 10:00-11:00 | TIF003       | Numerical Method | TIF-1 | Abdul    |
| Tuesday | 1  | 08:00-09:00 | TIF004       | AlproI        | TIF-2 | Abdul    |
| Tuesday | 2  | 09:00-10:00 | TIF005       | Prak.AlproI   | TIF-2 | Abdul    |
| Tuesday | 3  | 09:00-10:00 | TIF003       | Numerical Method | TIF-3 | Intan    |

From the graph made with side coloring, of the side color, two things can be known, like, first if the sides are the same color, indicating if those sides done at the same time. But if the colors used are different, then the schedule is not made at the same time. Then the second, the number of colors used illustrates the number of courses scheduled for each class each day. The following is a report of all the results of scheduling courses obtained from the Welch Powell Algorithm Coloring Graph process:
5. Conclusion
From the research, it can be concluded that:
1. The scheduling results can only be changed by entering a new recovery subject schedule.
2. Welch powell graph coloring algorithm can solve lecture scheduling problems well, in this case there is no clash between scheduled components.
3. Coloring is a form of iteration that will be run.
4. Different coloring results indicate that the recovery time cannot be done at the same time. The first step is to sort the schedule from the biggest to the smallest, then give the first color and so on so that there are no different colors with the same color.
5. The processing time is strongly influenced by the amount of component data scheduled, the more large data to be scheduled, the longer the time needed.

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