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Implementation of the Constraint Satisfication Problems Method in Genetic Algorithms for Course Scheduling Systems

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Abstract. The creation of class schedules requires a high level of precision and focus to generate the best possible timetable. A schedule with the best solution can provide comfort for both faculty and students, thus enhancing the quality of early meetings during classes. However, in the engineering faculty of Muhammadiyah University Cirebon, classes often do not start simultaneously with other faculties due to the manual scheduling process. Addressing this issue, a system is needed to automate the creation of class schedules. By implementing the Constraint Satisfaction Problems method to impose constraints before evaluating the fitness values in the Genetic Algorithm, it can assist in searching for the best solutions in accordance with the scheduling requirements of each program in the Engineering faculty. The results of black box testing on the system, item code 06, demonstrate that the system can produce schedules that comply with the requirements of each program in the faculty.

Keywords: Scheduling, System, Course, Constraint, Algorithm

INTRODUCTION

Before the active lecture begins, each study program designs the course schedule. Course scheduling is essential in providing comfort for students and lecturers on the availability of the right time for lecture activities. However, due to time constraints, course schedules often need to be in sync with the lecturers' time, which results in a second schedule adjustment in each class.

The Faculty of Engineering, University of Muhammadiyah Cirebon, often experiences lecture delays due to late schedule distribution and is often inefficient for time with lecturers. Compiling lecture schedules manually requires much time and accuracy to avoid scheduling conflicts that interfere with lecture activities.

The needs of students in completing their study period should be unrestricted just because they cannot take the required courses because the implementation of lectures is conflicted with the time of the implementation of other courses. In addition, the needs of lecturers who must spend much time doing other tasks besides teaching must also be considered.

Constraint satisfaction problems are an approach to solving a problem to find a state or object that meets several requirements or criteria. A *constraint* can be interpreted as limiting a given solution to optimize a problem. A *genetic algorithm* is a search algorithm based on the mechanism of natural systems, namely genetics and natural selection. The search techniques performed by genetic algorithms, along with possible solutions, are known as populations.

From the results of the previous problem description, researchers want to build a course scheduling system by implementing the *Constraint satisfaction problems* method on Genetic Algorithms at the Faculty of Engineering, University of Muhammadiyah Cirebon, in order to help ease the work of staff and provide comfort for students and lecturers on time for lectures.

Troubleshooting

The course scheduling system was created to solve problems in making course schedules. Therefore, a system is needed to create schedules automatically to produce the best solution. In making course schedules, this system uses *the constraint satisfaction problems* method to provide a limit value for each fitness value of a chromosome that will be evaluated on the genetic algorithm. The result of this system is that the system can produce lecture schedules with the best solution:

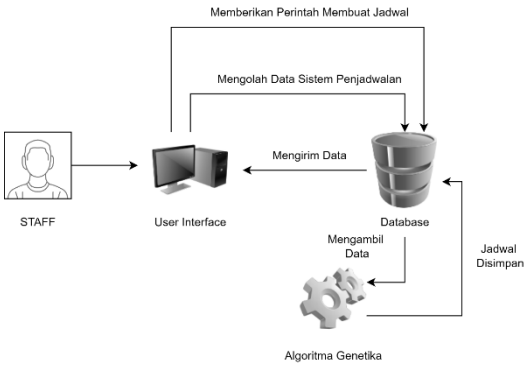

Figure 1 System Architecture

Use Case Diagram

Based on the results of the system requirements analysis, here is a *use case diagram* of the course scheduling system that will be created:

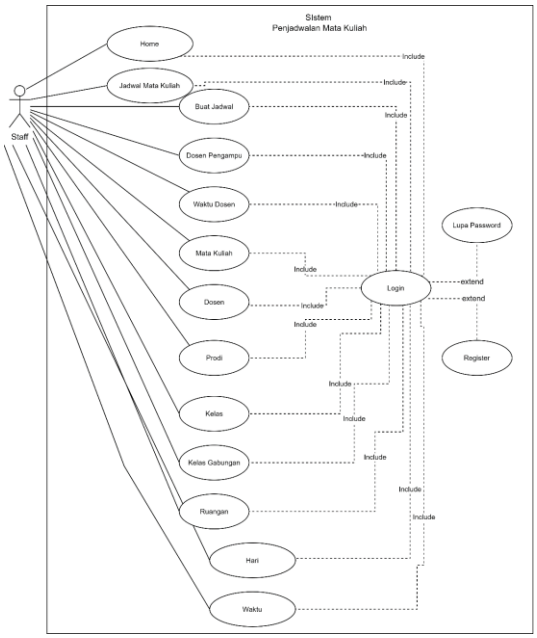

Figure 2 Use Case Diagram

Activity Diagram Create Schedule

Figure 3 illustrates the flow of the course schedule process where staff as actors can create a course schedule where staff select academic year data and click create the schedule. Furthermore, the system will process the creation of course schedules with genetic algorithms and limits using the *constraint satisfaction problems method* so that the schedule matches the requested criteria.

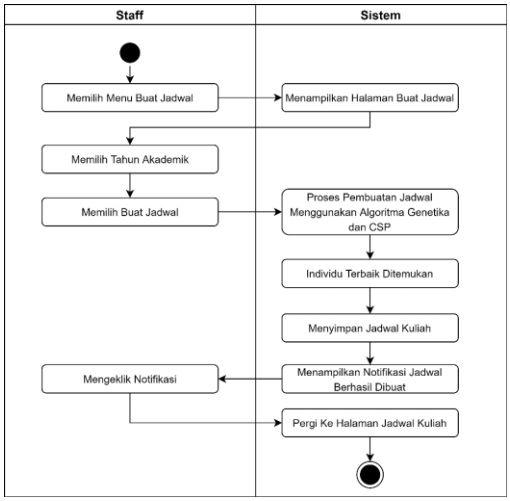

Figure 3 Activity Diagram Create Schedule

Entity Relationship Diagram

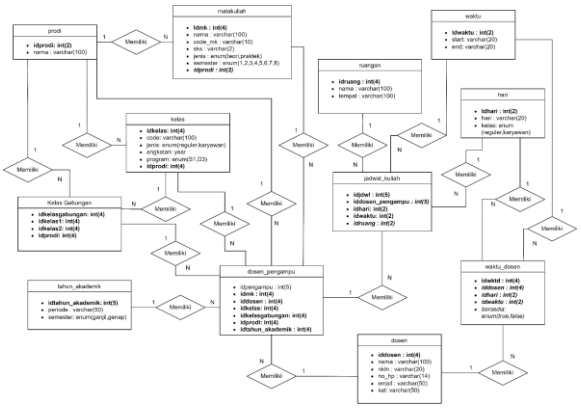

Figure 4 Entity Relationship Diagram

DISCUSSION

System Implementation

One of the features of this system is course scheduling, where staff are required to fill in lecture data first to make course schedules. The initial process of the system initializes the population first. The second stage evaluates constraints *so that the* schedule is under the limits that have been applied. The third stage conducts a fitness evaluation to determine the value of each chromosome that has been evaluated *for constraints*. The fourth stage is to make the best individual selection. The fifth stage performs crossing for individuals who are still rudimentary. The sixth stage will carry out mutations, and the results will be re-evaluated constraints. The process is carried out repeatedly until the best individual is found.

System Testing

Table 1 shows the test results of test item code 05, namely "Print PDF lecture schedule", the conclusion of the test is that staff can print the course schedule in Figures 5 and 6 is the display of the following pdf printout:

Table 1 Test Grain Code Test Results 05

Item Code	05		
Test Item Name	Print PDF of lecture schedule.		
Test Class	Print by StaffI.		
Purpose	Check whether the schedule that has been stored in the database can be printed in PDF format.		
Initial Conditions	Course Schedule Page		
Scenario			
Go to the lecture schedule page Input the academic year, and the prodi. Click export PDF.			
Result			
Data provided	Expected data	Observation	Conclusion
Input for academic year 2022/2023 Even and input for Informatics engineering study program	The user successfully downloaded the lecture schedule to PDF format	Successfully download the lecture schedule in PDF format	Appropriate Hope

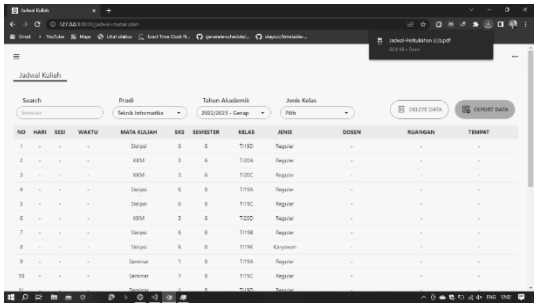

Figure 5 Test Grain Code Test Results 05

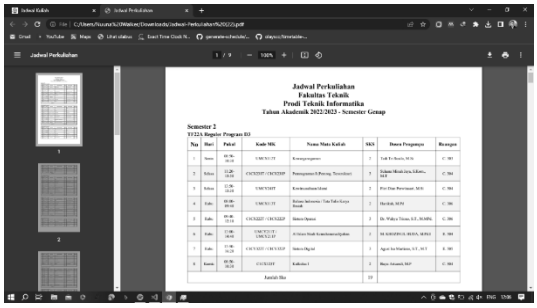

Figure 6 PDF Printout Display

Testing the results of the course scheduling system using the *constraint satisfaction problems* method on the genetic algorithm is a test to find out how long it takes to make a course schedule with the best results. The authors assign a 70% probability value for the chance that the cross occurs, and for the 40% chance that the mutation will occur. The following is the penalty value data if during the schedule creation process there is a conflict:

- The clash of days, rooms, and times occurred 1 point penalty.
- The lecturers clashed with a penalty of 1 point.
- Clash of Friday prayer time 1 point.
- Clashing with time that cannot be used by 1 point lecturers.

Table 2 Test Summary

Testing	Result	Duration
Create a schedule from 119 data without any lecturer time request	The system successfully created a schedule	2 Minute
Create a schedule from 119 data with lecturer time requests	The system successfully created a schedule	14 minutes
Create a schedule from 225 data without any lecturer time request	The system successfully created a schedule	45 Minutes
Create a schedule from 225 data with lecturer time requests	The system successfully created a schedule	3 hours 8 minutes

CONCLUSION

Based on the description and discussion, the conclusions are:

- The system can make lecture schedules efficiently according to the needs applied, starting from the merged classes and moving to time according to requests from lecturers.
- To process 119 data from 1 study program, the system produces an efficient schedule. It takes 2 minutes for the schedule without any request from the lecturer, and for requests from lecturers, it takes 14 minutes.
- The system produces an efficient schedule to process 225 data from 3 study programs. It takes 45 minutes for the schedule without any request from the lecturer, and for requests from lecturers, it takes 3 hours and 8 minutes.
- The more data you manage, the more comprehensive your search for finding the best solution using genetic algorithms.

As for some suggestions for system development:

- This system requires a long computational time to be developed so that the search for genetic algorithms is further reduced so that it can find solutions quickly.
- This system has yet to be able to create online classes so that it can be developed to adjust online lecture schedules.
- This system can be developed to select practicum courses that follow the practicum room.
- This system can be developed for scheduling ordinary courses with MBKM courses so that students get convenient time.

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