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Subject Scheduling Application Using Genetic Algorithm

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Abstract

Scheduling is a very important issue in an educational institution. The many obstacles sometimes make scheduling difficult to create. One method for solving such problems is to use genetic algorithms. Based on this background, the formulation of the problem of this study is "how to implement genetic algorithms for subject scheduling applications at SMK Bakti Pangkalpinang". The purpose of this study is to implement genetic algorithms for subject scheduling, formulate subject scheduling problems so that they can be solved with genetic algorithms and help schedule preparation to be more efficient. Genetic algorithms are heuristic search algorithms based on biological evolutionary mechanisms. In this study the author uses a prototype model, which includes activities such as gathering needs, designing and evaluating. The result of this study is an application that can be used to compile a lesson schedule with the desired results. Testing is done with blackbox testing and the test results show the application can function properly

Keywords: *Genetic algorithm, schedule, Prototype, UML, Blackbox*

1. Introduction

Genetic algorithm is one of the optimization algorithms and can be used in various case studies because it uses the principles of evolutionary theory. This algorithm is often used to find optimal solutions in both simple and complex cases. Genetic algorithms work on a population formed by cases represented as chromosomes and evaluated to obtain optimal values. This genetic algorithm has been widely applied to problem solving and modeling in technology, business, and entertainment midwives, such as scheduling optimization, automation programming, machine learning, economic models, immune system models, interactions between evolution and learning. The development of technology in the modern era is currently experiencing very rapid progress, where everyone can meet various technologies in various fields around human life, one of which is the existence of information technology. Information technology is a tool that can provide information to its users to obtain data or information that can support accuracy in making decisions using appropriate technology. All government agencies, private sectors, companies, schools, and universities have used technology to help the data processing process.

Scheduling comes from the word schedule which gets a pen affix which means the division of time based on a work sequence arrangement plan or a list or table of activities or an activity plan with a detailed division of implementation time. Scheduling is a very important issue in an educational institution. The many obstacles sometimes make scheduling difficult to create. Preparing a good scheduling needs to pay attention to various aspects including, the number of subjects held, the number of rooms, the number of teachers and the schedule of the teacher concerned. To solve these problems, the right algorithm is needed so that the scheduling process can run optimally, one algorithm that can be used for scheduling is a genetic algorithm.

Previous research used as a reference in this study includes research conducted by Yesri Elva in 2019 on "Subject Sistem Penjadwalan Mata Pelajaran Menggunakan Algoritma Genetika." [1], Research conducted by Dwi Oktarina and Alyauma Hajjah in 2019 regarding " Perancangan Sistem Penjadwalan Seminar Proposal dan Sidang

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Skripsi dengan Metode Algoritma Genetika."[2], Research conducted by I Made Adayana and I Komang Wijaya in 2017 on " Rancang Bangun Sistem Penjadwalan Sidang Skripsi Menggunakan Algoritma Genetika."[3], Research conducted by Ahmat Josi in 2017 on " Implementasi Algoritma Genetika Pada Aplikasi Penjadwalan Perkuliahan Berbasis Web Dengan Mengadopsi Model *Waterfall*[4], Research conducted by Yuslena Sari, Muhammad Alkaff, Eka Setya Wijaya, Syarifah Soraya, and Dany Primanita Kartikasari in 2019 concerning " Optimasi Penjadwalan Mata Kuliah Menggunakan Metode Algoritma Genetika Dengan Teknik Tournament Selection "[5].

2. Research Methodology

2.1. Scheduling

Scheduling is the process of assigning tasks to a schedule data set. Scheduling school subjects is information that determines the subject, the day and time of start, the space to be used which will form a structured and neatly arranged schedule so that teaching and learning activities can be carried out properly[6].

Scheduling is the timing of a scheduling operation activity which includes allocating facilities, equipment or labor for an operating activity and determining the sequence of implementation of operating activities. In the decision-making hierarchy, scheduling is the last rarity before the start of operations[7].

2.2. Genetic Algorithms

A genetic algorithm is a heuristic search algorithm based on the mechanism of biological evolution. Diversity in biological evolution is the variation of chromosomes between individual organisms. These chromosomal variations will affect the rate of reproduction and the degree of the organism's ability to stay alive. Basically, there are 4 conditions that greatly affect the evaluation process, namely[8] :

1. The ability of organisms to reproduce.
2. The existence of populations of organisms that can reproduce.
3. Diversity of organisms in a population
4. Difference in ability to servive.

Genetic algorithms in general can be illustrated in the following flow diagram [9] :

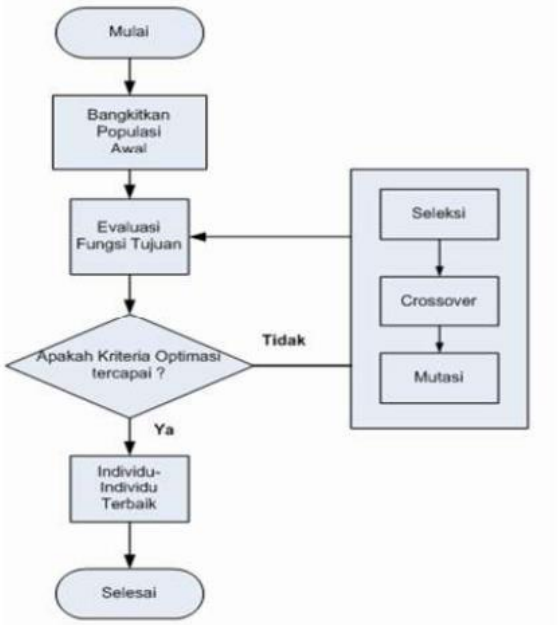

Figure 1. Simple Genetic Algorithm Flowchart

Information:
Figure 1 is an overview of genetic algorithms in general and will be implemented as follows [10] :

a) Revive the Early Population
   This process is a process used to generate a random initial population so that an initial solution is obtained. This initial population is randomly generated so that an initial solution is obtained. This population itself consists of a number of chromosomes that represent the desired solution.
b) Fitness Evaluation
   This process is a process to evaluate each population by calculating the fitness value of each chromosome and evaluating until the stop criterion is met. An individual is evaluated based on a particular function as a measure of performance. In the evolution of nature, individuals with low fitness value would have died. In the optimization problem, if the solution sought is to maximize a function h (known as the maximization problem), then the fitness value used is the value of the function h, namely fitness f = h.
c) Selection
   The selection process is a process to determine which individuals will be selected for crossover. There are several types of selection methods that can be used including: A method that mimics the roulette-wheel game where each chromosome occupies a circle piece on the roulette wheel proportionally according to its fitness value. The ranking selection process begins by ranking or sequencing chromosomes in the population based on their fintess and then assigning new fitness values based on their sequence.
d) Crossover
   This crossover process is a process to increase string diversity in a population. Crossover operators have the most important role in genetic algorithms because there is a process of gene mating (crossing) between two individuals (parents) that produces two new individuals (offspring) in the next generation.
e) Mutation
   Mutation is the process of changing the value of one or several genes in a chromosome. Mutations create new individuals by modifying one or more genes within the same individual. Mutations serve to replace genes lost from the population during the selection process as well as provide genes that were not present in the initial population.
f) Stop Criteria
   Stop criteria are criteria used to stop the genetic algorithm process which is the goal to be achieved from the process.
g) Results
   The result is the optimum solution obtained using genetic algorithms.

Genetic algorithms as a branch of evolutionary algorithms are adaptive methods that can be used to solve a value search in an optimization problem[11].

2.3. Prototype

In carrying out the development of this system, research uses a prototype system development model. This prototype model can help the development process because this model can be evaluated and changed to suit its needs.

Figure 2. Model Prototype

In figure 2 there are processes in the prototyping model in general are as follows:

a) Collection of Needs
   The developer and client will meet first and then determine the general purpose, known needs and an overview of the parts that will be needed.
b) Design
   Design was done quickly and the design represented all known aspects of the software, and this design became the basis for prototyping.
c) Prototype Evaluation.
   In this process, the client will evaluate the prototype made to clarify software needs.

2.4. Tool

The tool that the author uses is Unified Modeling Language (UML) is one of the language standards that is widely used to explain what the system does, make analysis and design of application flows, and describe architecture in object-oriented programming. UML is a visual language for modeling communication about a system using diagrams and supporting texts to describe the process of making applications to be created. There are 4 diagrams that the author uses, namely:

a) Usecase Diagram
   Usecase is the abstraction of the interaction between systems and actors. Usecase works by describing the type of interaction between the users of a system and the system itself through a story of how a system is used.
b) Activity Diagram
   Activities that describe a series of flows, are used to describe the activities formed in an operation so that they can also be used for other activities such as usecases or interactions.
c) Sequence Diagram
   Sequence diagrams are used to illustrate the behavior of a scenario. Its usefulness is to indicate the series of messages that are sent interaction between objects, something that happens at a certain point in the execution of the system.
d) Class Diagram
   A class describes a group of objects with the same properties, behaviors, and relationships. So that the existence of class diagrams can provide a global view of a system. A system usually has several class diagrams. Class diagrams are helpful in visualizing the class structure of a system.

3. Result and Discussion

3.1. System Design

a) Usecase Diagram

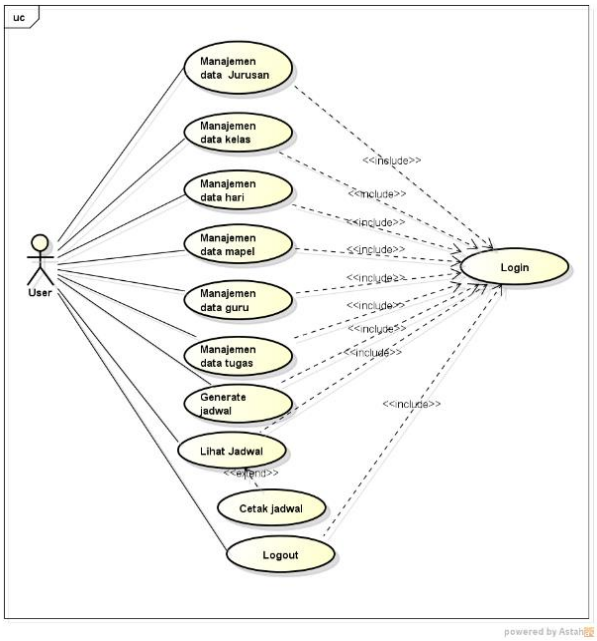

Figure 3. Usecase Diagram

b) *Class* Diagram

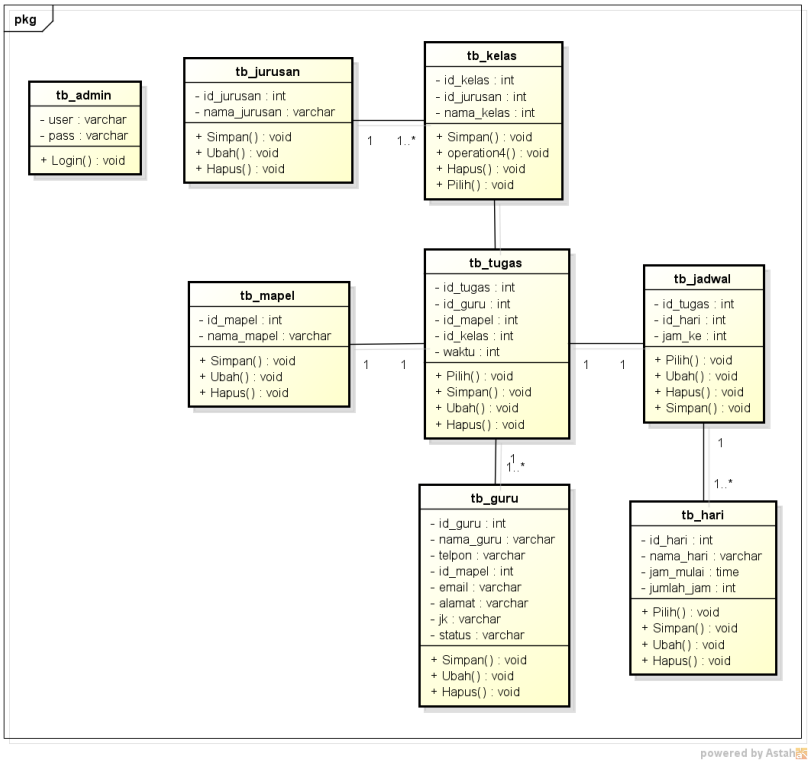

Figure 4. *Class* Diagram

3.2. Implementation

Figure 5 is a screen view of the main page, this page appears when the user has finished logging in. This page can be used to see the amount of data present.

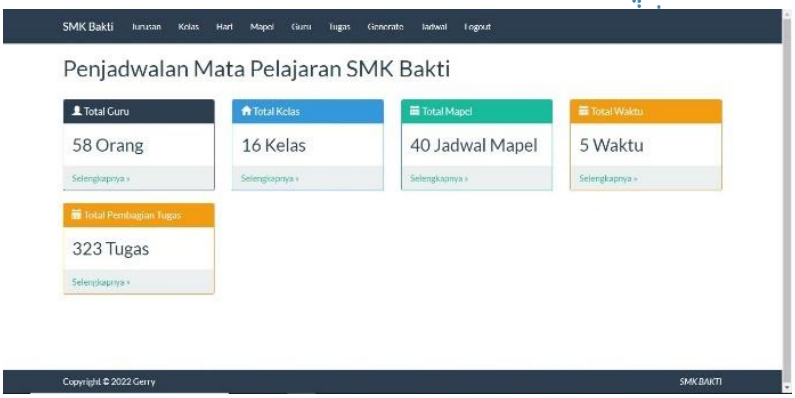

Figure 5. Main Page Screen Display

3.3. Application Testing (Using Black box Method)

This application conducts testing using the black box method. The black box method is carried out to find out the results of the output function of the application whether it is running properly and correctly. Testing focuses on the functional requirements of the application created. There are two applications to be tested, namely the reporting android application and the officer website application.

Table 1. Blackbox Testing

No	Functions tested	How to Test	Expected results	Test Results	Conclusion
1	Login	User enters username and password	If successful, the main page will appear, if it fails, a message will appear fail	Successfully logged in and displayed the main page. If it fails, a failed message will appear	The system runs according to the procedure
2	Data Management Department	1. User adds department data 2. User changes department data User deletes department data	1. If successful, it will be stored in the database and return to the department page, if it fails then a warning message appears 2. If successful, the data will be stored in the database and returned to the department page, if it fails, a warning message will appear. Delete the data from the database and return to the course page	1. Data successfully saved to database 2. The data is successfully changed and saved to the database Data successfully deleted from databas	The system runs according to the procedure
3	3 Class Data Managements	1. User adds class data 2. User changes class data User deletes class data	1. If successful, it will be stored in the database and return to the class page, if it fails then a warning message appears 2. If successful the data will be stored in the database and returned to the class page, if it fails	1. Data successfully saved to database 2. The data is successfully changed and saved to the database	The system runs according to the procedure

No	Functions tested	How to Test	Expected results	Test Results	Conclusion
			then a warning message will appear. Delete the data from the database and return to the class page.	Data successfully deleted from databas	
4	Day Data Management	1. User adds day data 2. User changes day data User deletes day data	1. If successful it will be stored in the database and return to the day page, if it fails then a warning message appears 2. If successful the data will be stored in the database and return to the day page, if it fails then a warning message appears. Delete data from the database and return to the days page	1. Data successfully saved to database 2. The data is successfully changed and saved to the database Data successfully deleted from databas	The system runs according to the procedure
5	Subject Data Management	1. User adds subject data 2. User changes subject data User deletes subject data	1. If successful it will be stored in the database and return to the subject page, if it fails then a warning message appears 2. If successful the data will be stored in the database and return to the subject page, if it fails then a warning message appears. Delete data from the database and return to the subject page	1. Data successfully saved to database 2. The data is successfully changed and saved to the database Data successfully deleted from databas	The system runs according to the procedure
6	Teacher Data Management	1. User adds teacher data 2. User changes teacher data User deletes teacher data	1. If successful, it will be stored in the database and return to the teacher page, if it fails then a warning message appears 2. If successful, the data will be stored in the database and returned to the teacher page, if it fails, a warning message will appear. Delete the data from the database and return to the teacher page	1. Data successfully saved to database 2. The data is successfully changed and saved to the database Data successfully deleted from databas	The system runs according to the procedure
7	Task Data Management	1. User adds task data 2. User changes task data User deletes task data	1. If successful, it will be stored in the database and return to the task page, if it fails then a warning message appears 2. If successful the data will be stored in the database and returned to the task page, if it fails then a warning message appears. Delete data from the database and return to the task page	1. Data successfully saved to database 2. The data is successfully changed and saved to the database Data successfully deleted from databas	The system runs according to the procedure
8	Generate	User generate	If successful, the	Data	The system runs

No	Functions tested	How to Test	Expected results	Test Results	Conclusion
	Schedule	schedule	calculation results will appear, if it fails, a failed message will appear	successfully generated and displays the calculation results	according to the procedure
9	View Schedule	User views schedule	Displays the schedule.	Successfully display the schedule that has been compiled	The system runs according to the procedure

4. Conclusions

Based on the results of the research that the author conducted, it can be concluded that the system built has run well by the needs identified at the beginning and the implementation of genetic algorithms is in accordance with the needs to support the scheduling process, so that the preparation can be done faster. Based on the results that have been done, the author provides suggestions that can be useful in increasing the effectiveness of work and being able to improve system performance. These suggestions include the following: : can be further developed into a mobile application. Requires reliable and competent human resources in website maintenance.

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