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THE APPLICATION OF THE GENETIC ALGORITHM METHOD IN ARRANGING LECTURE SCHEDULE AT MATHEMATICS STUDY PROGRAM FACULTY OF MATHEMATICS AND NATURAL SCIENCES (FMIPA) SYIAH KUALA UNIVERSITY

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ABSTRACT--*Scheduling is a division of time-based on a work order arrangement planning, a table of lists and activities, or a detailed activity plan. One example of scheduling is the lecture scheduling preparation at the university level. The special arrangement of lecture schedule at Mathematics Study Program, Faculty of Mathematics and Natural Sciences (FMIPA), Syiah Kuala University needs to measure the level of optimization in the form of constraint infringement. Optimal scheduling is a schedule formed by meeting all constraints. Mathematics Study Program FMIPA Syiah Kuala University is still prepared for the lecture schedule manually. Thus, it requires quite a long time. This reseacrh aims to facilitate Mathematics Study Program in arranging an optimal lecture schedule by eliminating conflict using Curriculum-based system, where the schedule must be arranged before the study card (KRS) filling process. By eliminating the conflict, The Genetic Algorithm successfully automatically arranged lecture schedule for Odd Semester at Mathematics Study Program, Faculty of Mathematics and Natural Sciences (FMIPA), Syiah Kuala University in Academic Year 2018/2019.*

Keywords--*The Genetic Algorithm, Lecture, Scheduling*

I. INTRODUCTION

Scheduling is work arrangements and resource allocation planning, including time and facilities, for each operation that must be completed [1]. Scheduling problems occur when multiple projects are being executed at the same time with limited resources. The scheduling problems can occur anywhere and in any case, for instance, scheduling for athletics programs, conferences, and schedules of educational institutions [2]. The scheduling can improve the quality of higher education effectively and efficiently with consideration of constraint [3]. The constraint can be assumed as a form of absence of lecturers, courses, or classrooms that are used at the same time.

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The Faculty of Mathematics and Natural Sciences (FMIPA) is one of the Faculties at Syiah Kuala University. One of its Study Programs is Mathematics. The study schedule at Mathematics Program Study is still prepared manually. Thus, it requires quite a long time. Problems such as schedule clashes between lecturers who have to fight over the same classroom, or students who get the same lecture time for different lecturers, often occur. With the above problems, the researchers want to make an optimal schedule, focusing on existing constraints. This research used The Genetic Algorithm approach. The Genetic Algorithm method is far better at solving scheduling problems. The Genetic Algorithm optimization can create solutions for scheduling classrooms and time by considering the constraints [3].

II. RESEARCH METODOLOGY

2.1 Data

This research uses data in the form of a list of teaching lecturers, courses, days, time, and available classrooms in odd semester at Mathematics Study Program, Faculty of Mathematics and Natural Sciences (FMIPA), Syiah Kuala University in Academic Year of 2018/2019.

2.2 Genetic Algorithm Method

The finding method used to solve the problem of the schedule in this study is The Genetic Algorithm. The concept used in The Genetic Algorithm is to follow what nature is doing [4].

2.2.1 Chromosome Initialization

Chromosome initialization is the stage of generating an initial population that contains a number of chromosomes. A chromosome contains genes with natural numbers. Each chromosome consists of 7 genes, which represent courses (theory and practicum), semesters, academic credit system (SKS), lecturers, lecture days, class hours, and classrooms. Meanwhile, each individual has 36 chromosomes, which is the number of theoretical and practical subjects. These individuals are randomly generated with random functions available in the MATLAB software.

2.2.2 Fitness Function

Fitness function in this research is a measure of an individual eligibility. The resulting fitness value represents how many constraints that occur in the individual. The greater the fitness value, the fewer constraints that occur, and vice versa. The fitness value for optimal scheduling in this research = 1. The following formula for calculating the fitness function:

$$Fitness = \frac{1}{(small\ number + penalty)} \qquad (1)$$

2.2.3 Selection

The selection method used in this research is roulette wheel selection. This method is applied by selecting the best individual by calculating the value of fitness and comparing it to other individuals.

2.2.4 Crossover

After the selection process, then continue with the crossover process. Before conducting the crossover process, random numbers are generated from [0-1] of a population. If the random number ≤ crossover probability = 0.6, then the individual is chosen as a parent to proceed to the crossover. The selected parent will then be crossover with the following process:

Table 1: Parent 1 for crossover

Course	Semester	SKS	Lect	Day	Time	Room
1	1	2	3	1	2	2
2	1	2	11	4	3	3
3	1	1	11	5	2	1
4	1	2	5	2	5	1
5	1	2	5	1	5	1

Table 2: Parent 2 for crossover

Course	Semester	SKS	Lect	Day	Time	Room
1	1	2	3	2	2	2
2	1	2	11	5	1	3
3	1	1	11	4	3	2
4	1	2	5	2	3	1
5	1	2	5	1	5	2

Crossover process for parent 1 and parent 2 are resulted as 2 offspring, namely:

Table 3: 1-point crossover resulting offspring

Course	Semester	SKS	Lect	Day	Time	Room
1	1	2	3	1	2	2
2	1	2	11	5	1	3
3	1	1	11	5	2	1
4	1	2	5	2	3	1
5	1	2	5	1	5	1

In Table 3, it can be seen that odd chromosomes become chromosomes that are retained from parent 1, while even chromosomes are replaced with chromosomes from parent 2.

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Table 4: 2-point crossover resulting offspring

Course	Semester	SKS	Lect	Day	Time	Room
1	1	2	3	2	2	2
2	1	2	11	4	3	3
3	1	1	11	4	3	2
4	1	2	5	2	5	1
5	1	2	5	1	5	2

In Table 4, it can be seen that odd chromosomes become chromosomes that are retained from parent 2, while even chromosomes are replaced with chromosomes from parent 1.

2.2.5 Mutations

Mutations in this research were carried out by exchanging genes in individuals to get optimal results. Selected individuals are from the result of crossover. The selection of the mutations is established by generating random numbers [0-1] as many as individual crossover results. If the random number $\leq$ mutation probability = 0.3, then the individual is selected as mutation. Unselect individuals for the mutation will be stored for the next generation. This mutation process is directed according to the optimal scheduling for lectures at Mathematics Study Program. The population in this study is maintained. If the fitness value does not meet the optimal condition, that is fitness = 1, then the process will be repeated in the fitness function.

2.3 Constraint

Constraint is the rule that must be met in scheduling lectures. The constraints in this research can be described as follows:

1. There are no lectures on Friday, from 12.00 pm to 02.00 pm.
2. There are no lecturers who teach on the same day and time.
3. There is only one subject per classroom.
4. A lecturer can only teach at most 3 courses a day.
5. The 1st and 2nd-time schedule of R2A room cannot be used, because it is used for general courses.
6. The laboratory room is only for practicum subjects.
7. Compulsory courses in the same semester may not be scheduled at the same time and day but in different rooms.
8. 4-credit course is scheduled in 2 different days (2-2).
9. 3-credit course is scheduled in 2 different days (2-2).
10. Wednesday is not scheduled for theoretical courses.
11. 2-credit course may not be scheduled on the 3rd study time.

If there is a constraint violation, the penalty value = 1 will be given.
If there is no a constraint violation, the penalty value = 0.

III. RESULT AND DISCUSSION

3.1 Scheduling Lectures Application with The Genetic Algorithms

Based on the results of The Genetic Algorithm process, an optimal lecture schedule is obtained with fitness = 1. This means that there is no conflicting schedule. The lecture scheduling application program at Mathematics Study Program, Faculty of Mathematics and Natural Sciences (FMIPA), Syiah Kuala University uses the MATLAB application based on the Graphical User Interface. The following is an application for scheduling lectures using The Genetic Algorithm method:

Figure 1: Display the main menu of scheduling lectures application.

Figure 2: Display the data management.

Figure 3: Display The Genetic Algorithm process.

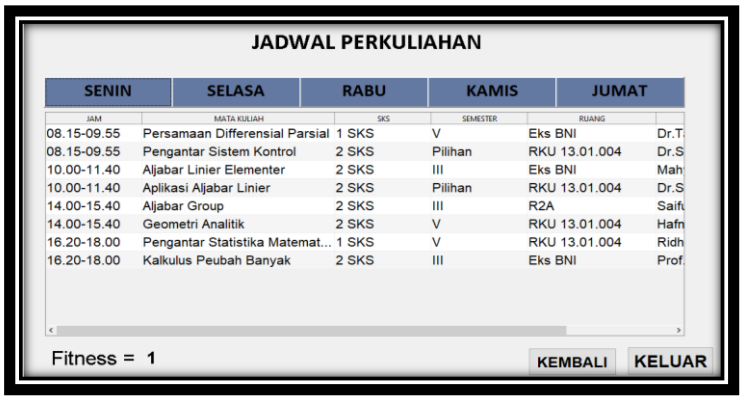

Figure 4: The lecture schedule on Monday.

Figure 5: The lecture schedule on Tuesday.

Figure 6: The lecture schedule on Wednesday.

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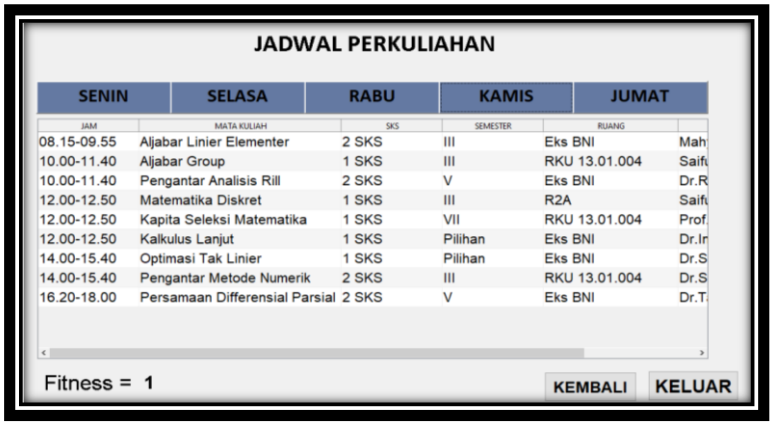

Figure 7: The lecture schedule on Wednesday.

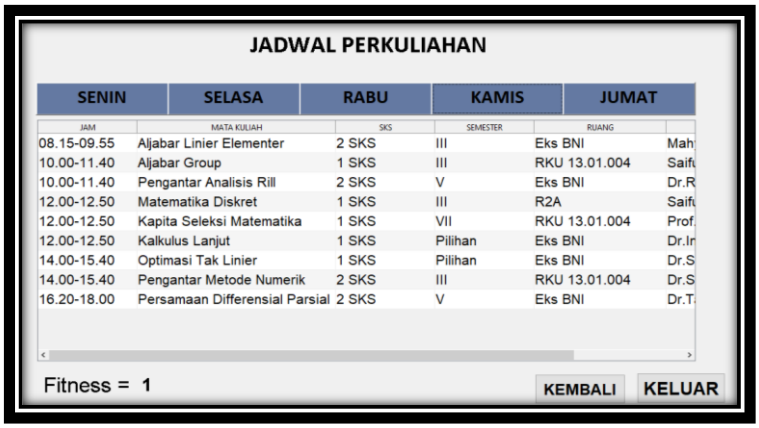

Figure 8: The lecture schedule on Thursday.

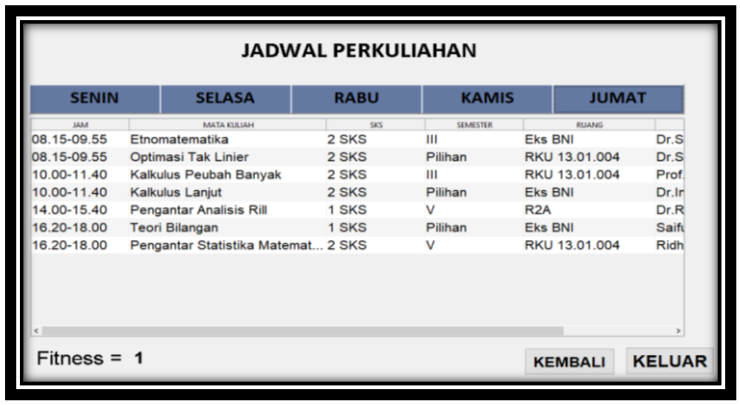

Figure 9: The lecture schedule on Friday.

3.2 The Genetic Algorithm Testing for Scheduling Lectures

The whole process an experiment was carried out on a population of 50, 100, and 150 with several generations, namely 100, 300, and 500. This experiment was carried out 10 times, with the aim to see the lecture schedule that was formed with the highest average fitness. The test results can be seen in the table below:

Table 5: Testing the final fitness value with a population of 50

Attempt to	Generation		
	100	**300**	**500**
1	0,33	0,25	0,33
2	0,25	0,20	1
3	0,20	0,50	0,33
4	0,25	0,25	0,33
5	0,33	0,20	0,50
6	0,25	0,50	0,33
7	0,14	0,16	0,50
8	0,20	0,33	0,25
9	0,50	0,33	0,33
10	0,16	0,50	0,50
Fitness Average	**0,26**	**0,32**	**0,44**

Table 6: Testing the final fitness value with a population of 100

Attempt to	Generation		
	100	**300**	**500**
1	1	1	0,50
2	0,33	0,25	0,50
3	1	0,33	0,50
4	0,50	0,25	1
5	0,20	0,33	0,50
6	0,50	1	1
7	0,25	0,50	0,50
8	0,33	0,50	0,33
9	0,33	1	0,50
10	0,25	0,50	0,50
Fitness Average	**0,46**	**0,56**	**0,58**

Table 7: Testing the final fitness value with a population of 150

Attempt to	Generation		
	100	**300**	**500**
1	0,50	0,50	0,50
2	0,50	0,33	0,50
3	0,50	1	1
4	0,50	1	0,50

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5	0,50	0,33	0,50
6	1	1	1
7	0,33	0,50	1
8	0,50	0,50	0,50
9	0,33	0,50	0,50
10	0,33	0,50	0,50
Fitness Average	**0,49**	**0,61**	**0,70**

Based on the three tables above, it can be seen that for a population of 150, the average fitness at the highest generation is greater than at a population of 50 and 100. From these results, it can be concluded that the greater the number of population and generation that are raised, the greater the average fitness produced. This is because every single individual is a solution (schedule). Thus, if many populations and generations are raised on The Genetic Algorithm of this study, more and more choices of solutions (schedules) are obtained.

IV. CONCLUSION

From the results of the research it can be concluded that:

1. The Genetic Algorithm successfully used for optimal lecture scheduling planning by eliminating conflict for Odd Semester at Mathematics Study Program, Faculty of Mathematics and Natural Sciences (FMIPA), Syiah Kuala University in Academic Year 2018/2019.
2. This research showed that the more population and generation that is raised, the greater the average fitness will be.
3. The application of genetic algorithms in this research is specifically used for scheduling lectures for Odd Semester at Mathematics Study Program

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