

Implementation Of Genetic Algorithm In Optimization Of Subject Scheduling

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ABSTRACT

Keywords

Scheduling
Automatic
Optimal
Genetic Algorithm

The activity of implementing teacher teaching schedules in a school is complicated. There are various aspects related to the scheduling that must be involved, among others there are schedules in which the teacher intersects with other class schedules, and the distribution of the Teaching and Learning Activities, schedule is also expected to be evenly distributed each day for each class. Therefore in this study, an application will be made that can facilitate the preparation of subject schedules automatically by implementing genetic algorithms. By making an application for preparing the schedule of subjects it is expected to facilitate and accelerate the student field in the process of making the schedule of subjects by existing resources and limitations. With this application, it is also expected to facilitate communication between teachers and students in arranging class schedules so that they can achieve optimal results at State Vocational High School 1 Malang.

1. Introduction

1.1. Background

During this time the scheduling of teaching teachers at State Vocational High School 1 Malang which includes subject schedules and the distribution of teachers in each class there is still using the manual method. There are a lot of clashes between classes because of the confusion of the student division to determine the schedule of subjects and the large number of rooms to be adjusted based on grade levels. The problems faced in the Vocational School are the scheduling system which is still manual because it is very complicated and the number of rooms divided for one class, so we need a system that can help the student in determining the schedule of subjects for one school year which is formed automatically through a computerized system.

Therefore in this thesis will try to make an application that can facilitate the preparation of subject schedules automatically by implementing genetic algorithms.

By making an application for preparing the schedule of subjects it is expected to facilitate and accelerate the student field in the process of making the schedule of subjects by existing resources and limitations. With this application, it is also expected to facilitate communication between teachers and students in arranging class schedules so that they can achieve optimal results at State Vocational High School 1 Malang..

1.2. Formulation of the problem

1. How do you analyze scheduling problems that occur at State Vocational High School 1 Malang?

2. How to define the problem in individual form?
3. How to calculate the fitness value of each individual?
4. How to implement Genetic Algorithms into the Java programming language?
5. How to test system performance?

1.3. Scope of the problem

1. Desktop-based programs are made with the Java programming language and use a MySQL database.
2. Each teacher has been assigned according to their respective fields of study.
3. Conditions for each individual who has a high fitness value so that the individual is not affected by mutations and crossovers can be seen below:
 - a. Every teaching and learning activity must not be a time-out on the same subject in 1 day.
 - b. Maximum teaching and learning activities in 1 subject must not exceed 3 hours in 1 day.
 - c. On the same day there may not be teaching and learning activities with the same subjects and the same hours in 1 day in different classes.

1.4. Research purposes

The purpose of the research to be carried out is to arrange scheduling using genetic algorithms so that an automatic schedule is obtained for the pair of subjects, time, space and the teacher (teacher) as a whole.

2. The Proposed Method

2.1. Scheduling Optimization

Optimizing subject scheduling is the process of preparing an implementation schedule that informs some subjects, the teaching teacher, the space, and the time of teaching and learning activities can produce an optimal schedule. Manually scheduling tends to require more time and accuracy for schedulers. To be able to make an optimal schedule, optimization methods are needed..

2.2. Genetic Algorithm

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire Genetic algorithms are heuristic search techniques based on the idea of the evolution of natural and genetic selection. This algorithm makes use of the natural selection process known as the evolution process.

Here are some basic notions that need to be known:

1. Genes are the basic variables that make up a chromosome. In genetic algorithms, these genes can have binary, float, integer, or character values.
2. Alleles are values of a gene, can be binary, float, integer, or character.
3. A chromosome is a combination of genes that make a certain meaning.

Genetic algorithm consists of eight components, whose task is to support the optimization, while the components are, coding scheme, fitness value, parental selection, crossing, mutation, elitism, population replacement, and cessation criteria.

3. Analysis and System planning

3.1 Problem Analysis

From the results of the research carried out it is known that the scheduling process at SMK Negeri 1 Malang is still done manually. So the results obtained are less effective and efficient because it requires a relatively long time.

3.2. Design of Genetic Algorithms

3.2.1 Encoding

Assignments is done outside the system. The system is only intended to arrange the schedule of The coding that will be used in this subject scheduling application is the value coding.

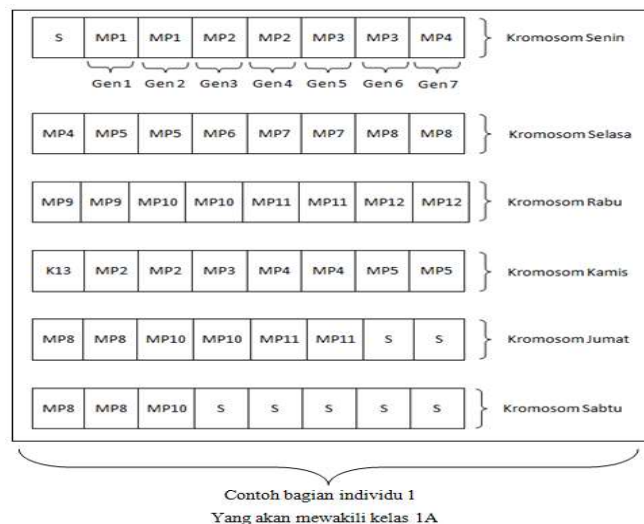
3.2.2 Chromosome Initialization

After this thesis, an individual has one chromosome, and chromosomes are composed of several genes. The length of a chromosome is as much as a gene that represents one day, in this case, each gene represents one subject.

Table 1. Number of Hours Each Weekly Subject

Kode	Subject	Number of Hours per Week	Number of genes
MP01	Pendidikan Agama	2	2
MP02	PPKn	2	2
MP03	Bahasa Indonesia	4	4
MP04	Bahasa Inggris	6	6
MP05	Matematika	8	8
MP06	IPA	6	6
MP07	IPS	6	6
MP08	Seni budaya	2	2
MP09	Pejaskes	2	2
MP10	TIK dasn PTD	4	4
MP11	Bahasa Daerah	2	2
MP12	Speaking atau Conversation	2	2
Total		46 Jam	46 Gen

Table 2. Chromosome Initialization



Note: Table 3.4 is an example of a part of individual 1 which is 1 schedule that has been arranged to represent 1 class, namely class 1A. What is meant by individuals here is 1 whole schedule composed of all class 1 which is formed from 10 classes.

3.2.3 Calculation of Fitness Values

Because the value of fitness is closely related to the condition of the value of a gene in a chromosome, then to determine it first seen whether the requirements are met or not. If fulfilled, the greater the weight value by predetermined weights. If it is not met, then the weight value is equal to 0. More details will be illustrated in the picture below:

1. Requirement 1: Every teaching and learning activity must not have time breaks on the same subject in 1 day.

Table 3. Example illustration of conditions 1

Monday	Weight 1	Information
S	-	Flag Ceremony
MP1	0	Fitness value is 0 because there is MP1 in this chromosome which emerges pause in the form of MP2 and MP3
MP1	0	Fitness value is 0 because there is MP1 in this chromosome which emerges pause in the form of MP2 and MP3
MP2	30	Fitness value is 30 because although there are other MP2 they appear together and there are no breaks
MP2	30	Fitness value is 30 because although there are other MP2 they appear together and there are no breaks
MP3	30	Fitness value 30 because stand-alone MP3 is not subject to conditions
MP1	0	Fitness value is 0 because there is MP1 in this chromosome which emerges pause in the form of MP2 and MP3
MP6	30	Fitness value of 30 because the MP6 stands alone is not subject to conditions

Small weight value due to different hours there are pauses and there are the same subjects

2. Requirement 2: Maximum teaching and learning activities in 1 subject must not exceed 3 hours in 1 day.

Table 4. Example illustration of conditions 2

Monday	Weight 1	Information
MP5	30	Fitness value 0 because MP5 stands alone is not subject to conditions
MP1	0	Fitness value is 0 because there is MP1 in this chromosome which appears 4 times and violates the conditions in 1 chromosome must have max 3 genes in common
MP1	0	Fitness value is 0 because there is MP1 in this chromosome which appears 4 times and violates the condition in 1 chromosome must have max 3 genes in common
MP1	0	Fitness value is 0 because there is MP1 in this chromosome which appears 4 times and violates the conditions in 1 chromosome must have max 3 genes in common
MP1	0	Fitness value is 0 because there is MP1 in this chromosome which appears 4 times and violates the conditions in 1 chromosome must have max 3 genes in common

Monday	Weight 1	Information
MP3	30	Fitness value 30 because stand-alone MP3 is not subject to conditions
MP4	30	Fitness value of 30 because MP4 stands with other MP4 but together
MP4	30	Fitness value of 30 because MP4 stands with other MP4 but together

3. Requirement 3: On the same day no teaching and learning activities with the same subjects and at the same time in 1 day in different classes.

Table 5. Example illustration of conditions 3

Monday A	Weight 3	Weight 3	Monday B	Information
S	-	-	S	-
MP1	30	30	MP3	Fitness value 30 because MP1 stands alone is not subject to condition
MP1	30	30	MP3	Fitness value 30 because MP1 stands alone is not subject to condition
MP2	30	30	MP1	Fitness value 30 because MP2 stands alone is not subject to condition
MP2	30	30	MP1	Fitness value 30 because MP2 stands alone is not subject to condition
MP3	30	30	MP5	Fitness value 30 because MP3 stands alone is not subject to condition
MP4	30	30	MP7	Fitness value 30 because MP4 stands alone is not subject to condition
MP4	0	0	MP4	Fitness value is small because there are the same MP at the same time in different classes

From the weight of the results of fulfilling the above conditions, the fitness value is calculated using the following formula:

$$\text{Fitness} = \frac{\text{Total weight in 1 day}}{\text{Number of hours in 1 day}}$$

Following is the process of mutation and crossover saw from the smallest weight value as follows:

Table 6. Examples of mutation and crossover processes

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
90	90	90	90	90	90
60	0	90	90	90	90
90	90	90	90	90	90
30	60	90	30	90	90
90	90	90	30	90	90
90	30	90	30	90	90
90	90	90	90	90	90
90	90	90	90	90	90

Diagram annotations: A box labeled "Process Crossover" has arrows pointing to the 0 value in Tuesday and the 60 value in Wednesday of the second row. A box labeled "Process Mutation" has arrows pointing to the 30 value in Monday and the 60 value in Tuesday of the fourth row.

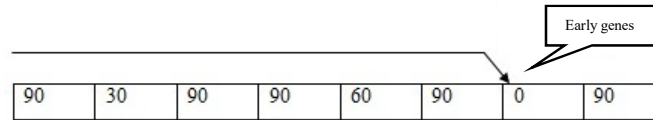
Calculate the most recent chromosome MSE with a chromosome that is the result of a crossover which is to calculate the average amount of all fitness on all chromosomes divided by the total value of the maximum amount of fitness. If the result exceeds the target error then the iteration continues, if the MSE error < target error then the iteration is stopped and as the final chromosome the genetic algorithm results.

3.2.4 Selection

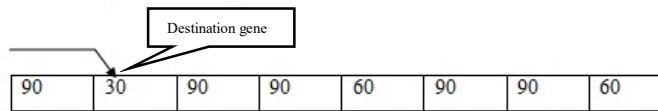
After calculating the fitness value, then the selection process is carried out which in this final project uses a ranking-based selection process.

1. The process of finding the smallest fitness value

The process of finding the smallest fitness value as a destination gene in one chromosome (in the crossover process) and as a destination gene on another chromosome (in the process of mutation).



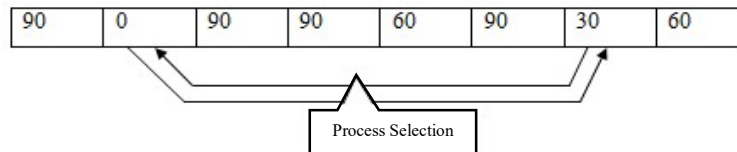
2. The process of finding other smallest fitness values



3.2.5 Mutation

After conducting the selection process, the mutation process is then performed, in which in this process the lowest fitness value in the chromosome is crossed with the gene that has the smallest fitness value in 1 chromosome.

1. The process of mutation from the first smallest fitness value to the second smallest fitness value



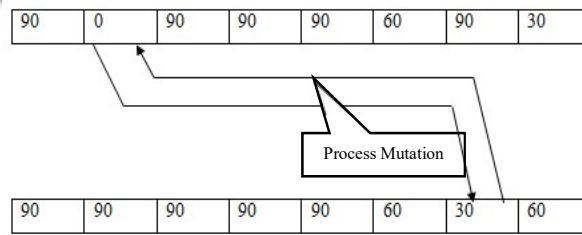
3.2.6 Crossovers

After doing the mutation process, then the process of crossing is carried out by transferring genes to other genes in 1 individual, wherein this process the lowest fitness value in the chromosome is crossed with the gene that has the smallest fitness value in 1 individual of the other chromosome

The process is considered complete if the average individual has maximum fitness value. If it is not maximized, the process is repeated from the determination of fitness to crossing until the average individual has the maximum fitness value or the iteration reaches the maximum limit.

3.3. Scheduling Display Design

This scheduling menu page will display a form containing input and button to process the making of the schedule using genetic algorithms.



The following is a display of the scheduling menu display design on the subject editor page. It will display an input form that functions for the editor either saving, changing, or deleting subject data.

Early chromosome table

Genetic process table

iteration Smallest error

Fig.1. The design of the scheduling display

Testing system Optimization of subject scheduling at State Vocational High School 1 Malang, using genetic algorithms. Thus the user can find out about the successes and deficiencies that exist in the system or software that has been made in this final project.

4. Implementation and Testing

4.1 Program Implementation

The application that has been made consists of several classes that are interrelated with one another. Below is a display of the login form interface and the main menu that is useful for inputting teacher data, subject data, class data, and hours in the program. Here is the picture of the form mentioned above:



Fig.2. Log In Form

EDITOR PENDIDIK

NIP:

Nama Guru:

Tempat Tanggal Lahir: 1 Januari

Jenis Kelamin: Laki - laki Perempuan

Alamat:

Jabatan:

Nip	Nama	Tempat	Tang...
1	Drs. A. Muzakin, M.Ag	Singosari	1
10	Suryati, S.Pd	Malang	1
11	Anif Nurcahyo, SE, M.Pd	Malang	1
12	Drs. Budi Irianto, M.Pd	Malang	1
13	Agus Sumarsono, S.Pd	Malang	1
14	Dra. Titin Suhemaning	Surabaya	1
15	Widiastoeft, S.Pd	Sidoarjo	1
16	Agus Wiyono, S.Pd	Sidoarjo	1
17	Kanti Setianingtyas, M.Pd	Sidoarjo	1
18	Eko Suryantono, S.Pd	Sidoarjo	1
19	Gatot Sugianto	Sidoarjo	1
2	Bambang Setiawan, S.Pd	Malang	1
Dra. Siti Chusnah	Sidoarjo	1	
21	Bandjajah, M.Pd	Lawang	1
22	Dra. Masruroh	Lawang	1
23	Dra. Trimurti Sisworini	Lawang	1
24	Much. Gatot, M.Pd	Lawang	1
25	Suprapti, S.Pd	Lawang	1
26	Dra. Wiwik Indriawati	Lawang	1
27	Roudhotul Jannah, S.Pd	Lawang	1
28	Dra. Titin Danardini	Surabaya	1
29	Drs. Darsono	Surabaya	1
3	Chunyah, S.Pd	Malang	1

Buttons: Simpan, Update, Delete, Reset, Kembali, Cari

Fig.3. Add teacher data Form

EDITOR MATA PELAJARAN

Kode Mata Pelajaran:

Nama Mata Pelajaran:

Jumlah Jam:

Kelas:

Nama Pengajar:

Kode	Mata Pelajaran	Jam	Kelas
MP13	Akuntansi	2	2

Buttons: Simpan, Update, Delete, Reset, Kembali

Fig.4. Data add subjects Form

Kode	Jam	Ket
j1	06.45-07.25	Aktif Belajar
j2	07.25-08.05	Aktif Belajar
j3	08.05-08.45	Aktif Belajar
j4	08.45-09.25	Aktif Belajar
j5	09.25-09.40	Istirahat
j6	09.40-10.20	Aktif Belajar
j7	10.20-11.00	Aktif Belajar
j8	11.00-11.40	Aktif Belajar
j9	11.40-12.10	Istirahat
j10	12.10-12.50	Aktif Belajar
j11	12.50-13.30	Aktif Belajar
j12	13.30-14.10	Aktif Belajar

Buttons: Edit, Kembali

Fig.5. Clock form

The following form is used to display the process and results of creating subject schedules using genetic algorithms.

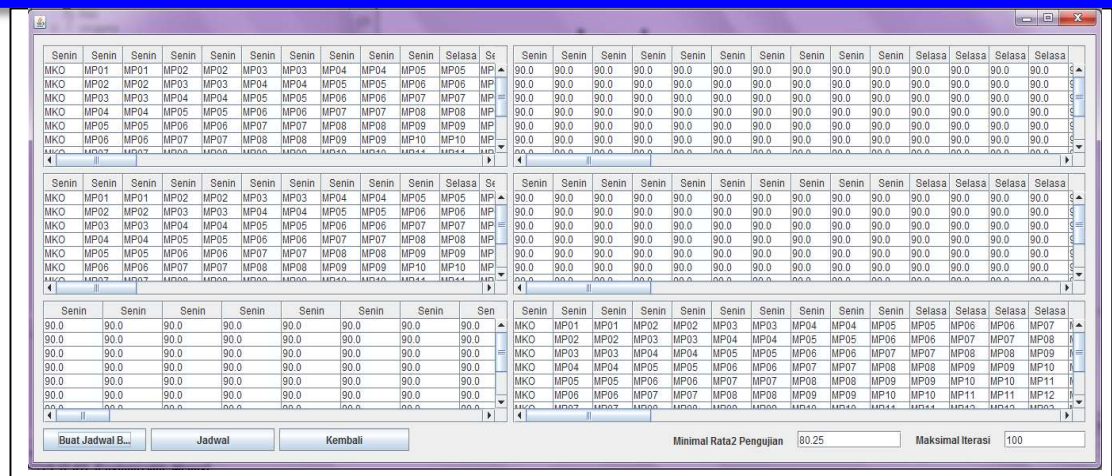


Fig.6. Application Form

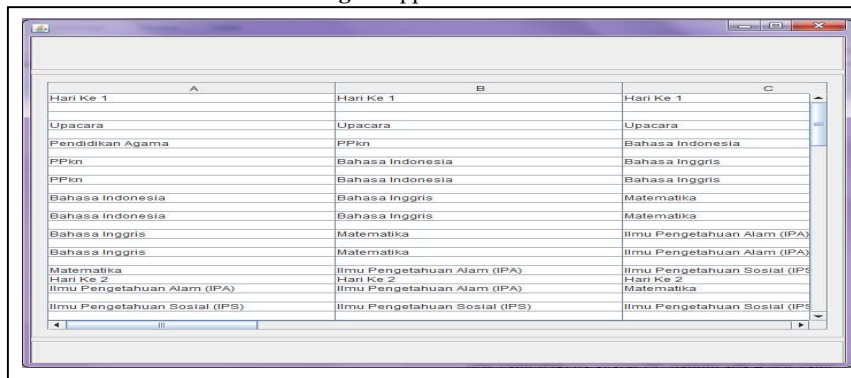


Fig.7. Display the results form

4.5 Testing Stage

The testing phase is carried out to find out which programs are made able to run well or not and to find out the shortcomings of the programs that have been made. This test is carried out to determine the difference in the number of generations needed if the termination condition in the form of the average fitness value of each chromosome gene is by the specified amount. The test results are shown in table 7.

Table 7. Tests carried out

F1	F2	F3	Average fitness value stops	Fitness value	Total Generation
35	8	152	80.25	80.25/90	1
84	8	140	80.5	80.50/90	51275
102	4	137	80.55	80.55/90	141006
97	4	142	80.65	80.65/90	1486985

Information :

- F1 = The grace period of teaching a teacher in 1 day and 1 class
- F2 = the number of teachers teaching more than 3 hours in 1 day and 1 class
- F3 = there is a conflict between teaching the teacher and the other class

From test 1 above, it can be seen that there are 35 genes affected by F1 conditions, 8 genes affected by F2 conditions and 152 genes affected by F3 conditions. Then the application stops when the new iteration runs 1 time with an average fitness value of 80.25.

From test 2 above it can be seen that there are 84 genes affected by F1 conditions, 8 genes affected by F2 conditions, and 140 genes affected by F3 conditions. Then the application stops when the iteration runs 51275 times with an average fitness value of 80.50.

From the 3 tests above, it can be seen that there are 102 genes affected by F1 conditions, 4 genes affected by F2 conditions, and 137 genes affected by F3 conditions. Then the application stops when the iteration runs 141006 times with an average fitness value of 80.55.

From test 5 above it can be seen that there are 97 genes affected by F1 conditions, 4 genes affected by F2 conditions, and 1142 genes affected by F3 conditions. Then the application stops when the iteration runs 1486985 times with an average fitness value of 80.65.

5. Conclusions

From the design and construction of application scheduling subjects with genetic algorithms in SMK 01 Malang that have been made it can be concluded that:

1. This application has fulfilled all the designs that have been made namely the scheduling application of subjects to be made, the process of division of teaching assignments is done outside the system. The system is only intended to arrange the schedule of subjects.
2. This application cannot be developed massively because it does not meet 100% output results it can be seen from the test results from the last test, it can be seen that the application stops when the maximum iteration is 1486985 with an average fitness value of 80.65. And will produce the output: 89.61%

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