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Lecture Scheduling Using Genetic Algorithm

Lecture scheduling at a university is a very important element, because it determines the progress of lecturing activity process. At the Indonesian Digital Technology University, the lecture scheduling process still uses Microsoft Excel, this is considered less than optimal because it takes a relatively long time, the process is long and requires a high level of accuracy, which is something that often becomes an obstacle in the scheduling process. The genetic algorithm can be used to solve problems on a large scale and with a high level of complexity, such as lecture scheduling. Genetic algorithms have advantages over other optimization methods, namely that genetic algorithms can optimize the problem solving of a complex scheduling problems with a very wide search space. There are several stages in a genetic algorithm, namely: initial population initialization, fitness evaluation, selection, crossover and mutation. The results of this research show that scheduling lectures using the genetic algorithm method in faster and more accurate results, because the process is carried out by finding the best solution from each generation iteration and the process will stop when the required solution is obtained. Meanwhile, scheduling lectures using MS Excel takes longer because it was done manually with the help of VLOOKUP formula and requires a high level of accuracy so that there are no conflicting lecture schedules. From the test results, using Python software with a genetic algorithm takes 0.609356 seconds with an accuracy level of 100%. Meanwhile, testing using MS Excel with VLOOKUP takes around 20 minutes with an accuracy rate of 95%.

***KeyWords**: Scheduling, Lectures, Genetic Algorithm*

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1 Introduction

In the world of education, scheduling has become a common thing, especially those related to lecture scheduling. Scheduling lectures at a university is a very important element, because it determines how the lecture activity process will take place. At the Indonesian Digital Technology University, lecture scheduling is done computerized using the Microsoft Excel program. This is considered less than optimal, because it takes a relatively long time, the process is long and requires a high level of accuracy which often becomes an obstacle in the lecture scheduling process.

Based on these problems, planning lecture scheduling can be done by applying methods that are often used to solve scheduling problems. One of them is using a genetic algorithm which is widely used for the best random search by trying several random solutions while recording the best solution[1]. Genetic algorithms have advantages over other optimization methods, namely that genetic algorithms can optimize problems with complex problems and a very wide search space [2]. Genetic algorithms are algorithms that are popularly used in artificial intelligence, especially in solving scheduling problems. This algorithm was developed based on the inspiration of the scientific evolutionary process, namely an algorithmic process in which each individual carries out evolutionary stages such as selection, mutation, and interbreeding or crossover. The aim of this process is to create new individuals from each generation, where these new individuals can solve lecture scheduling problems[3].

2 Research Methodology

2.1 Study of Literature. Saputra's research entitled Implementation of Genetic Algorithm In College Scheduling System Ftti Unjani Yogyakarta[11]. Ansari and Saubari's research entitled Application of Genetic Algorithm Concept on Course Scheduling[4].

2.2 Data Collection. Data was taken from the academic section of Universitas Teknologi Digital Indonesia and interviews with the head of academic department regarding lecturer scheduling.

2.3 System Analysis and Design. At this stage the system design process will be carried out. The following is the pseudocode of the genetic algorithm[9].

From the pseudocode stage of the genetic algorithm above, a system design is created as follows.

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Algorithm 1 Genetic Algorithm

```
t = 0;
Population Initialization P(t);
  Generating an initial population;
Evaluate P(t)
  Calculate the fitness value of each chromosome;
while has not met the criteria to stop do
    SelectionP(t);
    Crossover P(t);
    Mutation P(t);
    t = t + 1
Criterias met
```

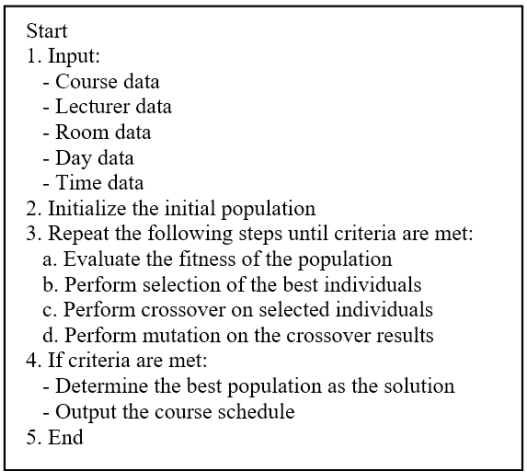

Fig. 1 System Flow

Figure 1 shows the system flow process, starting from initializing the initial population to produce an initial solution. Then proceed with evaluating fitness values, selection, crossover, gene mutation and obtaining new individuals. If the resulting new individual has a better fitness value than the process of generating the previous population, then the new individual is one of the individuals in the new population, if not, the previously generated individual is processed again for fitness evaluation. This algorithm cycle stops when the fitness value meets the predetermined criteria[12].

3 Results and Discussion

3.1 Case Study. The following is an example of solving a lecture scheduling case using a genetic algorithm. The data used takes 5 data samples from the 2022/2023 odd semester lecture schedule. The data table used is as follows.

Table 1 Course

No	Course	Class	Lecturer
1	Algoritma Pemrograman	1	Bambang P.D.P.
2	Metode Numerik	3	Domy Kristomo
3	Metode Penelitian	1	Widyastuti Andriyani
4	Pemrograman Web Client	1	Badiyanto
5	Sistem Pendukung Keputusan	2	Widyastuti Andriyani

Table 2 Day

No	Day
1	Monday
2	Tuesday
3	Wednesday
4	Thursday
5	Friday

Table 3 Time

No	Time
1	08.00-10.00
2	10.00-12.00
3	13.00-15.00
4	15.00-17.00

Table 4 Room

No	Room
1	T.3.1
2	T.3.2
3	T.3.3
4	T.3.4

There are several stages that must be carried out in a genetic algorithm, namely:

(1) *Initial Population Initialization Stage.* The initial population initialization is carried out randomly for the value of each gene according to the chromosome representation used[10], so that an initial solution is obtained using the following formula.

$$IPOP = round\{random(N_{ipop}, N_{bits})\} \quad (1)$$

Where $IPOP$ is the gene that will contain a random value generated by N_{ipop} (number of population) x N_{bits} (number of genes in each chromosome).

(2) *Fitness Evaluation Stage.* At this stage, each chromosome will have its fitness value calculated[5]. Then to determine the fitness value, use the following formula.

$$F = \frac{1}{(1 + \Sigma bd + \Sigma br + \Sigma bm)} \quad (2)$$

Where:
F = Fitness Value
bd = lecturer schedule conflict
br = room schedule conflict
bm = course schedule conflict
For each chromosome, the conflict and fitness values are obtained as in Table 5.

Table 5 Early Generation Fitness Calculations

Chromosome	Conflict	Calculate Fitness	Fitness Value
Chromosome 0	4	$\frac{1}{(1+4)}$	0,2
Chromosome 1	2	$\frac{1}{(1+2)}$	0,33
Chromosome 2	3	$\frac{1}{(1+3)}$	0,25
Chromosome 3	5	$\frac{1}{(1+5)}$	0,16
Chromosome 4	3	$\frac{1}{1+3}$	0,25

From these data, it can be concluded that chromosome 1 is the best chromosome among the 5 chromosomes, because it contains the highest fitness value.

(3) Selection Stage. At this stage, you will choose which chromosome will later be crossed against another chromosome. The method used uses the rank selection method (Hussain and Muhammad, 2020). The first is to determine the ranking of each chromosome based on the fitness value of each chromosome, so that a ranking is obtained as follows.
Chromosome 1 = 0.33
Chromosome 2 = 0.25
Chromosome 4 = 0.25
Chromosome 0 = 0.2
Chromosome 3 = 0.16
Because chromosome 1 has the best ranking, the value of the population ranking is 5. And the value of the population ranking below it will be (n-1). And the ranking values obtained are as follows.
Chromosome 1 = 5
Chromosome 2 = 4
Chromosome 4 = 3
Chromosome 0 = 2
Chromosome 3 = 1
Then the total ranking values of all chromosomes are added, so that all ranking values are obtained (5+4+3+2+1) = 15. After that, the cumulative of all ranking values is carried out as follows.
Chromosome 1 = 1-5
Chromosome 2 = 6-9
Chromosome 4 = 10-12
Chromosome 0 = 13-14
Chromosome 3 = 15
Then a roulette of random numbers with values 1-15 is created. Roulette is carried out as many as the value of the population is 5. Roulette is carried out to select which chromosome will later be crossover, then the chromosome pair is selected from the selection. The results of the roulette are as follows.
Chromosome 1 = 3
Chromosome 2 = 6
Chromosome 4 = 11
Chromosome 0 = 4
Chromosome 3 = 7
From the results of the roulette, the selection results for these chromosomes are as follows.

$$Chromosome1$$

$$\times$$

$$Chromosome1$$

$$Chromosome2$$

$$\times$$

$$Chromosome2$$

$$Chromosome4$$

$$\times$$

$$Chromosome4$$

$$Chromosome0$$

$$\times$$

$$Chromosome1$$

$$Chromosome3$$

$$\times$$

$$Chromosome2$$

So the chromosomes that will go through the crossover process stage are chromosome 0 and chromosome 3.

(4) Crossover Stage. At this stage, the chromosomes selected from the selection process will go through a crossover process. So the value of the chromosome 0 array will be replaced with the array value of chromosome 1 and the value of the chromosome 3 array will be replaced with the value of the chromosome 2 array. The method used uses 1 cut point[8]. Crossover is done by generating a percentage number from 0% to 100%. The number of roulettes is as many as the population, namely 5. The crossover probability used is 0.70 where the percentage is 70%. So, if the roulette result is <70%, then the chromosome array value will undergo a crossover process.
The following are the results of the chromosome 0 roulette:

0

roulette results = 43 %

1

roulette results = 53 %

2

roulette results = 69 %

3

roulette results = 80 %

4

roulette results = 72 %
Then the array values 0,1 and 2 on chromosome 0 will be crossed with the array values from chromosome 1 using the 1 cut point method.
The following are the results of the chromosome 3 roulette:

0

roulette results = 73 %

1

roulette results = 33 %

2

roulette results = 19 %

3

roulette results = 99 %

4

roulette results = 89 %
Then the values from arrays 1 and 2 on chromosome 3 will be crossed with the array values from chromosome 2 using the 1 cut point method.

(5) Mutation Stage. At this stage, the array value will be chosen randomly and the new value will be obtained randomly by generating a percentage value from 0% to 100% as a roulette[6]. Roulette is carried out as many times as the population is 5. The probability of mutation used is 40%. This means that if the percentage value is <40%, then the chromosome has a mutation. Then a random number will be generated from 0 to the array number –1. Because the number of arrays is 5, the random number generated has a value of 0–4. Then a roulette is carried out on the numbers 0–4. The result of the roulette is the array value that will change. Below are the roulette results for each chromosome.
Chromosome 0 : roulette results = 83 %
Chromosome 1 : roulette results = 36 %
Chromosome 2 : roulette results = 64 %
Chromosome 3 : roulette results = 76 %
Chromosome 4 : roulette results = 92 %

From these results, only chromosome 1 had a mutation. Then a random number is generated from 0–4 to select the array where the mutation occurs. And the result obtained from the roulette is 3. So on chromosome 1 array 3 a mutation will occur. Array value 3 is obtained from randomization of day, time, and room data.
After the mutation process is complete, the fitness value is then recalculated as in Table 6 .

Table 6 Generation 1 Fitness Calculations

Chromosome	Conflict	Calculate Fitness	Fitness Value
Chromosome 0	0	1/ (1+0)	1
Chromosome 1	0	1/(1+0)	1
Chromosome 2	0	1/(1+0)	1
Chromosome 3	0	1/(1+0)	1
Chromosome 4	3	1/(1+3)	0,25

In Table 6, the fitness value calculation for chromosomes 0, 1, 2 and chromosome 3 has reached 1 with a conflict of 0. So the generational iteration process to get the optimal schedule solution is in the 1st generation process, namely on chromosomes 0, 1, 2 and chromosome 3 as follows.
Chromosome 0 :
Widyastuti Andriyani (MP1):Wednesday:13.00-15.00:T.3.1
Bambang P.D.P. (AP1):Monday:13.00-15.00:T.3.4
Domy Kristomo (MN3):Thursday:08.00-10.00:T.3.1
Badiyanto (PWC1): Wednesday:10.00-12.00:T.3.3
Widyastuti Andriyani (SPK2):Monday:08.00-10.00:T.3.2

Chromosome 1 :
Domy Kristomo (MN3):Monday:08.00-10.00:T.3.1
Badiyanto (PWC1):Wednesday:10.00-12.00:T.3.3
Widyastuti Andriyani (SPK2):Thursday :13.00-15.00:T.3.4
Widyastuti Andriyani (MP1):Wednesday:08.00-10.00:T.3.2
Bambang P.D.P. (AP1):Friday:10.00-12.00:T.3.3

Chromosome 2 :
Bambang P.D.P. (AP1):Friday:15.00-17.00:T.3.2
Widyastuti Andriyani (MP1):Monday:08.00-10.00:T.3.2
Widyastuti Andriyani (SPK2):Thursday:13.00-15.00:T.3.4
Domy Kristomo (MN3):Tuesday:13.00-15.00:T.3.4
Badiyanto (PWC1):Wednesday:08.00-10.00:T.3.2

Chromosome 3 :
Widyastuti Andriyani (MP1):Thursday:13.00-15.00:T.3.2
Badiyanto (PWC1):Tuesday:13.00-15.00:T.3.3
Widyastuti Andriyani (SPK2):Tuesday:13.00-15.00:T.3.4
Bambang P.D.P. (AP1):Monday:08.00-10.00:T.3.2
Domy Kristomo (MN3):Thursday:13.00-15.00:T.3.4

3.2 Testing and Evaluation. In this research, testing will be carried out using MS Excel using the VLOOKUP formula which is commonly used by academic departments to create lecture schedules and Python software using the genetic algorithm method to solve lecture scheduling problems. The data used for this test uses lecture schedule data for the odd semester 2022/2023. From this data, 5 data samples were taken from 8 study programs each and 40 data samples were obtained as in Table7.

Table 7 Sample Test Data

No	COURSE NAME	LECTURER	CREDITS	CLASS	SEMESTER
1	Algoritma Pemrograman	Bambang DP, Dr., S.Si., M.Kom.	3	2	1
2	Prinsip Akuntansi	Sri W., SE, M.Si.	2	1	1
3	Pendidikan Bahasa Indonesia	Candra Andari, S.Pd., M.Pd.	2	2	1
4	Pengenalan Bisnis Digital	Yusuf Munandar Kusumanegara, S.Si., MT	2	1	1
5	Penambangan Data	Dani R., S.Kom., MT	3	2	5
6	Desain Web	Novianti S., S.Si., MT	3	2	5
7	Pemrograman Anti-Malware	Dwi Kurniawati, S.Kom., MT	3	1	7
8	Pemrograman Seluler	Deni Purnamasari, S.Pd., M.Kom.	3	1	5
9	Matematika	Endu P., M.Pd.	3	2	1
10	Prinsip Ekonomi	Fina Wahyuningrum, SE, M.Si.	2	1	1
11	Struktur Data	Dani R., S.Kom., MT	3	1	3
12	Informasi	Dina Pratiwi, S.Kom., MM	3	1	3
13	E-Bisnis	Dian N., S.Kom., MT	3	1	5
14	Pengembangan Aplikasi Seluler	Dwi P., S.Pd., M.Kom.	3	2	7
15	Pemrograman Web Lanjutan	Novianti S., S.Si., MT	3	1	5
16	Sistem Manajemen	Dina Pratiwi, S.Kom., MM	3	1	5
17	Prinsip Ekonomi	Fina W., SE, M.Si.	2	2	1
18	Grafik Komputer	Dian N., S.Kom., MT	3	2	5
19	Kecerdasan buatan	Dina Pratiwi, S.Kom., MM	3	1	5
20	Rekayasa Perangkat Lunak	Dian N., S.Kom., MT	3	1	7

Then to measure the performance of the model using a confusion matrix as shown in Figure 3 Confusion matrix can be used to evaluate the performance of a model or algorithm. The measures that are often used are Accuracy, Precision, Recall and F1 Score][13].

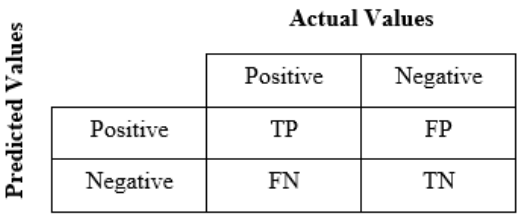

Fig. 2 Confusion Matrix

Information:
True Positive (TP) = The amount of data that is Positive and correctly predicted as Positive.
False Positive (FP) = The amount of data that is Negative but predicted as Positive.
False Negative (FN) = The amount of data that is Positive but predicted as Negative.
True Negative (TN) = The amount of data that has a negative value and is correctly predicted as negative.
Accuracy = Measures how well the model makes correct predictions out of the total predictions made.
Precision = Measures how well the model makes correct predictions for the positive class out of the total positive predictions.
Recall = Measures how well the model is at correctly identifying the positive class.
F1 Score = Measuring the comparison of weighted average precision and recall. Accuracy is used as a performance reference if the number of False Negative and False Positive data is very close. However, if the numbers are not close, then we should use the F1 Score as a reference.

(1) First Test: carried out using MS Excel with VLOOKUP using the following formula.

Table 8 Lecture Schedule Using MS Excel

Day	Time	Course	Lecturer	Cr.	Class	Sem	Room
Senin	08.00–10.00	Pengantar Teknologi Informasi	Luthfan Pramono, S.ST., MT	2	1	1	S2.3
Senin	08.00–10.00	Manajemen Ritel	Iwan Jaka Pradana, SE., MM	2	1	1	S2.4
Senin	08.00–10.00	Sistem Operasi	Luthfan Pramono, S.ST., MT	2	1	1	S2.3
Senin	08.00–10.00	Jaringan Komputer	Dika Fadila Sart., ST, MT	2	2	5	S2.4
Senin	10.00–12.00	Penambangan Data	Dika Fadila Sart., ST, MT	3	2	5	S1.2
Senin	10.00–12.00	Arsitektur Jaringan	Adiyuda Pratama, S.Kom., MT	3	1	7	S1.4
Senin	10.00–12.00	Algoritma Pemrograman	Bambang DP, Dr., S.Si., M.Kom., MMSI.	3	2	1	S2.1
Senin	10.00–12.00	Pemrograman Klien Web	Novianti S., S.Si., MT	3	1	5	S2.3
Senin	13.00–15.00	Pendidikan Bahasa Indonesia	Andari, S.Pd., M.Pd.	2	2	1	S1.2
Senin	13.00–15.00	Pengenalan Bisnis	Agus Suyoto, ST, MT	2	1	1	S2.4
Selasa	08.00–10.00	Prinsip Ekonomi	Fina Wahyuningrum, SE, M.Si.	2	1	1	S2.3
Selasa	08.00–10.00	Pengantar Teknologi Big Data	Dian Kusumasto, S.Kom., MM	2	1	5	S2.4
Selasa	08.00–10.00	Analisis Sistem	Dian Kusumasto, S.Kom., MM	2	1	5	S1.4
Selasa	10.00–12.00	Pemrograman Seluler	Dwi Kurniawati, S.Kom., MT	3	2	5	S2.1
Selasa	10.00–12.00	Pemrograman Web Server	Hartawan, ST, MT	3	2	5	S1.2
Rabu	08.00–10.00	Rekayasa Perangkat Lunak	Dian Kusumasto, S.Kom., MM	3	1	7	S2.4
Rabu	10.00–12.00	Visualisasi Data	Dwi Purnamasari, S.Pd., M.Kom.	3	1	5	S2.3
Rabu	13.00–15.00	E-Bisnis	Novianti S., S.Si., MT	3	2	7	S1.2
Kamis	08.00–10.00	Prinsip Akuntansi	Sri W., SE, M.Si.	2	1	1	S2.3
Jumat	10.00–12.00	Bisnis Digital	Yudi Kusumanegara, ST, MT	2	1	5	S2.4
Jumat	13.00–15.00	Bahasa Inggris	Dwi Wahyu Utami, S.Pd., MA	2	1	5	S2.3

Table 8 shows the test results using MS Excel with the VLOOKUP formula. It can be seen in Monday's schedule from 08.00 - 10.00 that there are still conflicting schedules, namely 1 lecturer teaching 2 different courses at the same time which is marked in red. And the time needed to complete the lecture scheduling takes around 20 minutes. In the first test of 40 data the following results were obtained.
True Positive (TP) = 24
False Positive (FP) = 0
False Negative (FN) = 2
True Negative (TN) = 14
Then to calculate the Accuracy, Precision, Recall and F1 Score values, use the following formula.

$$Accuracy = \frac{TP + TN}{TP + FP + FN + TN} \tag{3}$$

$$Accuracy = \frac{24 + 14}{24 + 0 + 2 + 14} = 0.95 \times 100\% = 95\%$$

$$Precision = \frac{TP}{TP + FP} \tag{4}$$

$$Precision = \frac{24}{24 + 0} = 1 \times 100\% = 100\%$$

$$Recall = \frac{TP}{TP + FN} \tag{5}$$

$$Recall = \frac{24}{24 + 2} = 0.92 \times 100\% = 92\%$$

$$F1\ Score = 2 \times \frac{Recall \times Precision}{Recall + Precision} \tag{6}$$

$$F1\ Score = 2 \times \frac{0.92 \times 1}{0.91 + 1} = 0.95 \times 100\% = 95\%$$

(2) Second Test: carried out using Python software with the genetic algorithm method.

```
> Generasi: 6
+---------+----------+----------+
| Jadwal  | Fitness  | Konflik  |
+---------+----------+----------+
|    0    |    0.5   |     1    |
|    1    |    0.5   |     1    |
|    2    |    0.5   |     1    |
|    3    |    0.2   |     4    |
|    4    |   0.167  |     5    |
+---------+----------+----------+

> Generasi: 7
+---------+----------+----------+
| Jadwal  | Fitness  | Konflik  |
+---------+----------+----------+
|    0    |    0.5   |     1    |
|    1    |    0.5   |     1    |
|    2    |    0.5   |     1    |
|    3    |   0.333  |     2    |
|    4    |    0.25  |     3    |
+---------+----------+----------+

> Generasi: 8
+---------+----------+----------+
| Jadwal  | Fitness  | Konflik  |
+---------+----------+----------+
|    0    |    1.0   |     0    |
|    1    |    1.0   |     0    |
|    2    |    0.5   |     1    |
|    3    |   0.333  |     2    |
|    4    |    0.25  |     3    |
+---------+----------+----------+
Squeezed text (132 lines).

> Generasi: 8

Durasi: 0:00:00.609356
```

Fig. 3 Generation Iteration Process

From the test results using Python software with the genetic algorithm method as in Figure 5. The optimal schedule solution is found in the 8th generation iteration process, because the fitness value has reached 1 with a conflict value of 0, which means there are no more conflicting class schedules and the time required is 0.609356 seconds. The lecture schedule output can be seen in Table 9.

Table 9 Lecture Schedule Outpput

No	Course Name	Room	Lecturer	Schedule
1	Algoritma Pemrograman	S2.3	Bambang DP, Dr., S.Si., M.Kom., MMSI	Senin 10:00 – 12:00
2	Prinsip Akuntansi	S2.4	Sri W., SE, M.Si.	Senin 08:00 – 10:00
3	Pendidikan Bahasa Indonesia	S2.1	Andari, S.Pd., M.Pd.	Senin 13:00 – 15:00
4	Pengenalan Bisnis	S1.4	Yusuf Munandar Kusumanegara, S.Si., MT	Senin 13:00 – 15:00
5	Sistem Operasi	S1.2	Dika Fadila Sart., ST, MT	Senin 08:00 – 10:00
6	Data Mining	S1.2	Dika Fadila Sart., ST, MT	Senin 10:00 – 12:00
7	Pemrograman Mobile	S2.3	Dwi Kurniawati, S.Kom., MT	Selasa 10:00 – 12:00
8	Pemrograman Jaringan	S2.1	Aditya Pratama, S.Kom., MT	Senin 10:00 – 12:00
9	Prinsip Ekonomi	S2.4	Fina Wahyuningrum, SE, M.Si.	Selasa 08:00 – 10:00
10	Pemrograman Web Server	S2.4	Hartawan, ST, MT	Selasa 10:00 – 12:00

In the second test, the following results were obtained from 40 data.
True Positive (TP) = 24
False Positive (FP) = 0
False Negative (FN) = 0
True Negative (TN) = 16

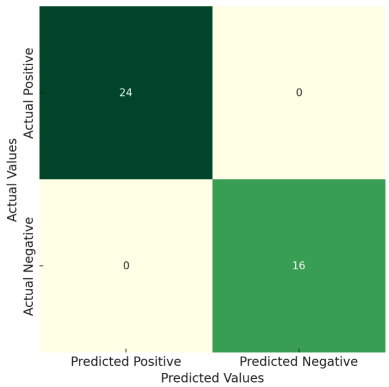

Fig. 4 Confusion Matrix Using Genetic algorithm

Model performance with True Positive (TP) = 24, False Positive (FP) = 0, False Negative (FN) = 0, and True Negative (TN) = 16. Then to calculate the Accuracy, Precision, Recall and F1 Score values, use the formula 3 4 5 6.

$$Accuracy = \frac{24+16}{24+0+016} = 1 \times 100\% = 100\%$$

$$Precision = \frac{24}{24+0} = 1 \times 100\% = 100\%$$

$$Recall = \frac{24}{24+0} = 1 \times 100\% = 100\%$$

$$F1\ Score = 2 \times \frac{1 \times 1}{1+1} = 1 \times 100\% = 100\%$$

Table 10 Test Results Comparison

Testing	Test 1	Test 2
Software	MS Excel	Python
Method / Formula	VLOOKUP	Genetic Algorithms
Amount of data	40	40
Schedule conflict	2	0
Accuracy	95 %	100 %
Time required	20 minute	0.609356 second

In Table 10 it can be seen that testing using Python software with the genetic algorithm method resulted in faster and more accurate results, because it only took 0.609356 seconds and there were no schedule conflicts. Meanwhile, testing using MS Excel with VLOOKUP takes longer, namely around 20 minutes and the results are less accurate because there are still conflicting lecture schedules.

4 Conclusion

Genetic Algorithm is a search method used to find the optimal solution to problems with numerous possible solutions, making it an effective approach for solving lecture scheduling problems. This method involves several stages, starting with the initialization of the initial population, followed by fitness evaluation, selection, crossover, and mutation processes. These steps are designed to produce a new population that can serve as a solution to scheduling conflicts. Based on test results using Python software and the genetic algorithm method, the process proved to be significantly faster and more accurate compared to MS Excel with VLOOKUP. The Python-based genetic algorithm completed the task in just 0.609356 seconds with a 100% accuracy rate, whereas MS Excel with VLOOKUP required approximately 20 minutes and achieved an accuracy rate of 95%. This difference highlights the efficiency of the genetic algorithm, particularly in ensuring high precision and eliminating conflicts in lecture schedules.

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