Genetic Algorithm for Employees Work From Office Schedule

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Abstract

Scheduling is nothing new for every company. During the Covid-19 pandemic, many things have changed, especially in the implementation of employee scheduling in the world of work. Changes were made to the employee attendance schedule to reduce the impact of the spread of the virus in the current covid-19 pandemic. Every company enforces rules for employees to be able to work from home. However, not every company employee is required to work from home, only a few employees from the company have been scheduled to work at home and some will work in the office as usual. This research was conducted with the aim of making it easier for companies to monitor employees and provide information about scheduling to employees during this covid-19 pandemic. The Genetic Algorithm For Employees, can assist employees in providing information about their attendance schedule and provide good value for the company. The research method used in this research is the documentation study method and the scheduling model uses genetic algorithms. The purpose of the application of genetic algorithms is to produce a scheduling system modeling that is fast and processed automatically without breaking the rules that have been set. The optimal solution of this scheduling applies 40% (Work From Office), 50% (Work From Home), 10% (employees who are required to go to the office urgently).

Keywords: Covid-19, Employees, Genetic Algorithm, Scheduling, Work From Office

Introduction

In the COVID-19 pandemic, this Genetic Algorithm For Employees can help companies and employees provide information to employees about their scheduling as well as provide companies with determining employee schedules and companies can find out how many arriving employees have to come to work and how many must come. Working from home, this system was created to help companies manage employees during the COVID-19 pandemic.

With scheduling, the company can be more optimal in achieving goals and objectives. Because several labor resources are more controlled to perform some tasks or operations within a certain period.

According to Haupt and Haupt, a Genetic Algorithm is a heuristic method developed based on the principles of genetics and the natural selection process of Darwin's Theory of Evolution. The optimization method was developed by John Holland in the 1960s and popularized by a student, David Goldberg, in the 1980s (Zukhri, 2014).

Based on this understanding, the purpose of the application of genetic algorithms is to produce a scheduling system modeling that is fast and processed automatically without violating the rules that have been set.

The advantage of genetic algorithms is that they can optimize problems with complex problems and a very wide search space. While the deficiency is that it requires a lot of generations to produce an optimal value.

This method was chosen because genetic algorithms can be used for employee scheduling processes to produce optimal solutions in the form of attendance schedules for work in the office and at home.

Genetic Algorithm for Employees Work From Office Schedule was created to make it easier for companies to monitor employees and provide scheduling information to employees. With this Genetic Algorithm For Employees, it can assist employees in providing information about their presence and provide good value to the company.

Literature Review

Scheduling well has many benefits for an organization, such as more effective use of resources, lower costs, and providing relief for employees in doing work (Ao & International Association of Engineers., 2013). Attendance is a work ethic given by the employer. Many educational institutions and government organizations in developing countries still use paper-based attendance methods to maintain attendance records (Walia & Jain, 2016). In companies, the attendance system can be used as a tool to help companies in many ways, such as: managing the daily attendance process, analyzing human resources, and recording overtime information, and transferring it to the payroll system (Md. Shakil, 2013). Attendance management is important for every organization, as it can decide whether a company like the public or private sector will

be successful in the future. Companies must track each of their employees to maximize their performance (Jacksi et al., 2018) to perform some tasks or operations within a certain time and is a decision-making process whose role is very important in a company to allocate existing resources to more optimal company goals and objectives. (Pinedo, 2008).
The genetic algorithm has seven basic components, but many variations of methods are proposed to be used for each component. Each component has its advantages and disadvantages, such as a method that is good for solving problems in case A but not necessarily able to solve problems in case B or even not being able to solve problems in case C. (Hijriana, 2015).

Research Method
This study uses the Ranjit Kumar methodology (Kumar, 2018). The methodology used can be used to provide an overview of the research process, this methodology consists of 8 stages as follows:

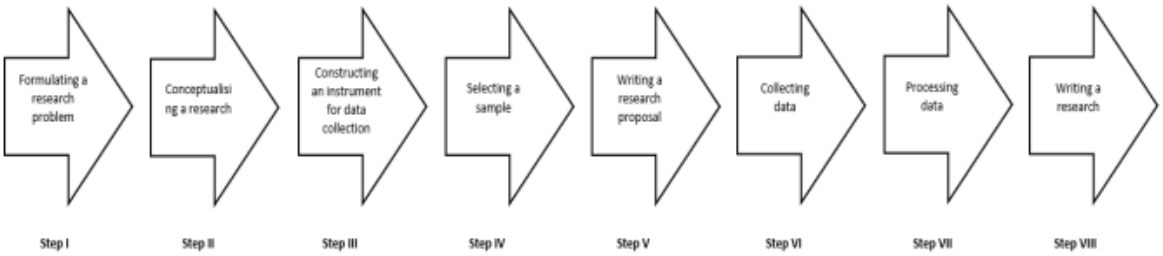


Figure 1. Ranjit Kumar Methodology

This study uses primary data sources obtained directly by using the study documentation data collection method.

Formulating a Research Problem
This step is needed for the research process, where at this step a search is carried out to update the existing absent menu. This research does not create a new system but updates the old system by following company regulations during this Covid-19 pandemic.

Conceptualizing a Research Design
The concept of this research design is used by researchers to determine the answers to the problems at hand. The design concept used in this study uses a genetic algorithm that can optimize problems with complex problems with a very wide search space.

Constructing an Instrument for Data Collection
This study uses primary data obtained from the company and can change at any time. The data is obtained by using the documentation study method from the company through employees directly to get accurate results.

Selecting a Sample
The sample used for research needs is a work schedule that will be divided into two types, namely WFH and WFO. The sample used in this scheduling system is about 52 workers consisting of 7 sections.

Writing a Research Proposal
Following are the research proposals:
1. The system is based on the old system that has been updated to follow company regulations during the Covid-19 pandemic.
2. The design concept uses genetic algorithms to perform problem-by-problem optimization.
3. The research is made for the needs of the company that is used for worker scheduling.
4. The data used are primary data obtained from the company.
5. In this study, there were 52 employees as the sample to be used.
6. The research report to be submitted consists of several chapters, namely: introduction, literature review, research methods, results and discussion, conclusions and suggestions, references.

Collecting data
The data collection used in this study is guided by the data obtained from the documentation study method of the company, in the form of an employee dataset consisting of 7 attributes and 4 of them in the form of class attributes including:

Table 1. Attributes of Employee Data Collection

no	attribute	type
1	id_employed	integer
2	id_team	integer
3	name	Variable character

Processing and Displaying
For data processing that will be used in this research, an application (Genetic Algorithm For Employees and Safe Entrance For Work From Office Scheduling) is used. In this application, there are three cases where employees with WFH status will be absent online at their homes, while in the second case, employees with WFO status will be absent online but are required to come to the office, and the third case if there are employees who come to the office but on a WFH schedule. cannot enter the room and the employee schedule will be displayed for 1 week.

Writing a Research Report
The last stage is making a research report which consists of several chapters, namely: introduction, literature reference, research methods, results and discussion, conclusions and suggestions, references.

Results and Discussions
To prevent the virus (covid-19) but still able to increase the effectiveness of working face-to-face at PT Neuronworks Indonesia, then a work operational activity policy is being applied. Based on the data and facts collected, the schedule made has several rules. The rules are with a minimum number for Work From Office is (R-1) two days a week with (R-2) a maximum staff capacity of 50% following the Instructions of the Ministry of Home Affairs (Indonesian: Kementerian Dalam Negeri or Kemendagri) Numbers 39 and 41 of 2021 concerning the implementation of PPKM level 3 in Bandung City. (R-3) To do the job optimally, one team must be on the same WFO schedule. In this case, (R-4) the working day is set from Monday to Friday. One of the methods that can be used to solve the problem is to apply the Genetic Algorithm approach.

1. PT Neuronworks Indonesia Data
The sample data for PT Neuronworks Indonesia's schedule is shown in Table 2. This sample was created manually by humans and requires time to determine the schedule. If the rules change, the person in charge of making this schedule must rearrange the team and readjust the timing. Therefore, the Genetic Algorithm only needs to set the parameters needed to be adjusted to the existing regulations.

Table 2. PT Neuronworks Indonesia WFO schedule sample data

Team	ID Employee	Name	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
MDS - Irvan	11171008	Irvan Hasbi Taufiq	WFH	WFH	WFO	WFH	WFO	OFF	OFF
	11171009	Muhammad Rizky Fauzi	WFH	WFH	WFO	WFH	WFO	OFF	OFF
	11171010	Mohamad Aldo Firdaus	WFH	WFH	WFO	WFH	WFO	OFF	OFF
	11171011	Fajar Ega Firmansyah	WFH	WFH	WFO	WFH	WFO	OFF	OFF
	11171012	Andri Budi Santoso	WFH	WFH	WFO	WFH	WFO	OFF	OFF
	11171013	Julyan Widianto	WFH	WFH	WFO	WFH	WFO	OFF	OFF
	11171014	Bayu Dian Nugroho	WFH	WFH	WFO	WFH	WFO	OFF	OFF
	11171015	Dini Paramita	WFH	WFH	WFO	WFH	WFO	OFF	OFF

2. System Design

The output of this analysis is a spreadsheet file for Employees Work From Office Schedule optimization applying a Genetic Algorithm. The program plan is described in Figure 2. This program requires two main data inputs, specifically Employees raw data and Genetic Algorithm parameters.

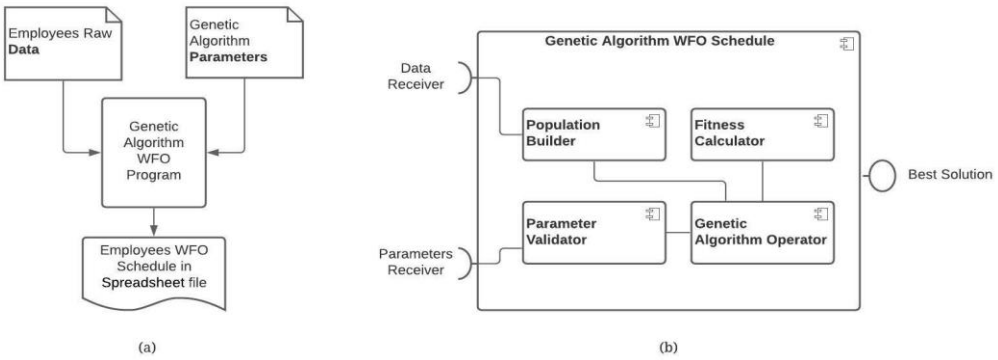


Figure 2. The plan of Employees Work From Office Schedule-Genetic Algorithm;
(a) Conceptual diagram; (b) Component Diagram

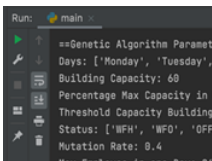
There are several components used to run this program as shown in Figure 2 (b). Parameter validator is a component that processes Genetic Algorithm Parameter data to be used as an Employee raw data configuration to control the calculation method. Population Builder will build some individual data as the first population. Then, the first population will be calculated by the Fitness Calculator component. The Genetic Algorithm Operator component will run the operation process after the first population has been created. At this step, there is a selection, crossover, mutation, and regeneration process to find the best solution.

3. Input and Output Design

The input and output system are presented in Figure 3. Raw data of employees and Genetic Algorithm parameters will be inputted into the program. As presented in Figure 3 (a) Employees data is the output system consists of (1) Total Employees is from a calculated length of data employees per team and add up as many as the existing team; (2) Total Team is from a calculated length of raw data of employees; (3) Team Sample is represented data from Raw data of employees.

As shown in Figure 3 (b), The second input is Genetic Algorithm parameters. (1) The Days are represented (R-4) days in one week. The number of days calculated for the initiation of the number of genes available in 1 chromosome. (2) Building Capacity is a representation of the maximum capacity Building can fill. (3) Percentage Max Capacity in percent is from the rule of (R-2) a maximum staff capacity of 50% following the Instructions of the Ministry of Home Affairs. (4) Threshold Capacity Building is the maximum capacity of an entire building when implementing the new rule. (5) Status defined with WFH, WFO, and OFF. (6) Mutation Rate is the frequency of new mutations in a single gene in every process for checking the best population. It can fill by 0 to 1. (7) Max Employee in one Day calculated from Percentage Max Capacity but, it's using ceil function. So, the result will be rounded to the top because the number is a representation of a person. It will be the threshold for inserting every team in a day of WFO because the rule is (R-3) one team must be on the same WFO schedule.

(a)



(b)

Figure 3. Sample of input & output (a) The input of raw data of employees;
(b) The input of Genetic Algorithm Parameters

4. Computation Design

Computation Flow Chart of Employees Work From Office Schedule-Genetic Algorithm is presented in Figure 4. The first step of this computation is input Data and Parameter. If data and parameter inputted computation will begin to initial population generation by Population Builder component.

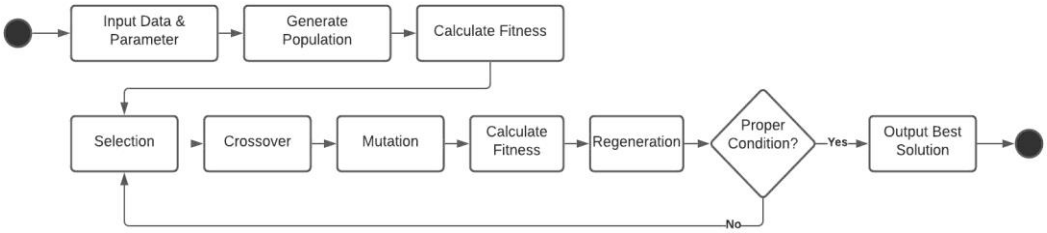


Figure 4. Computation Flow Chart of Employees Work From Office Schedule-Genetic Algorithm

The generated population will be calculated by the Fitness Calculator component to provide a value for each population that has been created. If there is no individual whose fitness value is equal to the fitness threshold, then the process will continue with the Genetic operation by the Genetic Algorithm Operator. The operator performs an iterative process, namely selection, crossover, mutation, and evaluation of fitness values and regeneration until one of several stop conditions is triggered. Stopping conditions are (1) at least there is an individual whose fitness value = 1; (2) employees who work from office ≤ Max Employees in one Day.

5. Initial Population

In this research, to generate the initial population, the technique used is to take status variables, day variables, team variables, then represented in the form of chromosomes. After that, the initial population is formed based on information from the number of N chromosomes. The initial population randomly generated for a chromosome evaluation process, wherein this research the length of the gene consisting of 7 genes, namely gene 1, gene 2 to gene N, can be seen from Figure 5 below. There are 7 genes in this research: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday. The chromosome is the number of the current team, which is seven teams.

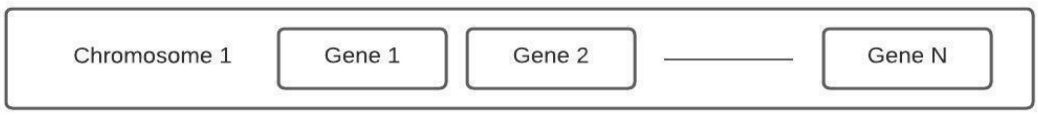


Figure 5. Initial Population

6. Chromosome

The formation of chromosomes determines the number of genes used and can represent a solution to the problem. Deciding on this solution that arises is represented by a set of parameters. These parameters are called genes that unite to form chromosomes. The amount of time available on workdays is from Monday to Friday. The number of chromosomes itself is seven chromosomes. There are seven genes in every chromosome. In this study, the gene value is the operational activity status of the team: WFO, WFH, and OFF represented as A for WFO, B for WFH, C for OFF. The values are randomized to fill in the gene. For example, the first gene consists of an initial population, then randomly generated to evaluate every chromosome. In this research, chromosomes are explained in Figure 6 below:

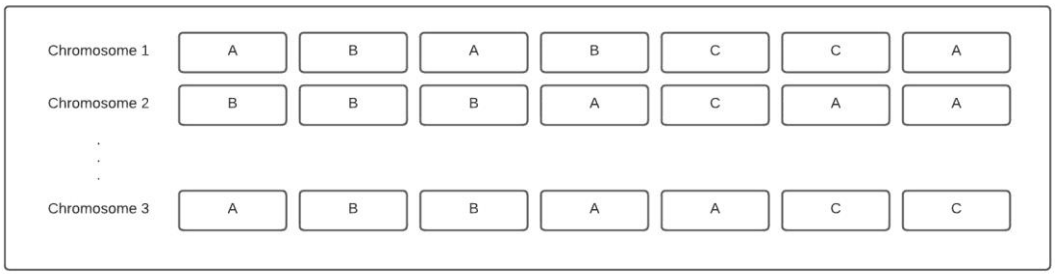


Figure 6. Generate Chromosome

7. Fitness Function

In this research, several conditions affect the fitness weight of each chromosome. First, when there are two A letters, it can't be more or less. Second, there must be two C letters in gene 6 and gene 7. The last one must be three B letters. When the condition does not match, it will be calculated as falses condition of each chromosome slot in the individual. In this calculation, two A letters mean that there are 2 WFO schedules in one week, then the remaining three days of the working day are WFH. Saturday and Sunday are Off Day.

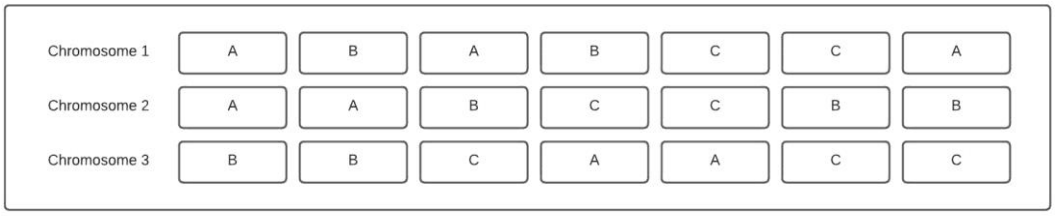


Figure 7. Chromosome Sample

The fitness value is calculated based on the number of falses that occur in each chromosome slot in an individual. The example chromosome in Figure 7 will produce the following fitness value in Table 3.

Table 3. Fitness Validation Sample

Individual	**Condition**			**False Total**
	Two A Letters in Gene 1-5	**Three B Letters in Gene 1-5**	**Two C Letter in Gene 6 and 7**	
Chromosome 1	FALSE	FALSE	FALSE	3
Chromosome 2	TRUE	FALSE	FALSE	2
Chromosome 3	TRUE	FALSE	TRUE	1

From the data in Table 3, the fitness value is calculated using the Fitness Formula below:

- Chromosome 1 = $1 \div (1 + 3) = 0.25$
- Chromosome 2 = $1 \div (1 + 2) = 0.33$
- Chromosome 3 = $1 \div (1 + 1) = 0.5$

8. Selection

Selection is the process to choose a parent's chromosome based on the fitness value of every chromosome in the population. Tournament selection randomly selects N individuals from a population. If the chromosome has the highest fitness value, it will be the winner of the tournament. In this research, Chromosome 3 and Chromosome 1 are the best from this population, chromosomes selected as a pair of the parent.

9. Crossover

At this step, the two-parent chromosomes will encounter a random crossing process. In this research, the cross-breeding method uses a crossover point. After the cut-off point is chosen randomly, information will exchange from the two chromosomes based on the cut-off point that has been determined. In this process, a child's chromosome will produce a result of a cross between the two parents, where the child's chromosome

contains genes from a combination of both parents and is different from the parent's genes. The following are the stages of the chromosome crossover process of two-parent individuals who will exchange gene values.

10. Mutation

The next stage after the crossover process is mutation. The mutation process is by selecting or modifying the genes on a chromosome using the mutation rate. This change has a lower or higher fitness value than the parent solution. A random number is generally between [0-1], for example, 0.1 (Suyanto, 2005). taken less than the mutation rate, then the value of the gene is exchanged for the value of another gene at random.

11. Regeneration

After carrying out the gene exchange process with the previous method, new individuals will be found and regenerated into the population. This process emulates spring's and parent's fitness values. Two individuals who have the best fitness value will enter the population and it will be the new generation for the next algorithm process. This process keeps the best individual stay in the population.

12. Termination

In the Computation Flow Chart as presented in Figure 4. There is a proper condition process that will terminate the best solution if the condition is not matched. This process will check if the employees who work from the office are no more than Max Employees in one Day. When the threshold is reached, this system will find another best solution that has not reached max employee in a day.

13. Result

The result of the resulting test is shown in Figure 8. It shows that each chromosome has the following condition: there are two A letters, three B letters, and C letters at the end of the gene.

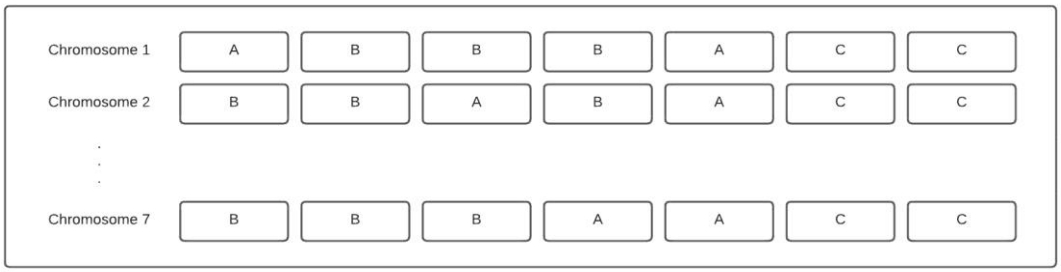


Figure 8. Population Result

Conclusion

The conclusion from the results of implementing genetic algorithms in scheduling Work From Office at PT Neuronworks Indonesia are as follows:

1. The work from office scheduling at PT Neuronworks Indonesia aims to generate a schedule automatically. So, that displays the Work From Office schedule for each employee.
2. In optimizing the preparation of the Work From Office schedule at PT Neuronworks Indonesia using a genetic algorithm, parameters are needed the number of employees, employee data that wrapped in each team.

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