Journal of Applied Business and Technology (JABT)

APPLICATION OF GENETIC ALGORITHM IN TOURISM ROUTE OPTIMIZATION IN PEKANBARU CITY

Eri Yanto[a] ,Ramalia Noratama Putri[b*]

[a,b]Department of Computer Science, Institut Bisnis dan Teknologi Pelita Indonesia, 28156, Pekanbaru, Indonesia

Article history
Received
31 August 2019
Received in revised form
11 November 2019
Accepted
16 December 2019
Published Online
20 Januari 2020

*Corresponding author
ramalia.noratamaputri@lecturer.pelitaindoneia.ac.id

Abstract
The number of tourist attractions that are not yet well known, reinforced by the release of Pekanbaru City Government data that the tourism sector only accounts for about 0.9% of the national tourism sector. Therefore, this study aims to optimize the determination of Pekanbaru city tourist travel routes by using genetic algorithms or Genetic Algorithms. Genetic algortima process generally consists of several stages, starting from the initial generation, determination of fitness, crossover stage, mutation to the generation of advanced stages. With an accuracy rate of the best offered solutions reaching around 88% and an average solution search of about 19 seconds per iteration on a constant 100x trial, the results of this study can be used to help general users or Tour & Travel businesses in determining travel routes more optimal travel and a better travel experience.

Keywords: Route, Optimalization, Travel, Algorithm, Genetic Algorithm

1.0 INTRODUCTION

Technology has become one of the primary needs that is inseparable from human (Atikah, 2019). Changes brought about by technology can be seen from the patterns of human habits today. This is because technological development is oriented to all the conveniences available to achieve the best results(Insani & Sari, 2017).

Starting from the demand for optimization, a new algorithm is known as the Genetic Algorithm. Genetic Algorithms are Heuristic algorithms that are based on the mechanism of biological evolution. Genetic algorithms can be applied to several types of non-linear objective functions and have the flexibility to be implemented efficiently on certain problems(Jollyta, Johan, & Hajjah, 2017).

The element of optimization and efficiency as a basic indicator of this algorithm is supported from various previous studies as stated in the Journal of the Shortest Route Search Application Using Genetic Algorithms to find the shortest route for fire fighters in the Pontianak region(Utami et al., 2014). The same thing is also applied to the Implementation of Genetic Algorithms for route search based on the fastest time of attractions in Ngawi district with the results of research providing an efficient time solution to the destination(Annasir, 2013).

This can also be applied in the city of Pekanbaru, given that there are still many tourist attractions that are not yet well known and the number of tourist itineraries that are not efficient enough, such as the choice of the geographical location of tourist objects that are far apart can cause a less-than-comfortable travel experience for tourists and could have an impact on tourism sector in Pekanbaru city.

Therefore, the author wishes to optimize the effectiveness and efficiency of determining the route of travel by using the Genetic Algorithm. With the implementation of this optimization, it can help general users. local business people and

even the government in determining the optimum travel route and high accuracy value so that it can be utilized to support business processes and improve the local economy.

LITERATURE REVIEW

Optimization

Optimization is the search for the best value either in the form of minimum or maximum of an objective function which is carried out by identifying the best solution of a problem. Optimization can also mean efforts to improve performance so that it has good quality and high work results(Abraham, 2015).

Route

The route is the distance or direction that must be taken as a link between places. With the route, then a path can be determined to reach the destination(Rizki et al., 2017).

System

The system can be interpreted as a collection of components or elements as parts that interact as a single unit jointly operating data, producing information to achieve certain goals in common(Fransisca & Putri, 2019).

Algorithm

The algorithm is adapted from the word algorithm in the book Abu Ja'far Muhammad Ibnu Nusa Al-Khuwarizmi, a series of commands or instructions that are made clearly and systematically based on a logical sequence in solving problem(Fauzi, 2011).

Genetic Algorithm

Genetic algorithm or also called Genetic Algorithm, is one of the heuristic search technique algorithms that is based on the mechanism of biological evolution both on the idea of evolution of natural and genetic selection. Utilization in the natural selection process so that individuals can continuously undergo gene changes to adapt to their living environment, which is strong individuals who are able to survive(Setiawan, Putri, & Suryanita, 2019a) .

Further studies on the stages of the Genetic Algorithm are as follows :

1. Initial Generation

Also called initial initialization, with the application of gene representations in binary, integer, real and permutation forms. Initial generation is done by generating random numbers.

2. Determination of the fitness function

As an indicator that determines how good an individual. With the formula for determining the fitness value of each individual as follows:

Q(i)= 1/(fitness(i))

3. Determination of mutation and crossover probability values

This probability value will affect how likely the mutation or crossover is in the genes contained in an individual.

4. Selection Process

This selection process is an individual screening stage that will go through the next stage such as the mutation and crossover stages.

5. Crossover Process

Referring to the crossover probability value that has been determined in the third stage, then that value will affect how many genes will cross between a pair of parent individuals that have been determined from the selection process.

6. Mutation Process

Referring to the mutation probability value that has been determined in the third stage, the value will affect how many mutations occur in a population, with the process carried out in each individual parent, in exchange for the position of their genes.

7. The generation of new individuals

The final stage of the genetic algorithm, by determining the 2 best individuals based on fitness values, to participate in the next iteration(Oktarina & Hajjah, 2019).

TSP

The TSP concept, short for Travel Salesman Problem, is a combinatorial optimization problem concept which is generally used in determining the most optimum travel route from one location and then proceed to visit other locations. With the provisions of each city may only be visited once(Fanggidae & Aldo, 2015).

Accuracy Testing

Accuracy is the calculation of the number of correct predictive proportions of an event, as the same measurement (Setiawan, Putri, & Suryanita, 2019b).

Accuracy is formulated in the equation as follows:

Accuracy = (TP+TN)/(TP+FP+TN+FN)

Information :

TP : True Positive

TN : True Negative

FP : False Positive

FN : False Negative

While the level of accuracy can be diagnosed as follows :

Accuracy 0.90 – 1.00 = Excellent Classification

Accuracy 0.80 – 0.90 = Good Classification

Accuracy 0.70 – 0.80 = Fair Classification

Accuracy 0.60 – 0.70 = Poor Classification

Accuracy 0.50 – 0.60 = Failure

2.0 METHODOLOGY

One of the research methods in question is the System Development Life Cycle (SDLC), with a stage scheme starting from the stages of data collection, data analysis, system design, system implementation, system testing and conclusions.

The research method used by the writer on the system using Genetic Algorithms. The Genetic Algorithm stages are initial generation, fitness function determination, determination of mutation and crossover probability values, selection / selection process, crossover process, mutation process and new individual generation.

3.0 RESULTS AND DISCUSSION

Early Codification

The codification process is the process of coding the variables contained in the activity process. As for supporting this research, tourism data are used as follows. The tourism object codification is attached in the following table 1.

Table 1 : Codification of Tourism Object

Name Of Tourism Object	Object Code
Taman Rekreasi Alam Mayang Pekanbaru	1
Museum Sang Nila Utama Pekanbaru	2
Desa Okura	3
Danau Wisata Bandar Kayangan Lembah Sari	4
Taman Budaya	5
Riau Fantasi	6

Asia Farm	7
Mesjid Agung An Nur	8
Perpustakaan Soeman H.S	9
Taman Putri Kaca Mayang	10
Balai Adat Riau	11
Pasar Wisata Pekanbaru	12
Hutan Kota Pekanbaru	13
Anjungan Seni Idrus Tintin	14

These data are used in this study with the criteria that become a reference that is the total distance from all existing travel routes. Description of distance data from each tourism object to other attractions can be seen in table 2 with the following km units.

Table 2 : Example of Distance Between Tourism Objects

Kode	1	2	3	4	5	6	7
1	0	8,3	31,3	18,2	8,5	12,4	2,2
2	6,5	0	26,3	13,2	0,23	10,7	8,8
3	30,6	28,3	0	14,1	28,3	35,4	30,5
4	17,5	15,2	12	0	15,2	22,3	17,4
5	6,4	1,5	26,1	13	0	10,5	8,6
6	10,1	8	34,1	21	8	0	12,3
7	2,2	10,8	31	17,9	10,8	14,6	0

Analysis of Genetic Algorithm Results

The Genetic Algorithm process starts from the initial generation process or also called the initial initialization in determining the individual to be processed, determining the fitness value of the individuals raised, then continues to the selection stage with the Tournament Selection method, the crossover stage with the Ordered-Based Crossover method, the stages mutation until a new individual is formed and is repeatedly adjusted to the number of iterations that have been determined by taking into account the best individual results, based on the highest fitness value.

The initial conditions are as follows:
Starting point coordinates: 6
End point coordinates: 3
Number of Iterations: 25
Number of Individuals: 10
Number of points: 10
Mutation Probability: 50%
Crossover Probability: 50%

Initial population generation by referring to the initial provisions above, the system will automatically generate random numbers with a maximum value in accordance with the number of attractions listed in the system, which currently has 14 attractions, so the numbers generated randomly start from 1- 14 where each number represents a particular tourist attraction. Initial generation values can be seen in table 3 below.

Table 3 : The 25th Initial Iteration Generation Table

No	1	2	3	4	5	6	7	8	9	10
1	6	11	14	7	1	10	4	12	2	3
2	6	8	9	4	11	5	14	12	1	3
3	6	4	7	2	11	1	14	9	13	3
4	6	2	12	8	1	11	4	14	9	3
5	6	4	13	7	2	10	5	8	1	3
6	6	14	5	9	2	8	11	10	4	3
7	6	8	7	2	11	4	5	13	14	3
8	6	10	2	1	5	11	7	12	8	3
9	6	4	14	9	13	1	7	5	11	3
10	6	1	13	8	12	10	9	4	14	3

After the initial generation, the calculation of the total distance of each individual begins to get the fitness value, using the following formula :

$$f = \frac{1}{tot}$$

With *f* as the fitness value and tot representation of the total distance value. For example in Individual 1, the following fitness values are obtained $\frac{1}{89,9} = 0,011123$. As for the overall assessment can be seen in the following table 4.

Table 4 : The 25th Fitness Iteration Generation Table

No	1	2	3	4	5	6	7	8	9	10	Fitness
1	6	11	14	7	1	10	4	12	2	3	89,9
2	6	8	9	4	11	5	14	12	1	3	92,4
3	6	4	7	2	11	1	14	9	13	3	99,5
4	6	2	12	8	1	11	4	14	9	3	86,5
5	6	4	13	7	2	10	5	8	1	3	103,2
6	6	14	5	9	2	8	11	10	4	3	46,1
7	6	8	7	2	11	4	5	13	14	3	96,6
8	6	10	2	1	5	11	7	12	8	3	78,5
9	6	4	14	9	13	1	7	5	11	3	90,5
10	6	1	13	8	12	10	9	4	14	3	80,1

After the fitness assessment, selection is done using the Tournament Selection method, where this type of method focuses on finding 2 individuals with the best fitness values. Therefore, it is sorted by individuals based on fitness values starting from the highest to the lowest. The results of this selection can be seen in table 5 below.

Table 5 : The 25th Selection Iteration Generation Table

No	1	2	3	4	5	6	7	8	9	10
6	6	14	5	9	2	8	11	10	4	3
8	6	10	2	1	5	11	7	12	8	3
10	6	1	13	8	12	10	9	4	14	3
4	6	2	12	8	1	11	4	14	9	3
1	6	11	14	7	1	10	4	12	2	3
9	6	4	14	9	13	1	7	5	11	3
2	6	8	9	4	11	5	14	12	1	3
7	6	8	7	2	11	4	5	13	14	3
3	6	4	7	2	11	1	14	9	13	3
5	6	4	13	7	2	10	5	8	1	3

The crossover stage is performed on the 2 best individuals who are screened through the selection stages with the indicator of fitness value. The crossover process is carried out by the Ordered-Based Crossover method.

By randomly determining the position of genes that refer to the specified crossover probability value. Starting with the first parent, each random gene that is determined to pass the crossover stage will copy the gene in the second parent that is exactly below the specified value. Then move the number to the first parent and also need to eliminate the number on the first parent if the number is the same as

the one to be crossed, this is done so that no gene duplication occurs in one individual. Crossover results can be seen in the following table 6.

Table 6 : The 25th Crossover Iteration Generation Table

No	1	2	3	4	5	6	7	8	9	10
1	6	11	14	7	1	10	4	12	2	3
2	6	8	9	4	11	5	14	12	1	3
3	6	4	7	2	11	1	14	9	13	3
4	6	2	12	8	1	11	4	14	9	3
5	6	4	13	7	2	10	5	8	1	3
6	6	14	10	9	2	8	5	11	4	3
7	6	8	7	2	11	4	5	13	14	3
8	6	10	2	1	5	8	7	12	11	3
9	6	4	14	9	13	1	7	5	11	3
10	6	1	13	8	12	10	9	4	14	3

The mutation stage is not carried out on every individual in the population, but is the same as the crossover which is only done on the 2 best individuals who are determined through the selection stage.

After the 2 parent individuals cross the stages of crossing, then at the mutation stage, gene exchange is carried out only within the scope of the individual.

Similar to crossovers that depend on the probability value of a crossover, mutations also refer to the predetermined mutation probability values. Details of mutation values can be seen in the following table 7.

Table 7 : The 25th Mutation Iteration Generation Table

No	1	2	3	4	5	6	7	8	9	10
1	6	11	14	7	1	10	4	12	2	3
2	6	8	9	4	11	5	14	12	1	3
3	6	4	7	2	11	1	14	9	13	3
4	6	2	12	8	1	11	4	14	9	3
5	6	4	13	7	2	10	5	8	1	3
6	6	14	2	5	9	10	8	11	4	3
7	6	8	7	2	11	4	5	13	14	3
8	6	11	8	1	5	10	7	2	12	3
9	6	4	14	9	13	1	7	5	11	3
10	6	1	13	8	12	10	9	4	14	3

Based on the initial conditions set by the user and through the stages of the Genetic Algorithm process, the best individual is the sixth individual in the twenty-fifth iteration, with a total distance of 38.88km and a fitness value of 0.0257. The final results of the Genetic Algorithm process can be seen in table 8 below.

Table 8 : The 25th Iteration Results Analysis Table

No	1	2	3	4	5	6	7	8	9	10	Fitness
6	6	14	2	5	9	10	8	11	4	3	0,0257
10	6	1	13	8	12	10	9	4	14	3	0,0124
8	6	11	8	1	5	10	7	2	12	3	0,0123
4	6	2	1	8	1	1	4	1	9	3	0,0115

			2			1		4			
1	6	11	14	7	1	10	4	12	2	3	0,0111
9	6	4	14	9	13	1	7	5	11	3	0,0110
2	6	8	9	4	11	5	14	12	1	3	0,0108
7	6	8	7	2	11	4	5	13	14	3	0,0103
3	6	4	7	2	11	1	14	9	13	3	0,01
5	6	4	13	7	2	10	5	8	1	3	0,0096

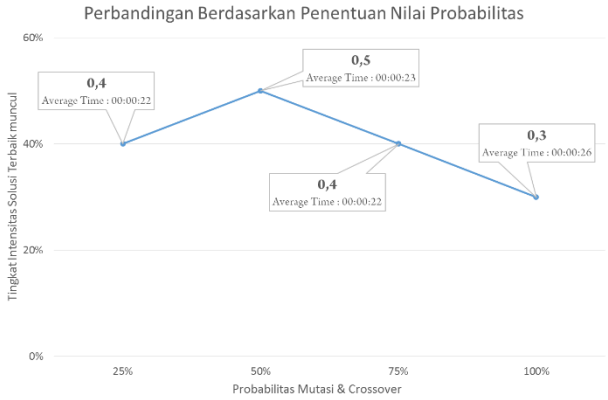
As for getting an illustration of the effect of mutation and crossover probability values, number of individuals and number of generations, further experiments are carried out and the following results are obtained,

1.1. Testing & Analysis

Accuracy testing was carried out on as many as 100x trials and 88x obtained the best solution, with the following results :

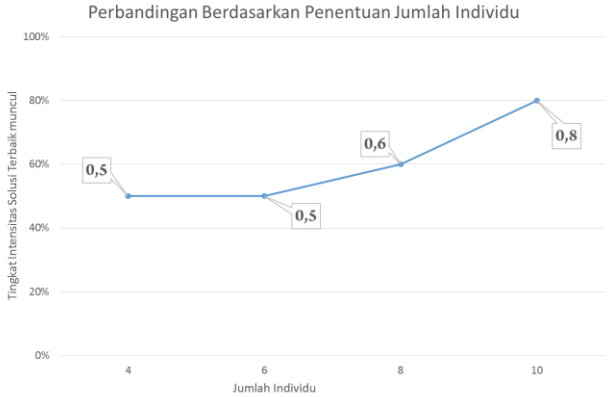
$$Accuracy = \frac{88 + 0}{88 + 12 + 0 + 0}$$
$$Accuracy = 0{,}88$$
$$Accuracy = 88\%$$

This Accuracy value of 88% signifies testing at the Good Classification level. While the comparison based on the determination of the probability value shows the dominance of the mutation and crossover probability at a value of 50%.



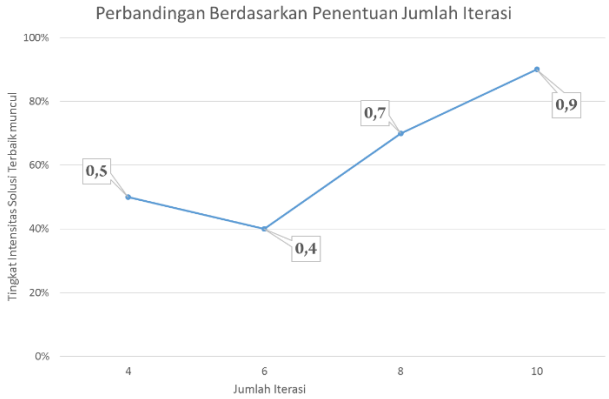
Pitcure 1. Comparison graph based on probability values

And comparisons based on determining the number of individuals show that the more the number of individuals the more likely the intensity of the best solution will emerge.



Pitcure 2. Comparison graph based on the number of individuals

Meanwhile, when compared to the determination of the number of iterations, there is a tendency that is the same as the number of individuals, ie the more the number of iterations the more likely the intensity of the best solution appears.

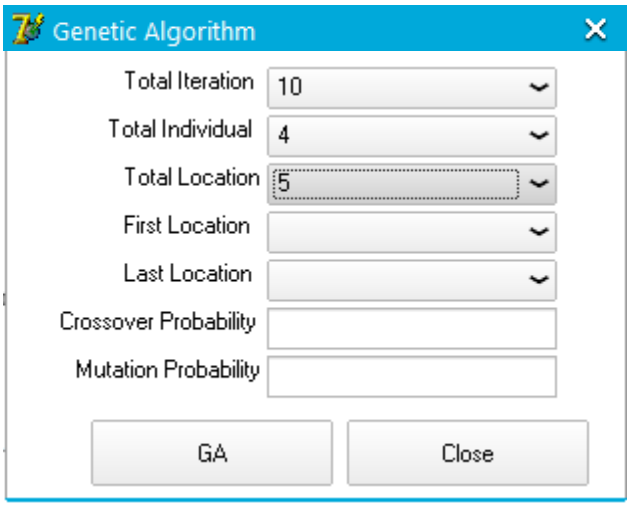


Pitcure 3. Comparison graph based on the number of iterations

1.2. System Interface

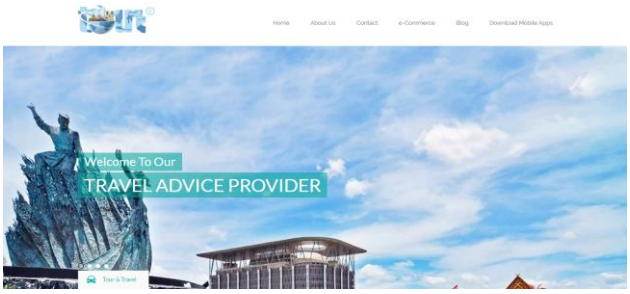
Display the interface of this system is expected to provide a display of concepts that have been implemented from ideas and designs at the system design stage so that it can be a reference and make it easy for users to understand how to work, use the system and the features available on the system.

1. GA Main Page
   The GA Main Page is the base page used for the genetic algorithm process to produce the best individual output.



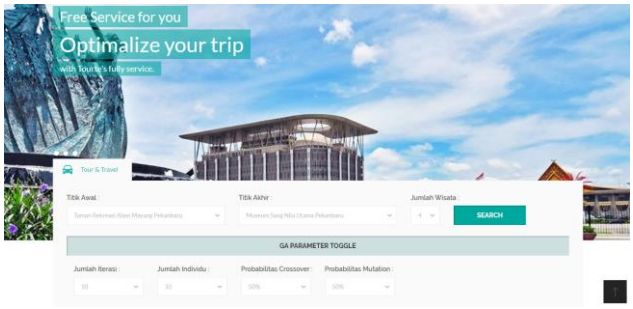
Pitcure 4. GA Main Page Interface

2. Startpage Website
   The main page of the website is the page that is accessed by the user in general in order to determine the criteria for tourist routes and get the optimum tour route reference from the system.



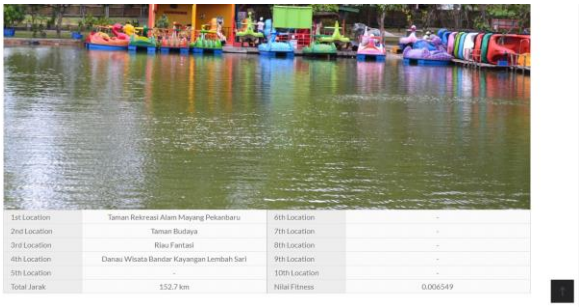
Pitcure 5. Startpage Website Interface

On this main page there is also a toggle for general users who want to determine the parameters of the Genetic Algorithm.



Pitcure 6. Toggle Genetic Algorithm Parameter Interface

When the specified criteria lead to an olution result that has been generated from the genetic algorithm process.



Pitcure 7. Display of Genetic Algorithm Process Results Interface

4.0 CONCLUSION

Based on the results of research that has been done, it can be concluded as follows:

1. Genetic algorithm can be used in optimizing the determination of tourist routes with a case example of the number of individuals 10 in 25 iterations, 10 points starting from the point of Fantasy Riau to ending in Okura Village for 100 times the experiment. The results of the tour route Riau Fantasi - The Idrus Tintin Art Pavilion - The Sang Nila Utama Museum Pekanbaru - Taman Budaya - Soeman Library H.S. - Taman Putri Mayang Glass - An'nur Great Mosque - Riau Traditional Hall - Bandar Khayangan Lembah Sari Lake - Okura Village (6-14-2-5-9-10-8-11-4-3) and 88% accuracy (Good Classification).
2. Number of generations, iterations, crossover probability values and mutation probability values. affect the results obtained in determining the optimum travel route, with reference to the fitness value obtained, and obtained a better possibility if the iteration is determined as many as 10, as many as 10 individuals and the value of the mutation and crossover probability of 50%.
3. The implementation of an optimization system for determining travel routes with genetic algorithms can be designed in the Delphi programming language as the core of the program, and the use of websites and android mobile as a program interface that is more attractive and user-friendly for general users.

Based on research conducted, then there are some suggestions as follows:

1. In order that the tourism object data can be more concrete and complete with direct observation to each tourism object before being registered and verified in the tourism route optimization system.
2. In order to develop the system that has been designed by the author, further use and apply the Genetic Algorithm method to build a better system.

3. In order for the new system to be fully beneficial to the general public, there needs to be knowledge and training for general users and sysadmins.

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