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IMPLEMENTATION OF GENETIC ALGORITHM IN COMPLETION TRAVELING SALESMAN PROBLEM STUDY CASE OF GARUDA EXPRESS DELIVERY (GED)

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ABSTRACT

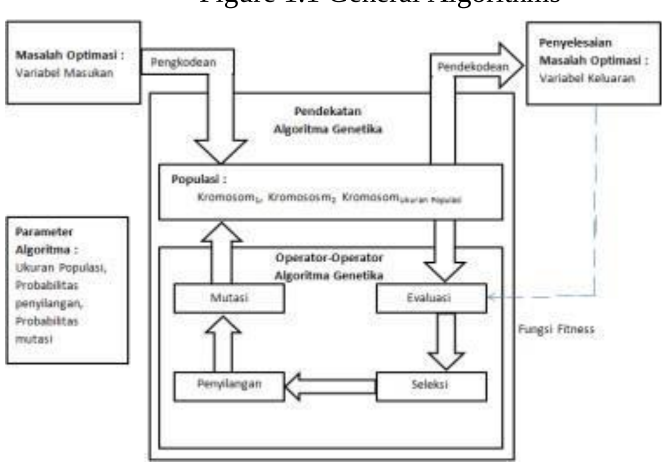
Indaily distribution activities, GED is a shipping service company. Always associated with couriers as inter mediaries. Where each courier will send a package to several different places. Surely they (couriers) want to immediately complete their tasks, by finding or determining the path that is traversed in order to shorten the work and return to the office and then make a report. This case is commonly called the Traveling Salesman Problem, which can be solved by several methods. One of them is by optimization of Genetic Algorithms. Genetic Algorithm methods can provide solutions to these problems by providing input (input) from several addresses that they will (courier) distribute. Then the input will be processed with several stages starting from initialization, selection, crossover, mutation and regeneration. The results are then displayed in graphical form which links the shipping addresses. The results of the study, obtained the fastest route with a maximum of 10 points or shipping address, which can be used by the courier in its distribution. In this study, the objective valueisthe value of the length of the road section taken from the Google Map. With termination rules or conditions that state that the smallest and largest fitness values must be the same or 60% of the fitness of the genetic algorithm population shows the greatest fitness. This rule will give the same and accurate results even though the number of generations produced is different.

Keywords: Genetic Algorithms, Shortest Path Problems, Crossovers, Mutations

1. INTRODUCTION

Genetic Algorithm is an optimization technique based on natural genetics. Toproduceanoptimalsolution, whichcanbeused to solve heruistic problems. Such is the case with Garuda shipping service companies Express Delivery (GED). Where a courier must visit the customer's place, 1 place each onceand return to theplace of origin(office). So that thetotaldistance traveled to a minimum. In general, Genetic Algorithms are explained as Figure 1.1 below.

Figure 1.1 General Algorithms



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2.BASIC THEORY

Problems like the above are commonly known as Traveling Salesman Problem or (TSP). Which can be resolved premises Genetic Algorithm optimization method, with several stages as shown in Figure 2.1 below :

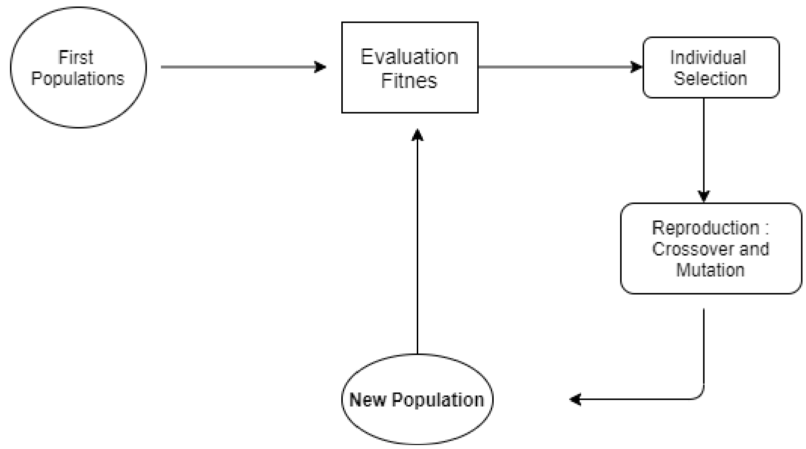

Figure 2.1 Stage On GA

2.1. Initialization

Thecodingprocessorencoding is oneofthedifficultprocessesin Genetic Algorithms. This is due to the process encoding for every problem is different, because not all techniques encoding suitable for every problem. Process encoding produce the string which is then called a chromosome.Stringconsistsofasetofbitsknown as genes (Luke, et al., 2005: 1-2). Technique encoding used in TSP is permutation encoding. On permutation encoding, chromosomes are collections of numbers that represent positions in a seriesofselections. Inbrief, thischromosome representationcanbe explained in Figure 2.2

b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8

Figure 2.1.1 : Representation of chromosomes with $b_i \in \{ 0.1\}$

2.2 Evaluation

The process of calculating and looking for values fitness from the smallest to the largest, which will aterbeusedas chromosomes parent on the process crossover. Because TSP looks for a minimum value, then fitness is inverse of objective value. Where the agreed objective function is the distance between points Σ (b 1, b 2, b 3, ... b n). While fitness is inverse of objective value $f = \frac{1}{f(x)}$

2.3 Cossover

The process of cross breeding or better known as the crossover process (also known as crossing / recombination) is crossing two chromosomes to form a new chromosome that is expected to be better than it parent. There are several crossover techniques that can be used to Finishing TSP, one of which is Partially Mapped Crossover (PMX). For more clarity Can be seen illustration of this mutation method in Figure 2.3.1 and 2.3.2 as below :

Parent 1	J	O	E	V	F	C	L	B	P	S
Parent 2	P	S	J	F	E	O	B	C	V	L

Figure 2.3.1 Chromoson Parent

Child 1	J	O	E	V	F	O	B	C	V	L
Child 2	P	S	J	F	E	C	L	B	P	S

Figure 2.3.2 Crossover Ilustration

2.4 Mutation

The mutation process is carried out after the process crossover by selecting a chromosome to be randomly mutated then determining the mutation point on that chromosome randomly. Mutation technique used in this research is a technique Insertion Mutation. This technique begins by selecting two random numbers then the genes in the position of the first random number are exchanged for genes that are in these cond random number. Illustration as shown in Figure 2.4.1 below.

1	2	3	4	5	6	7	8

1	2	6	4	5	3	7	8

Figure 2.4.1 : Illustration Insertion Mutation

In the case of TSP it is not justified if there is more than one gene / city in common. For that, another mutation technique needs to be added so that in each chromosome results crossover do not have more than one same gene. Illustration like in Figure 2.6 below.

b_1	J	O	E	V	F	C	L	B	P	S
b_n	J	O	E	V	F	O	B	C	V	L
mutasi	J	O	E	V	F		B	C	V	L

Figure 2.4.2: Illustration of chromosomes after mutation must be absent the same one

2.5 Regeneration

Regeneration is a selection process from the previous stage that produces the best chromosomes, to be used to the next generation, to find the expected generation. After going through all stages of population generation, evaluation, selection, crossover and mutation. Finally, the regeneration stage closes a generation process. Which already has all the data needed for the regeneration process, namely population, parent, child, mutants (chromosomes result from mutations).

3. RESULT AND DISCUSSION

Testing uses test data in the form of input data Shipment Delivery Record (SDR) courier and desired number of iterations. SDR input data are explained in the following table 3.1

Table 3.1 Shipment Delivery Record (SDR)

No.	Cosignee Name	Cosignee Address
1.	Ali Fikri	Jl. Bratang Binangun Vi No 33 Rt 001/07 Baratajaya Surabaya
2.	Gallery Itc Mega Grosir	Jl. Gembong No 20-30 (Itc Mega Grosir Lt 2 Blok 2/H 3A) Surabaya
3.	Cahaya Terang	Jl. Gembong Tebasan No. 29 Surabaya
4.	Setiawan Sukses Bersama	Jl. Gembong Tebasan No. 34 A Surabaya
5.	Steven Gunawan	Jl. Kertopaten No 62 Kel Simolawang Kec Simokerto Surabaya
6.	Acacia It Service Surabaya	Jl. Kusuma Bangsa No 084 E Surabaya
7.	Surya Jaya Wira Sukses	Jl. Pandan No. 3 Surabaya
8.	Citibank Surabaya	Jl. Panglima Sudirman 66-68 Surabaya (Bumi Mandiri Tower Ii)
9.	Pt Bank Uob Indonesia Cab Surabaya	Jl. Panglima Sudirman No. 53 Surabaya
10.	Maybank Kc Pemuda Surabaya	Jl. Pemuda 60-70 Surabaya
11.	Pt Global Teleshop Tbk Surabaya	Jl. Pemuda No 27-31 Embong Kaliasin Genteng (Gt Wtc Galeria Lt 1 No 702 Surabaya)
12.	Smartfren Surabaya	Jl. Pemuda No 60-70 Plaza Sinar Mas Surabaya
13.	Makmur Abadi	Jl. Pencindilan No. 18 A Surabaya
14.	Tjahjono Tjondro Lukito	Jl. Plampitan 8 No.14 Rt.004 Rw.002 Kel.Peneleh Kec.Genteng Surabaya
15.	Ibu Sjarleine	Jl. Sumatera No 103 Gubeng Surabaya
16.	Gadjah Mada	Jl. Undaan Wetan No. 16E Surabaya
17.	Cv Surya Sandang	Pengampon Square Blok C/ 32-33 Surabaya

For more test plans can be seen in the table 3.2 bellow :

Table. 3.2 Testing Plans

No.	Number of Nodes	The amount of literacy	Number of Trials	Type of testing
1.	5	500	3x	Black Box
2.	6	500	3x	Black Box
3.	7	700	3x	Black Box
4.	8	800	3x	Black Box
5.	9	900	3x	Black Box
6.	10	1000	3x	Black Box

The application will produce the most optimal results then displayed in graphical form Google map. Complete with line which connects between places of visit. Some functions like how to get the distance between places and also make line in Google map, The application utilizes several features google api, that is Distance Matrix APIand geocode. Next is the application testing in detail.

3.1 Initialization

Population generation is done by selecting a delivery point from the SDR data, to fill in the value of genes on each chromosome and done as many as the population determined is at least 5, a maximum of 10 points. Like Figure 3.1 below.

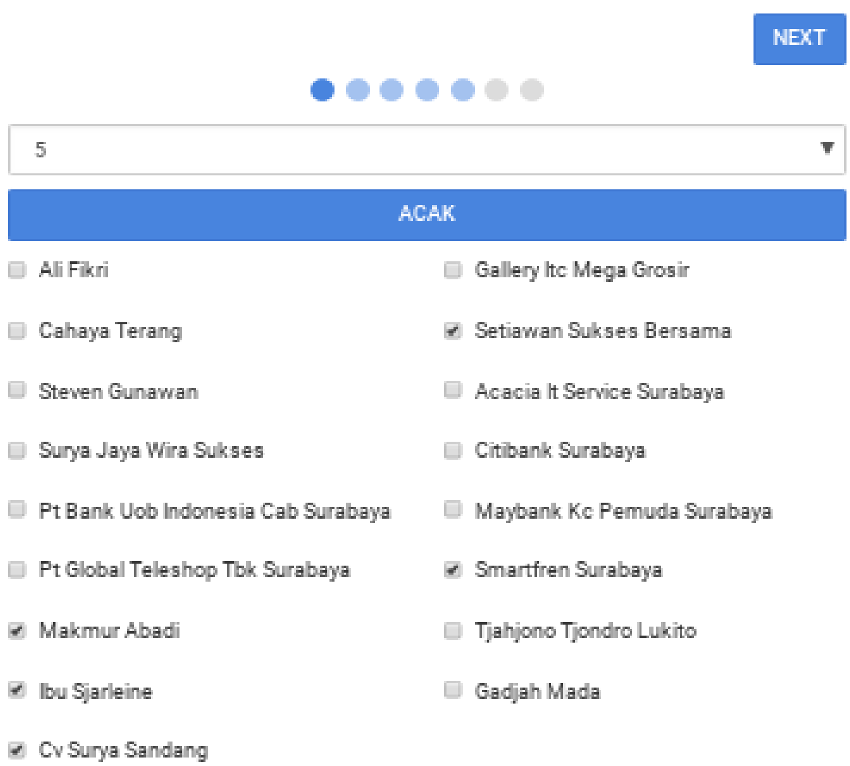

Figure 3.3.1: Selecting a delivery point

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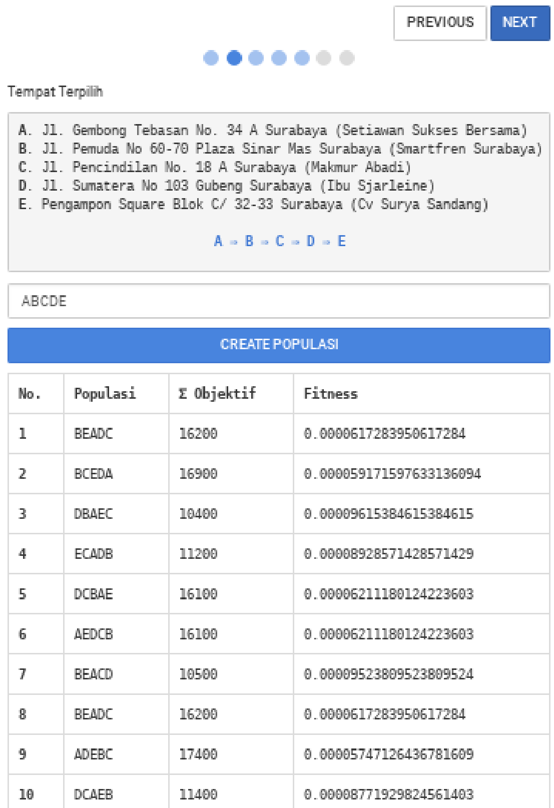
The selected point will be the gene for each chromosome then generate population as in Figure 3.2.2 below:



No.	Populasi	Σ Objektif	Fitness
1	BEADC	16200	0.0000617283950617284
2	BCEDA	16900	0.000059171597633136094
3	DBAEC	10400	0.00009615384615384615
4	ECADB	11200	0.00008928571428571429
5	DCBAE	16100	0.00006211180124223603
6	AEDCB	16100	0.00006211180124223603
7	BEACD	10500	0.00009523809523809524
8	BEADC	16200	0.0000617283950617284
9	ADEBC	17400	0.00005747126436781609
10	DCAEB	11400	0.00008771929824561403

Figure 3.3.2: Population generation

3.2 Selection

Furthermore, each chromosome undergoes an evaluation process to get an objective and fitness value from each chromosome. From the previous stage the application only needs to choose which chromosome will be selected to become the parent chromosome. As in Figure 3.2.1

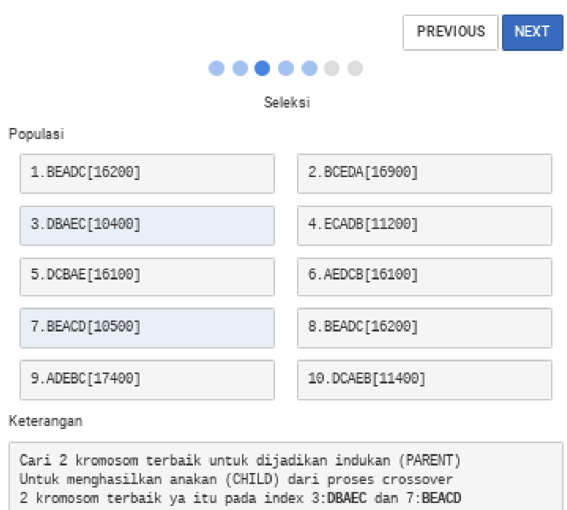


Figure 3.2.1: Process of selecting the best chromosome

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3.3 Crossover

Pair some parts of the genes from the parent chromosome to become a new chromosome, the child chromosome. In accordance with the agreement above as shown in Figure 3.3 below.

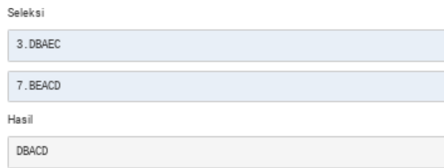

Figure 3.3.1 Crossover Process

3.4 Mutation

Next chromosome results from crossover mutated according to the agreement above. Because the problem faced is TSP, each chromosome may not have a gene that is repeated. So the function of mutation here is to make sure there are no identical genes / twins in each chromosome. This application mutation process can be seen as Figure 3.4.1 below.

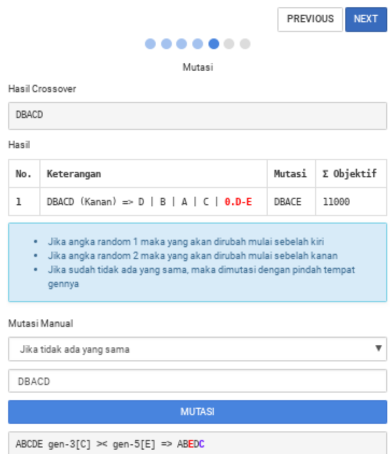

Figure 3.4.1 Mutation Procress

3.5 Regeneration

The mutated chromosome will be used to replace the chromosome with a value fitness Lowest. For previous data manipulation, can be seen in Figure3.4.1 above. From the old population data, there will be a change or replace according to agreement. Namely the chromosome with the smallest fitness value will be replaced with the chromosome that results from the mutation process. So there generation process can be seen in Figure 3.5.1 below:

Populasi baru

No.	Populasi	Σ Objektif	Fitness
1	BEADC	16200	0.0000617283950617284
2	BCEDA	16900	0.000059171597633136094
3	DBAEC	10400	0.00009615384615384615
4	ECADB	11200	0.00008928571428571429
5	DCBAE	16100	0.00006211180124223603
6	AEDCB	16100	0.00006211180124223603
7	BEACD	10500	0.00009523809523809524
8	BEADC	16200	0.0000617283950617284
9	DBACE	11000	0.0000909090909090909
10	DCAEB	11400	0.00008771929824561403

Figure 3.5.1 New Population

Which will then be continued to the next generation with a new population. And will stop regenerating until the specified iteration limit or stop conditions are completed. With several stop conditions, namely:

1. Minimum and maximum values are the same
2. The amount of regeneration has reached 500 or in accordance with the maximum recursive input that is required.

From 1st generation to specified generation limit or predetermined stop condition. The resulting graph is shown in Figure 3.5.2 below.

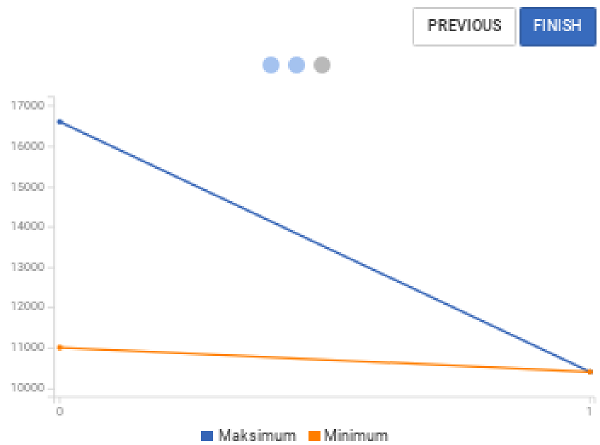

Figure 3.5.2 : 1st to n generation graphs

Because the highest and lowest chromosomes are the same, then that is considered the best coromosome produced by the Genetic Algorithm Optimization system. Namely chromosomes **ECDBA** with an objective value **10400** and will be converted into a graph Google map as in figure 3.5.3

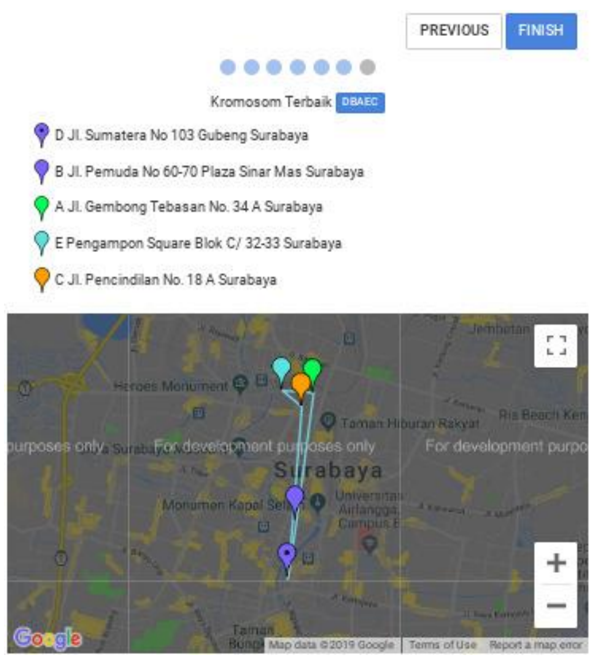

Figure 3.5.3 Graph Google map

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After testing the system 3 times the experiment in each group of genes used, produces the following analysis:

1. Number of genes or points, affect total generation produced. The more genes, the more generations are produced.
2. The best chromosome in a generation lastly, have significant objective value differences from the first generation raised.
3. In experiment no.4 with 8 gene inputs, no Stop on condition or rules for termination of iteration. But it stops at the maximum number of iterations given. Minimum value of fitness/the objective value produced by each experiment is the same and does not increase in size during the next trial. The results of all experiments are summarized in a table, can be seen in table 3.5.1 as below.

Table 3.5.1 Result Testing

Node	Boundary generation Experiment			Generations are complete at Experiment			Minimum value Experiment		
	Ke-1	Ke-2	Ke-3	Ke-1	Ke-2	Ke-3	Ke-1	Ke-2	Ke-3
5	100	100	100	91	62	70	19700	19700	19700
6	1000	1000	1000	249	351	300	11100	11100	11100
7	1000	1000	1000	420	310	497	21000	21000	21000
8	5000	5000	5000	374	5000	5000	14500	14500	14500
9	5000	5000	5000	730	872	839	16600	16600	16600
10	5000	5000	5000	565	1314	940	22600	22600	22600

From table 3.5.1 above, 83% of applications run quite optimally in completing the CSR program in the Garuda case study Express Delivery. Because the optimization process with the genetic algorithm method goes according to plan and stops at the desired stop criteria. That is when all the objective values of chromosomes in the population are the same. Although 2 of them stop at the maximum limit of iteration, the resulting objective value remains and will change if one of the chromosomes has a better fitness value than before.

4.CONCLUSION

After doing the optimization system development Traveling Salesman Problem with Genetic Algorithms and implementing the system, the conclusions of this study are:

1. In experiments with 8 genes as input, process optimization does not stop at the first condition, i.e. if the maximum and minimum values are the same. But the application stops at a predetermined generation limit. But the final result or objective value and fitness which is fixed and unchanged after 3 times the experiment.
2. From 18x testing with various input node, 83% stop at the first stop rule. That is when the maximum and minimum values of the objective value are the same. Then by 16%, the application stops at the given iteration limit. Experimental data has been summarized in tabular form, such as table 6.9 in the previous chapter.
3. Each trial will stop according to 2 criteria, which are first if the objective value is minimal and maximum at the same value. Or the second stops at the given iteration limit.

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