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Genetic Algorithm Design on Traveling Salesman Problem

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Abstract
A traveling Salesman Problem (TSP) is a search for the shortest route range and the fastest time by a Salesman from a city to the destination city. Many algorithms have been used and developed to solve TSP problems, but some need more performance. One of the algorithms that can solve TSP problems is a genetic algorithm. In implementing this case study, a genetic algorithm will be applied to solve TSP problems. A genetic algorithm is implemented based on a natural selection process known as the evolutionary process; individuals continuously experience changes in their genes to adapt to their environment so that only strong individuals can survive. This journal aims to find out how effective TSP problem-solving is by applying a Genetic Algorithm. The results of writing this journal show that the Genetic Algorithm can solve TSP problems well.

Keywords : algorithm, genetic algorithm, optimization, traveling salesman problem

Abstrak
Travelling Salesman Problem (TSP) merupakan pencarian jangkauan rute terpendek dan waktu tercepat oleh seorang Salesman dari suatu kota ke-n kota tujuan, Banyak algoritma telah digunakan dan dikembangkan untuk menyelesaikan permasalahan TSP, namun ada beberapa algoritma yang dirasa kurang dalam hal performasinya. Salah satu algoritma yang mampu menyelesaikan permasalahan TSP adalah Algoritma genetika. Dalam implementasi studi kasus ini, Algoritma genetika akan diterapkan untuk menyelesaikan permasalahan TSP. Algoritma Genetika merupakan suatu algoritma yang diterapkan berdasarkan proses seleksi alamiah yang dikenal sebagai proses evolusi, individu secara terus menerus mengalami perubahan gen untuk meneyesuaikan dengan lingkungan hidupnya sehingga hanya individu-indiviidu yang kuat yang mampu bertahan. Tujuan dari penulisan jurnal ini adalah mengetahui seberapa efektif melakukan penyelesaian masalah pada TSP dengan menerapkan Algoritma Genetika. Dari hasil penulisan jurnal ini diperoleh bahwa Algoritma Genetika mampu menyelesaikan permasalahan TSP dengan baik,

Kata Kunci: algoritma, algoritma genetika, genetika, optimasi, travelling salaesman problem.

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1. Introduction

Science and technology have recently developed rapidly (Hannawati et al., 2001). Along with this, various new problems emerged, including efficiency and optimization. The process of calculating profit optimization manually is deemed unable to provide accurate results in a short time. Therefore, an appropriate algorithm is needed to obtain maximum profit optimization results that are accurate and efficient. This study will discuss the maximum profit optimization process using genetic algorithms. Genetic algorithms can solve complex problems (Mahmudy, 2013). Optimization is finding the shortest distance to get where you want to go. In everyday life, there are many examples that we can meet to determine the shortest path to be taken.

The traveling salesperson problem is one of the optimization problems that attracts the attention of mathematicians and especially computer scientists because TSP is easy to define but difficult to solve. (Amri et al. 2012). The Traveling Salesman Problem (TSP) is a classic optimization problem that is difficult to solve conventionally. The exact solution to this problem will involve an algorithm that requires finding all possible solutions. Many optimization problems have been solved using Genetic Algorithms, including task assignment problems in distributed systems, traveling salesman problems, timetabling, transportation, and knapsack (Anita Desiani, 2006).

One example of finding the fastest route is selecting the route the delivery driver chooses to arrive at the destination on time. Each delivery destination must be visited once, then returned to the starting point. This problem is known as *the Traveling Salesman Problem* (TSP). One form of TSP development that is more complicated involving two or more variables is TSP-TW, namely finding the optimal route that takes into account the total travel time and customer availability time (Gambardella, 1999).

The problem that often occurs in everyday life is choosing the range to be covered, both distance and time. The shorter the distance traveled, the faster the time taken. To solve these frequent problems, the Genetic Algorithm is considered very suitable for solving distance optimization problems. In this problem, the example taken is optimizing the distance from Jl. Mastrip to Cendrawasih Hotel will help determine the distance and the fastest time to arrive at the destination.

2. Methods

A genetic algorithm is an algorithm that utilizes the natural selection process known as the evolutionary process proposed by Charles Darwin. In the process of evolution, individuals are continuously changing their genes to adapt to their environment. "Only strong individuals survive." The genetic algorithm presents a problem solution as a chromosome to get optimal results in solving the problem. Several steps must be taken using the genetic algorithm (Nugraha, 2008).

Defining individuals is the first step in solving genetic algorithms, where individuals state one of the possible solutions to existing problems. The second step is to define the value of fitness. Fitness is a value that each individual owns to determine whether the solution is good or not. The third step is individual selection. Selection is done to get a good parent candidate. Good parents will produce good children (Widodo, 2010). The selection method used is the roulette wheel selection method. In this method, the parent is selected based on its fitness value; the better the fitness value, the more likely it is to be selected (Wati, 2011). The fourth step is the crossover. Crossover is a genetic algorithm operator that combines two parents to produce offspring chromosomes, also called the crossover process (Sudarningsih et al., 2015). The fifth step is mutation. The mutation changes the value of one or several genes in a chromosome. Mutations create new individuals by modifying one or more genes in the same individual (Darmayasa, 2016). A new generation will be formed from the genetic algorithm process, repeated continuously until it reaches the desired generation.

2.1 Flowcharts

In the process of finding the optimal distance using this genetic algorithm, several steps must be carried out to achieve the optimal distance. The steps are described in the following flowchart.

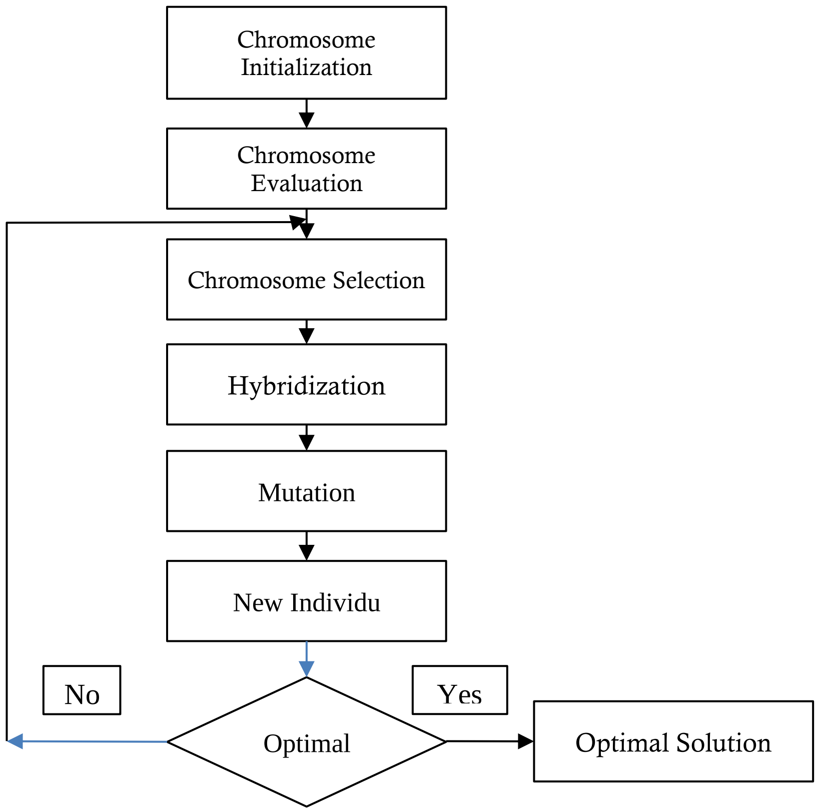

Figure 1. Genetic algorithm flowchart

3 . Results and Discussion

The traveling salesperson problem is depicted in Figure 2 as follows:

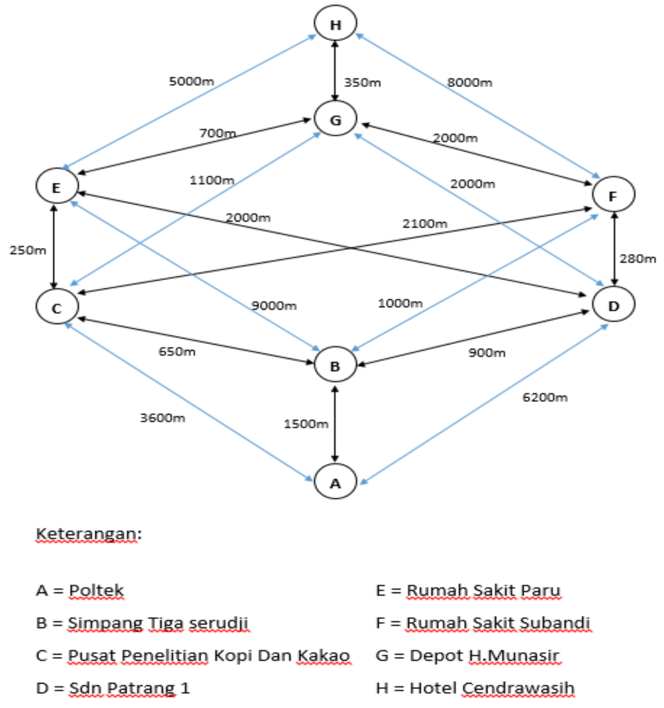

Figure 2. Traveling salesperson problem

3.1. Initialization

Chromosome[1] = ABCEGH

Chromosome[2] = ABDFGH
Chromosome[3] = ABCFGH
Chromosome[4] = ABDEGH

3.2. Chromosome Evaluation

Fitness[1] :
1500+650+250+700+350 = 3450
Fitness[2] :
1500+900+280+2000+350 = 5030
Fitness[3] :
1500+650+2100+2000+350 = 6600
Fitness[4] :
1500+900+2000+700+350 = 5450

3.3. Chromosome Selection

Q[i] = 1/Fitness
Q[1] : 1/3450 = 0.00029
Q[2] : 1/5030 = 0.000199
Q[3] : 1/6600 = 0.000152
Q[4] : 1/5450 = 0.000183

Total = 0.00824

To find the probability, use the following formula:
P[i] = Q[i]/Total
P[1] : 0.00029 / 0.00824 = 0.35191
P[2] : 0.000199 / 0.00824 = 0.241369
P[3] : 0.000152 / 0.00824 = 0.183953
P[4] : 0.000183 / 0.00824 = 0.222768

Accumulative Probability
C[1] = 0.35191
C[2] = 0.35191 + 0.241369 = 0.593279
C[3] = 0.35191 + 0.241369 +0.183953= 0.777232
C[4] = 0.35191 + 0.241369 + 0.183953 + 0.222768
= 1,000 _

Generate a random number R
R[1] = 0.313
R[2] = 0.765
R[3] = 0.101
R[4] = 0.45

The new population formed, namely:
Chromosome[1]=[1]=ABCEGH
Chromosome[2]=[2]=ABCFGH
Chromosome[3]=[3]=ABDEGH

3.4. Crossover (crossover)

50% Crossover Probability
R[1]= 0.189
R[2]= 0.348
R[3]= 0.645
R[4]= 0.876

The random number for the chromosome to be *crossover* :
C[1]=1
C[2]=2
crossover process
= Chromosome[1] { A - B - C - E - G - H }
= Chromosome[2] { A - B - C - F - G - H }

Crossover results
= Chromosome[1] { A - B - C - F - G - H }
= Chromosome[2] { A - B - C - E - G - H }

The new population formed, namely:
Chromosome[1]=[1]= A - B - C - F - G - H
Chromosome[2]=[2]= A - B - C - E - G - H
Chromosome[3]=[3]= A - B - D - F - G - H
Chromosome[4]=[3]= A - B - D - E - G - H

3.5. Mutation

In the TSP case, the mutation scheme used is the swapping mutation. The number of chromosome mutations in a population is determined by the parameter mutation rate (ñm). The mutation process involves exchanging randomly selected genes with the next gene. If the gene is at the end of the chromosome, it is exchanged with the first gene. We first calculate the total length of the genes in one population: Total length of genes = number of genes in 1 chromosome * number of chromosomes = 4 * 6 = 24

We select the position of the mutated gene, and it is done by generating a random number between 1 - the total length of the gene, namely 1-18. For example, we determine ñm = 10 %. Then the number of genes to be mutated is = 0.1* 24 = 2.4.

The five gene positions that will be mutated after being randomized are positions 16 and 21.
Mutation process:
Chromosome[1]=[1]= A - B - C - F - G - H
Chromosome[2]=[2]= A - B - C - E - G - H
Chromosome[3]=[3]= A - B - D - G - F - H
Chromosome[4]=[4]= A - B - E - D - G - H

The genetic algorithm process for 1 generation has been completed. Then the fitness value after 1 generation is:

Fitness[1] :
1500+900+280+2000+350 = 5030
Fitness[2] :
1500+650+250+700+350 = 3450

Fitness[3] :
1500+900+2000+2000+8000= 14400
Fitness[4] :
1500+900+2000+2000+350= 6750

4. Conclusion

From the results and discussions that have been carried out, it can be concluded that 1) The genetic algorithm can be used to search for the shortest route from the routes in the problem above. 2) With the optimization of this path, it is expected to know the shortest route information that will be passed. 3) For the case of the problem above, a search using the Genetic Algorithm produces the route: [Poltek, Simpang Tiga Serudji, Coffee and Cocoa Research Center, Lung Hospital, Depot H. Munasir, Hotel Cendrawasih] with a total distance of 3450m

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