# Optimization of Traveling Salesman Problem on Scheduling Tour Packages using Genetic Algorithms

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**Abstract.** Ciayumajakuning or often referred to as Cirebon, Indramayu, Majalengka and Kuningan, is located on the east side of West Java. In supporting the regional economy, the West Java government program, especially the community, is focused on the tourism sector. the short time of tourists and the number of tourist destinations that want to be visited, make tourists have to schedule their tour as effectively as possible. By using the Traveling Salesman Problem optimization can minimize the distance of tourist visits by considering the availability of time. The solution to this problem is by combining Traveling Salesman Problems and Genetic Algorithms that can represent candidates for scheduling solutions into chromosomes randomly, then evaluate using the fitness function and then do the selection. The selection method used in this study is the roulette wheel selection method, then crossovers and mutations. In each generation, chromosomes are evaluated based on the value of the fitness function. After several generations the genetic algorithm will produce the best chromosome, which is the optimal solution. this study Code A = Starting Point B = Buddhist Dayak Tribe Segandu Earth, Indramayu Code C = Mangrove Forest Sustainable Beach Karangsong Code D = Heritage Museum Kasepuhan Palace Cirebon Code E = Keraton Kacirebonan Kode F = Goa Sunyaragi Cirebon Code G = Starting Point . The Total Distance to be Passed is 17,706 Km

## 1. Introduction

Ciayumajakuning or often referred to as Cirebon, Indramayu, Majalengka and Kuningan, is located on the east side of West Java. In supporting the regional economy, the West Java government program, especially the community, is focused on the tourism sector. Tourist destinations in Ciayumajakuning which are full of history, culture, and religion include the palace of the lonely, the palace of kacirebonana, Trusmi, the tomb of Sunan Gunung Jati, the Kampung of Uganda (Dayak Losarang), the Building of Linggar Jati negotiations, etc. Meanwhile, the short time of tourists and the number of tourist destinations that want to be visited, make tourists have to schedule their tour as effectively as possible. By using the Traveling Salesman Problem optimization can minimize the distance of tourist visits by considering the availability of time. Traveling salesman problem (TSP) is a combinatorial optimization problem. This is a difficult problem NP and TSP are the most studied problems in the field of optimization. But with the increasing number of cities, the complexity of the problem continues to increase [6]. Related research is three algorithms for this problem, namely, construction heuristic algorithms, DSA, and HGA. We use four rules in the construction heuristic algorithm. DSA contains two heuristic rules, and also contains two effective methods for problem-solving [7]. Related research is Interchanging Mutation and Violated Directed Mutation (VDM. Both mutation methods are compared to get a better mutation method. The library is also designed to be able to define custom constraints or scheduling conditions that have not been accommodated in the library without core program

modification [15]. Related research Problem solving Traveling salesman problems using genetic algorithms, there are various representations such as binary representation, path, adjacency, ordinal, and matrix. In this article, we propose a new crossover operator for traveling salesman problems to minimize total distance[14]. This approach has been associated with path representation, the most natural way to represent a tour of law [11]. Related research There are many heuristics for completing TSP that approach the final answer. Some algorithms that approach the last answer are the Nearest Neighbor algorithm, Genetic algorithm, Simulation Annealing, and Ant Colony Optimization to name a few [12]. The ant colony algorithm, the Nearest Neighbor Algorithm, and the Genetic algorithm are discussed and implemented in this paper. Comparative studies were also conducted between the algorithms mentioned above, and the results of the research have been given in this paper[13] Genetic algorithm (GA) approach has been used to solve various types of optimization problems [5] Genetic algorithms [1] are search and optimization algorithms based on natural evolution principles, which were first introduced by John Holland in 1970. Genetic algorithms also apply optimization strategies by simulating species evolution through natural selection. Genetic algorithms generally consist of two processes. The first process is the selection of individuals for the production of the next generation and the second process is the manipulation of individuals chosen to form the next generation with crossover and mutation techniques [2]. Selection mechanism determines which individuals are chosen for reproduction and how many offspring each individual produces. The main principle of the selection strategy is getting better individual; the higher the chance to become a parent [3]

## 2. Methodology

Research used in research. Optimization of Traveling Salesman Problem (TSP) on scheduling tour packages using Genetic Algorithms. The following steps of the research carried out in solving the problem can be seen in the research flow diagram as shown in Figure 1 [8].

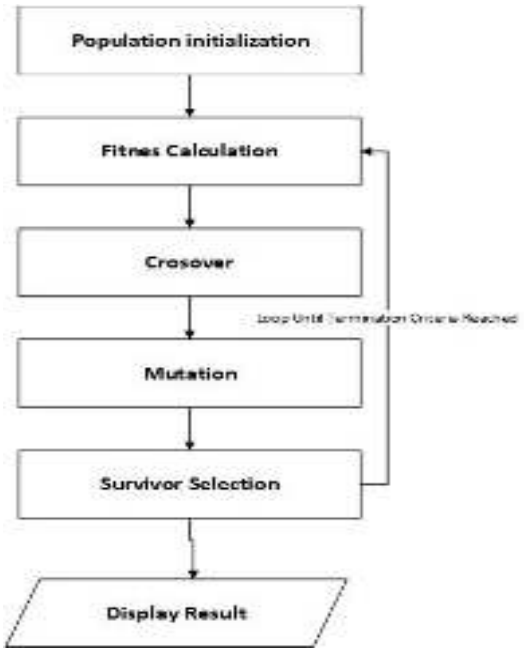


**Figure 1**. Research flow chart [4]

The first dataset has ten tourist destinations scattered in the small and yellow regions, the distribution of which can be used as problem solving. The dataset can be seen in table 1

**Table 1**. Coordinate tourism

| Group | Code | Point Name | Latitude | Longitude |
|---|---|---|---|---|
| Ciayumajakuning Tourism | T001 | Dayak Buddhist Tribe of Bumi Segandu, Indramayu | -6.3974 | 108.149631 |
| Ciayumajakuning Tourism | T002 | Karangsong Sustainable Beach Mangrove Forest | -6.3025556 | 108.368401 |
| Ciayumajakuning Tourism | T003 | Kacirebonan Palace | -6.7246829 | 108.565351 |
| Ciayumajakuning Tourism | T004 | Keraton Palace | -6.7223931 | 108.567824 |
| Ciayumajakuning Tourism | T005 | Cirebon Kasepuhan Palace Heritage Museum | -6.7263338 | 108.571006 |
| Ciayumajakuning Tourism | T006 | Goa Sunyaragi Cirebon Tourism Park | -6.7364612 | 108.543466 |
| Ciayumajakuning Tourism | T007 | Mount Ciremai Palutungan National Park | -6.943183 | 108.440733 |
| Ciayumajakuning Tourism | T008 | Curug Cipeuteuy | -6.823917 | 108.381999 |
| Ciayumajakuning Tourism | T009 | Sang Cipta Rasa Great Mosque | -6.7255523 | 108.570028 |
| Ciayumajakuning Tourism | T010 | Tomb of Sunan Gunung Jati Cirebon | -6.6711991 | 108.54005 |

Comparison of distance matrices to measure tourism 1 to another 10 tours to get diagonal distance information or vice versa 10 tourism to tourism 1, while data can be seen in the table.

**Table 2.** Matrix comparison between distances

| Code | Alternative Name | T001 | T002 | T003 | T004 | T005 | T006 | T007 | T008 | T009 | T010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T001 | Dayak Buddhist Tribe of Bumi Segandu, Indramayu | 0.00 km | 32.71 km | 71.16 km | 71.38 km | 77.07 km | 74.31 km | 105.78 km | 75.48 km | 76.93 km | 69.88 km |
| T002 | Karangsong Sustainable Beach Mangrove Forest | | 0.00 km | 58.30 km | 57.99 km | 59.09 km | 60.26 km | 103.70 km | 73.40 km | 59.47 km | 52.18 km |
| T003 | Kacirebonan Palace | | | 0.00 km | 0.69 km | 0.87 km | 3.01 km | 40.97 km | 29.31 km | 0.81 km | 7.54 km |
| T004 | Keraton Palace | | | | 0.00 km | 1.18 km | 3.65 km | 41.60 km | 29.94 km | 1.12 km | 8.02 km |
| T005 | Cirebon Kasepuhan Palace Heritage Museum | | | | | 0.00 km | 3.83 km | 41.78 km | 30.12 km | 0.14 km | 7.99 km |
| T006 | Goa Sunyaragi Cirebon Tourism Park | | | | | | 0.00 km | 39.24 km | 26.84 km | 4.27 km | 8.71 km |
| T007 | Mount Ciremai Palutungan National Park | | | | | | | 0.00 km | 42.82 km | 41.83 km | 46.79 km |
| T008 | Curug Cipeuteuy | | | | | | | | 0.00 km | 30.18 km | 36.36 km |
| T009 | Sang Cipta Rasa Great Mosque | | | | | | | | | 0.00 km | 8.35 km |
| T010 | Tomb of Sunan Gunung Jati Cirebon | | | | | | | | | | 0.00 km |

1. [***Start***] Generate random population of n chromosomes [4,9,10].
   The initial population of chromosomes is made randomly, consisting of ten chromosomes, each chromosome showing the sequence of tours to be traversed and each gene representing from travel from tour 1 to tour 10 to get optimal results
   a) First Chromosome : | 1 | 4 | 13 | 8 | 2 | 9 | 12 | 7 | 6 | 5

b) Second Chromosome : | 3 | 5 | 11 | 7 | 2 | 9 | 12 | 7 | 6 | 5
c) Third Chromosome : | 5 | 3 | 12 | 6 | 2 | 9 | 12 | 7 | 6 | 5
d) Fourth Chromosome : | 6 | 5 | 13 | 5 | 2 | 9 | 12 | 7 | 6 | 5
e) Fifth Chromosome : | 7 | 7 | 14 | 4 | 2 | 9 | 12 | 7 | 6 | 5

2. [***Fitness***] Evaluate the fitness f(x) of each chromosome x in the population.
3. [***Crossover***] point crossover is applied to the pair of chromosomes so that new chromosomes will be generated which might have better fitness value. In 2-point crossover, randomly two positions in the chromosomes are chosen and then replace the gene with each other in both chromosomes
4. [***Mutation***] With a mutation probability mutate new offspring at each locus (position in chromosome).
5. [***Accepting***] Place new offspring in a new population.
6. [***Replace***] Use new generated population for a further run of algorithm.
7. [***Test***] If the end condition is satisfied, stop, and return the best solution in current population.
8. [***Loop***] Go to step 2

## 3. Result and Discussion

Shows that Genetic Algorithms are fast techniques to get optimal results. The test dataset which has the Cirebon Prosecutor Station's starting point with coordinate latitude -6.705403, and Longitude 108.55541590000007 has a destination point for the Dayak Buddhist Tribe of Bumi Segandu, Indramayu [T001], Karangsong Sustainable Beach Mangrove Forest [T002], Kacirebonan Palace [T003], Cirebon Kasepuhan Palace Heritage Museum [T005], Goa Sunyaragi Cirebon Tourism Park [T006]. The number of chromosomes that will be generated 5, by maximizing 10 generations, while crossover rate 75 and mutation rate 25. The results can be seen in Tabel 3.

**Table 3.** Generate results

| No | Name | Value |
|---|---|---|
| 1 | Best Fitness | 172.706 |
| 2 | Execution Time | 0.046112060546875 |
| 3 | Generate | 5 |
| 4 | Rute Cromossom | the starting point of the Cirebon Prosecutor's Station with coordinate latitude -6.705403, and Longitude 108.55541590000007 Dayak Buddhist Tribe of Bumi Segandu, Indramayu [T001], Karangsong Sustainable Beach Mangrove Forest [T002], Cirebon Kasepuhan Palace Heritage Museum [T005], Kacirebonan Palace [T003], Goa Sunyaragi Cirebon Tourism Park [T006]. Code A = Starting Point B = Buddhist Dayak Tribe Segandu Earth, Indramayu Code C = Sustainable Beach Mangrove Forest Karangsong Code D = Heritage Museum of Kasepuhan Palace Cirebon Code E = Keraton Kacirebonan Kode F = Goa Sunyaragi Cirebon Tourism Park Code G = Starting Point |

The route results are T001-T002-T005-T003-T006. The results of the route can be seen in Figure 2.

**Figure 2.** Results of route data set

Based on figure 2, it explains the starting point of the Cirebon Prosecutor's Station with coordinate latitude -6.705403, and Longitude 108.55541590000007 Dayak Buddhist Tribe of Bumi Segandu, Indramayu [T001], Karangsong Sustainable Beach Mangrove Forest [T002], Cirebon Kasepuhan Palace Heritage Museum [T005], Kacirebonan Palace [T003], Goa Sunyaragi Cirebon Tourism Park [T006]. Code A = Starting Point B = Buddhist Dayak Tribe Segandu Earth, Indramayu Code C = Sustainable Beach Mangrove Forest Karangsong Code D = Heritage Museum of Kasepuhan Palace Cirebon Code E = Keraton Kacirebonan Kode F = Goa Sunyaragi Cirebon Tourism Park Code G = Starting Point. The Total Distance to be Passed is 170,706 Km

## 4. Conclusion

Results of this study Code A = Starting Point B = Buddhist Dayak Tribe Segandu Earth, Indramayu Code C = Sustainable Beach Mangrove Forest Karangsong Code D = Heritage Museum of Kasepuhan Palace Cirebon Code E = Keraton Kacirebonan Kode F = Cirebon Sunyaragi Tourism Park Code G = Starting point. The Total Distance to be Passed is 17,706 Km. It is known that genetic algorithms are a very suitable approach in optimizing Traveling Salesman Problems. However, genetic algorithms are dependent on crossover and mutation.

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