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Search Optimization of The Shortest Route Using the Generate And Test Algorithm

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Abstract

Searching is a search method that belongs to the science of Artificial intelligence. The Generate and Test algorithm is able to solve problems related to heuristic searches in the terminology of Artificial Intelligence. The problem that often occurs is the user's lack of understanding about the completion of the General and Test Algorithm so that it takes a lot of time and money to get the final value, for that we need a completion of the shortest path search to minimize costs and time. The General And test method is a method of solving search cases The shortest path using several points and weights of the journey where all points must be visited once and the end point of the journey is the same as the starting point of the journey. The final benefit of this research helps users to find a very good alternative to take a decision.

Keywords*; Artificial Intelligence, General and Test, Alternative Route Selection, Time, Cost*

1. Introduction

Generate and Test algorithm is the simplest algorithm in heuristic search technique. In Generate and Test, there are two important procedures, namely generate (generate) that is generating all possible solutions and test (testing) which is testing the generated solution. The Generate and Test algorithm combines the DFS algorithm with backtracking, which is moving backwards to the initial state. The Generate and Test Algorithm is as follows:

a) Generate a possible solution;
b) Test each node which is a solution by comparing the node with the end node of a selected path with the expected set of goals;
c) If a solution has been found, then exit the system. If you haven't found a solution, then go back to step 1[1].

Optimization is the search for variable values that are considered optimal, effective and efficient to achieve the desired results. Many optimization problems arise in everyday life, one of which is the vehicle route problem (Vehicle Routing Problem/VRP). In the search for routes that must be passed, there are still many people who use manual maps, be it for the paths that must be passed from one location to another or to simply look for a certain location or place. Usually the shortest path is obtained by calculating the time taken or based on the distance from the origin city to the destination city. The more alternative paths to the destination city, the more complicated the way to calculate the shortest path. This is done to minimize the cost and time required. In mathematics, the problem of finding the shortest route is explained in graph theory. In general, graph theory is a branch of mathematics that deals with graphs, where the main components of a graph are vertices and edges. The point in this problem is the destination while the side is the path. One of the optimization problems that can be solved by using the method heuristics are Hill Climbing Algorithm and Ant Colony Algorithm[2]. The system development uses various supporting theories, including:A graph G contains two sets, namely a finite non-empty set V(G) of objects called vertices and a finite (possibly empty)

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set whose elements are called edges such that each element e in E(G) is an unordered pair of vertices. -point V(G). Graph formulas are [3]:

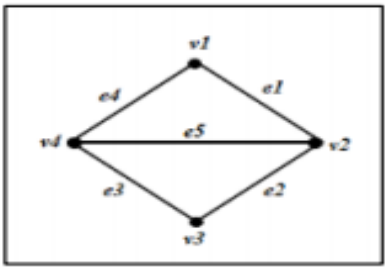

Figure 1. A graphIn Figure 1, 1, 2, 3, 4 are vertices,whereas 1, 2, 3, 4 are sides

To solve the shortest distance problem, we can represent the existing problem into a graph structure, where the point represents the city and the side represents the path that connects the two cities. Each side is given a weight that states the distance between the two cities. The program is designed to simulate the distance between locations which is described as a graph and then the shortest path is generated as the final result using GIS, is a computer system used for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the earth's surface. GIS can also be interpreted as an organized collection of computer hardware, software, geographic data and personnel designed to efficiently obtain all forms of geographically referenced information [4].

Heuristics is a technique that improves efficiency in the search process, but at the expense of completeness. To measure the performance of search methods, there are four criteria that can be used (Coppin, 2004):

a) Completeness: does the method guarantee finding a solution if a solution exists;
b) Time complexity : how long it takes;
c) Space complexity : how much memory is required;
d) Optimality: does the method guarantee finding the best solution if there are several different solutions [5].

There are many algorithms for searching the shortest route. The selection of the most optimum algorithm is always a problem in finding the shortest route, where each algorithm has its own advantages and disadvantages. In the scope of finding the shortest route, it cannot be said directly which algorithmthe most optimum for the whole case, because it is not necessarily an algorithm that have a high optimization for one case have a high optimization for another case [6]. The traveling salesman problem is a topic that attracts the attention of many mathematicians because it is easy to define but difficult to solve. The number of plot combinations along with the number of cities thatvisited on TSP makes this problem not easy. In Figure 1 there are seven cities thatwill be traversed by the salesman and one point is defined as the starting route and the final route of the trip. To search for a routeshortest distance, must first know the distance of each point. However, if the distance of each point is not known, the coordinates of each point can be used [7].

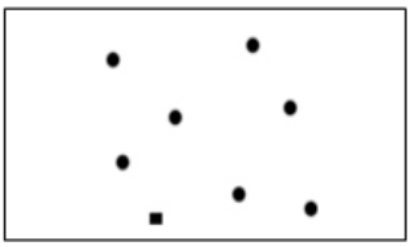

Figure 2. City points that are crossed

Determination of mileage using the Traveling Salesman Problem method(TSP) the solution is using the heuristic method, the results are almost optimal. The simplest method of the heuristic approach, with the nearest unvisited city approach, the procedure is:

1) By looking at the distribution network map which has the shortest distance entered into the table.
2) Based on the data table in the form of a matrix processed using the TSP method, the steps are as follows:
    a) Step 1 By looking at the horizontal rows in the table find the shortest distance from the source.
    b) Step 2 By looking vertically at the point step 1 find the shortest distance.
    c) Step 3 Repeat steps 1 and 2, until all cities are passed. Then choose a solution by seeing which one has the shortest distance from the source. Then if there are paths that have the same value choose one [8].

The Traveling Salesman Problem (TSP) is known as one of the optimization problems that has attracted the attention of researchers for decades. The Traveling Salesman Problem (TSP) is a very well-known problem in graph theory. The name of this problem was inspired by the problem of a merchant traveling around several cities. The description of the problem is as follows: given a number of Cities and the distance between Cities. Determine the shortest circuit that must be traversed by a merchant if the merchant departs from a city of origin and stops each city exactly once and returns to the city of origin of departure. The problem of the trader's journey is to determine the Hamilton cycle which has the minimum weight on a connected graph (Wicaksana et al., 2014). TSP has the following rules:

1) Must visit each city exactly once, no less or more;
2) All cities must be visited in one trip (tour);
3) It starts and ends in the same city [9].

Generate and test cases in Salesman Program cases. explanation of the combination of 4 cities with eachEach combination includes:

a) Swap City 1,2 (swap the order of the position of the 1st city with the 2nd city).
b) Swap City (swap the order of the position of the 2nd city with the 3rd city)
c) Swap Cities (change the order of the position of the 3rd city with the 4th city).
d) Swap City (swap the order of the 4th city position with the 1st city
e) Swap City 2,4 (swap the order of position of the 2nd city with the 4th city).
f) Swap City1,3 (swap the order of the position of the 1st city with the 3rd city).

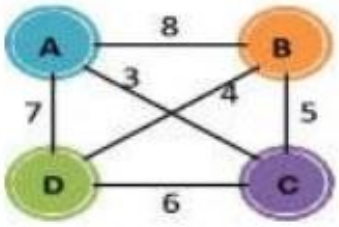

Figure 3. track length

The purpose of the TSP method is to choose the route that has the minimum total distance value among several route options [10]. In the scope of short circuit search, it cannot be said directly which algorithm is the most optimum for the whole case, because it is not necessarily the algorithm that has the highest optimization for one case has the highest optimization for another case. Optimization that achieves the efficiency of the algorithm's work process time, the travel time required to reach the final destination and the short distance traveled always depends on every existing condition. There are many algorithms to perform short circuit searches. The selection of the most optimum algorithm always poses problems in finding the shortest circuit, where each algorithm has its

advantages and disadvantagestheir respective drawbacks. The shortest path search has been applied in various fields tominimize costs or speed up the course of a process (Purnawanto et al, 2005). The shortest path problem is generally explained using the concept of a graph, which can be either a directed graph or an undirected graph. An edge in an undirected graph can be assumed to allow travel in both directions. On the other hand, an edge in a directed graph can only be used in one direction. Usually in determining the shortest path by using a weighted graph. Each edge in a weighted graph has a value or weight (Sushma, 2013). In finding the shortest path, the more points and lines in the graph, the more complicated (Mardlootillah et al, 2014). A graph structure is developed by assigning a weight to each edge. Weighted graphs can be used to represent various concepts. For example, if a graph represents a road network, its weight can mean the length of the road, travel time or the highest speed limit for a particular road, so to determine the shortest path, a weighted graph is needed [11].

2. Research Methodology

The method used in this research is a case study so that the steps taken in this research are to find, collect, study and analyze data so as to produce the Shortest Route value. Steps to solve case problems can be seen in the flow below:

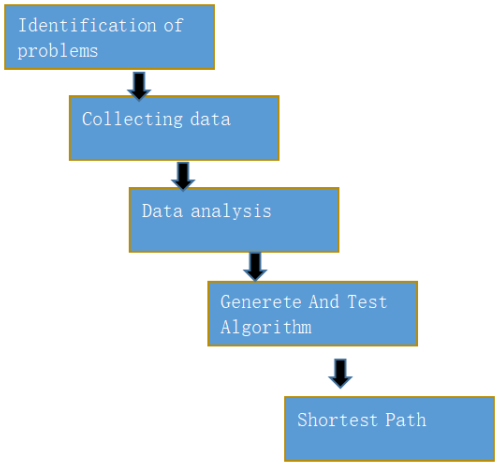

Figure 4. Framework

3. Results and Discussion

The Generate and test method is part of a simple method in the heuristic search process. The working process of this method is from combining depth first search with a backtracking system because it requires a complete solution that must be generated before testing. If the solution generation process is carried out systematically, the procedure will find a solution. If the problem space is very large or wide then it will take a very long time. The steps that must be taken to find the shortest route include:

a) Generate a possible solution that is owned, the solution can be in the form of a state which is likened to a path from the initial position moving to the destination position;
b) Do a test, Test whether the solution can be accepted according to the criteria that will be given;
c) If the solution has been found then the search is stopped, if it has not been found then repeat these steps so that you find a solution.

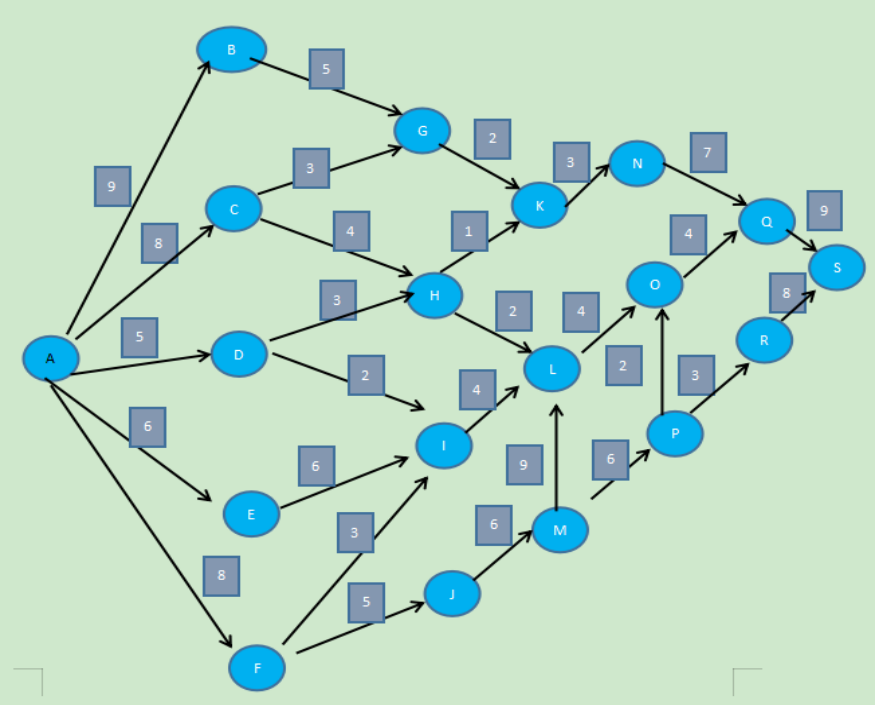

Figure 5. Generate And Test Algorithm Implementation

In the picture above, it is known that the Generate And Test Algorithm case consists of 19 Nodes consisting of Nodes A-B-C-D-E-F-G-H-I-J-K-L-M-N-O-P-Q-R-S and the distance of each node can be seen in the picture above. The arrow that connects the nodes is a path that can be passed. Problems In the case of this research, a beverage salesman is in City A about to go to deliver goods to City S. The problem that occurs is which route must be passed in order to save transportation costs and travel time.

Preliminary analysis of the data to be processed include:

Initial Stete (initial state) = A

Goal (Goal) = S

To solve this problem, DFS algorithm is needed. To minimize costs and save time on the way a salesman must produce the shortest route. Because what will be processed is the shortest route, the criteria to be chosen is the solution that produces the shortest distance route, in this case we use a heuristic function that is used as a direction.

a) 1st step See the path to go, Generate a solution using the Dept First Search Algorithm (The lane to be directed to A-B-G-K-N-Q-S)
   F(A-B-G-K-N-Q-S) = 9+5+2+3+7+9 = 35
   Test Criteria to be used
   Because the path A-B-G-K-N-Q-S is the first solution that has been generated, it is used for the first solution, namely f(A-B-G-K-N-Q-S).
b) Step 2
   Generate a solution using the Dept First Search Algorithm (The lane to be addressed is A-C-G-K-N-Q-S
   f=A-C-G-K-N-Q-S = 8+3+2+3+7+9= 32
   Test Criteria used
   Since f(A-B-G-K-N-Q-S)> f(A-B-G-K-N-Q-S then the temporary solution is = f=A-C-G-K-N-Q-S f= 8+3+2+3+7+9= 32
c) Step 3
   Generate a solution using the Dept First Search Algorithm (The lane to be addressed is f= A-C-H-K-N-Q-S
   A-C-H-K-N-Q-S : 8+4+1+3+7+9 = 32

Since f=A-C-G-K-N-Q = f=A-C-H-K-N-Q-S, the temporary solution is = f=A-C-G-K-N-Q-S f= 8+3+2+3+7+9= 32 or f= A-C-H-K-N-Q-S : 8+4+1+3+7+9 = 32

d) Step 4
Generate a solution using the Dept First Search Algorithm (the path to be addressed is f=A-C-H-L-O-Q-S : 8+4+2+4+4+9= 33
Since f=A-C-G-K-N-Q = f=A-C-H-K-N-Q-S < f=A-C-H-L-O-Q-S, the temporary solution is = f=A-C-G-K-N-Q-S f= 8+3+2+3+7+9= 32 or f= A-C-H-K-7+4+1+3+ 9 = 32

e) Step 5
Generate a solution using the Dept First Search Algorithm (The path to be addressed is f= A-D-H-K-N-Q-A-D-H-K-N-Q-S : 5+3+1+3+7+9=28
Because f=A-C-G-K-N-Q = f=A-C-H-K-N-Q-S>A-D-H-K-N-Q-S : 5+3+1+3+7+9=28 then the temporary solution is = f=A-D-H-K-N-Q-S : 5+3+1+3+7+9=28

f) Step 6
Generate a solution using the Dept First Search Algorithm (the lane to be addressed is A-D-I-L-O-Q-S : 5+2+4+4+4+9 =28
Result f=A-D-H-K-N-Q-S = A-D-I-L-O-Q-S

g) Step 7
Generate a solution using the Dept First Search Algorithm (the lane to be addressed is A-D-H-L-O-Q-S : 5+3+2+4+4+9 =27
The result of f=A-D-H-K-N-Q-S = A-D-I-L-O-Q-S< A-D-H-L-O-Q-S : 5+3+2+4+4+9 =27 then the result used is A-D-H-L-O-Q-S : 5+3+2+4+4+9 =27

h) Step 8
Generate a solution using the Dept First Search Algorithm (The lane to be addressed is A-D-H-L-O-Q-S : 5+3+2+4+4+9 = 27 : 6+6+4+4+4+9=33
Result A-D-H-L-O-Q-S < A-D-H-L-O-Q-S : 5+3+2+4+4+9 =27

i) Step 9
Generate a solution using the Dept First Search Algorithm (the lane to be addressed is A-F-I-L-O-Q-S : 8+3+4+4+4+9 =32
Result A-D-H-L-O-Q-S < A-F-I-L-O-Q-S : 5+3+2+4+4+9 =27

j) Step 10
Generate a solution using the Dept First Search Algorithm (the lane to be addressed is A-F-J-M-P-R-S : 8+5+6+6+3+8 =36
Result A-D-H-L-O-Q-S < A-F-J-M-P-R-S : 5+3+2+4+4+9 =27

k) Step 11
Generate a solution using the Dept First Search Algorithm (The lane to be addressed is A-F-J-M-L-O-Q-S : 8+5+6+9+4+4+9 =45
Result A-D-H-L-O-Q-S < A-F-J-M-L-O-Q-S : 5+3+2+4+4+9 =27

l) Step 12
Generate a solution using the Dept First Search Algorithm (The lane to be addressed is A-F-J-M-P-O-Q-S : 8+5+6+6+2+4+9 =40
Result A-D-H-L-O-Q-S < A-F-J-M-P-O-Q-S = 5+3+2+4+4+9 =27

The closest distance image can be seen in the image below
Final Solution 1. Alternative chosen A-D-H-L-O-Q-S : 5+3+2+4+4+9 =27

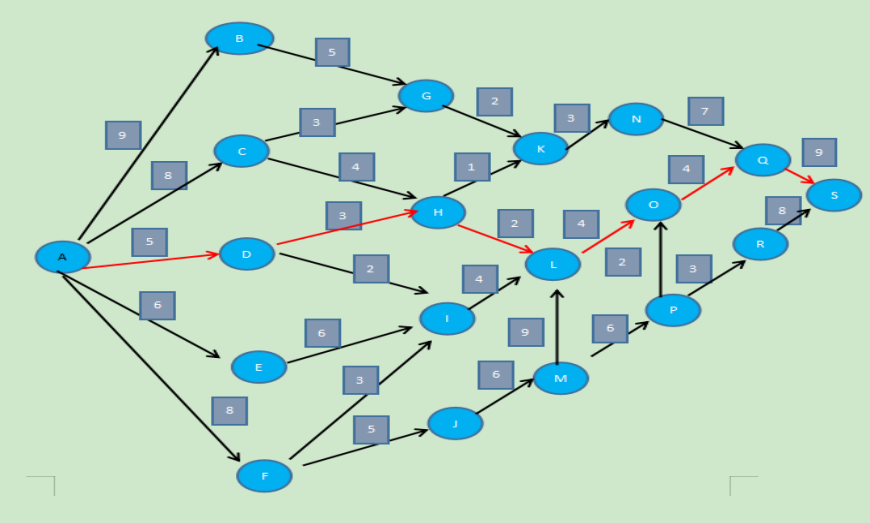

Figure 6. Final Solution

Table 1. Route table and the length of time it takes

No	Route	Shortest Route	Time
1	A-B-G-K-N-Q-S : 9+5+2+3+7+9 = 35	35	35
2	A-C-G-K-N-Q-S : 8+3+2+3+7+9= 32	32	32
3	A-C-H-K-N-Q-S : 8+4+1+3+7+9 = 32	32	32
4	A-C-H-L-O-Q-S : 8+4+2+4+4+9= 33	32	33
5	A-D-H-K-N-Q-S : 5+3+1+3+7+9=28	28	28
6	A-D-I-L-O-Q-S : 5+2+4+4+4+9 =28	28	28
7	A-D-H-L-O-Q-S : 5+3+2+4+4+9 =27	27	27
8	A-E-I-L-O-Q-S : 6+6+4+4+4+9=33	27	33
9	A-F-I-L-O-Q-S : 8+3+4+4+4+9 =32	27	32
10	A-F-J-M-P-R-S : 8+5+6+6+3+8 =36	27	36
11	A-F-J-M-L-O-Q-S : 8+5+6+9+4+4+9 =45	27	45
12	A-F-J-M-P-O-Q-S : 8+5+6+6+2+4+9 =40	27	40

The test criteria used are because A-F-J-M-P-O-Q-S > A-F-J-M-P-O-Q-S, the temporary solution used is 5+3+2+4+4+9 = 27, because all processes have been carried out to completion, there is nothing left to process so the process step by step is stopped. So that beverage sales can save time and cost of eating, the alternative route that can be used by beverage salesmen is A-D-H-L-O-Q-S 5+3+2+4+4+9 with a distance of 27 minutes.

4. Conclusion

The final result of this study can be concluded that the application of the Generete Algorithm and test can be used as a reference in finding the shortest alternative to find a solution in finding the shortest route to find the smallest value that is useful for saving time and costs for beverage salesmen. After calculating step by step there are 1 2 Routes that can be taken by the beverage salesman where each step has a different value. The smallest route obtained from the results of this study is A-F-J-M-P-O-Q-S = 5+3+2+4+4+9 =27 . Generated and test routes can be used as guidelines for finding the shortest route so as to obtain more accurate results.

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