Application of Dijkstra’s Algorithm and Hamiltonian Cycle in Third Party Logistics

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Abstract—3PL companies have to visit a lot of cities to deliver logistics. Each city is connected to the other city by road, railway, or airplanes. To reduce costs, they have to find the most efficient route to go to each city that they need to visit. We develop a solution due to this problem based on Dijkstra’s Algorithm and Hamiltonian Cycle.

Keywords—Dijkstra’s Algorithm, Graph, Hamiltonian Cycle, Hamiltonian Graph, Traveling Salesman Problem

I. INTRODUCTION

Third party logistics (3PL) is a provider of outsourced logistics services that cover anything that involves management of the way resources are moved to the areas where they are required to be. These kind of companies are important part of today’s supply chain. Many 3PL companies offer many kind of services including; inbound freight, freight consolidation, warehousing, distribution, order fulfillment, and outbound freight.

Nowadays, 3PL has become more important in logistic sector. Companies tend to use 3PL’s service because they do not want to deal with logistics issues and problems. It is also because they want to reduce the costs.

In the 3PL, we have to consider the supply chain. We have to find the most efficient and shortest way to deliver the logistics, so we can save the costs. We address the routing problem that faced by 3PLs provider in planning day-of-week delivery routes for their customers who need to make deliveries to their destination. The route will be the most important issue which may charge great costs to the company if it is neglected.

The goal here is to minimize the total cost for the transportation and inventory while satisfying the customers. This problem that we get to reach that goal also known as Traveling Salesman Problem. And we offer Hamiltonian Cycle and Dijkstra’s Algorithm as the solution for this problem which can give us the most efficient route as we wish.

We can take an example in Java island. The problem is to find the most efficient way send the logistics to each city in Java island.

II. THEORY

A. Graph

1. Definition

Graph is a set of points and lines that connect some of the points. The points in graph are also known as vertices or nodes. And the lines that connect the vertices known as edges or arcs. The edges of some graphs may be directed or undirected. In formal terms, graph is an ordered pair of $G = (V,E)$, where $V$ is a set of points, vertices, or nodes and $E$ is a set of edges or arcs.

Diagram 1. Example of Graph

2. Weighted Graph

Weighted graph is a graph where the edges is given a numerical weight. A weighted graph is also a special type of labeled graph in which the labels are numbers.

Picture 1. Java Island
http://islandoanialisme.blogspot.co.id/2014/12/java.htm
3. Graph Cycle
A graph cycle is a subset of the edge set in the graph that forms a path and first node of the path corresponds to the last node.

B. Hamiltonian Cycle

Hamiltonian cycle is a graph cycle that through the graph and visit each nodes in the graph exactly with the ending point in the one it is started. The example of the Hamiltonian cycle is the cycle graph.

C. Travelling Salesman Problem

The travelling salesman problem is one of graph theory problem that requiring the most efficient Hamiltonian cycle a salesman can take to go to each of \( n \) cities. The basic idea of Travelling Salesman Problem is to find the shortest route for the salesman so he can visit a number of cities and return to his starting point in the end of the route. The travelling salesman problem is typical of hard optimization problem.
D. Dijkstra’s Algorithm

Dijkstra’s Algorithm is named after Edsger Wybe Dijkstra. Dijkstra’s Algorithm is an algorithm to find the shortest path from a point in a graph to a destination. Application of Dijkstra’s algorithm in our daily life is to get to another place with the shortest route. In picture 7, we can find the shortest way from A to B with Dijkstra’s Algorithm.

The idea of the algorithm is to continuously calculate the shortest distance beginning from a starting point, and to exclude longer distances when making an update. It consists of the following steps:

1. Initialization of the starting node with 0
2. Marking the distance of the starting node as permanent and other distances as temporarily.
3. Calculate the temporary distances of all neighbour nodes of the starting node by summing up its distance with the weights of the edges.
4. If the calculated distance of a node is smaller than the current one, update the distance and set the current node as antecessor. This step is also called update and is Dijkstra's central idea.
5. Setting of the node with the minimal temporary distance as starting node. Mark its distance as permanent.
6. Repeating of steps 4 to 7 until there aren't any nodes left with a permanent distance, which the neighbour nodes still have temporary distances.
Dijkstra’s Algorithm’s Pseudocode:

1: function Dijkstra(Graph, source):
2:   for each vertex v in Graph:
3:     dist[v] := infinity
4:     previous[v] := undefined
5:     dist[source] := 0
6:     Q := the set of all nodes in Graph
7:     while Q is not empty:
8:       u := node in Q with smallest dist[]
9:       remove u from Q
10:      for each neighbor v of u:
11:         alt := dist[u] + dist_between(u, v)
12:         if alt < dist[v]
13:           dist[v] := alt
14:           previous[v] := u
15: return previous[]

III. APPLICATION OF DIJKSTRA’S ALGORITHM AND HAMILTONIAN CYCLE

In 3PL, we have to find the most efficient route that go through each city once for sending the logistics and back to the starting city as in the travelling salesman problem. We can implement Dijkstra’s algorithm and Hamiltonian cycle to solve it, which is as we know, hamiltonian cycle can fulfill that requirement.

Each city is connected to the other city by road, airplanes, or railway. So we have to make a list of the city that we need to visit and the distance between the cities. From the list, we will use Dijkstra’s algorithm and Hamiltonian cycle to make the route.

Picture 15 is the example of the travelling salesman problem that can be solve with Dijkstra algorithm and Hamiltonian cycle. In that picture, we want to visit Kota E, Kota A, Kota B, Kota C, and Kota D.
Our starting point is Kota E. From Kota E to Kota A, with Dijkstra’s algorithm, we can find the shortest way to go there, so do from Kota A to another city. And at the end, it will return to Kota A again as we wish with Hamiltonian cycle. This example can be implemented in the real cities for 3PL delivery plan before it delivers the logistics.
IV. CONCLUSION

Dijkstra’s algorithm and Hamiltonian cycle can be implemented to find the most efficient route for third party logistics delivery plan.

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REFERENCES


PERNYATAAN

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