RESEARCH ARTICLE OPEN ACCESS

Survey on Various Shortest Path Algorithms Used in Routing

Yashash H L
(Information Science, RV College of Engineering,Bangalore
Email: yashashhl25@gmail.com

----------**********----------

Abstract:

This paper tells about different algorithms which can be used in routing. Routing is process of sending a packet from a source to destination. So it is very important to choose which algorithm will efficiently pass the packet in shortest time. In this paper we will get to know the comparison between different shortest path graph based algorithms which are used in routing. Here we will study different algorithms like, Bellman-Ford Shortest Path algorithm, Dijkstra's Algorithm to find the shortest path, Floyd-Warshall's Algorithm and others.

Keywords **—Shortest path, Dijkstra's Alogrithm, Bellman- ford Alogrithm , johnson's Algorithm , Floyd-Warshall, Routing**

----------**********----------

I. INTRODUCTION

Routing Algorithms play an important role in communication using packets. So computer network is an important factor, so selecting a right routing algorithms will increase the efficiency and decrease the time of communication in a drastic manner. Routing is a process of communicating between the nodes. It is a process of sending a packet from source to destination. So selecting a good routing algorithm plays an important factor in communication. It decreases the cost of sending a packet from source to destination. Routing algorithms determine the path in which a packet will travel in a network which contains thousand of nodes. There are many cost factors which are important for routing a packet. Cost factors maybe a distance between the nodes, simple way is setting distance value as 1 between every nodes. Cost may also be based on financial cost, bandwidth, propagation delay. So the important factor in routing is decreasing the cost of sending information from source to destination. There are two main factors in routing, one is routing protocols and other is routing algorithms. Protocols are like set of rules and regulations a node or packet or the network should follow while sending a packet from source to destination. Algorithms are ones which solve the problem, by selecting the right path in which a packet can travel in the network so that the cost is minimum.

Routing Protocols

A protocols are set of rules and regulations, combinations of procedures that allow routers in the network to communicate with each other and get adapt to the changes. The main purpose of the routing protocol is to

 ©IJSRED: All Rights are Reserved

dynamically interact with all the other nodes to gather information about the different paths and the cost to travel those paths by interacting with other nodes during runtime. Routing protocols are mainly categorized into interior protocol and exterior protocol. Interior protocol is inside a single network or a domain, where as the Exterior protocol is for communication in between the domains.

I. LITERATURE SURVEY

A. Kapil Joshi and Neha Chauhan

This paper [1] aims at giving an understanding about the routing protocols and understand routing techniques. Which protocol to use based on the metrics.

B. ShijinDai,XiaorongJingandLeminLi

This paper [2] aims at finding the best optimal way for creating routing protocols and aims at analyzing the different routing protocols.

C. Arjun RK, Pooja Reddy, Shama and M Yamuna

This paper [3] aims at understanding Dijkstra‘s Algorithm, and ways to optimize the Dijkstra‘s algorithm by using different efficient optimization techniques.

D. Andre V Goldberg and Tomasz Radzik

This paper [4] talks about Bellman -Ford Algorithm, how it can be implemented, and ways to optimize the algorithm. This paper also talks about a new algorithm that works at same time complexity and space complexity as of Bellman-Ford Algorithm.

E.Understanding the need to Routing Algorithms

In a network where thousands of packets travel betweenSource and destination. It is very important how much cost a packet takes to travel from source to destination. So a network which uses less cost to communicate information from source to destination can be called as an efficient network. So to accomplish this, we need efficient routing algorithms which can be used to find the path in which the packet mush travel so that it will reach the destination with very low cost utilization.

F. Identifying the metrics that can be used in selecting the routing algorithms

The important metrics which can be used to choose a routing algorithms are:

- Time complexity of the algorithm
- Space complexity of the algorithm
- Accurate
- Consistency

These metrics can be further broken down for every node in a network which thousands of nodes

- How much time it took to send a packet from one node to another
- What are the performance, financial costs involved in sending a packet from one node to another.
- If the packet was sent to Destination

 ©IJSRED: All Rights are Reserved

Bellman-Ford Algorithm

Bellman-Ford algorithm is used to compute the shortest path from a single source to all other vertices in a graph. It also helps in detecting negative weight cycles, which is the drawback of Dijkstra‘s algorithm. Bellman ford algorithm takes two nested for loops so its time complexity is O(n2). This uses Dynamic Programming where we compute the value once and store it in an array or matrix and use them when there‘s a need to compute the same value we just use it from the matrix or array. Compared to Bellman-Ford, Dijkstra is better in terms of time complexity because it runs in O(nlogn) using the priority queue approach(Greed Algorithm). But the main advantage of bellman-ford is identifying negative edges. Inthisalgorithmineach step we keep relaxing the edges, so we try out all possible ways and pick out the best one, that‘s how dynamic programming algorithms work.

Some principals used in Bellman-Ford Algorithm

- *All edges cost can be both negative or positive.*
- *The graph can be directed or undirected*
- *The graph should be connected.*

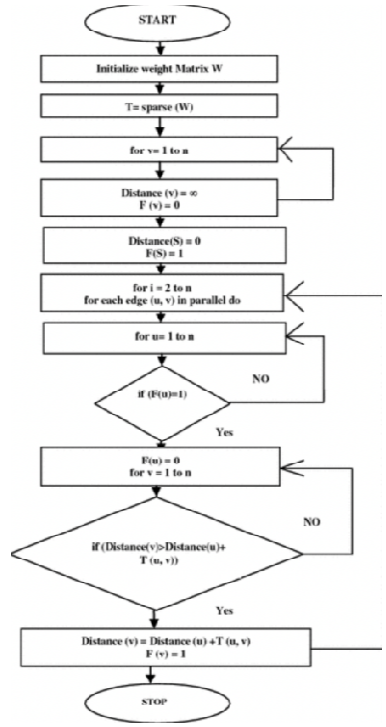

Figure 1: Different steps in Bellman-Ford Algorithm

Dijkstra‘s Algorithm

Dijkstra‘s Algorithm is used to compute the shortest path from a single source to all other vertices in a graph. This is the most efficient way of solving a single-source shortest path problem as it uses the Greedy approach wherein each step it chooses the optimal one. This uses priority queue (heaps) data structures to compute the result. The time complexity of Dijkstra‘s algorithm is O(nlogn). But this has one drawback we can‘t compute the results when the graph has negative weight cycles. So Bellman-Ford was introduced. In each step, we choose an optimal vertex and mark the vertex as visited and in the next step, we search for the optimal

one in the remaining vertices which are not visited, that‘s how the algorithm works.

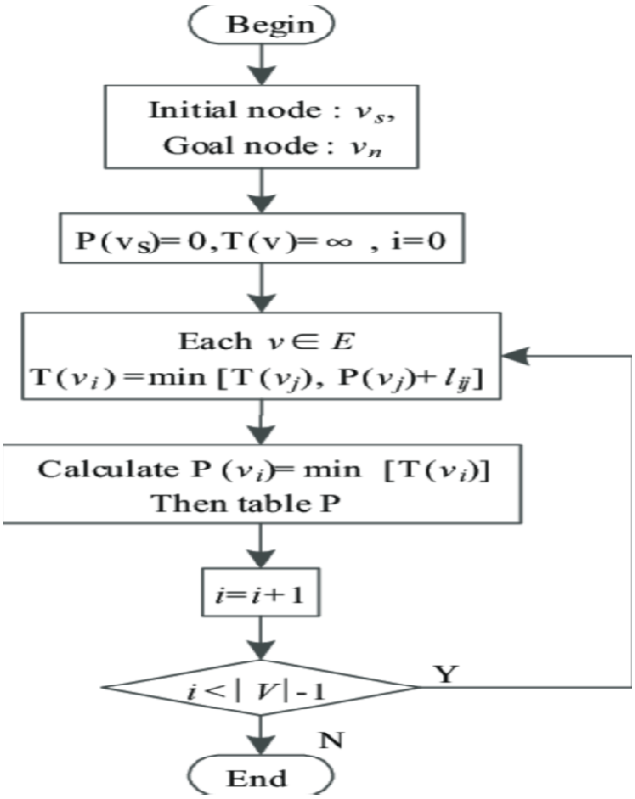

Figure 2: Different steps in Dijkstra‘s Algorithm

Some principals used in Dijkstra‘s Algorithm

- *All edges should be positive.*
- *The graph can be directed or undirected*
- *The graph should be connected.*

Floyd Warshall‘s Algorithm

To find the distance between all pairs of nodes in a network it is better to used Floyd Warshall algorithm. Output of this algorithm is a matrix of sixe (V * V), where V is number of vertices, each entry in the matrix gives the shortest distance needed to travel from one node to another ndoe in network. Floyd Warshall uses dynamic programming approach where each instance is recorded using the matrix and using the old matrix a new matrix is created.

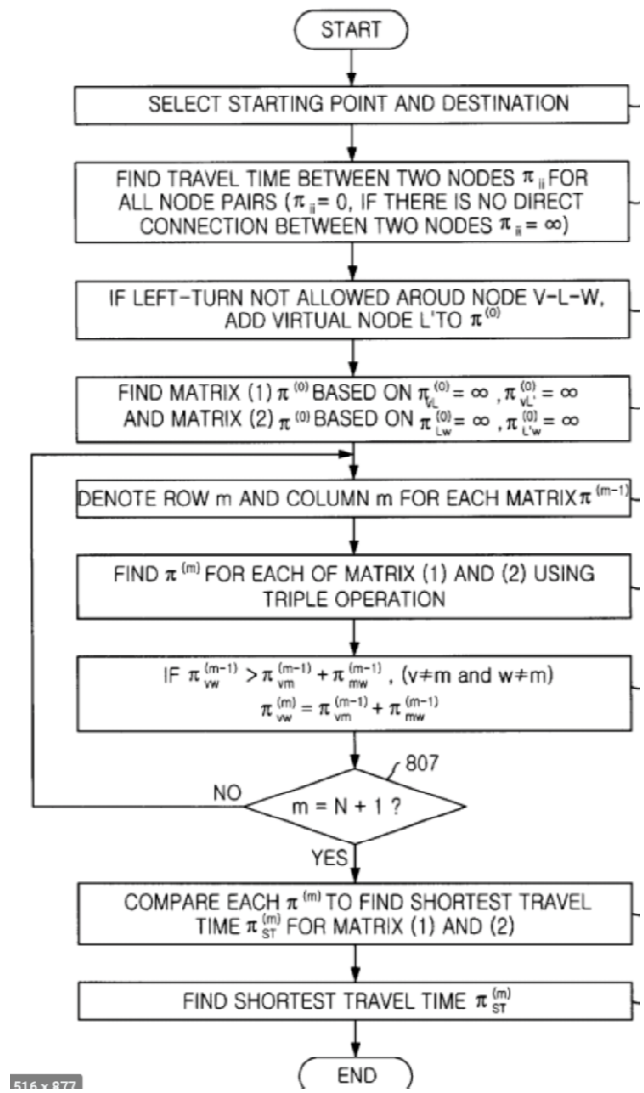

Figure 3: Different steps in Floyd Warshall's Algorithm

Johnson's Algorithm

Johnson's Algorithm is also used for the finding the shortest paths between all pairs of nodes in a network. It is similar to Floyd Warshall algorithm but it is used to overcome one of the drawback from Floyd Warshall algorithm. Floyd Warshall algorithm used to takes a lot of time to compute the distance between all the pairs of nodes. The time complexity was O(V*V*V), where V represents number of vertices. Whereas for Johnson's algorithm the time complexity is O(V*V*logV). Johnson's algorithm uses both Dijkstra's and Bellman-Ford Algorithms. We know that Dijkstra's algorithm is the fastest of all for computing the shortest path between any two nodes in the network. Since it uses the Greedy approach. Unfortunately it has a drawback it cannot compute the shortest path if there are negative weighted edges in the network. So the idea of Johnson's algorithm is to re weight all the edges in such a way that negative edge can be represented as positive edge and then we can apply Dijkstra's algorithm on that graph to find the shortest path between source and destination. To convert the graph with negative weighted edges to positive weighted edges, it uses Bellman-Ford algorithm.

Conclusion

Routing algorithms play an important role in networking, communication between the nodes, and to pass information from source to destination. Selecting routing algorithm is also a very important task. So there are many algorithms which are used to find the shortest path between source and destination,Dijkstra's used to find path from single source to destination.Bellman-Ford also considers negative weights. Similarly for shortest paths between all the pairs of nodes we have Floyd Warshall algorithm and Johnson algorithm. In this paper, it is concentrated to understand different kind of algorithms used in routing. This paper also compares routing algorithms and also provides various metrics which can be considered while selecting a routing algorithm for packet transfer in the network.

Metrics	Dijkstra	Bellman-Ford	Floyd Warshall	Johnson
Time Complexity	O(E+ VlogV)	O(VE)	$O(V^3)$	$O(V^2 logV + VE)$
Space Complexity	$O(V^2)$	$O(V^2)$	$O(V^3)$	-
Negative edges	No	Yes	Yes	Yes
Single Source	Single	Single	Multiple	Multiple
All Sources	Only one source	Only one source	All sources	All sources

Table 1: Comparing different routing algorithms

REFERENCES

[1] Peter Hofner, and Bernhard Moller. 2012." Dijkstra, Floyd and Warshall Formal Aspects of Computing, 459–476.

[2] Huang, B, Wu, Q, and Zhan, F.B. 2007. "A shortest path algorithm with novel heuristics for dynamic transportation networks. International Journal of Geographical Information Science. Vol. 21, No. 6, 625–644.

[3] Asmaa Shaker Ashoor.2015. "Performance Analysis between Distance Vector Algorithm (DVA) & Link State Algorithm (LSA) For Routing Network".International Journal of Scientific & Technology Research. Vol 4, ISSN 02,101- 105.

[4] Anu Pradhan, and Kumar, G. 2013. "Finding All-Pairs Shortest Path for a Large-Scale Transportation Network Using Parallel Floyd-Warshall and Parallel Dijkstra Algorithm". Journal of Computing in Civil Engineering ASCE. 263-273.

[5] Forouzan, B. A. "TCP/IP Protocol Suite". 2010. Prentice Hall. ISBN-13: 978-0-13-2126953. 282-333.

[6] Wei Zhang , Hao Chen , Chong Jiang , Lin Zhu. 2013. "Improvement And Experimental Evaluation Bellman-FordAlgorithm". International Conference on Advanced Information and Communication Technology for Education ICAICTE , 150-153.

[7] Hemalatha, S, and Valsalal, P. 2012. "Identification of Optimal Path in Power System Network Using Bellman Ford AlgorithmS". Hindawi Publishing Corporation Modelling and Simulation in Engineering.

[8] Andrew, S, and David, J. 2011. "Computer network". ISBN-13: 978-0-13-212695-3. 350-366.

[9] Mariusz Głabowski, Bartosz Musznicki, Przemysław Nowak , and Piotr Zwierzykowski. 2013. "Efficiency Evaluationof Shortest Path Algorithms". The Ninth Advanced International Conference on Telecommunications (IARIA). ISBN: 978-1-61208-279-0.

[10] Kevin,R. Hutson, Terri L, Schlosser, and Douglas, R. Shier.2007. "On the Distributed Bellman-Ford Algorithm andthe Looping Problem" .Informs Journal on Computing. Vol 19, No 4, 542- 551.

[11] Cormen, Thomas H, Leiserson, Charles E, and Rivest, Ronald L.Stein Clifford . 2001. "Johnson's algorithm forsparse graphs". Introduction to Algorithms. ISBN 978-0-262 03293-3. 636– 640.

[12] Phillip, G. Bradford , and David , A.Thomas.2009." Labeled Shortest Paths in Digraphs With Negative and PositiveEdge Weights". EDP Sciences.567–583.

[13] Nizami Gasilov, Mustafa Doğan, and Volkan Arici. 2011. "Two-stage Shortest Path Algorithm for Solving OptimalObstacle Avoidance Problem" JOURNAL OF RESEARCH (IETE). VOL 57. ISSUE 3, 278-185.

 ©IJSRED: All Rights are Reserved