

**5SENG001W: Algorithms Design & Implementation**

**Coursework (2020/21)**

**Explanation Report**

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**Data Structure: -**

Adjacency matrix is used as the data structure. Adjacency matrix is a V\*V array. The entry of the matrix is the capacity. If there is no path it is represented by 0 and if there is a path it is represented by its capacity (weight). In adjacency matrix we can check if two nodes are connected or not by o(1) approach. Inserting an edge also can done by o(1) times. So the time efficiency is high. For represent this 2D array is used which can hold fixed number of data of same data type. The reason to choose that is we can simply access any element by index, ability of storing large data and we already know the array size and data type.

**Ford Fulkerson Algorithm with BFS : -**

Ford Fulkerson algorithm is a greedy approach to calculate the maximum flow of a network of a graph. The Ford-fulkerson algorithm is a dynamic network routing algorithm that has advantages over static routing algorithms in that each router maintains a table of the best known distances to neighbours on the network.

The breadth first search (BFS) is used to find the path. This is a path finding algorithm that is capable of always finding the solution if one exists. BFS uses more memory but it will find the shortest path first. In here queue used which is a built in data structure and designed to have elements inserted at the end of the queue. It is working on first in first out method.

**Short run of the algorithm: -**

To find the max flow first we initialize a residual graph similar to the original graph. Residual graph where residualGraphMatrix[i][j] indicates residual capacity of edge from i to j (if there is an edge. If residualGraphMatrix [i][j] is 0, then there is not). Then create an array to store parent nodes. In pathSearchBFS method we have a Boolean array of nodes first we initialize all nodes un visited. Then queue is created to add the visited nodes. When adding a node to queue that node is removed from the parent array and marked visited as true. There is a while loop runs until queue is empty. BFS\_queue.poll() is used to remove the first element in the queue. Finally, pathSearchBFS method returns true or false. If we reached sink in BFS starting from source, then return true, else false. Then that value is taken by the first while loop in the findMaxFlow() method and it will run until false value returned from the pathSearchBFS. First the flow value is assigned to maximum value. Then find maximum flow which can be passes through the path. If the path has a flow, value of forward edge of the residual graph will be deducted the flow value and added to the backward edge and the flow value will update by that value. Then max flow is updated by the founded flow on that path.

**Pseudocode;**

**Ford Fulkerson**

Begin

create residual graph

initialize max\_flow to 0 run breadth first search (bfs) while true:

run breadth first search

check minimum value path\_flow, residual graph check max\_flow

return flow

End

**Breadth first search**

Begin

create graph to check visited values create queue

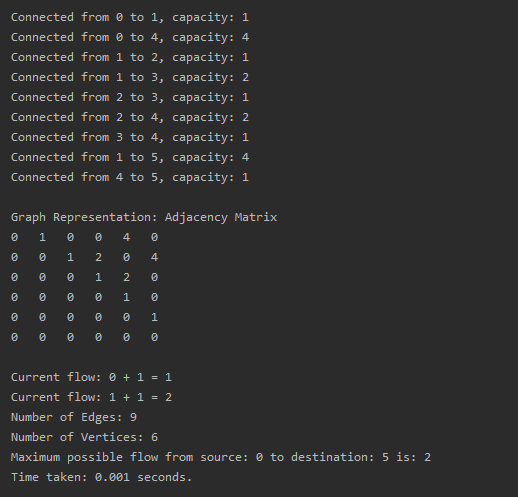
while queue is empty

drop front element from queue mark visited elements end while

return if visited

end

**Output;**

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|  |  |  |  |
| --- | --- | --- | --- |
| Vertices | Time | Ratio | Log 2 ratio |
| 6 | 0.001 | - | - |
| 12 | 0.001 | 1 | 0 |
| 24 | 0.001 | 1 | 0 |
| 48 | 0.004 | 4 | 2 |
| 96 | 0.013 | 3.25 | 1.6 |
| 192 | 0.02 | 1.5 | 0.5 |
| 384 | 0.085 | 4.25 | 2.08 |
| 786 | 0.575 | 6.7 | 2.7 |
| 1536 | 4.731 | 8.2 | 3 |

By using the doubling hypothesis, it can demonstrate that log ratio value is around 2. As the log ratio value is 2 the big O notation for this algorithm is o(n2). In my algorithm I have used while loop inside a for loop which should have time complexity o(n2).