

CS 372/469 – Spring 2022

Lab 3

Due: 04/03/2022 11:59 pm

For each of the following questions, write a successful running code in any programming language that you prefer. Your code should run without any errors for any *valid* input.

All problems are borrowed from GeeksForGeeks.

Question 1 (30 points):

Given a *directed graph (nodes and edges)* and a *starting node*, return the Breadth First Traversal of the graph from that node.

Source (Open at your own risk – solution is also on this page):

<https://www.geeksforgeeks.org/breadth-first-search-or-bfs-for-a-graph/>

Input and Output Example (from the above source):

Input: $n = 4, e = 6$

$0 \rightarrow 1, 0 \rightarrow 2, 1 \rightarrow 2, 2 \rightarrow 0, 2 \rightarrow 3, 3 \rightarrow 3$

Output: BFS from vertex 2 : 2 0 3 1

Your code should be able to traverse the above input format (e.g. $0 \rightarrow 1, 0 \rightarrow 2, 1 \rightarrow 2, 2 \rightarrow 0, 2 \rightarrow 3, 3 \rightarrow 3$) **from a given text file** and create edges in your data structure.

Your algorithm must have a time complexity of $O(V + E)$

Question 2 (35 points):

Given a *directed graph with weights* and a source vertex in the graph, find the shortest paths from the source to all vertices in the given graph using Dijkstra's Algorithm that uses a priority queue.

Source (Open at your own risk – solution is also on this page):

<https://www.geeksforgeeks.org/dijkstras-shortest-path-algorithm-in-java-using-priorityqueue/>

Input and Output Example (modified from the above source):

Input: $n = 5, e = 9$

$A \rightarrow B (4), B \rightarrow C (3), C \rightarrow B (1), B \rightarrow D (2), B \rightarrow E (3), C \rightarrow E (5), E \rightarrow D (1), A \rightarrow C (2), C \rightarrow D (4)$

Output:

Shortest Distance from A to C is 2

Shortest Distance from A to B is 3

Shortest Distance from A to E is 6

Shortest Distance from A to D is 5

The above is the same example from Slide 39.

Your code should be able to traverse the above input format (e.g. $A \rightarrow B (4), B \rightarrow C (3), C \rightarrow B (1), B \rightarrow D (2), B \rightarrow E (3), C \rightarrow E (5), E \rightarrow D (1), A \rightarrow C (2), C \rightarrow D (4)$) **from a given text file** and create edges and its weights in your data structure.

Your algorithm must have a time complexity of $O((|V|+|E|)\log|V|)$

Question 3 (35 points):

Given a boolean 2D matrix, find the number of islands **using a queue**. A group of connected 1s forms an island.

Source (Open at your own risk – solution is also on this page):

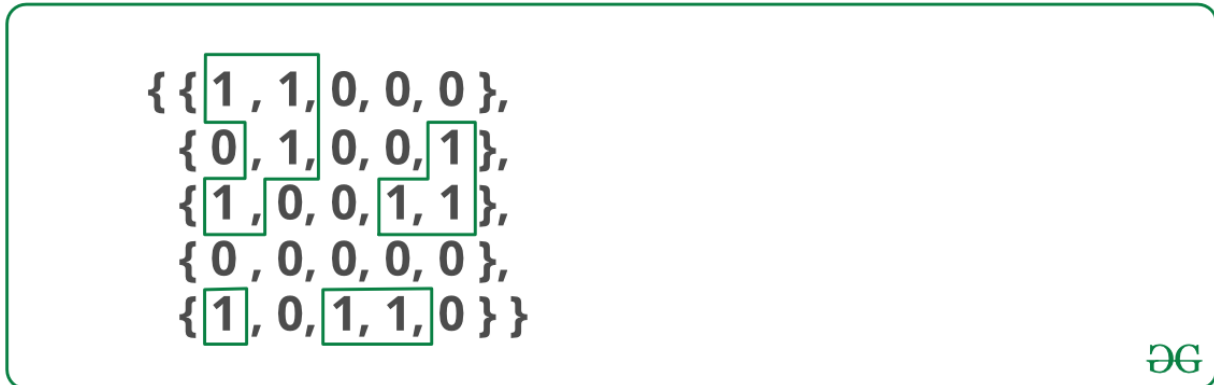
<https://www.geeksforgeeks.org/islands-in-a-graph-using-bfs/?ref=rp>

Input and Output Example (from the above source):

```
Input : 1, 1, 0, 0, 0,  
        0, 1, 0, 0, 1,  
        1, 0, 0, 1, 1,  
        0, 0, 0, 0, 0,  
        1, 0, 1, 0, 1
```

Output : 5

Explanation (from the above source):



<https://media.geeksforgeeks.org/wp-content/uploads/20190704154734/FindNumberOfIslands.png>

Your code should be able to traverse the above input format from a given text file.

Your algorithm must have a time complexity of $O(\text{numRows} \times \text{numColumns})$

Submission Instructions: Put all your solutions in a properly commented file named *lab3_lastname_firstname.EXTENSION*, where EXTENSION = the appropriate extension for the programming language that you chose.