



Batch: D3 Roll No.: 16010123294

Experiment / assignment / tutorial No. 08

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of the Staff In-charge with date

Title: Study of Graph traversal methods

Objective: To Understand Graph Traversal Methods - BFS & DFS.

Expected Outcome of Experiment:

CO	Outcome
2	Apply linear and non-linear data structure in application development.

Books/ Journals/ Websites referred:

1. *Fundamentals Of Data Structures In C* – Ellis Horowitz, Satraj Sahni, Susan Anderson-Fred
2. *An Introduction to data structures with applications* – Jean Paul Tremblay, Paul G. Sorenson
3. *Data Structures A Pseudo Approach with C* – Richard F. Gilberg & Behrouz A. Forouzan
4. <https://www.geeksforgeeks.org/binary-tree-data-structure/>
5. <https://www.thecrazyprogrammer.com/2015/03/c-program-for-binary-search-tree-insertion.html>



Abstract:

Graph is a non-linear data structure consisting of vertices and edges. The vertices are sometimes also referred to as nodes and the edges are lines or arcs that connect any two nodes in the graph. More formally a Graph is composed of a set of vertices(V) and a set of edges(E). The graph is denoted by $G(V, E)$.

Graph data structures are a powerful tool for representing and analyzing complex relationships between objects or entities. They are particularly useful in fields such as social network analysis, recommendation systems, and computer networks. In the field of sports data science, graph data structures can be used to analyze and understand the dynamics of team performance and player interactions on the field.

BFS & DFS on the assigned graphs:

DFS

Computer Science and Engineering > Data Structures - 1 > Experiments

Depth First Search

1. Which one of the following is an application of a directed graph?

- ☐ a. Mobile communication graph
- ☐ b. Water network graph
- ☒ c. Scheduling courses with prerequisites
- ☐ d. Graph of friends

2. If m & n represent the number of vertices & edges respectively, then which one of the following can not be true.

- ☐ a. $m > 0$ & $n > 0$
- ☐ b. $m > 0$ & $n = 0$
- ☒ c. $m = 0$ & $n > 0$
- ☐ d. $m = 10000$ & $n = 1$

3. Which one of the following data structures supports random access of elements?

- ☐ a. Linked List
- ☐ b. Tree
- ☒ c. Array
- ☐ d. Graph

4. In which of the following data structures, you can traverse in only one direction

- ☐ a. Undirected graph
- ☐ b. Doubly linked list
- ☐ c. Array
- ☒ d. Directed Graph

5. Which one of the following is an application of a directed graph?

- ☐ a. Scheduling courses with prerequisites
- ☐ b. Data broadcasting from parent to children nodes
- ☐ c. Family tree
- ☒ d. All of the above

[Print Out](#)



Computer Science and Engineering > Data Structures - 1 > Experiments

Aim
Overview
Basics of Graphs
Graph Traversals
Pretest
Depth First Search
Aim
Concept
Algorithm
Demo
Practice
Exercise
Quiz
Code Assessment
Analysis
Posttest
Further Readings/References
Feedback

Depth First Search

1. Which one of the following data structures is used in DFS?

- ☐ a. Heap
☐ b. Dequeue
☐ c. Linked List
☒ d. Stack

2. What is backtracking in DFS?

- ☒ a. Going to the parent node if all the children nodes have been visited
☐ b. Going to the parent node when a children node has been visited
☐ c. Going to the sibling node when all the children nodes have been visited
☐ d. Going to the sibling node when a children node has been visited

Submit Quiz

2 out of 2

Computer Science and Engineering > Data Structures - 1 > Experiments

Aim
Overview
Basics of Graphs
Graph Traversals
Pretest
Depth First Search
Code Assessment
Analysis
Aim
Space and Time Complexity
Comparison of BFS with DFS
Quiz
Posttest
Further Readings/References
Feedback

Depth First Search

1. If there are 10 edges in a graph, in the worst case how many edges can be traversed?

- ☐ a. 5
☐ b. 1
☐ c. 9
☒ d. 10

2. Which one of the following is correct?

- ☐ a. DFS uses queue & BFS can be done using stack & recursion.
☐ b. In DFS, all the neighbors are traversed before other nodes.
☐ c. DFS is a vertex-based algorithm while BFS is an edge-based algorithm.
☒ d. BFS is an optimal algorithm while DFS is not optimal.

Submit Quiz

2 out of 2

Computer Science and Engineering > Data Structures - 1 > Experiments

Aim
Overview
Basics of Graphs
Graph Traversals
Pretest
Depth First Search
Code Assessment
Analysis
Posttest
Further Readings/References
Feedback

Depth First Search

1. Which one of the following steps is incorrect when performing DFS?

- ☐ a. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☒ b. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☐ c. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☐ d. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.

2. What is the time complexity of DFS? V is the number of vertices & E is the number of edges

- ☐ a. $O(V)$
☒ b. $O(V^2)$
☐ c. $O(E)$
☐ d. $O(E^2)$

3. Pick the incorrect option

- ☐ a. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☐ b. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☐ c. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☒ d. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.

4. Which one of the following are applications of DFS?

- ☐ a. Topological Sorting
☐ b. Minimum Spanning Tree
☐ c. Finding connected components
☒ d. All of the above

5. DFS can only be applied on Trees & not on Graphs.

- ☐ a. True
☒ b. False

6. Pick the incorrect option

- ☐ a. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☒ b. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☐ c. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.
☐ d. DFS is done by following one of the graph vertices and if it is used as a source node in DFS.

7. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

8. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

9. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

10. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

11. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

12. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

13. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

14. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

15. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

16. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

17. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

18. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

19. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

20. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

21. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

22. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

23. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

24. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

25. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

26. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

27. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

28. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

29. DFS is used to find the shortest path.

- ☐ a. True
☒ b. False

BFS

Aim

Overview

Basics of Graphs

Graph Traversal

Basics of Queues

Pretest

BFS

Analysis

Posttest

Further Readings/References

Feedback

Breadth First Search

Choose difficulty: ☒ Beginner ☒ Intermediate ☒ Advanced

1. Which of the following policies does a queue follow?

☒ a. FIFO - First In First Out Explanation

☐ b. LIFO - Last In First Out Explanation

☐ c. FILO - First In Last Out Explanation

☐ d. Random order Explanation

2. Which of the following describes a standard graph traversal algorithm?

☐ a. visiting all the edges of the graph Explanation

☒ b. visiting all the vertices of the graph Explanation

☐ c. Detecting all the cycles in the graph Explanation

☐ d. None of the above Explanation

3. Consider the following undirected graph:

Vertices, $V = \{a, b, c, d, e, f\}$

Edges, $E = \{a, b, b, c, c, d, d, e, e, f, f, g\}$

Where each array within E signifies an edge between the two mentioned vertices

Which of the following data structures is represented by the above graph?

☐ a. Tree Explanation

☒ b. cyclic graph Explanation

☐ c. Disconnected Graph Explanation

☐ d. Complete Graph Explanation

4. Consider the following undirected graph:

Vertices, $V = \{a, b, c, d, e, f\}$

Edges, $E = \{a, b, b, c, c, d, d, e, e, f, f, g\}$

Where each array within E signifies an edge between the two mentioned vertices

If we were to store this graph's vertices in a queue in the order top to bottom, parent to child and left to right, edges that appear first in the queue will appear first in the queue with 'a' as the root, what index would vertex 'e' be stored at (assume 0 indexing for the queue and no deletions)?

☐ a. 0 Explanation

☐ b. 3 Explanation

☒ c. 4 Explanation

☐ d. 5 Explanation

[Submit Quiz](#)

Instructions

Observation:

BFS is done on the node 0 !!!

Sequence of nodes visited on performing BFS on node 0: 0, 1, 2, 3, 4

Min Speed Max Speed

Control buttons: Play, Pause, Stop, Reset

Instructions

Observation:

Your sequence: 0, 1, 2, 3, 4

Correct!

Control buttons: Play, Pause, Stop, Reset



Instructions

Legend:
Source Node
Unvisited Node
Visited Node

Observation:
Selected node is the correct node.
BFS is done!!
Sequence of nodes visited in performing BFS on node 0: 0,1,2,3,4

Reset New graph

Computer Science and Engineering > Data Structures - 1 > Experiments

Breadth First Search

Choose difficulty: ☒ Beginner ☐ Intermediate

1. Which of the following are applications of BFS?
☐ a. To find the Minimum Spanning Tree (MST) - Explanation
☐ b. To find the shortest distance to a node from the root - Explanation
☐ c. Cycle detection in undirected graphs - Explanation
☒ d. All of the above - Explanation

2. Imagine a 4x4 grid (assume 1 indexing) where the hero stands in the cell (0,3) and the villain is in the cell (3,3). Assuming the hero can only move up, down, left and/or right to the immediately adjacent cells and cannot move out of the grid, how many steps will it take for the hero to reach the villain (given that the villain is stationary)?
☐ a. 1 - Explanation
☐ b. 2 - Explanation
☒ c. 3 - Explanation
☐ d. 4 - Explanation

Submit Quiz
Score: 2 out of 2

Computer Science and Engineering > Data Structures - 1 > Experiments

Breadth First Search

1. Consider the following graph:
Vertices: V = {a, b, c, d, e, f}
Edges: E = {a, b, b, a, c, b, d, b, e, e, f, c, f, f}
Where each array within E signifies an edge between the two mentioned vertices.
How many iterations of the queue would it take for the algorithm to traverse this graph completely?
☐ a. 3 - Explanation
☐ b. 5 - Explanation
☒ c. 6 - Explanation
☐ d. 7 - Explanation

2. When will the space complexity of BFS be greater than DFS? Note that maximum height in the options refers to the longest thread of vertices from the root to a leaf or final non-repeating vertex.
☒ a. If the maximum height is greater than the maximum number of nodes in a single level - Explanation
☐ b. If the maximum height is greater than the maximum number of nodes in a single level - Explanation
☐ c. BFS and DFS have same the space complexity - Explanation
☐ d. Space complexity of DFS is always greater than that of BFS - Explanation

Submit Quiz
Score: 2 out of 2



Computer Science and Engineering > Data Structures - 1 > Experiments

Aim
Overview
Basics of Graphs
Graph Traversal
Basics of Queues
Pretest
BFS
Analysis
Posttest
Further Readings/References
Feedback

Breadth First Search

Choose difficulty:

☒ Intermediate

☐ Advanced

1. Which of the following is a use of the extra Visited array (the array used to keep track of which nodes have been visited/traversed) in BFS?

- ☒ a. To avoid getting stuck in a loop. Explanation
☐ b. To decide which node to traverse next. Explanation
☐ c. To preemptively end the algorithm when all nodes are marked as visited thus saving time. Explanation
☐ d. None of the above. Explanation

2. What would happen if we used a stack instead of a queue in BFS?

- ☐ a. The algorithm would simply traverse the graph in the reverse order, i.e. from bottom to top (leaves to root). Explanation
☒ b. The algorithm would become equivalent to DFS. Explanation
☐ c. The algorithm would not work properly, i.e. it will not traverse the graph properly and/or completely. Explanation
☐ d. No change in the algorithm, i.e. it remains unaffected. Explanation

3. Why is the time complexity of BFS $O(V + E)$?

- ☐ a. Because it considers all vertices and edges in the worst case. Explanation
☒ b. Because it considers all vertices and edges in all cases. Explanation
☐ c. This is not the correct time complexity of BFS. Explanation
☐ d. None of the above. Explanation

4. Consider the following graph:

Vertices, $V = \{a, b, c, d, e, f\}$

Edges, $E = \{a, b, a, c, b, d, b, e, e, f, c, f\}$

Where each array within E signifies an edge between the two mentioned vertices and a is the root.

Which of the following represents the correct sequence of the queue used in BFS to traverse the above graph?

- ☐ a. $f \rightarrow d \rightarrow b, c \rightarrow b, e \rightarrow f \rightarrow d \rightarrow b, c \rightarrow d, e \rightarrow f$ Explanation
☐ b. $f \rightarrow d \rightarrow b, c \rightarrow b, c, d, e \rightarrow b, c, d, e, f$ Explanation
☐ c. $f \rightarrow d \rightarrow b, c \rightarrow d, e \rightarrow d, e, f \rightarrow b, f \rightarrow d, e$ Explanation
☒ d. $f \rightarrow d \rightarrow b, c \rightarrow b, d \rightarrow d, e \rightarrow f, b \rightarrow b, f \rightarrow f$ Explanation

Submit Quiz

Score: 4 out of 4

Conclusion:-We implement the BFS and DFS via virtual lab for deeper understanding.

PostLab Questions:

1) Differentiate between BFS & DFS

Traversal Approach:

BFS: Explores neighbors level by level, moving outward from the starting node.

DFS: Explores as far down a branch as possible before backtracking.

Data Structure:

BFS: Uses a queue to manage nodes, ensuring a level-order traversal.

DFS: Uses a stack (or recursion) to go deep into each branch before returning.



Time Complexity:

Both BFS and DFS have a time complexity of $O(V + E)$, where V is the number of vertices and E is the number of edges.

Applications:

BFS: Ideal for finding the shortest path in unweighted graphs.

DFS: Useful for cycle detection, pathfinding in mazes, and topological sorting.

2) Applications of BFS & DFS

BFS Applications:

- Shortest Path in Unweighted Graphs: Finds the shortest path between two nodes in an unweighted graph.
- Web Crawlers: Crawls web pages level by level.
- Social Networking Sites: Finds connections or friends within a certain degree.
- GPS Navigation: Helps in finding the shortest route in maps (unweighted scenarios).

DFS Applications:

- Cycle Detection: Identifies cycles in directed and undirected graphs.
- Topological Sorting: Used in scheduling tasks where certain tasks depend on others.
- Maze/Pathfinding Algorithms: Helps in exploring all possible paths and backtracking if a path is blocked.
- Solving Puzzles: Solves problems like Sudoku, where depth exploration is needed to find a solution.