UNIVERSITY OF CALOOCAN CITY
COMPUTER ENGINEERING DEPARTMENT

Data Structure and Algorithm

Laboratory Activity No. 12

Graph Searching Algorithm

Submitted by:
Villanueva, Bryan O.

Instructor:
Engr. Maria Rizette H. Sayo

October 25, 2025

I. Objectives

Introduction

Depth-First Search (DFS)

- Explores as far as possible along each branch before backtracking
- Uses stack data structure (either explicitly or via recursion)
- Time Complexity: O(V + E)
- Space Complexity: O(V)

Breadth-First Search (BFS)

- Explores all neighbors at current depth before moving deeper
- Uses queue data structure
- Time Complexity: O(V + E)
- Space Complexity: O(V)

This laboratory activity aims to implement the principles and techniques in:

- Understand and implement Depth-First Search (DFS) and Breadth-First Search (BFS) algorithms
- Compare the traversal order and behavior of both algorithms
- Analyze time and space complexity differences

II. Methods

- Copy and run the Python source codes.
- If there is an algorithm error/s, debug the source codes.
- Save these source codes to your GitHub.
- Show the output

1. Graph Implementation

```
from collections import deque
import time

class Graph:
    def __init__(self):
        self.adj_list = {}

    def add_vertex(self, vertex):
        if vertex not in self.adj_list:
            self.adj_list[vertex] = []

    def add_edge(self, vertex1, vertex2, directed=False):
        self.add_vertex(vertex1)
        self.add_vertex(vertex2)

        self.adj_list[vertex1].append(vertex2)
        if not directed:
            self.adj_list[vertex2].append(vertex1)
```

```
    def display(self):
        for vertex, neighbors in self.adj_list.items():
            print(f"{vertex}: {neighbors}")
```

2. DFS Implementation

```
def dfs_recursive(graph, start, visited=None, path=None):
    if visited is None:
        visited = set()
    if path is None:
        path = []

    visited.add(start)
    path.append(start)
    print(f"Visiting: {start}")

    for neighbor in graph.adj_list[start]:
        if neighbor not in visited:
            dfs_recursive(graph, neighbor, visited, path)

    return path

def dfs_iterative(graph, start):
    visited = set()
    stack = [start]
    path = []

    print("DFS Iterative Traversal:")
    while stack:
        vertex = stack.pop()
        if vertex not in visited:
            visited.add(vertex)
            path.append(vertex)
            print(f"Visiting: {vertex}")

            # Add neighbors in reverse order for same behavior as recursive
            for neighbor in reversed(graph.adj_list[vertex]):
                if neighbor not in visited:
                    stack.append(neighbor)
    return path
```

3. BFS Implementation

```
def bfs(graph, start):
    visited = set()
    queue = deque([start])
    path = []

    print("BFS Traversal:")
    while queue:
        vertex = queue.popleft()
        if vertex not in visited:
            visited.add(vertex)
            path.append(vertex)
            print(f"Visiting: {vertex}")
```

```
            for neighbor in graph.adj_list[vertex]:
                if neighbor not in visited:
                    queue.append(neighbor)

        return path
```

Questions:

1. When would you prefer DFS over BFS and vice versa?
2. What is the space complexity difference between DFS and BFS?
3. How does the traversal order differ between DFS and BFS?
4. When does DFS recursive fail compared to DFS iterative?

III. Results

GRAPH IMPLEMENTATION

```python
from collections import deque
import time

class Graph:
    def __init__(self):
        self.adj_list = {}

    def add_vertex(self, vertex):
        if vertex not in self.adj_list:
            self.adj_list[vertex] = []

    def add_edge(self, vertex1, vertex2, directed=False):
        self.add_vertex(vertex1)
        self.add_vertex(vertex2)

        self.adj_list[vertex1].append(vertex2)
        if not directed:
            self.adj_list[vertex2].append(vertex1)

    def display(self):
        for vertex, neighbors in self.adj_list.items():
            print(f"{vertex}: {neighbors}")
```

Figure 1 Graph Implementation

DFS IMPLEMENTATION

```python
def dfs_recursive(graph, start, visited=None, path=None):
    if visited is None:
        visited = set()
    if path is None:
        path = []

    visited.add(start)
    path.append(start)
    print(f"Visiting: {start}")

    for neighbor in graph.adj_list[start]:
        if neighbor not in visited:
            dfs_recursive(graph, neighbor, visited, path)

    return path

def dfs_iterative(graph, start):
    visited = set()
    stack = [start]
    path = []

    print("DFS Iterative Traversal:")
    while stack:
        vertex = stack.pop()
        if vertex not in visited:
            visited.add(vertex)
            path.append(vertex)
            print(f"Visiting: {vertex}")

            # Add neighbors in reverse order for same behavior as recursive
            for neighbor in reversed(graph.adj_list[vertex]):
                if neighbor not in visited:
                    stack.append(neighbor)
    return path
```

Figure 2 DFS Implementation

BFS IMPLEMENTATION

```python
def bfs(graph, start):
    visited = set()
    queue = deque([start])
    path = []

    print("BFS Traversal:")
    while queue:
        vertex = queue.popleft()
        if vertex not in visited:
            visited.add(vertex)
            path.append(vertex)
            print(f"Visiting: {vertex}")

            for neighbor in graph.adj_list[vertex]:
                if neighbor not in visited:
                    queue.append(neighbor)

    return path
```

Figure 3 BFS Implementation

ANSWERS:

1. When would you prefer DFS over BFS and vice versa?

- I would prefer DFS when I need to go deep into a path before exploring others, like in solving mazes or searching for a path that leads to a specific goal. It's also useful when the graph is very large but not too deep. On the other hand, I would use BFS when I need the shortest path between two nodes or when I want to explore all nodes level by level, like in finding the shortest route on a map.

2. What is the space complexity difference between DFS and BFS?

- DFS usually uses less memory because it only needs to store the current path and visited nodes, which depends on the depth of the graph. BFS, however, needs more memory since it stores all the nodes in a level before moving to the next one, especially in wide graphs.

3. How does the traversal order differ between DFS and BFS?

- In DFS, the traversal goes deep first it explores one path all the way down before moving to another path. In BFS, the traversal goes level by level, visiting all neighbors of a node before moving to their children.

4. When does DFS recursive fail compared to DFS iterative?

- DFS recursive can fail when the graph is too deep, because it may cause a stack overflow due to too many recursive calls. DFS iterative doesn't have this problem since it uses an explicit stack and can handle deeper graphs without crashing.

IV. Conclusion

In this laboratory activity, I learned how to implement and understand the difference between Depth-First Search (DFS) and Breadth-First Search (BFS) algorithms. By running and debugging Python codes, I was able to see how each algorithm works in traversing a graph. DFS explores deeper paths first, while BFS visits nodes level by level. I also learned that DFS uses less memory compared to BFS, but it can cause stack overflow when using recursion on deep graphs.