Assignment No: 02
BFS Algorithms

CSE-0408 Summer 2021

Joy Sarkar
Department of Computer Science and Engineering
State University of Bangladesh (SUB)
Dhaka, Bangladesh
joysarker39@gmail.com

***Abstract*—Breadth-first search (BFS) is an algorithm for searching a tree data structure for a node that satisfies a given property. It starts at the tree root and explores all nodes at the present depth prior to moving on to the nodes at the next depth level. Extra memory, usually a queue, is needed to keep track of the child nodes that were encountered but not yet explored. This assignment is basically implementation of a BFS algorithms.**

***Index Terms*—BFS, graph, Networkx, Matplotlib**

I. Introduction

Graph traversal means visiting every vertex and edge exactly once in a well-defined order. While using certain graph algorithms, you must ensure that each vertex of the graph is visited exactly once. The order in which the vertices are visited are important and may depend upon the algorithm or question that you are solving.

During a traversal, it is important that you track which vertices have been visited. The most common way of tracking vertices is to mark them.

Breadth First Search (BFS)

There are many ways to traverse graphs. BFS is the most commonly used approach.

BFS is a traversing algorithm where you should start traversing from a selected node (source or starting node) and traverse the graph layerwise thus exploring the neighbour nodes (nodes which are directly connected to source node). You must then move towards the next-level neighbour nodes.

II. Literature Review

Konrad Zuse devised BFS and its use in finding related components of graphs in his (rejected) Ph.D. thesis on the Plankalkül programming language in 1945, but it wasn't published until 1972. Edward F. Moore recreated it in 1959 to determine the shortest path out of a maze, and C. Y. Lee later extended it into a wire routing method (published 1961).

III. Proposed Methodology

Input: A graph G and a starting vertex root of G
Output: Goal state. The parent links trace the shortest path back to root

```
1   procedure BFS(G, root) is
2    let Q be a queue
3      label root as explored
4      Q.enqueue(root)
5      while Q is not empty do
6        v := Q.dequeue()
7        if v is the goal then
8          return v
9        for all edges from v to w in G.adjacentEdges(v) do
10           if w is not labeled as explored then
11             label w as explored
12             Q.enqueue(w)
```

We are using **NetworkX** for creating Graph. NetworkX is a Python package for the creation, manipulation, and study of the structure, dynamics, and functions of complex networks(Graph).
Also using **matplotlib.pyplot**, we can graphically represent our graph.

IV. Conclusion

This assignment is based on graphically representation on python of BFS algorithms. Time Complexity: O(V+E) where V is number of vertices in the graph and E is number of edges in the graph.

Acknowledgment

I would like to thank my honourable**Khan Md. Hasib Sir** for his time, generosity and critical insights into this project.

References

[1] Cormen Thomas H.; et al. (2009). "22.3". Introduction to Algorithms. MIT Press.

BFS

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[1]:
```
import networkx as nx
import matplotlib.pyplot as plt
from collections import deque
import random
```

[2]:
```
def CreateGraph(node, edge):
    G = nx.Graph()
    for i in range(1, node+1):
        G.add_node(i)
    for i in range(edge):
        u, v = random.randint(1, node), random.randint(1, node)
        G.add_edge(u, v)
    return G
```

[3]:
```
def DrawGraph(G, color):
    pos = nx.spring_layout(G)
    nx.draw(G, pos, with_labels = True, node_color = color, edge_color = 'black'␣
 ↪,width = 1, alpha = 0.7)  #with_labels=true is to show the node number in the␣
 ↪output graph
```

[4]:
```
def DrawIteratedGraph(G,col_val):
    pos = nx.spring_layout(G)
    color = ["green", "blue", "yellow", "pink", "red", "black", "gray", "brown",␣
 ↪"orange", "plum"]
    values = []
    for node in G.nodes():
        values.append(color[col_val[node]])
    nx.draw(G, pos, with_labels = True, node_color = values, edge_color =␣
 ↪'black' ,width = 1, alpha = 0.7)  #with_labels=true is to show the node number␣
 ↪in the output graph
```

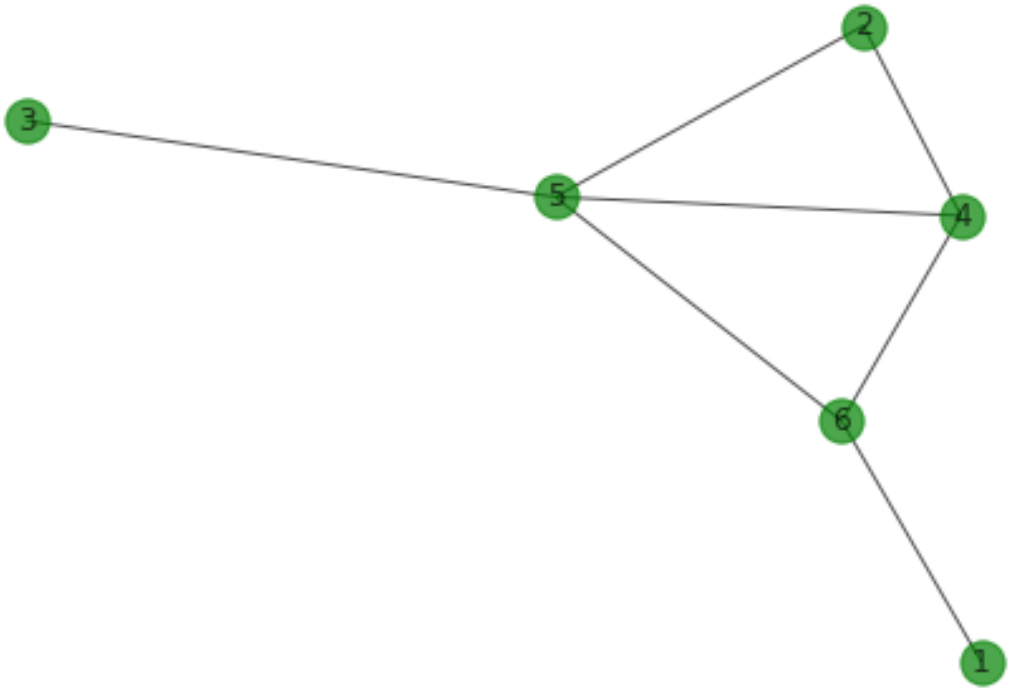
[5]:
```
def DrawSolutionGraph(G,col_val):
    pos = nx.spring_layout(G)
    values = []
    for node in G.nodes():
        values.append(col_val.get(node, col_val.get(node)))
```

```
    nx.draw(G, pos, with_labels = True, node_color = values, edge_color =␣
↪'black' ,width = 1, alpha = 0.7)  #with_labels=true is to show the node number␣
↪in the output graph
```

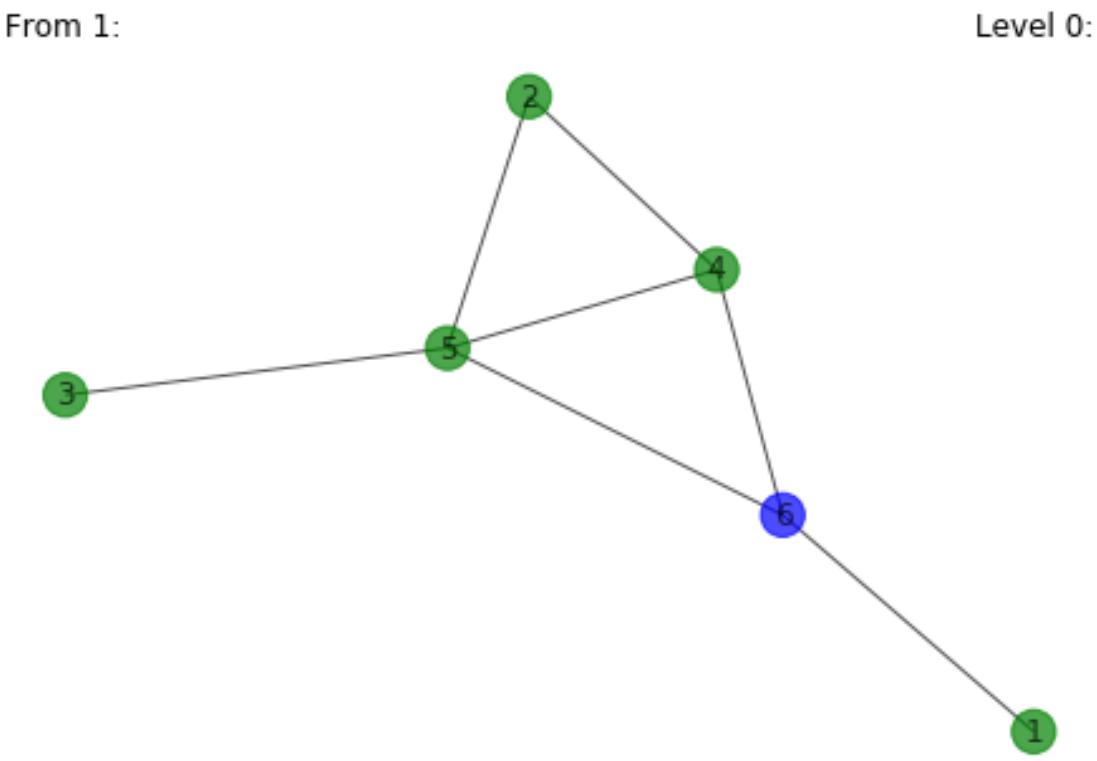
[6]:
```
def BFS(start):
    queue = deque()
    queue.append(start)
    visited[start] = True
    level[start] = 0

    while queue:
        u = queue.popleft()
        print(u, " -> ", end = "")
        for v in G.adj[u]:
            if not visited[v]:
                queue.append(v)
                visited[v] = True
                level[v] = level[u] + 1

        DrawIteratedGraph(G, level)
        plt.title('From {}:'.format(u), loc='left')
        plt.title('Level {}:'.format(level[u]), loc='right')
        plt.show()

    print("End")
```

[7]:
```
if __name__ == "__main__":

    node, edge = 6, 10

    G = CreateGraph(node, edge)
    print("Nodes: ", G.nodes)
    DrawGraph(G, "green")
    plt.show()
    visited = [False for i in range(node+1)]
    level = [0 for i in range(node+1)]
    parent = [0 for i in range(node+1)]
    root = 1
    BFS(root)
```

```
Nodes:  [1, 2, 3, 4, 5, 6]
```



1 ->



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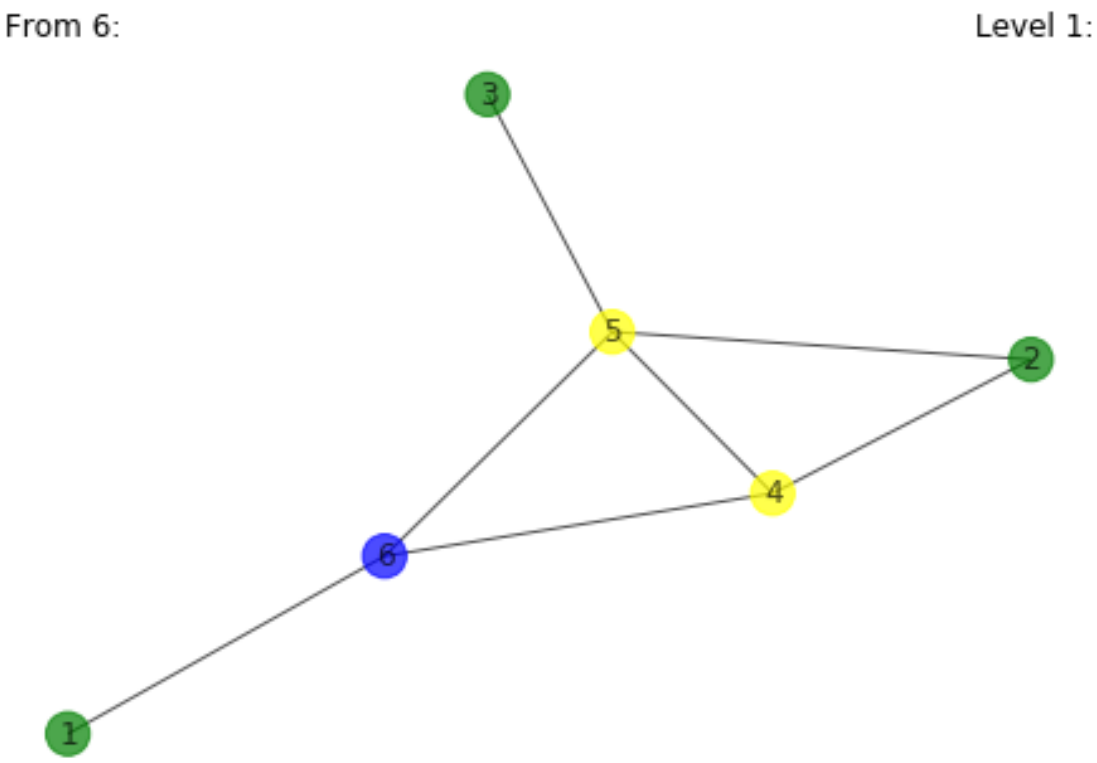
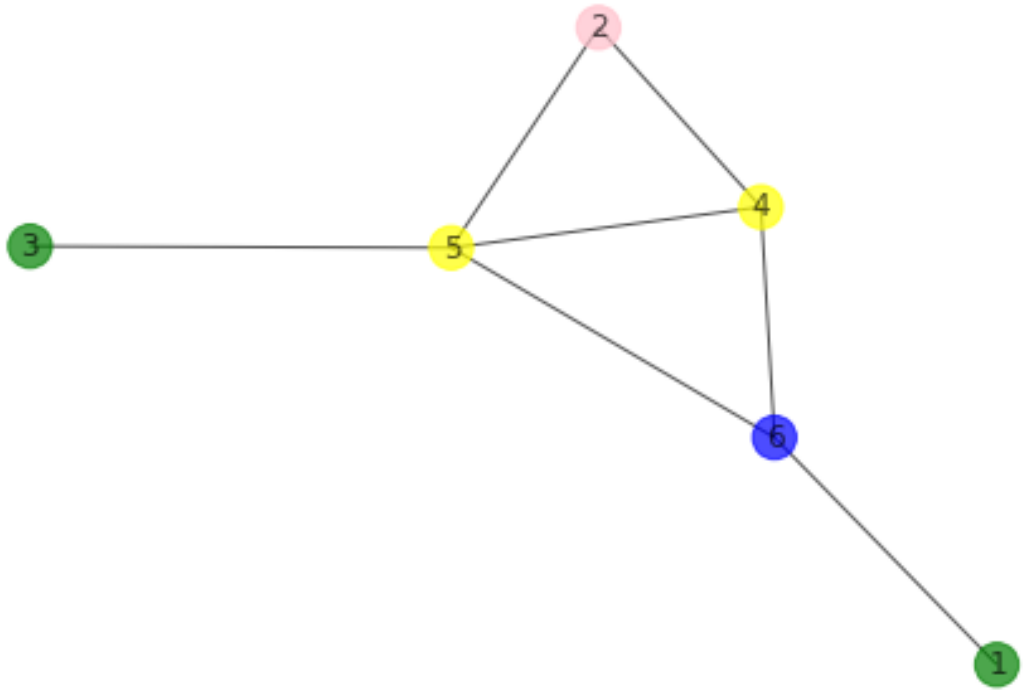


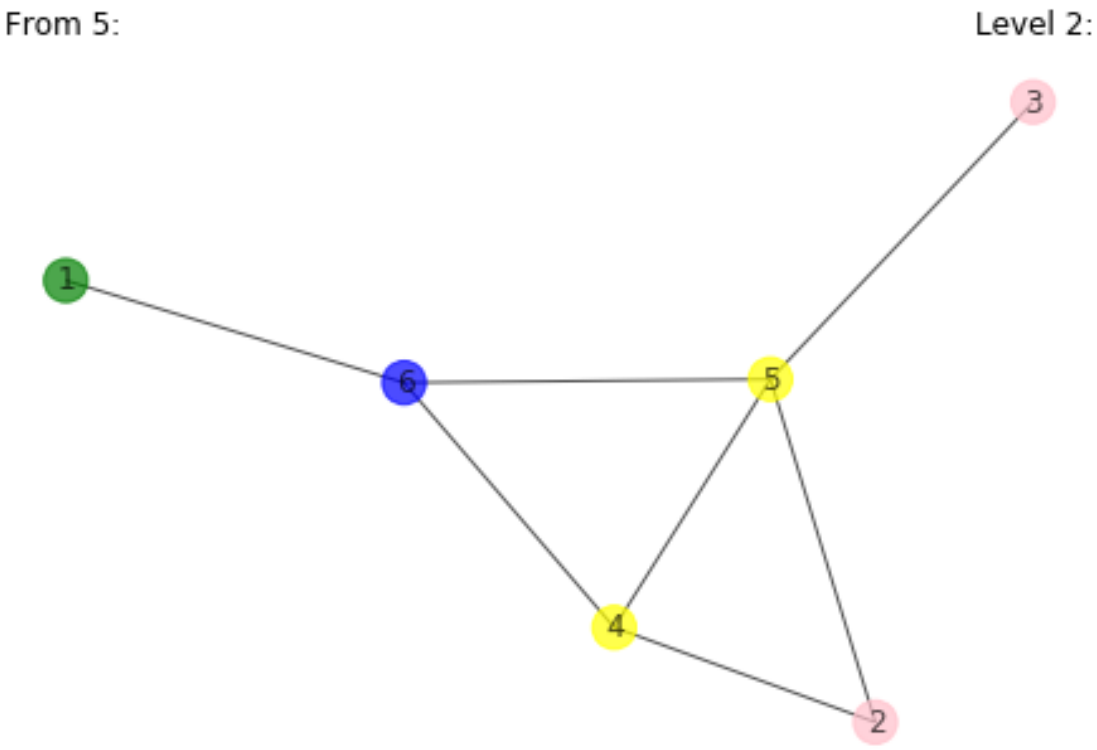
4 ->

From 4:

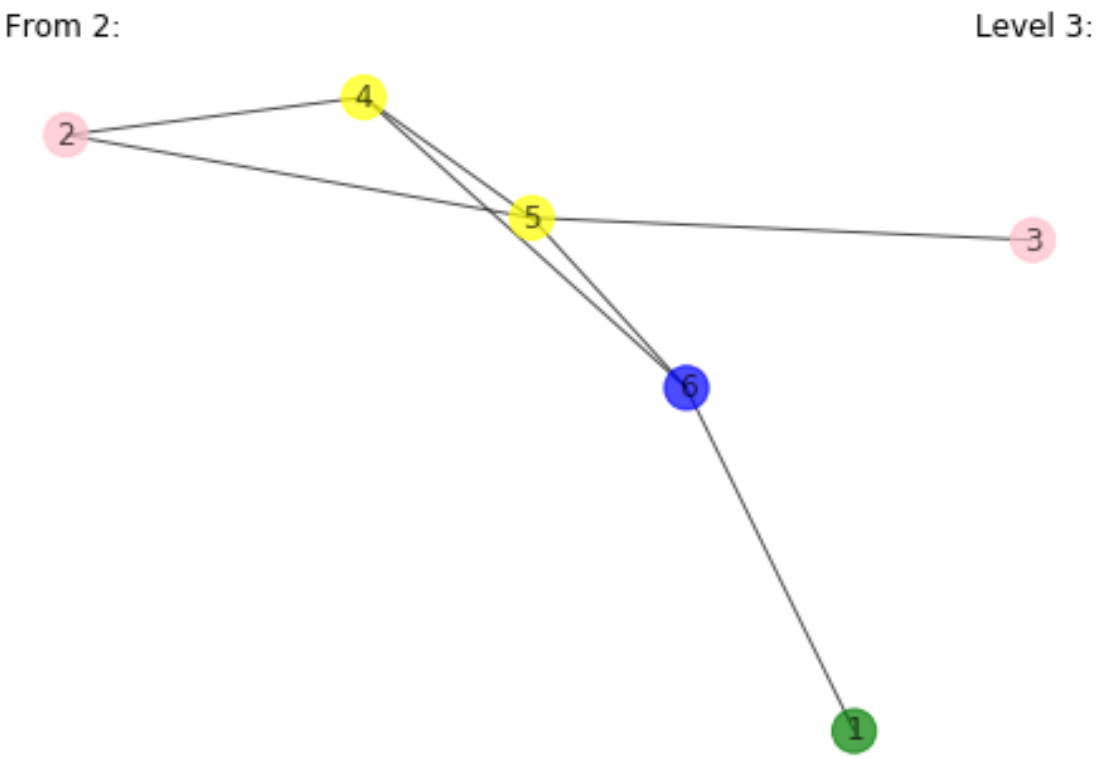
Level 2:



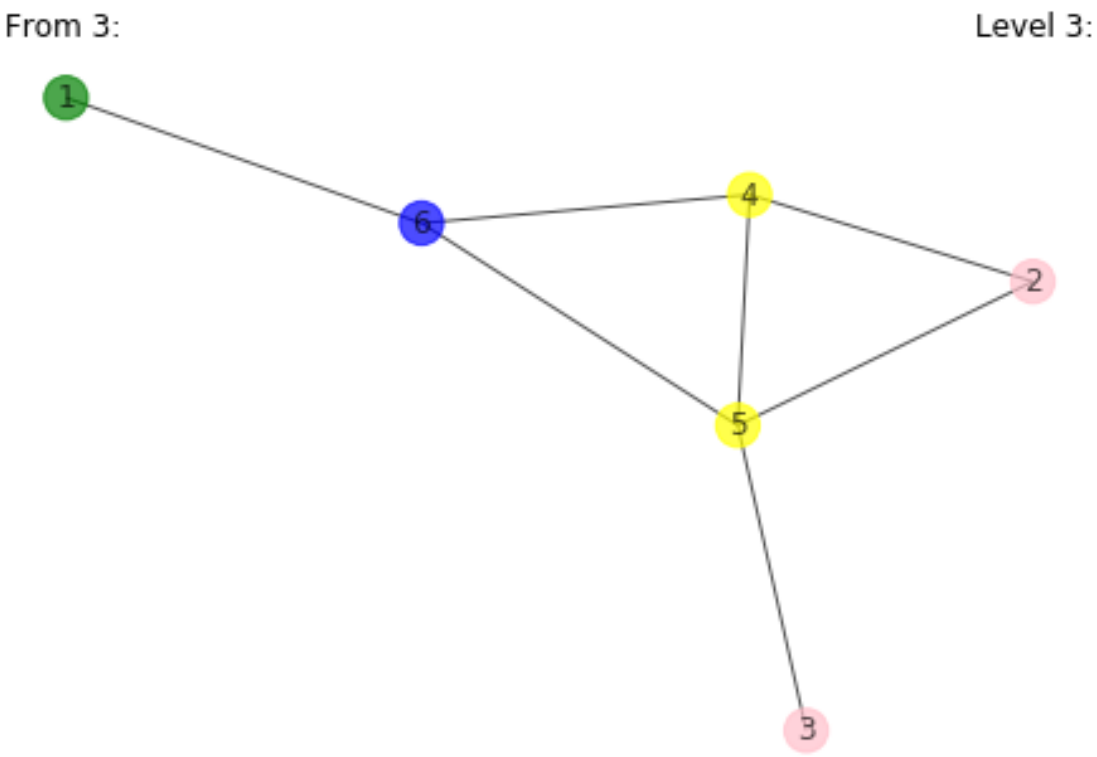
5 ->



2 ->



3 ->



End

[ ]: