Depth First Search:

DFS1:

```
#DFS non recursive
def dfs_non_recursive(graph, source):
    if source is None or source not in graph:
        return 'Invalid Input'
    path = []
    stack = [source]
    while (len(stack) != 0):
        s = stack.pop()
        if s not in path:
            path.append(s)
        if s not in graph:
            continue
        for neighbor in graph[s]:
            stack.append(neighbor)
    return ' '.join(path)

def main():
    graph = {
        'A': ['D', 'C', 'B'],
        'B': ['E'],
        'C': ['F', 'G'], #The example has G, F but that seems w
rong.
        'D': ['H'],
        'E': ['I'],
        'F': ['J']
    }

    path = dfs_non_recursive(graph, 'A')
    print(path)
main()
```


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```
PS C:\Users\fagge\Documents\CS591> python -u "c:\Users\fagge\Documents\CS591\DFS1.py"
A B E I C G F J D H
PS C:\Users\fagge\Documents\CS591>
```


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DFS2:

```
#DFS Recursive
def dfs_recursive(graph, source, path = []):
    if source not in path:
        path.append(source)

        if source not in graph:
            return path
        for neighbor in graph[source]:
            path = dfs_recursive(graph, neighbor, path)
    return path

def main():
    graph = {
        'A': ['D', 'C', 'B'],
        'B': ['E'],
        'C': ['F', 'G'], #The example has G, F but that seems w
rong.
        'D': ['H'],
        'E': ['I'],
        'F': ['J']
    }

    path = dfs_recursive(graph, 'A')
    print(*path)
main()
```

```
PS C:\Users\fagge\Documents\CS591> python -u "c:\Users\fagge\Documents\CS591\DFS2.py"
A D H C F J G B E I
PS C:\Users\fagge\Documents\CS591>
```


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DFS3:

```
#Binary Tree DFS
class Node:
    def __init__(self, value):
        self.value = value
        self.left = None
        self.right = None

class Tree:
    def __init__(self, value):
        self.root = Node(value)

    def insert(self, value):
        current = self.root
        while True:
            if value > current.value:
                if current.right is None:
                    current.right = Node(value)
                    break
                else:
                    current = current.right
            elif value < current.value:
                if current.left is None:
                    current.left = Node(value)
                    break
                else:
                    current = current.left
            else:
                current.value = value
                break

    def DFSTree(self, node: Node):
        if node is None:
            return
```


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```
        else:
            print(node.value, end = ' ')
        self.DFSTree(node.left)
        self.DFSTree(node.right)

    def PrintDFSTree(self):
        self.DFSTree(self.root)

def main():
    root = Tree(7)
    root.insert(2)
    root.insert(25)
    root.insert(9)
    root.insert(80)
    root.insert(0)
    root.insert(5)
    root.insert(15)
    root.insert(8)

    root.PrintDFSTree()
main()
```

```
PS C:\Users\fagge\Documents\CS591> python -u "c:\Users\fagge\Documents\CS591\tempCodeRunnerFile.py"
7 2 0 5 25 9 8 15 80
PS C:\Users\fagge\Documents\CS591>
```


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DFS4:

```
#DFS networkx and matplot lib
import networkx as nx
import matplotlib.pyplot as plt

G = nx.Graph()
G.add_node(1)
G.add_node(2)
G.add_node(3)
G.add_node(4)
G.add_node(5)
G.add_nodes_from([6, 7, 8, 9])

G.add_edge(5, 8)
G.add_edge(5, 4)
G.add_edge(5, 7)
G.add_edge(8, 2)
G.add_edge(4, 3)
G.add_edge(4, 1)
G.add_edge(7, 6)
G.add_edge(6, 9)

nx.draw(G, with_labels = True, font_weight = 'bold')

output = list(nx.dfs_preorder_nodes(G, source = 5))

plt.show()
```


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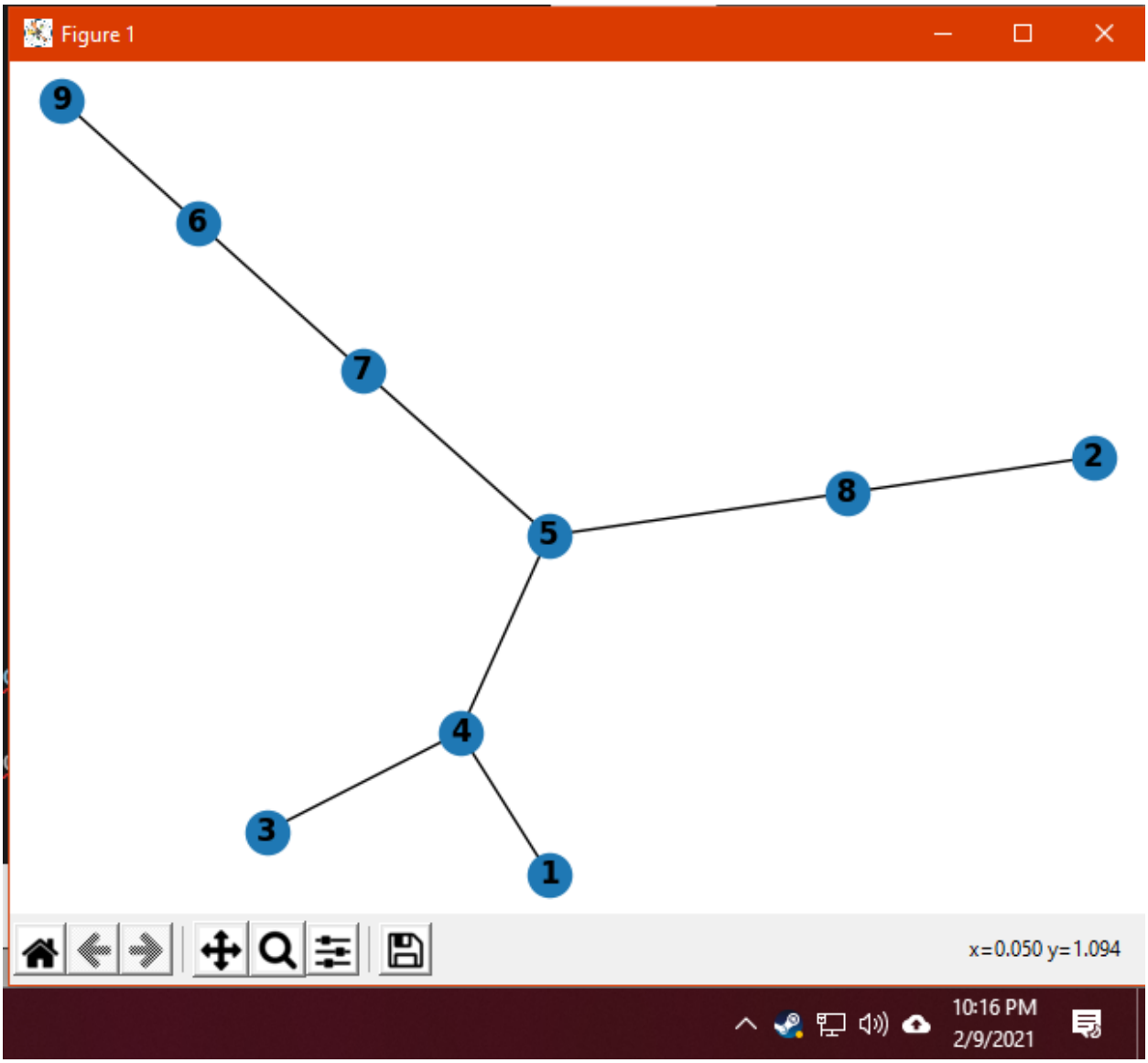

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DFS5:

```
#networkx digraph
import networkx as nx
import matplotlib.pyplot as plt

def dfs(dag, start, visited, stack):

       if start in visited:

           # node and all its branches have been visited
           return stack, visited


       if dag.out_degree(start) == 0:

           # if leaf node, push and backtrack
           stack.append(start)

           visited.append(start)

           return stack, visited

       #traverse all the branches
       for node in dag.neighbors(start):

           if node in visited:

               continue

           stack, visited = dfs(dag, node, visited, stack)

       #now, push the node if not already visited
       if start not in visited:
```


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```
            print("pushing %s"%start)

            stack.append(start)

            visited.append(start)

        return stack, visited

def topological_sort_using_dfs(dag):

        visited = []

        stack=[]

        start_nodes = [i for i in dag.nodes if dag.in_degree(i)==0]

    #      print(start_nodes)

        for s in start_nodes:

            stack, visited = dfs(dag, s, visited, stack)

        print("Topological sorted:")

        while(len(stack)!=0):

            print(stack.pop(), end=" ")

dag = nx.digraph.DiGraph()
dag.add_nodes_from(['A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I'])
dag.add_edges_from([('A', 'B'), ('A', 'E'), ('B', 'D'), ('E', 'C'),
```


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```
                    ('D', 'G'), ('C', 'G'), ('C', 'I'), ('F', '
I')])
topological_sort_using_dfs(dag)
topological_sorting = nx.topological_sort(dag)
print()
for n in topological_sorting:
    print(n, end=' ')
```

```
PS C:\Users\fagge\Documents\CS591> python -u "c:\Users\fagge\Documents\CS591\DFS5.py"
pushing D
pushing B
pushing C
pushing E
pushing A
pushing F
Topological sorted:
H F A E C I B D G
H F A E C I B D G
PS C:\Users\fagge\Documents\CS591>
```


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DFS6:

```
#Connected components DFS
import networkx as nx
import matplotlib.pyplot as plt

def dfs_traversal(graph, start, visited, path):
        if start in visited:
            return visited, path
        visited.append(start)
        path.append(start)
        for node in graph.neighbors(start):
            visited, path = dfs_traversal(graph, node, visited,
 path)
        return visited, path

def find_connected_components(graph):
    visited = []
    connected_components = []
    for node in graph.nodes:
        if node not in visited:
            cc = []
            visited, cc = dfs_traversal(graph, node, visited, c
c)
            connected_components.append(cc)
    return connected_components

def main():
    graph = nx.Graph()
    graph.add_nodes_from(['A', 'B', 'C', 'D', 'E', 'F', 'G', 'H
', 'I'])
    graph.add_edges_from([('A', 'B'), ('B', 'E'), ('A', 'E')])
    graph.add_edges_from([('C', 'D'), ('D', 'H'), ('H', 'F'), (
'F', 'C')])
    graph.add_edge('G', 'I')
```


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```
    nx.draw(graph, with_labels =  True, font_weight='bold')
    plt.show()

    connected_components = find_connected_components(graph)
    print(f'Total number of connected components = {len(connect
ed_components)}')

    for cc in connected_components:
        print(cc)

main()
```


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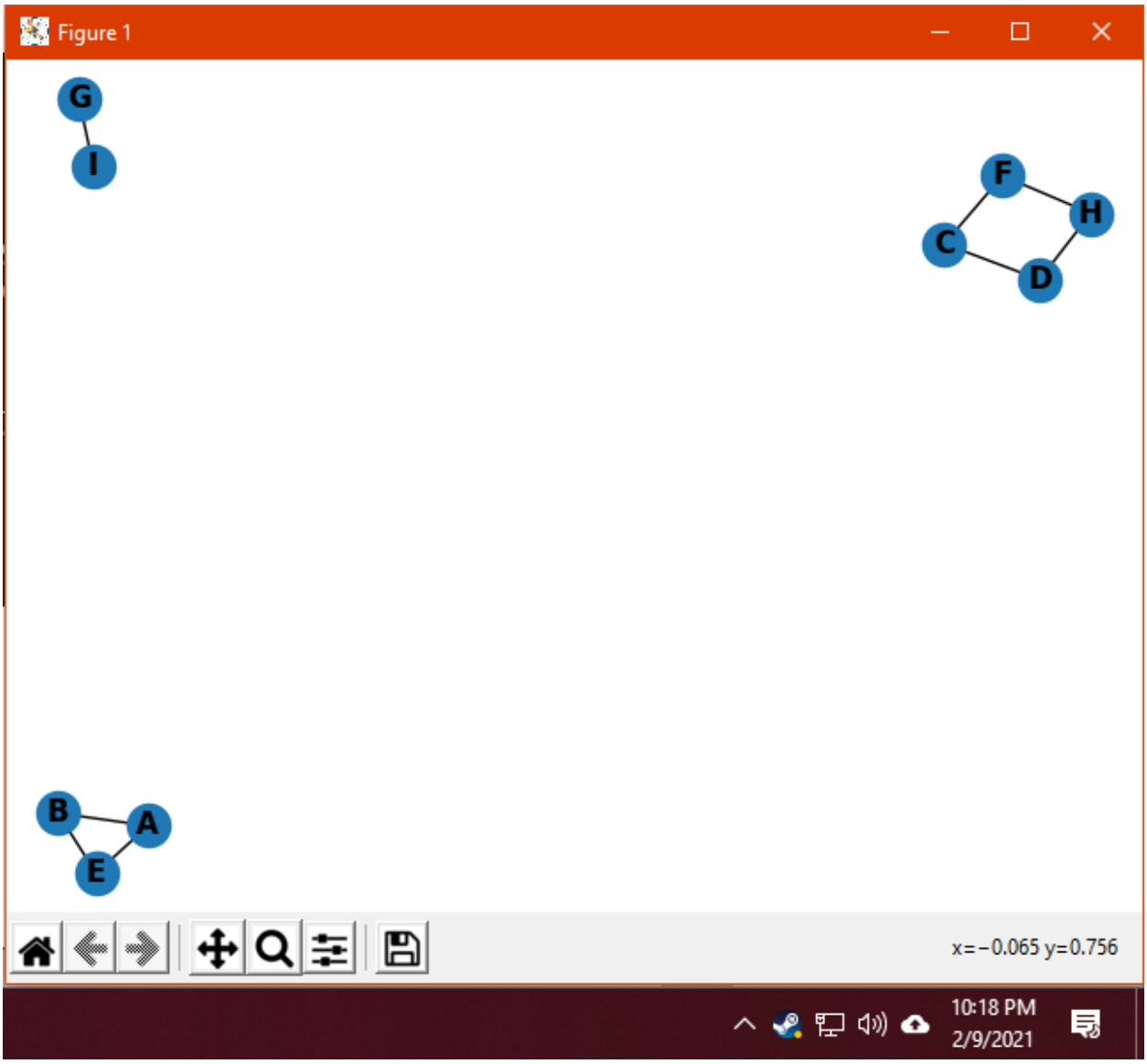


```
PS C:\Users\fagge\Documents\CS591> python -u "c:\Users\fagge\Documents\CS591\DFS6.py"
Total number of connected components = 3
['A', 'B', 'E']
['C', 'D', 'H', 'F']
['G', 'I']
PS C:\Users\fagge\Documents\CS591>
```


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Breadth First Search:

Iterative BFS:

```
#Iterative BFS
from collections import deque

class Graph:
    def __init__(self, edges, N):

        #A list of lists that represents an adjacency list
        self.adjList = [[] for _ in range(N)]

        #This adds edges to the undirected graph
        for (src, dest) in edges:
            self.adjList[src].append(dest)
            self.adjList[dest].append(src)

#Perform BFS on the graph with starting point 'v'
def BFS(graph, v, discovered):

    q = deque() #queue for BFS
    discovered[v] = True #source vertex marked discovered

    #enqueue source vertex
    q.append(v)

    #loop till queue is empty
    while q:
        #dequeue front node and print it
        v = q.popleft()
        print(v, end=' ')

        #do for every edge `v -> `u
        for u in graph.adjList[v]:
```


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```
            if not discovered[u]:
                #mark it as discovered and enqueue it
                discovered[u] = True
                q.append(u)

if __name__ == '__main__':
    edges = [
        (1, 2), (1, 3), (1, 4), (2, 5), (2, 6), (5, 9),
        (5, 10), (4, 7), (4, 8), (7, 11), (7, 12)
        #vertexes 0, 13, and 14 are single nodes
    ]
    N = 15

    graph = Graph(edges, N)

    discovered = [False] * N

    for i in range(N):
        if not discovered[i]:
            BFS(graph, i, discovered)
```

```
PS C:\Users\fagge\Documents\CS591> python -u "c:\Users\fagge\Documents\CS591\Assignment2\tempCodeRunnerFile.py"
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
PS C:\Users\fagge\Documents\CS591>
```


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Recursive BFS:

```
#Recursive BFS Implementation
from collections import deque

class Graph:
    def __init__(self, edges, N):
        self.adjList = [[] for _ in range(N)]

        #add edges to the undirected graph
        for (src, dest) in edges:
            self.adjList[src].append(dest)
            self.adjList[dest].append(src)

#Perform BFS recursively on the graph
def recursiveBFS(graph, q, discovered):
    if not q: return

    #dequeue front node and print it
    v = q.popleft()

    print(v, end=' ')

    #do for every edge `v -> `u
    for u in graph.adjList[v]:
        if not discovered[u]:
            #mark it as discovered and enqueue it
            discovered[u] = True
            q.append(u)
    recursiveBFS(graph, q, discovered)

if __name__ == '__main__':
    #List of Graph edges:
    edges = [
        (1, 2), (1, 3), (1, 4), (2, 5), (2, 6), (5, 9),
```


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```
        (5, 10), (4, 7), (4, 8), (7, 11), (7, 12)
    ]

    N = 15
    #build a graph from edges
    graph = Graph(edges, N)

    discovered = [False] * N

    q = deque()

    for i in range(N):
        if not discovered[i]:
            discovered[i] = True

            q.append(i)

            recursiveBFS(graph, q, discovered)
```

```
PS C:\Users\fagge\Documents\CS591> python -u "c:\Users\fagge\Documents\CS591\Assignment2\BFSRecursive.py"
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
PS C:\Users\fagge\Documents\CS591>
```


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