

## TCS-409

### Tutorial 5

<u>Q1</u>	<u>BFS</u>	<u>DFS</u>
	<ul style="list-style-type: none"><li>• Stands for Breadth first search</li><li>• BFS uses queue to find the shortest path.</li><li>• BFS is better when target is closer to source.</li><li>• BFS is slower than DFS.</li></ul>	<ul style="list-style-type: none"><li>• Stands for Depth first search</li><li>• It uses stack to find shortest path.</li><li>• DFS is better when target is far from source.</li></ul>

### Application of DFS

- Using DFS we can find path between two vertices.
- We can perform topological sorting which is used to scheduling jobs.
- We can use DFS to detect cycles.
- Using DFS, we can find strongly connected components of a graph.

### Application of BFS

- BFS is also used to detect cycles.
- Finding shortest path & minimal spanning tree in unweighted graph.

- In networking, finding a route for packet transmission.
- Finding a route through GPS navigation system.

Q2 Breadth first search uses queue data structure. In BFS you mark any node in the graph as source node and start traversing from it. BFS traverse all the nodes in the graph and keeps marking them as completed. BFS visited an adjacent unvisited node marks it as done and insert it into queue.

Q3 Sparse Graph - A graph in which the number of edges is much less than the possible number of edges.  
Dense Graph - A dense graph is a graph in which the number of edges is close to the maximal no. of edges of edges.

- If the graph is sparse, we should store it as list of edges.
- If a graph is dense we should store it as adjacency matrix.

Ques-4

Sol<sup>n</sup> DFS can be used to detect cycle in a Graph.  
DFS for a connected graph produces a tree. There is a cycle in a graph only if there is a back edge present in the graph. A back edge is an edge that is from a node to itself or one of its ancestors in the tree produced by DFS.

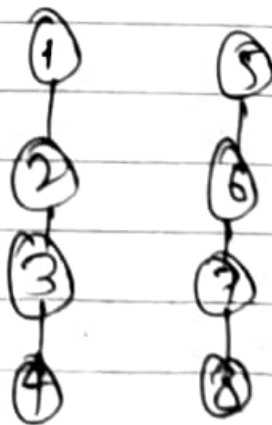
BFS can also be used to detect cycles. Just perform BFS while keeping a list of previous nodes at each <sup>node</sup> visited or else constructing a tree from the starting node. If I visit a node that is already marked by BFS, I found a cycle.

Ques

Soln Disjoint set Data Structure:

- It allows to find out whether the two elements are in the same set or not efficiently.
- A disjoint set can be defined as the subsets when there is no common element between the two sets.

E.g:  $S_1 = \{1, 2, 3, 4\}$   
 $S_2 = \{5, 6, 7, 8\}$



operations performed:

i) find:

```
int find (int v)
```

```
{ if (v == parent[v])  
    return v;
```

```
return parent[v] = find (parent[v]);  
}
```

Union:

```
void union (int a, int b)
```

```
{ a = find(a)  
  b = find(b)
```

```
if (a != b)
```

```
{ if (size[a] < size[b])
```

```
    swap (a, b) }
```

```
parent [b] = a;
```

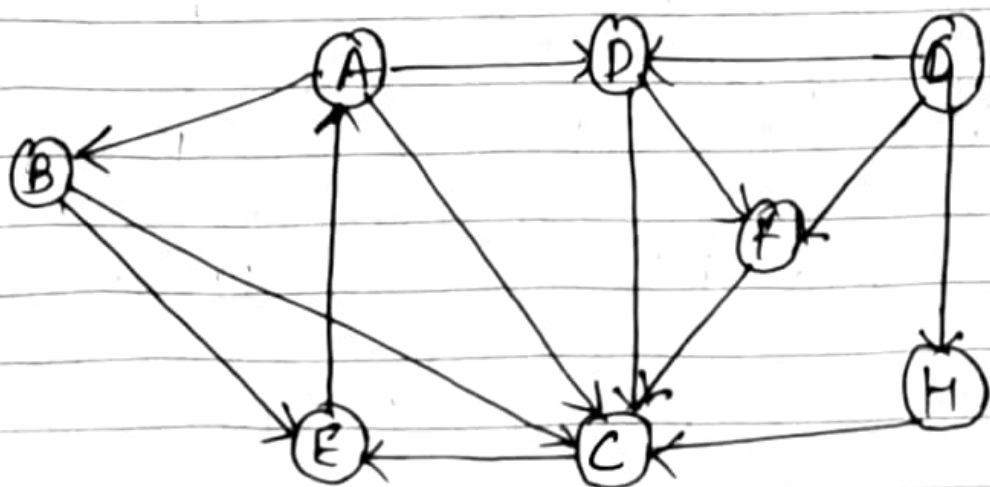
```
size[a] += size[b];
```

```
}
```

```
}
```

Qw-6

Sol<sup>n</sup>:



BFS: Node : (B) (E) (C) (A) (D) (F)  
 parent: - B B E A D

path:  $B \rightarrow E \rightarrow A \rightarrow D \rightarrow F$

DFS:  
 Node processed B B C E A D F  
 stack B CE EE AE DE FE E

path:  $B \rightarrow C \rightarrow E \rightarrow A \rightarrow D \rightarrow F$

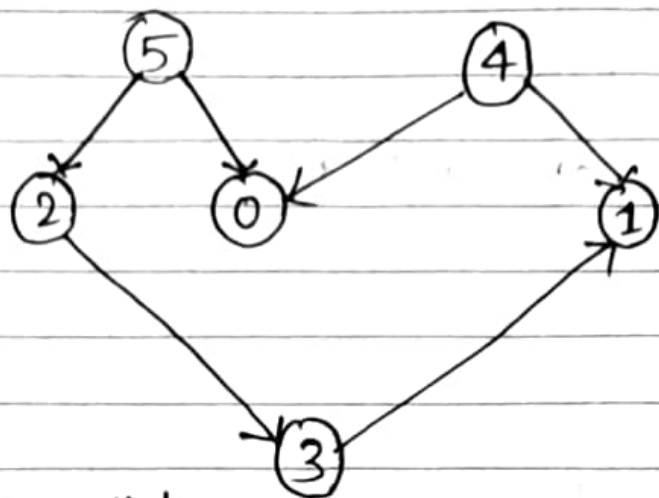
Ques 7

Soln:  $V = \{a, b, c, d, e, f, g, h, i, j\}$   
 $E = \{a, b, c, a, c, b, c, d, e, f, e, g, h, i, j\}$

(a, b)		$\{a, b, c, d, e, f, g, h, i, j\}$
(a, c)		$\{a, b, c, d, e, f, g, h, i, j\}$
(b, c)		$\{a, b, c, d, e, f, g, h, i, j\}$
(b, d)		$\{a, b, c, d, e, f, g, h, i, j\}$
(e, f)		$\{a, b, c, d, e, f, g, h, i, j\}$
(e, g)		$\{a, b, c, d, e, f, g, h, i, j\}$
(h, i)		$\{a, b, c, d, e, f, g, h, i, j\}$

No. of connected components = 3.

Ques  
Soln.



Adjacency list.

0 →  
1 →  
2 → 3  
3 → 1  
4 → 0, 1  
5 → 2, 0

visited:

0	1	2	3	4	5
false	false	false	false	false	false

stack (empty)

Step 1: Topological sort(0), visited[0] = true

Stack [0]

Step 2: Topological sort(1), visited[1] = true.

Stack [0, 1]

Step 3: Topological sort(2), visited[2] = true

Topological sort(3), visited[3] = true.

Stack [0, 1, 3, 2]

Step 4:

Stack [0, 1, 3, 2, 4]

Step 5:

Stack 

0	1	3	2	4	5
---	---	---	---	---	---

Step 6: Print all elements of stack from top to bottom

→ 5, 4, 2, 3, 1, 0

Ques-9

Sol<sup>n</sup>: Algorithms that use Priority Queue:

- (i) Dijkstra's Shortest path Algorithm using priority Queue.  
When graph is stored in the form of list or matrix, priority queue can be used to extract minimum efficiently when implementing Dijkstra's Algo.
- (ii) Prim's Algorithm: It is used to implement Prim's algorithm to store key of nodes to extract minimum key node at every step.
- (iii) Data Compression: It is used in Huffman's code which is used to compress data.

Ques-10 Min heap

- Sol<sup>n</sup>:
- In min heap the key present at root node must be less than or equal to among the keys present at all its children.
  - Uses the ascending priority.
  - The minimum key present at the root node.

Max heap

- In max-heap the key present at root node must be greater or equal to the key present at all its children.
- Uses descending priority.
- The maximum key present at the root node.