Design and Analysis of Algorithms

Tutorial-5

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Answers

Ans1. Using Breadth First Search (BFS), we can find the minimum No. of nodes between a source node and destination node, while using Depth First Search, we can find if a path exists between two nodes.

Applications of BFS - To detect cycles in a graph
- Minimum distance comparison.

Applications of DFS - To detect cycles in a graph
- To detect & compare multiple paths.

Ans2. DFS: We use stack data structure to implement Depth First Search because order doesn't have much importance.

BFS: We use queue data structure to implement Breadth First Search because order matters in this case.

Ans 3. Sparse Graph: Number of edges is close to minimal number of edges.

Dense Graph: The number of edges is close to the maximal number of edges.

Ans 4. Cycle Detection in BFS

1. Compute in-degree (No. of incoming edges) for each of the vertex present in graph and count of nodes = 0
2. Pick all the vertices with in degree as 0 & add them to queue.
3. Remove a vertex from the queue, then
   - Increment count by 1.
   - Decrease in-degree by 1 for all neighbours.
   - If in-degree of a neighbouring node is = 0 add to queue.
4. Repeat 3 until queue is empty.
5. If No. of visited nodes is not equal to No. of nodes then graph has a cycle.

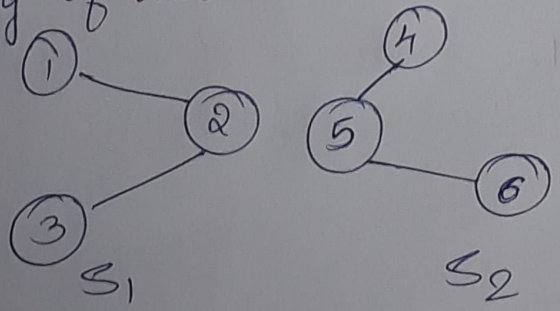
Cycle Detection using DFS.

A similar process is done in DFS as null, but in DFS, we have the option of doing recursive calls for vertices which are adjacent to the current node & are not yet visited. If recursive function return false, then graph does not have a cycle

Ans 5. Disjoint Set Data Structure.

It is a data structure that is used in various aspects of cycle detection. This is literally a grouping of two or more disjoint sets.

Eg.



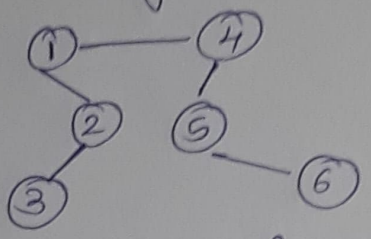
$S_1 = \{1, 2, 3\}$

$S_2 = \{4, 5, 6\}$

Operations

1. Union - Merge two sets when edge is added.

$S1 \cup S2 = S3$ →



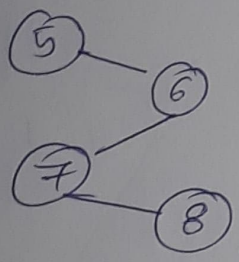
2. Find ( ) tells which element belongs to which set -

Find (1) = S_1 | Find (4) = S_2.

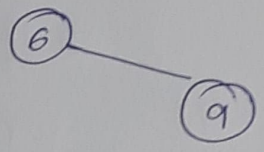
3. Intersection - Output another set as common elements

$S1 \cap S2 = \{\phi\}$, $S4 \cap S5 = \{6\}$

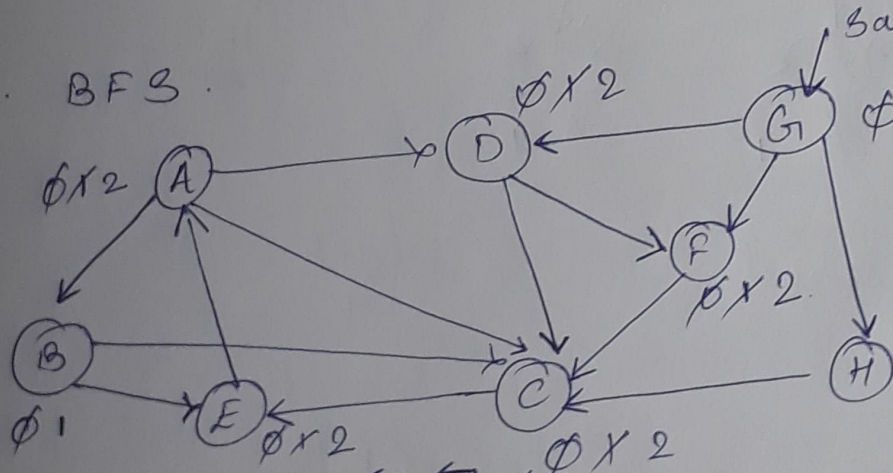
S_4



S_5 =



(Ans 6. BFS.

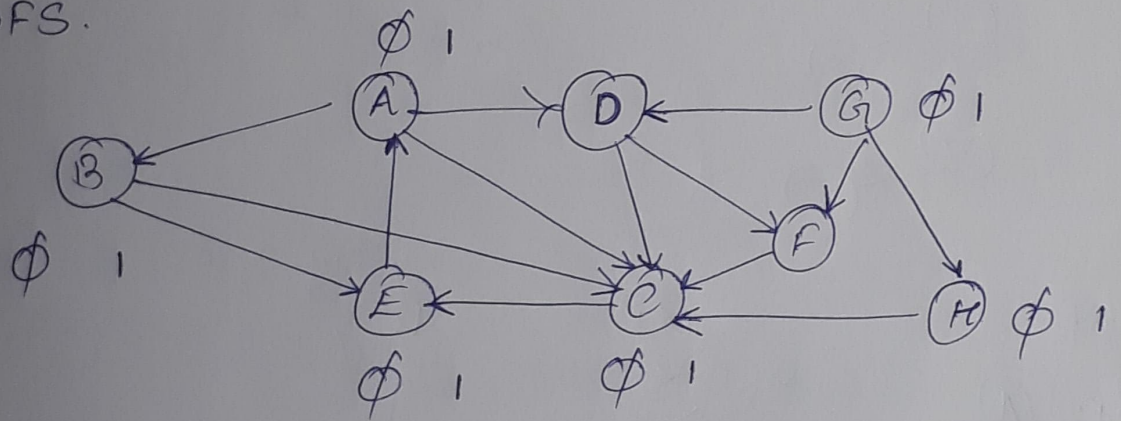


Node ← G H F D C E A B. All nodes visited from source G.

Parent — G G G H C E A.

Source	Destination	Path
G	A	G → H → C → E → A
G	B	G → H → C → E → A → B
G	C	G → H → C
G	D	G → D
G	E	G → H → C → E
G	F	G → F.
G	H	G → H.

DFS.



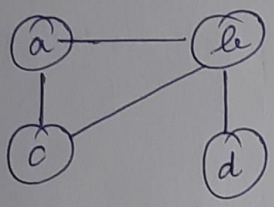
Node Processed	Stack.
	G
G	DF H.
D	CF H
C	E F H
E	A F H.
A	B F H.
B	F H.
F	H
H	—

Only to empty the stack.

Source	Destination	Path
G	A	G → D → C → E → A.
G	B	G → D → C → E → A → B.
G	C	G → D → C.
G	D	G → D
G	E	G → D → C → E
G	F	G → F.
G	H	G → H.

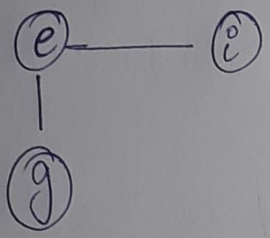
Ans 7.

(i)



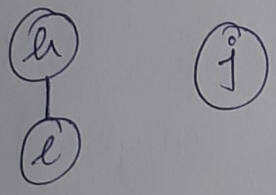
No. (v) = 4
No. (cc) = 1

(ii)



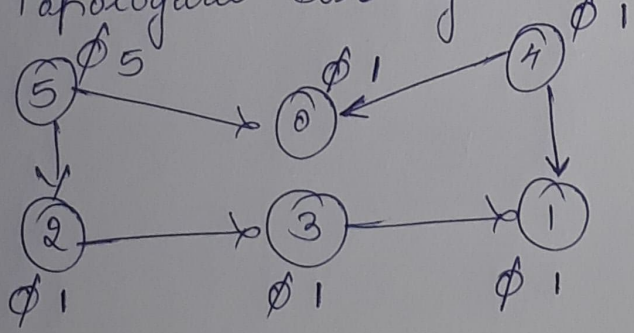
No. (v) = 3
No. (cc) = 1

(iii)



No. (v) = 3
No. (cc) = 2.

Ans 8. Topological Sorting



Adjacency List

0 →
1 →
2 → 3
3 → 1
4 → 0, 1
5 → 2, 0

Stack

0	1	3	2	4	5

Head →

Topological : 5 4 2 3 1 0

DFS Stack → | 4 | 0 | 1 | 3 | 2 | 5 | Head →

DFS → 5 → 2 → 3 → 1 → 0 → 4.

Ans 9. Application of Priority queue.

(i) Dijkstra's Algorithm - We need to use a priority queue here so that minimal edges can have higher priority.

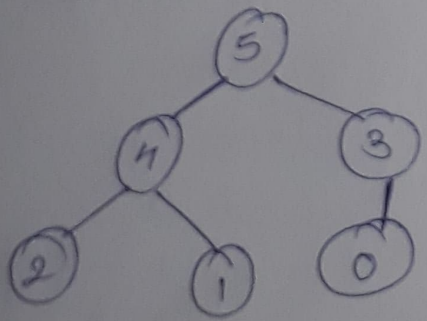
(ii) Load Balancing - Load balancing can be done from branches of higher priority to those of lower priority.

(iii) Interrupt Handling - To provide proper numerical priority to more important interrupts.

(iv) Huffman Code - For data compression in Huffman code.

Ans 10. Max Heap where parent is bigger than both childs.

Eg.



Min Heap : Where parent is smaller than both 7 childs

Eg.