Computer Science & IT

Data Structure & programming

Graph & Hashing

Lecture No. 01

By- Abhishek Sir

Recap of Previous Lecture

- Topic — Heap adjust
- Topic — Counting
- Topic — Build Heap / Heapify
- Topic
- Topic

Slide

Topics to be Covered

- Topic — Graph Representation
- Topic — BFS traversal.
- Topic
- Topic
- Topic

Slide

Topic : Graph

Graph : $G(V, E)$ Set of vertices & Set of edges between pair of vertices.

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Topic : Graph

$G(V, E)$

$V = \{1, 2, 3, 4, 5\}$

$E = \{(1,2), (1,3), (2,4), (3,4), (4,5)\}$

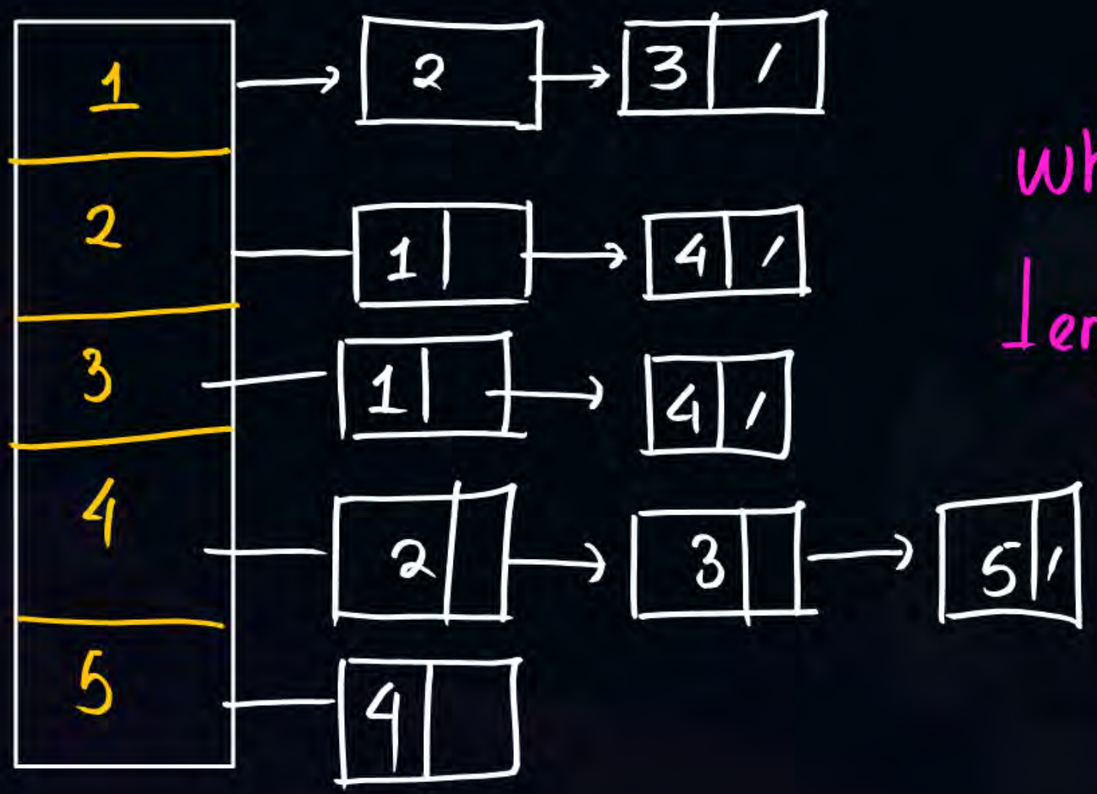
Graph Representation

1. Adjacency List
2. Adjacency Matrix

Slide

Topic : Graph

Adjacency List :



Array of Linked list of Adjacent Node

What will be the length of linked list? (degree of Node)

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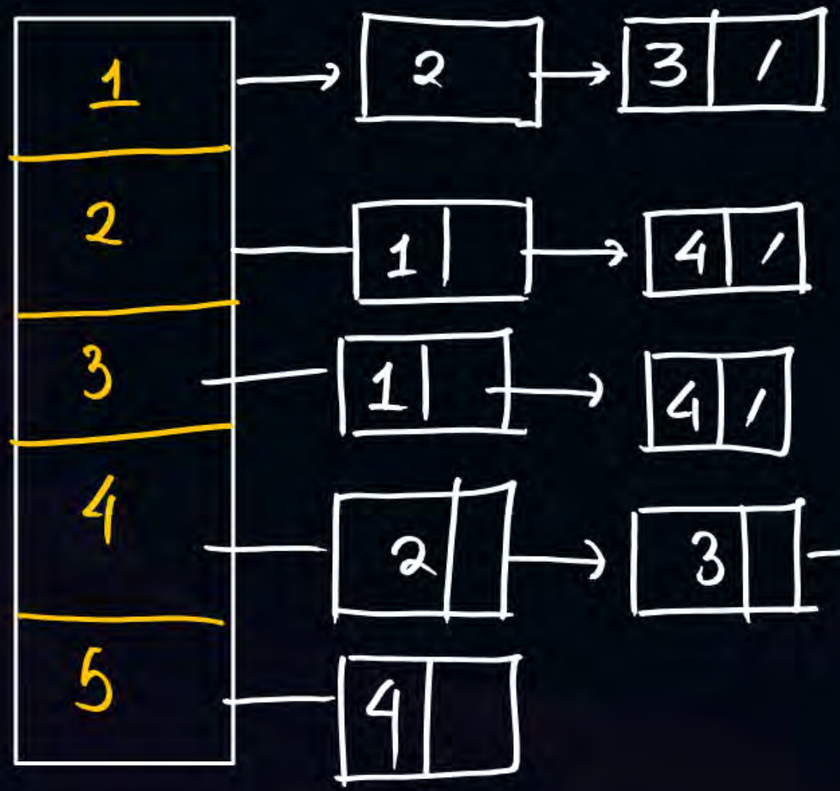
Topic : Graph

Adjacency List :



Space

|V| = Node

No. of Node

+ Sum of all list

$|V| + \sum deg(v_i)$

$(|V| + 2E)$

$= O(\quad)$

Slide

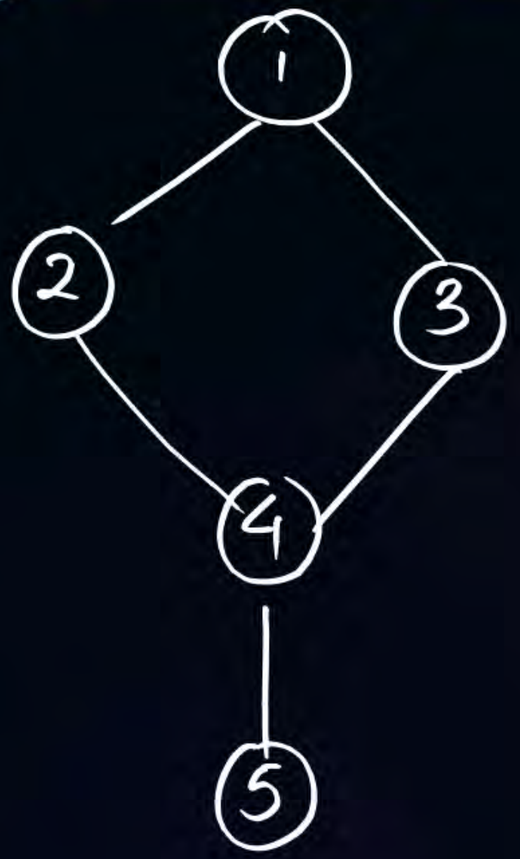
Topic : Graph

Adjacency list is used when graph is sparse

Less No. of edges.

Slide

Topic : Graph



Adjacency Matrix M is used to represent the graph

$M[i,j] = 1 \quad (i,j) \in E$ otherwise 0

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

M[i,j] is Symmetric

$M[i,j] = M^T[i,j]$

Slide

Topic : Graph

|V| is No. of Node

Space in Adjacency Matrix = V * V = V^2

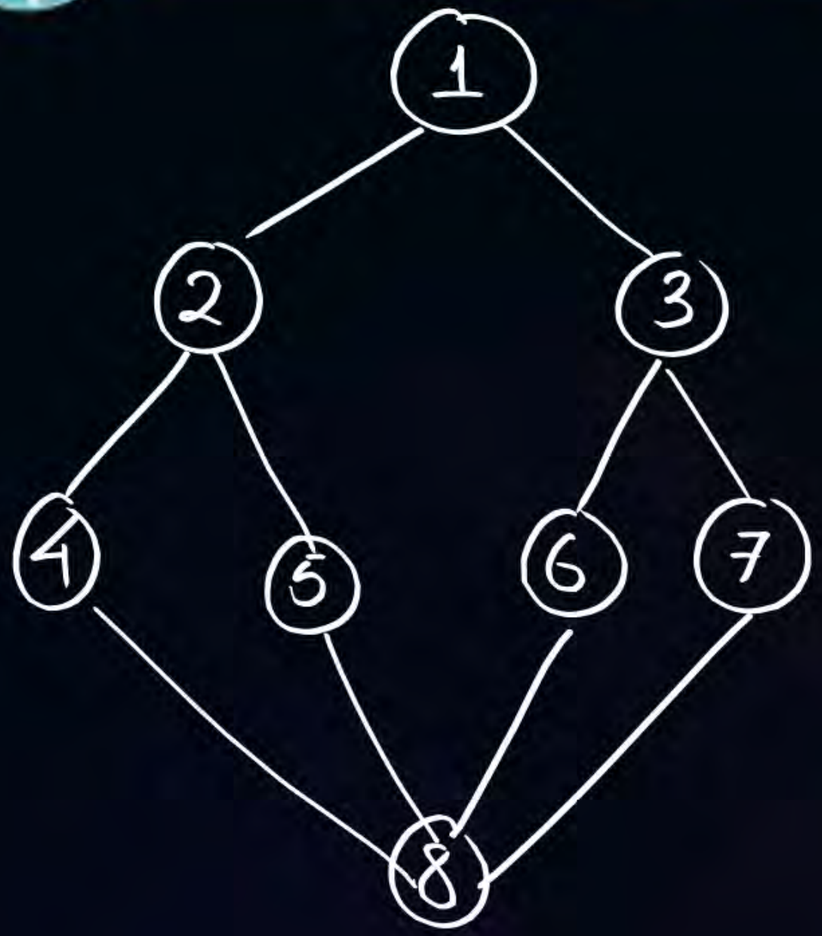
Topic : Graph

Graph Traversal : visiting Nodes of graph

* BFS (Breadth first Search)
* DFS (Depth first Search) ← Algorithm

Slide

Topic : Graph



In BFS, after visiting a Node x Adjacent Node of x is visited.

to maintain the order data structure queue is used.

Slide

Topic : Graph

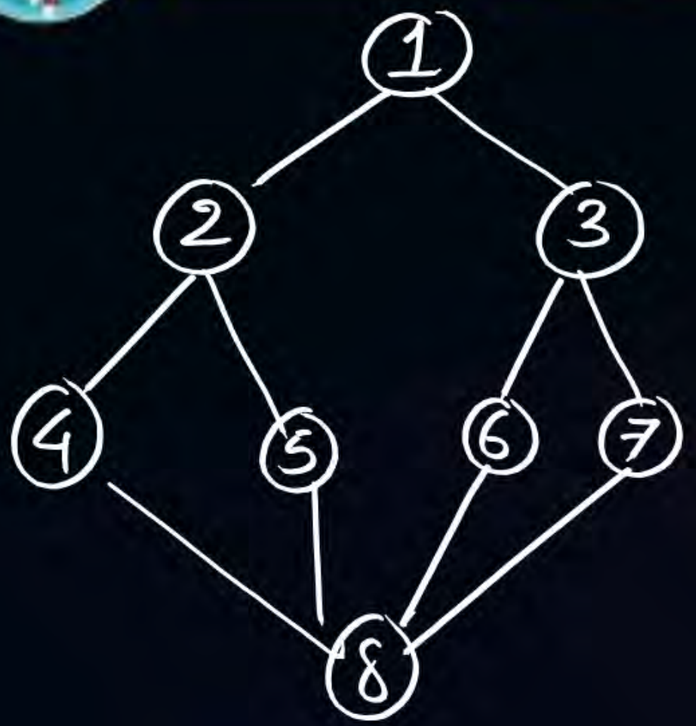
Queue

Adjacent Node is visited and to maintain order we insert in queue

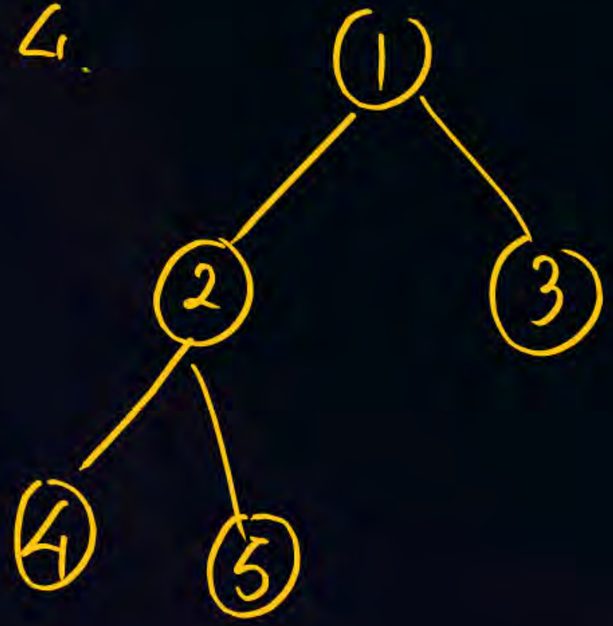
3
2

Slide

Topic : Graph



4.



Queue

3
2

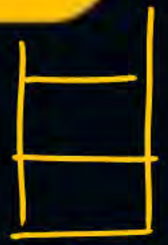
delete 2 visit adjacent Node 2 put them in Q

5
4
3

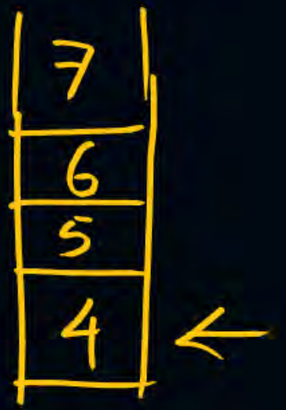
if queue is empty then stop else delete element from Q and visit adjacent Node if they are Not visited and put them in queue

Slide

Topic : Graph



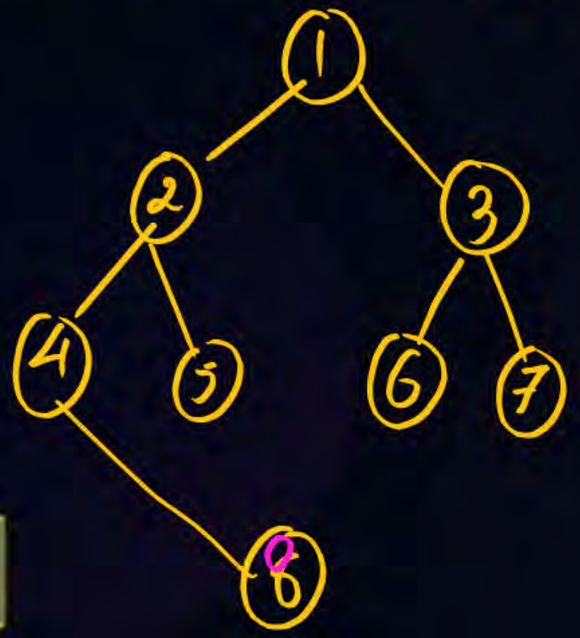
Queue



delete 2 from Q and visit adjacent Node if Not visited and put them in Q

Slide

Topic : Graph



← Since 2 is already visited we will not put in queue again

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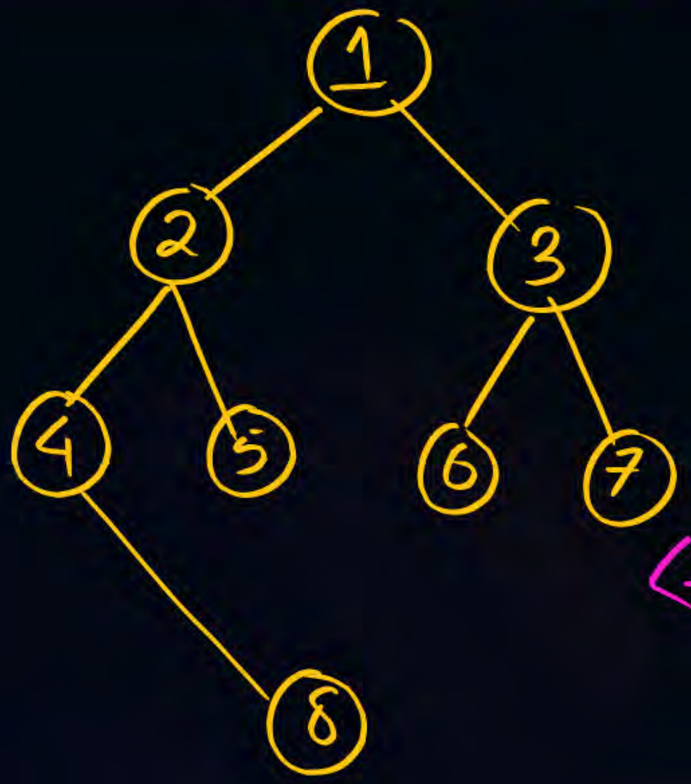
Topic : Graph



Since all Node are visited vertex in Q will be deleted & No new vertex will be added.

BFS tree

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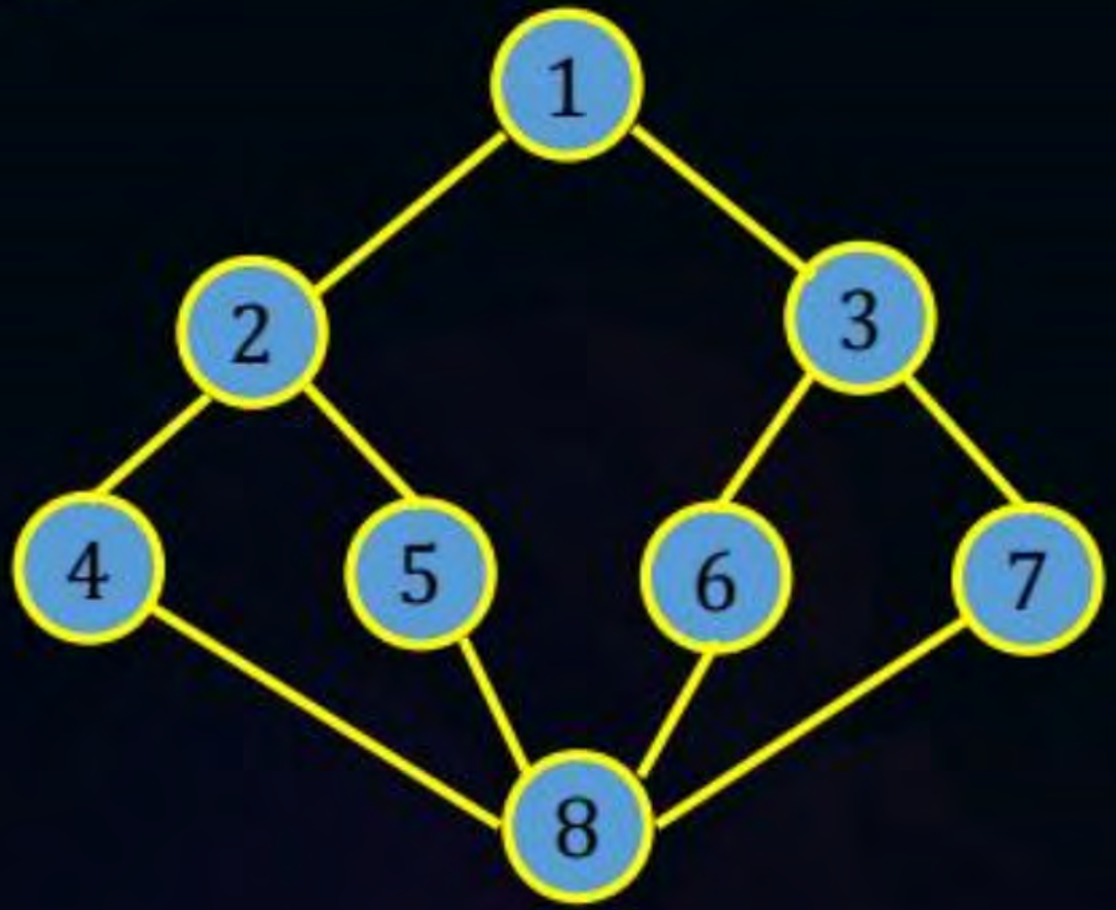
Topic : Graph



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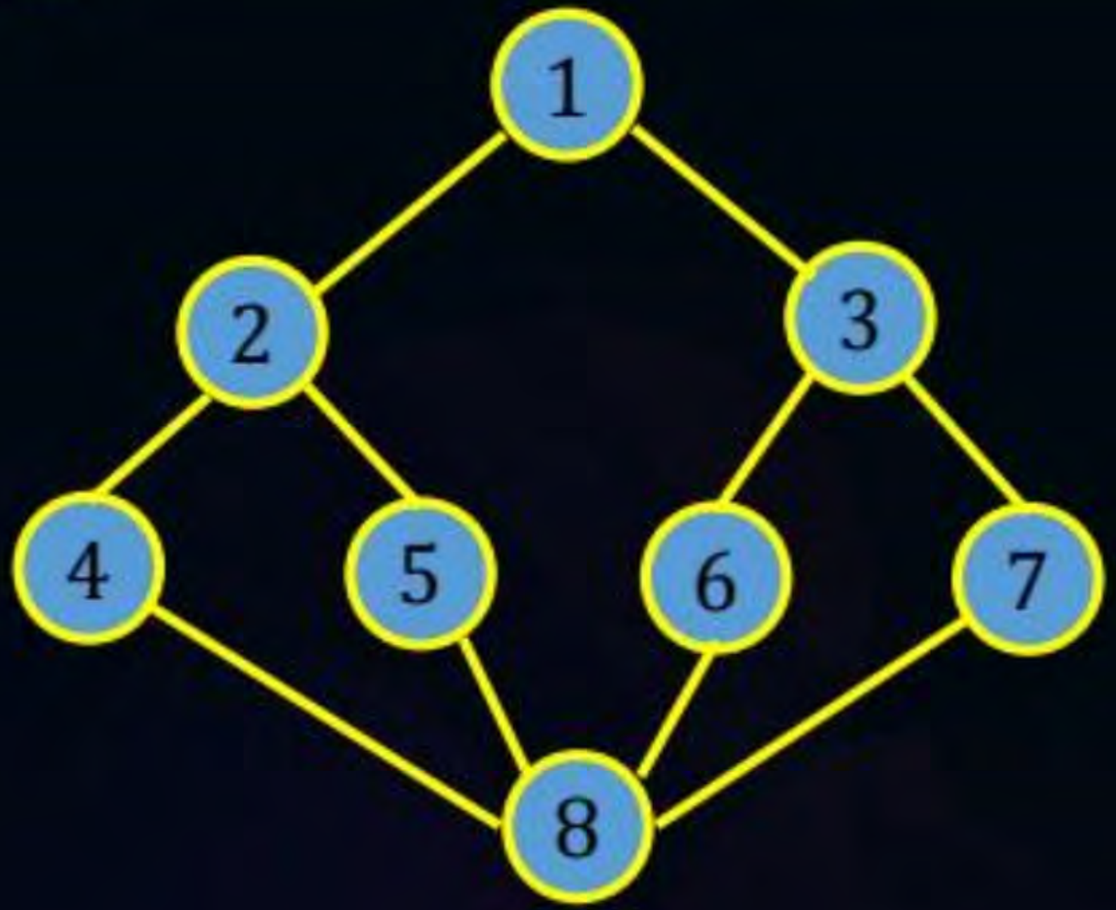
Topic : Graph



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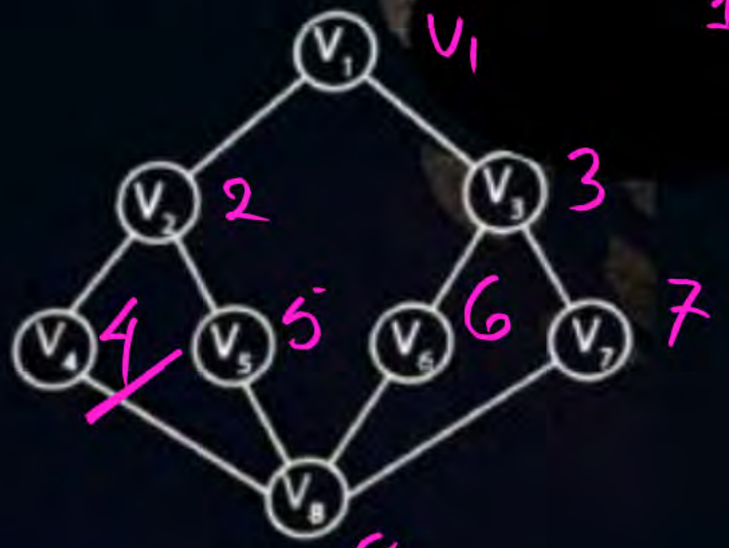
Question

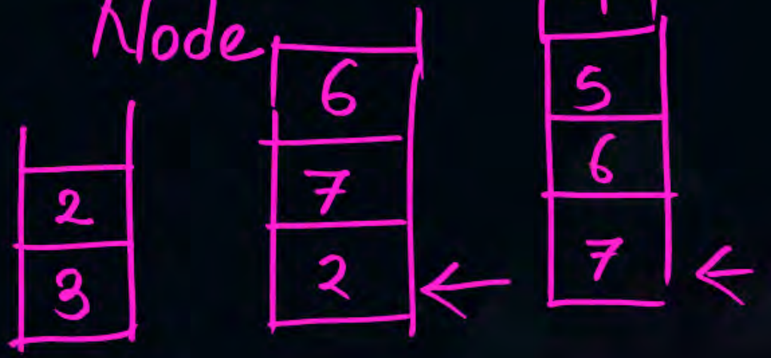
Consider the following graph:



1, 2, 3

[D]

Visit adjacent Node



Identify valid **BFS** search sequence

(a) 1, 3, 2, 5, 4, 7, 6, 8

(b) 1, 2, 3, 6, 7, 4, 5, 8

(c) 1, 2, 3, 4, 6, 7, 5, 8

(d) 1, 3, 2, 7, 6, 5, 4, 8

Slide

Question

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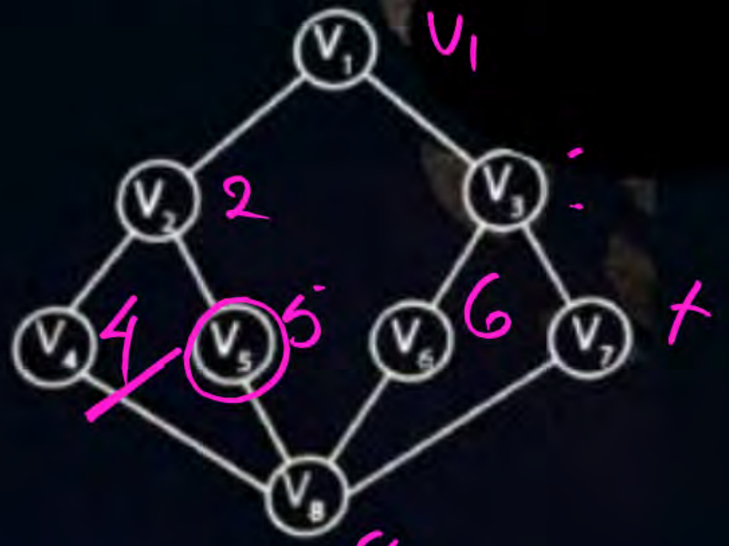

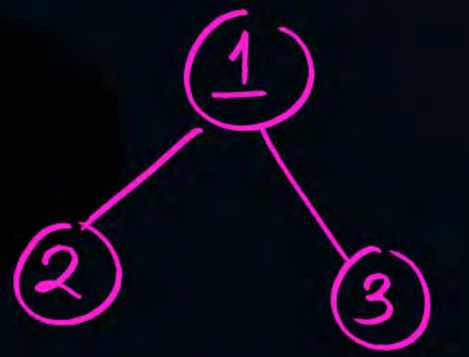

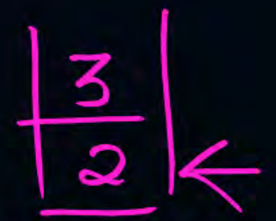

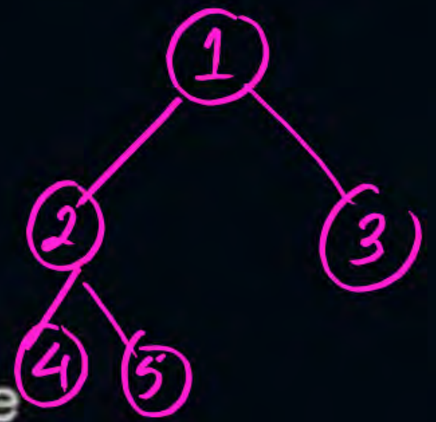

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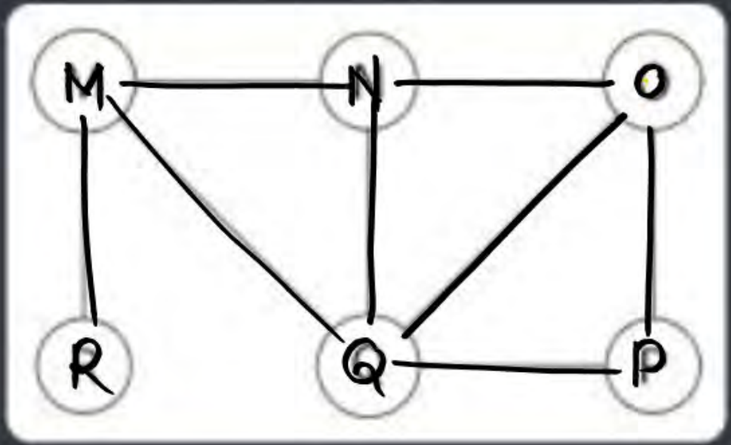
Slide

Question

The Breadth First Search (BFS) algorithm has been implemented using the queue data structure. Which one of the following is a possible order of visiting the nodes in the graph below?



A. MNOPQR
B. NQMPOR
C. QMNROP
D. POQNMR ✓

M N O P Q R q
↑ ↑
N Q M P O R q
↑
Q M N R O P q
↑
P O Q N M R ✓

Slide

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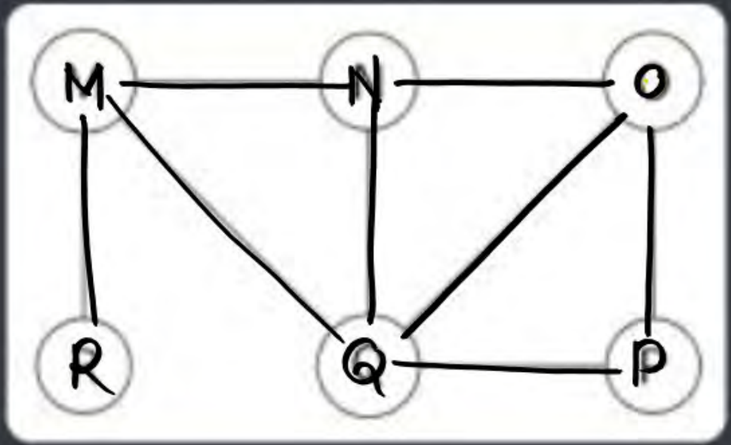

A. MNOPQR
B. NQMPOR
C. QMNROP
D. POQNMR

Slide

Question

Q. Breadth First Search (BFS) is started on a binary tree beginning from the root vertex. There is a vertex t at a distance four from the root. If t is the n^{th} vertex in this BFS traversal, then the maximum possible value of n is _____.

Question

Consider the following graph:

Identify **valid BFS** search sequence

(a) 1, 3, 2, 5, 4, 7, 6, 8

(b) 1, 2, 3, 6, 7, 4, 5, 8

(c) 1, 2, 3, 4, 6, 7, 5, 8

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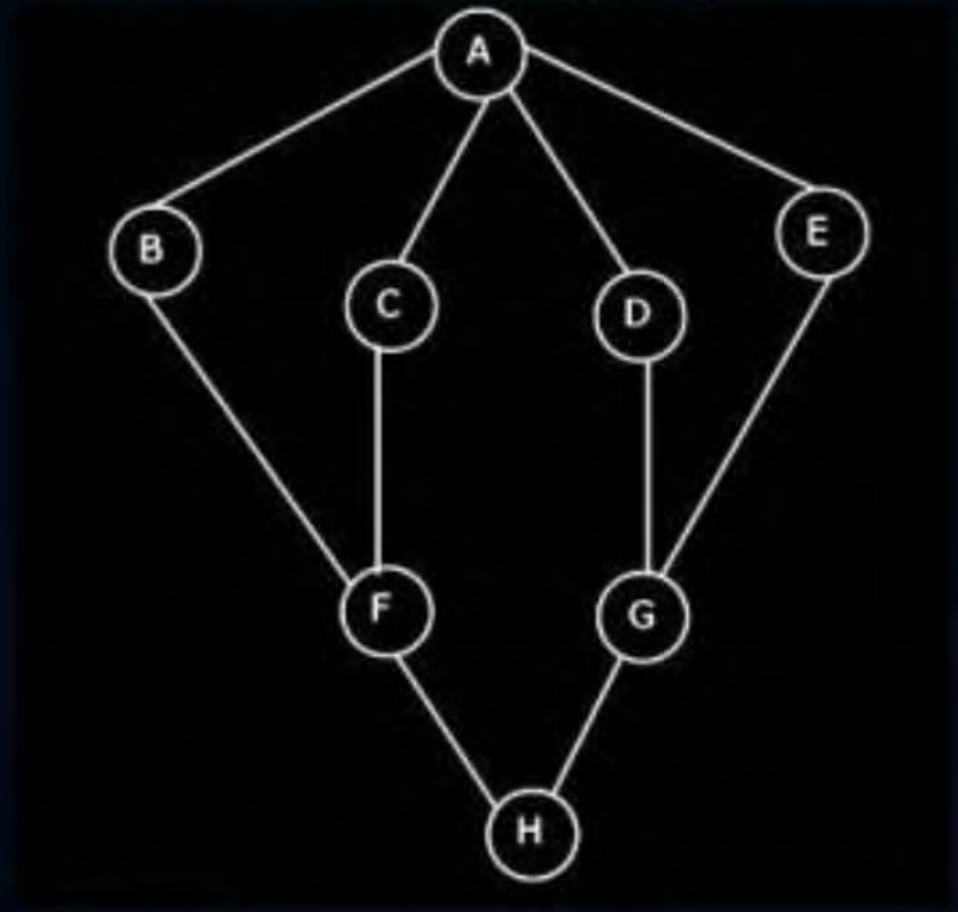
Slide

Topic : Graph

Consider the following graph



How many different breadth-first search traversals are possible considering H as a source vertex?

(A) 1

(B) 4

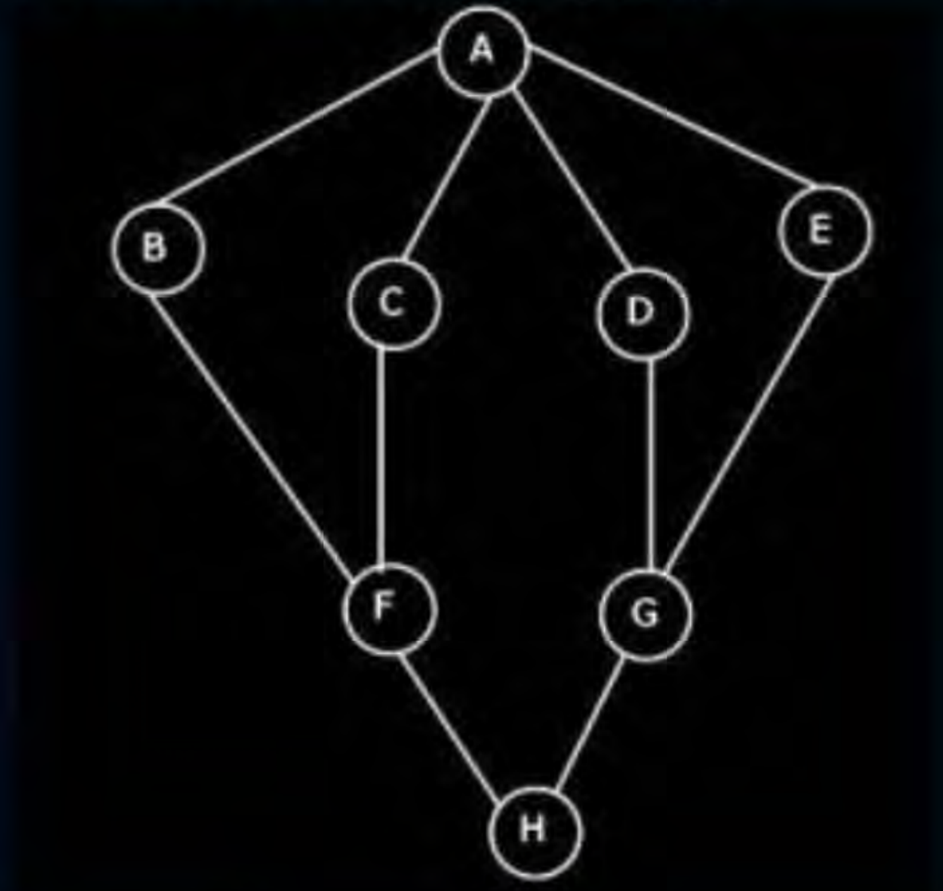
(C) 16

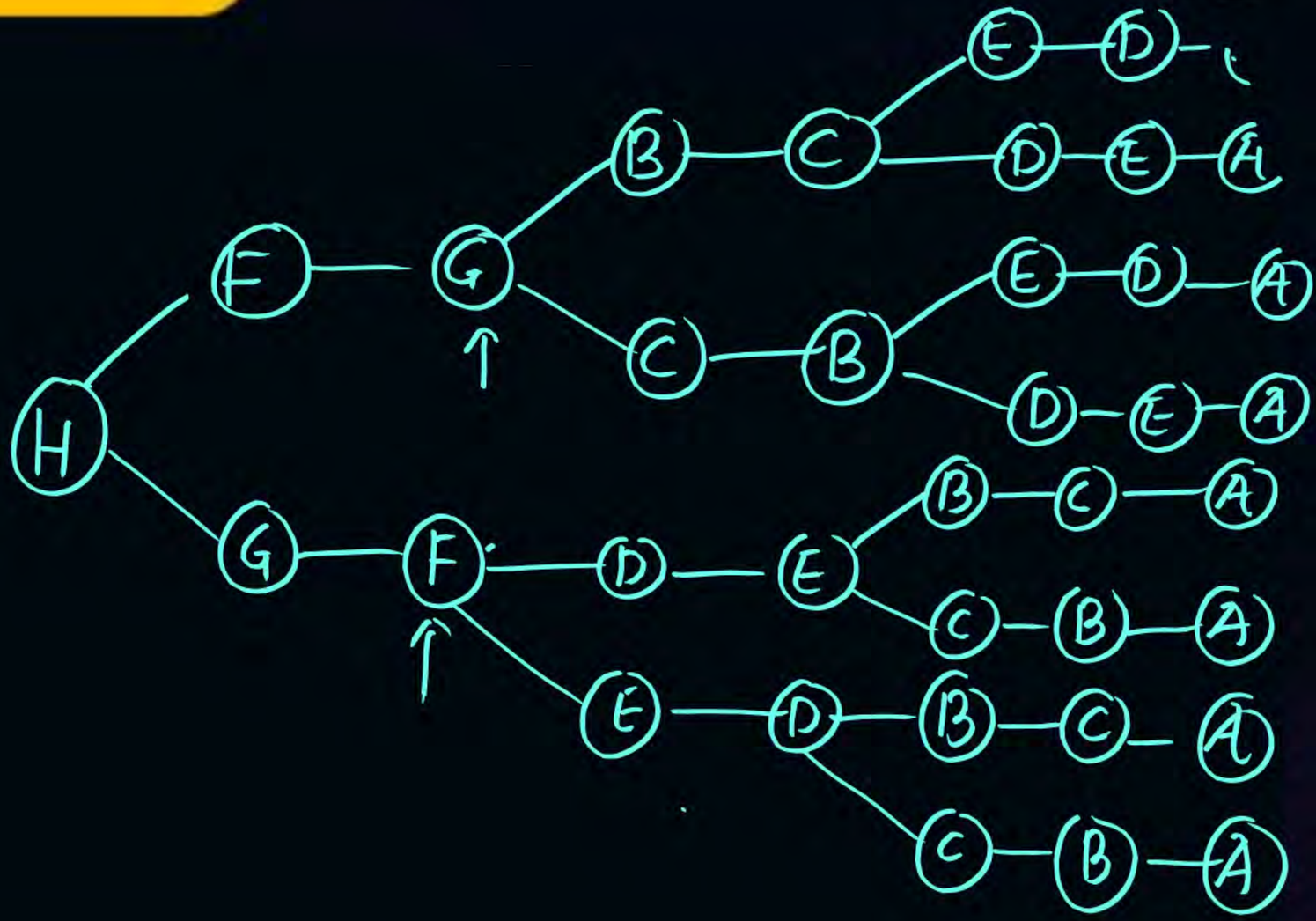
(D) 8

Slide

Topic : Graph

Consider the following graph





Slide

Question

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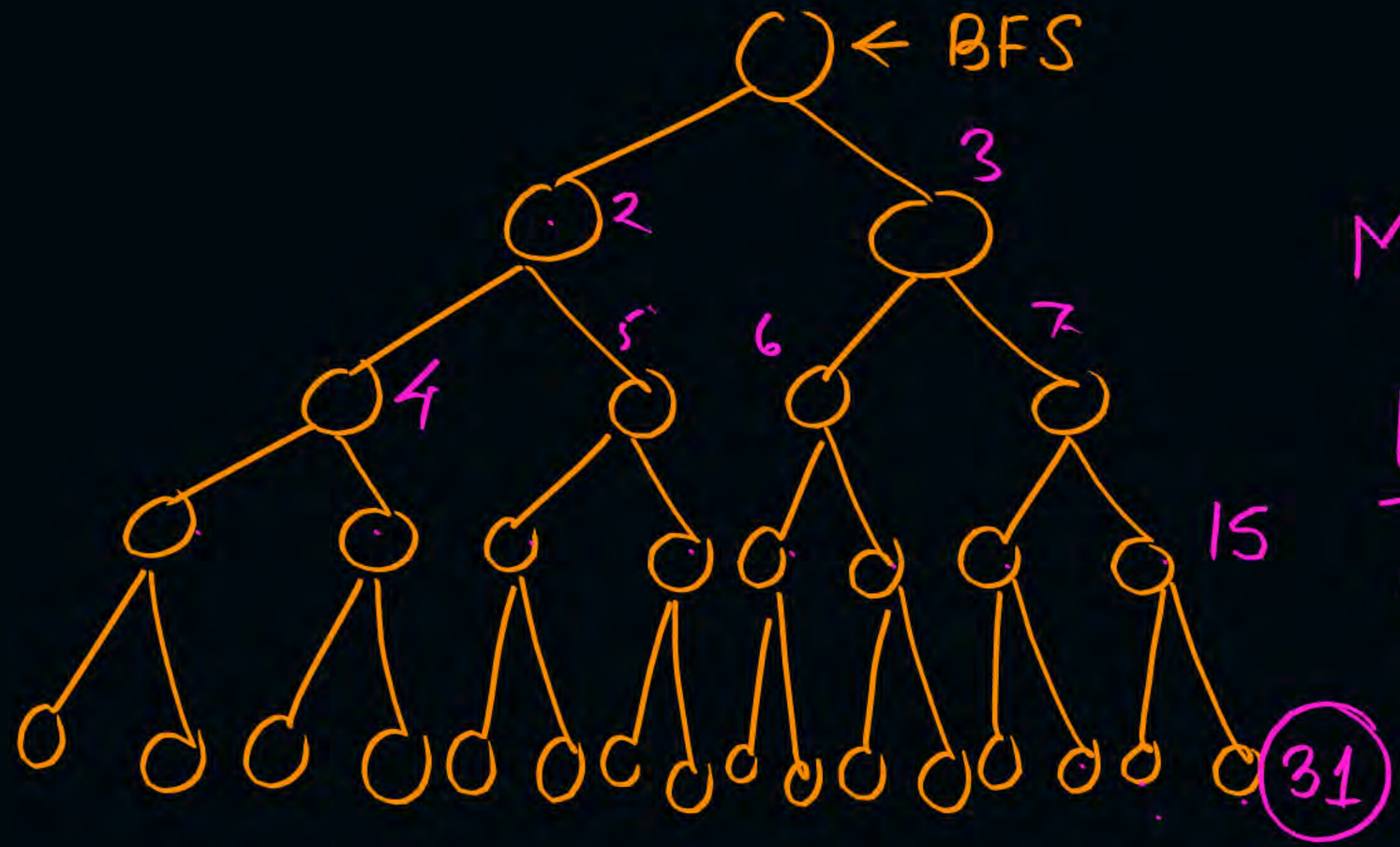
Slide



Max value

FBT

$n = 31$

Topic : Hashing

Search element in Data structure

1. Array : ordered Binay Search $O(\log_2 n)$
   unordered Linear Search $O(n)$

2. Linked List < ordered / unorder } $O(n)$

3. BST $O(h) \equiv O(n)$

4. AVL tree $O(h) \equiv O(\log_2 n)$

Slide

Topic : Hashing

Direct Addressing : We use large size of array and index of array represent key value.

Telecom company database

"9800089000"

A[9800089000]

1 key value

It requires constant time

O(1)

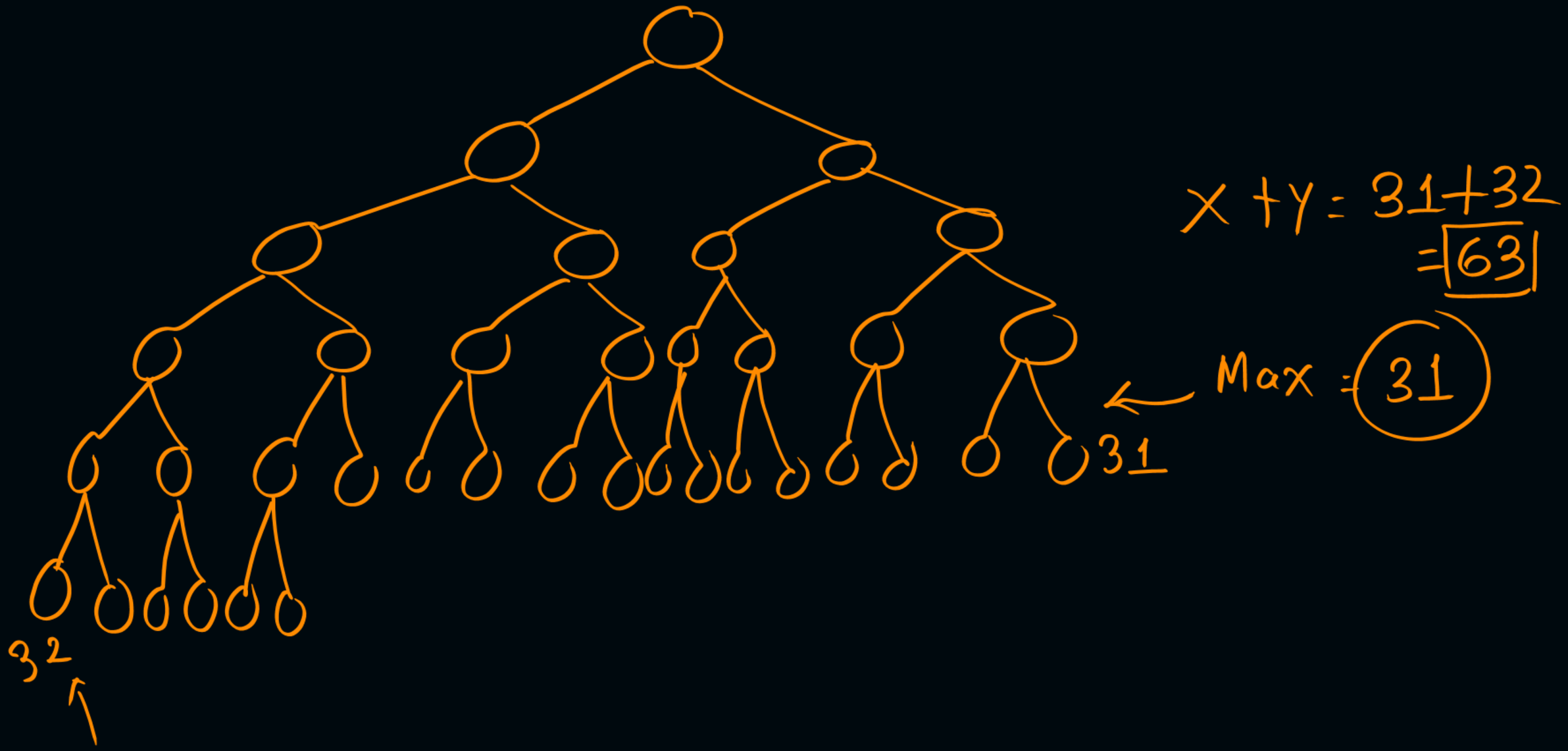
Slide

Topic : Hashing

Disadvantage : 1. Space wasted.

2. Large amount of memory required

3. Insertion Deletion


x + y = 31 + 32
= 63
Max = 31
31
32

2 mins Summary

Topic — Graph representation

Topic — Adjacency Matrix

Topic — Adjacency List

Topic — BFS

Topic — Direct Addressing

Slide

THANK - YOU

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