DATA STRUCTURES AND ITS APPLICATIONS

Basic Concept and Definitions: Trees

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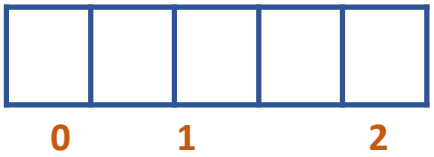
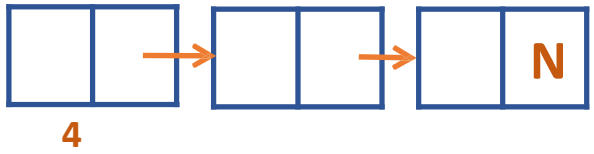
Linear Data Structures



List as an Array



List as a Linked List

Disadvantage:

- Fixed Size
  - Expansion ✗
  - Shrink ✗
- Random Insertion & Deletion is Time Consuming

Disadvantage:

- Random Access is Time consuming

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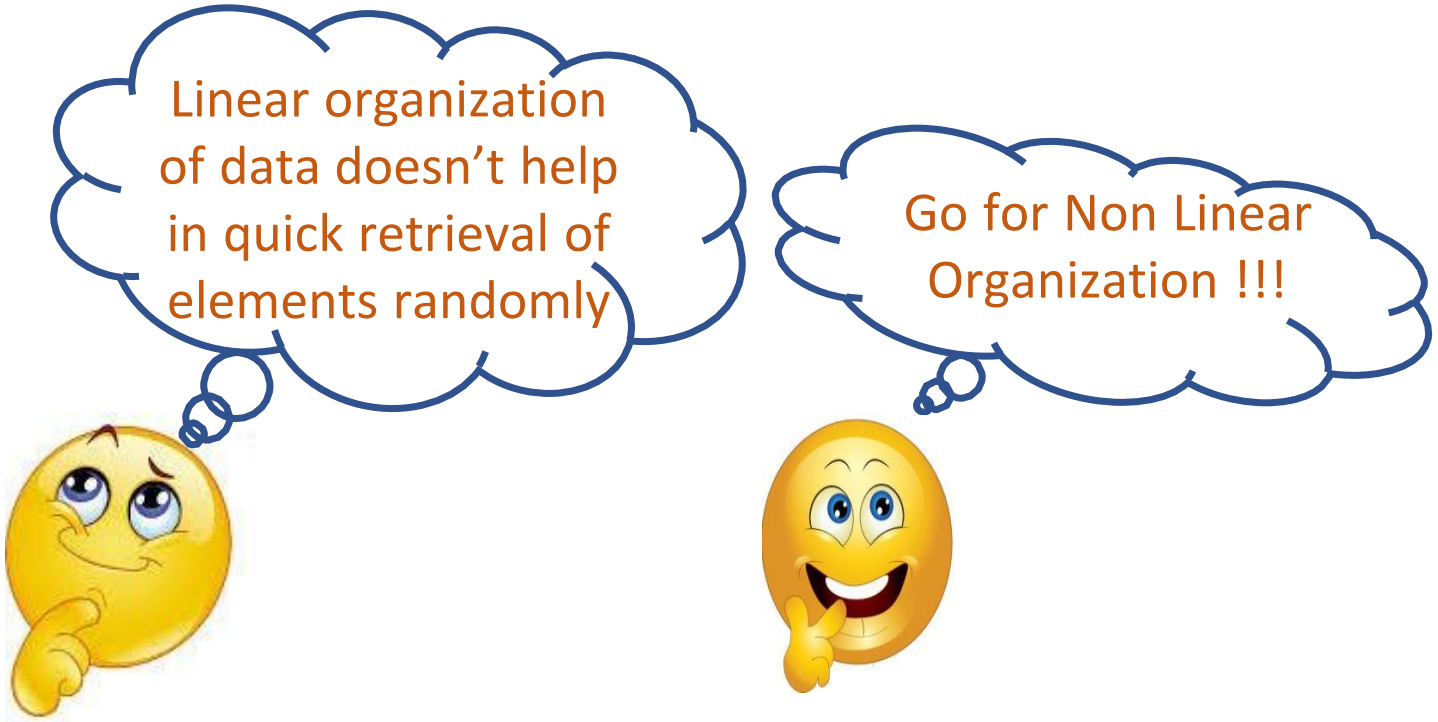
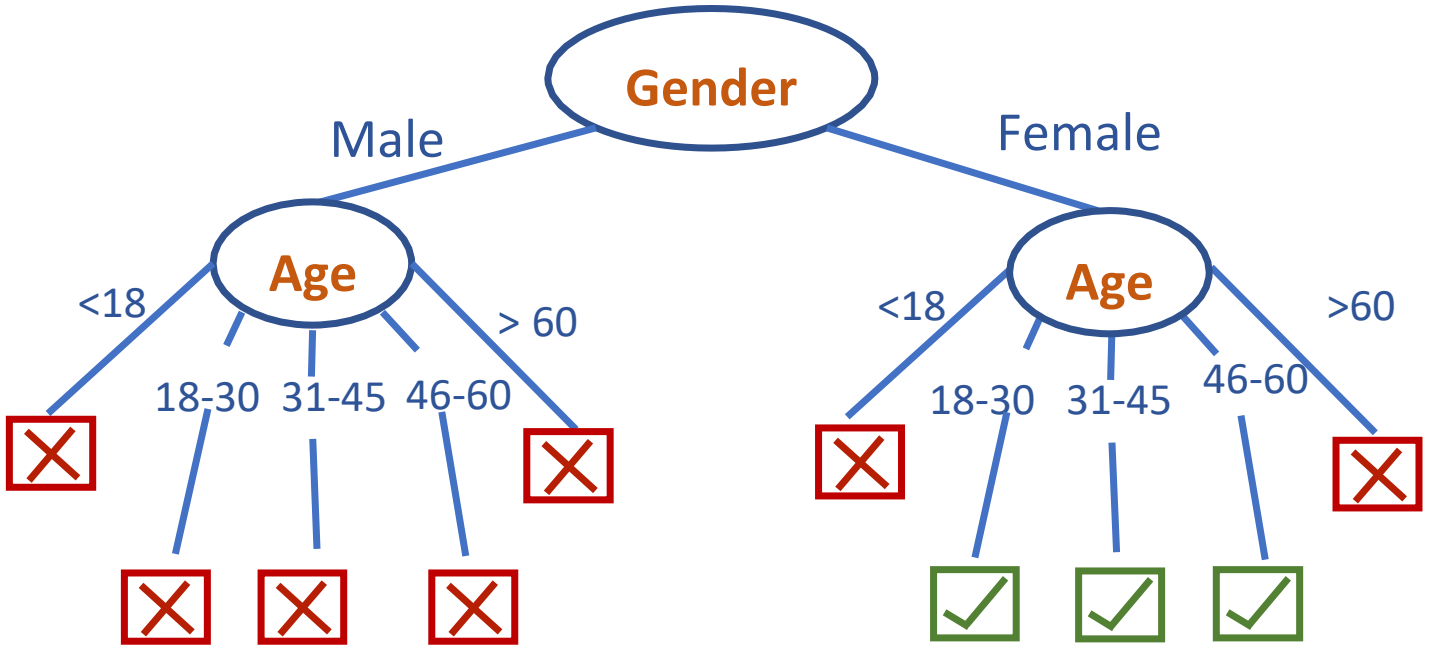
Introduction to Trees



Example: To improve the probability of purchase of Women's Formal Wear in Less Time

Name: abc Gender: M Age: 25 email id: abc@xyz.com	Name: def Gender: F Age: 21 email id: def@xyz.com	Name: ghi Gender: F Age: 10 email id: ghi@xyz.com	...	Name: pqr Gender: F Age: 60 email id: pqr@xyz.com
0	1	2	...	9999
	...	...		...
0	1	2	...	9999

Example: To improve the probability of purchase of Women's Formal Wear in Less Time



Search Not

Matched Search

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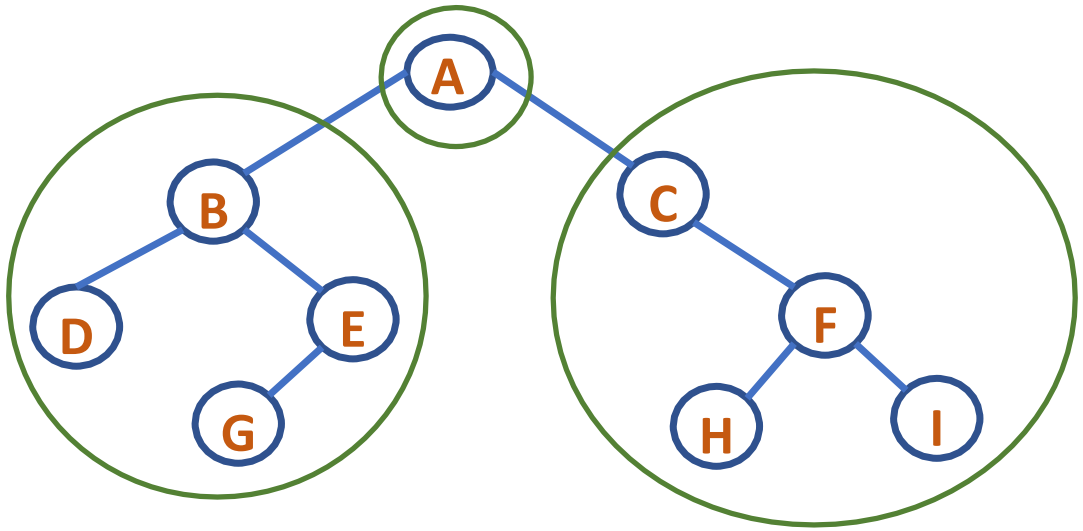
Binary Trees

- Non Linear Data Structure
- Finite set of elements that is either empty or is partitioned into three subsets
- First subset: is a single element, called the root
- Second subset: is a binary tree, called the left binary tree
- Third subset: is a binary tree, called the right binary tree



Binary Trees: Terminologies

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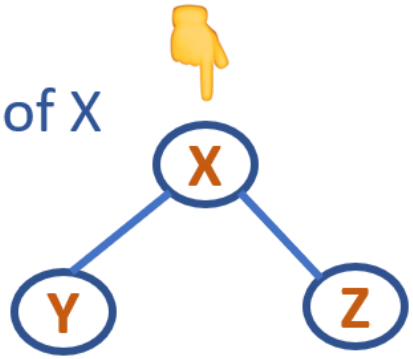
- Each element of a binary tree is called a node of the tree
- Left node Y of X is called left child of X
- Right node Z of X is called the right child of X
- X is called the parent of Y and Z
- Y and Z are called siblings



- A node which has no children is called leaf node/external node
- A node which has a child is called the non leaf node/internal node

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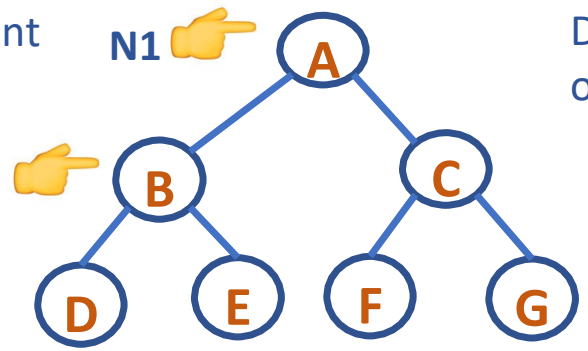
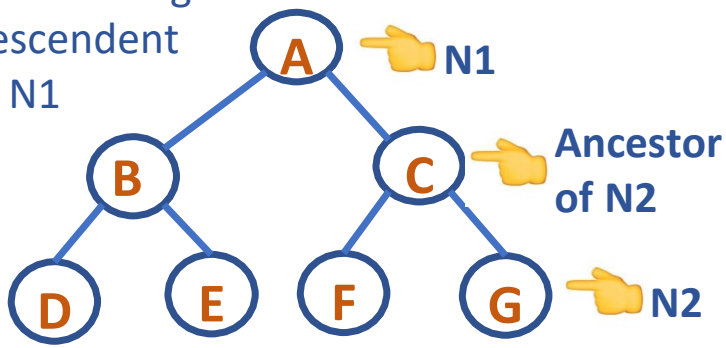
Binary Trees: Terminologies

- A node N1 is called the ancestor of a node N2 if
  - N1 is either the parent of N2 or
  - N1 is the parent of some ancestor of N2
- A node N2 becomes the descendent of node N1
- Descendent can be either the left descendent or the right descendent

N2 is the Left Descendent of N1



N2 is the Right Descendent of N1



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Binary Trees: Terminologies

- Level of a node

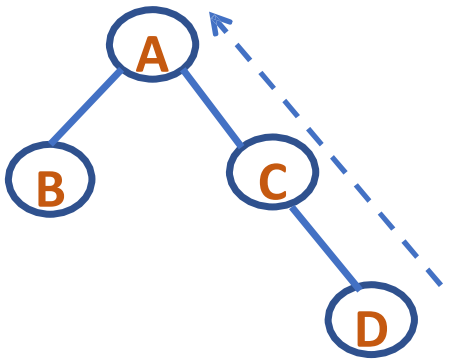
Root has level 0; level of any other node is one more than its parent

- Depth of a tree

Maximum level of any leaf in the tree (path length from the deepest leaf to the root)

- Depth of a node

Path length from the node to the root

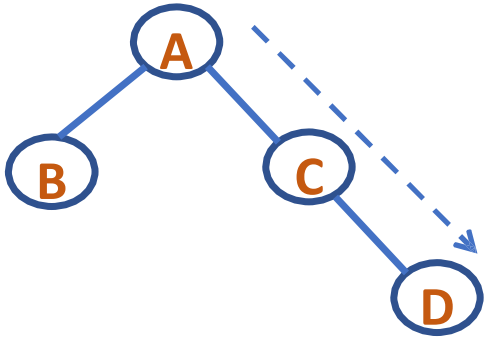


Level of node A – 0
Level of node B – 1
Level of node C – 1
Level of node D – 2

Depth of tree: 2
Depth of node A: 0
Depth of node B: 1
Depth of node C: 1
Depth of node D: 2

Binary Trees: Terminologies

- Height of a tree: Path length from the root node to the deepest leaf
- Height of a node: Path length from the node to the deepest leaf



Height of Tree: 2

Height of Node A : 2
Height of Node B : 0
Height of Node C : 1
Height of Node D : 0

Binary Trees: Terminologies

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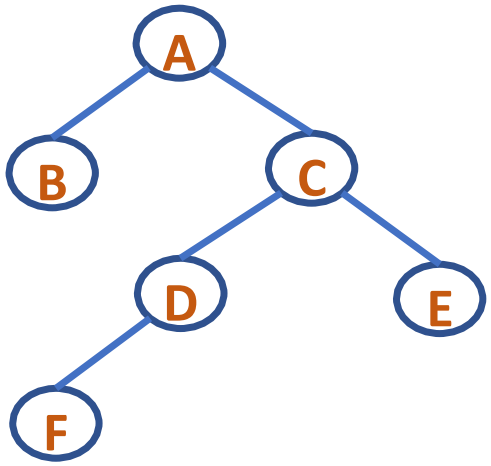
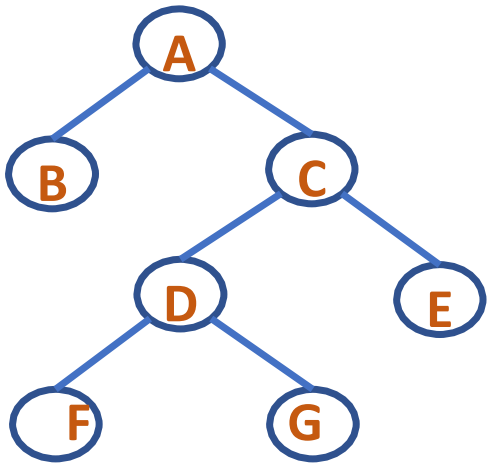
Strictly Binary Tree

A Binary tree where every node has either 0 or two children



Not a Strictly Binary Tree

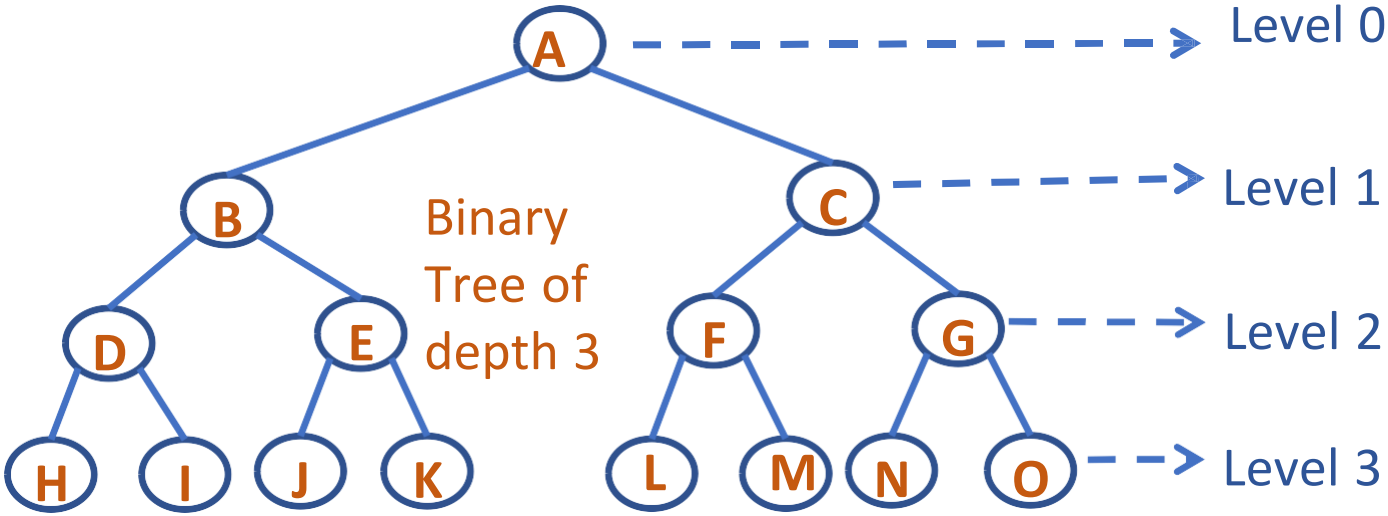


Strictly Binary Tree

Binary Trees: Terminologies

Fully Binary Tree

- A binary tree with all the leaves at the same level
- If the binary tree has depth d, then there are 0 to d levels
- Total no. of nodes = $2^0 + 2^1 + \ldots + 2^d = 2^{(d+1)} - 1$



Binary Trees: Terminologies

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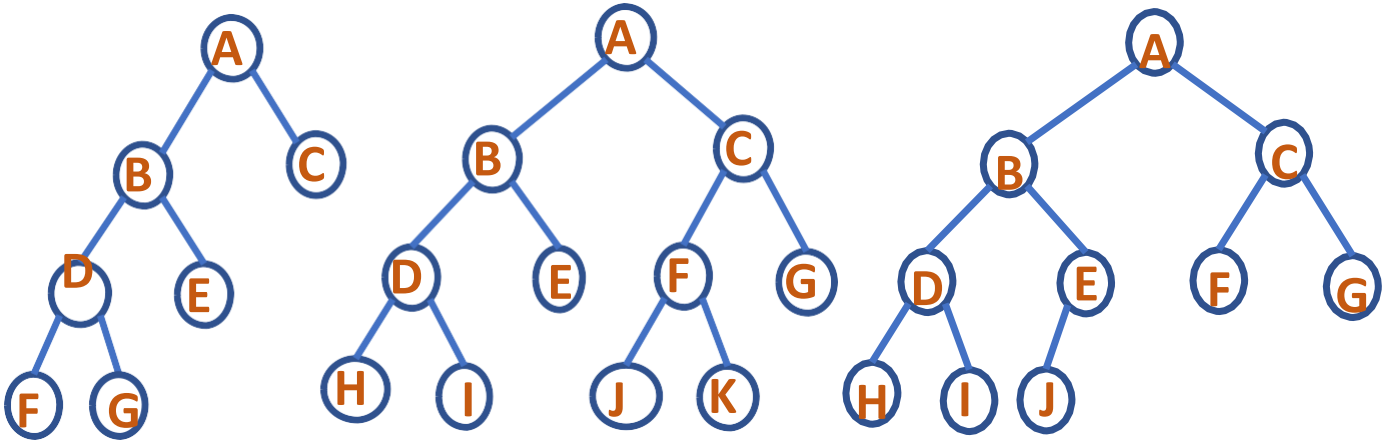
Complete Binary Tree

A complete binary tree is a binary tree in which all the levels are completely filled except possibly the lowest one, which is filled from the left.



Not Complete Binary Trees

Complete Binary Tree

Binary Tree Properties

- Every node except the root has exactly one parent
- A tree with n nodes has n-1 edges (every node except the root has an edge to its parent)
- A tree consisting of only root node has height of zero
- The total number of nodes in a full binary tree of depth d is $2^{(d+1)} - 1$, $d \geq 0$
- For any non-empty binary tree, if n_0 is the number of leaf nodes and n_2 the nodes of degree 2, then $n_0 = n_2 + 1$

1. Which of the following is true for a complete binary tree?

A) All internal nodes have exactly 2 children.

B) Every level is completely filled except possibly the last, which is filled from left to right.

C) Every leaf node is at the same level.

D) It has the maximum number of nodes possible for its height.

1. Which of the following is true for a complete binary tree?

A) All internal nodes have exactly 2 children.

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2. The maximum number of nodes in a binary tree of height h (root at height 0) is:

A) 2^h

B) $2^h - 1$

C) $2^{h+1} - 1$

D) $2h - 1$

2. The maximum number of nodes in a binary tree of height h (root at height 0) is:

A) 2^h

B) $2^h - 1$

C) $2^{h+1} - 1$

D) $2h - 1$

3. Which of the following is true about a Full Binary Tree?

A) Every node has exactly 2 children.

B) Every internal node has either 0 or 2 children.

C) All levels except possibly the last are completely filled.

D) Nodes are stored in level-order sequence.

3. Which of the following is true about a Full Binary Tree?

A) Every node has exactly 2 children.

B) Every internal node has either 0 or 2 children.

C) All levels except possibly the last are completely filled.

D) Nodes are stored in level-order sequence.

4. If a full binary tree has n internal nodes, how many leaf nodes does it have?

A) n

B) n + 1

C) 2n

D) 2^n

4. If a full binary tree has n internal nodes, how many leaf nodes does it have?

A) n

B) n + 1

C) 2n

D) 2^n

5. Which of the following is true about a perfect binary tree?

A) All internal nodes have two children, and all leaves are at the same level.

B) Every level is completely filled except possibly the last.

C) Every non-leaf node has exactly one child.

D) All internal nodes have two children, and all leaves are not at the same level.

5. Which of the following is true about a perfect binary tree?

A) All internal nodes have two children, and all leaves are at the same level.

B) Every level is completely filled except possibly the last.

C) Every non-leaf node has exactly one child.

D) All internal nodes have two children, and all leaves are not at the same level.

THANK YOU

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