Sanjivani Rural Education Society's
Sanjivani College of Engineering, Kopargaon-423 603
(An Autonomous Institute, Affiliated to Savitribai Phule Pune University, Pune)
NACC 'A' Grade Accredited, ISO 9001:2015 Certified

Department of Computer Engineering
(NBA Accredited)

Subject- Data Structures-II(CO214)
Unit-II Tree

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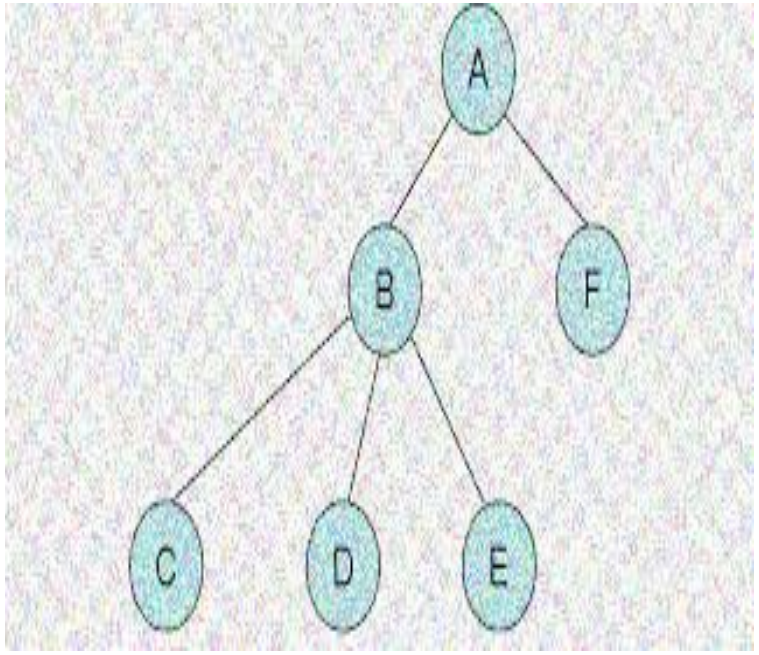
Contents

- Tree: Introduction, Tree Terminologies, Binary Tree, Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, operations on BST, Applications – Expression Tree, Huffman Encoding.

Tree Introduction

- It is a Non-linear Data structure
- Trees are mainly used to represent data containing the hierarchical relationship between elements, example: records, family trees, and table of contents.
- A tree may be defined as a finite set 'T' of one or more nodes such that
  - There is a node designated as the root of the tree
  - The other nodes are divided into n>=0 disjoint sets T_1, T_2, T_3, T_4 …. T_n are called the sub trees or children of the root.



- Example of Tree- Book Index
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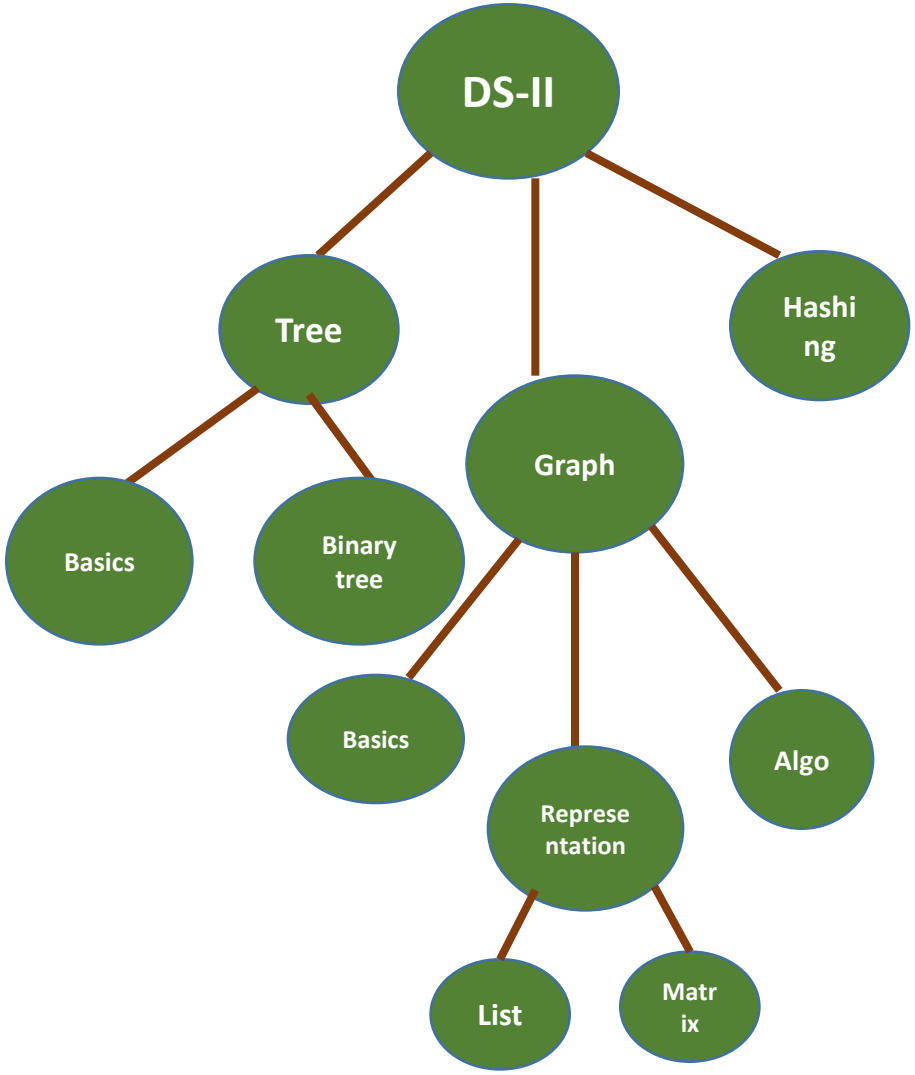
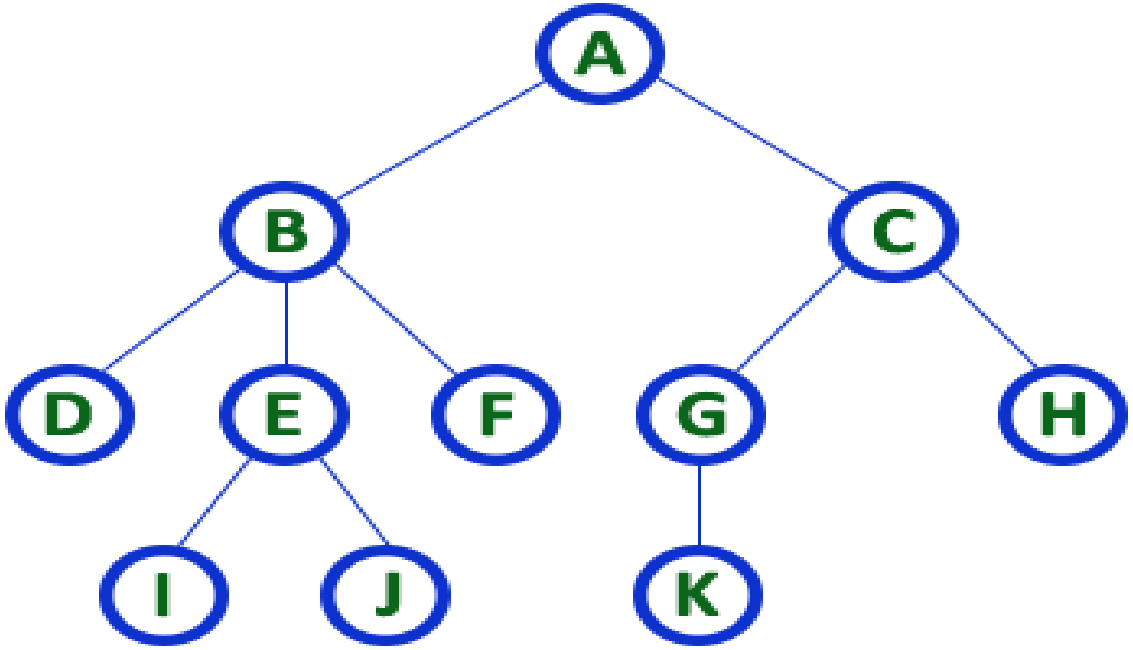


Definition : if T is not empty,

- T is a special tree which has the root that has no parent
- Each node v of T different than the root has a unique parent node w; each node with parent w is a child of w



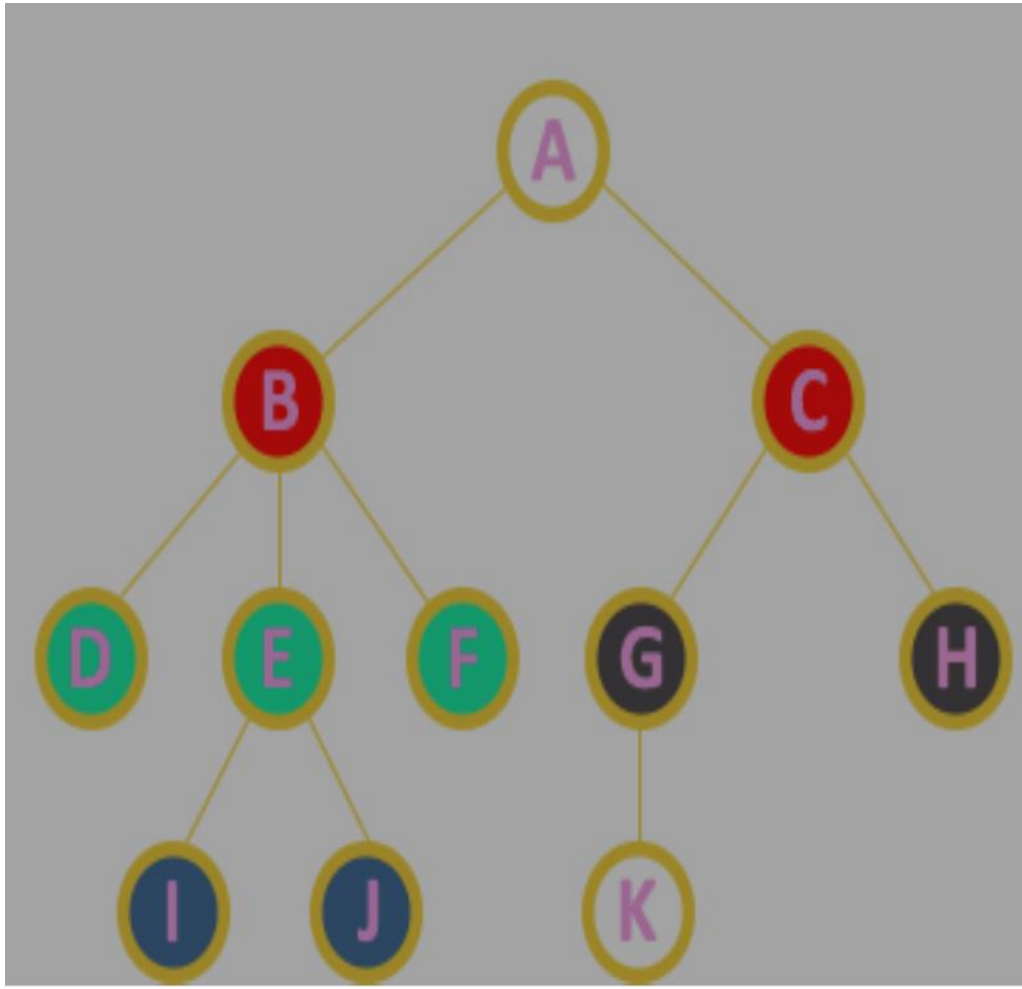
TREE with 11 nodes and 10 edges

- In any tree with 'N' nodes there will be maximum of 'N-1' edges
- In a tree every individual element is called as 'NODE'

Terminologies

- **Root:** In a tree data structure, the first node is called as **Root Node**.
- Every tree must have a root node. We can say that the root node is the origin of the tree data structure. In any tree, there must be only one root node. We never have multiple root nodes in a tree.
- **Node:** A Node is a information of any type. Node often represented as letter, string or number. Information of each node is inside circle. Line joining information is called as branches or edges
- **Siblings:** Two nodes that have same parent are called siblings
- **Internal nodes :** nodes that have children
- **External nodes or leaves :** the node which does not have a child is called as **LEAF Node**. Leaf nodes also called as External or terminal node.

- Ancestors: ancestors of node are all the nodes along the path from root to that node. Ancestor of K is A ,C, G
- Forest: A forest is a set of n>=0 disjoint trees. if we remove root of tree we get a forest. if we remove A , then we get forest with 2 trees.
- **Descendants**: The list of all node reachable from that node.
- E.g.Descendant of node C are G,H,K



B & C Siblings

D E & F Siblings

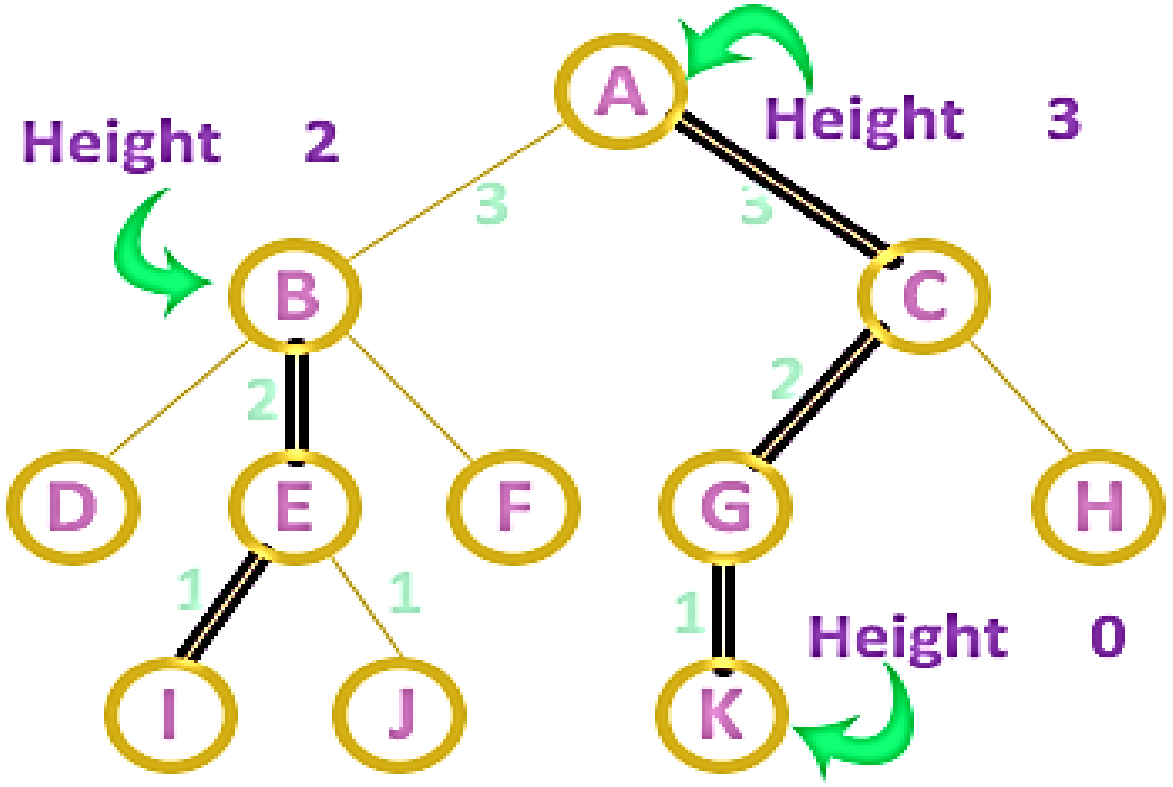
G & H Siblings

I & J Siblings

- In any tree the nodes which has same Parent are called 'Siblings'

- The children of a Parent are called 'Siblings'

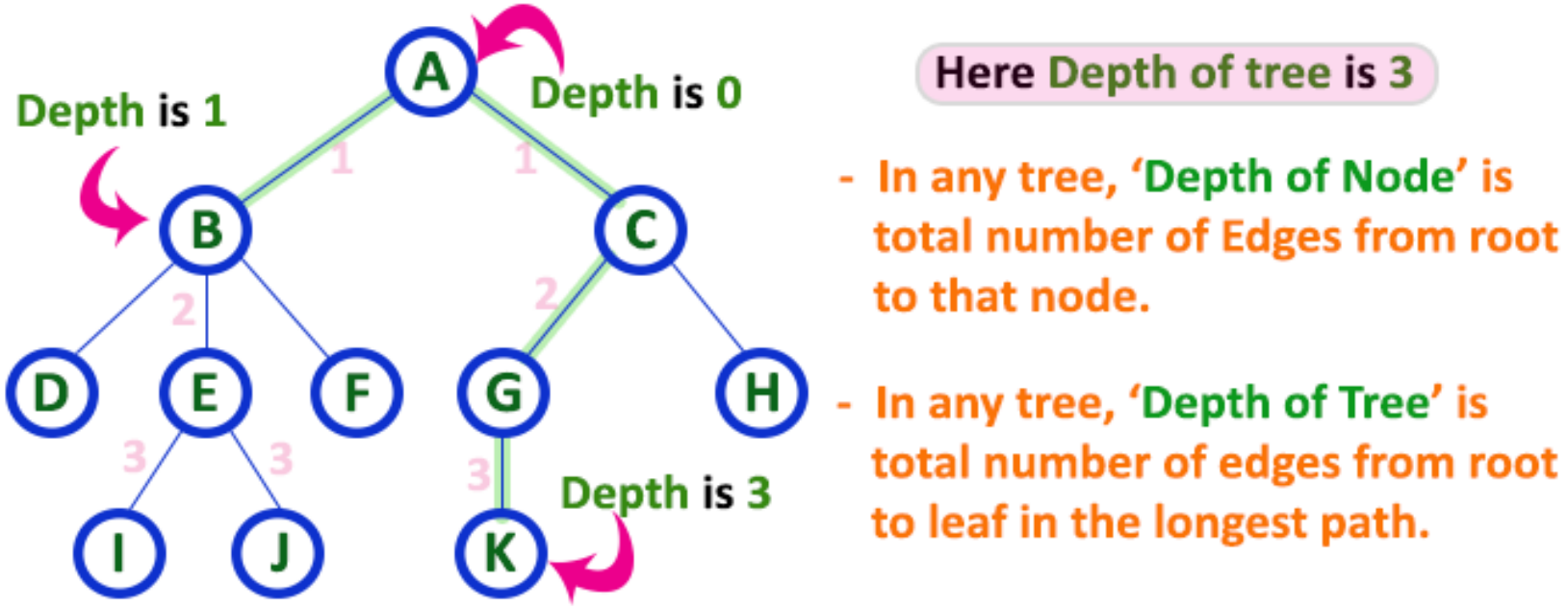
- **Degree of node:** The total number of children of a node is called as **DEGREE** of that Node.
- **Degree of tree:** The highest degree of a node among all the nodes in a tree is called as '**Degree of Tree**‘
- **Level:** In a tree data structure, the root node is said to be at Level 0 and the children of root node are at Level 1 and the children of the nodes which are at Level 1 will be at Level 2 and so on... In simple words, in a tree each step from top to bottom is called as a Level and the Level count starts with '0' and incremented by one at each level (Step)
- **Height:** The total number of edges from leaf node to a particular node in the longest path is called as **HEIGHT** of that Node. In a tree, height of the root node is said to be **height of the tree**. In a tree, **height of all leaf nodes is '0'.**



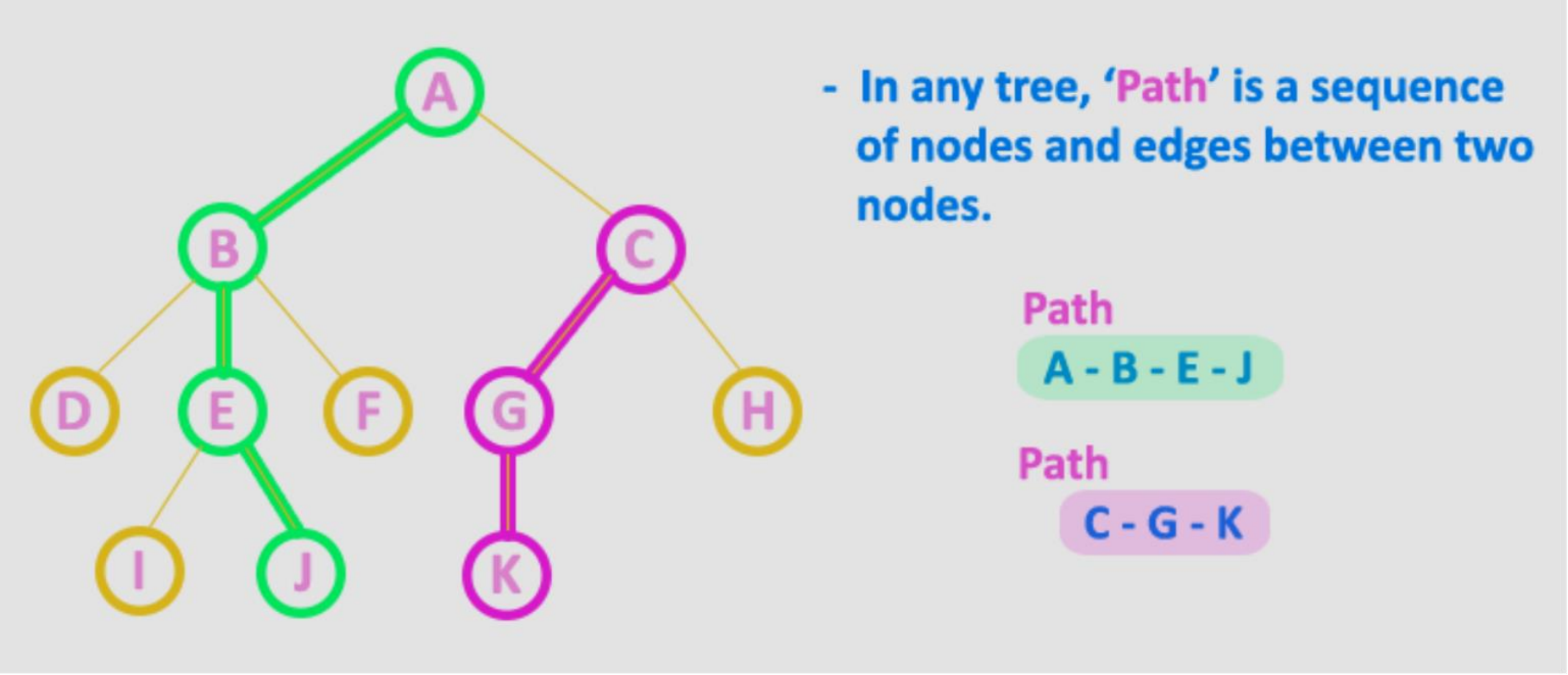
Height of tree 3

- In any tree, 'Height of Node' is total number of Edges from leaf to that node in longest path.
- In any tree, 'Height of Tree' is the height of the root node.

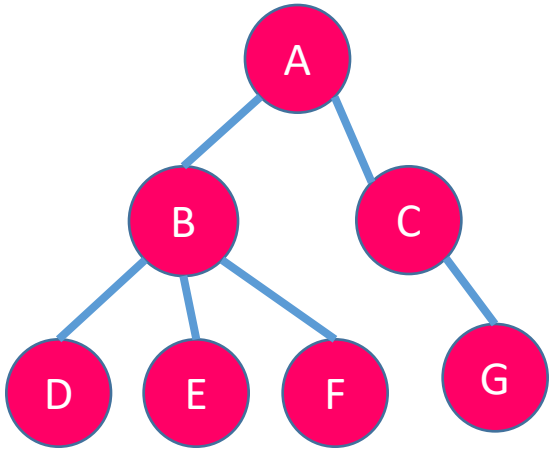
- **Depth:** In a tree data structure, the total number of edges from root node to a particular node is called as **DEPTH** of that Node. In a tree, the total number of edges from root node to a leaf node in the longest path is said to be **Depth of the tree**. In simple words, the highest depth of any leaf node in a tree is said to be depth of that tree. In a tree, **depth of the root node is '0'.**

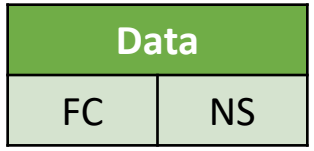


Path: The sequence of Nodes and Edges from one node to another node is called as **PATH** between that two Nodes. **Length of a Path** is total number of nodes in that path. In below example **the path A - B - E - J has length 4**.

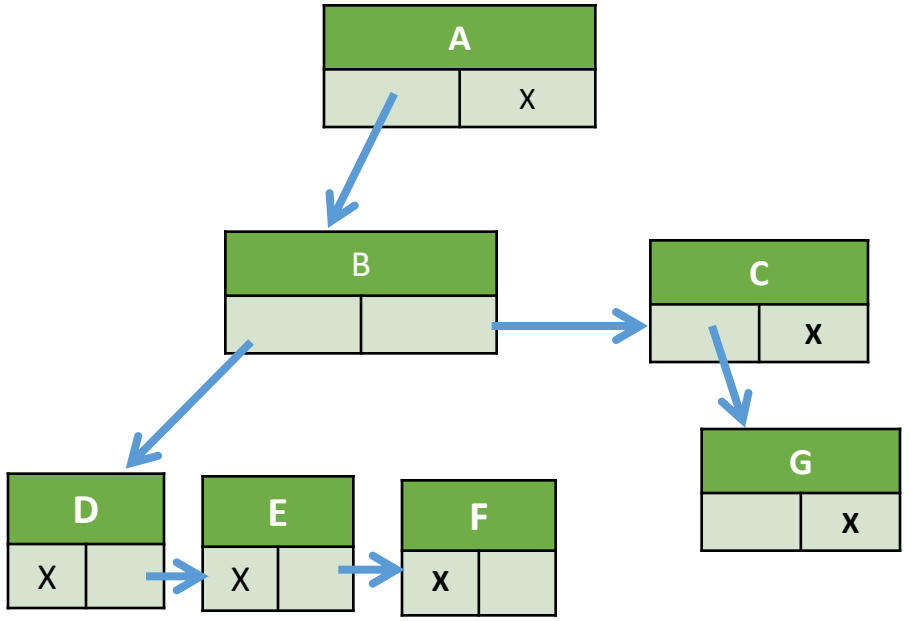


Tree Representation

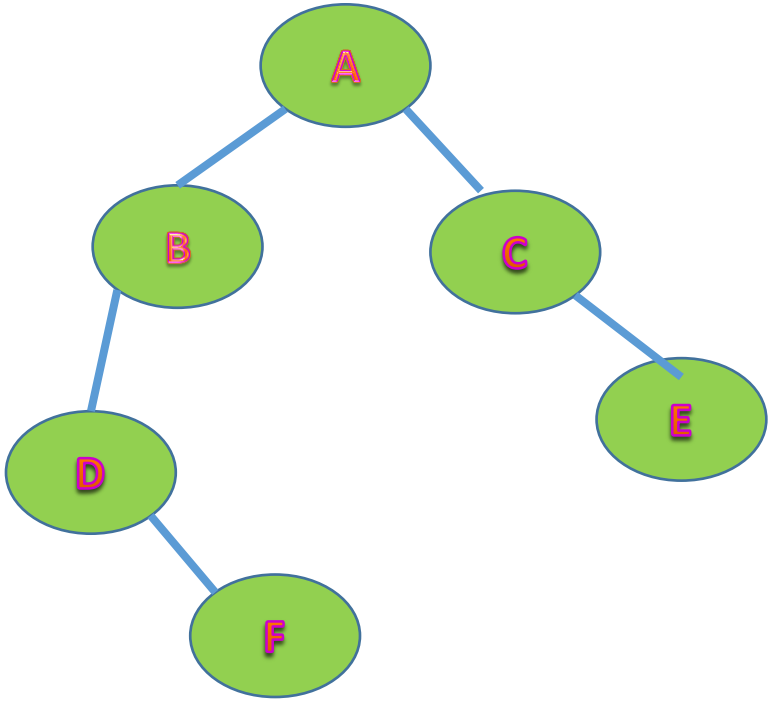


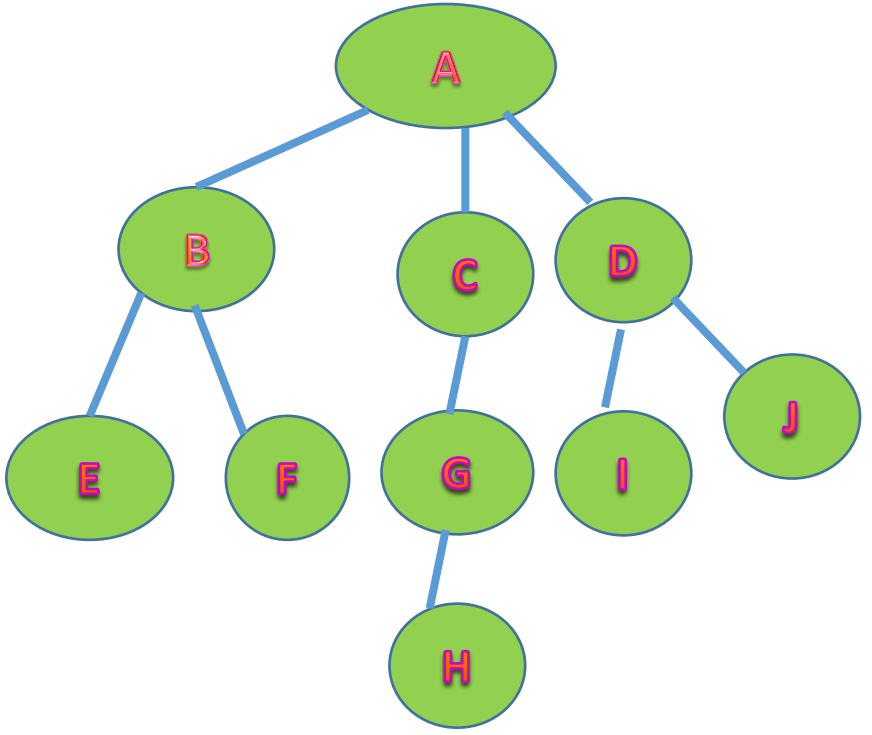


Node Representation



Excercise





Exercise

- Degree of node B
- Height of tree
- Height of node B
- Which nodes are leaves
- parent of node C
- Ancestors of node E
- Descendent of node E
- Right siblings of node D and E
- Different path of legnth 3