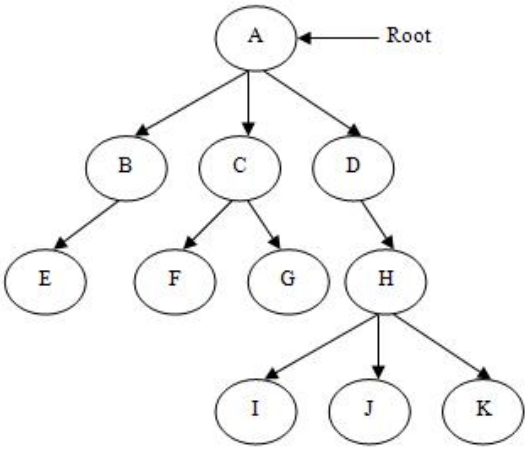
6. Tree Data Structure

What is Tree?

A tree is a widely-used data structure that emulates a hierarchical tree structure with a set of linked nodes.

A rooted tree has a distinguished node called root.



Some Terms related to Trees:

1. Root, parent, child, sibling, leaf

Every child node has a unique parent.

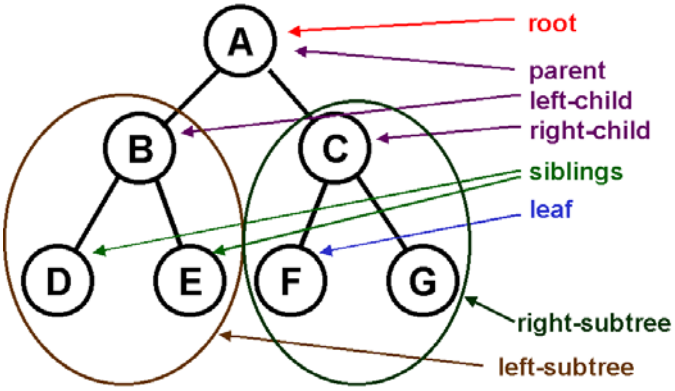
Every parent node can have any number of children (including none).

There is one unique node in every tree which has no parent and is called the root of the tree.

An internal node has one or more children.

A leaf node has no children.

Nodes with the same parent are called siblings.

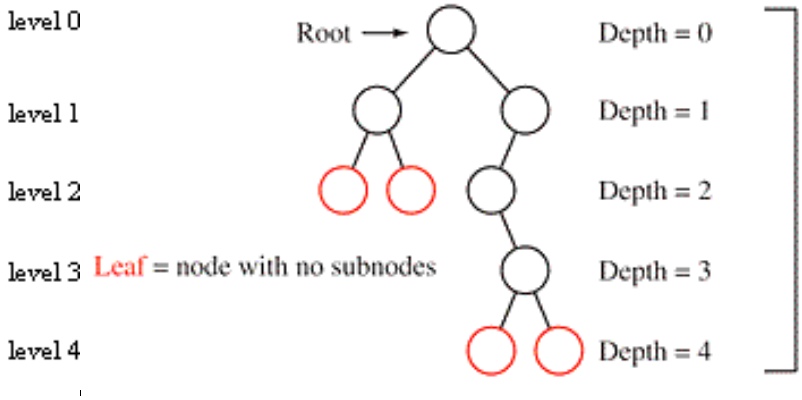


2. Size, depth, height and level

The size of a tree is the number of nodes that it contains.

The depth of a node is the number of edges from the root to the node.

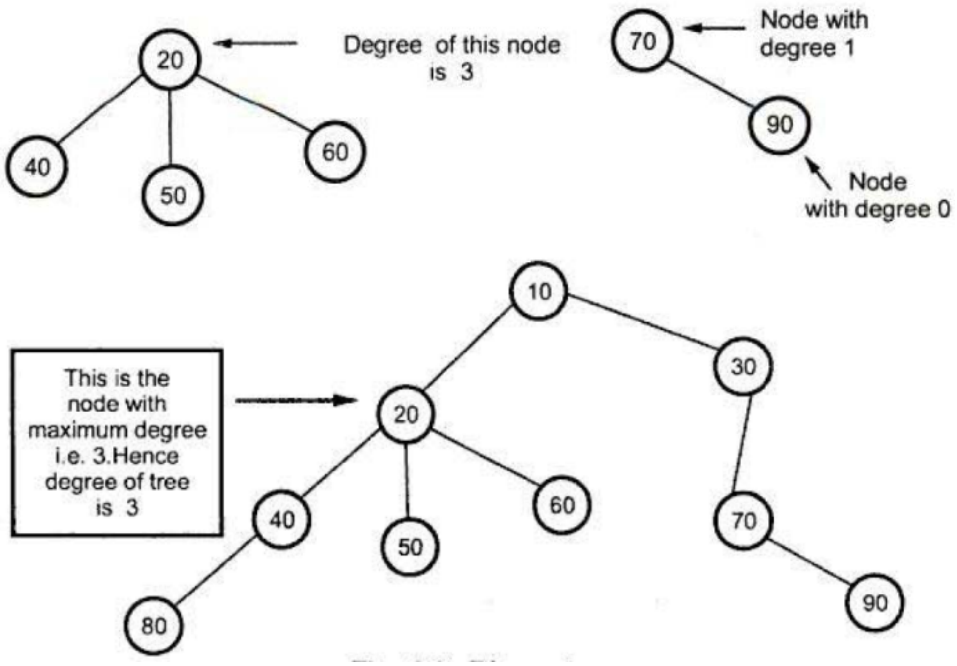
The height of a tree is the largest depth of any of its nodes.



Size=9 Height=4

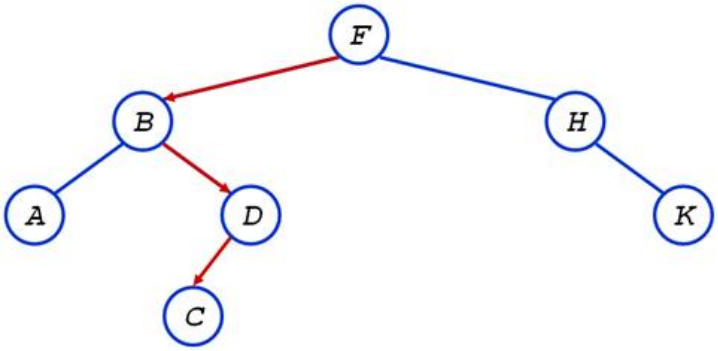
3. Degree

The degree of a node is the number of its children.
The degree of a tree is the maximum degree of any of its nodes.



4. Path

Path between two nodes in a tree is a sequence of edges which connect those nodes.

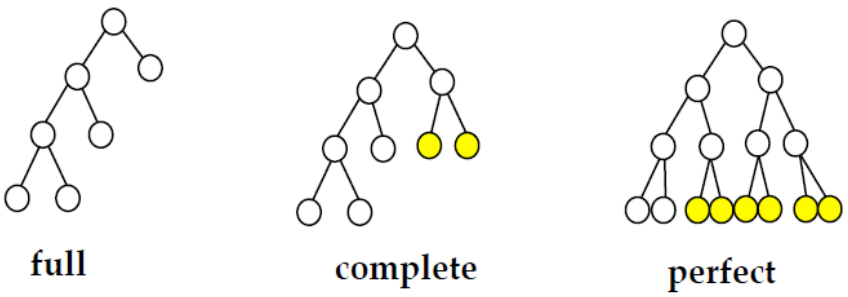


Path from F to C is (FB, BD, DC)

Special Types of Trees:

1. Binary Tree:

A binary tree is a rooted tree in which no node can have more than two children, and the children are distinguished as left and right.
A full binary tree is a tree in which every node other than the leaves has two children.
A complete binary tree is a binary tree, which is completely filled, with the possible exception of the bottom level, which is filled from left to right.
A perfect binary tree is a binary tree with all leaf nodes at the same depth. All internal nodes have degree 2.

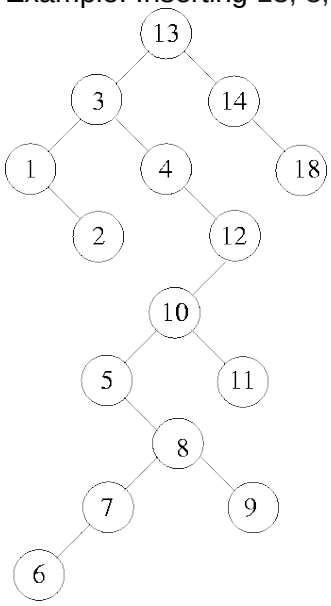


2. Binary Search Tree:

It is a binary tree such that for every node N in the tree:

- All keys in N's left sub tree are less than the key in N, and
- All keys in N's right sub tree are greater than the key in N.
- Note: if duplicate keys are allowed, then nodes with values that are equal to the key in node N can be either in N's left sub tree or in its right sub tree (but not both). In these notes, we will assume that duplicates are not allowed.

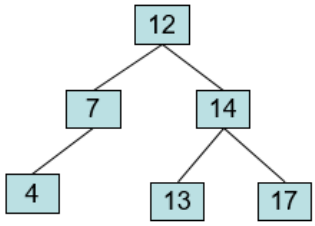
Example: Inserting 13, 3, 4, 12, 14, 10, 5, 1, 8, 2, 7, 9, 11, 6, and 18 in a BST.



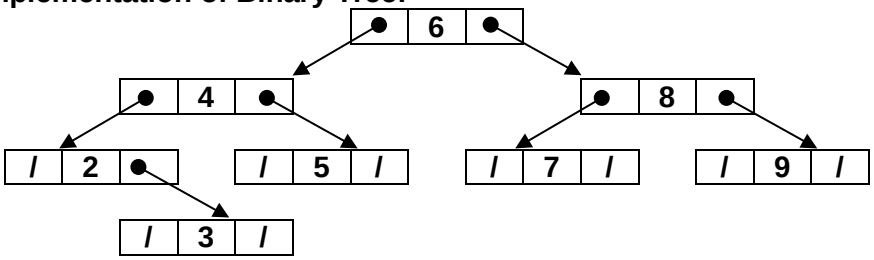
3. AVL (Adelson Velsky Landis) Tree:

It is a binary search tree such that no node that has sub trees differing in height by more than 1.

Example: Inserting 14, 17, 11, 7, 53, 4, and 13 into an empty AVL tree.



Implementation of Binary Tree:



Advantages of Binary Tree:

Quick search, Quick inserts, Quick deletes (If the tree remains balanced)

Disadvantages of Binary Tree:

Deletion algorithm is complex.