Tree

- ***Tree*** is a finite set of nodes with one specially designated node called the "***root***" and the remaining node are partitioned into disjoints sets T1 to Tn, where each of those sets is a TREE.
- T1 to Tn are called ***sub-trees*** of the root

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Terms used with trees

- ***Node***: A item storing information and branches to other nodes
- ***Null Tree***: Tree with no node
- ***Leaf Node:*** Terminal node of a tree & does not have any node connected to it
- ***Degree of a Node:*** No of sub trees of a node
- ***Degree of a tree:*** Degree of a tree is maximum degree of a node in the tree

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Terms used in trees

- ***Parent Node:*** node having other nodes connected to it
- ***Siblings:*** Children of the same parents
- ***Descendants:*** all those node which are reachable from that node
- ***Ancestor:*** all the node along the path from the root to that node

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Terms used in Trees

- ***Level of a Node:***
  - Indicates the position of the node in the hierarchy
  - Level of any node is level of its parent +1
  - Level of root is 0
- ***Depth of a tree:*** maximum level of any node in the tree
- ***Traversal*** : Visiting each node of tree exactly once

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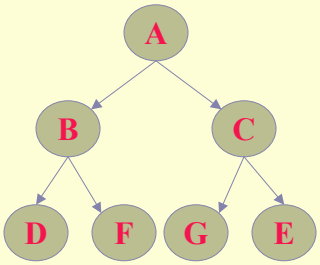
Binary Tree Traversal

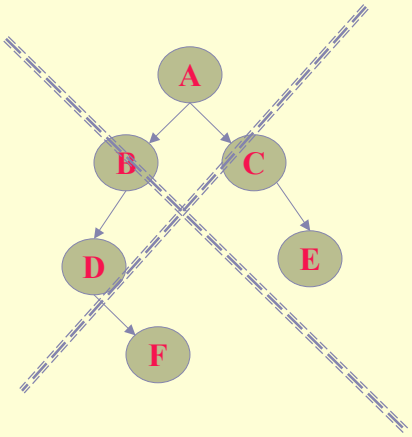
- In-order → L V R
- Pre-Order → V L R
- Post-Order → L R V
- The traversal algorithms can be implemented easily using recursion.
- Non-recursive algorithms for implementing traversal needs stack to store node pointers.

Types of Trees

- ***Binary Trees:*** It is a finite set of nodes partitioned into three sub sets:- Root, Left sub tree, Right sub tree
- ***Binary Search tree:*** A binary search tree is a binary tree in which the nodes are arranged according to their values
- ***Strictly Binary tree:*** All non leaf node have two branches
- ***Complete Binary tree:*** Tree with all leaf nodes at the same level

Complete Binary Tree





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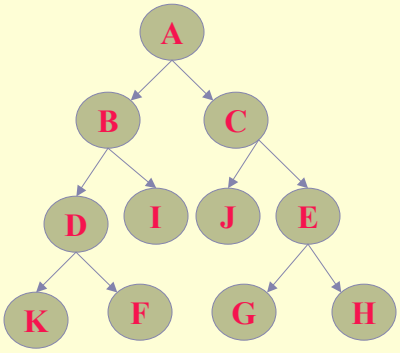
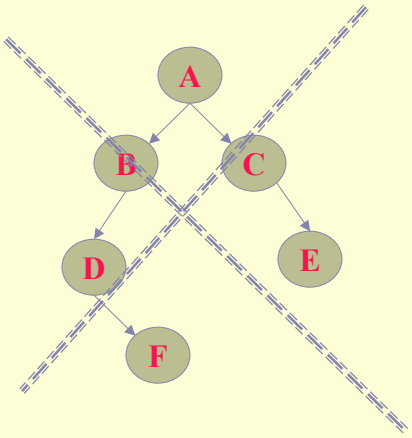
Strictly Binary Tree





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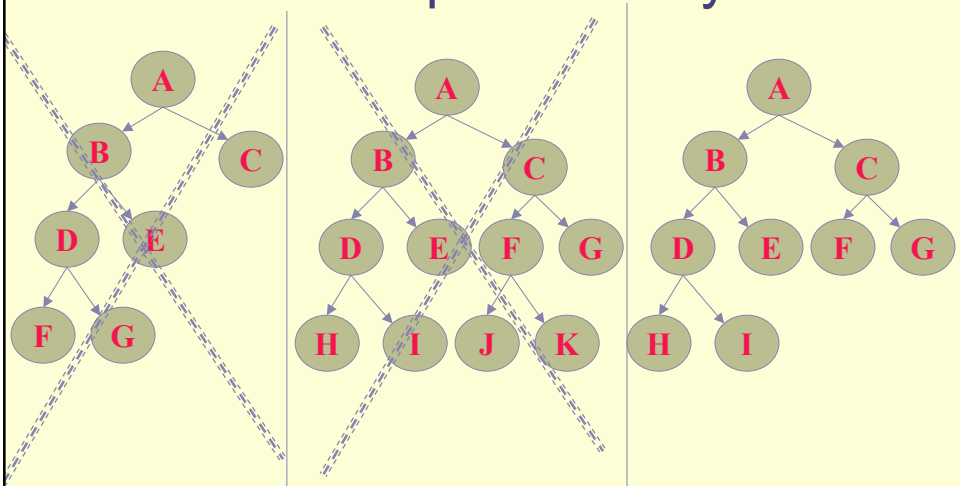
Types of trees

- ***Skewed Binary tree:*** The branches of this tree have either only left branches or right branches
- ***Almost Complete Binary Tree:*** A Binary Tree of depth *d* is said to be an Almost Complete Binary Tree if:
  - Each leaf in a tree is at level *d* or *d-1*
  - For any node N1 in a tree with right descendent at level d , N1 must have Son and every left descendant of N1 should be either a leaf or should have two sons

Almost complete binary tree



Binary Search Tree

- A binary search tree is a binary tree in which the nodes are arranged according to their values so that searching will be faster.
- Generally, value of left child is smaller than parent while value of right child is greater than parent.

Balanced Binary Trees

- A balanced tree, also called ***AVL Tree*** is a binary tree in which the heights of the two sub trees of every node never differ by more than one.
- The balance factor of a node in a binary tree is defined as the height of its left sub tree minus height of its right sub tree.
- Each node in a balanced tree has a balance factor of 1,0 or –1.

Threaded Binary Tree

- In a linked representation of a binary tree having n nodes there will be a total of 2n links out of which n+1 links will be null
- For a Larger value of n this results in a lot of memory wastage
- Main idea is to replace these null links with some use full links which may be used for traversal
- Concept was developed by Perlis and Thorton
- In a threaded Binary Tree the NULL links are replaced by pointers called Threads, which point to some other nodes of a tree

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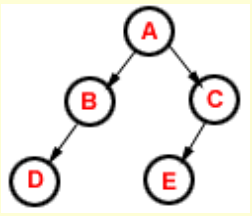
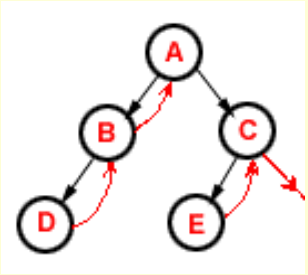
Right in-threaded tree

- A binary tree in which the NULL links are replaced with the empty right sub-tree is called Right in threaded tree.





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Left in-threaded Tree

- A left in-threaded binary tree is may be defined as one in which each NULL pointer is altered to contain a thread to that nodes inorder predecessor.