

A tree is an ADT that is either empty or has a root and n number of subtrees. The root and all subtrees are disjoint.

Binary Tree:

A binary tree is a tree that is either empty or has a root and at most two subtrees that are themselves binary trees.

Properties of Trees:

1. There is only single path from root to a node.
2. In tree there is exactly one root node and every child has only one immediate parent.
3. In trees, there is parent child relationship so flow can be there with direction top to bottom or vice versa.

Ancestor of a node

An ancestor of a node is any other node on the path from the node to the root.

Descendant of a node

A node p is a descendant of a node q if and only if q is an ancestor of p.

Degree of a node

For a given node, its number of children. A leaf has necessarily degree zero.

Level

The level of a node is the number of edges along the unique path between it and the root node.

Size of a tree

Number of nodes in the tree.

Strict Binary Tree/ Full Binary Tree:

A strict binary/ full binary tree is a tree in which each node has 2 children or none at all.

Leaf Nodes/external nodes:

nodes that have no children.

Non leaf nodes /internal nodes:

nodes that have at least one child.

Depth of a node:

the depth of a node X in a tree T is defined as the length of the simple path (number of edges) from the root node of T to X.

Height of a Node:

The height of a node Y is the number of edges on the longest downward simple path from Y to a leaf.

Height of a Tree:

The height of a tree is defined as the height of its root node.

Perfect Binary Tree:

Perfect Binary Tree A Binary tree is Perfect

Binary Tree in which all internal nodes have two children and all leaves are at the same level.

Some textbooks use the same definition of full binary tree as the definition of a perfect tree.

Complete Binary Tree:

A complete binary tree is a binary tree in which every level, except possibly the last, is completely filled, and all leaf nodes are as far left as possible.

Binary Search Tree:

all keys of left subtree are less than the key of root, all keys of right subtree are greater than root's key. The subtrees are also BSTs

By definition, duplicates are not allowed in bst.

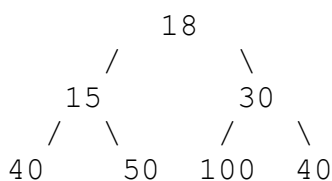
here is a difference between a STRICT and FULL BINARY TREE.

1) FULL BINARY TREE: A binary tree of height h that contains exactly $(2^h)-1$ elements is called a full binary tree. (Ref: Pg 427, Data Structures, Algorithms and Applications in C++ [University Press], Second Edition by Sartaj Sahni).

or in other words

In a FULL BINARY TREE each node has exactly 0 or 2 children and all leaf nodes are on the same level.

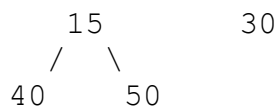
For Example: The following is a FULL BINARY TREE:



2) STRICT BINARY TREE: Each node has exactly 0 or 2 children.

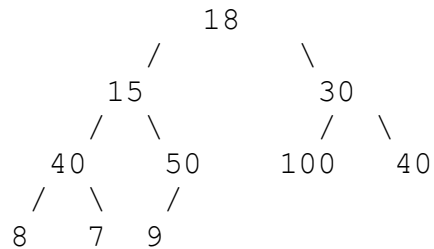
For example: The following is a STRICT BINARY TREE:





3) COMPLETE BINARY TREE: A Binary Tree is complete Binary Tree if all levels are completely filled except possibly the last level and the last level has all keys as left as possible.

For Example: The following is a COMPLETE BINARY TREE:



Note: The following is also a Complete Binary Tree:

