Binary Tees:

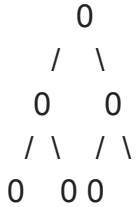
- Binary tree are a data structures used for storing data. They are a hierarchical data structures.
- Binary tree nodes at most can hold 2 children nodes.
- A real life application is used such as a file system within a computer
- The height of a tree starts at the root and works its way down.
- A **full binary tree** (sometimes proper **binary tree** or 2-**tree**) is a **tree** in which every node other than the leaves has two children
- A binary tree T with n levels is **complete** if all levels except possibly the **last are completely full**, and the last level has all its nodes to the left side.
- A **traversal** is a process that visits all the nodes in the tree. Since a tree is a nonlinear data structure, there is no unique traversal.
- There are three different types of depth-first traversals:
    - PreOrder traversal - visit the **parent** first and then **left** and **right children**.
    - InOrder traversal - visit the **left** child, then the **parent** and the **right child**.
    - PostOrder traversal - visit **left child**, then the **right child** and then the **parent**.
    - All the above operations can easily be done by recursion.

- The height h of a complete binary tree with N nodes is at most O(log N). We can easily prove this by counting nodes on each level, starting with the root, assuming that each level has the maximum number of nodes:

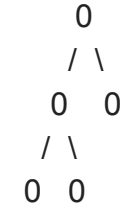
  $n = 1 + 2 + 4 + ... + 2^{h-1} + 2^h = 2^{h+1} - 1$, h being the height of the tree

- Some of the operations for a binary tree includes: inserting, removing, searching, height of the tree and the 3 depth first search traversal which are preorder, inorder, and postorder.

Complete Binary Tree:



Full Binary Tree:



- This is a complete binary tree because it has its childern of the nodes at the leftmost level
- The full binary tree is because all the nodes have 2 children and even though the second level right node has no children, this is still considered a full tree. So its 2 children or none at all.

References:

http://www.cs.cmu.edu/~adamchik/15-121/lectures/Trees/trees.html
http://courses.cs.vt.edu/~cs3114/Fall09/wmcquain/Notes/T03a.BinaryTreeTheorems.pdf