# BINARY TREES

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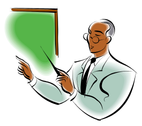
In computer science, a binary tree is a tree data structure that has at most TWO children.

NOTE: A binary tree may

a) be empty
b) have only a single node called the root
c) have a root with at most two descendants, with each descendant being the root of another binary tree



***Watch These:***
***Trees:*** ***https://www.youtube.com/watch?v=qH6yxkw0u78***
***Binary:*** ***https://www.youtube.com/watch?v=H5JubkIy_p8***
**Note: Implementation in these videos are done using C and C++*

***Read:***
*Module 5 (Page 47) of CMSC 204 Manual*

## TERMS

- Root (Top)
- Parent
- Left Child
- Right Child
- Leaves **(nodes with no children)**
- Internal Node **(a node with at least one child)**
- Level

  - **the level of a** node in a binary tree **is equal to 1 plus the level of its father (note that the level of the root is 0).**
- Height
  - **the height of a** binary tree **is the** greatest level assignment **given to a node in a tree**
  - **it is the** longest path **from the root to a leaf**

**"Level i of a binary tree is FULL"**
- if there are exactly 2^i nodes at this level

**"Binary Tree of height k is FULL"**
- if level k in a binary tree is full

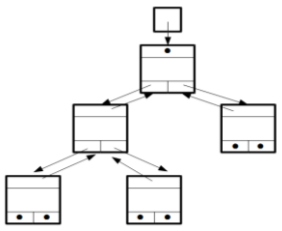
**"Binary Tree of height k is BALANCED"**
- if level k-1 in the binary tree is full

**"Binary Tree is HEIGHT BALANCED"**
- if at EVERY NODE in the tree, its left and right subtrees differ by NO MORE THAN 1 in HEIGHT

## IMPLEMENTATION

The binary tree is implemented using a linked list

***Watch:***
***Binary Tree Part 1:***
***[https://www.youtube.com/watch?v=CrCClRcLTfU](https://www.youtube.com/watch?v=CrCClRcLTfU)***
***Binary Tree Part 2:***
***[https://www.youtube.com/watch?v=5DW5ScDBH-E](https://www.youtube.com/watch?v=5DW5ScDBH-E)***
**Note: Identify what traversal is used in the second video*



## BINARY TREE TRAVERSALS

“In order to search a binary tree, a way of visiting each node in the tree at least once must be formulated. This method of visiting each node in the tree at least once is popularly known as TREE TRAVERSAL.” (EA Albacea)

* traversal – visiting, modify algorithm so that it will become a search function

### A. INORDER TRAVERSAL

- Left subtree is visited
- The root node is visited
- Finally, the right subtree is visited

NOTE: this is done recursively!!!

### B. PREORDER TRAVERSAL

- The root node is visited
- The left subtree is then visited
- Finally, the right subtree is visited

NOTE: also recursive!!!

### C. POSTORDER TRAVERSAL

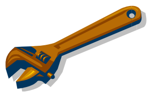
- The left subtree is visited
- The right subtree is visited
- Finally, the root is visited

NOTE: recursive!!!

***Watch:***
***Binary Tree Traversals:***
***https://www.youtube.com/watch?v=gm8DUJJhmY4***
*Note: Implementation is done using C and C++*

## EXPRESSION TREES

- One popular application of binary trees is the creation of expression trees.
- Definition: an expression tree is a binary tree where the leaves hold the operands of the expression and the internal nodes the operators of the expression.



***Try creating expression trees on paper and perform the different traversals on the drawn expression trees:***

- ((2+4)*(9-2))
- (((4+3)*(2-1))*(3/1))
- ((((4+3)*(2-1))*(3/1))-((2+5)*(1+1)))

***Takeaway Thoughts and Questions:***

1. *What new knowledge about binary trees is the most interesting for you?*
2. *Do you suppose you'll make use of (a) trees and (b) binary trees in your profession*?