DESIGN AND ANALYSIS OF ALGORITHMS
UE19CS251

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Binary Tree

Major Slides Content: Anany Levitin

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Binary Tree

- A *binary tree* **T** is defined as a finite set of nodes that is either empty or consists of a root and two disjoint binary trees $\mathbf{T_L}$ and $\mathbf{T_R}$ called as the left and right subtree of the root

- The definition itself divides the Binary Tree into two smaller structures and hence many problems concerning the binary trees can be solved using the Divide – And – Conquer technique

- The binary tree is a Divide – And – Conquer ready structure ☺

Height of a Binary Tree

- Height of a Binary Tree: Length of the longest path from root to leaf

ALGORITHM Height(T)

//Computes recursively the height of a binary tree

//Input: A binary tree T

//Output: The height of T

if T = Ø return -1

else return max(Height(T_L), Height(T_R))+ 1

Height of a Binary Tree - Analysis

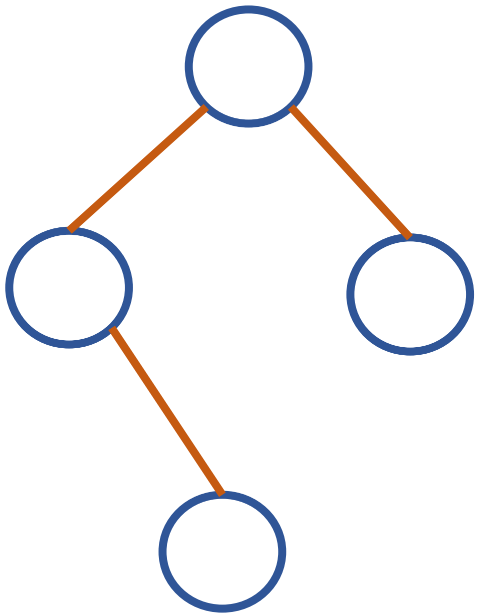
- The measure of input's size is the number of nodes in the given binary tree. Let us represent this number as n(T)
- Basic Operation: Addition
- The recurrence relation is setup as follows:

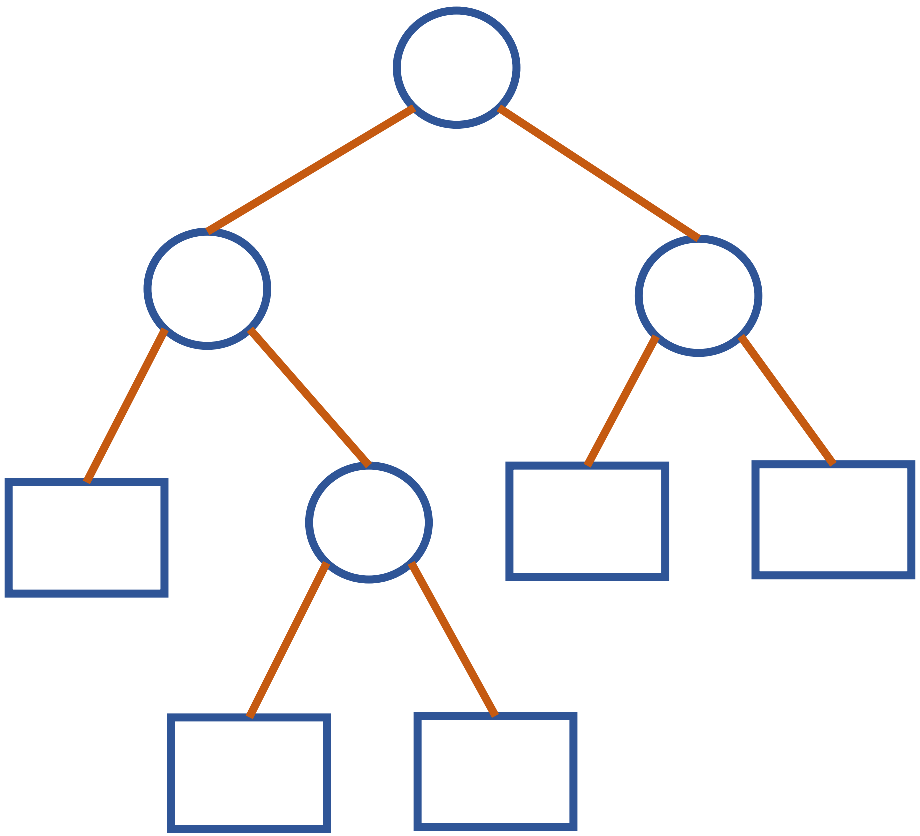
$$A(n(T)) = A(n(T_L)) + A(n(T_R)) + 1, \quad \text{for } n(T) > 0$$

$$A(0) = 0$$

Height of a Binary Tree - Analysis

- In the analysis of tree algorithms, the tree is extended by replacing empty subtrees by special nodes called external nodes





Height of a Binary Tree - Analysis

- x – Number of external nodes
- n – Number of internal nodes

$$x = n + 1$$

- The number of comparisons to check whether a tree is empty or not:

$$C(n) = n + x = 2n + 1$$

- The number of additions is:

$$A(n) = n$$

Binary Tree Traversals

- The three classic traversals for a binary tree are inorder, preorder and postorder traversals

- In the preorder traversal, the root is visited before the left and right subtrees are visited (in that order)
- In the inorder traversal, the root is visited after visiting its left subtree but before visiting the right subtree
- In the postorder traversal, the root is visited after visiting the left and right subtrees (in that order)

Binary Tree Traversals

```
Algorithm Inorder(T)
if T ≠ ∅
    Inorder(Tleft)
    print(root of T)
    Inorder(Tright)
```

Algorithm Preorder(T)

if $T \neq \varnothing$

print(root of T)

Preorder(T_{left})

Preorder(T_{right})

Algorithm Postorder(T)

if $T \neq \varnothing$

Postorder(T_{left})

Postorder(T_{right})

print(root of T)

THANK YOU

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