Binary Trees

CS 62 - Fall 2015
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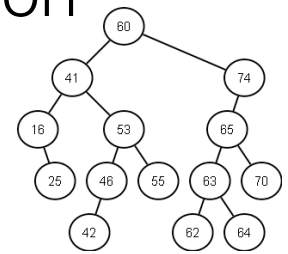
Definition

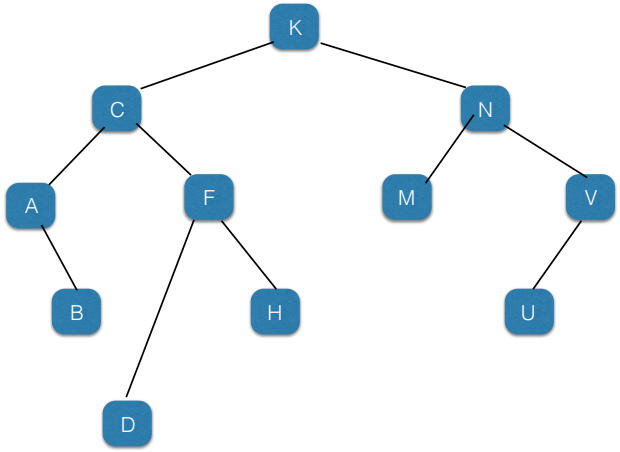


- Def: A tree is either
  - empty or
  - consists of a node, called the root node, together with a collection of trees, called its subtrees. These trees are disjoint from each other and the root.

More Defs

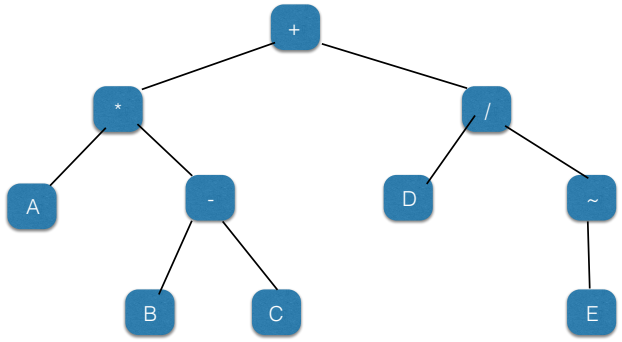
- An *edge* connects a node to its subtrees.
- The roots of the subtrees of a node are said to be the *successors* or *descendants* of the node.
- Nodes without successors are called *leaves*. The others are called *interior nodes*.
- All nodes except root have unique predecessor.
- A collection of trees is called a *forest*.

Example: Binary Search Tree



Example: Expression Tree

[A*(B-C)]+(D/~E)



Family Tree Terminology

- *Parent* node is directly above *child* node
- Sibling node has same parent
- Ancestor and descendant follow
- A node plus all descendants is a subtree

More Terminology

- Simple path is series of distinct nodes s.t. there is edge between successive nodes.
- Path length = # edges in path

Height of node = length of longest path to a leaf
Height of tree = height of root
Degree of node is # of children

More Terminology

- Level/depth of node defined recursively:
  - Root is at level 0
  - Level of any other node is one greater than level of parent
- Level of node is also length of path from root to the node.

Binary tree has all nodes of degree ≤ 2.

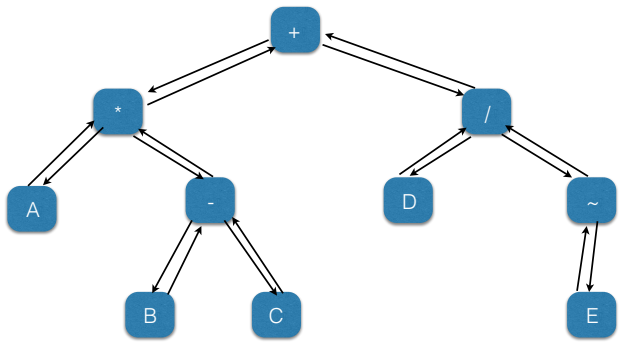
Counting

- If T is a binary tree with n nodes and height h,
  - then at level k T has $\leq 2^k$ nodes
  - then T has $\leq 2^{h+1} - 1$ nodes
  - then $\log(n+1) - 1 \leq h \leq n - 1$

Binary Trees in Java

- No implementation in standard Java libraries
- Structure5 has BinaryTree<E> class, but no interface (*though Prof. Bruce added one*).
- Like doubly-linked list:
  - value: E
  - parent, left, right: BinaryTree<E>

Linked Representation



See BinaryTreeInterface.java

Tree Traversals

- Traversals:
  - Pre-Order: root, left subtree, right subtree
  - In-Order: left subtree, root, right subtree
  - Post-Order: left subtree, right subtree, root
- Most algorithms have two parts:
  - Build tree
  - Traverse tree, performing operations on nodes

Animals Game

- Guess animal using only true-false questions.
- See demo program

Look at BinaryTree.java

Notice leaves are nodes w/null values