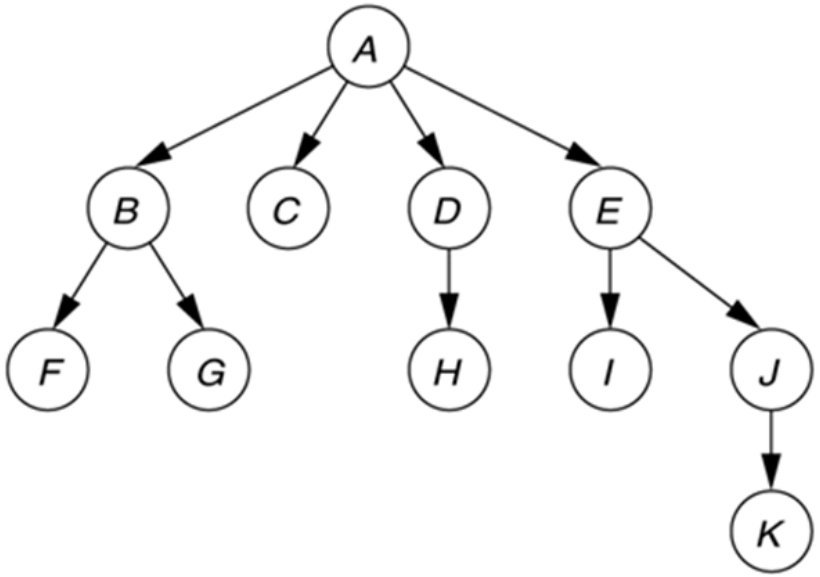

CSSE 230 Day 6

Intro to Trees

After today, you should be able to…
…use tree terminology
…write recursive tree functions

Q1-2

Announcements

- Review Day 5's quizzes on Java Collections and Data Structures
- Preview of HW3: includes an essay

Observation about Stacks and Queues Infix → Postfix problem

- It must be O(n), so you can't grow your strings
- character-by-character:
  - Strings are immutable, so characters must be copied. s += "*" is as slow as growing an array using the +1 scheme
- Solution? Use a StringBuilder!
  - They have internal capacity, which doubles when full!
- See the example at the end of Warmup and Stretching's ShapeTest.java for an example.

Exam 1

- Exam 1 –next week: ~~7–9 pm~~
  - Coverage:
    - Everything from reading and lectures, Sessions 1–5
    - Programs: Warmup, Stacks and Queues
    - Homeworks 1–2
  - Allowed resources:
    - Written part: ½ of one side of 8.5 x 11 paper
      - Goal: to let you use formulas but force you to summarize.
      - Also, I don't want you to spend so much time looking things up.
    - Programming part:
      - Textbook
      - Eclipse (including programs you have written for CSSE230)
      - CSSE230 web pages and materials on Moodle
      - Java API documentation – bookmark these in your browser
    - Two previous 230 Exam 1's are available in Moodle

Exam 1 Possible Topics

- Written (50-70%):
  - Growable Arrays
  - MCSS
  - big O/θ/Ω: true/false, using definitions, code analysis
  - Binary search
  - ADT/Collections
  - Choosing an ADT to solve a given problem

- Programming (30-50%):
  - Implementing an ADT using an array, nodes, or another ADT
  - Writing an efficient algorithm to solve a simple array-based problem

Questions?


LOOKS LIKE RAIN---
I'D BETTER CLOSE UP.
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Next:

- an implementation that offers interesting benefits, but is more complex to code than arrays or lists…
- … Trees!

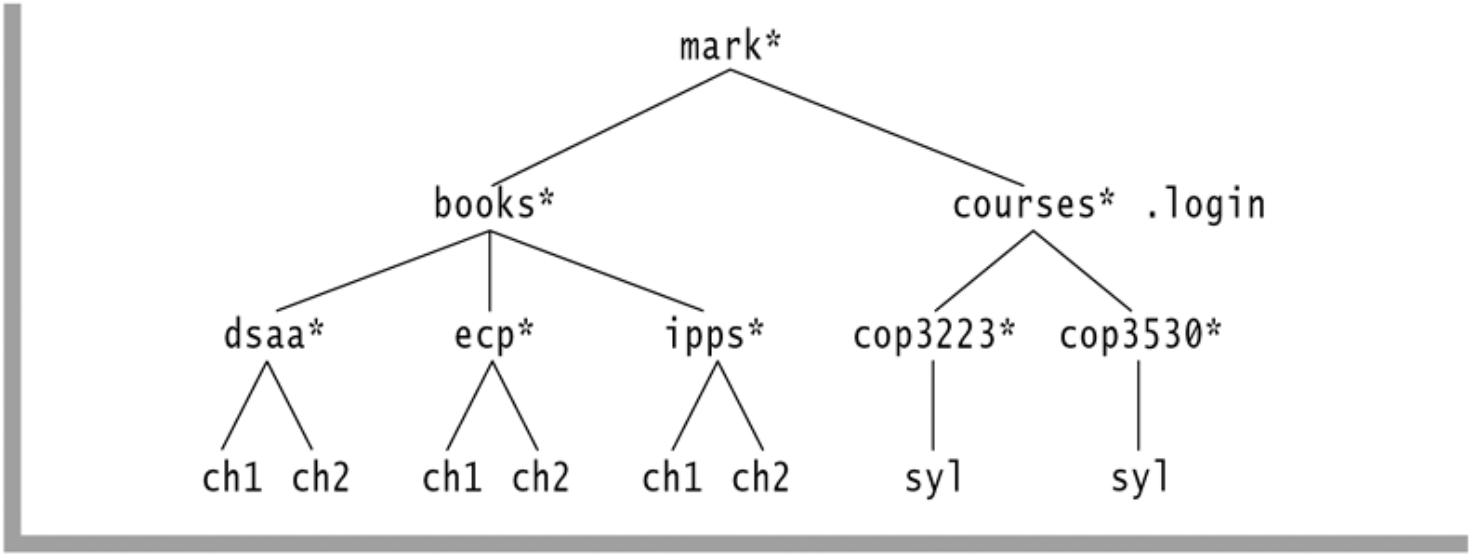
Trees

Introduction and terminology for three types

Trees in everyday life

- Class hierarchy tree (single inheritance only)
- Directory tree in a file system

figure 18.4
A Unix directory

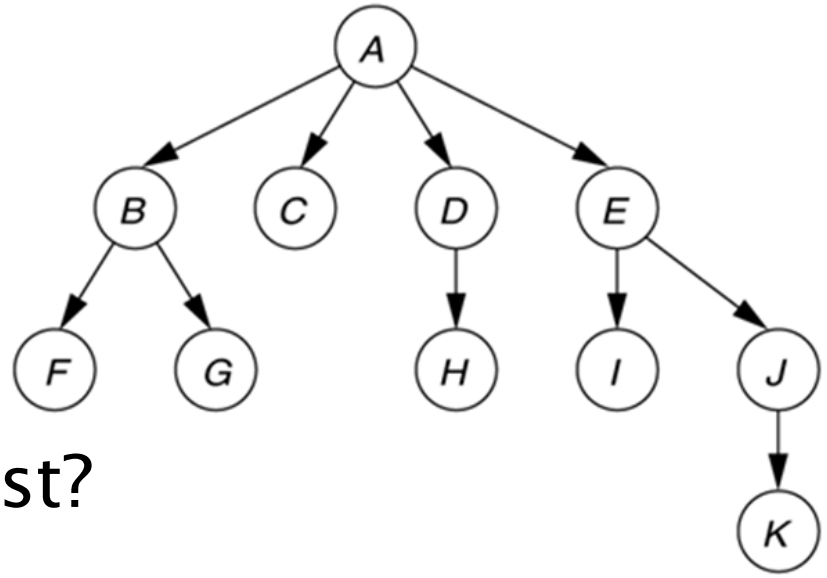


Traverse a Directory Tree

```
import java.io.File;

public class TraverseFiles {

    public static void main(String... args) {
        File[] files =
           new File("C:/EclipseWorkspaces/csse230-2014/BST2").listFiles();
        showFiles(files, 0);
    }

    public static void showFiles(File[] files, int indent) {
        for (File file : files) {
            if (file.isDirectory()) {
                System.out.println("            ".substring(0,indent) +
                                   "Directory: " + file.getName());
                showFiles(file.listFiles(), indent+1); // Calls method again.
            } else {
                System.out.println("            ".substring(0,indent) +
                                   "File: " + file.getName());
            }
        }
    }
```

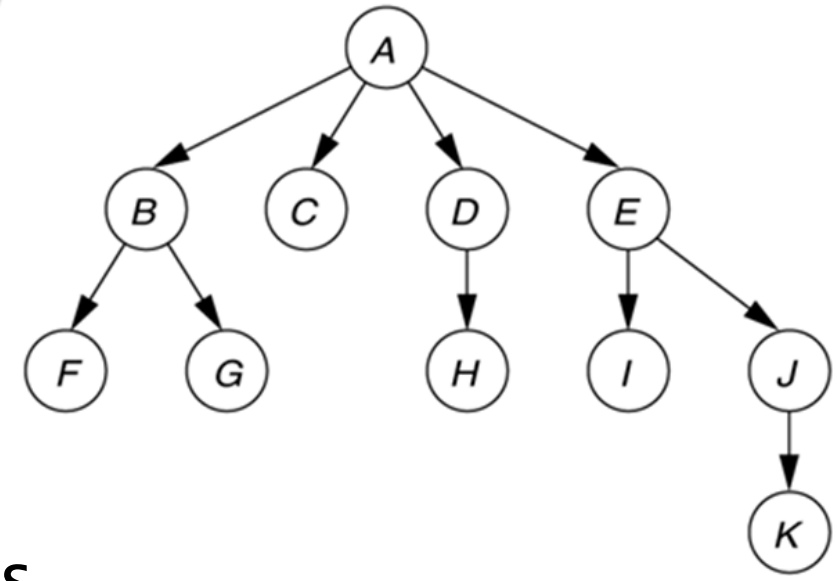
A General Tree—Global View

- A collection of nodes
- Nodes are connected by directed edges.
  - One special root node has no incoming edges
  - All other nodes have exactly one incoming edge
- One way that Computer Scientists are odd is that our trees usually have their root at the top!



- How are trees like a linked list?
- How are they different?

Tree Terminology

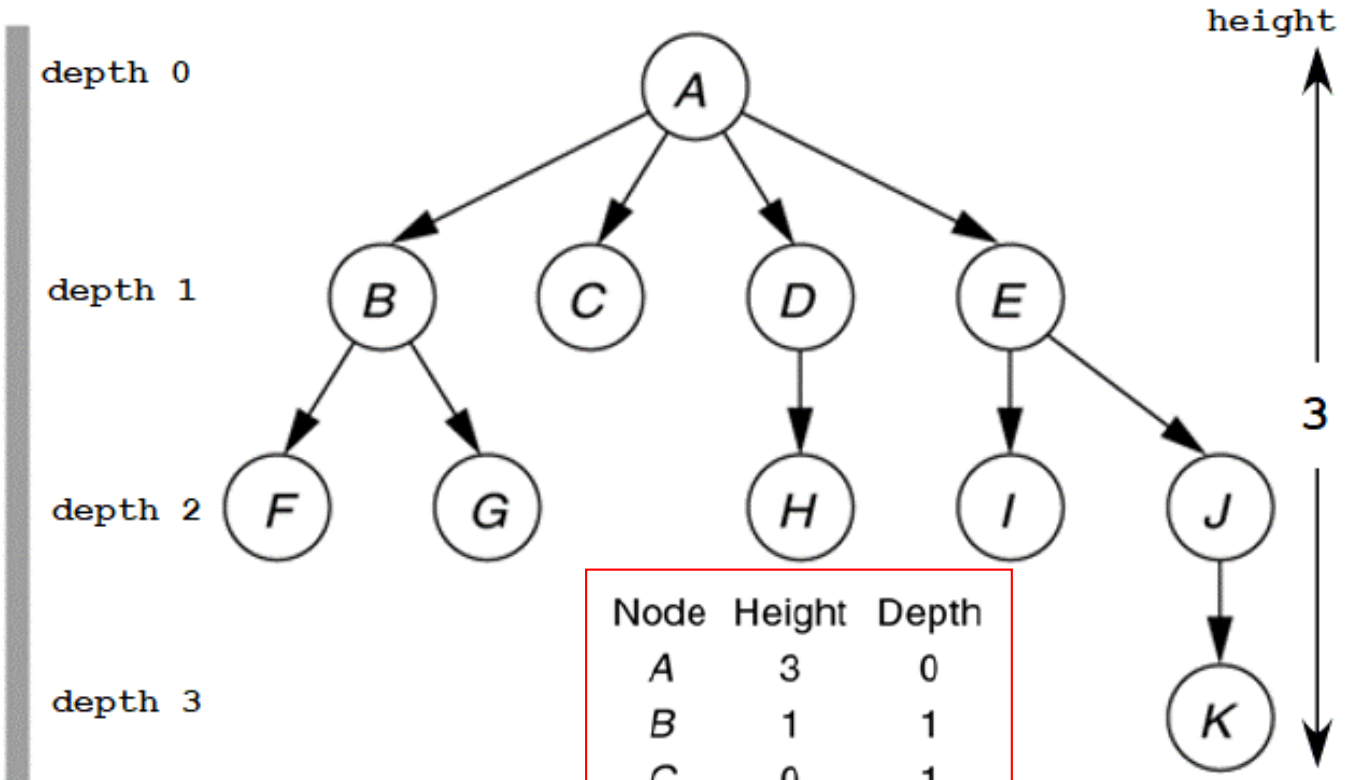


- Parent
- Child
- Grandparent
- Sibling
- Ancestors and descendants
- Proper ancestors, proper descendants
- Subtree
- Leaf, interior node
- Depth and height of a node
- Height of a tree

Node height and depth examples

figure 18.1

A tree, with height and depth information



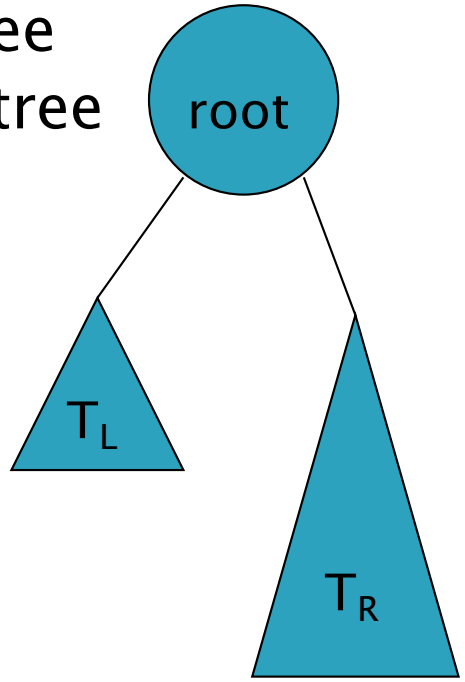
Node	Height	Depth
A	3	0
B	1	1
C	0	1
D	1	1
E	2	1
F	0	2
G	0	2
H	0	2
I	0	2
J	1	2
K	0	3

The **height of a tree** is the height of its root node.

Which is larger, the sum of the heights or the sum of the depths of all nodes in a tree?

Binary Tree: Recursive definition

- A **Binary** Tree is either
  - empty, or
  - consists of:
    - a distinguished node called the root, which contains an element, and
    - A left subtree T_L, which is a binary tree
    - A right subtree T_R, which is a binary tree



- A **Binary** tree node has at most 2 children

- How do you search for an item?

Q8-10

Binary Search Tree (BST)

- A binary tree with the Search Property:
  - Every element in the left subtree is smaller than the root, and every element in the right subtree is larger than the root. And this is true at **every node**, not just the root.

- Compare: search on
  - Binary tree?
  - Binary Search Tree?

Q11

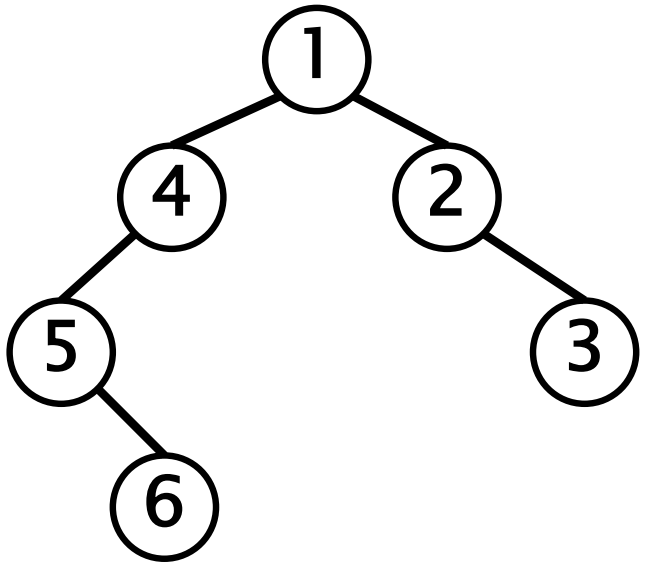
Recursion in Binary Trees

- (Review) Write size() for linked list
  - Non-recursively
  - Recursively
- Write size() for a tree
  - Recursively
  - Non-recursively (later)
- What are characteristics of correct, efficient recursive code?

Growing Trees

- Let's start the BinarySearchTrees assignment: implement a `BinaryTree<T>` class

Test tree:



A single tiny recursive method for size will touch **every node in the tree.** Let's write, then watch in debugger.