

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 \rightarrow 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

1

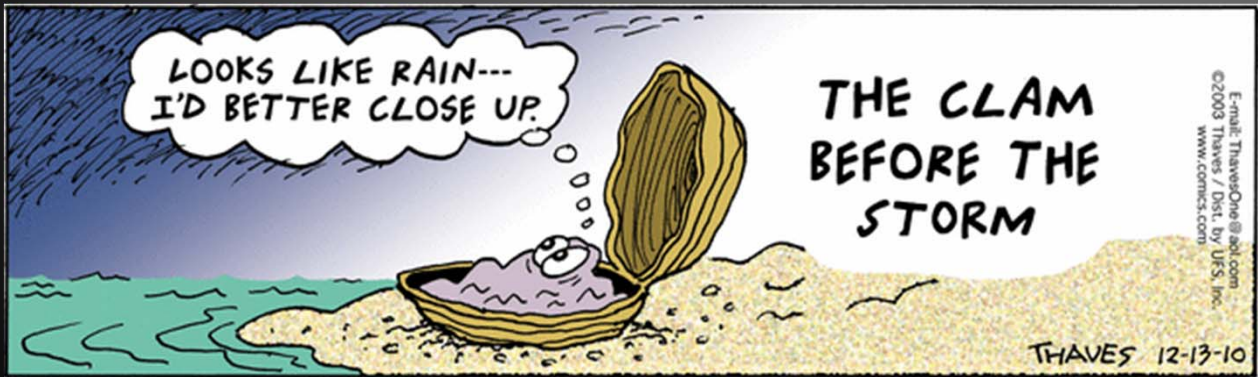
- ▶ Exam 1 – Tuesday next week: 7–9 pm
 - Coverage:
 - Everything from reading and lectures, Sessions 1–5
 - Programs: Warmup, Stacks and Queues
 - Homeworks 1–2
 - Allowed resources:
 - Written part: $\frac{1}{2}$ of one side of 8.5 x 11 paper
 - Goal: to let you use formulas but force you to summarize.
 - 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 $O/\theta/\Omega$: 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?



Next:

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

Trees

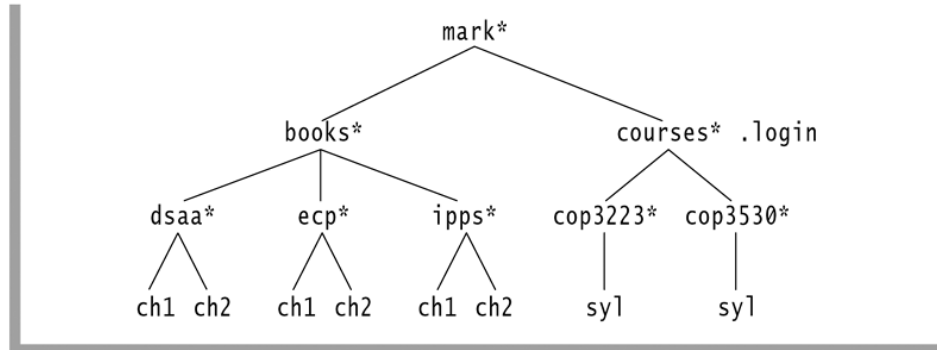
Introduction and terminology
for three types



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;

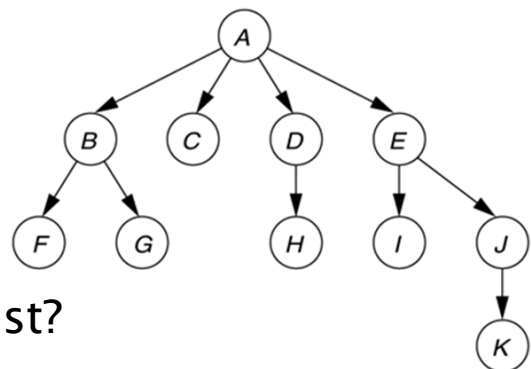
public class TraverseFiles {

    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!

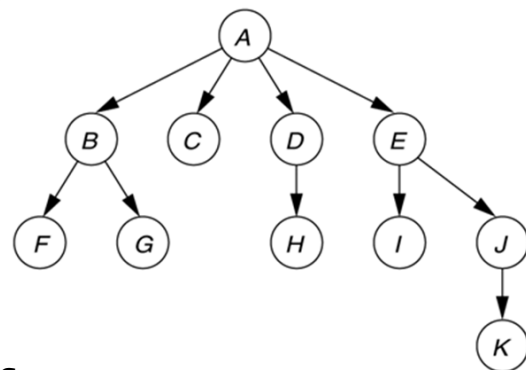


- ▶ How are trees like a linked list?
- ▶ How are they different?

Q3-7

Tree Terminology

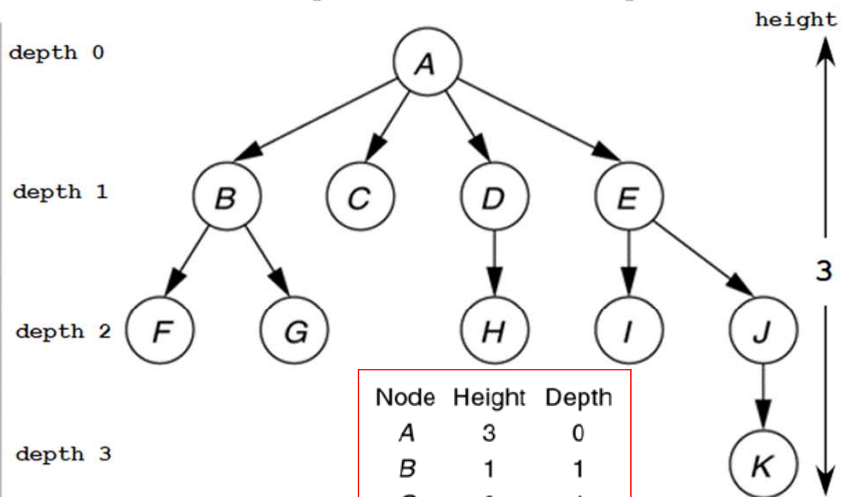
- ▶ Parent
- ▶ Child
- ▶ Grandparent
- ▶ Sibling
- ▶ Ancestors and descendants
- ▶ Proper ancestors, proper descendants
- ▶ Subtree
- ▶ Leaf, interior node
- ▶ Depth and height of a node
- ▶ Height of a tree



Node height and depth examples

figure 18.1

A tree, with height and depth information



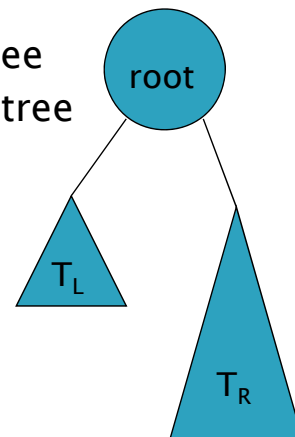
The height of a tree is the height of its root node.

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

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

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



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

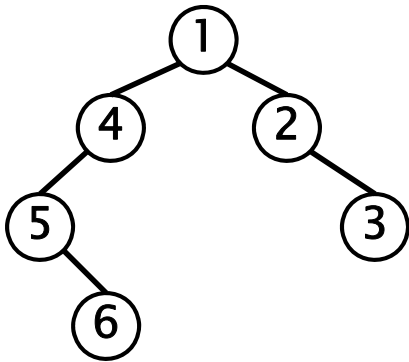
- ▶ Write size() for a tree
 - Recursively
 - Non-recursively (later)

- ▶ 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.