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Administrivia

- Homework 8 on Web (not yet complete). Due next Friday.

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Trees — Overview

- You probably know trees from PAD 2. In math terms, we can say a tree is a kind of graph — acyclic, connected, one node designated “root”.
- Can be used to represent any kind of hierarchy, e.g.:
 - Table of contents of a book.
 - Hierarchical help system.
 - Arithmetic expression.

Trees — Terminology

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- Some terminology should be familiar: root, subtree, parent, children, root of subtree.
- Other terms:
 - Depth of node (distance from root), height of tree (maximum depth).
 - Binary tree — at most two children per node.
 - Full binary tree.
 - Complete binary tree.

Trees — Recursive Definition

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- Tree is either
 - A single node, or
 - The tree formed by combining a root r with (disjoint) subtrees t_1 through t_n .
- (Example.)

Computer-Friendly Representation of Trees

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- Can of course use any representation that works for general graphs.
- Can also use array representation for binary trees: Number the nodes from 1 to N , and make a 2-by- N array for left/right children.
- Can also use pointer-based representation — simpler for binary trees, but possible for general trees as well.

Tree Traversals

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- For linear data structures (lists, arrays, etc.), basically only one reasonable way to “walk through” the structure to visit each element.
- For trees, there are three “reasonable” ways:
 - Preorder traversal (root first, then subtrees).
 - In-order traversal (leftmost subtree first, then root, then rest).
 - Postorder traversal (subtrees first, then root)
- Functions to perform any of these (e.g., and print each node as it is visited) are almost trivial to write recursively, much more difficult without recursion.

Trees — Special Types

- Special types (familiar from PAD 2?):
 - Sorted binary tree.
 - Heap.

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Trees and Recursion/Induction

- Easy to write other recursive algorithms to operate on trees — e.g., function to find height of tree.
- If we use the recursive definition of a tree, we can prove things about trees using induction. Example from textbook — prove that number of arcs is one less than number of nodes.

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Minute Essay

- Write a recursive function to count the number of nodes in a tree.
- Reminder: Homework 7 due by 5pm.

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