Data Structures in Java

Session 7

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Announcements

- Homework 2 released on website
  - Due Oct. 6^{th} at 5:40 PM (7 days)
- Homework 1 solutions posted
- Post homework to
  Shared Files, Homework #2

Review

- Review of **scope**
- Stack applications examples
- Stack implementation (easy)
- Queue ADT definition and implementation

Today's Plan

- Lists, Stacks, Queues in Linux
- Introduction to Trees
  - Definitions
  - Tree Traversal Algorithms
- Binary Trees

Lists, Stacks, Queues in Linux

- Linux:
  - processes stored in Linked List
  - FIFO scheduler schedules jobs using queue
  - function calls push memory onto stack

Drawbacks of Lists

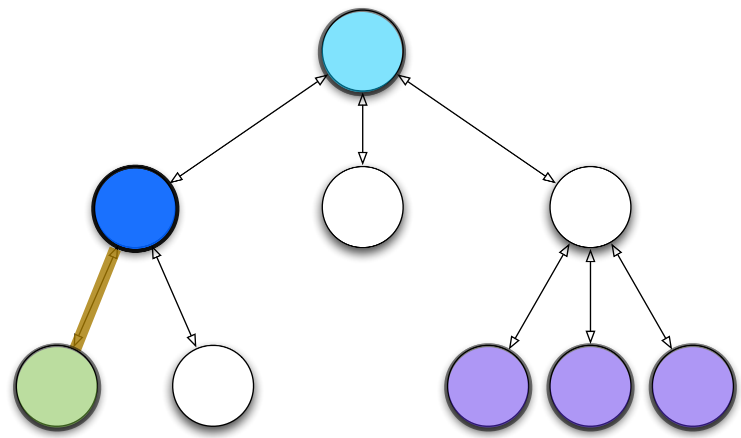
- So far, the ADT's we've examined have been linear
- O(N) for simple operations
- Can we do better?
  - Recall binary search: log N for find :-)
  - But list must be sorted. N log N to sort :-(

Trees

- Extension of Linked List structure:
  - Each node connects to multiple nodes
- Example usages include file systems, Java class hierarchies
- Fast searchable collections

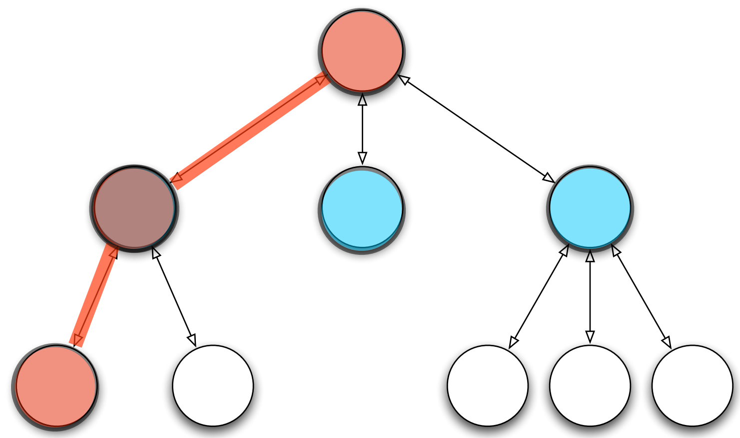
Tree Terminology

- Just like Linked Lists, **Trees** are collections of **nodes**
- Conceptualize trees upside down (like family trees)
  - the top node is the **root**
  - nodes are connected by **edges**
  - edges define **parent** and **child** nodes
  - nodes with no children are called **leaves**



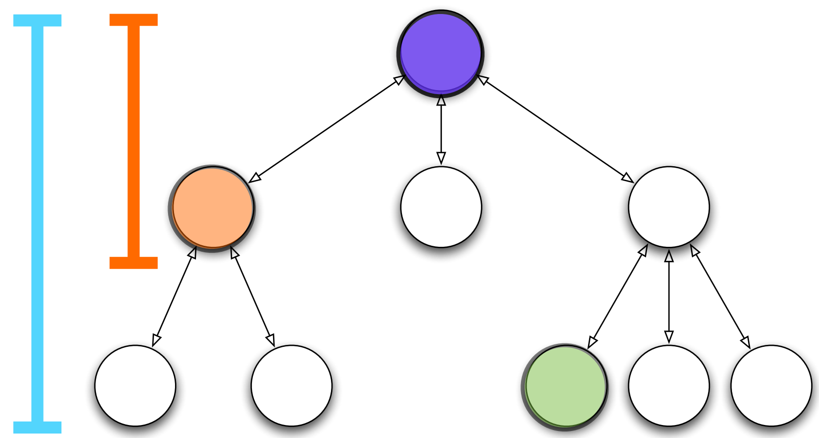
More Tree Terminology

- Nodes that share the same parent are **siblings**
- A **path** is a sequence of nodes such that the next node in the sequence is a child of the previous

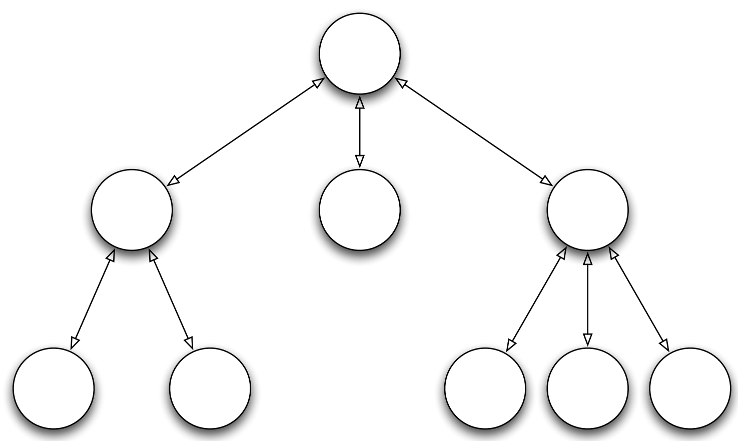


More Tree Terminology

- a node’s **depth** is the length of the path from root
- the **height** of a tree is the maximum depth
- if a path exists between two nodes, one is an **ancestor** and the other is a **descendant**



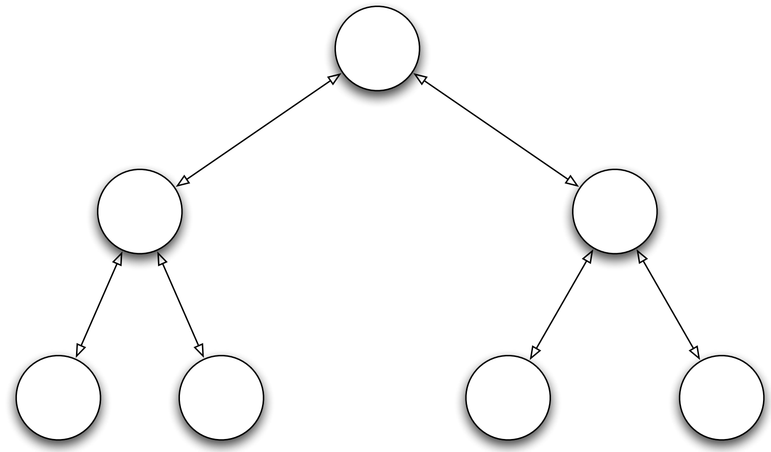
Tree Implementation

- Many possible implementations
- One approach: each node stores a list of children
- ```
  public class TreeNode<T> {
      T Data;
      Collection<TreeNode<T>> myChildren;
  }
  ```
  ```

Tree Traversals

- Suppose we want to print all nodes in a tree
- What order should we visit the nodes?
  - **Preorder** - read the parent before its children
  - **Postorder** - read the parent after its children

Preorder vs. Postorder

- ```
  // parent before children
  preorder(node x)
      print(x)
      for child : myChildren
          preorder(child)
  ```
- ```
  // parent after children
  postorder(node x)
      for child : myChildren
          postorder(child)
      print(x)
  ```



Binary Trees

- Nodes can only have two children:
  - left child and right child
- Simplifies implementation and logic
- ```
  public class BinaryNode<T> {
      T element;
      BinaryNode<T> left;
      BinaryNode<T> right;
  }
  ```
- Provides new **inorder** traversal
  ```

Inorder Traversal

- Read left child, then parent, then right child
- Essentially scans *whole* tree from left to right
- inorder(node x)

```
    inorder(x.left)
    print(x)
    inorder(x.right)
```

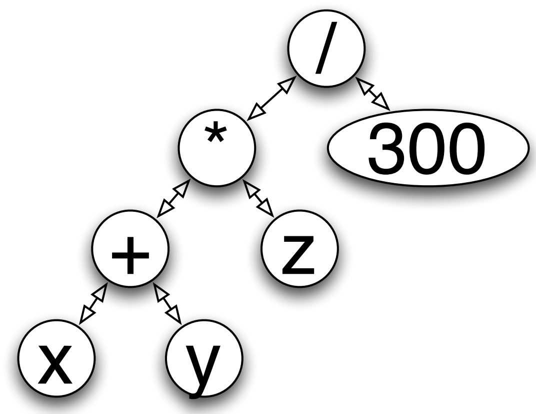


Binary Tree Properties

- A binary tree is **full** if each node has 2 or 0 children
- A binary tree is **perfect** if it is full and each leaf is at the same depth
  - That depth is O(log N)

Expression Trees

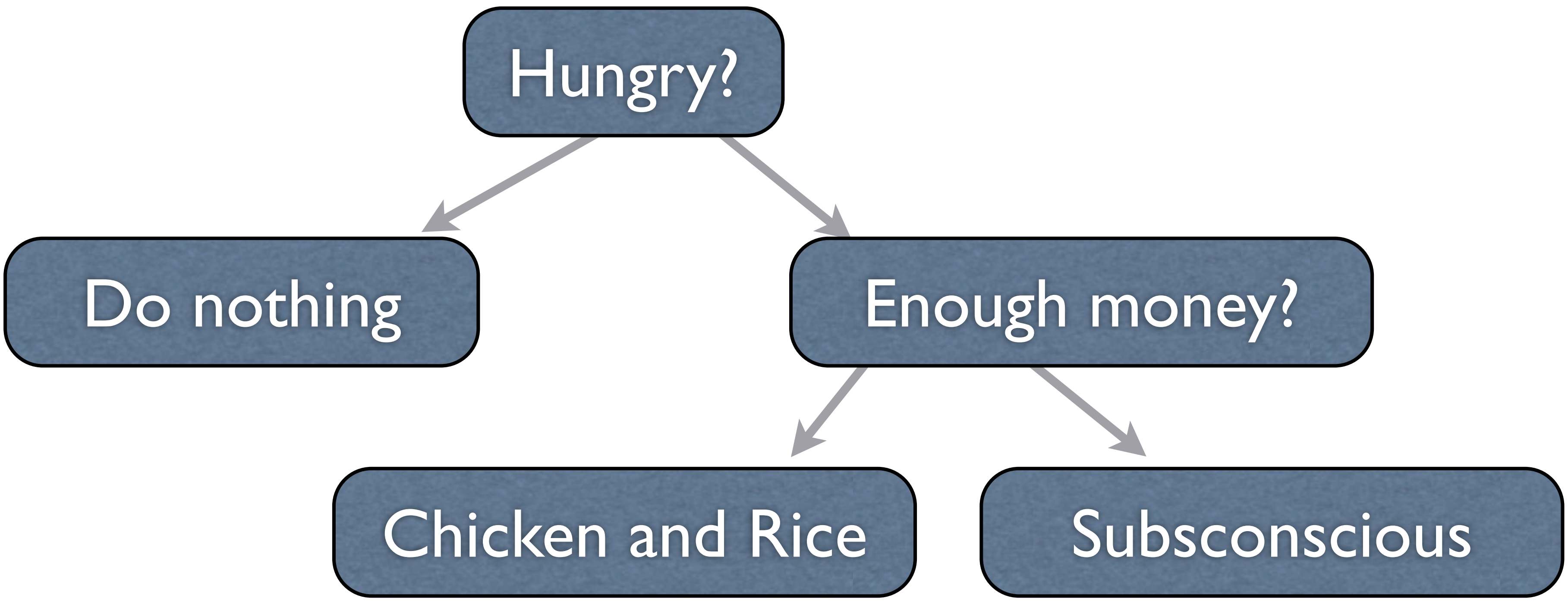
- Expression Trees are yet another way to store mathematical expressions
    - ((x + y) * z)/300



- Note that the main mathematical operators have 2 operands each
- Inorder traversal reads back infix notation
- Postorder traversal reads postfix notation

Decision Trees

- It is often useful to design decision trees
- Left/right child represents yes/no answers to questions



Reading

- This class: Weiss 4.1-4.2
- Next class: Weiss 4.3