

For Monday

- Read Weiss, chapter 4, section 5
- Homework:
 - Chapter 4, exercise 9

Programming Assignment 2

- Any questions?

Bucket Sort

- Also known as bin sort
- Radix sort

Binary Search Trees

- An addition to our possible dictionary implementations
- We're interested in operations:
 - Search
 - Insert
 - Delete
 - Output in ascending order of keys
 - FindMin
 - FindMax

Definition

- Binary tree
- Each element has an associated key
- Keys are not duplicated
- For any node, all keys in its left subtree are smaller than its key and all keys in its right subtree are larger than its key

Binary Search Tree Operations

- Search
 - Time Complexity
- Insert
 - Time Complexity
- Deletion
 - Of a leaf
 - Of a node with one non-empty subtree
 - Of a node with two non-empty subtrees
 - Time Complexity
- Output Ordered List
- FindMin
- Find Max

Problem With Binary Trees

- Basic operations are $O(h)$
- What is the height?
- Best case --
- Worst case --

Solution

- How we can solve the performance problems of binary search trees?

AVL Search Trees

- An AVL tree is a binary tree such that:
 - the difference between the heights of the left subtree and the right subtree is no more than one
 - the left subtree and the right subtree are AVL trees
- An AVL search tree is simply a binary search tree which is also an AVL tree

Maintaining the AVL Properties

- Each node has a balance factor associated with it -- 0, 1, or -1
- If the nodes subtrees have equal heights, the balance factor is 0
- If the right subtree has greater height (by 1) the balance factor is -1
- If the left subtree has greater height (by 1) the balance factor is 1

Binary Search Tree Operations

- Search
 - Time Complexity
- Insertion
 - May have to rotate
 - Time Complexity
- Deletion
 - May have to rotate up to $\log(n)$ times
 - Time Complexity