

CS261 Data Structures

AVL Trees II

Concepts and Examples

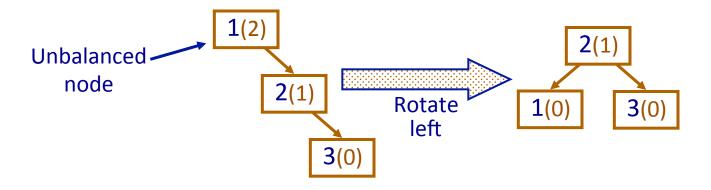


Goals

- Introduce AVL Tree Concepts
 - Rotation
 - Balancing
- Work through AVL Tree examples

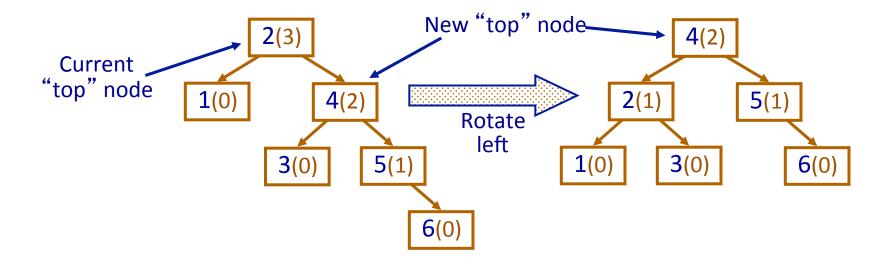


Case 1: Single Rotation





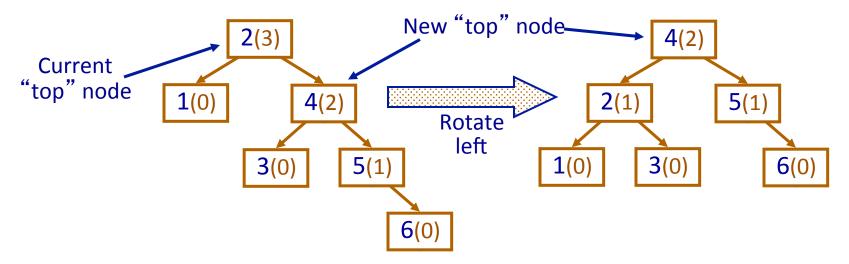
Case 1: Single Rotation Example 2



AVL Trees: Rotation Pseudocode

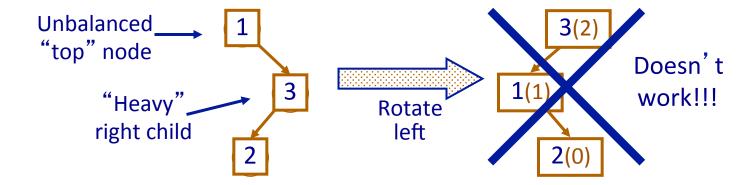
Pseudocode to rotate current ("top") node left:

- 1. New top node is the current node's right child
- 2. Current node's new right child is the new top node's (old right child's) left child
- 3. New top's left child is the current node
- 4. Set height of current node
- 5. Set height of new top node
- 6. Return new top node



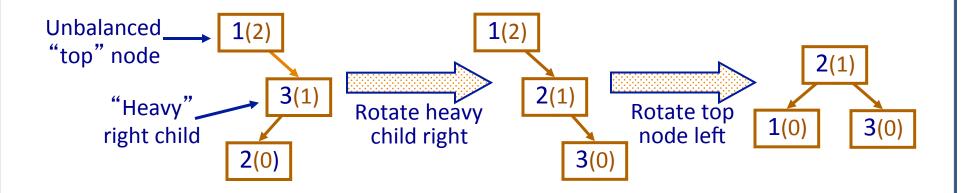


- Sometimes a single rotation will not fix the problem:
 - Can happen when an insertion is made on the left (or right) side of a node that is itself a heavy right (or left) child





- Fortunately, this case is easily handled by rotating the child before the regular rotation:
 - 1. First rotate the heavy right (or left) child to the right (or left)
 - 2. Rotate the "top" node to the left (or right)





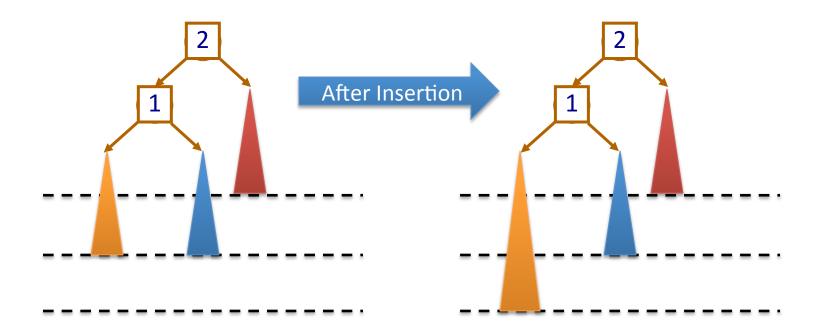
AVL Trees: Balacing Pseudocode

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Balancing pseudocode (to rebalance an unbalanced node):
If left child is tallest (by more than 1):
    If left child is heavy on the right side: // Double rotation needed.
        Rotate the left child to the left
    Rotate unbalanced ("top") node to the right
Else if right child is tallest(by more than 1)
    If right child is heavy on the left side: // Double rotation needed.
        Rotate the right child to the right
    Rotate unbalanced ("top") node to the left
Return new "top" node
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Case 1: Single Rotation

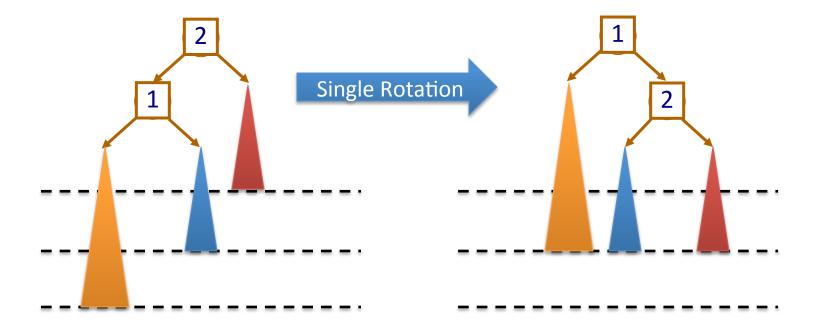
- Have a node (2) that is heavy on the left (1)
- Operation makes (2) unbalanced and that heavy child heavy on left





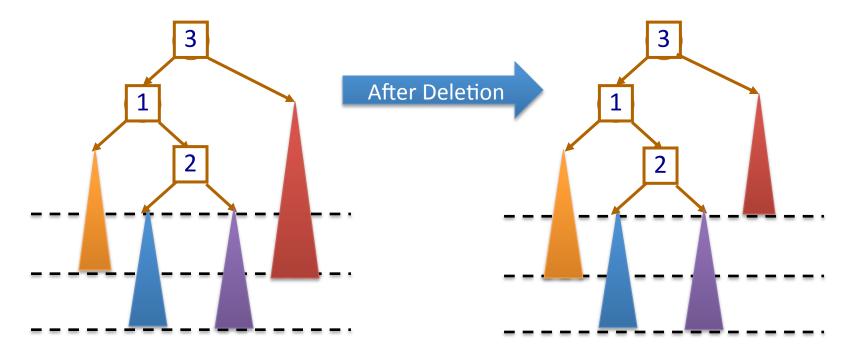
Case 1: Single Rotation

Single rotation fixes the problem



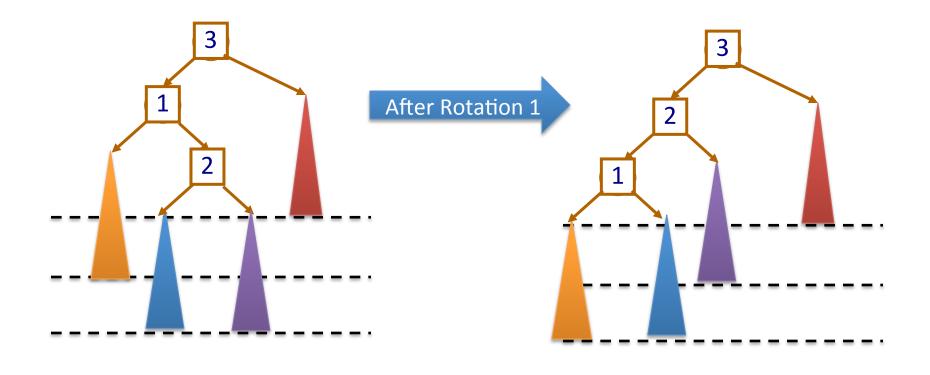


- Have a node (3) with a heavy left child (1)
- Operation makes (3) unbalanced and (1) is heavy on the right



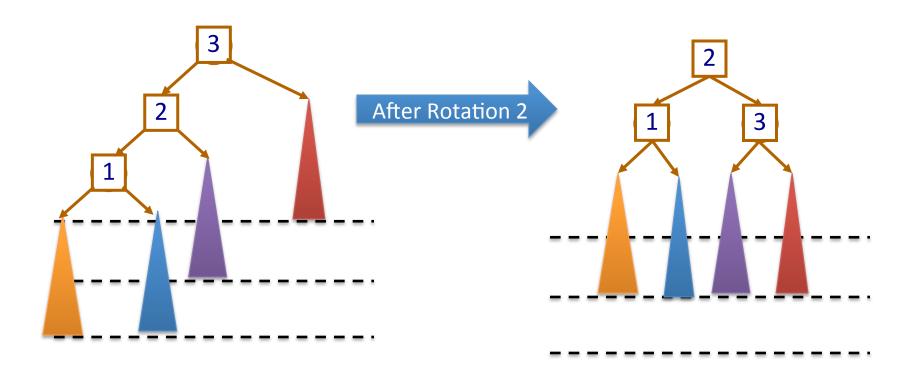


• First, rotate heavy child (1) to the left





Next, rotate unbalanced node (3) to the right



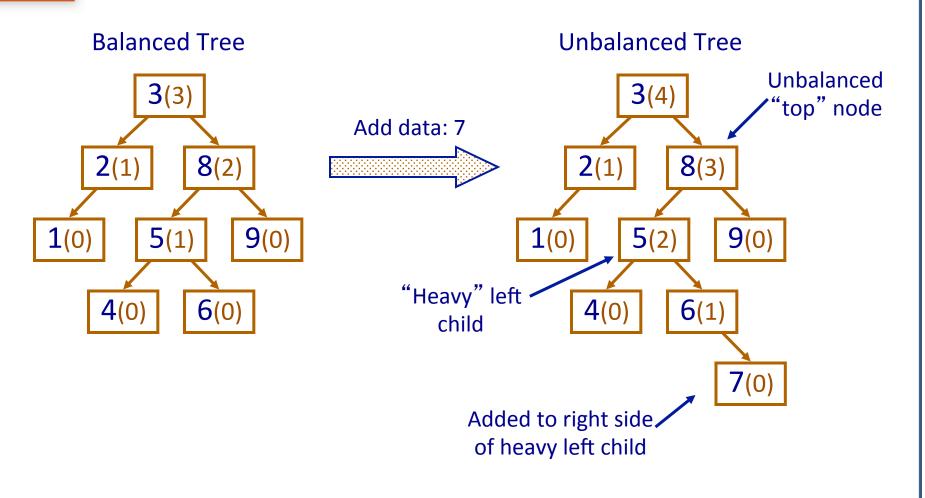


Rotations

- Can be the result of additions or removals
- All cases hold for the "right" side as well, just replace all lefts with rights and all rights with lefts

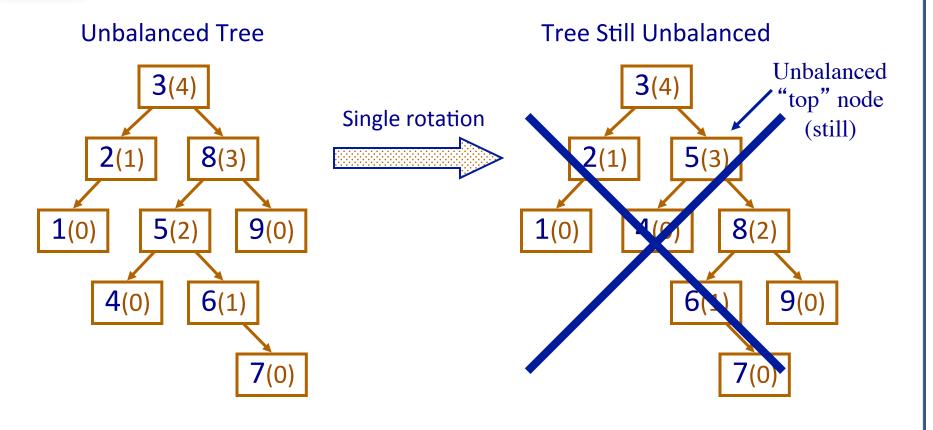


AVL Trees: Example



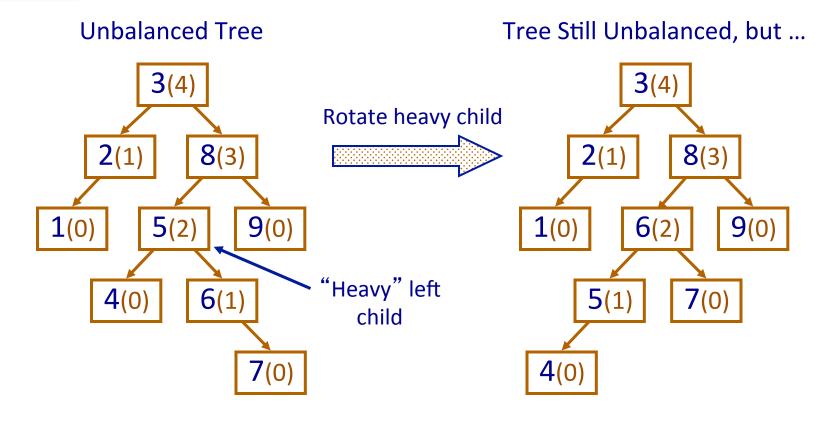


AVL Trees: Double Rotation Example



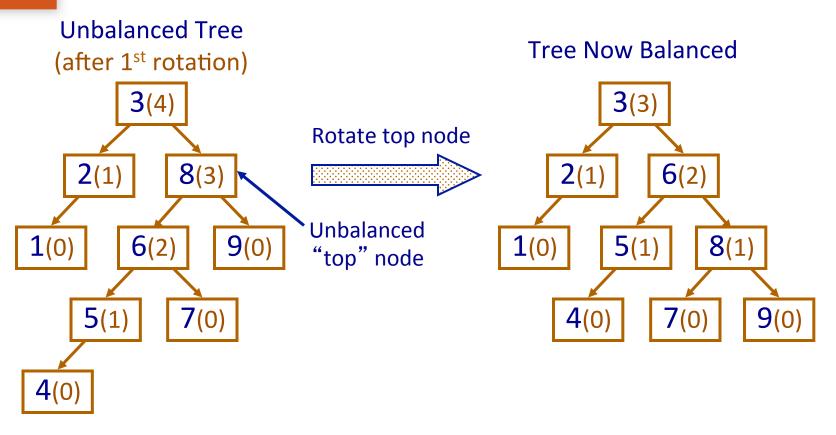


AVL Trees: Double Rotation Example





AVL Trees: Double Rotation Example





Your Turn

• Worksheet: AVL Practice