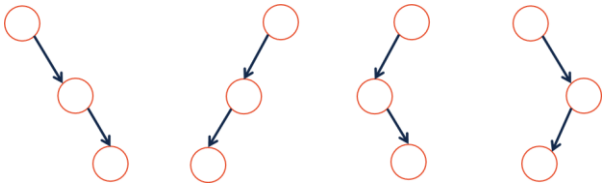
CS 225

#21: AVL Operations

October 16, 2017

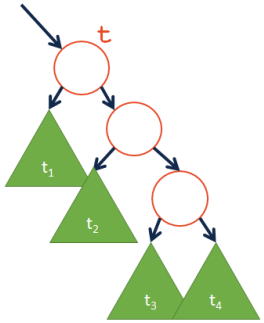
Four AVL Rotation Templates:



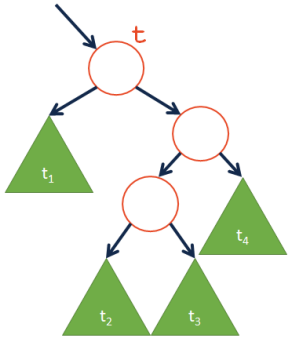
Detecting Imbalance:

b =

Theorem #1: If an insertion occurred in subtrees $\mathbf{t_3}$ or $\mathbf{t_4}$ and a subtree was detected at **t**, then a _____ rotation about t restores the balance of the tree.

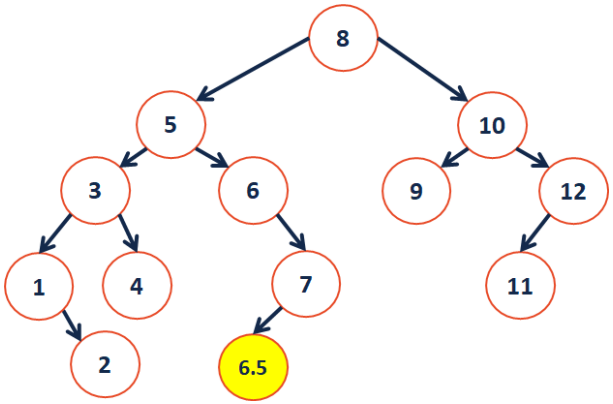


Theorem #2: If an insertion occurred in subtrees $\mathbf{t_2}$ or $\mathbf{t_3}$ and a subtree was detected at **t**, then a _____ rotation about t restores the balance of the tree.



AVL Insertion

Pseudocode:



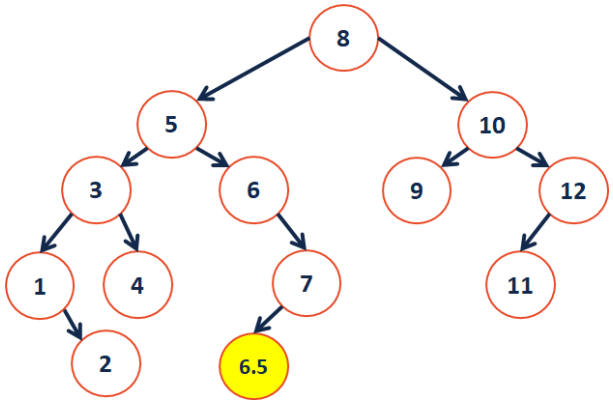
AVL.h (snippet)

```
1  struct TreeNode {
2    T key;
3    unsigned height;
4    TreeNode *left;
5    TreeNode *right;
6  }
```

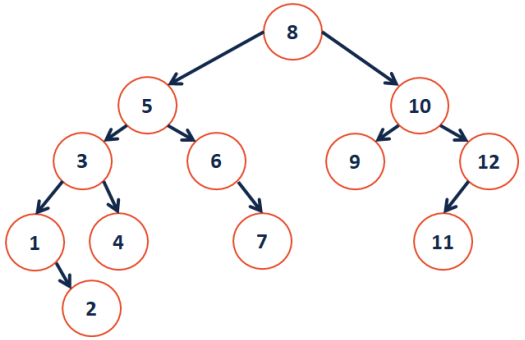
AVL Insertion

AVL.cpp (snippet)

```
1   template <class T>
    void AVLTree<T>::_insert(const T & x, treeNode<T> * & t ) {
2     if( t == NULL ) {
3       t = new TreeNode<T>(x, 0, NULL, NULL);
4     }
5
6     else if( x < t->key ) {
7       _insert( x, t->left );
8       int balance = height(t->right) - height(t->left);
9       int leftBalance = height(t->left->right)
                        - height(t->left->left);
10      if ( balance == -2 ) {
11        if ( leftBalance == -1 ) { rotate_____________( t ); }
12        else                     { rotate_____________( t ); }
13      }
14    }
15
16    else if( x > t->key ) {
17      _insert( x, t->right );
18      int balance = height(t->right) - height(t->left);
19      int rightBalance = height(t->right->right)
                         - height(t->right->left);
20      if( balance == 2 ) {
21        if( rightBalance == 1 ) { rotate_____________( t ); }
22        else                    { rotate_____________( t ); }
23      }
24    }
25
26    t->height = 1 + max(height(t->left), height(t->right));
27  }
```



AVL Removal



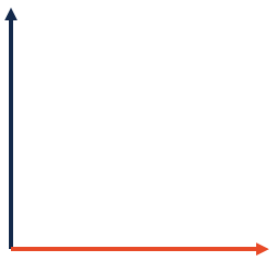
AVL Analysis

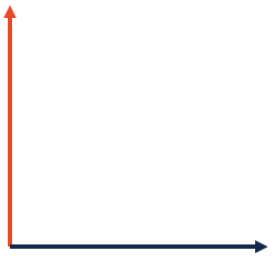
We know: _____.

We will argue: h = _____.

Big-O is defined as:

Visually:





CS 225 – Things To Be Doing:

1. Exam #6 live now! (Programming exam: lists, trees)
2. MP4 extra credit submission starts tonight!
3. New lab on Wednesday
4. Daily POTDs