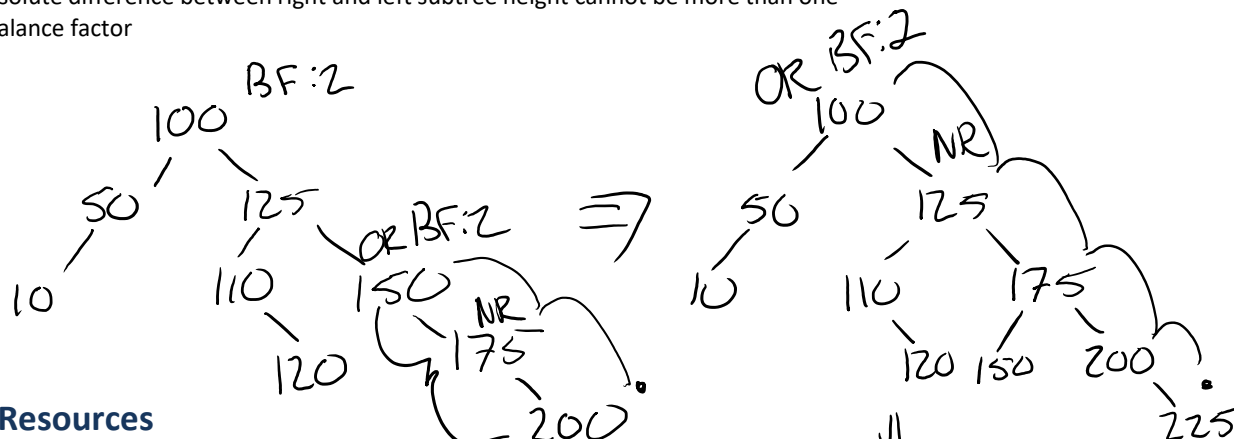# 2018-03-01 AVL Trees Part 2

Thursday, March 1, 2018   8:59 AM

AVL Tree Recap

- (recursive) Absolute difference between right and left subtree height cannot be more than one
    - Term: balance factor

Visualization Resources

- BST Visualization: http://www.cs.usfca.edu/~galles/visualization/BST.html
- AVL Visualization: http://www.cs.usfca.edu/~galles/visualization/AVLtree.html
- Visualization homepage: http://www.cs.usfca.edu/~galles/visualization/Algorithms.html

- In certain situations, this "simple" AVL rotation algorithm won't work. Consider:
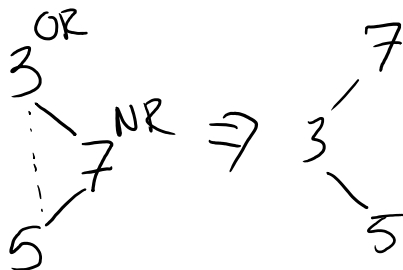

- A single rotation cannot fix these trees. To fix, we need a slightly more complex algorithm.

Full AVL Algorithm

- (requires one additional check and up to one additional rotate)
1. Where the imbalance occurs (Original Root), if the balance factor < 0
    a. New Root = Original Root's left child
    b. If New Root's balance factor > 0, perform a left rotation at New Root first
    c. THEN, perform actual rotation at Original Root
2. If Original Root's balance factor > 0
    a. New Root = Original Root's right child
    b. If New Root's balance factor < 0, perform right rotation at New Root first
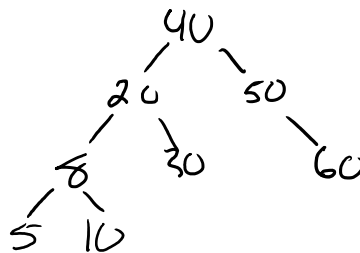   c. THEN, perform actual rotation at Original Root
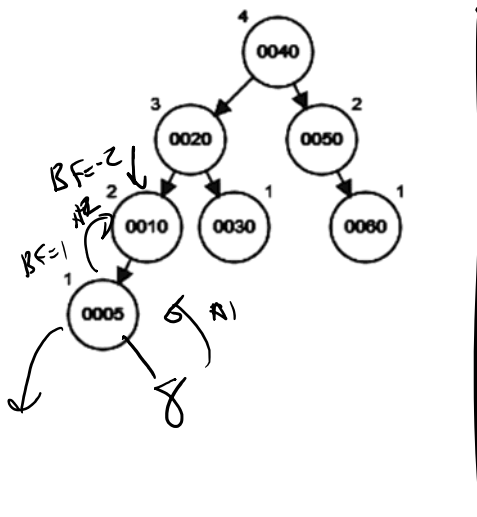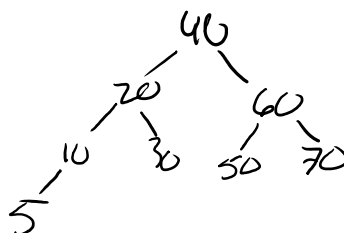
Back to simple examples
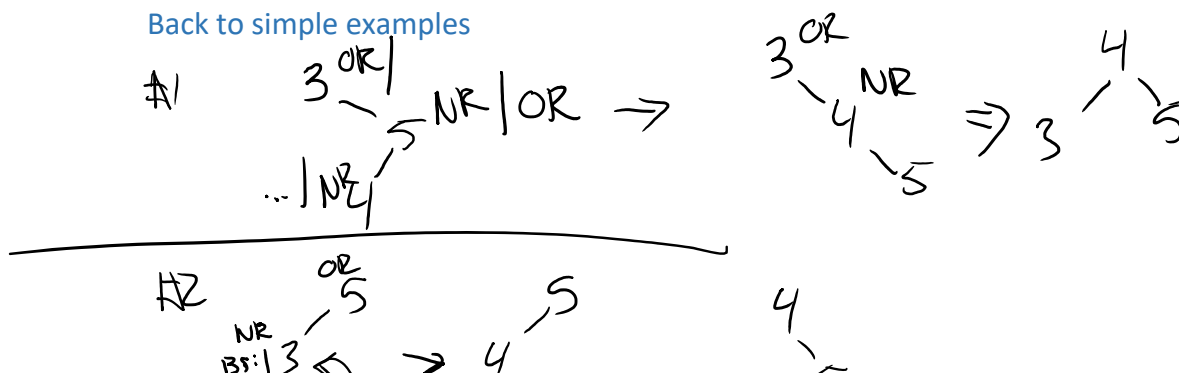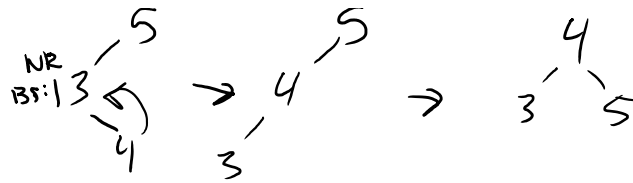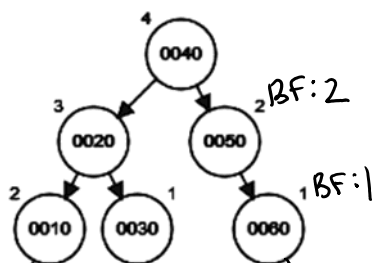
Example adds from an empty tree
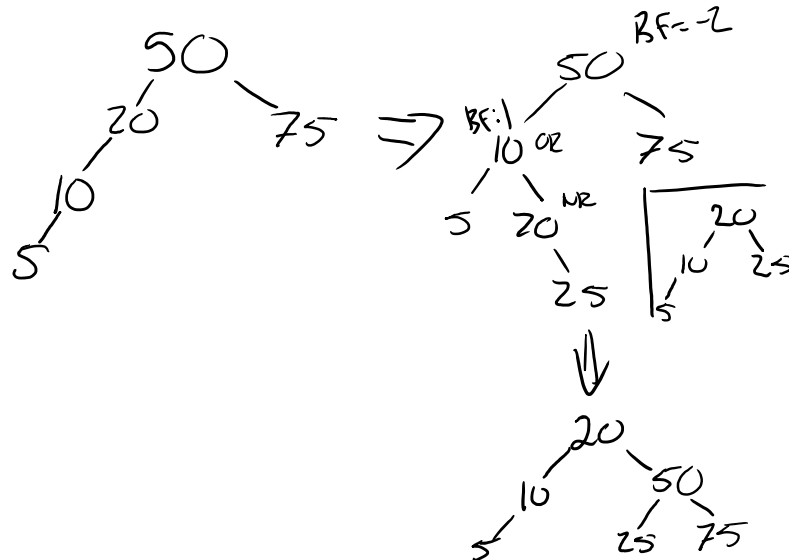
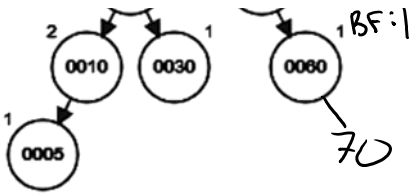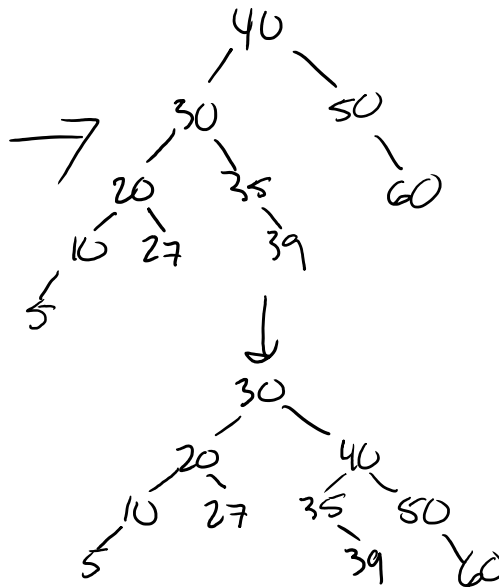## AVL Trees Handout

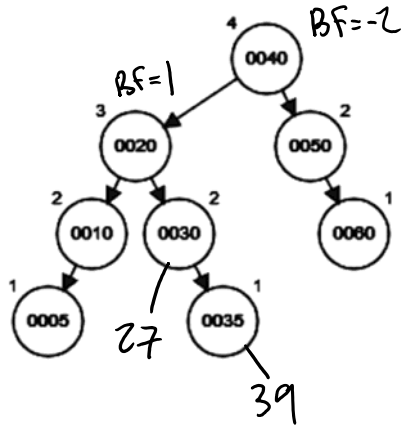1. Add 8 to the following AVL tree

2. Add 70 to the following AVL tree

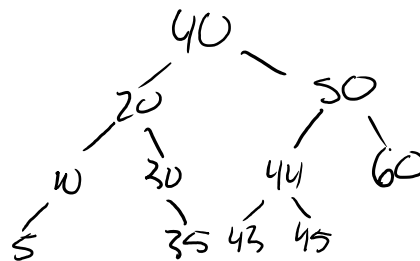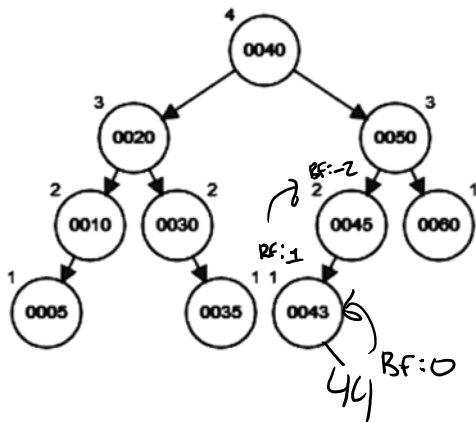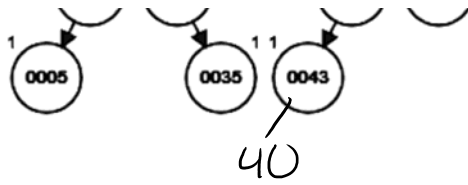2 0010   0030   1   0060   BF:1

5́

1 0005   70

3. Add 39 to the following AVL tree

4 0040   BF=-2
BF=1
3 0020   2 0050
2 0010   0030 2   0060 1
1 0005   27   0035 1
            39

40
30   50
20   35   60
10 27   39
5

↓

30
20   40
10 27   35   50
5   39   60

4. Add 44 to the following AVL tree

4 0040
3 0020   0050 3
2 0010 0030 2   BF:-2 0045   0060 1
1 0005   BF:1 1 1 0035 0043
                          44 BF:0

40
20   50
10   30   44   60
5   35 43 45

5. Add 40 to the following AVL tree

4 0040
3 0020   0050 3
2 0010 0030 2   2 0045   0060 1
1 0005   1 1 0035 0043

1
0005

1 1
0035 0043

40
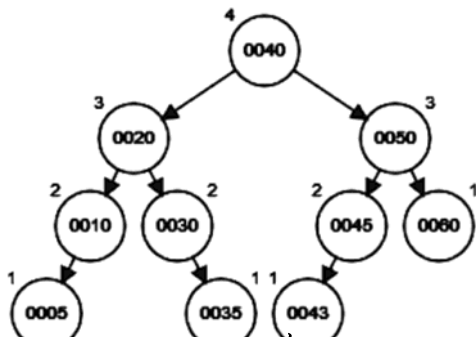
6. Remove 60 from the following AVL tree

4
0040

3
0020

3
0050

2
0010

2
0030

2
0045

1
0060

1
0005

1 1
0035 0043