#### Height of a tree node:

- 1. The height of a node with no elements is 0
- 2. The height of a node with 1 element is 1
- 3. The height of a node with > 1 element is 1 + the height of its tallest subtree

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#### AVL tree:

A binary tree in which the difference between the height of the right and left subtrees of the root is never more than one.

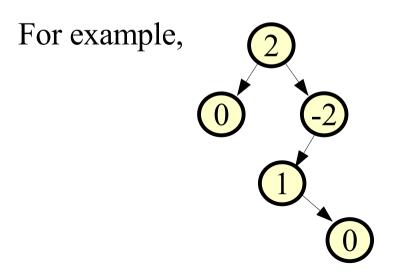
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#### AVL tree:

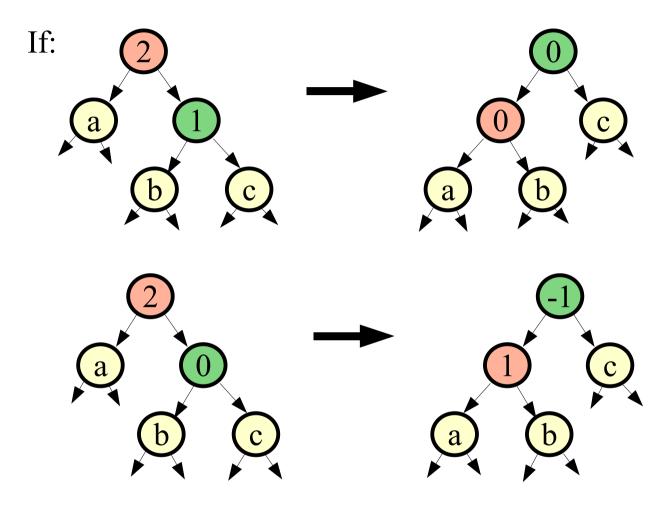
A binary tree in which the difference between the height of the right and left subtrees of the root is never more than one.

Each node keeps a balance number which is the difference in heights of its two subtrees.



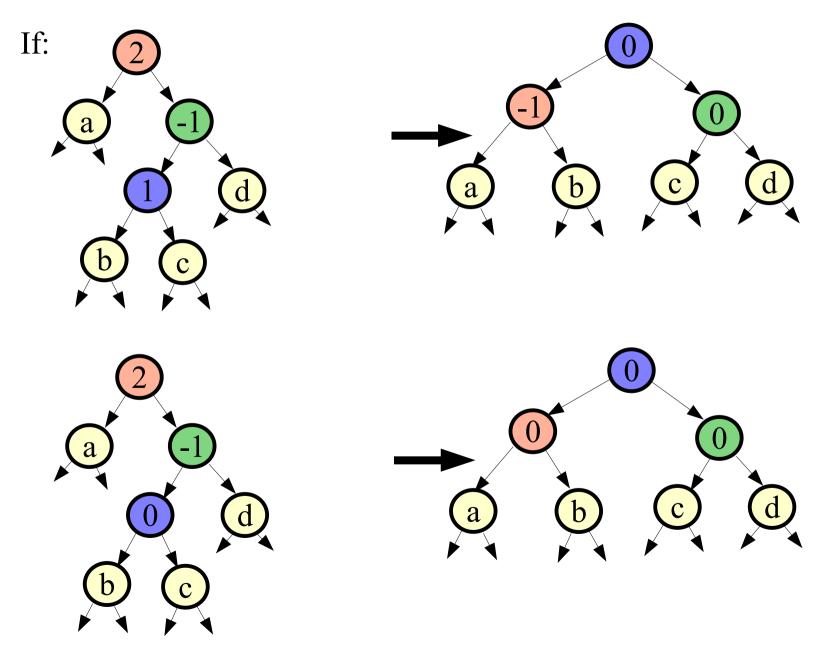
Whenever a balance number is not 0,-1,+1, perform some rotations according to some rules on following pages

Rules for rotation:

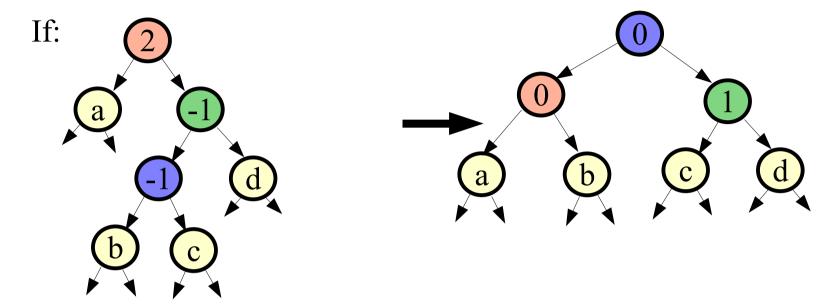


Plus mirror image of these two cases

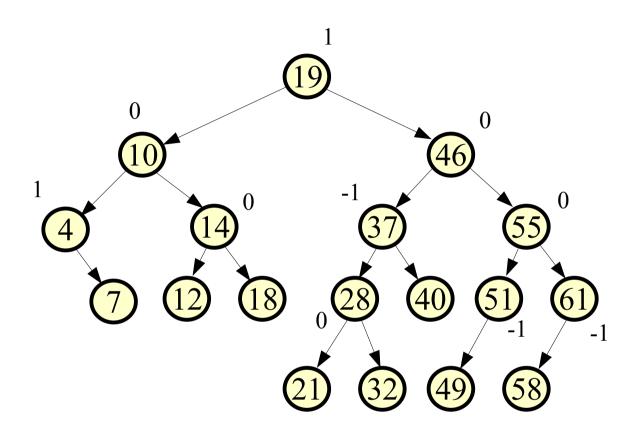
Rules for rotation:

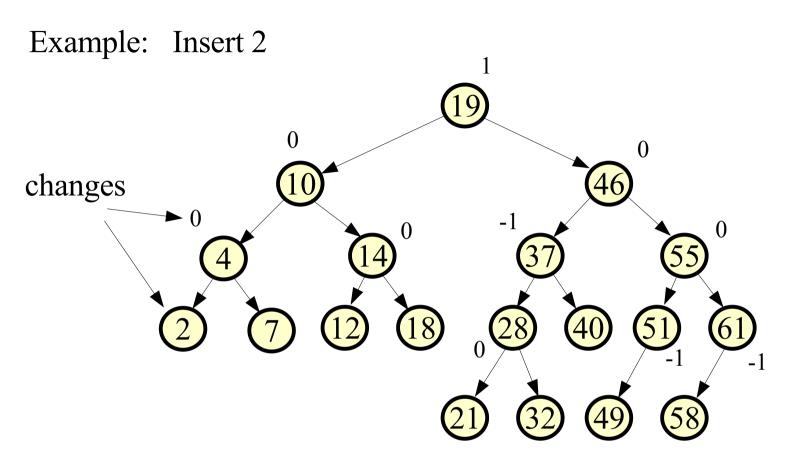


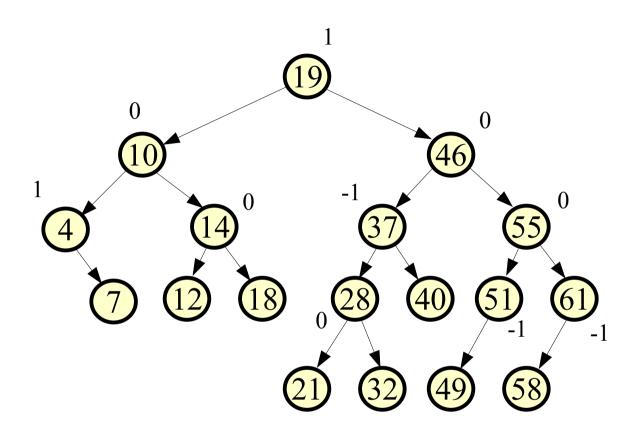
Rules for rotation:

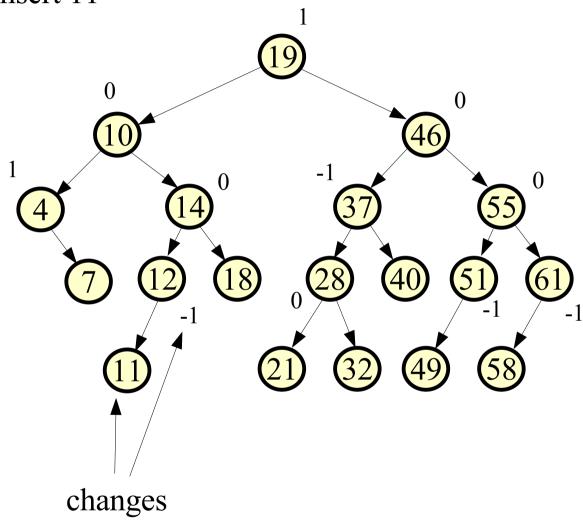


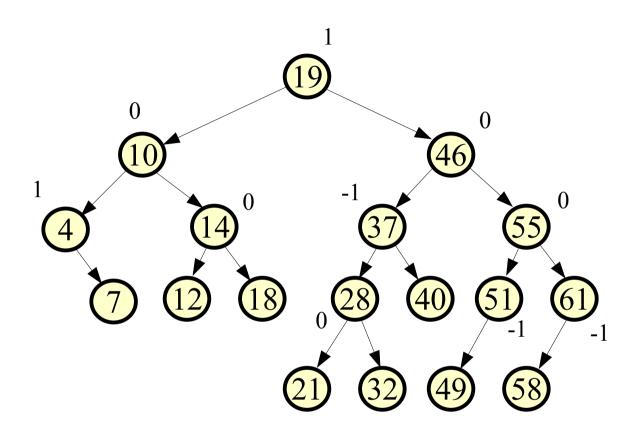
Plus mirror image of these three cases

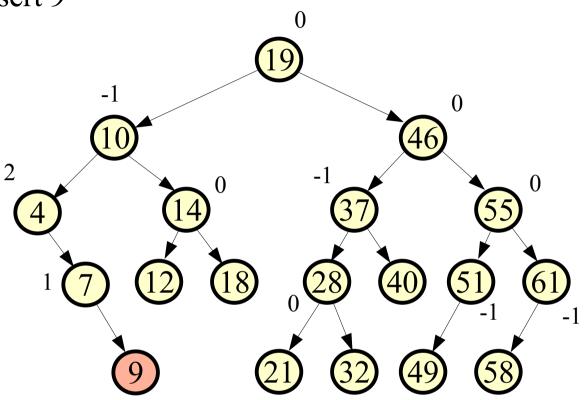




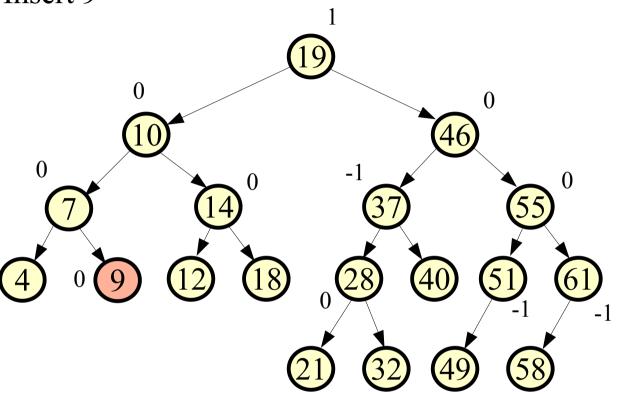




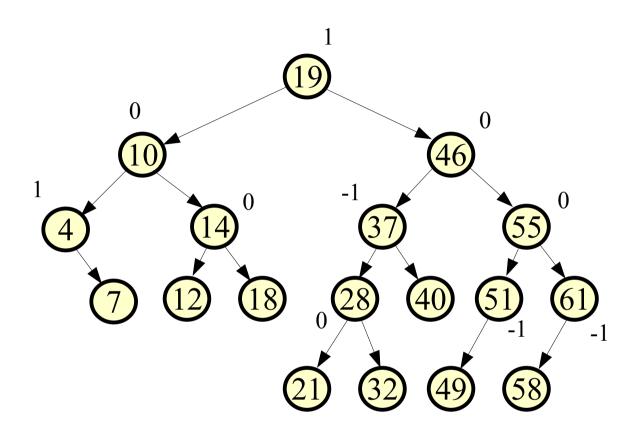


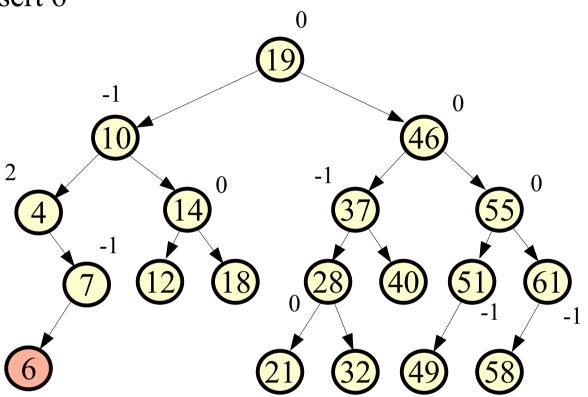


Example: Insert 9

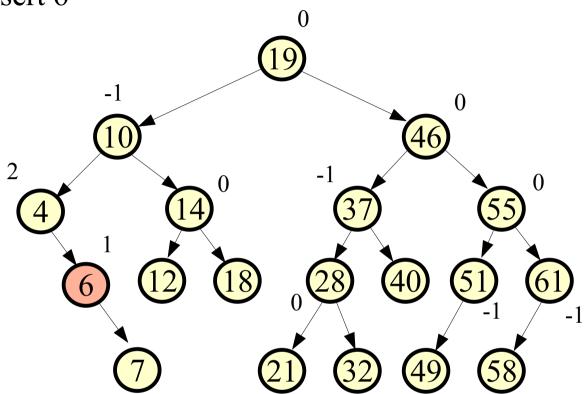


Rotation around 7



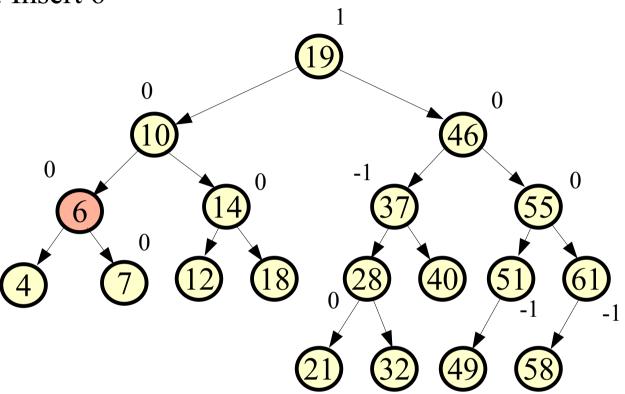


Example: Insert 6

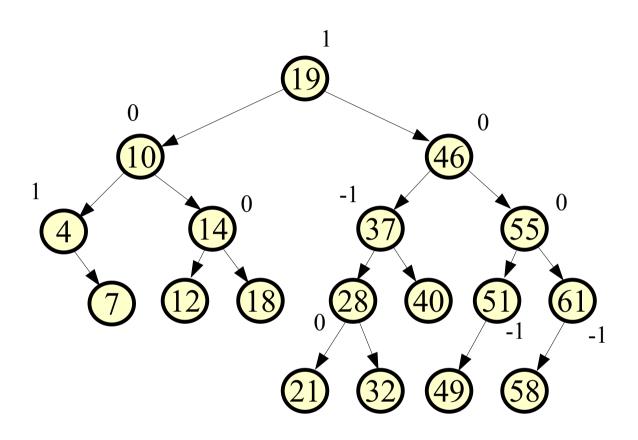


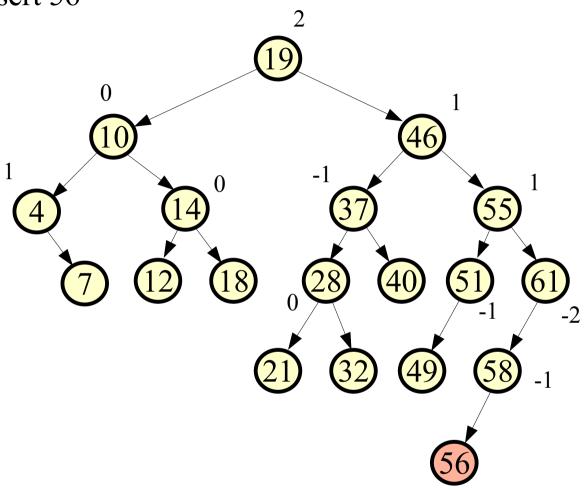
Double rotation

Example: Insert 6

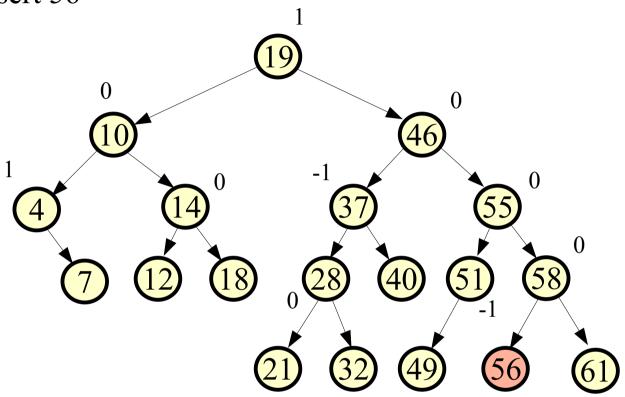


Double rotation

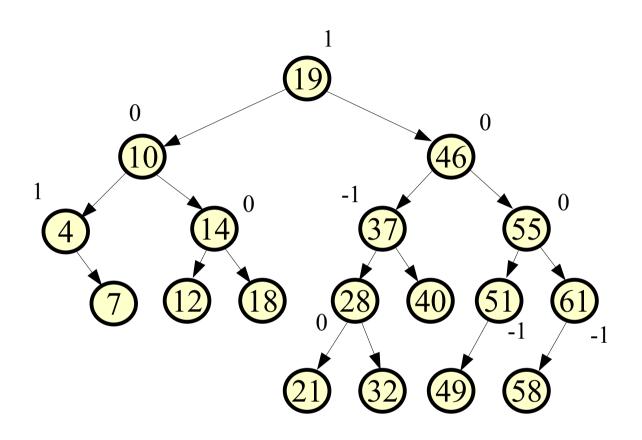


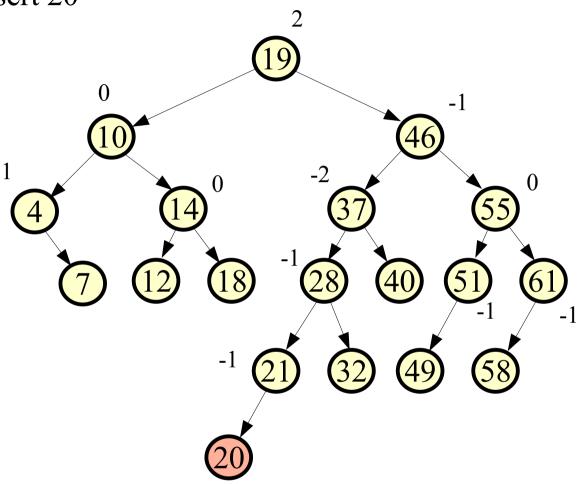


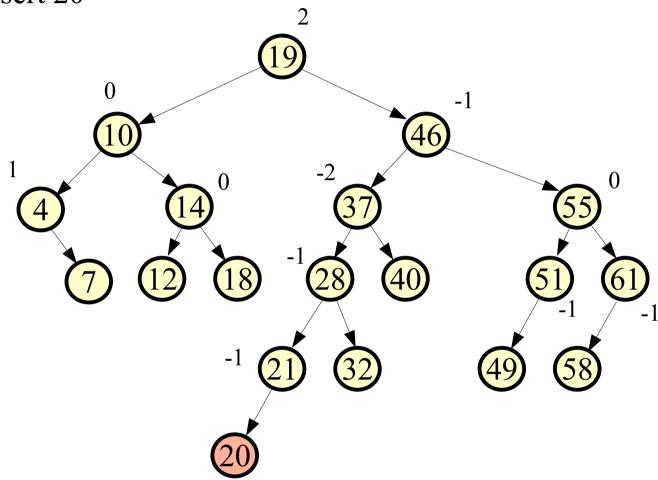
Example: Insert 56

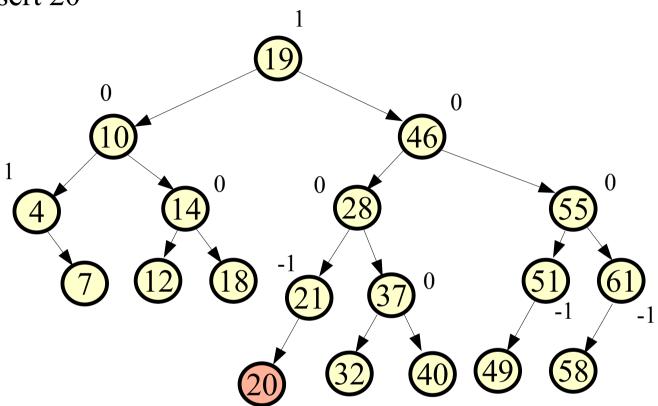


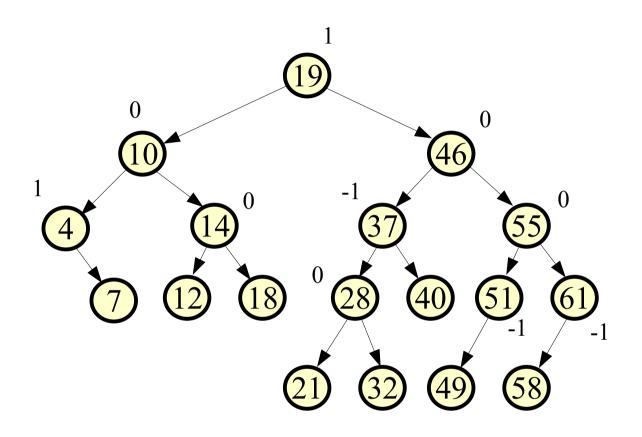
Single rotation around 58

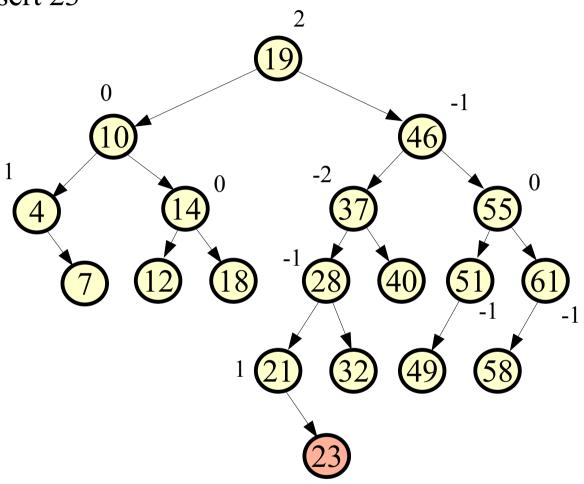




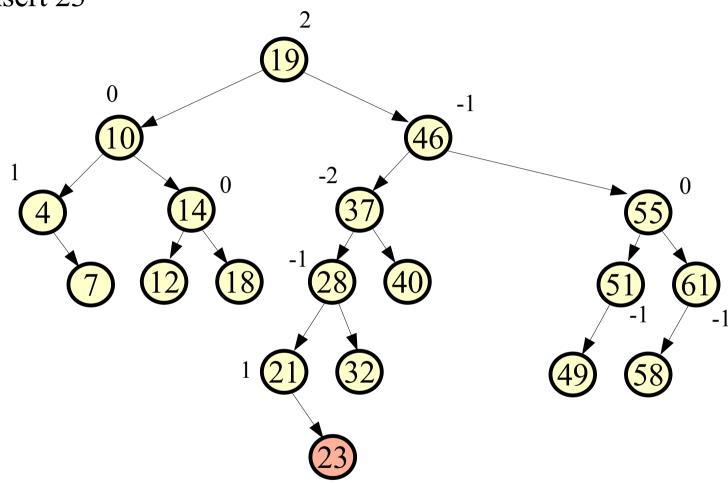






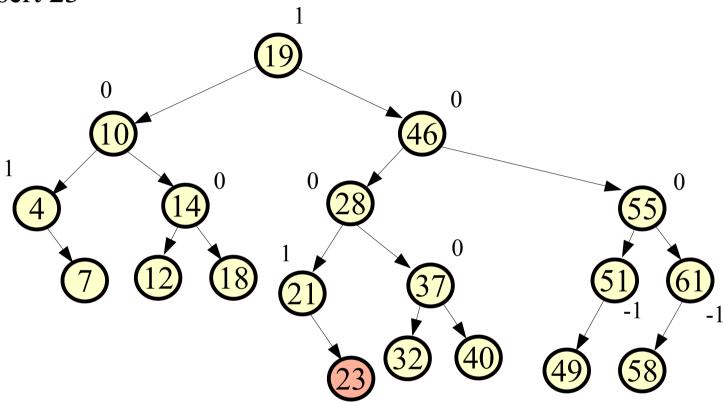


Example: Insert 23

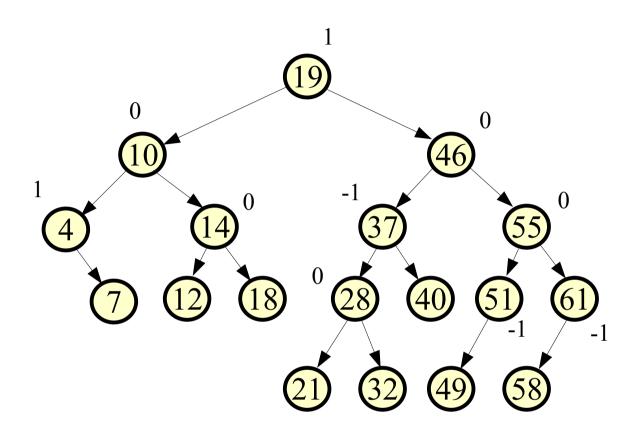


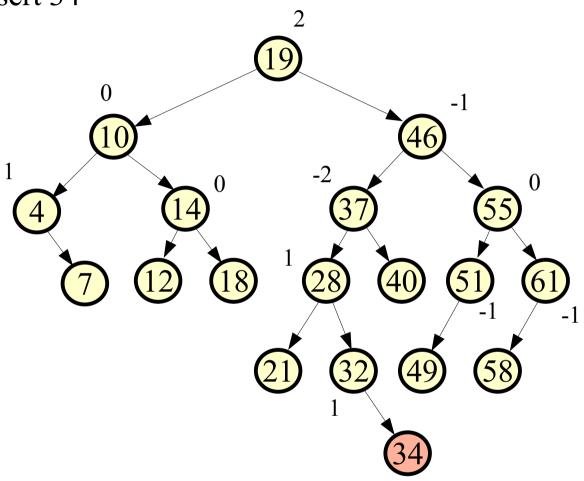
Rotation around 28

Example: Insert 23

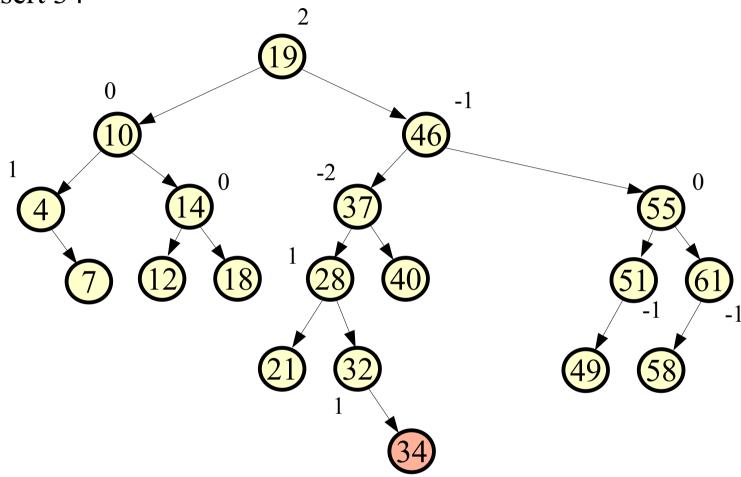


Rotation around 28



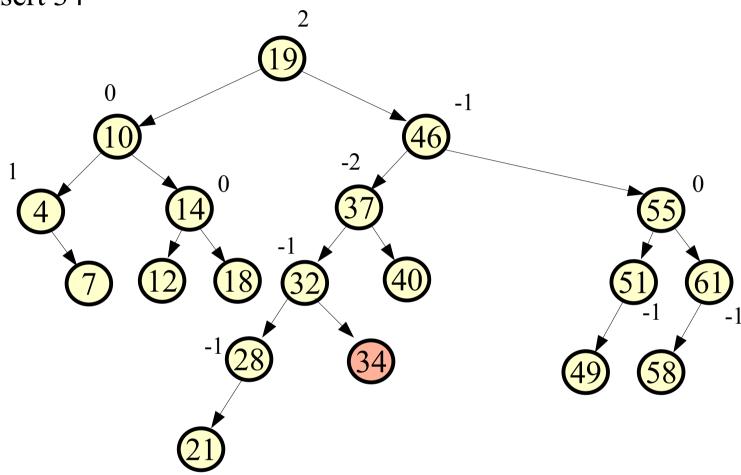


Example: Insert 34



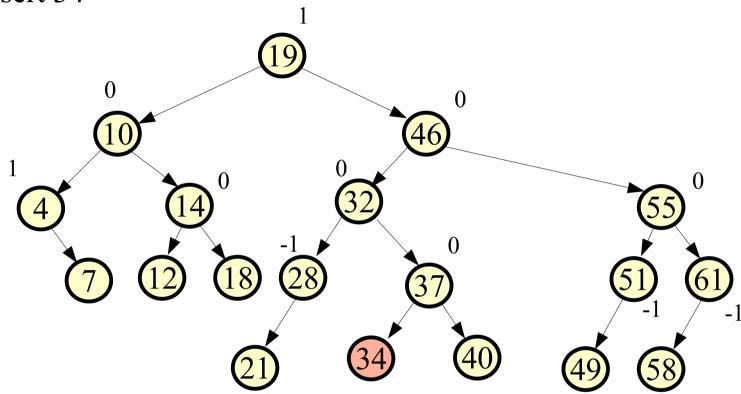
Double rotation around 32

Example: Insert 34

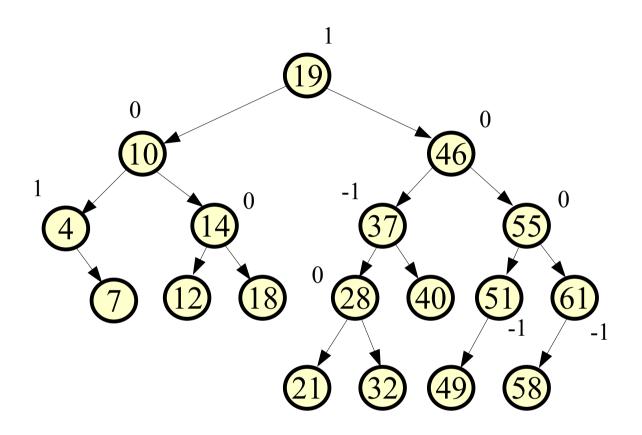


Double rotation around 32

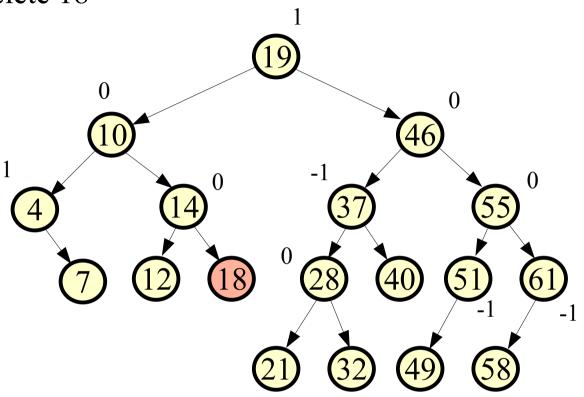
Example: Insert 34



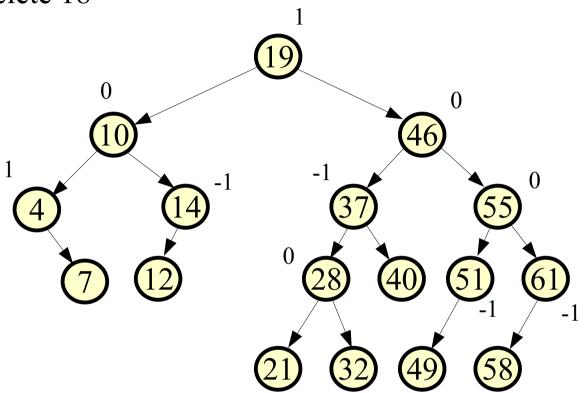
Double rotation around 32



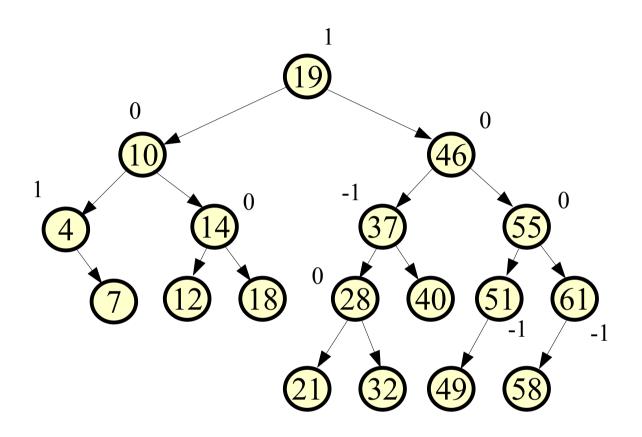
Example: Delete 18

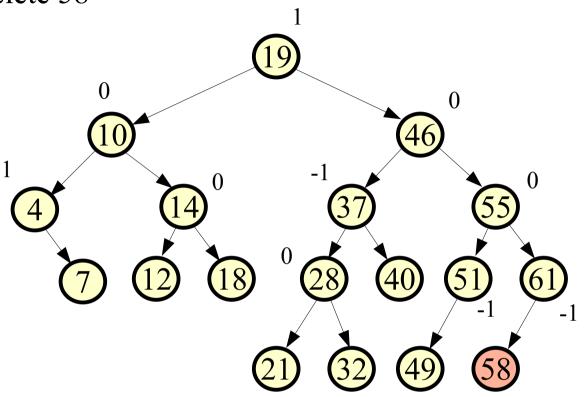


Example: Delete 18

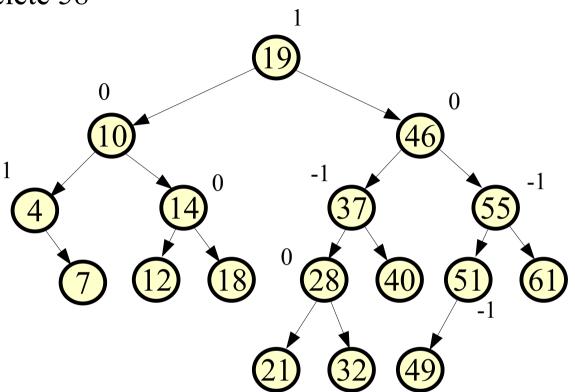


Example:

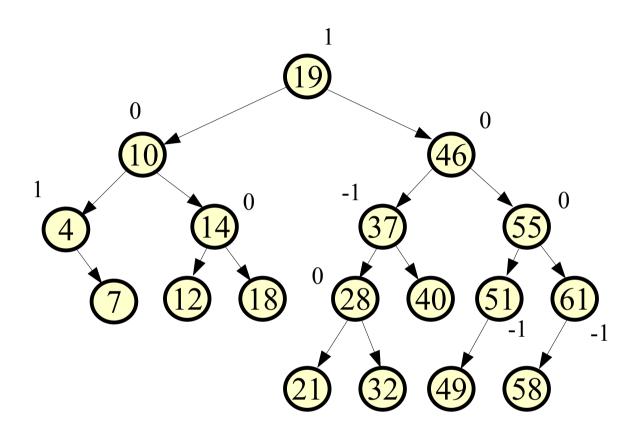


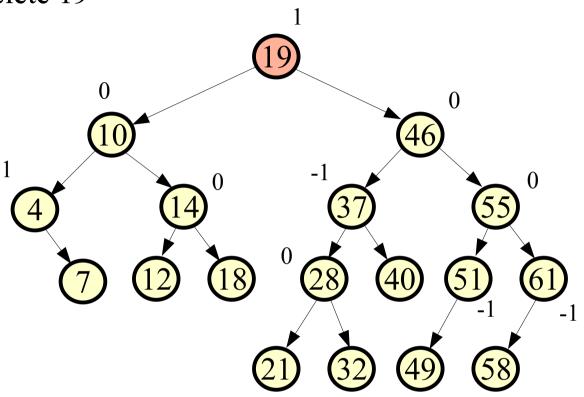


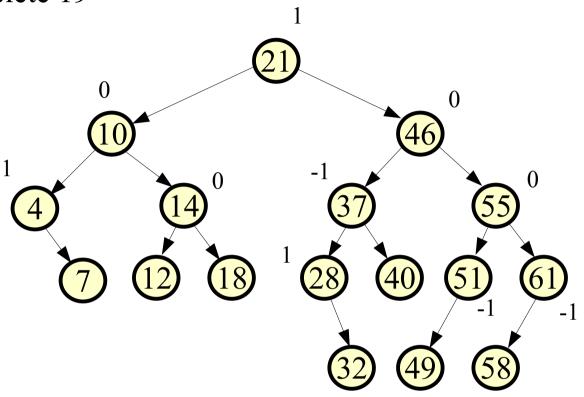
Example: Delete 58

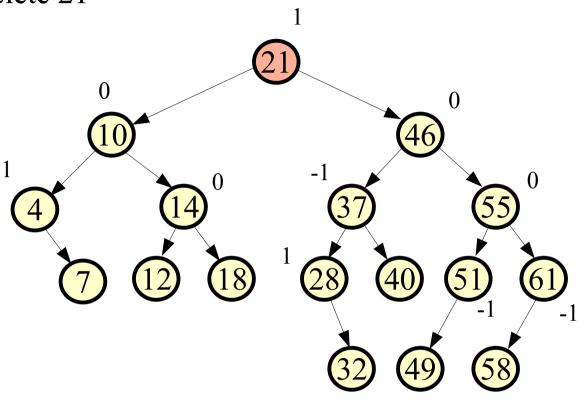


Example:

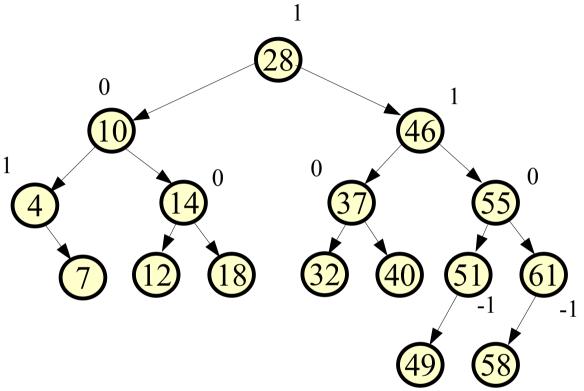


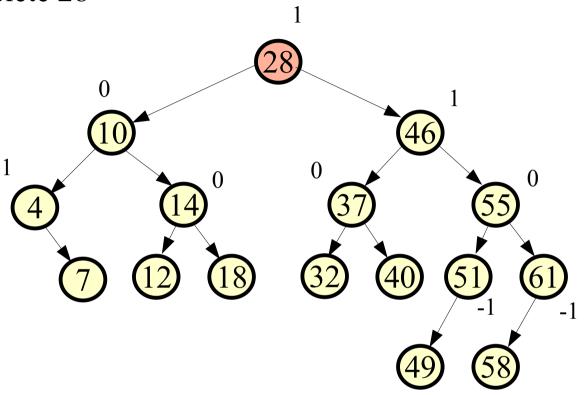




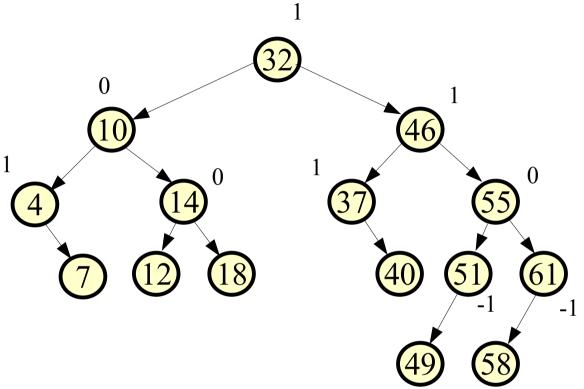


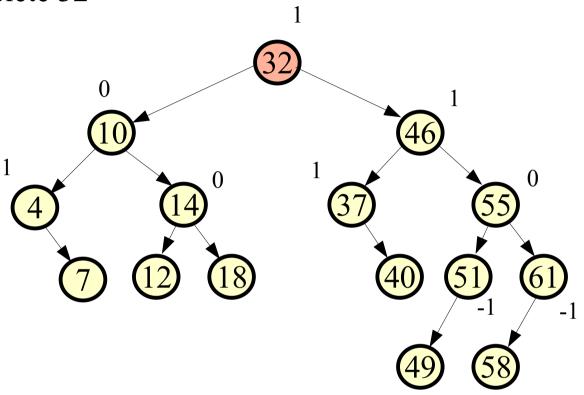
Example: Delete 21



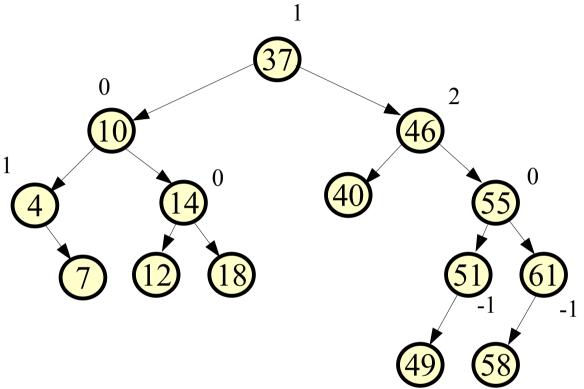


Example: Delete 28



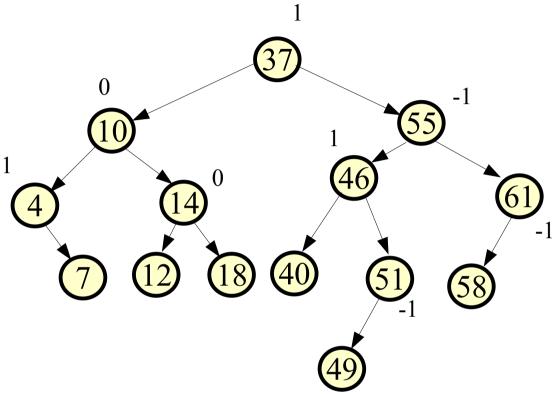


Example: Delete 32



Rotation around 55

Example: Delete 32



Rotation around 55