Unit 7 – AVL Tree

CS 201 - Data Structures II
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Habib University

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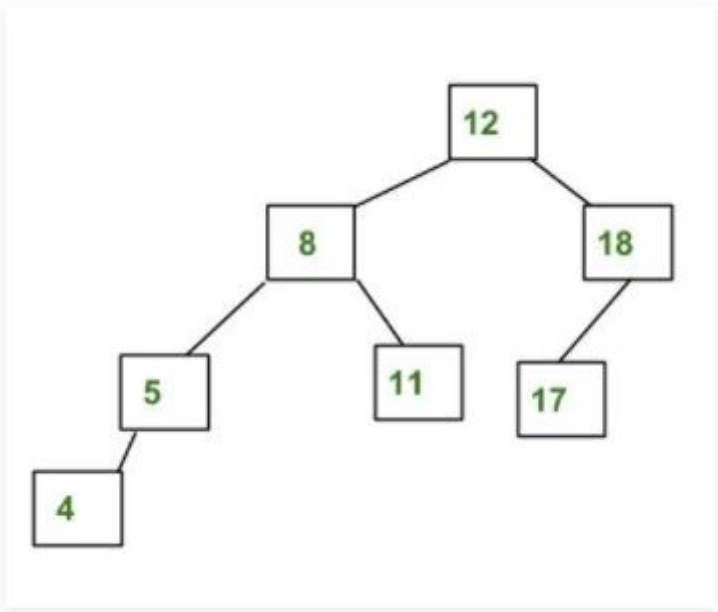
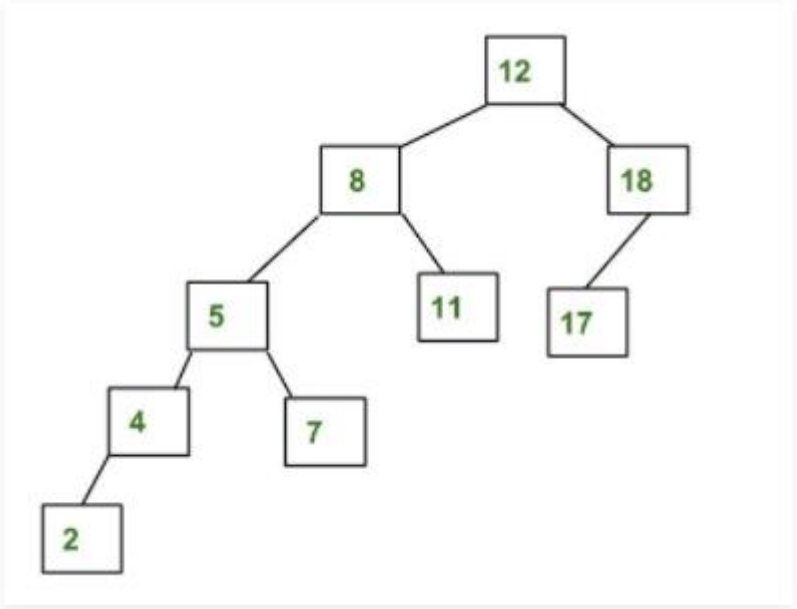
AVL Tree

- AVL tree is a self-balancing Binary Search Tree (BST) where the difference between heights of left and right subtrees cannot be more than one for all nodes.

Example



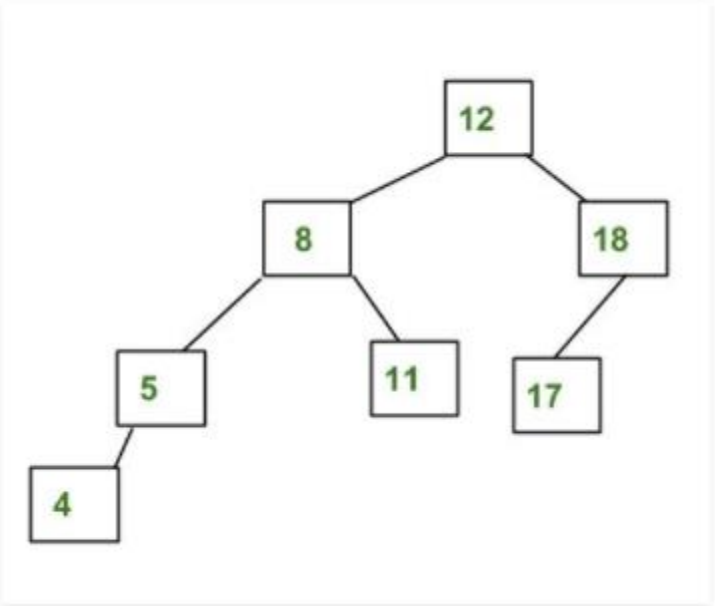
AVL Tree



Not an AVL Tree

Height-balance property

***Height-Balance Property*:** For every position p of T, the heights of the children of p differ by at most 1.

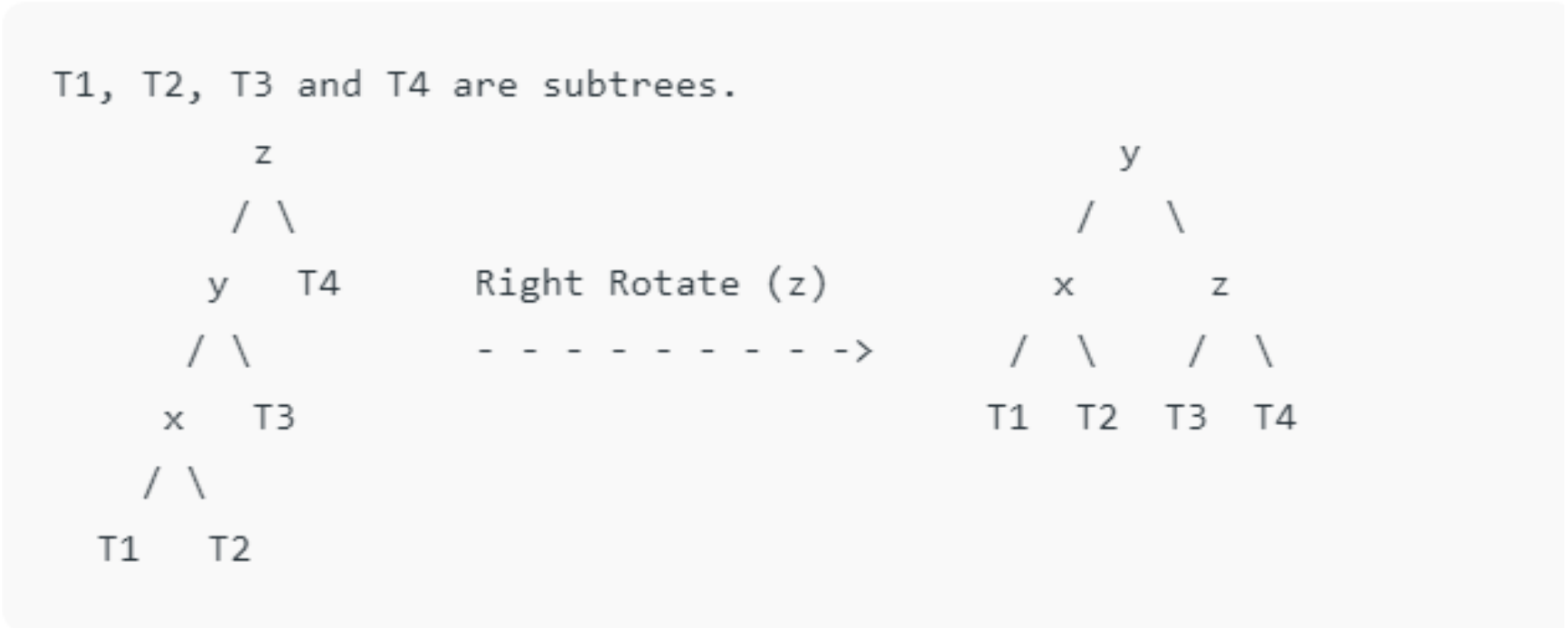


Constructing an AVL Tree

Fixing height disbalance

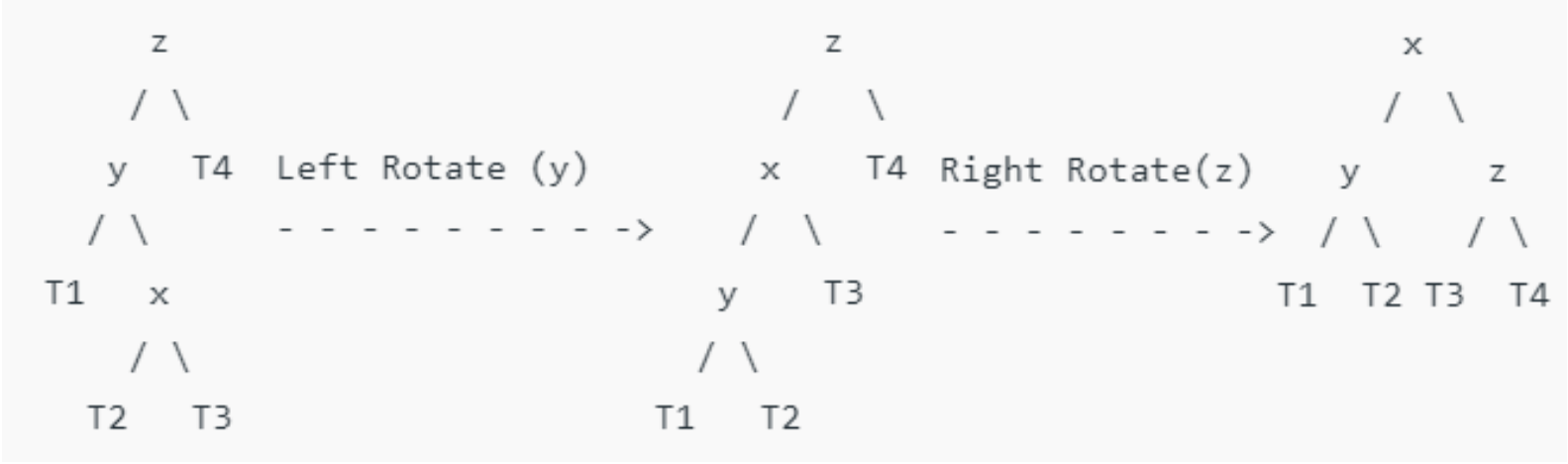
- In case of height disbalance, there are four possible case:
  - Left-Left
  - Left-Right
  - Right-Right
  - Right-Left

Left-Left Case



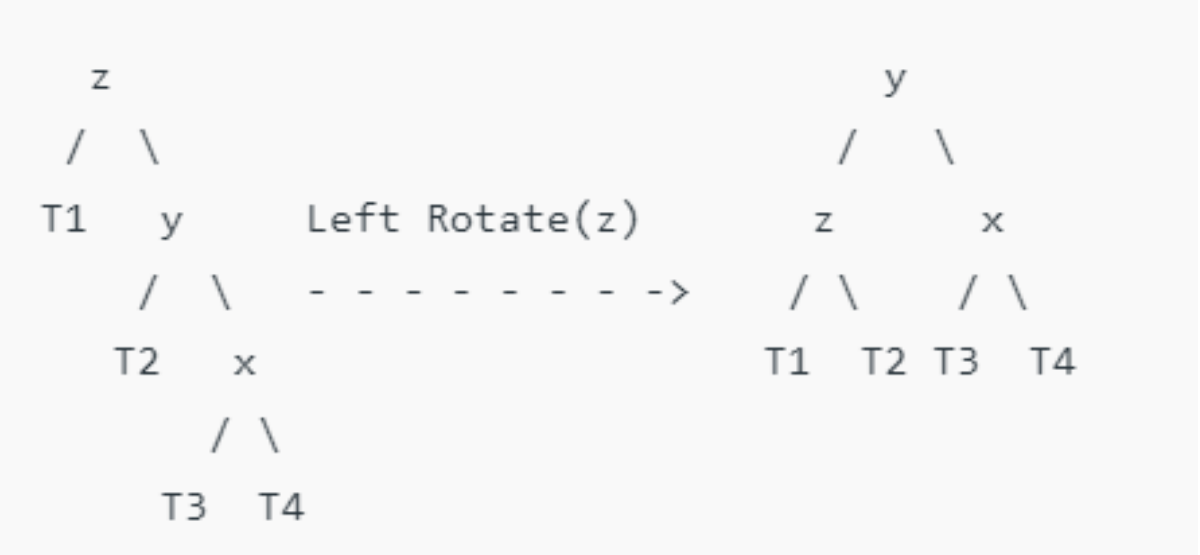
https://www.geeksforgeeks.org/insertion-in-an-avl-tree/?ref=lbp

Left-Right Case



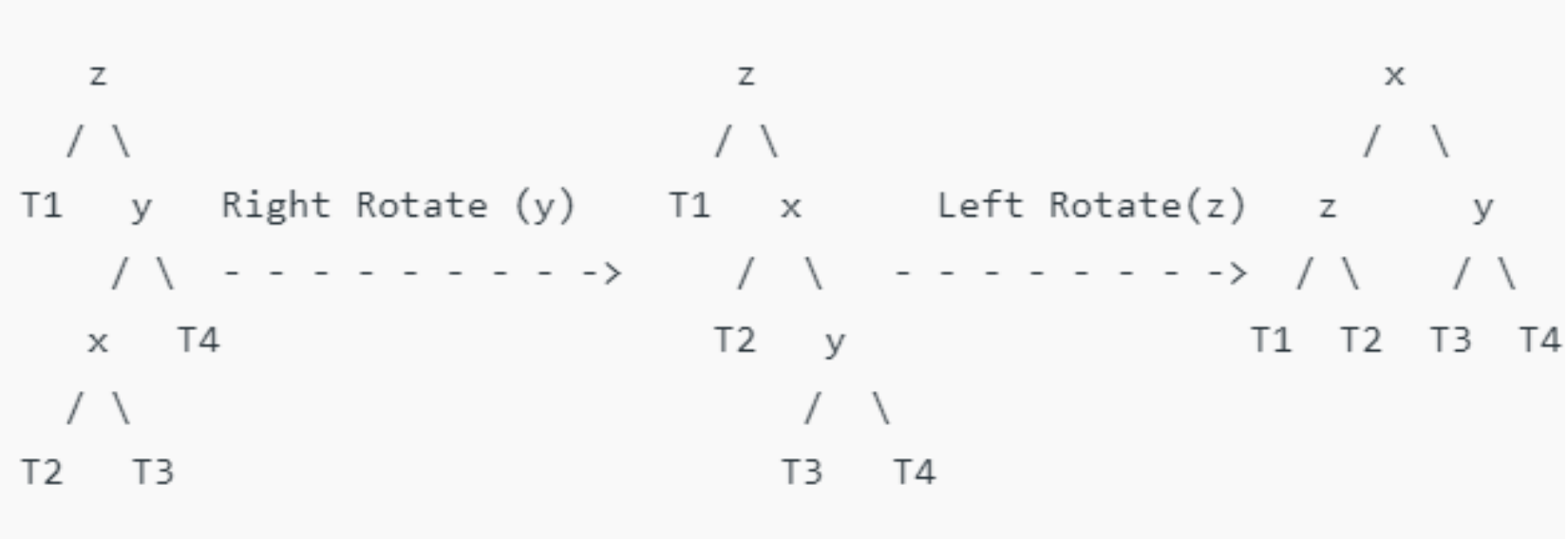
https://www.geeksforgeeks.org/insertion-in-an-avl-tree/?ref=lbp

Right-Right Case



https://www.geeksforgeeks.org/insertion-in-an-avl-tree/?ref=lbp

Right-Left Case



https://www.geeksforgeeks.org/insertion-in-an-avl-tree/?ref=lbp

Inserting a node in AVL Tree

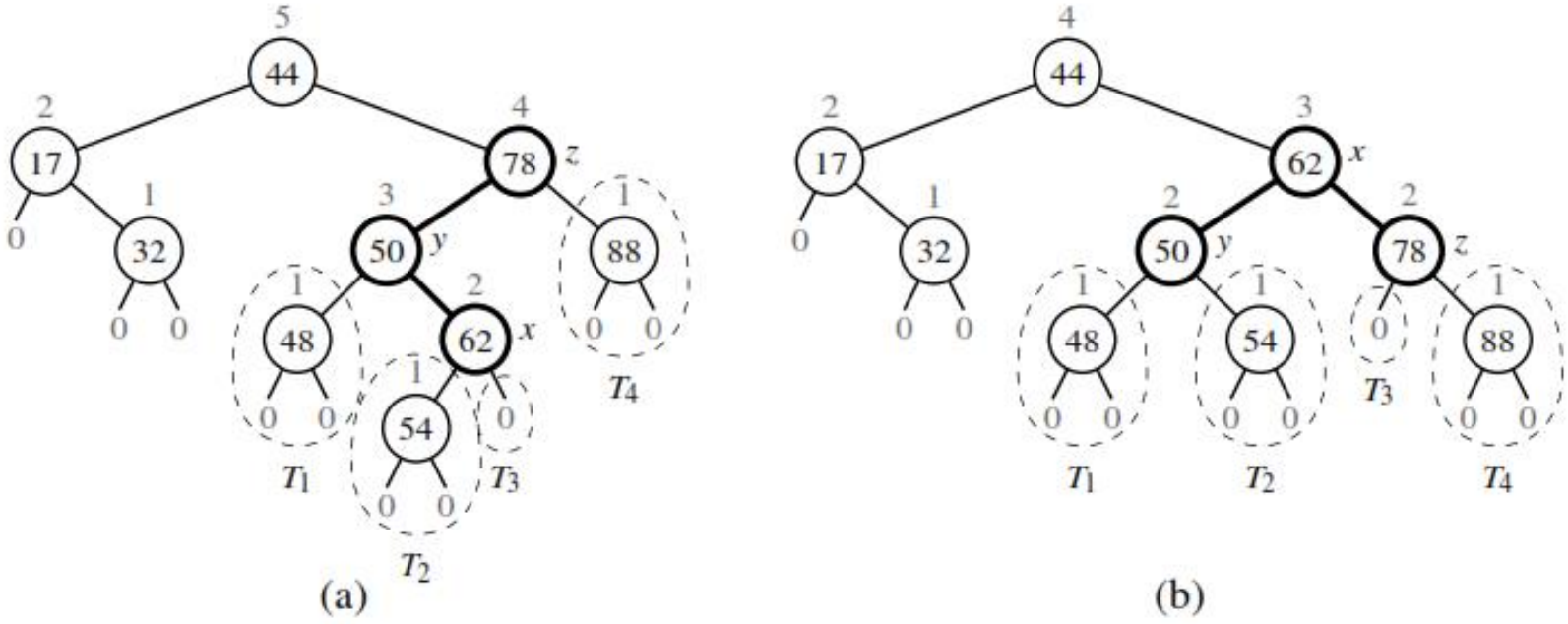


Figure 11.12: An example insertion of an item with key 54 in the AVL tree of Figure 11.11: (a) after adding a new node for key 54, the nodes storing keys 78 and 44 become unbalanced; (b) a trinode restructuring restores the height-balance property. We show the heights of nodes above them, and we identify the nodes x, y, and z and subtrees T_1, T_2, T_3, and T_4 participating in the trinode restructuring.

Example

- Let’s construct an AVL tree with given values:
  - 1,2,3,4,5,6,7,8,9

Exercise - Building a AVL tree

- 4,9,13,2,18,15,6,1

AVL Tree Visualisation

- https://www.cs.usfca.edu/~galles/visualization/AVLtree.html

Deleting a node in AVL Tree

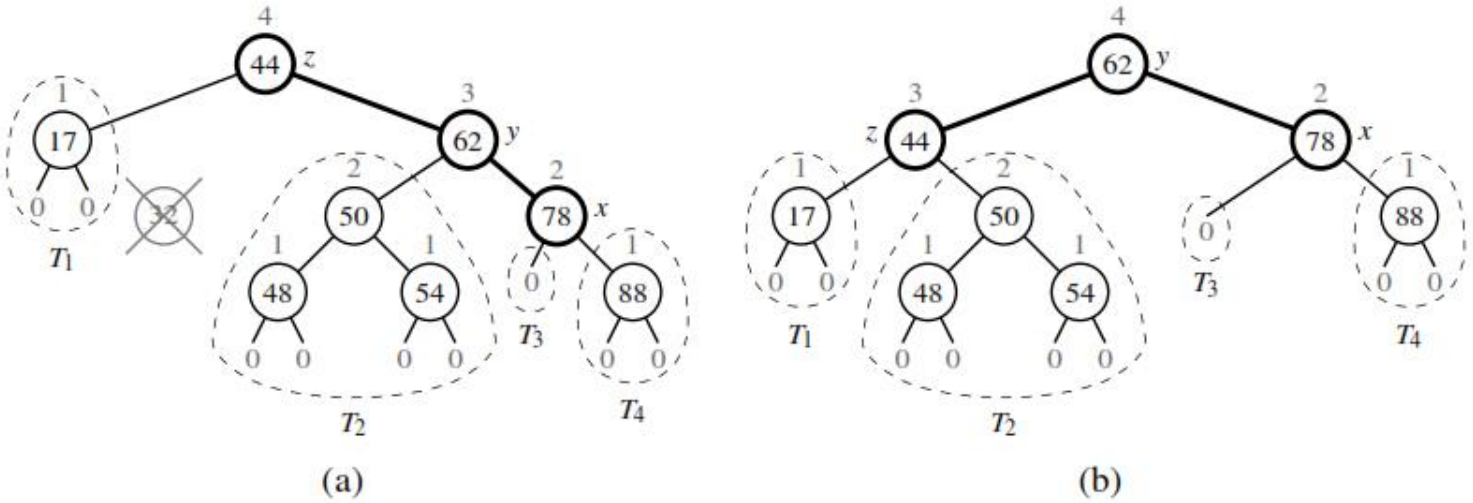
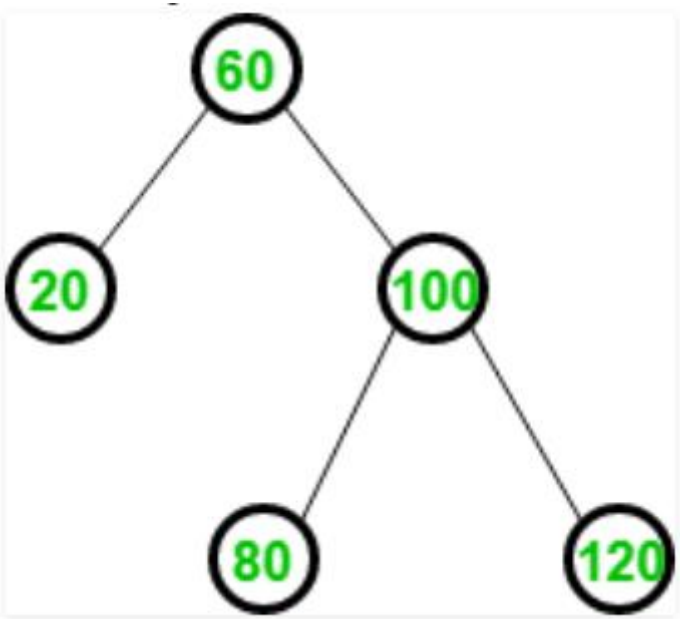


Figure 11.14: Deletion of the item with key 32 from the AVL tree of Figure 11.12b: (a) after removing the node storing key 32, the root becomes unbalanced; (b) a (single) rotation restores the height-balance property.

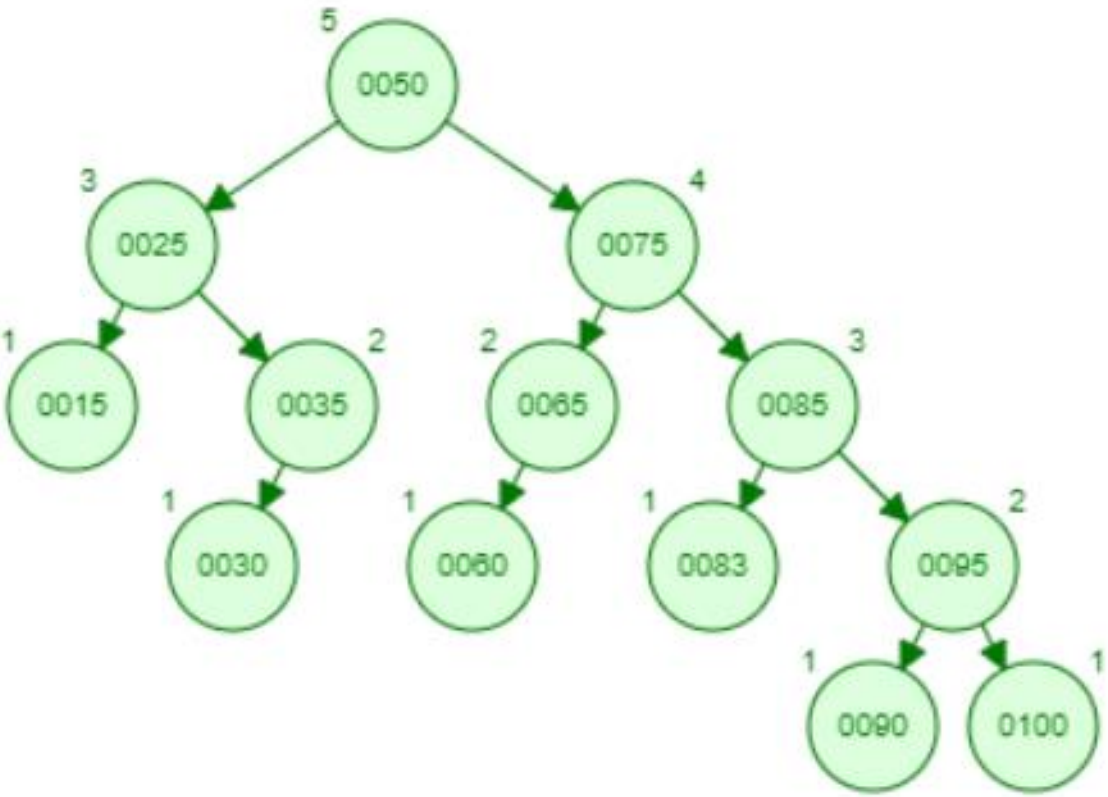
Exercise

- Remove 20 from this tree.



Exercise

- Delete 15 from the given tree.



Resources

- Open Data Structures (pseudocode edition), by Pat Morin. Available online at http://opendatastructures.org
- Data Structures and Algorithms in Python, by Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser. 2013. (1st. ed.). Wiley Publishing
- Insertion in an AVL Tree - GeeksforGeeks

Thanks