CS 130A Data Struc & Alg 1

1. Consider the following binary search tree. Perform the following operations sequentially and draw the tree after the each operation.

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delete(7)
insert(6)
insert(7)
insert(18)
delete(19)
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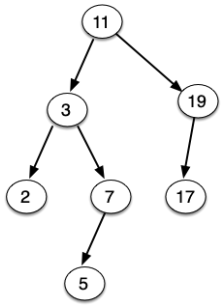
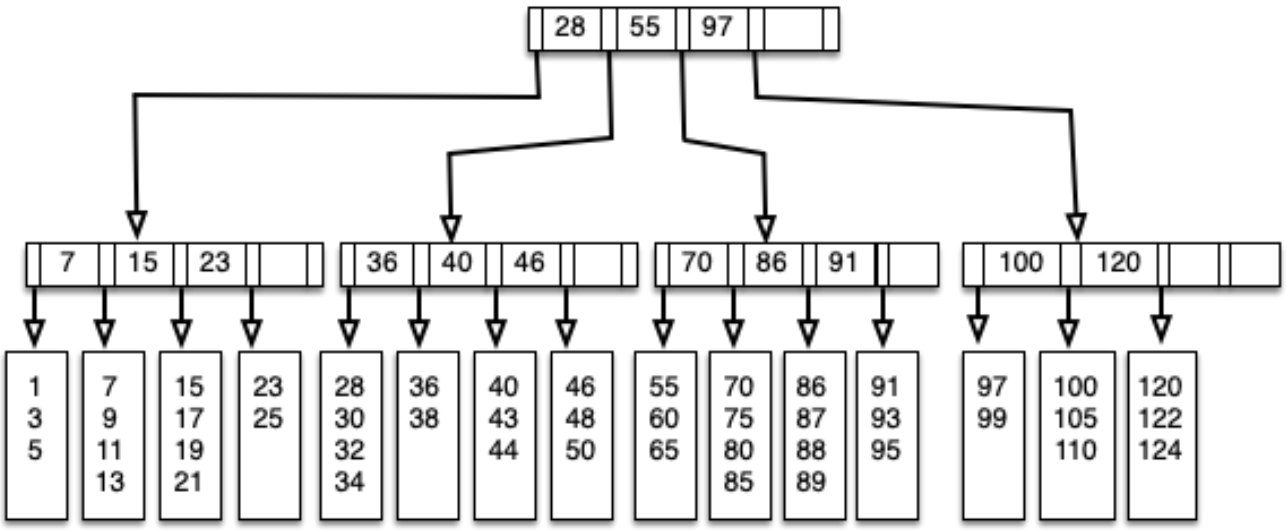


2. Start with an AVL tree that has a single node containing the key 15. Consecutively insert the following keys to the tree. At each step, insert the key, draw the new tree, and check to see if the tree still has the AVL property. If it doesn't, fix it using single or double rotation, and draw the new tree, and explain which rotation you used.

   Keys to enter (in this order): 10, 5, 20, 25, 30, 35, 50, 45, 40

3. Consider the following B-tree with parameters $M = 5$ and $L = 4$, and answer the questions below. After each step, draw ONLY the corrected part of the tree.



   a) Insert the key 53 into this tree.
   b) Insert the key 22 into this tree (after Step a) by adoption.
   c) Insert the key 14 into the new tree (after Step b) by splitting.
   d) Insert the key 90 into the new tree (after Step c) by splitting.
   e) Delete 28 from the tree (after Step d).
   f) Delete 99 from the tree (after Step e) by merging.
   g) Find the min/max number of records this B-tree can hold if its height is 2, 3, 4, 5, 10.

4. We want to build an optimal B-tree with the following assumptions: a) the block size of a disk is 4,096 bytes, b) Branches use 4 bytes, c) Keys use 16 bytes, c) The records (including the keys) are 128 bytes, d) There are 16m records.
   Answer the following questions.
   (a) What are the optimal values of L and M?
   (b) What is the min/max number of branches, keys, and records in a leaf node?
   (c) What is the min/max number of branches, keys, and records in a non-leaf node?
   (d) What is the min/max number of branches, keys, and records in the root node?
   (e) What are the height of the tree and the total number of leaf and non-leaf nodes, assuming all 16m keys are inserted.
   (f) Assuming 4 disk accesses takes a second, what is the expected time for finding, inserting, and deleting a key?

Deliver the assignment via Gradescope. Late submissions are not accepted.