CSCI-2725 Homework 4

Yitao Tian

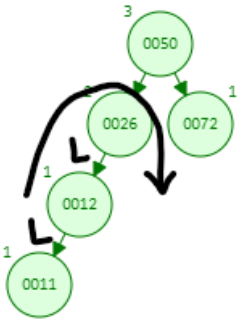
April 17, 2023

Extra credit: There is 5 percentage extra credit if you don't submit hand-written homework (including the diagrams). You can use LaTeX or any other tool to write your homework.

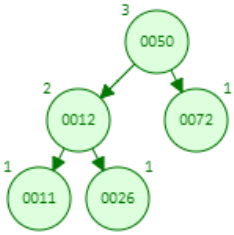
1. (20 points) **Construct** an AVL tree using the following input (in the given order)

   $$50,\ 26,\ 72,\ 12,\ 11,\ 25,\ 68,\ 45,\ 55,\ 77,\ 47$$

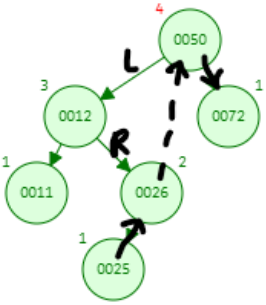
   Show which node got unbalanced, what rotation operation you need to perform and all the intermediate steps as you are performing the rotation operations (something similar to examples shown in the class).



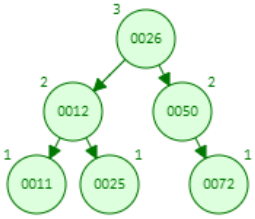
(a) Before first rotation (LL)



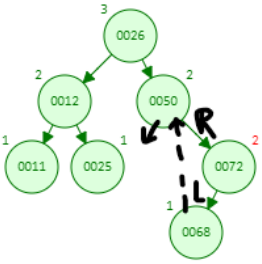
(b) After first rotation (LL)



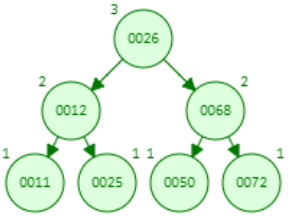
(c) Before second rotation (LR)



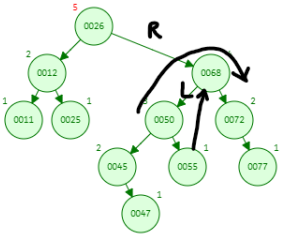
(d) After second rotation (LR)



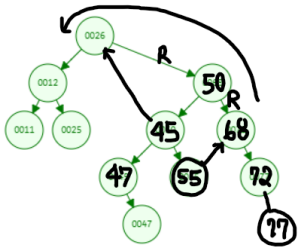
(e) Before third rotation (RL)



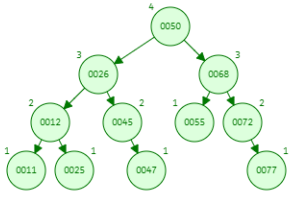
(f) After third rotation (RL)



(g) Before fourth (1st half) rotation (RL)



(h) Before fourth (2nd half) rotation (RR)



(i) Final AVL tree

Figure 1: AVL Insertions

2. (20 points) **Construct** a binary search tree using the following input (in the given order)

50, 26, 72, 12, 11, 94, 53, 99, 67, 98, 37, 80

Figure 2: Initial BST

(a) Is the above tree a valid AVL tree?

Answer: No

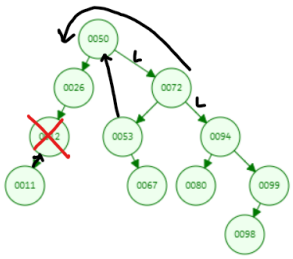
Explan.: BF of 50 is -2

(b) Delete the following nodes from the above tree using the AVL delete (in the given order)

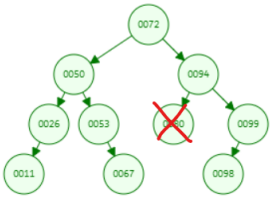
37, 12, 80, 50, 98, 11

Show all your intermediate steps as you are deleting nodes from the tree including the rotation operations.

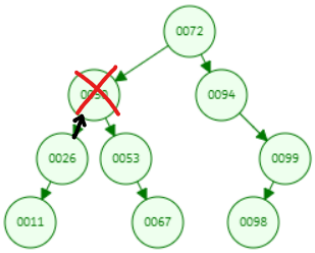
(a) Deleting 37



(b) Deleting 12; before LL rotation

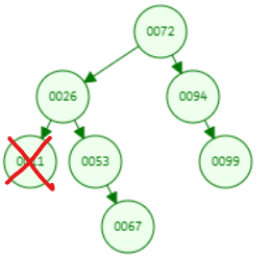


(c) Deleting 80; after LL rotation

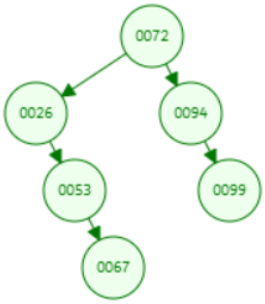


(d) Deleting 50; replace with predecessor

(e) Deleting 98



(f) Deleting 11



(g) Final AVL tree

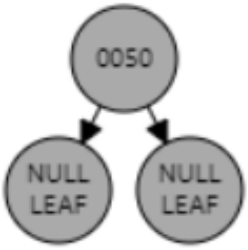
Figure 3: AVL Deletions

3. (20 points) **Construct** a red-black tree using the following input (in the given order)

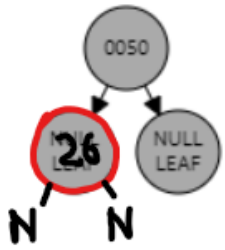
   50, 26, 72, 37, 28, 15, 17, 24

   Show all your intermediate steps including the recoloring and restruc- turing operations.

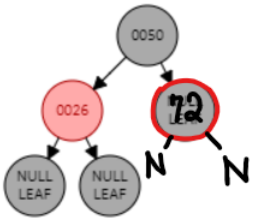
   Note: nodes circled in red mean red nodes, in black means black nodes, regardless of node text or background color.



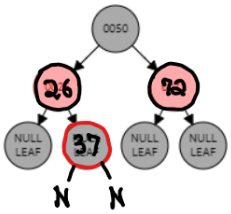
(a) Inserted 50



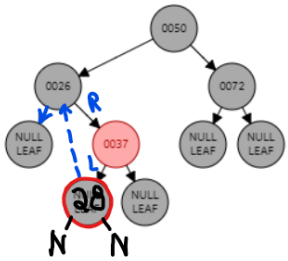
(b) Inserting 26



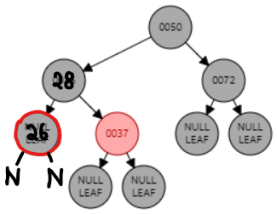
(c) Inserting 72



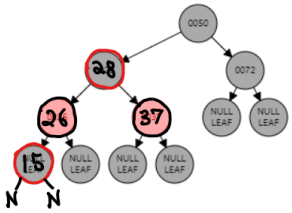
(d) Inserting 37; recoloring children of 50



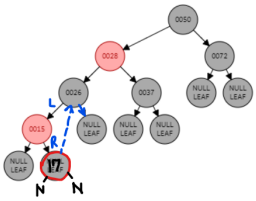
(e) Inserting 28; before RL rotation and recoloring



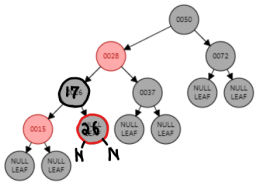
(f) Inserting 28; after RL rotation and recoloring



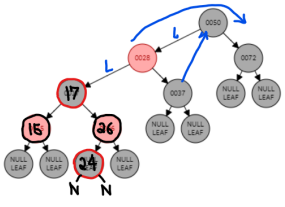
(g) Inserting 15; recoloring 28 and its children



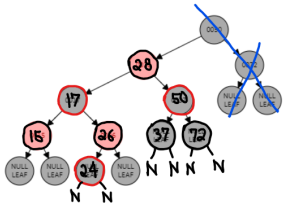
(h) Inserting 17; before LR rotation and recoloring



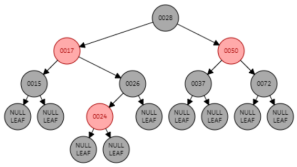
(i) Inserting 17; after LR rotation and recoloring



(j) Inserting 24; recoloring 17 and its children; before LL rotation



(k) Inserting 24; after LL rotation and recoloring



(l) Final red-black tree

Figure 4: RBT Insertions