Data Structures and Algorithms in Python

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Study Guide: Hints to Exercises

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Chapter 11 Search Trees

Hints

Reinforcement

R-11.1) Recall the definition of where we perform an insertion in a binary search tree.

R-11.2) You will need to draw 8 trees, but they are all small.

R-11.3) You can enumerate them with pictures.

R-11.4) Try a few examples of five-entry binary search trees.

R-11.5) Try a few examples of five-entry AVL trees.

R-11.6) Use a loop to express the repetition

R-11.7) There is one of each type. Which one is which?

R-11.8) Mimic the figure in the book.

R-11.9) Mimic the figure in the book.

R-11.10) Think about the data movements needed in an array list representation of a binary tree.

R-11.11) Carefully note the heights of all subtrees before the deletion, and after the deletion but before the restructuring.

R-11.12) Carefully note the heights of all subtrees before the deletion, and after the deletion but before the restructuring.

R-11.13) Carefully trace the potential heights of various subtrees.

R-11.14) Use a pencil with a good eraser.

R-11.15) Each entry is splayed to the root in increasing order.

R-11.16) No. Why not?

R-11.17) It is not k_1. Why?

R-11.18) You will need at list five entries to find a counterexample.

R-11.19) Use the correspondence rules described in the chapter.

R-11.20) Use a pencil with a good eraser.

R-11.21) Use a pencil with a good eraser.

R-11.22) Consider looking at the (2,4) tree and red-black tree definitions again.

R-11.23) Recall the definition of a binary search tree, in general.

R-11.24) Some have $O(\log n)$ worst-case height and some have $O(n)$ worst-case height. Make sure you know which. Also, try to get the constant factors right in this case.

R-11.25) You need to create a node that does not satisfy the AVL balance condition, but would be acceptable in a red-black tree. A good example would be a tree with at least 6 nodes, but no more than 16.

R-11.26) Note that the black-path length must have been identical for each path downward from p.

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Creativity

C-11.29) The method is similar to priority-queue sorting.

C-11.30) Review what it means for splay trees to have $O(\log n)$ amortized time performance.

C-11.31) You should make a single call to utility `_subtree_search`.

C-11.32) Show that $O(n)$ rotations suffice to convert any binary tree into a ***left chain***, where each internal node has an external right child.

C-11.33) Where might the search path for k diverge from a path to one of the other keys?

C-11.34) Consider the maximum number of times the recursive method is called on a position that is not within the subrange.

C-11.35) Consider a top-down recursive approach.

C-11.36) Make sure that the result is a valid AVL tree.

C-11.37) Note that this method returns a single integer, so it is not necessary to visit all s items that lie in the range. You will need to extend the tree data structure, adding a new field to each node.

C-11.38) How do the rebalancing actions affect the information stored at each node?

C-11.39) Use triangles to represent subtrees that are not affected by this operation, and think of how to cascade the imbalances up the tree.

C-11.40) Think carefully about how the balance of a node and its ancestors changes immediately after an insertion or deletion.

C-11.41) Just consider the operations that could change the leftmost position or who points to it.

C-11.42) How do the rebalancing actions affect the minimum?

C-11.43) Have each node of the tree maintain references to its inorder neighbors.

C-11.44) How do the rebalancing actions affect the inorder relationships?

C-11.45) Carefully review the steps of deletion when given a direct reference to the position to be deleted.

C-11.46) These operations will be easier if you know the size of each subtree.

C-11.47) Is it possible for an splay tree to also be a red-black tree?

C-11.48) Study closer the balance property of an AVL tree and the rebalance operation. Also, make a node high up in tree have its AVL balance depend on the node that just got inserted.

C-11.49) Study closer the balance property of an AVL tree and the rebalance operation.

C-11.50) Find the right place to "splice" one tree into the other to maintain the (2,4) tree property. Also, it is okay to destroy the old versions of T and U.

C-11.51) Find the right place to "splice" one tree into the other to maintain the red-black tree property.

C-11.52) You don't need to use induction here.

C-11.53) Think about a way of using the structure of the binary search tree itself to indicate color.

C-11.54) Search down for k and cut along this path. Now consider how to "glue" the pieces back together in the right order.

C-11.55) Consider the red and black meaning of the three possible balance factors in an AVL tree.

C-11.56) Since you know the node x will eventually become the root, maintain a tree of nodes to the left of x and a tree of nodes to the right of x, which will eventually become the two children of x.

C-11.57) The analysis in the book works also for half-splay trees, with minor modifications.

C-11.58) If you are having trouble with this problem, you may wish to gain some intuition about splay trees by "playing" with an interactive splay tree program on the Internet.

C-11.59) Force such a replacement to take place and then attempt to use an existing position instance to the item that served as the replacement.

C-11.60) Make sure that each item remains at its original node instance.

Projects

P-11.61) We've provided the implementations; you need to develop the experiment.

P-11.62) In this case, you will need a skip list implementation to test.

P-11.63) Remember that a single node of the tree might store multiple (key,value) pairs.

P-11.64) The order is implicit in the tree, so adding these methods should not be hard.

P-11.65) Think carefully about how to uniquely represent the position of a single (key,value) pair.

P-11.66) Use a recursive method to do the conversion.

P-11.67) The most significant challenge is how to handle the insertion of duplicate, given that the original tree search will stop when it finds the existing key.

P-11.68) Review the cases for zig-zag, zig-zig, and zig. Make sure you do splaying right before doing anything else.

P-11.69) First figure out a way that works assuming that all keys in existing mergeable heaps are distinct, and then work out how this is not strictly necessary.