Pre-class Work - Lesson “Red-black trees—part II” CS110

Create a Google document to record all your answers. Be ready to paste a link to your Google document into a class poll (make sure the document’s settings are such that one can assess its content from the link).

Question 1. (Exercise 13.2-1, Cormen et al.)

[Estimate: 3 minutes] Write pseudocode for RIGHT-ROTATE.

```
Right Rotate (T, x):

y = x.left

x.left = y.right          # make y right subtree the subtree of x's left subtree

If y.right != T.nil:

        y.right.p = x

y.p = x.p

if x.p == T.nil:

        T.root = y

elif: x == x.p.right:

        x.p.right = y

else:

        x.p.left = y

y.right = x               # perform switch

x.p = y
```

Question 2. (Exercise 13.2-2, Cormen et al.)

[Estimate: 3 minutes] Argue that in every *n*-node binary search tree, there are exactly (*n*−1) possible rotations.

Given that a rotation is essentially a switch/rotation of a subtree, we know that it is possible to make a rotation from any node to any other node (even if it is not convenient to do so). If we can make a rotation from any node to any other node, we can make n-1 rotations (-1 accounts for the current node, since we can’t rotate it on itself).

Question 3. (Exercise 13.2-3, Cormen et al.)

[Estimate: 4 minutes] How do the depths of nodes in a BST change when a rotation is performed? Explain your answer.

The depth of the root node of a subtree is reduced by 1, as well as all its children and other nodes beneath it. On the other hand, the node that is rotated onto (put as a new child of the subtree’s root) gains 1 extra depth. The reason for this is easy to understand when visualized. E.g.

```
Before Rotation

3

  \

    2

      \

        1

Post Rotation

     2

  /     \

3         1
```

2 loses 1 depth, and so does 1. 3 gains 1 depth.

Question 4. (Exercise 13.3-2, Cormen et al.)

[Estimate: 5 minutes] Write down or illustrate the red-black trees that result after successively inserting the keys 41; 38; 31; 12; 19; 8 into an initially empty red-black tree.