Program #4
Red-Black Trees
CSE 464/564

For this assignment, we will be completing three separate exercises from the textbook to explore sorting algorithms: problems 3.3.44 and 3.3.45 and 3.3.446on page 456. Here are the specifications.

1. *Average search time*: Run empirical studies to compute the average and standard deviation of the average length if a path to a random node (internal path length divided by tree size, plus 1) in a red-black BST built by insertion of *n* random keys into an initially empty tree, for n from 1 to 10,000. Do at least 1.000 trials for each tree size. Plot the results in a Tufte plot, like the one at the bottom of page 457, fit with a curve plotting the function *lg n – 0.5*.
2. *Count rotations*. Instrument your BST program to plot the number of rotations and node splits that are used to build the trees. Discuss the results.
3. *Height*. Instrument your BST program to plot the height of red-black BSTs. Discuss the results.

What to turn in:
1. The java files that you develop. These will be graded for style in addition to accuracy.
2. A document (pdf) with these parts:
    a. Data and graphs from your experiments about average search times in part 1 above. Discuss what these data and graphs mean.
    a. Data and graphs from your experiments about the number of rotations in part 2 above. Discuss what these data and graphs mean.
    b. Data and graphs from your experiments about the height of red-black BSTs in part 3 above. Discuss what these data and graphs mean.

You may use the red-black BSTs code provided by the textbook authors. See:
*   https://algs4.cs.princeton.edu/code/edu/princeton/cs/algs4/RedBlackBST.java.html
Use the graphing methods from Draw.java class that the authors have provided. That is, your pdf answer will include text and graphs to make your point.