# CS146 HW Assignment 3

(Hardcopy due before lecture on **Thursday, May 10, 2018.**)

Please note: All HW assignments are giving you opportunities to learn and to verify the concepts of the topics from the lectures. They are for individual work only. **You cannot consult with any other people and cannot copy or receive answers from any people (students or tutors for example) or internet**. You are not allowed to work as a team. Usually, some questions may have different correct solutions with the same concept. The HW must be stapled before submission.

1. (15%) What is the maximum black height and actual height and of a RB Tree with 15 nodes? Draw a RB tree with 15 nodes that can achieve this maximum height. (Draw and explain your answer.)

2. (30%) Follow the RB-Insert and RB-Insert-fixup pseudo codes in the textbook (Ch13.3 page 315 and 316) to insert the following values:

     10, 8, 13, 14, 18, 11, 15, 17

   into an initially empty RB tree.
   To receive full points, you must draw each corresponding RB Tree for every corresponding case and every step in each case (i.e. case 0, 1, 2, 3) when inserting a value. In each step of RB tree graph, you MUST show and specify corresponding case numbers, recolors, and rotations.
   (Hint: a total number of 15 RB trees must be drawn including an initial step only containing root node 10)

3. (15%) Prove the following statements regarding RB Tree:
   a) "If a Black node has only one child that child must be a Red leaf."
   b) "If a Red node has any children, it must have two children and they must be Black."
   c) "Due to the property rules there are limits on how unbalanced a Red Black tree may become."

4. (25%) Follow the RB-Delete and RB-Delete-fixup pseudo codes in the textbook (Ch13.3 page 324 and 326) to delete value 4 and then delete 7 from the following RB tree.
   To receive full points, you must draw each corresponding RB Tree for every corresponding case and every step in each case (i.e. case 1, 2, 3, 4) when deleting a node. In each step of RB tree graph, you MUST show and specify corresponding cases, recolors, and rotations.
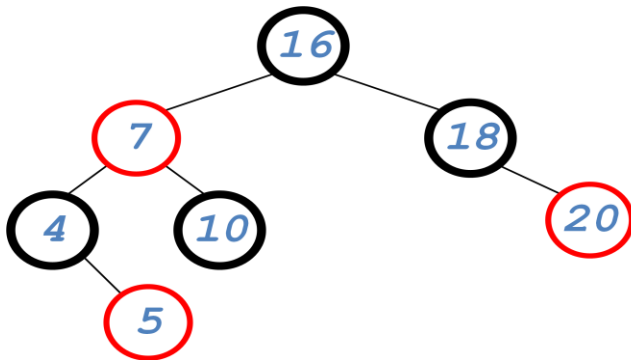
5. (15%) Draw the result RB trees for the following operations;
   a) Using the RB Tree below, insert value 53 to the RB tree.
   b) Using the RB Tree below, delete value 15 from the RB tree.
   c) Using the RB Tree below, delete value 60 from the RB tree.