Algorithms -- COMP.4040 Honor Statement
(Courtesy of Prof. Tom Costello and Karen Daniels with modifications)

Must be attached to each submission

Academic achievement is ordinarily evaluated on the basis of work that a student produces independently. Infringement of this Code of Honor entails penalties ranging from reprimand to suspension, dismissal or expulsion from the University.

Your name on any exercise is regarded as assurance and certification that what you are submitting for that exercise is the result of your own thoughts and study. Where collaboration is authorized, you should state very clearly which parts of any assignment were performed with collaboration and name your collaborators.

In writing examinations and quizzes, you are expected and required to respond entirely on the basis of your own memory and capacity, without any assistance whatsoever except such as what is specifically authorized by the instructor.

I certify that the work submitted with this assignment is mine and was generated in a manner consistent with this document, the course academic policy on the course website on Blackboard, and the UMass Lowell academic code.

Date: 6/26/2019

Name (please print): PHONG VO

Signature: Phong

Due Date: June 27, 2019 (Th), BEFORE the class starts

This assignment covers textbook Chapter 12&13.

1. BST: Using the definitions on p. 1177 of our textbook for *depth* of a tree node and *height* of a tree, consider the set of keys **K** = < 20, 5, 1, 12, 7 > and the different possible insertion orders for the keys in **K**. Based on the different possible insertion orders and their resulting Binary Search Trees, answer the following questions. (30 points)

a) What is the minimum height of a Binary Search Tree constructed from **K**? Show an insertion order for the keys in **K** that generates a Binary Search Tree of minimum height. Draw the corresponding Binary Search Tree.

b) Are there any other insertion orders (beyond what you found in (a) above) for the keys in **K** that produce a Binary Search Tree of minimum height? If so, provide one such sample insertion order and its accompanying Binary Search Tree.

c) What is the maximum height of a Binary Search Tree constructed from **K**? Show an insertion order for the keys in **K** that generates a Binary Search Tree of maximum height. Draw the corresponding Binary Search Tree.

2. Red-Black Tree: Exercise 13.1-1 on p311 in textbook (20 points)

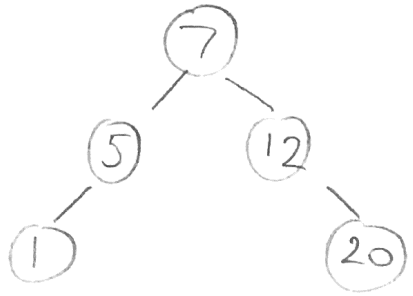
3. Red-Black Tree: Exercise 13.2-3 on p314 in textbook (20 points)

4. Red-Black Tree: For the set of keys given above in Problem 1, show the sequence of red-black trees that result after successively inserting the keys into an initially empty red-black tree in the order given: **K** = < 20, 5, 1, 12, 7 >. *(Show at least one tree resulting from each insertion). State which case from the textbook applies. Assume that the root is always colored black.)* (30 points)

HW 9

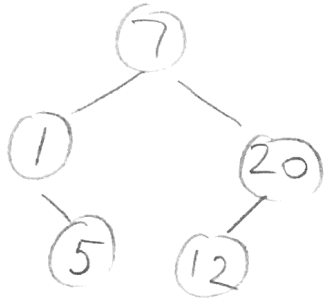
① $K = \langle 20, 5, 1, 12, 7 \rangle$

a)



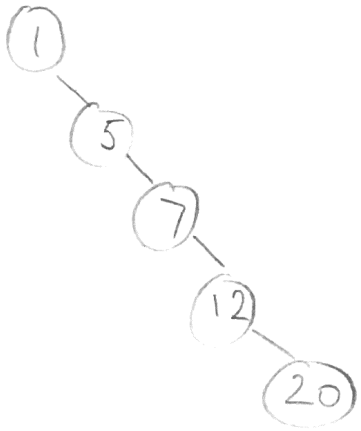
Minimum height = 2

b)

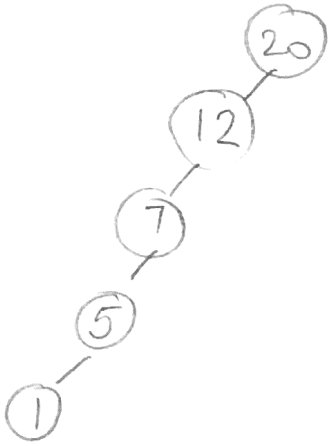


Minimum height = 2 is maintained

c)



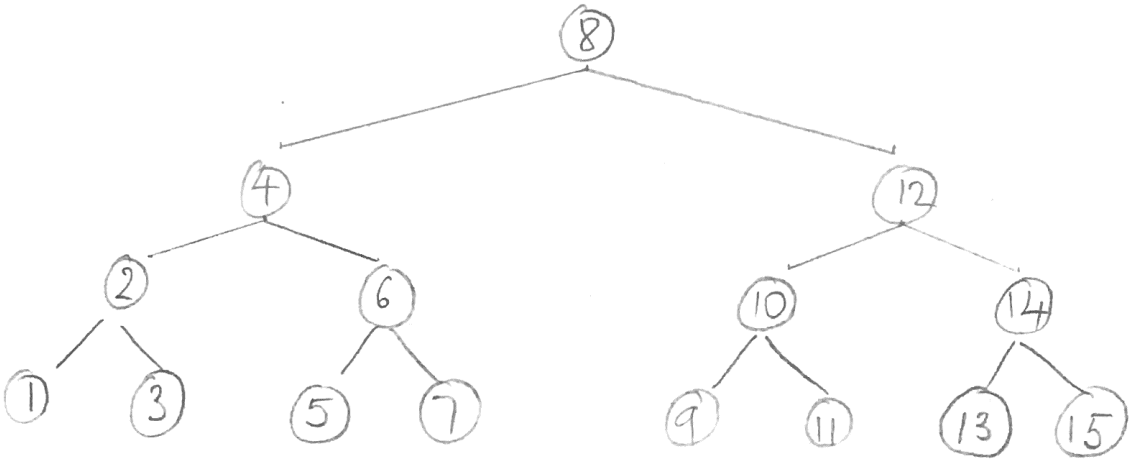
OR



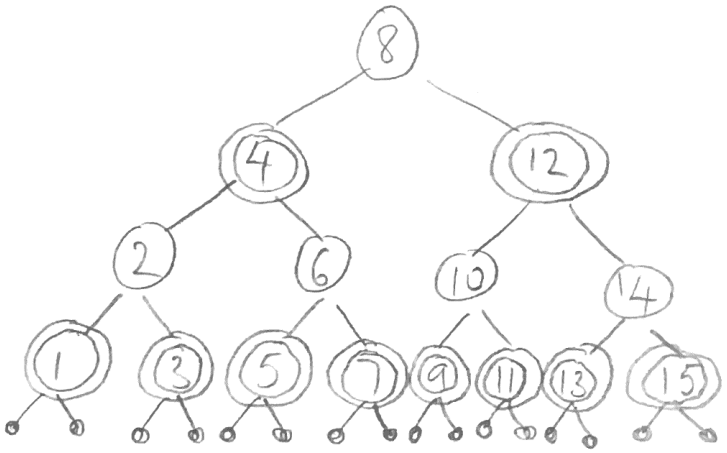
In this case, the BST has the maximum height = 4

HW 9

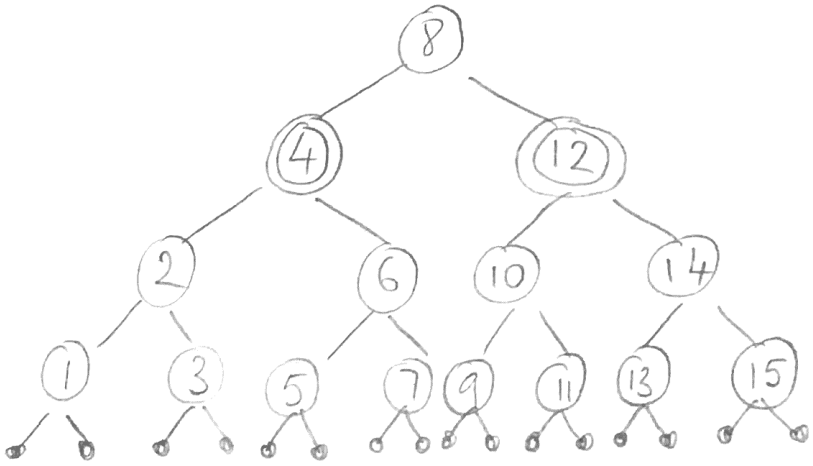
② Key = {1, 2, 3, ... 15}, with height 3



Black-height=2:

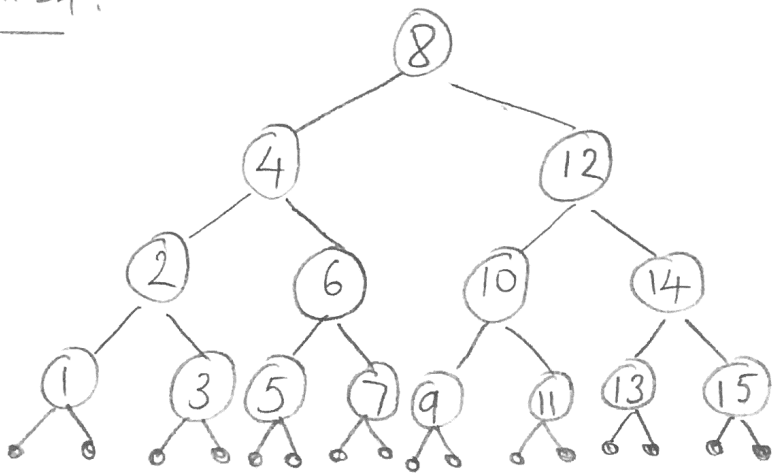


Black-height=3:

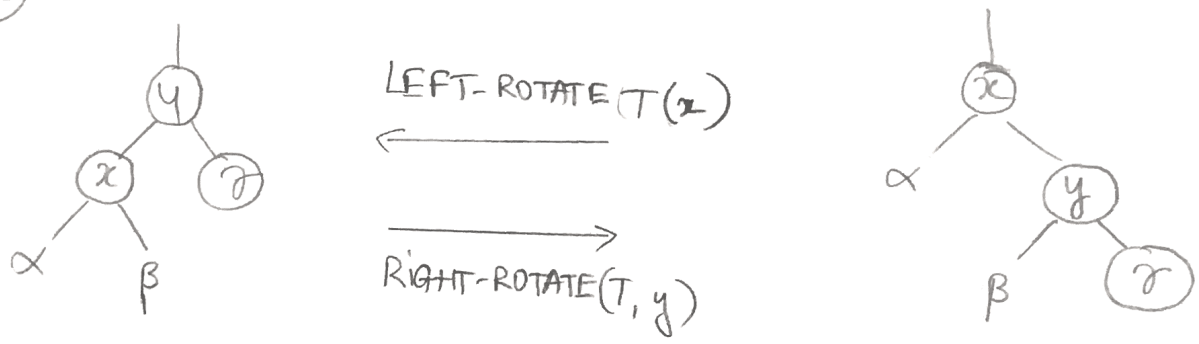


Black-height = 4: (See next page)

Black-height = 4:



(3)

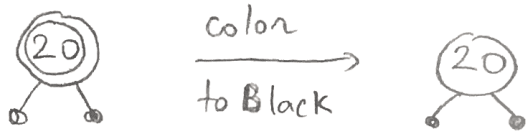


The depth of 'a' increase by 1.
The depth of 'b' is not changed.
The depth of 'c' decrease by 1

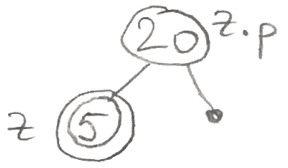
HW 9

④ $K = \langle 20, 5, 1, 12, 7 \rangle$

(1) insert 20

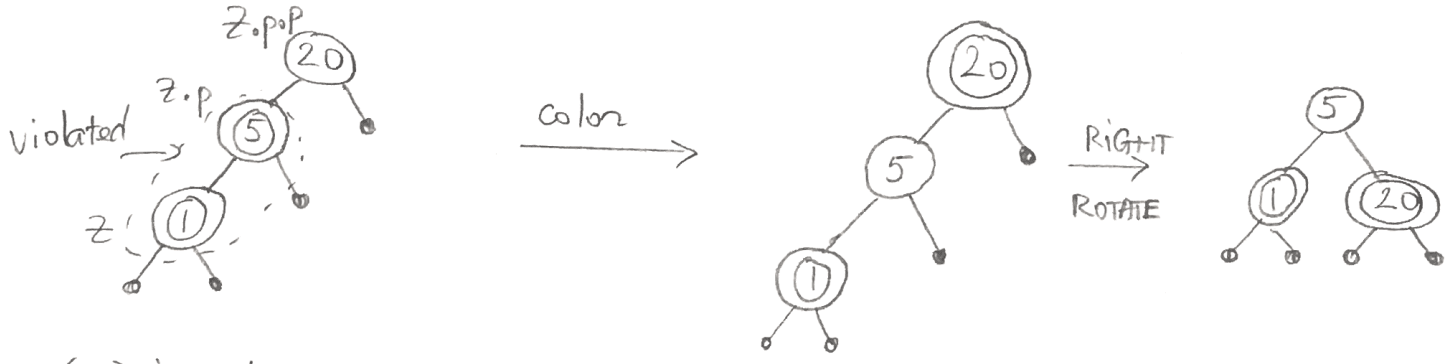


(2) insert 5

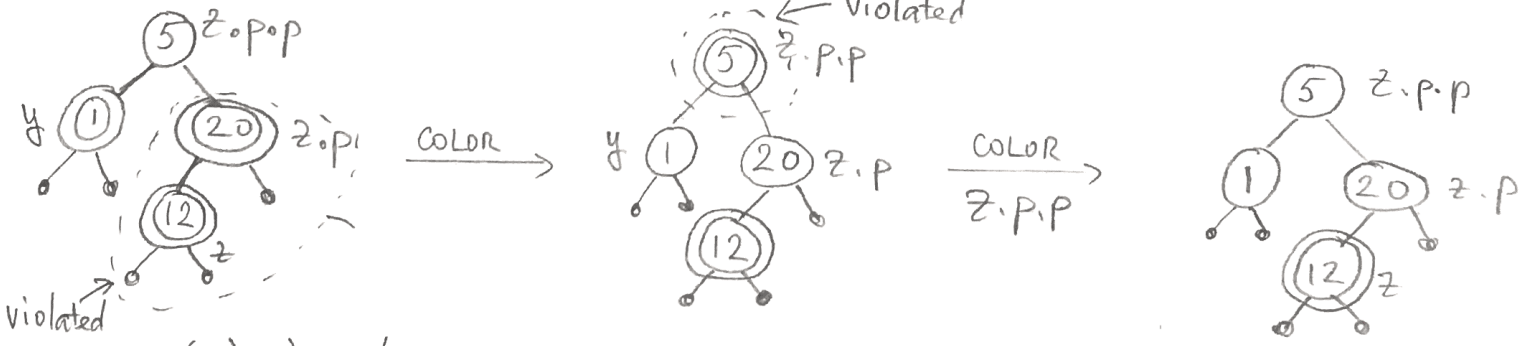


z.p is not RED
no fixup applied.

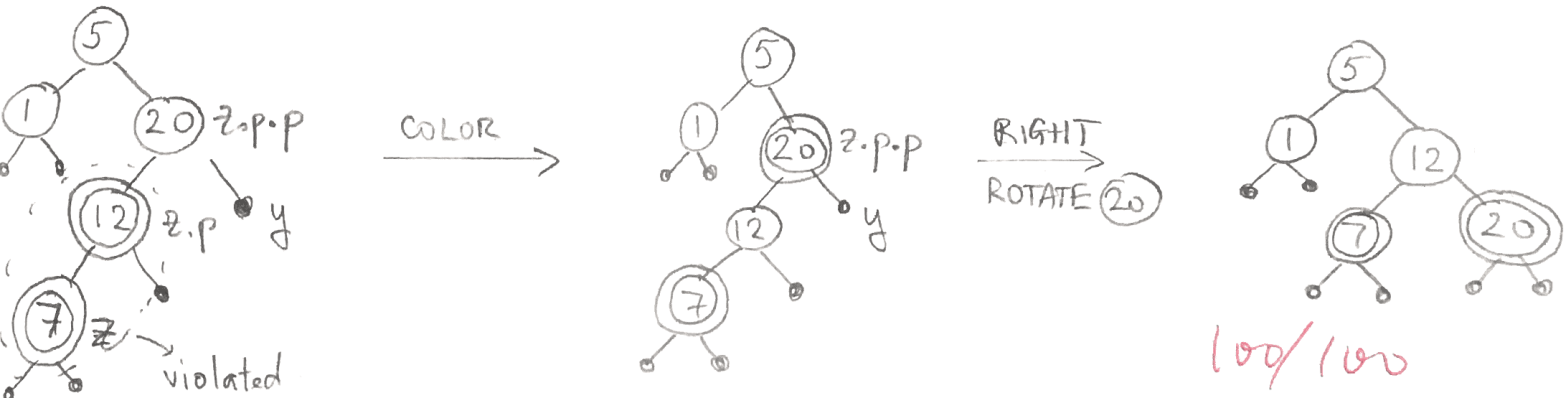
(3) insert 1



(4) insert 12



(5) insert 7:



100/100