

# Homework 1

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CSEN 5336 Analysis of Algorithms

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**Problem 1.** Illustrate the operation of RADIX-SORT on the following list of English words:  
COW, DOG, TOW, RUG, ROW, HUG, MOB, FOX, TAB, BAR, CAR, FUR

Assuming standard lexicographic (alphabetic) ordering for the sort.

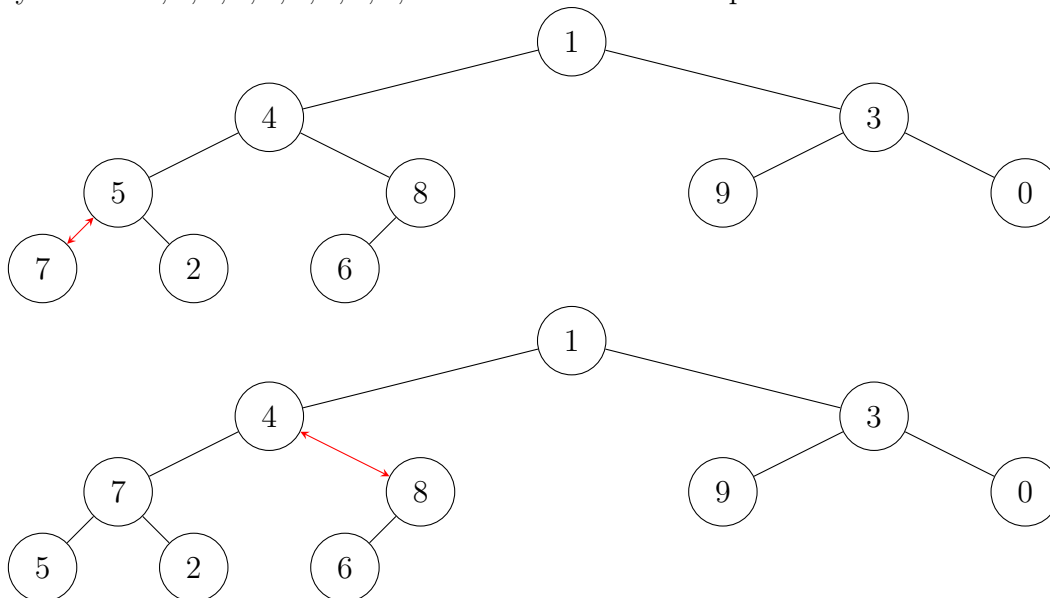
Iterations:

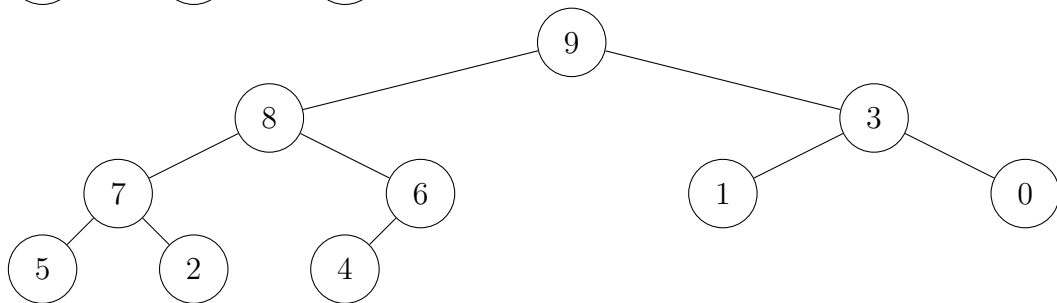
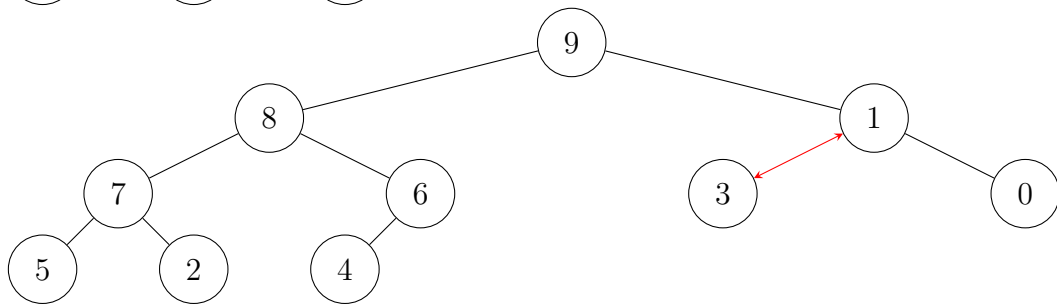
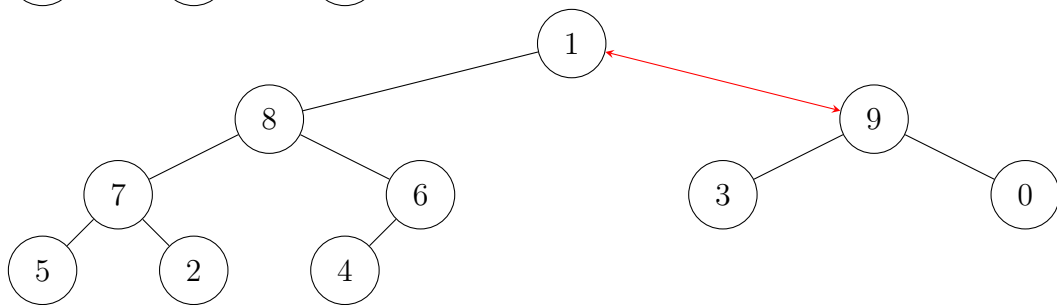
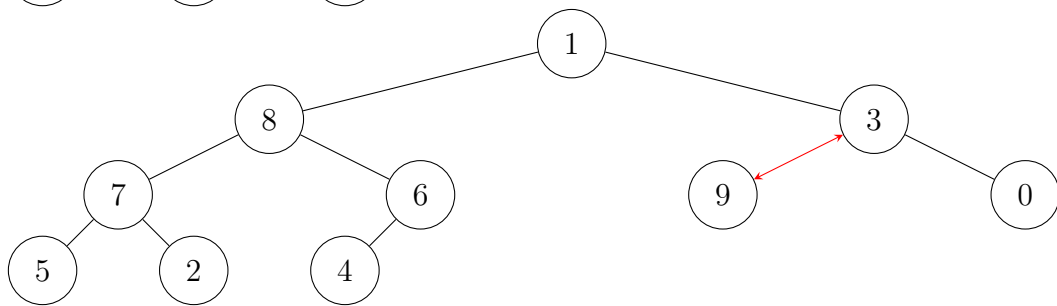
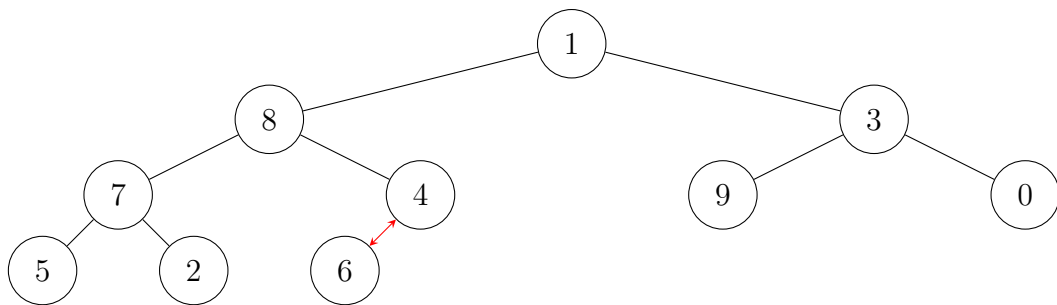
1: MOB, TAB, DOG, HUG, BAR, CAR, FUR, COW, TOW, ROW, FOX

2: TAB, BAR, CAR, MOB, DOG, COW, TOW, ROW, FOX, HUG, FUR

3: BAR, CAR, COW, DOG, FOX, FUR, HUG, MOB, ROW, TAB, TOW

**Problem 2.** Use the procedure MAX-HEAPIFY in a bottom-up manner to convert the array  $A = \langle 1, 4, 3, 5, 8, 9, 0, 7, 2, 6 \rangle$  to build a max heap





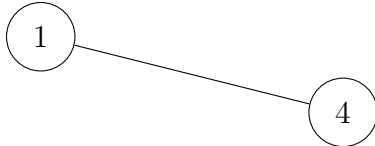
Resulting array is  $\langle 9, 8, 3, 7, 6, 1, 0, 5, 2, 4 \rangle$ .

**Problem 3.** Insert the following set of keys 1, 4, 3, 5, 8, 9, 0, 7, 2, 6 in an empty binary search tree in the order they are listed.

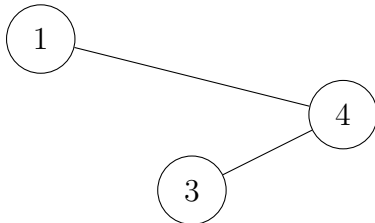
After adding 1



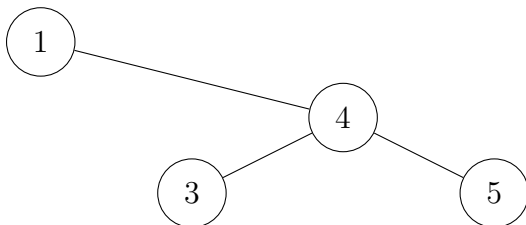
After adding 4



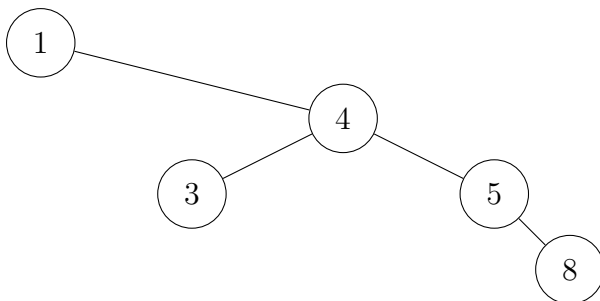
After adding 3



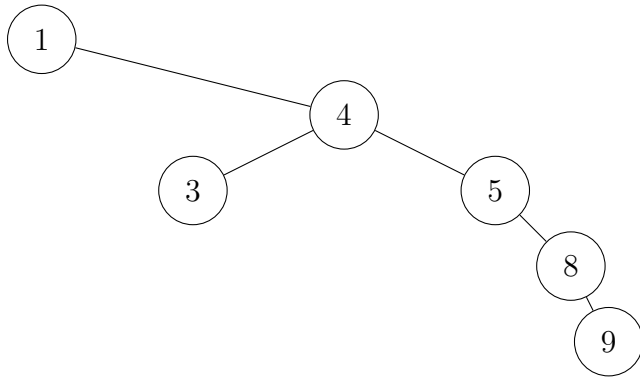
After adding 5



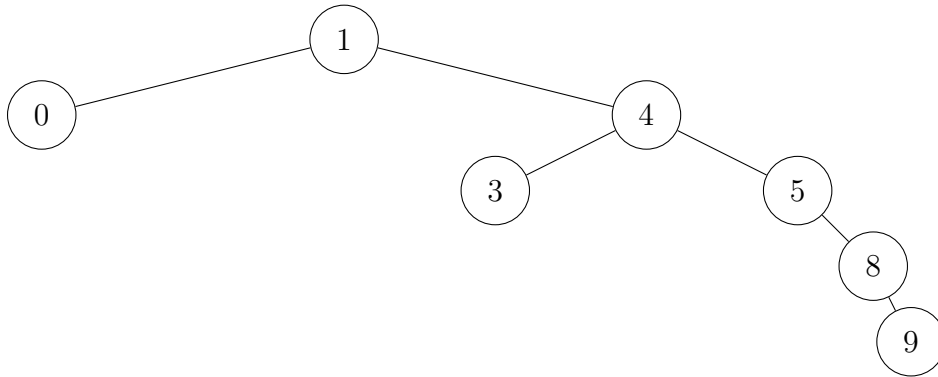
After adding 8



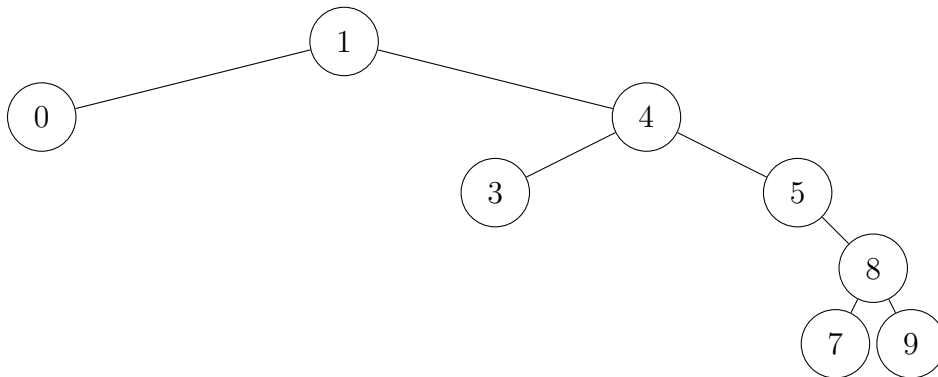
After adding 9



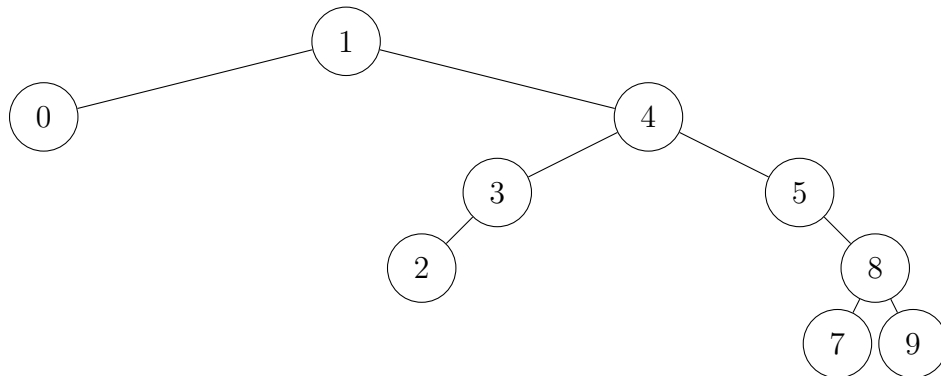
After adding 0



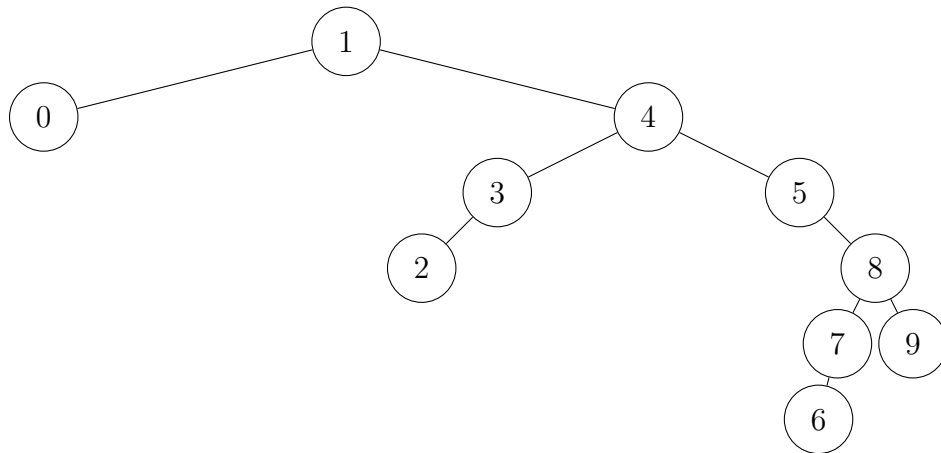
After adding 7



After adding 2



After adding 6

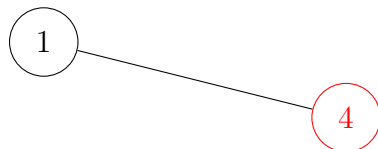


**Problem 4.** Insert the following set of keys 1, 4, 3, 5, 8, 9, 0, 7, 2, 6 in an empty red-black tree in the order they are listed.

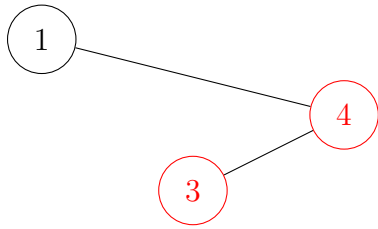
After adding 1



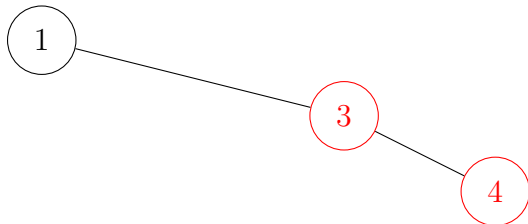
After adding 4



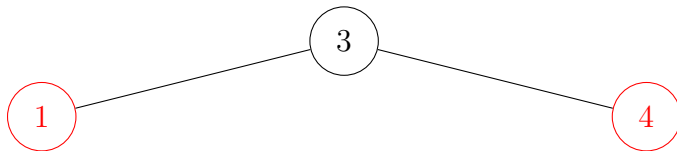
After adding 3



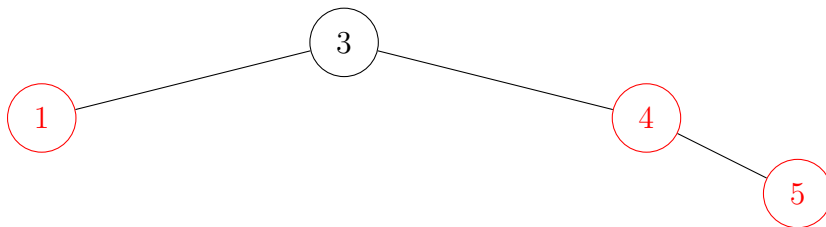
Case 5, right rotate on z.p



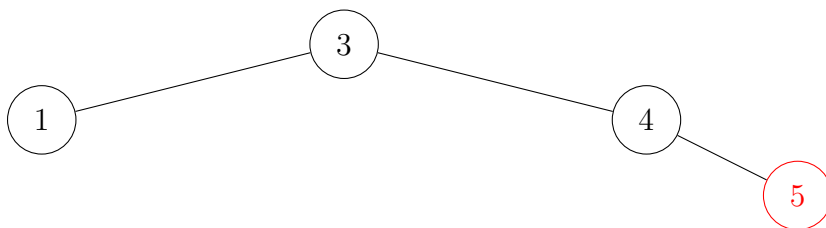
Case 4, change color of z.p and z.p.p and left rotate on z.p.p



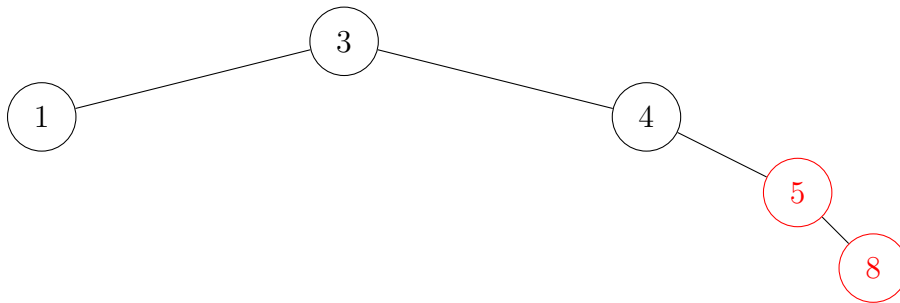
After adding 5



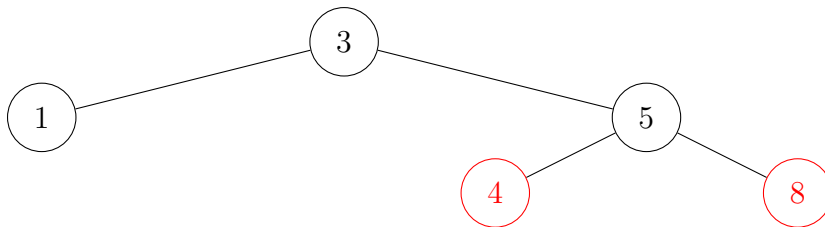
Case 1, change color of z.p, y, z.p.p



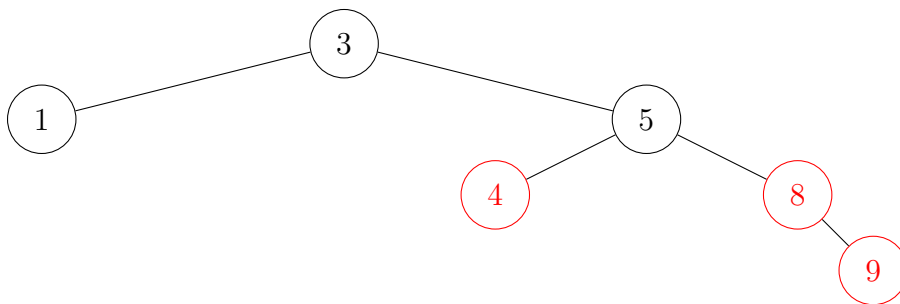
After adding 8



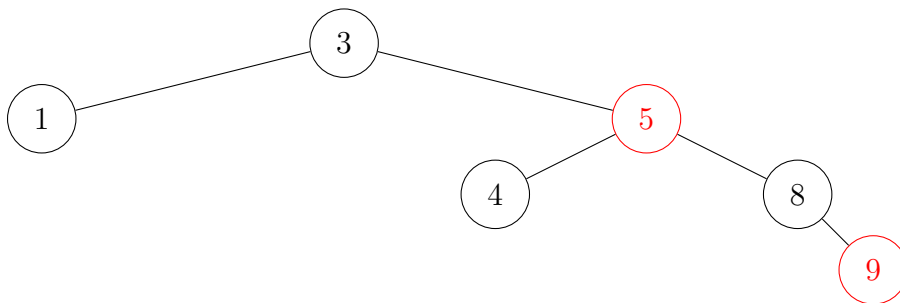
Case 4, change color of z.p and z.p.p and left rotate on z.p.p



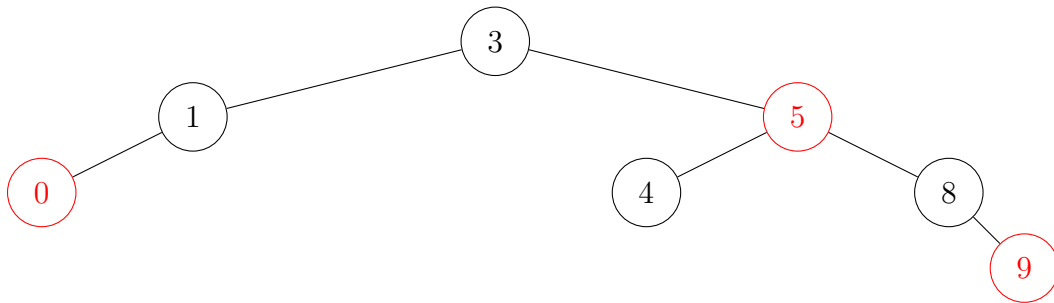
After adding 9



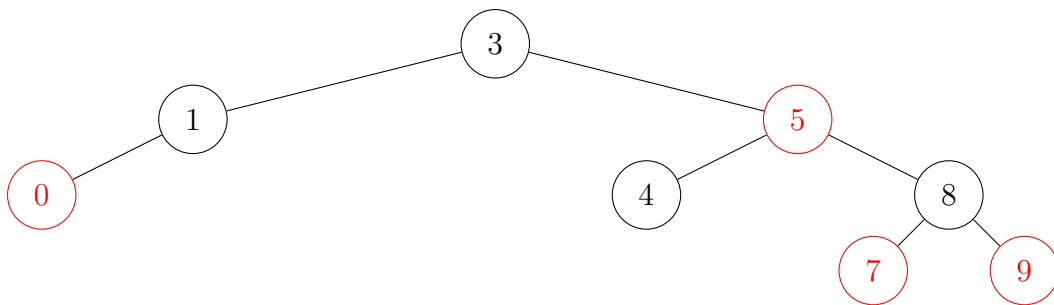
Case 1, change color of z.p, y, z.p.p



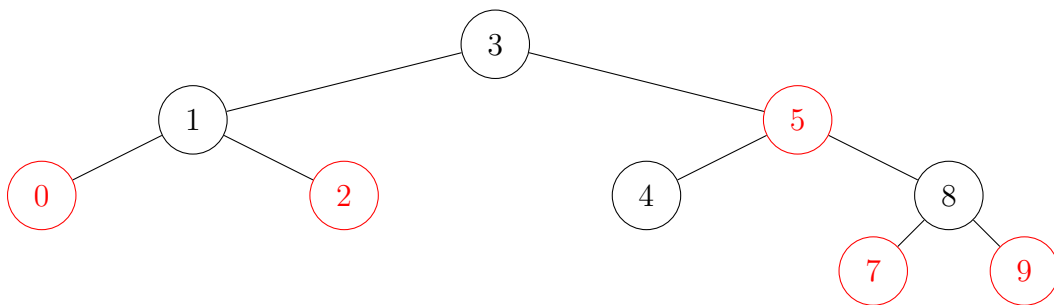
After adding 0



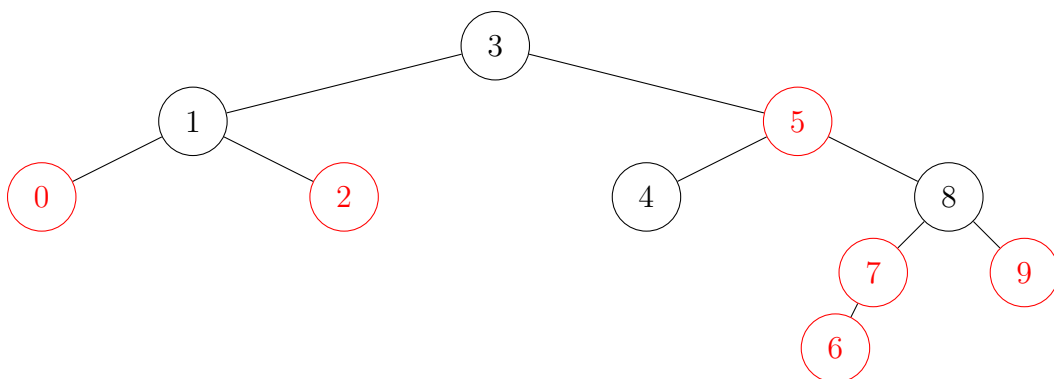
After adding 7



After adding 2

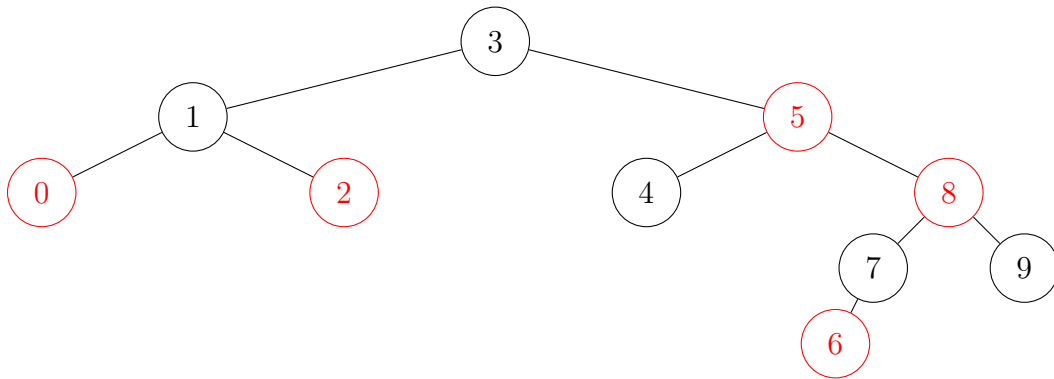


After adding 6

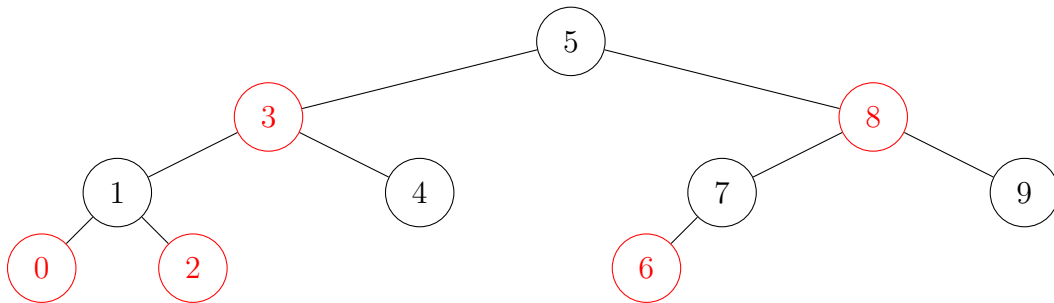




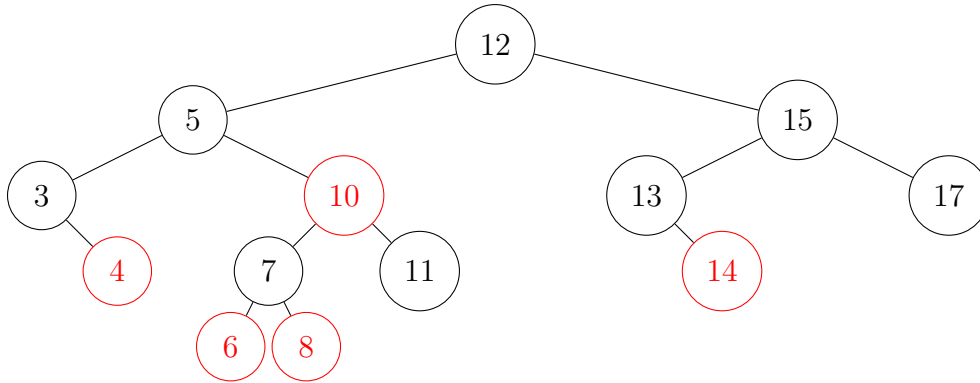
Case 1, change color of z.p, y, z.p.p



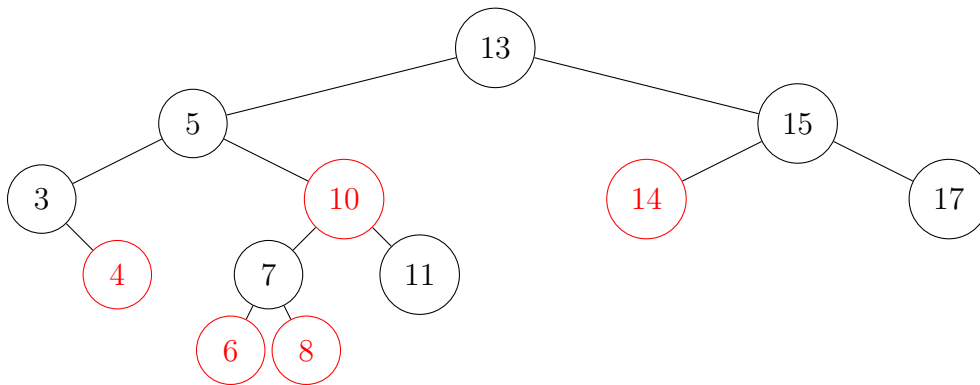
Case 4, change color of z.p, and z.p.p and left rotate on z.p.p



**Problem 5.** Remove the node with key '12' from the following red-black tree



Case 6, replace z by its successor y, y takes color of z



Case 3, recolor child

