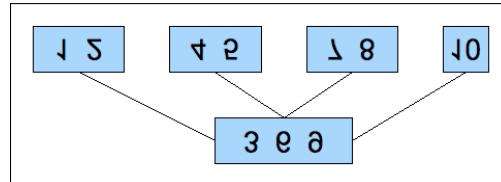


COMP3506/COMP7505—Algorithms and Data Structures

School of Information Technology and Electrical Engineering

Week 10 Tutorial Sample Solutions

Question 1.

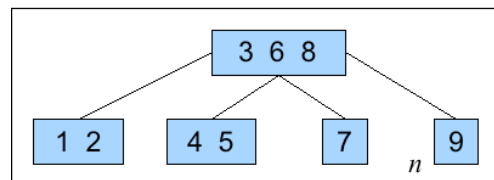
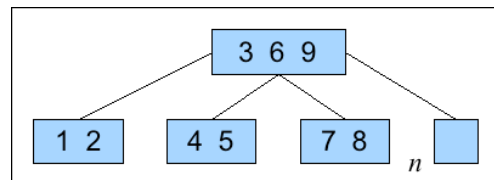


Above is a (2,4) tree containing the keys 1 – 10.

Remove the keys 10, and 8. Show the resulting tree after each removal and describing what action is being taken (fusion or transfer).

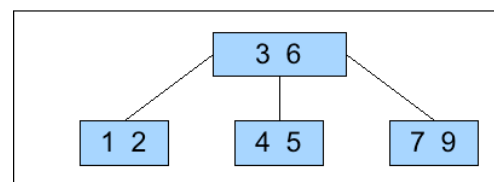
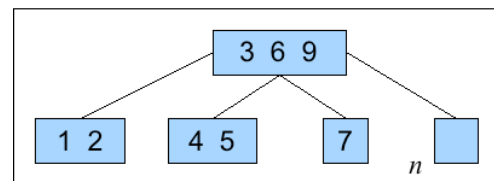
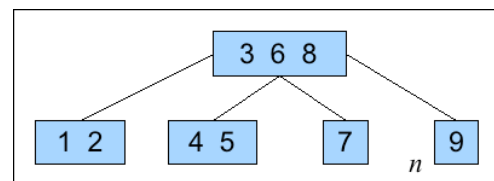
Remove 10:

The key 10 is removed causing an underflow in n , which is resolved using a transfer – the key 8 is moved from the sibling of n to its parent replacing the key 9 which is moved to the node, n .



Remove 8:

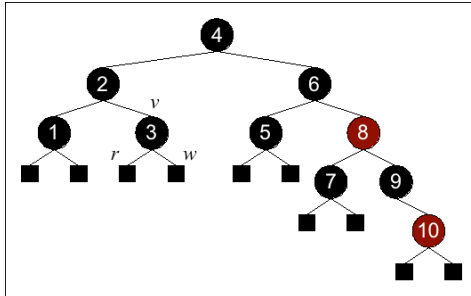
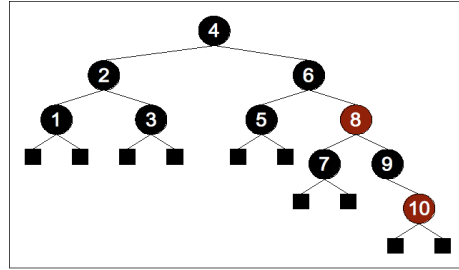
The key 8 is swapped with its in-order successor 9, then removed causing an underflow in n , which is resolved using a fusion – n is fused with its sibling and the key 9 is brought down from the parent.



Question 2.

To the right is a Red-Black tree containing the keys 1 – 10.

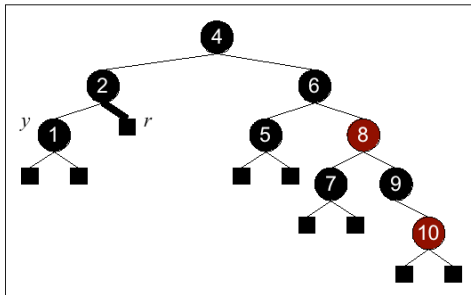
Remove the keys 3, 5 and 7. Show the resulting tree after each removal.



Remove 3:

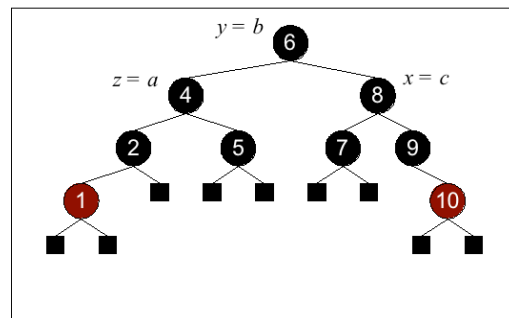
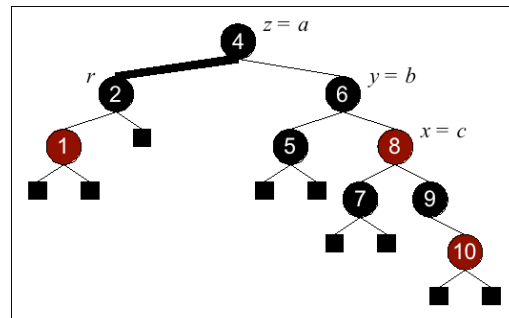
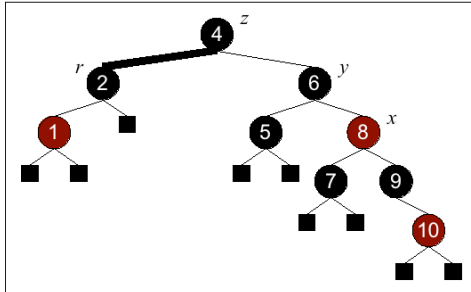
The node storing 3 is removed, causing a double-black violation at r . As y , the sibling of r , is black and so is its children, a recolor is performed (case 2).

This causes the double-black to be propagated up to the node storing 2, r .



The double-black is then resolved using a restructure (case 1).

The nodes labelled a and c are coloured black, and node labelled b is coloured the previous colour of the parent of nodes r and y .

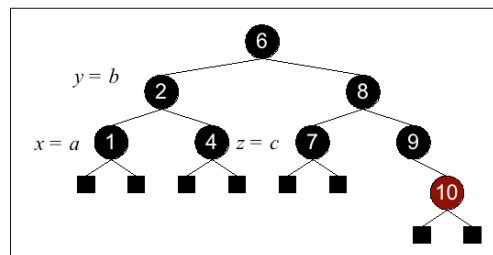
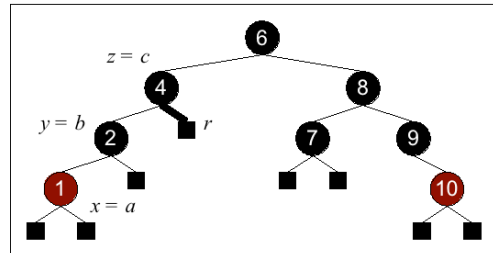
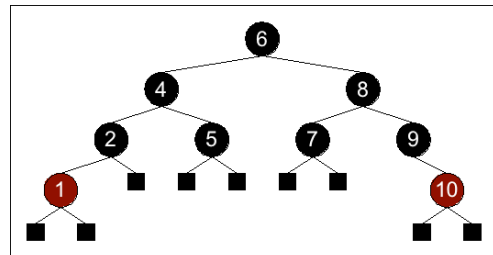


Question 2 (cont)

Remove 5:

The node containing key 5 is removed causing a double-black violation at r , which is handled using a restructure (case 1).

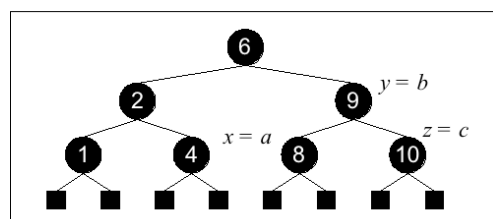
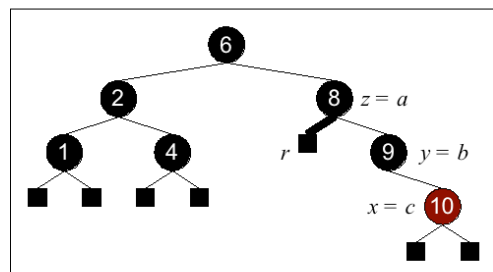
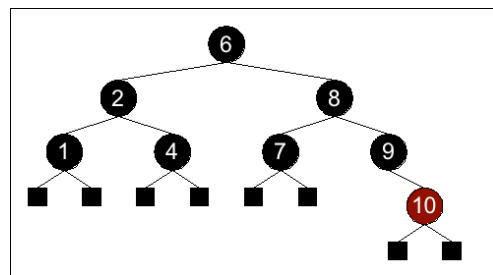
The nodes labelled a and c are coloured black and the node labelled b is coloured the previous colour of the parent of r (black).



Remove 7:

The node containing key 7 is removed causing a double-black violation at r , which is handled using a restructure (case 1).

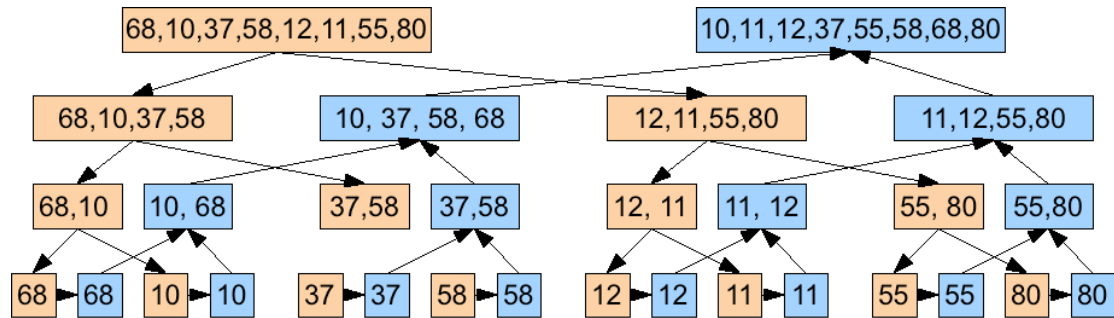
The nodes labelled a and c are coloured black and the node labelled b is coloured the previous colour of the parent of r (black).



Question 3.

Sort the following numbers using merge-sort: **68, 10, 37, 58, 12, 11, 55, 80**

Show your progress using the binary tree representation used in the lectures.



Question 4.

Sort the following numbers using quick-sort: **68, 10, 37, 58, 12, 11, 55, 80**

Show your progress using the binary tree representation used in the lectures.

