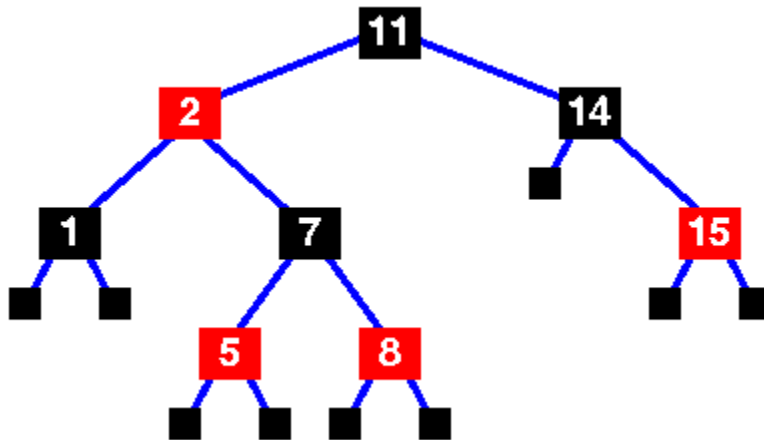
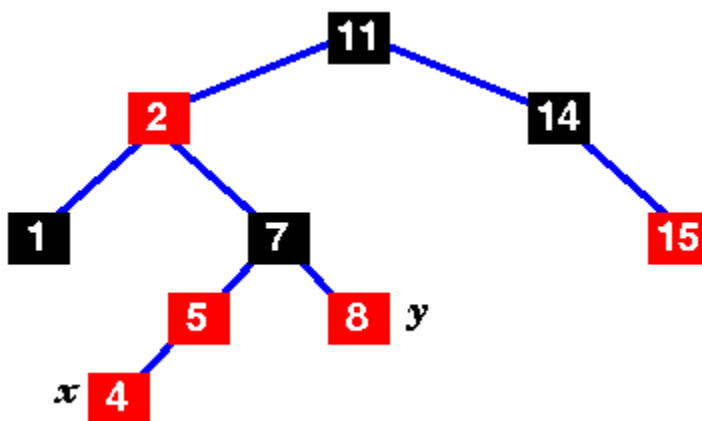


RED BLACK TREE OPERATION



Here's the original tree

The black sentinel nodes have been omitted to keep the diagrams simple.



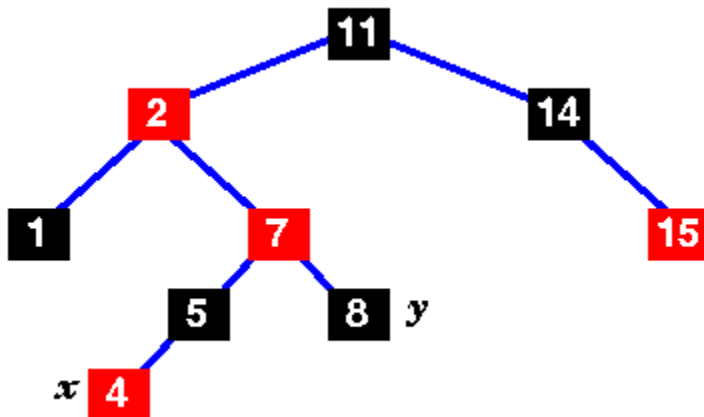
The tree insert routine has just been called to insert node "4" into the tree.

This is no longer a red-black tree - there are two successive red nodes on the path

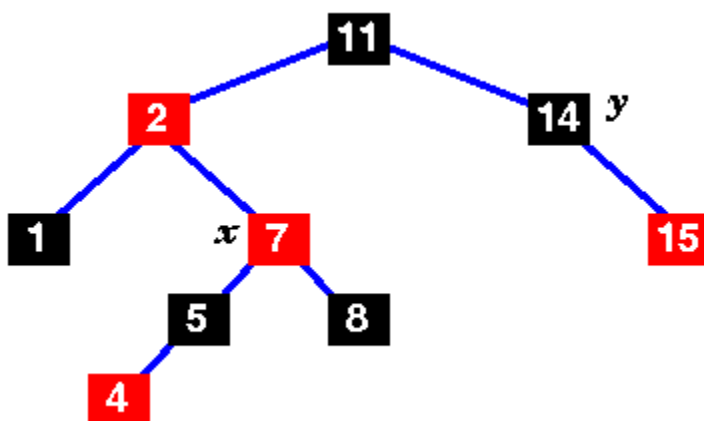
11 - 2 - 7 - 5 - 4

Mark the new node, x , and its **uncle**, y .

y is red, so we have case 1 ..



Change the colours of nodes 5, 7 and 8.

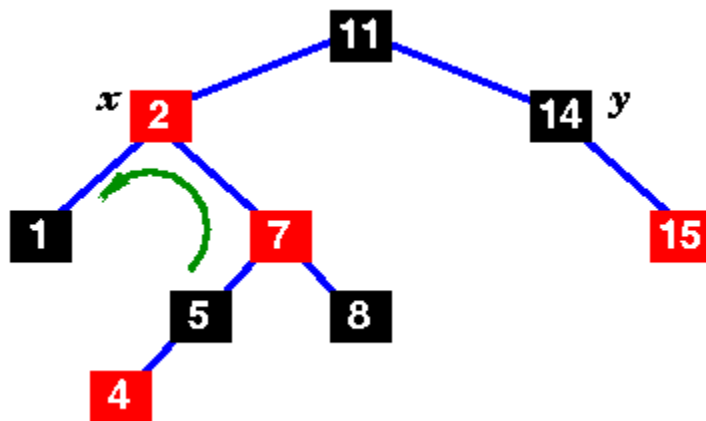


Move x up to its grandparent, 7.

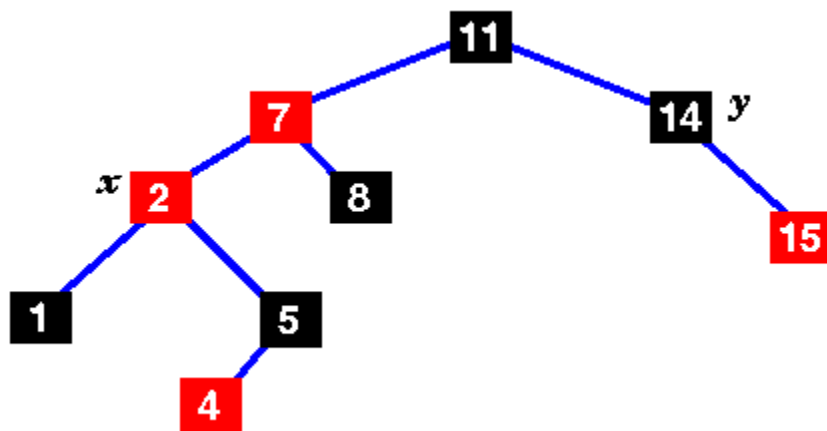
x 's parent (2) is still red, so this isn't a red-black tree yet.

Mark the uncle, y .

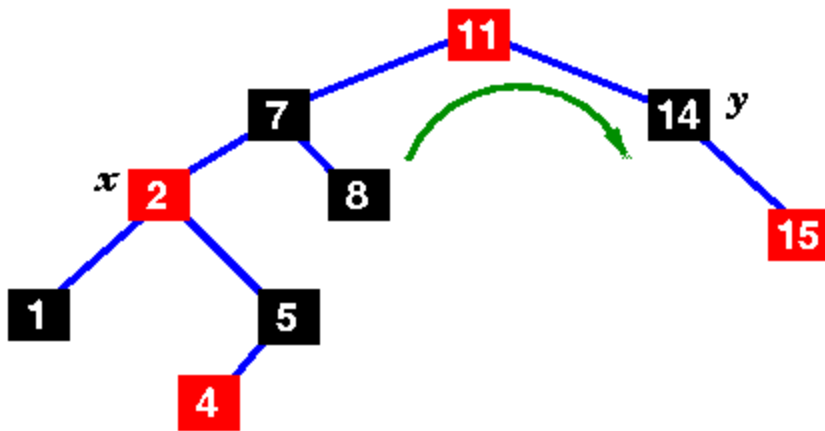
In this case, the uncle is black, so we have case 2 ..



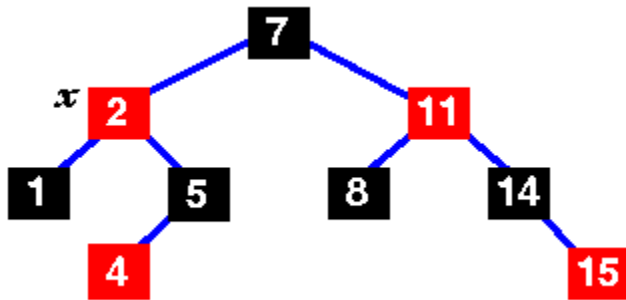
Move x up and rotate left.



Still not a red-black tree .. the uncle is black, but x's parent is to the left



Change the colours of 7 and 11 and rotate right.



This is now a red-black tree, so we're finished!

$O(\log n)$ time!