Red-Black Tree | Set 2 (Insert)

In the previous post, we discussed introduction to Red-Black Trees. In this post, insertion is discussed.

In AVL tree insertion, we used rotation as a tool to do balancing after insertion caused imbalance. In Red-Black tree, we use two tools to do balancing.

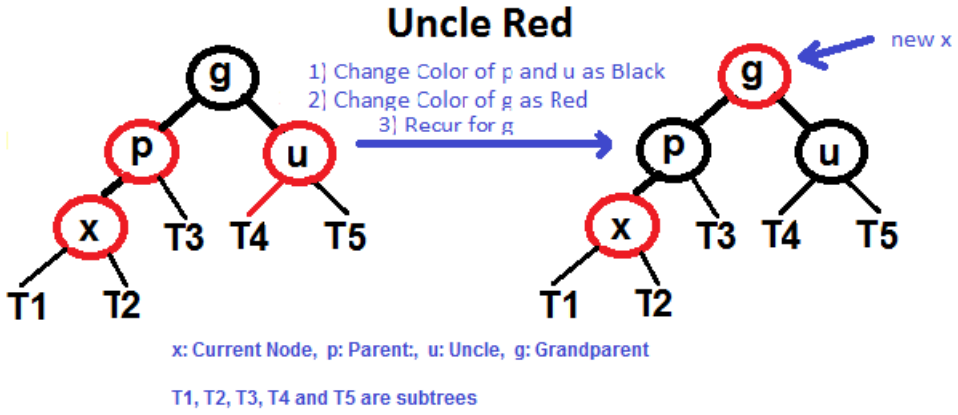
1) Recoloring
2) Rotation

We try recoloring first, if recoloring doesn't work, then we go for rotation. Following is detailed algorithm. The algorithms has mainly two cases depending upon the color of uncle. If uncle is red, we do recoloring. If uncle is black, we do rotations and/or recoloring.

Color of a NULL node is considered as BLACK.

Let x be the newly inserted node.
1) Perform standard BST insertion and make the color of newly inserted nodes as RED.

2) Do following if color of x's parent is not BLACK or x is not root.
….**a) If x's uncle is RED** (Grand parent must have been black from property 4)
……..**(i)** Change color of parent and uncle as BLACK.
……..**(ii)** color of grand parent as RED.
……..**(iii)** Change x = x's grandparent, repeat steps 2 and 3 for new x.



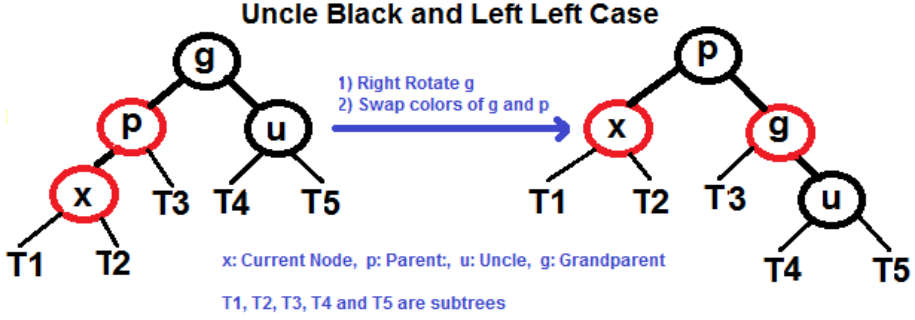
....**b) If x's uncle is BLACK**, then there can be four configurations for x, x's parent (**p**) and x's grandparent (**g**) (This is similar to AVL Tree)
.....**i)** Left Left Case (p is left child of g and x is left child of p)
.....**ii)** Left Right Case (p is left child of g and x is right child of p)
.....**iii)** Right Right Case (Mirror of case a)
.....**iv)** Right Left Case (Mirror of case c)

3) If x is root, change color of x as BLACK (Black height of complete tree increases by 1).

Following are operations to be performed in four subcases when uncle is BLACK.

All four cases when Uncle is BLACK

Left Left Case (See g, p and x)



Left Right Case (See g, p and x)

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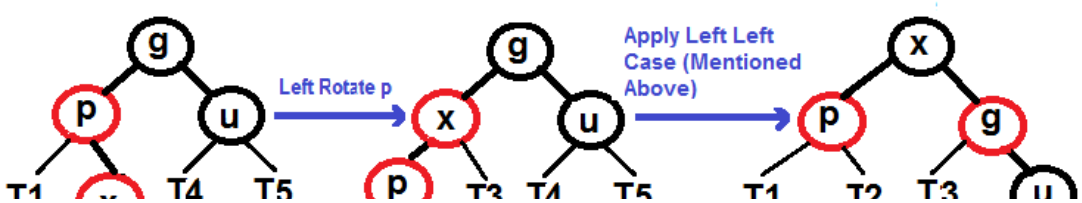
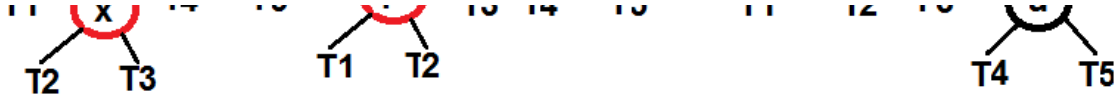
Uncle Black and Left Right Case

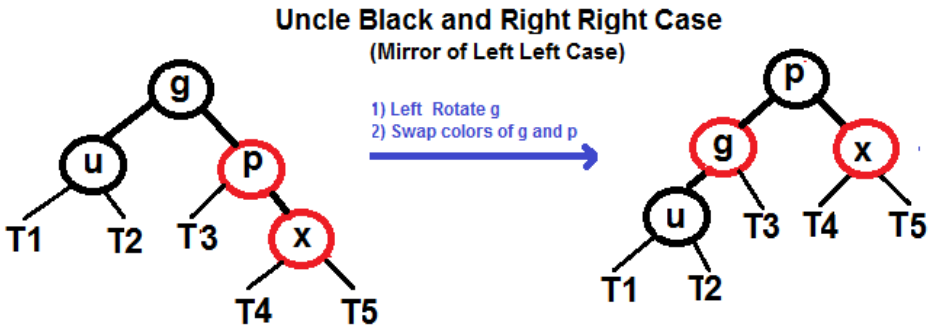




x: Current Node, p: Parent:, u: Uncle, g: Gr

T1, T2, T3, T4 and T5 are subtrees

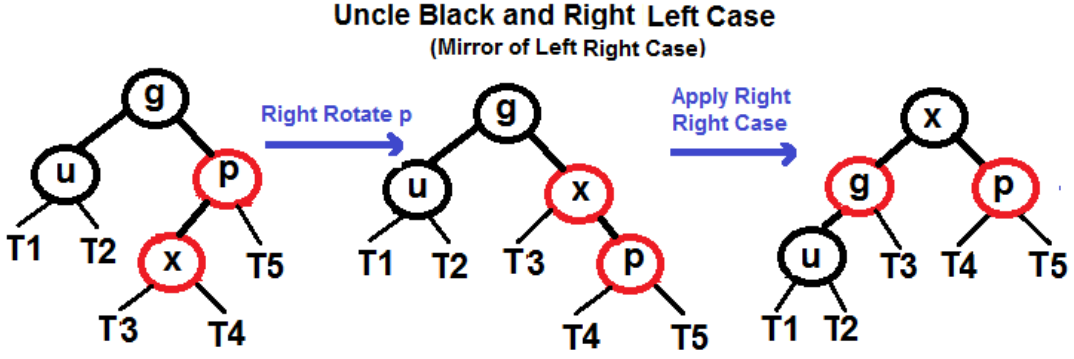
Right Right Case (See g, p and x)



x: Current Node, p: Parent:, u: Uncle, g: Grandparent

T1, T2, T3, T4 and T5 are subtrees

Right Left Case (See g, p and x)

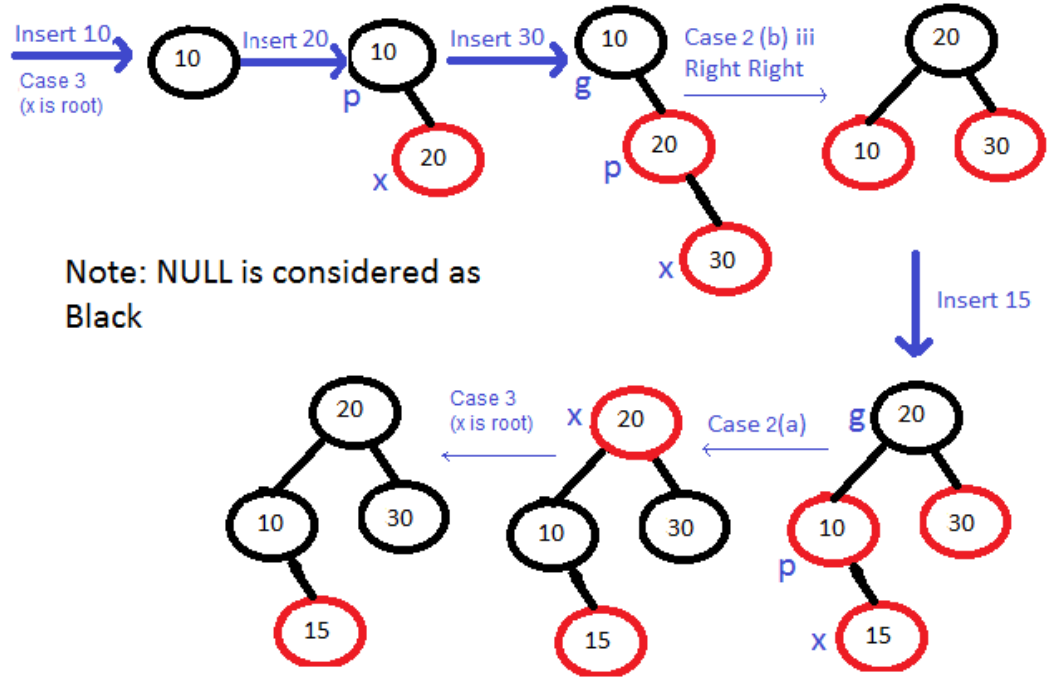


x: Current Node, p: Parent:, u: Uncle, g: Grandparent

T1, T2, T3, T4 and T5 are subtrees

Examples of Insertion

Insert 10, 20, 30 and 15 in an empty tree



We will soon be discussing implementation of above insertion algorithm.

Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.

695

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affiszerv Your example has two 4s on row 3, that's why it...

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sandeep void rearrange(struct node *head) {...

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4,7,17; it showed a tree with 4 as root and 12 as left node !! that is wrong. So

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Very well Explained. Keep these rules handy and view this animation.
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After every insertion; apply these rule and guess what should be behaviour. Yo

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First time ever, I understood insertion in red-black tree. Thanks.

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