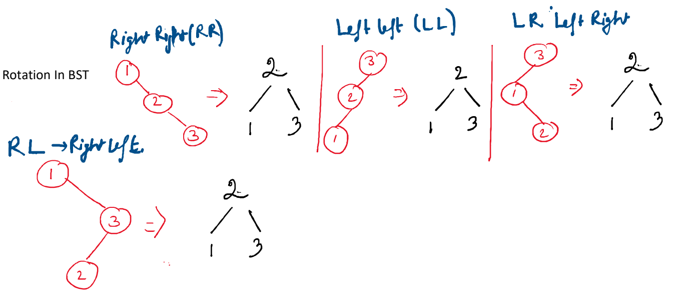
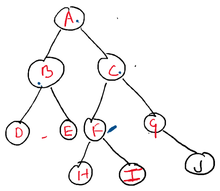
06 February 2025 14:50

Rotation In BST



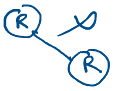
Left child = Minimum
Right child = Max.
Root = Remaining one.

Terminology — Grandparent, Parent, Uncle.



Node	Parent	Grand Parent	Uncle.
J	G	C	F
I	F	C	G
H	F	C	G
D	B	A	C
E	B	A	C
F	C	A	B .

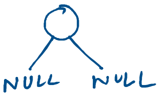
RBT Property — A Red-Black Tree is a type of binary search tree providing efficient insertion, deletion, and lookup operations.



BB
BR
RB

Properties of Red-Black Trees

1. **Node Color**: Each node is either red or **black**.
2. **Root Property**: The root of the tree is always **black**.
3. **Red Property**: Red nodes cannot have red children (no two consecutive red nodes on any path).
4. **Black Property**: Every path from a node to its descendant null nodes (leaves) has the same number of **black** nodes.
5. **Leaf Property**: All [redacted] (NIL nodes) are **black**.



Insertion In RBT.

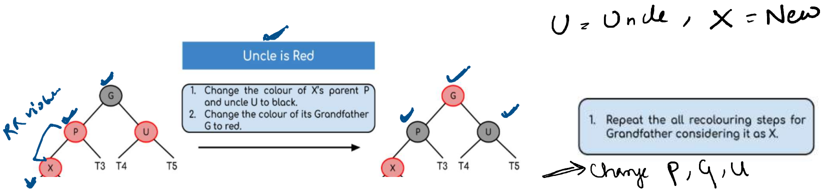
Step 1:

- Insert the new node with color **red**.

Step 2:

- Case 1: Node is the Root
  - Recolor it to **black**.
- **Case 2: Red-Red Violation** (Parent and newly inserted node are both red)
  - Case 2.1: Uncle is Red
    - Recolor the **parent** and the **uncle** to **black**.
    - Recolor the **grandparent** to **red**.
    - Repeat the fix-up process from the **grandparent**.
  - Case 2.2: Uncle is Black or Null
    - Perform **rotations** to balance the tree.
    - Recolor the nodes accordingly.

G = Grand Parent, P = Parent
U = Uncle, X = New Node to Insert.



Uncle is Red

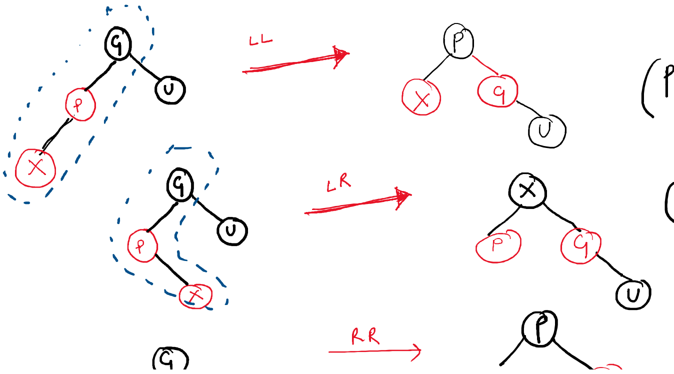
1. Change the colour of X's parent P and uncle U to black.
2. Change the colour of its Grandfather G to red.

1. Repeat the all recolouring steps for Grandfather considering it as X.

→ Change P, G, U

Uncle is Black /NULL

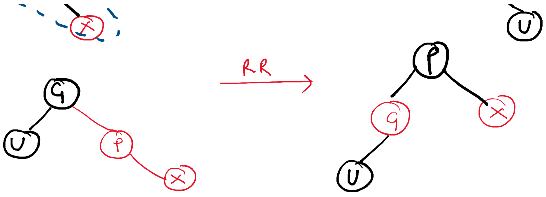
Rotation G P X



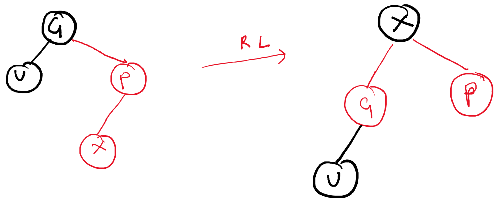
(P, G swap color)

(X, G swap color)

(P G swap color)

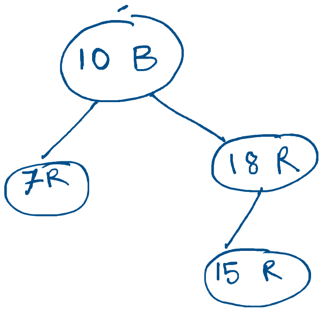


(P,G swap color)



(x,G swap color)

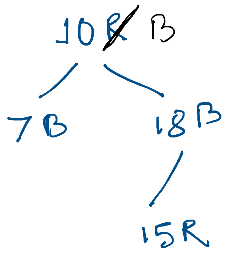
10 18 7 15 16 30 70 insert into RBT.

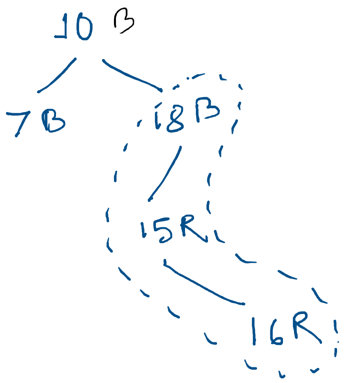


RR violation -

Uncle = Red.

P,G,U color change

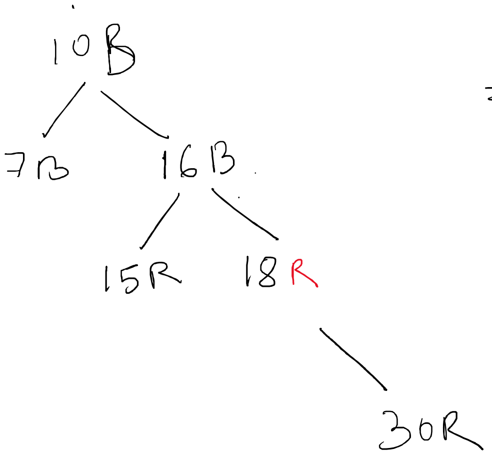




RR violation

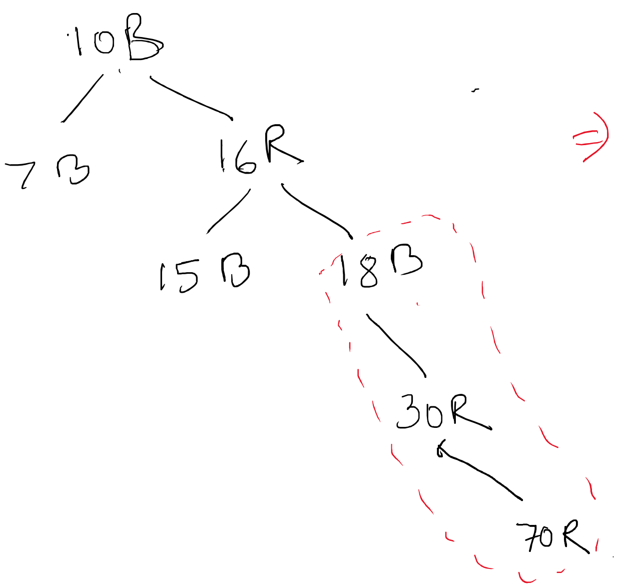
Uncle = NIL

LR



RR violation.

Uncle = Red.



RR viola

Uncle = Red.

P G U change color

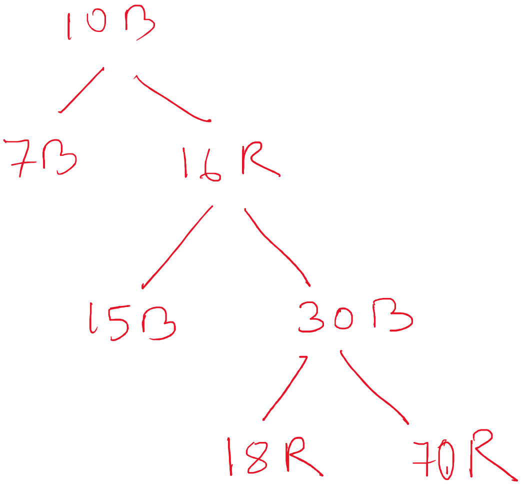
70 R

RR violation -

Uncle = NIL

Rotation = RR

P, G change color


10 B
7 B
16 R
15 B
30 B
18 R
70 R