Red-Black Tree Rotations
Red-Black Diagrams

The diagrams which follow show the rotations and recoloring for each “case” for Bottom-Up Insertion, Top-Down Insertion and Bottom-Up Deletion.

Bear in mind that each case has a left-right symmetrical twin which is not shown here.
Bottom-Up Insertion

**Case 0** - X is the root

- Color it black

**Case 1** - U is Red

- Recolor P, G, U
- Move X up to G
- Move to another case

**Case 2** - Uncle is black. X and P are opposite children

- Zig-Zag Rotation
- Recolor X and G

**Case 3** - Uncle is Black

- X and P are both left (right) children

- Rotate P around G
- Recolor P and G
Top Down Insertion

**Case 1** – P is Black

![Graph Illustrating Case 1](image1)

**Case 2** – P is red and P and X are both left (right) children

![Graph Illustrating Case 2](image2)

**Case 3** – P is red and P and X are opposite children

![Graph Illustrating Case 3](image3)