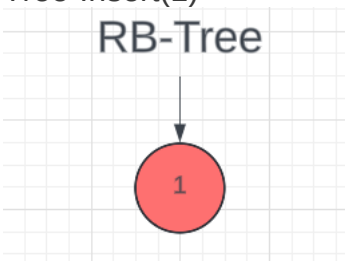
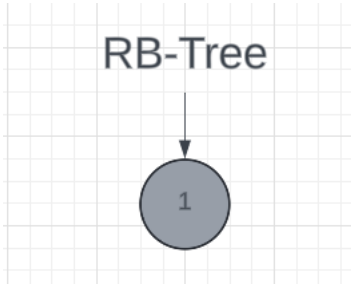
Insertions

INSERT 1

Tree-Insert(1)

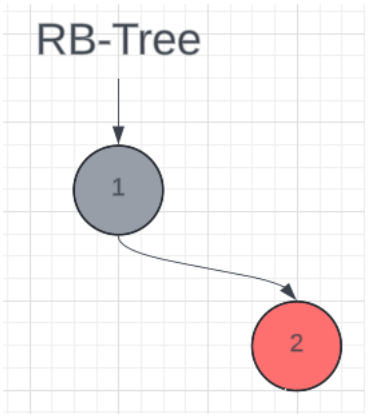


Case 0: insert is root



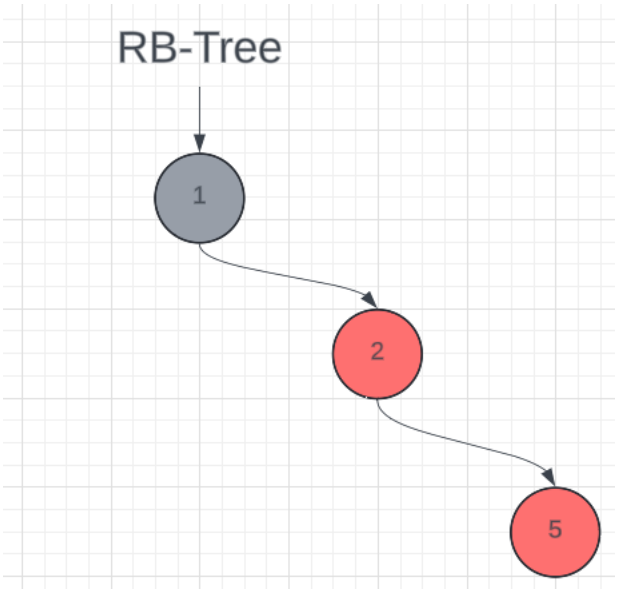
INSERT 2

Tree-Insert(2)

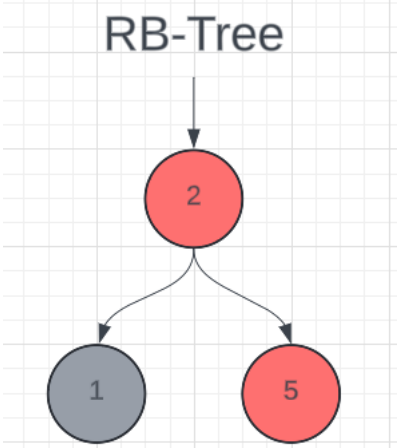


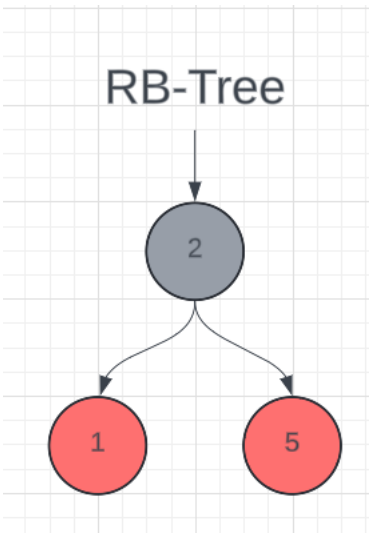
INSERT 5

Tree-Insert(5)



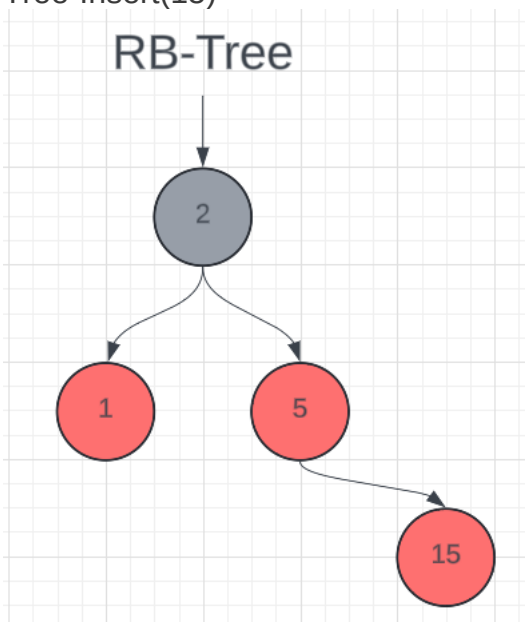
Case 3: 5's uncle is black, 5 is a left child, and 2 is a left child



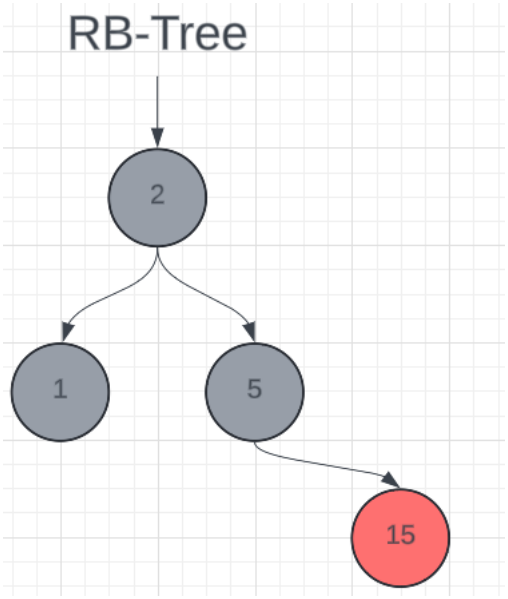


INSERT 15

Tree-Insert(15)

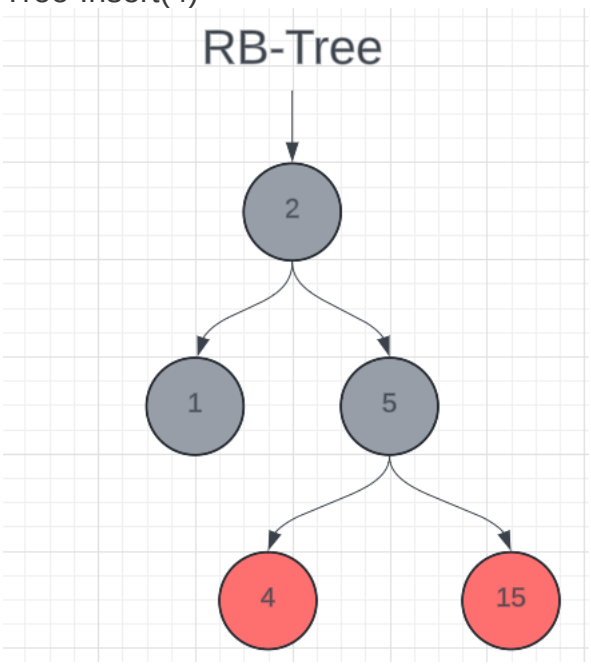


Case 1: uncle is red



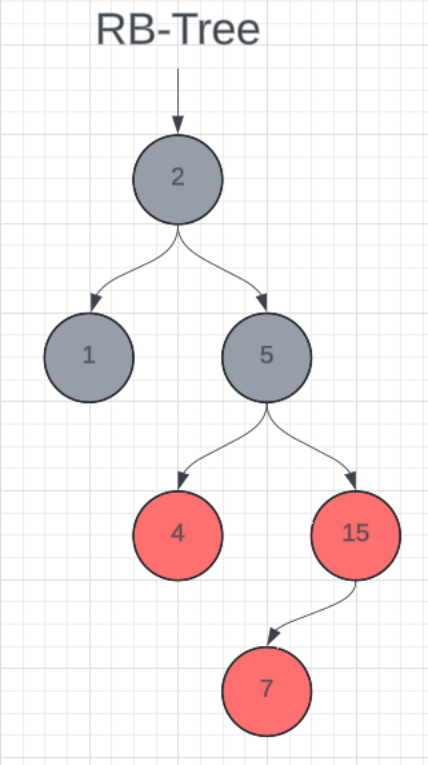
INSERT 4

Tree-Insert(4)

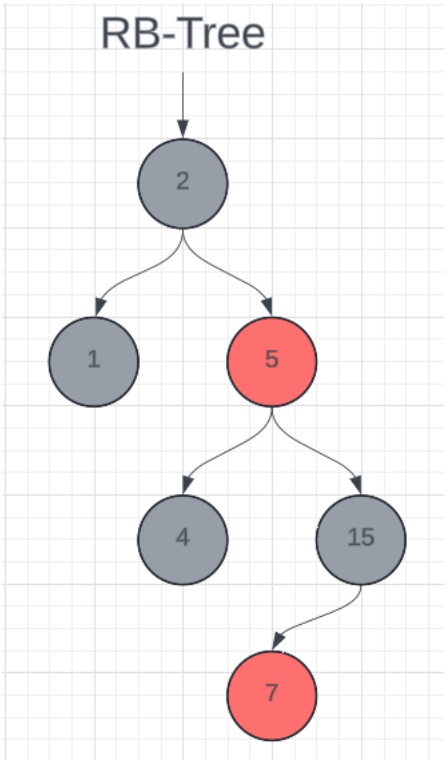


INSERT 7

Tree-Insert(7)

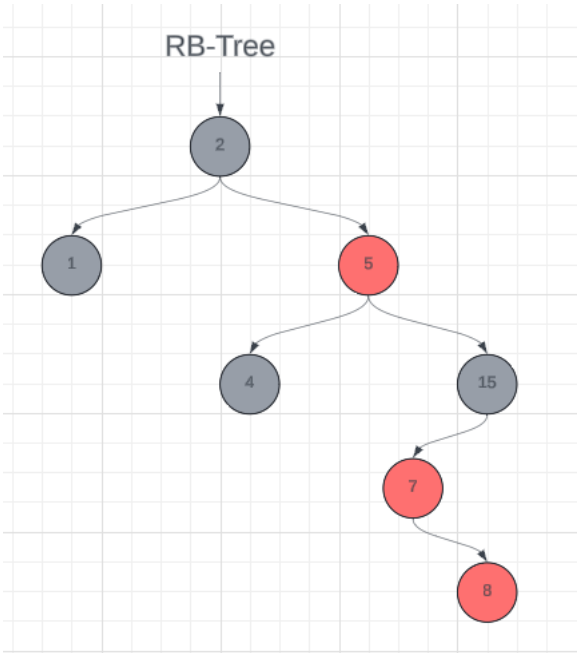


Case 1: 4 is red

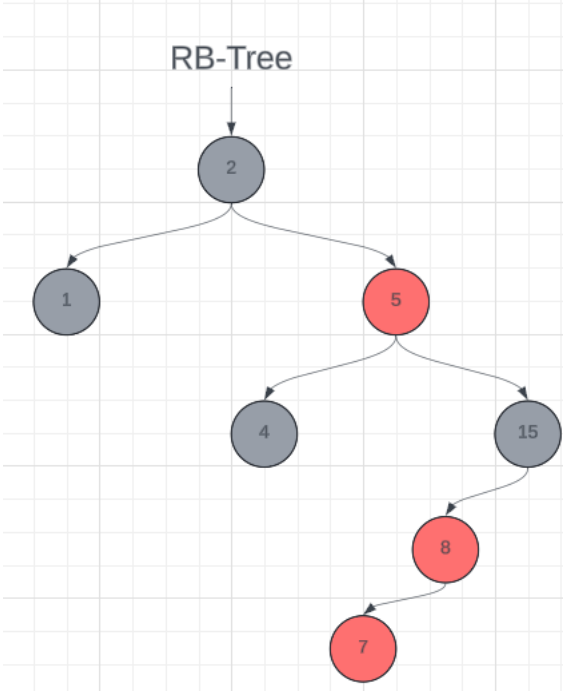


INSERT 8

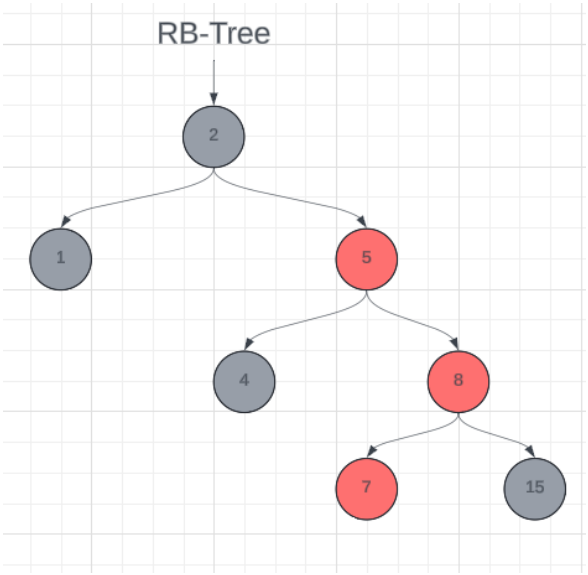
Tree-Insert(8)

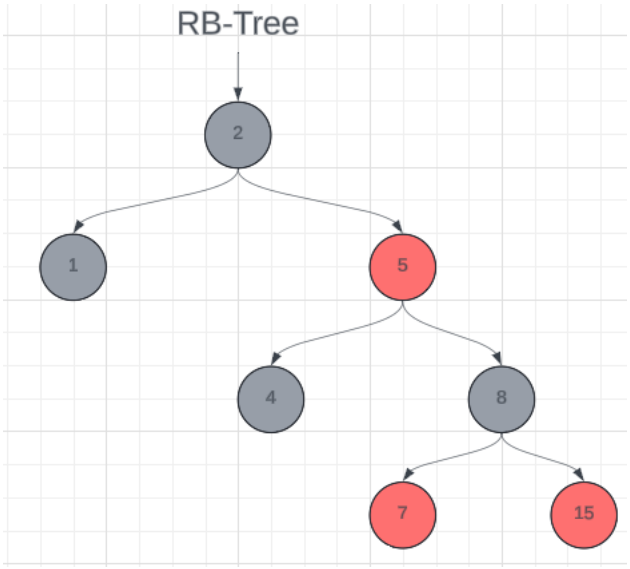


Case 2: 8’s uncle is black, 8 is right child, and 7 is left child



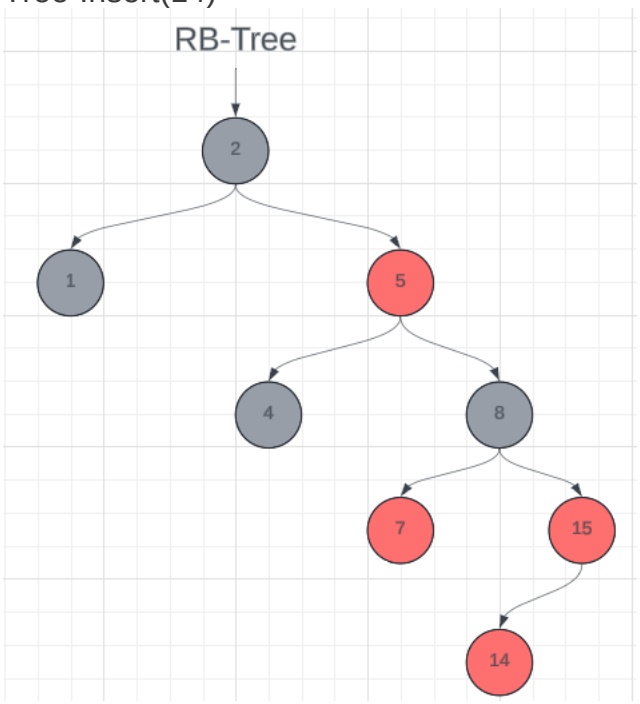
Case 3: 7’s uncle is black, 7 is left child, and 8 is left child



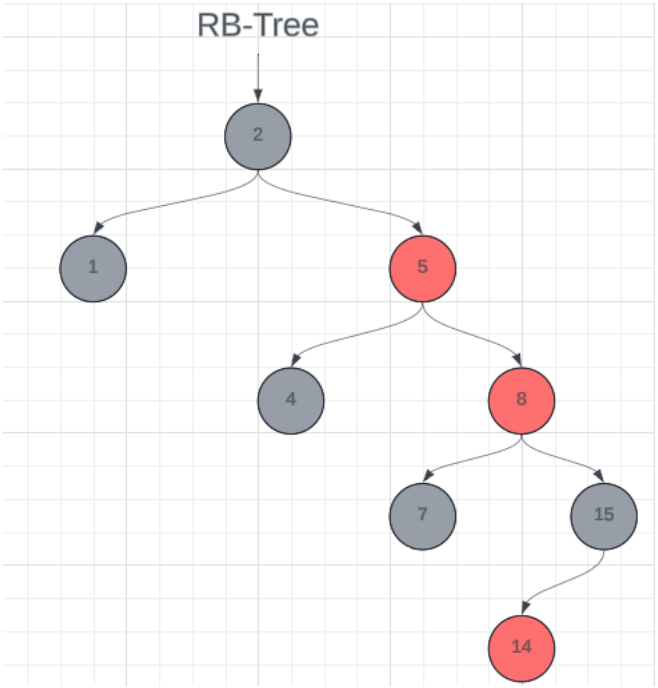


INSERT 14

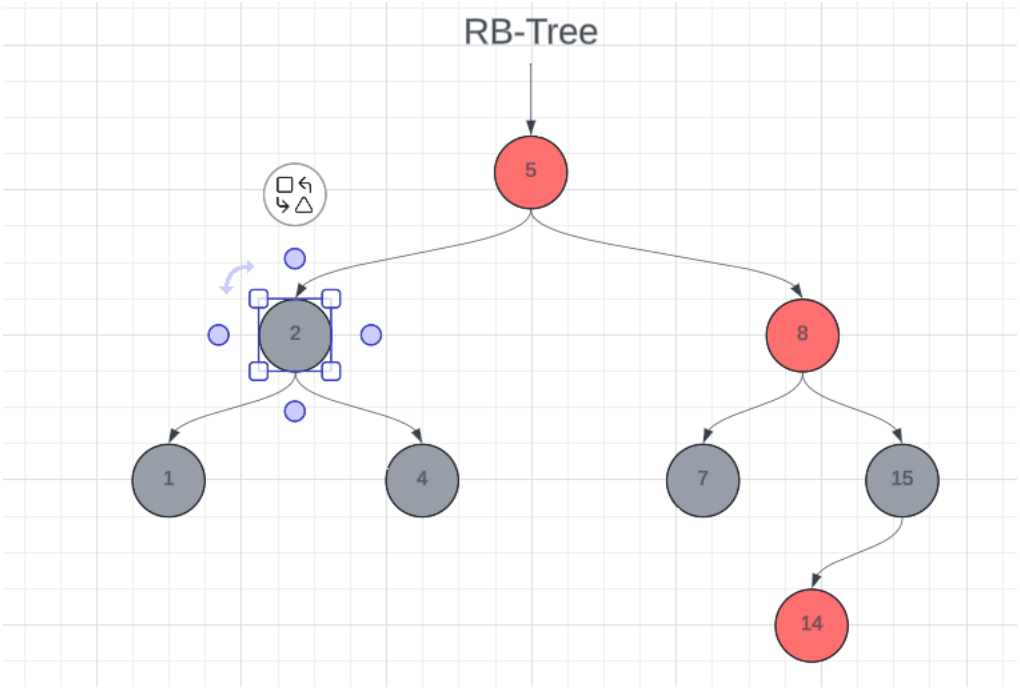
Tree-Insert(14)

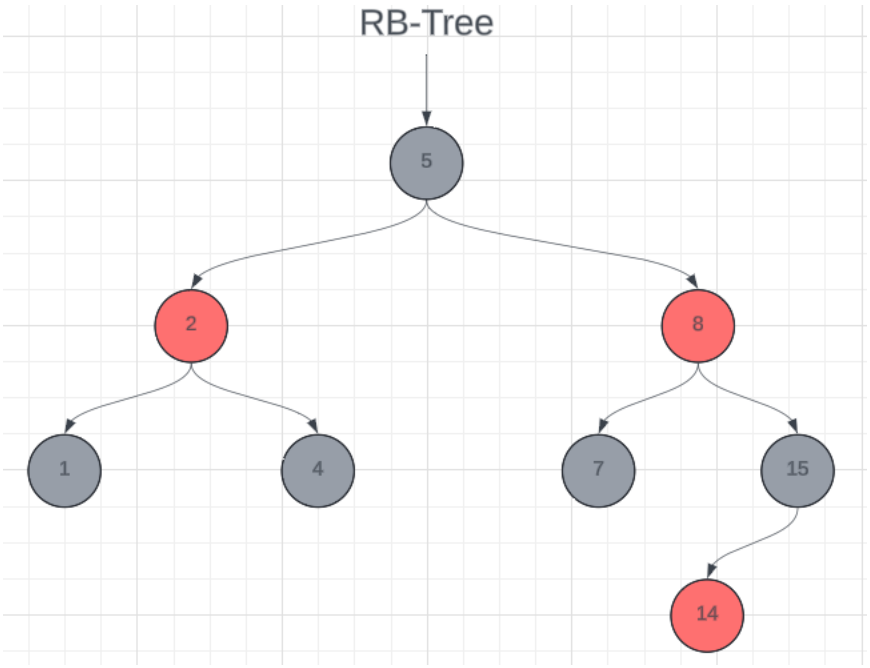


Case 1: 7 is red



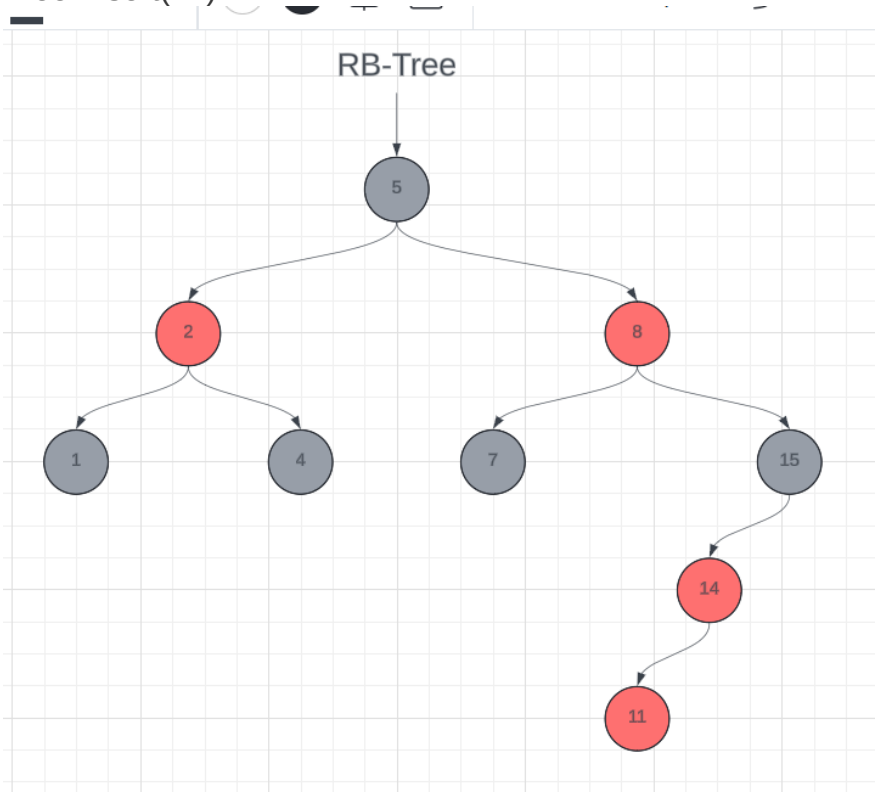
Case 3: 1 is black, 8 and 5 are left children



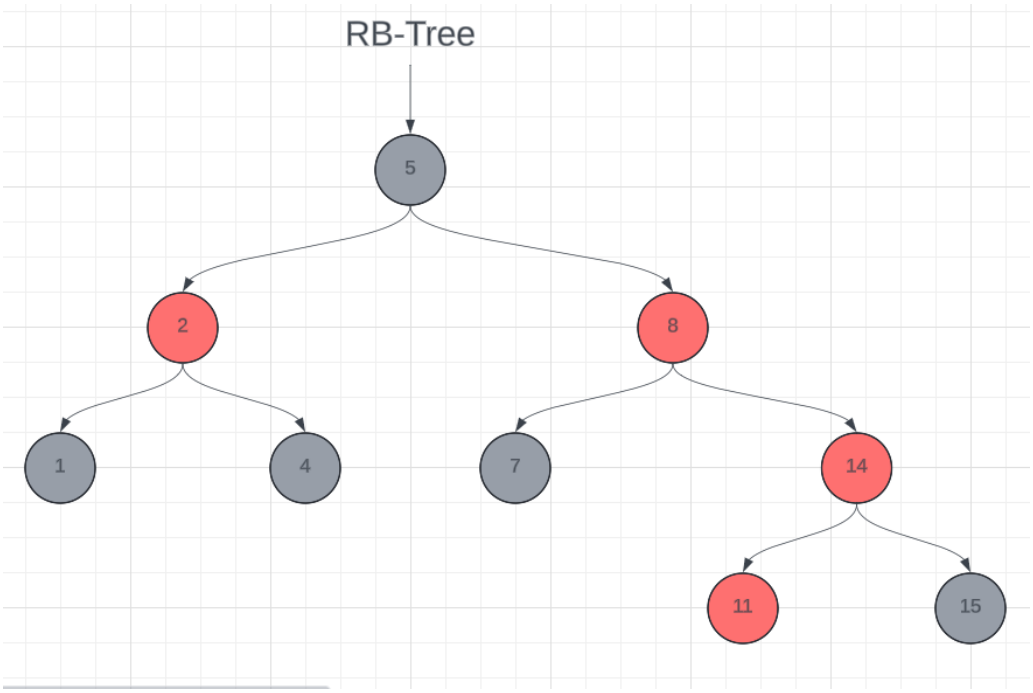


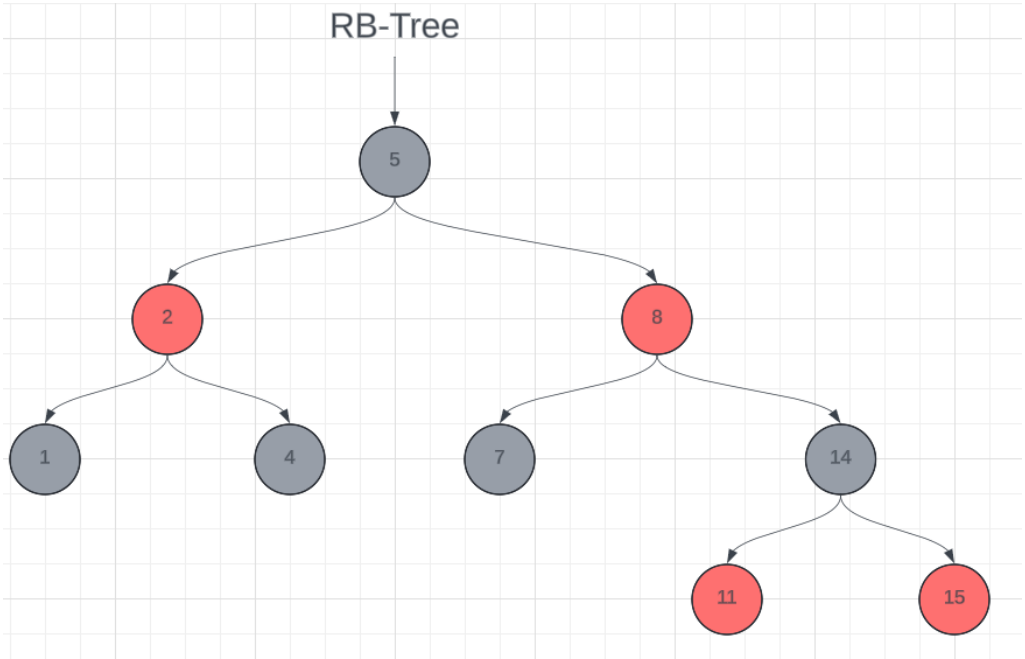
INSERT 11

Tree-Insert(11)

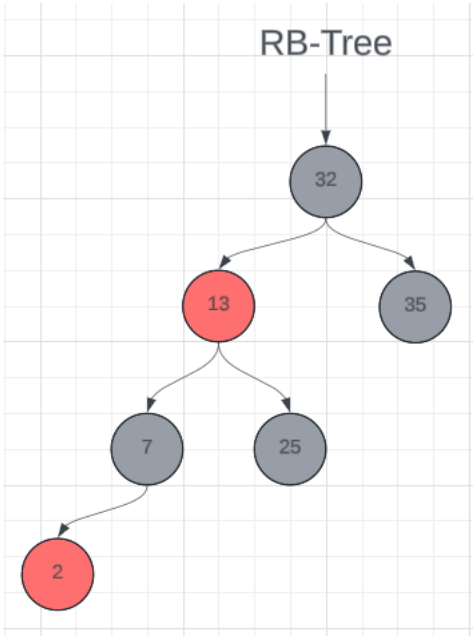


Case 3: 11’s uncle is black and both 11 and 14 are left children


RB-Tree
5
2
8
1
4
7
14
11
15

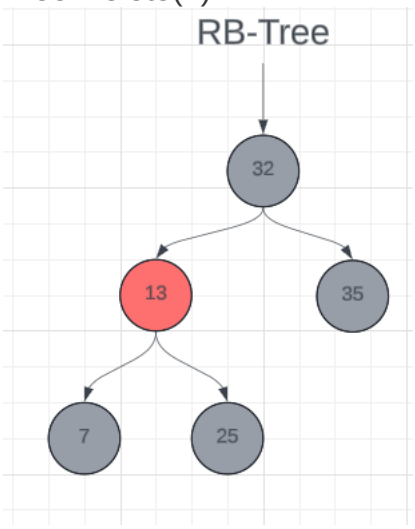

RB-Tree
5
2
8
1
4
7
14
11
15

Deletion



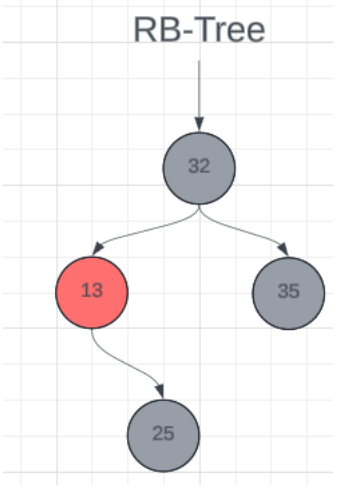
DELETE 2

Tree-Delete(2)

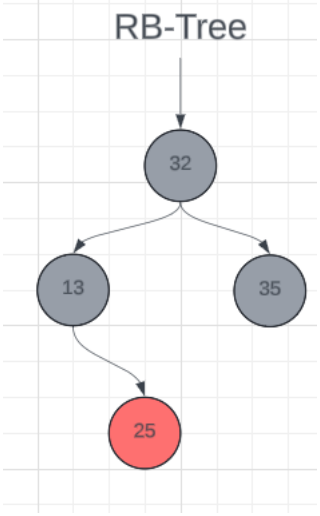


DELETE 7

Tree-Delete(7)

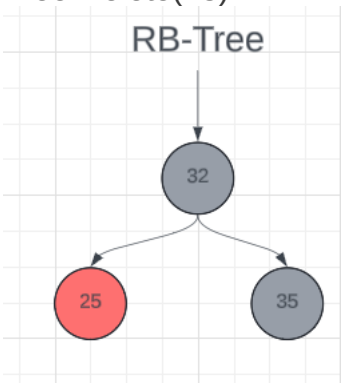


Case 2: 25 and its children are black.

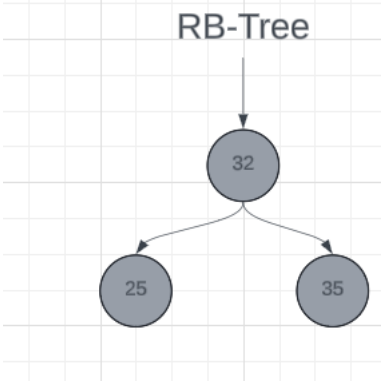


DELETE 13

Tree-Delete(13)

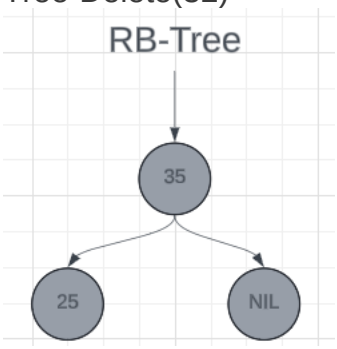


Case 2: 35 and its children are black



DELETE 32

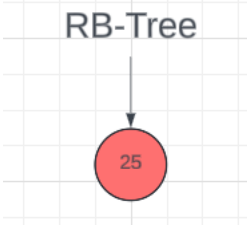
Tree-Delete(32)

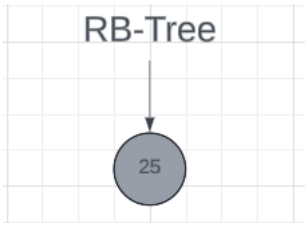


Case 2: 25 and its children are black

DELETE 35

Tree-Delete(35)




RB-Tree
25