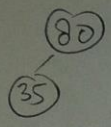
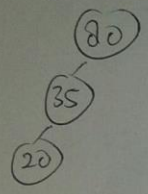
Tree Simulation

A AVL Tree.

Insert

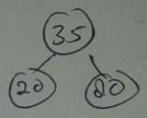
1. 

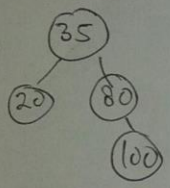
2. 

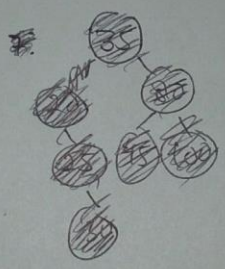
3. 

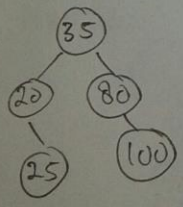
-> unbalanced

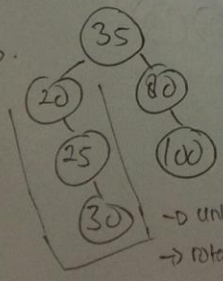
-> rotation (using right rotation) ->



4. 

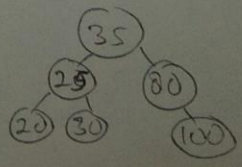


5. 

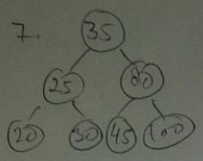
6. 

-> unbalanced

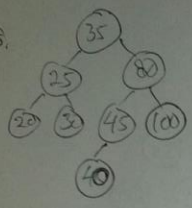
-> rotation (using left rotation) ->



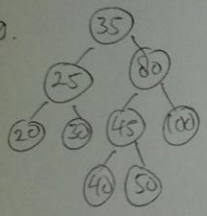
7.



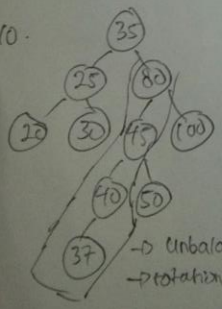
8.



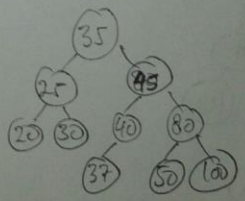
9.



10.



→ Unbalance
→ rotation (right rotation) →

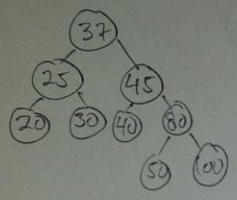


Delete
AVL Tree

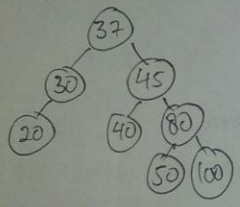
1. Delete 35

Cari Successor / predecessor

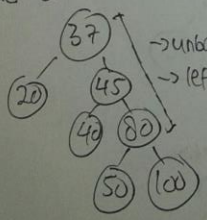
Successor = 37



2. Delete 25

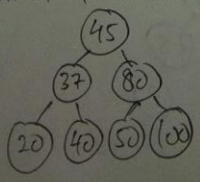


3. Delete 30



→unbalanced
→left rotation

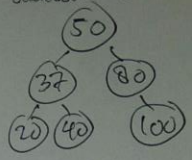
→hasil left rotation



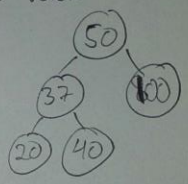
4. Delete 45

Cari Successor / predecessor

Successor = 50



5. Delete 80

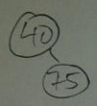


(B)

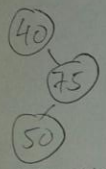
Insert AVL Tree

1. Insert 40

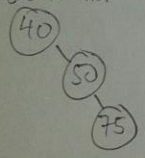
2. Insert 75



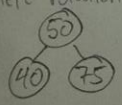
3. Insert 50



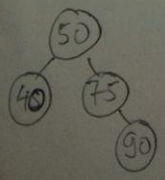
right-left rotation.
→ right rotation



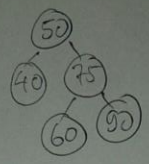
→ left rotation



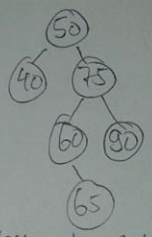
4. Insert 90



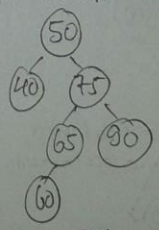
5. Insert 60



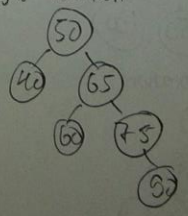
6. Insert 65



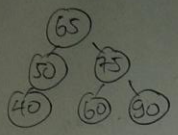
left right rotation
→ left rotation



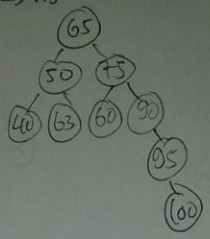
→ right rotation



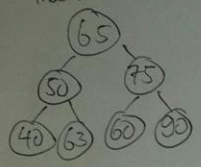
→ left rotation



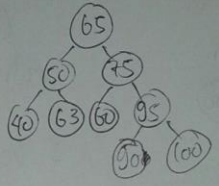
for.
→ right rotation



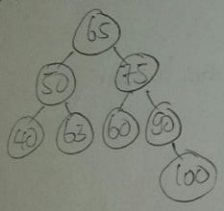
7. Insert 63



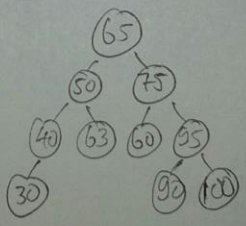
→ left rotation



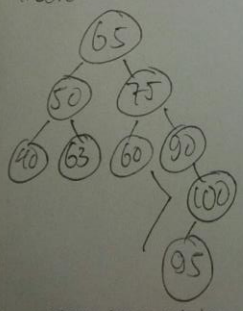
8. Insert 100



10. Insert 30



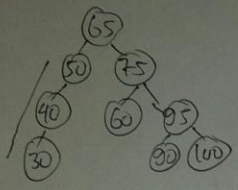
9. Insert 95



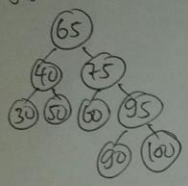
→ right-left rotation

Delete

1. Delete 63



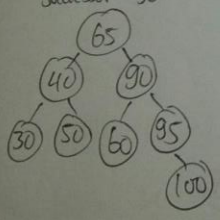
-> right rotation



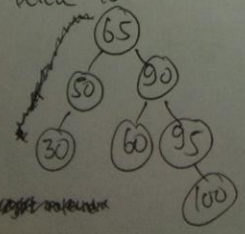
2. Delete 75

cari successor / predecessor

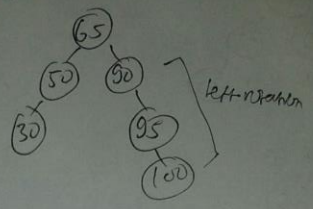
successor = 90.

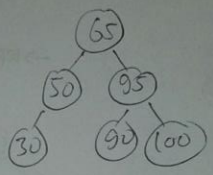


3. Delete 40



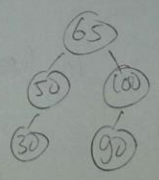
4. Delete 60





5. Delete 95

cari successor



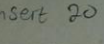
2-3 Tree

Insert $m = 3$.

1. Insert 80.

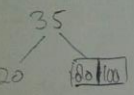
2. Insert 35

3. Insert 20

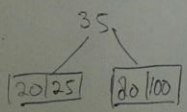


key ≠ 2.

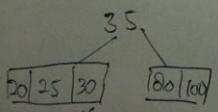
4. Insert 100

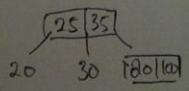


5. Insert 25

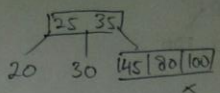


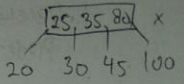
6. Insert 30

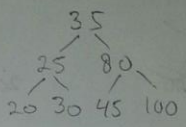




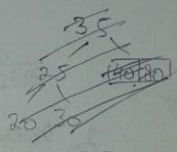
7. Insert 45

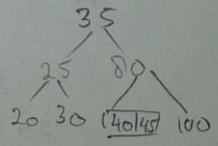




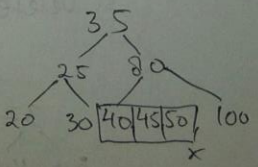


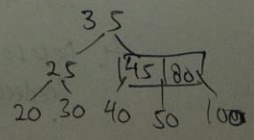
8. Insert 40



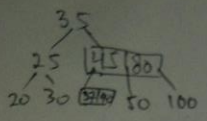


9. Insert 50





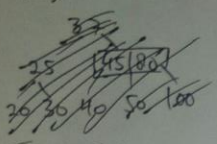
10 Insert 37



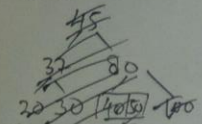
Delete

~~1. Delete 35~~

~~Successor = 37~~



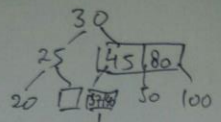
~~2. Delete 25~~

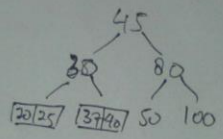


~~3. Delete 30~~

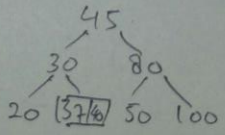
1. Delete 35

Predecessor = 30

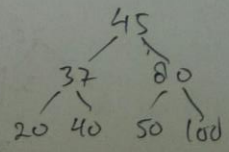




2. Delete 25

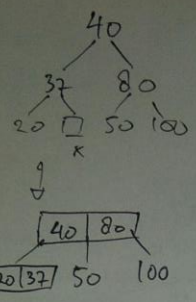


3. Delete 30

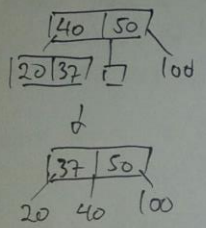


4 Delete 45

Predecessor = 40



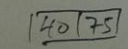
5. Delete 80



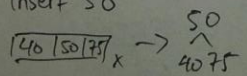
B. $m = 3$.

1. Insert 40

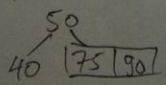
2. Insert 75



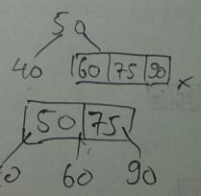
3. Insert 50



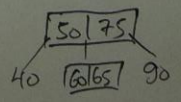
4. Insert 90



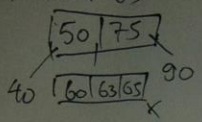
5. Insert 60

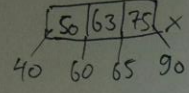


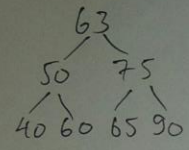
6. Insert 65



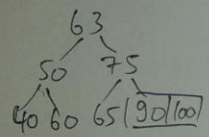
7. Insert 63



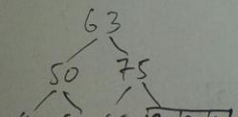


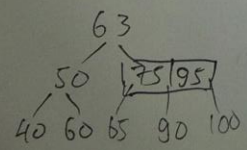


8. Insert 100

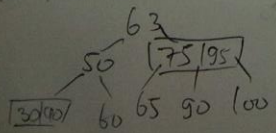


9. Insert 95





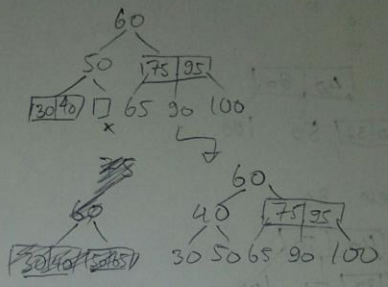
10. Insert 30



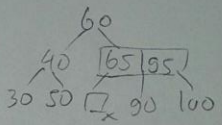
Delete

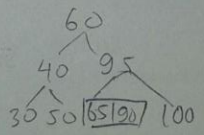
1. Delete 63

Predecessor : 60

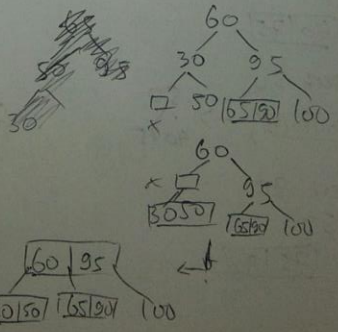


2. Delete 75



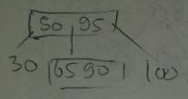


3. ~~40~~ Delete 40



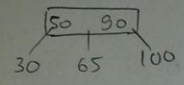
4. Delete 60

Predecessor = 50



5. Delete 95

Predecessor = 90

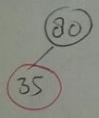


Red Black Tree

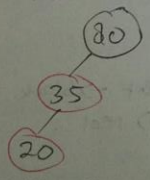
A.

1. Insert 80

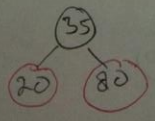
2. ~~80~~ Insert 35



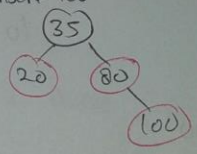
3. Insert 20



right rotation

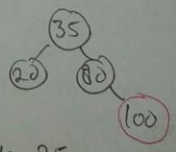


4. Insert 100

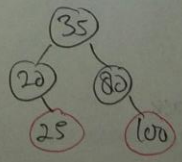


Uncle = red

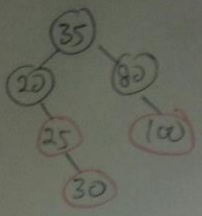
Uncle and parent = black

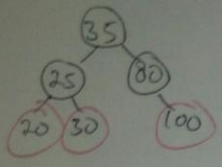


5. Insert 25

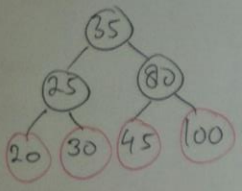


6. Insert 30

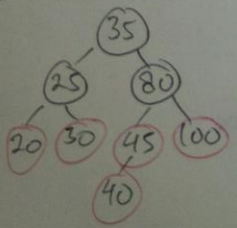




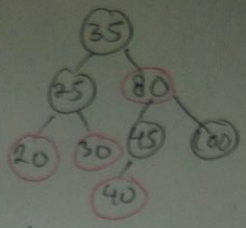
7. Insert 45



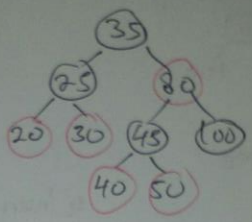
8. Insert 40



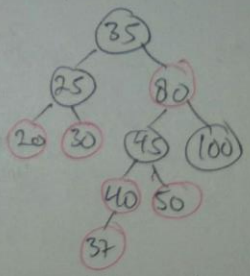
Uncle = red
Uncle parent ~~=~~ black
Grandparent -> red



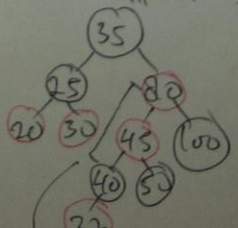
9. Insert 50



10. Insert 37



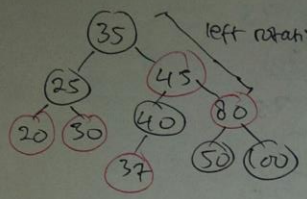
Uncle = red
Uncle and parent -> black
grandparent -> red

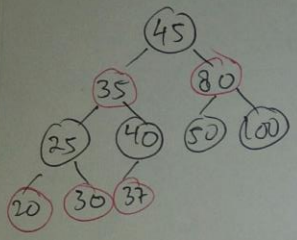


right rotation

Right rotation

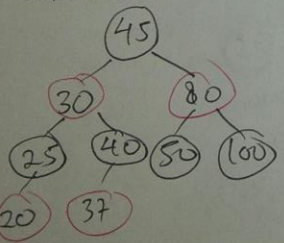
left rotation



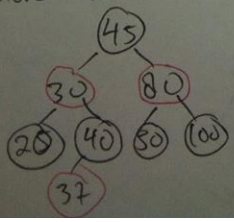


Delete

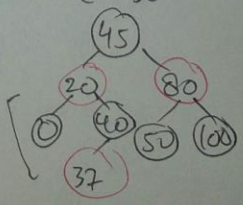
1. Delete 35



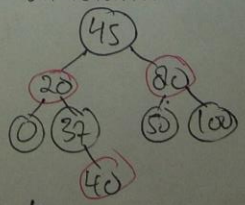
2 Delete 25



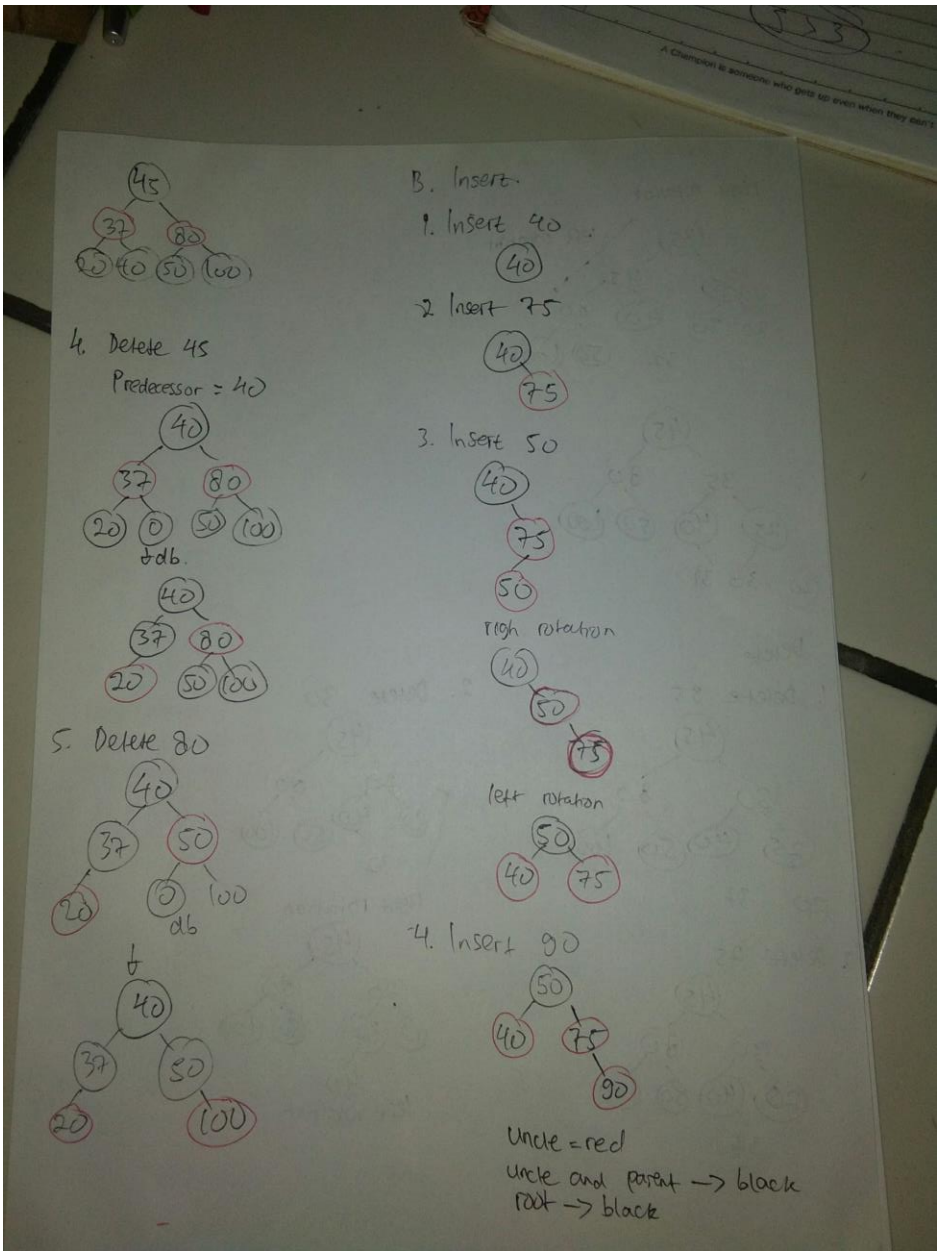
2. Delete 30

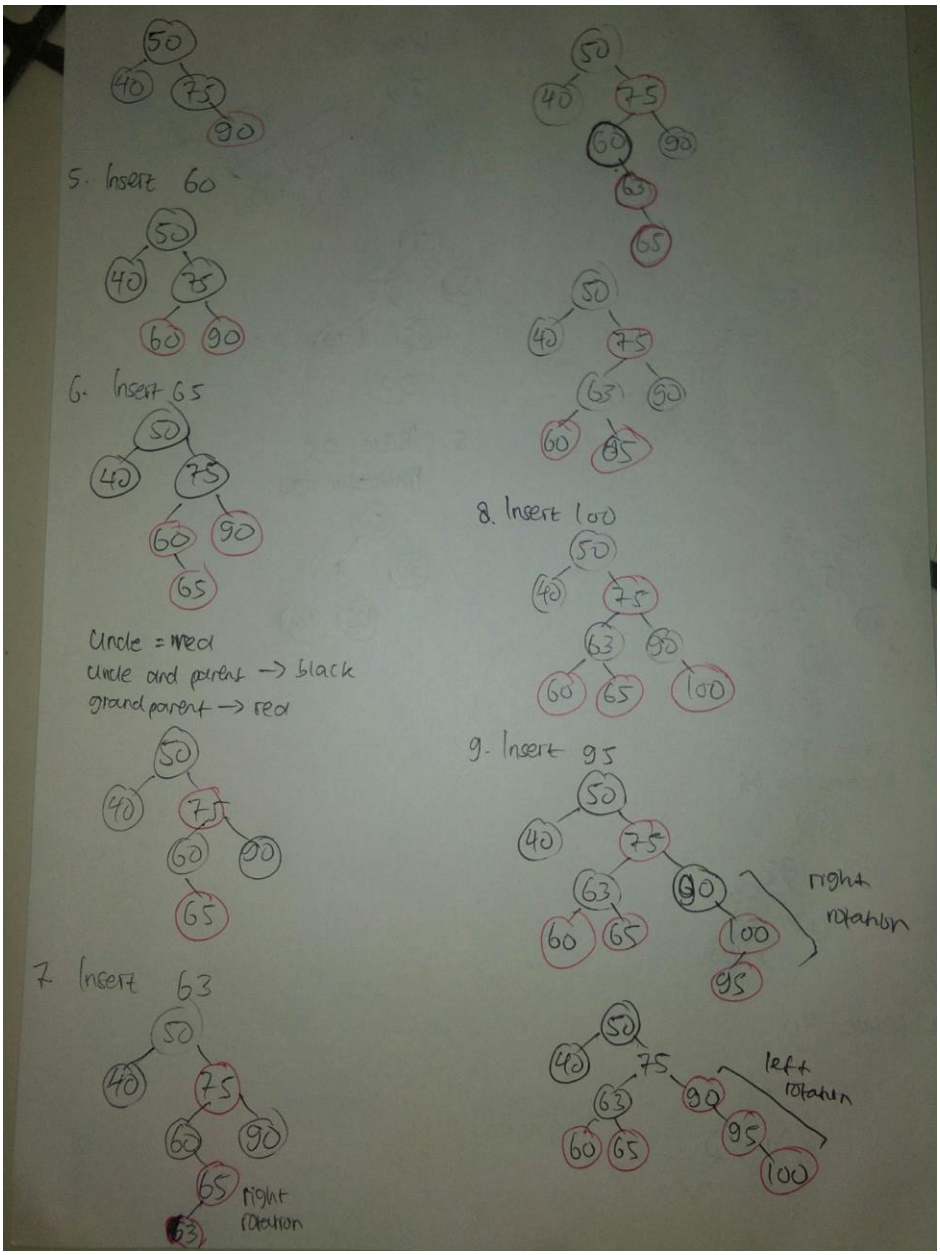


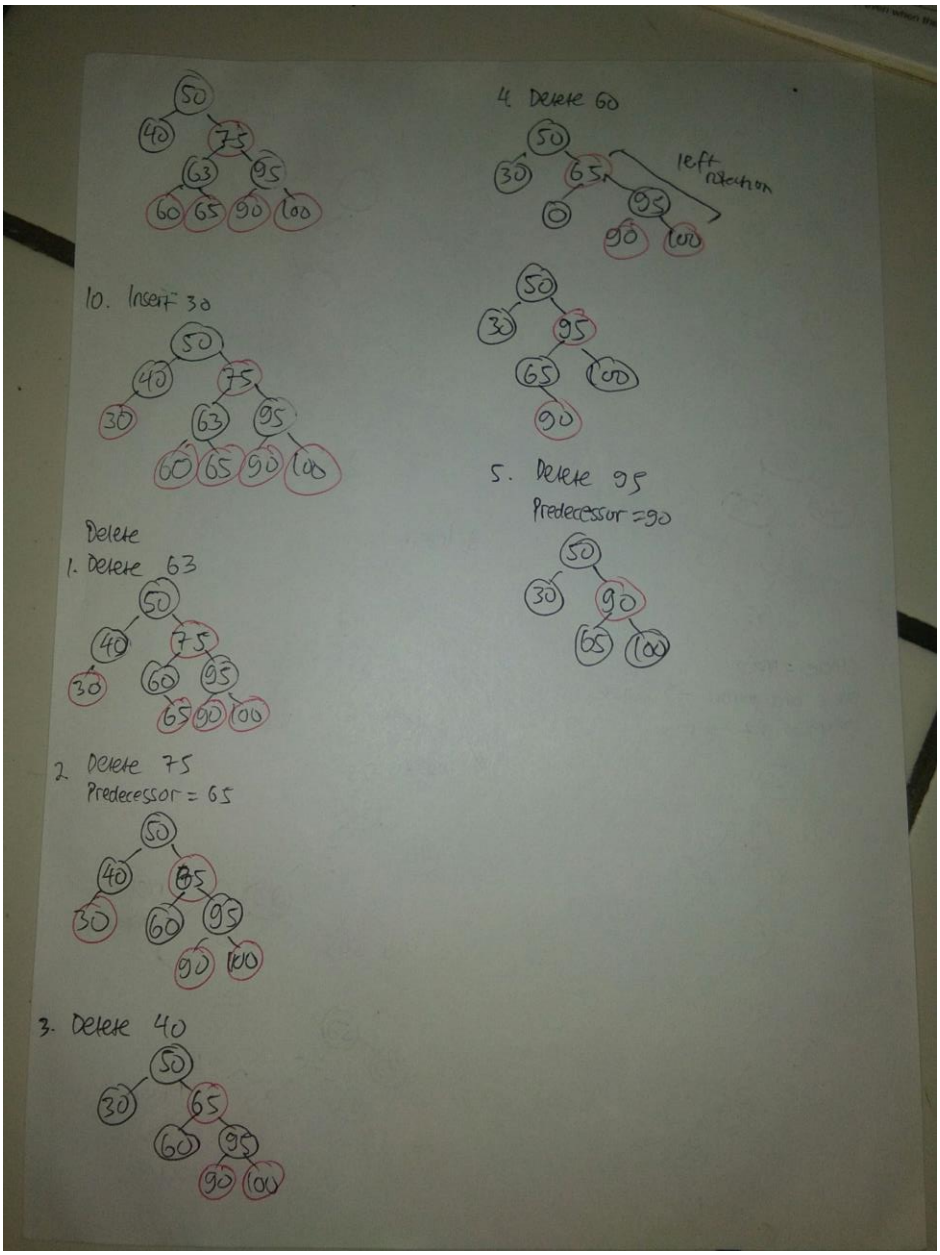
Right rotation



left rotation


45
37
80
20
40
50
100
4. Delete 45
Predecessor = 40
40
37
80
20
0
50
100
db.
40
37
80
20
50
100
5. Delete 80
40
37
50
20
0
100
db
40
37
50
20
100
B. Insert.
1. Insert 40
40
2. Insert 75
40
75
3. Insert 50
40
75
50
right rotation
40
50
75
left rotation
50
40
75
4. Insert 90
50
40
75
90
Uncle = red
Uncle and parent -> black
root -> black


5. Insert 60
6. Insert 65
Uncle = red
uncle and parent → black
grandparent → red
7. Insert 63
right rotation
8. Insert 100
9. Insert 95
right rotation
left rotation


50
40
75
63
95
60
65
90
100
10. Insert 30
50
40
75
30
63
95
60
65
90
100
Delete
1. Delete 63
50
40
75
30
60
95
65
90
100
2. Delete 75
Predecessor = 65
50
40
65
30
60
95
90
100
3. Delete 40
50
30
65
60
95
90
100
4. Delete 60
50
30
65
0
95
90
100
left rotation
50
30
95
65
100
90
5. Delete 95
Predecessor = 90
50
30
90
65
100