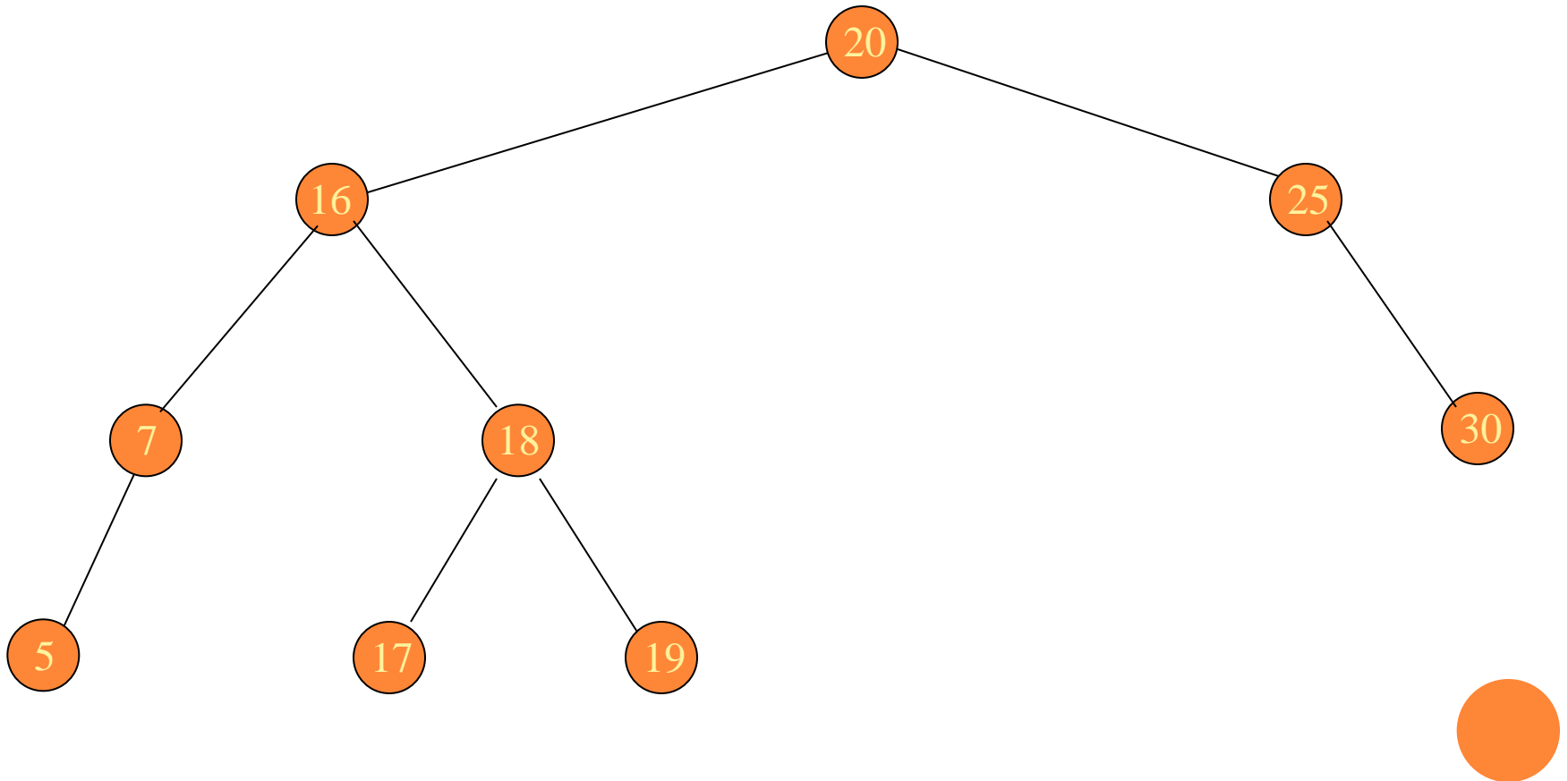


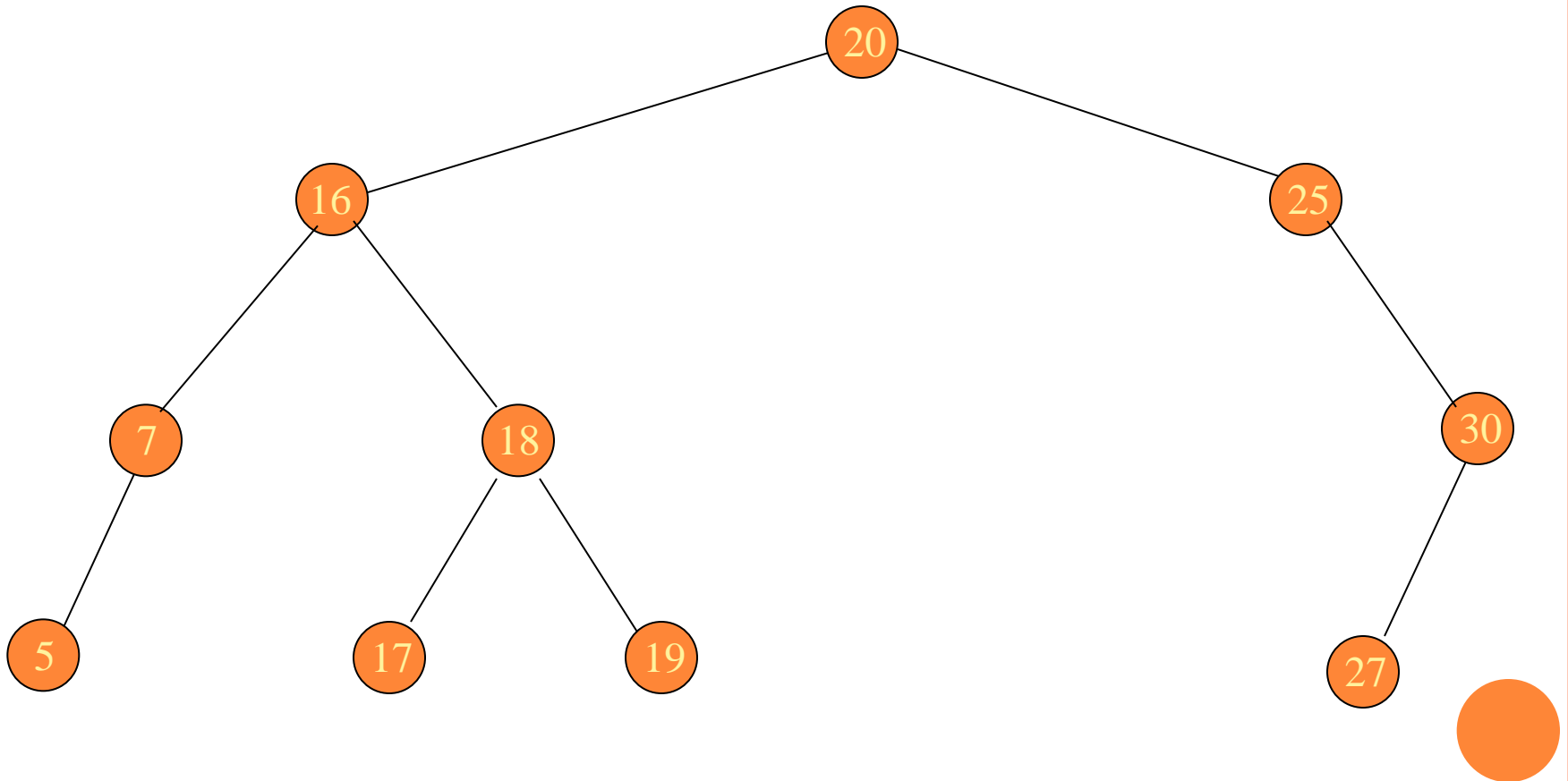
AVL TREES (ADELSON – VELSKII – LANDIS)

AVL tree:



AVL TREES

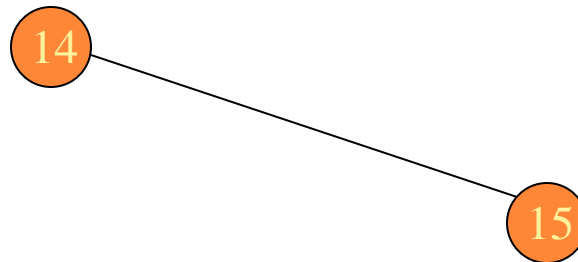
Not AVL tree:



AVL TREE ROTATIONS

Single rotations: insert 14, 15, 16, 13, 12, 11, 10

- First insert 14 and 15:



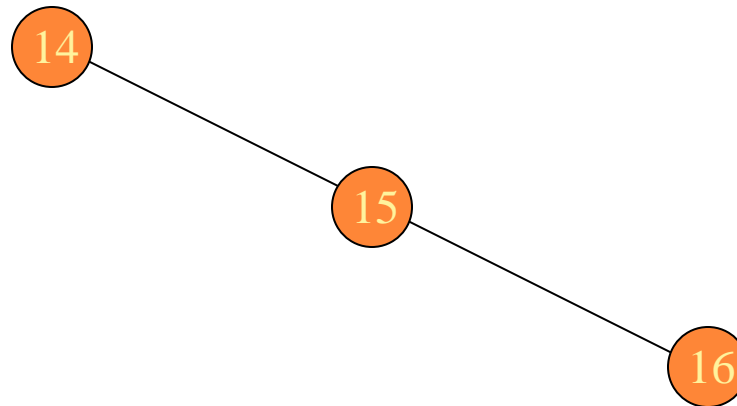
- Now insert 16.



AVL TREE ROTATIONS

Single rotations:

- Inserting 16 causes AVL violation:



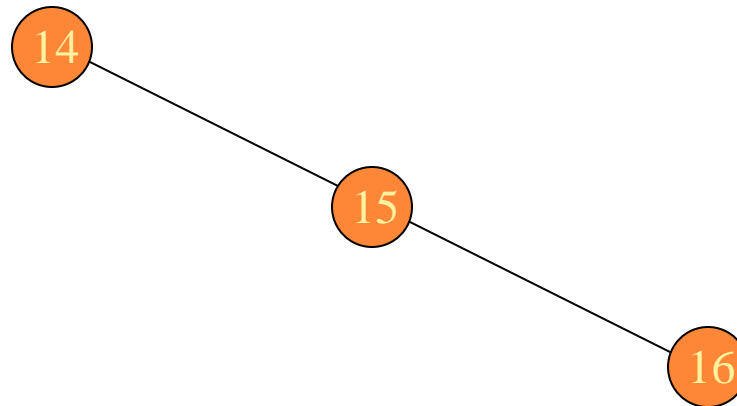
- Need to rotate.



AVL TREE ROTATIONS

Single rotations:

- Inserting 16 causes AVL violation:



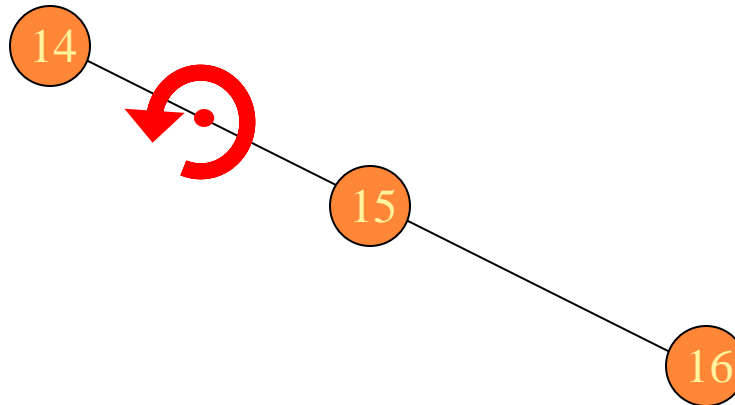
- Need to rotate.



AVL TREE ROTATIONS

Single rotations:

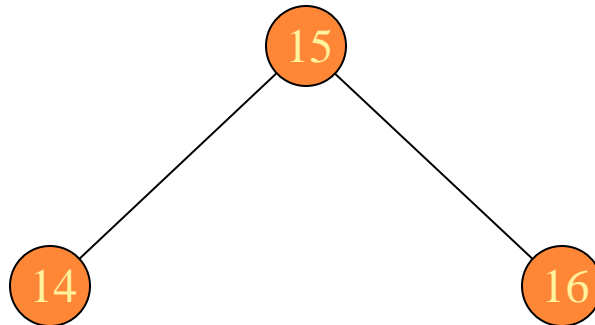
- Rotation type:



AVL TREE ROTATIONS

Single rotations:

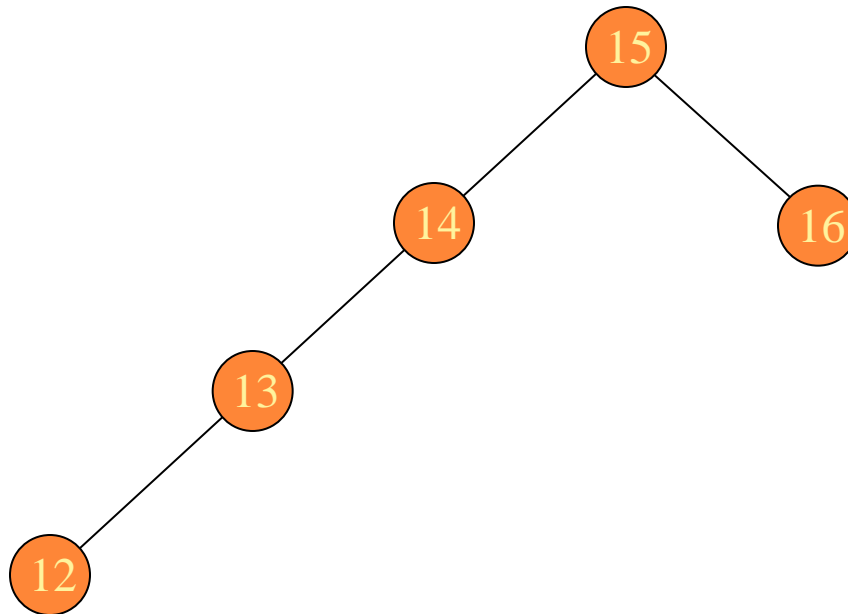
- Rotation restores AVL balance:



AVL TREE ROTATIONS

Single rotations:

- Now insert 13 and 12:



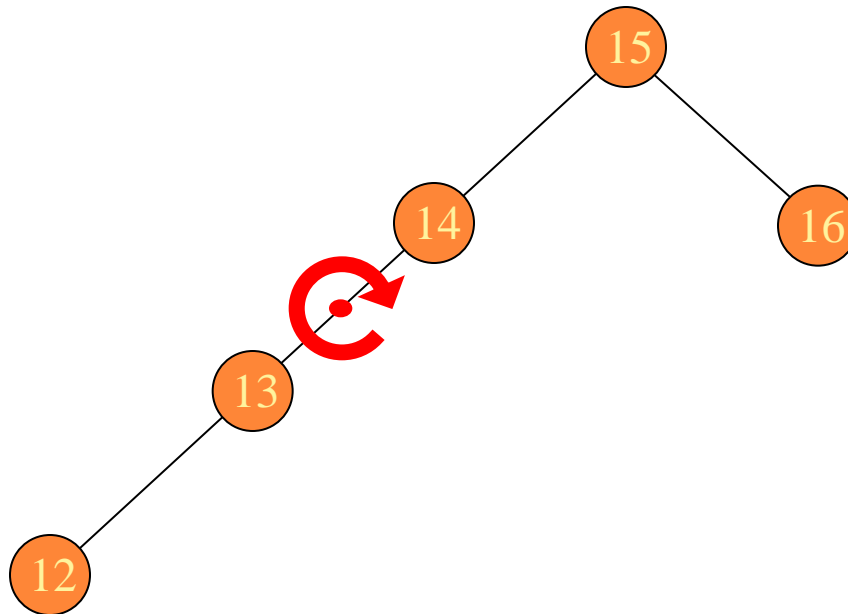
- AVL violation - need to rotate.



AVL TREE ROTATIONS

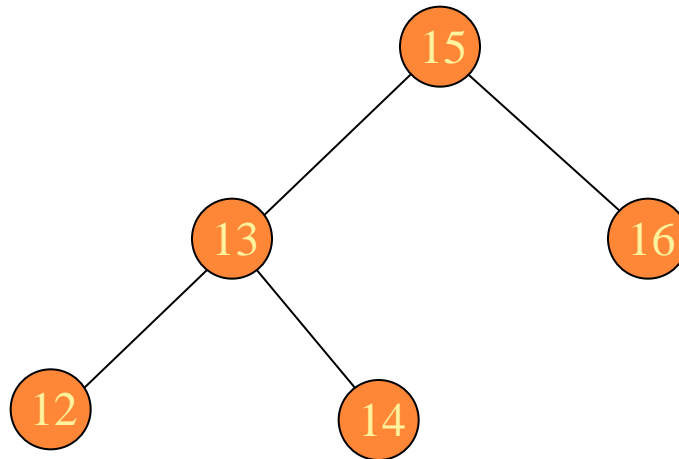
Single rotations:

- Rotation type:



AVL TREE ROTATIONS

Single rotations:

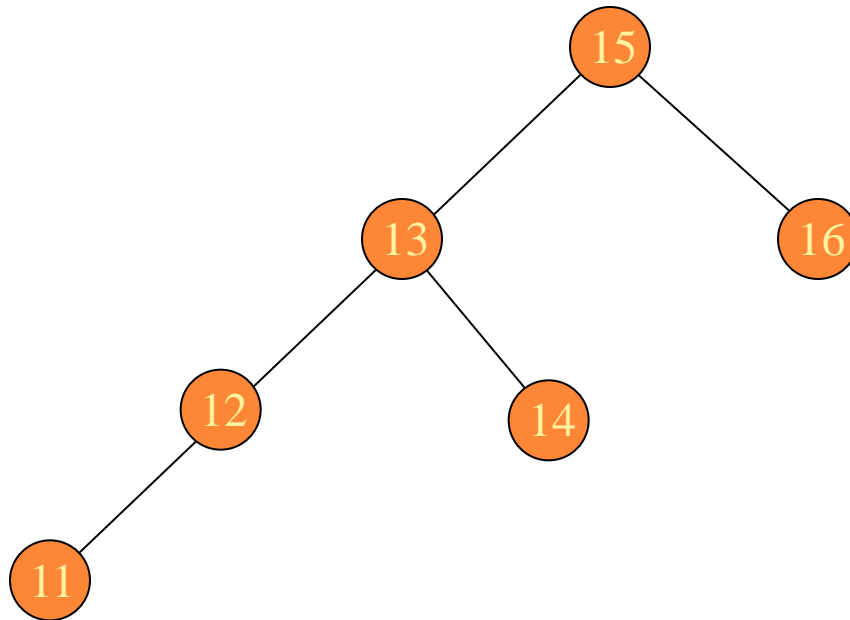


- Now insert 11.



AVL TREE ROTATIONS

Single rotations:



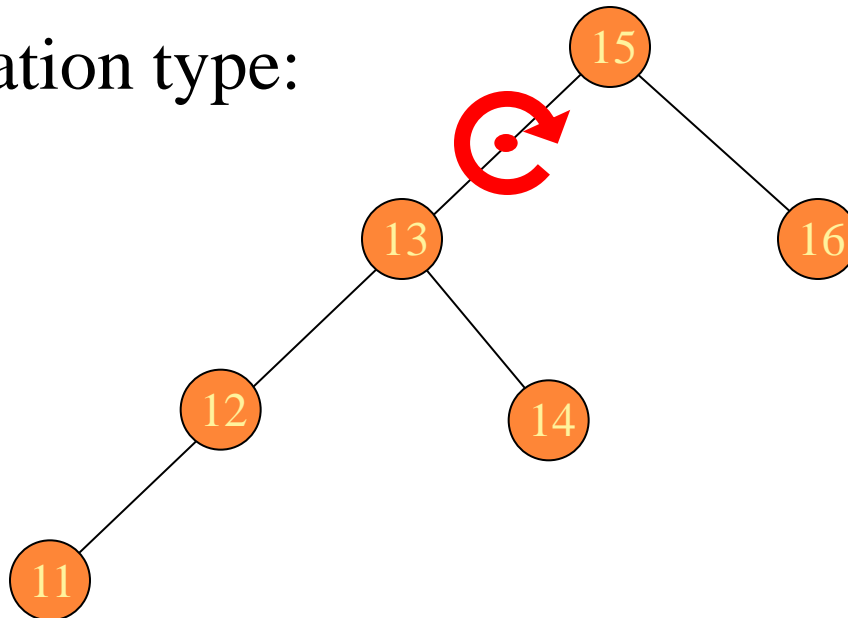
- AVL violation – need to rotate



AVL TREE ROTATIONS

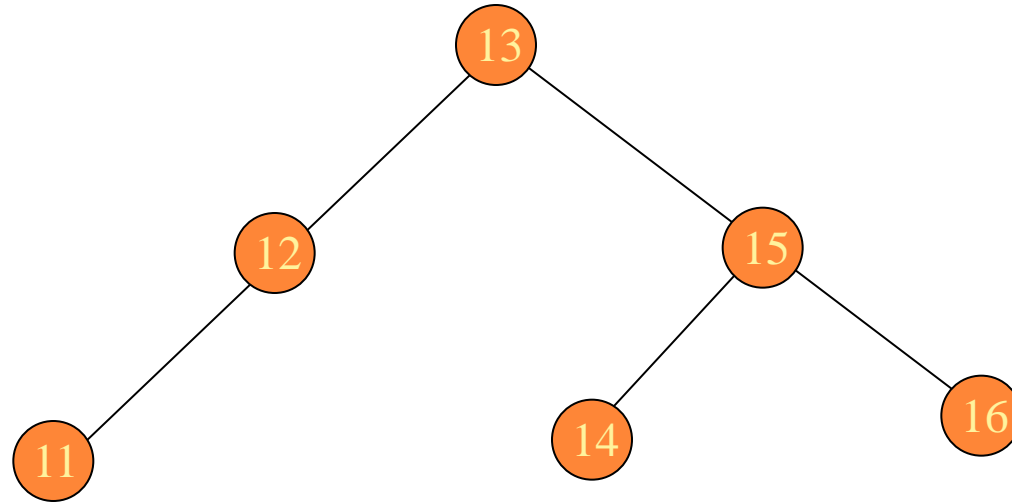
Single rotations:

- Rotation type:



AVL TREE ROTATIONS

Single rotations:

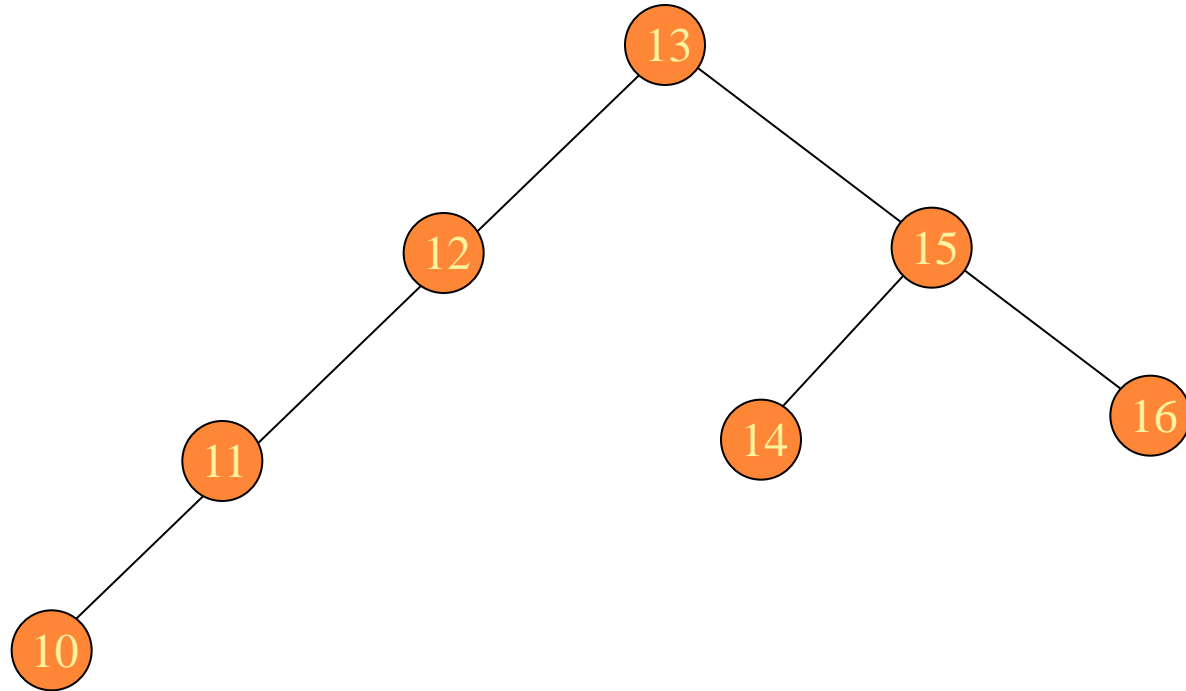


- Now insert 10.



AVL TREE ROTATIONS

Single rotations:



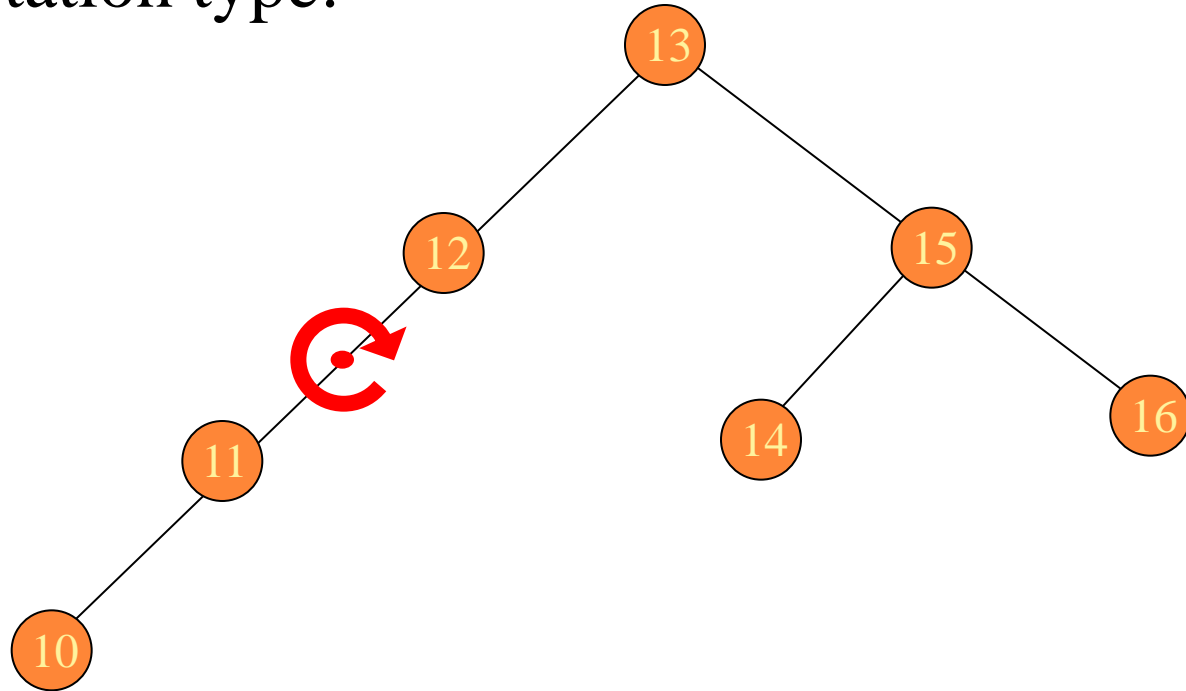
- AVL violation – need to rotate



AVL TREE ROTATIONS

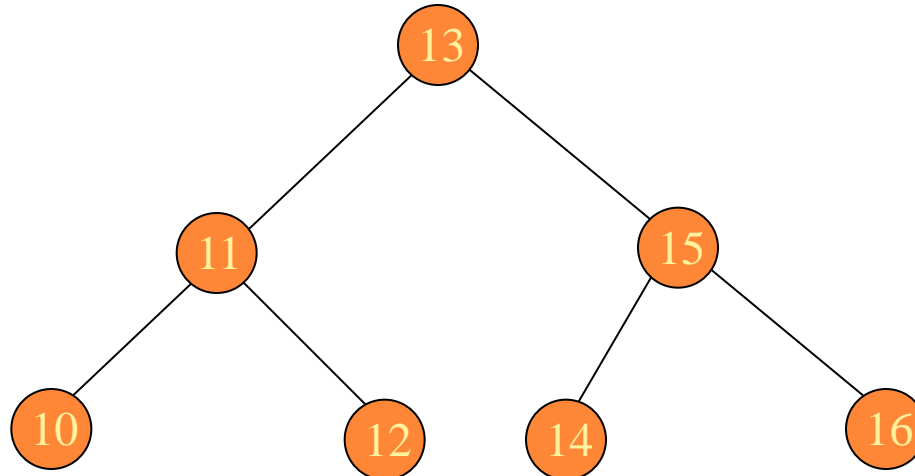
Single rotations:

- Rotation type:



AVL TREE ROTATIONS

Single rotations:



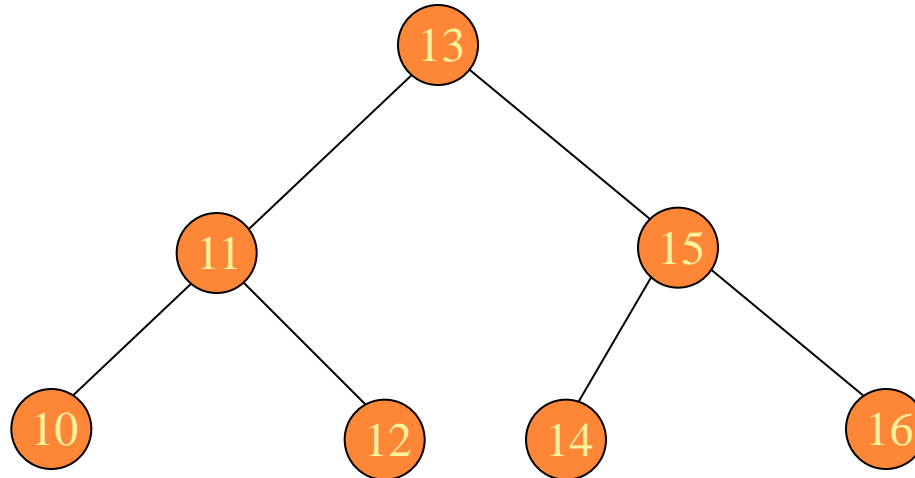
- AVL balance restored.



AVL TREE ROTATIONS

Double rotations: insert 1, 2, 3, 4, 5, 7, 6, 9, 8

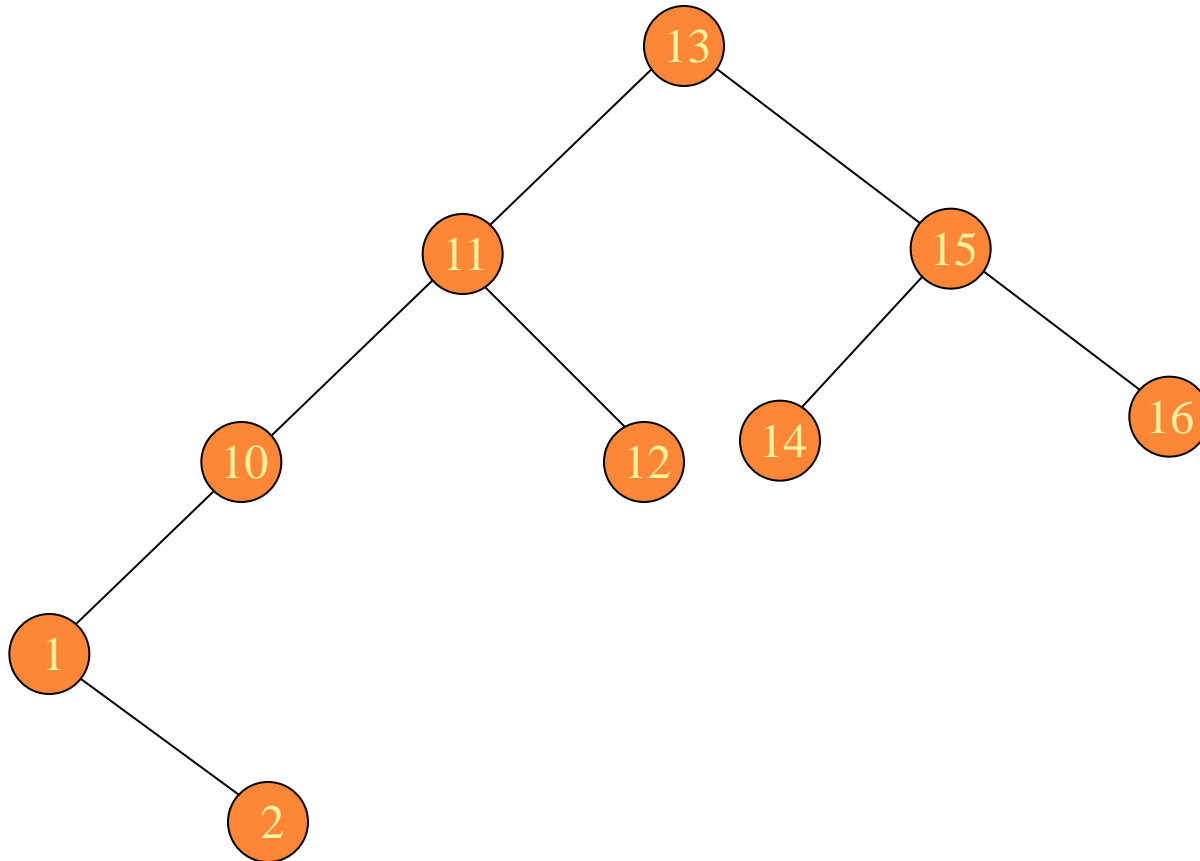
- First insert 1 and 2:



AVL TREE ROTATIONS

Double rotations:

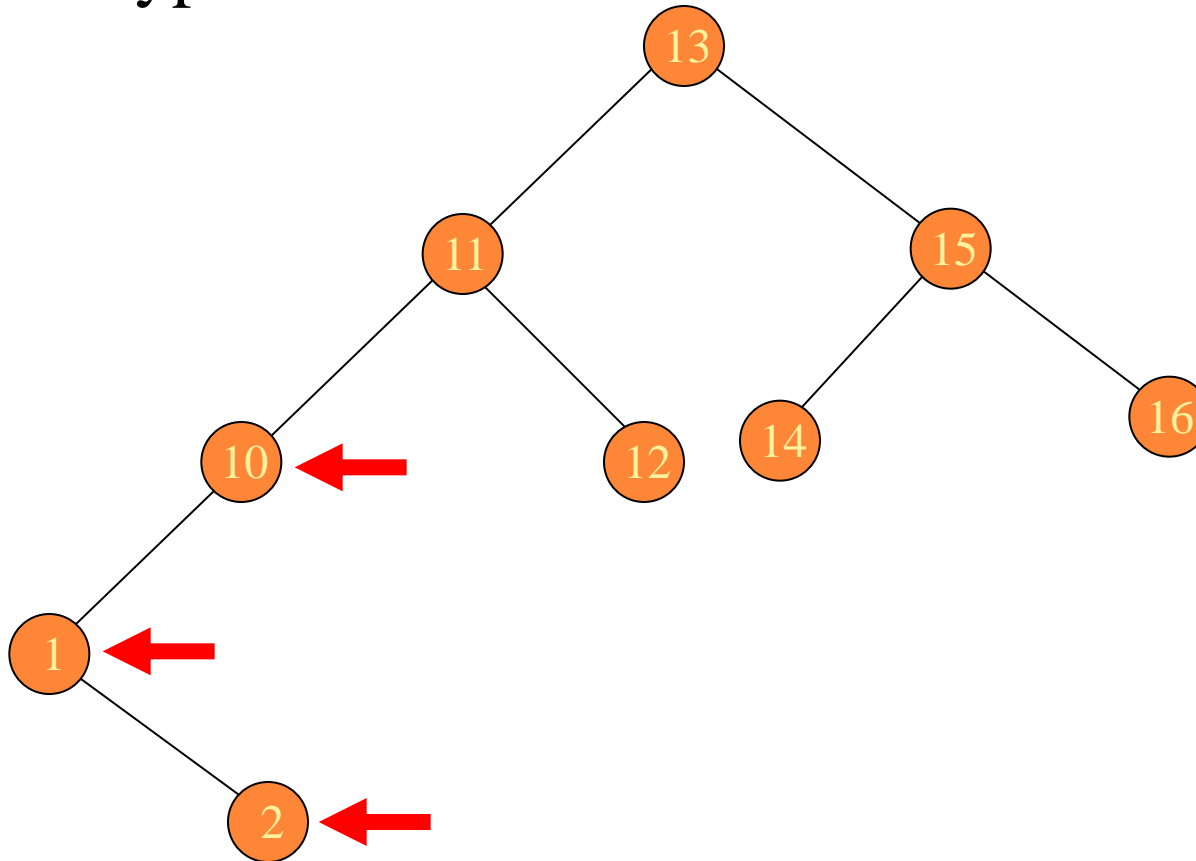
- AVL violation - rotate



AVL TREE ROTATIONS

Double rotations:

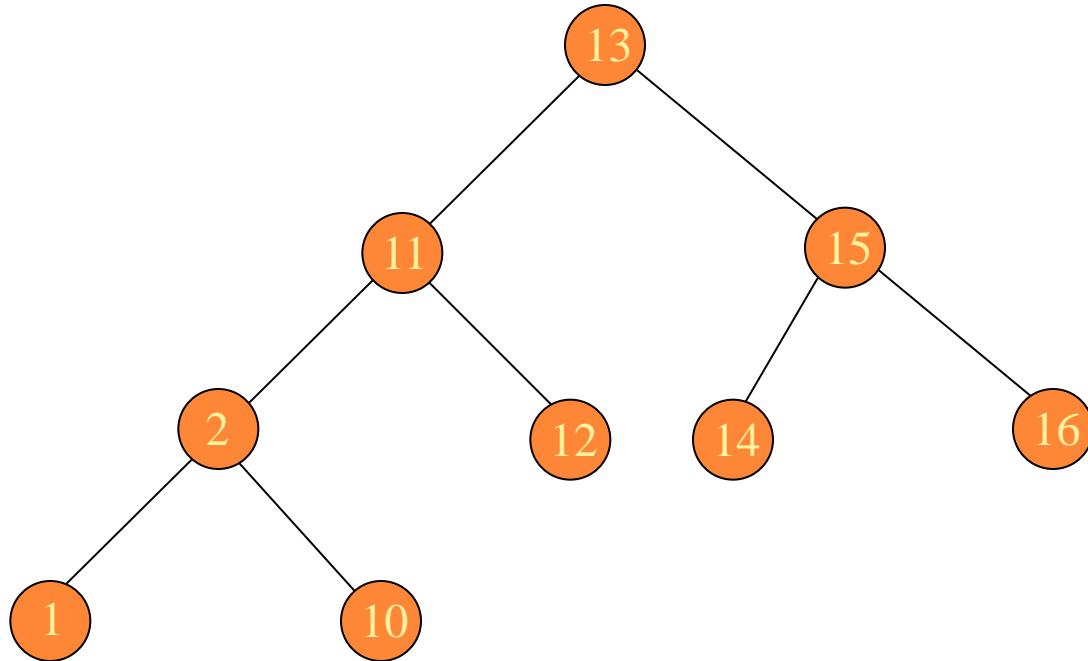
- Rotation type:



AVL TREE ROTATIONS

Double rotations:

- AVL balance restored:



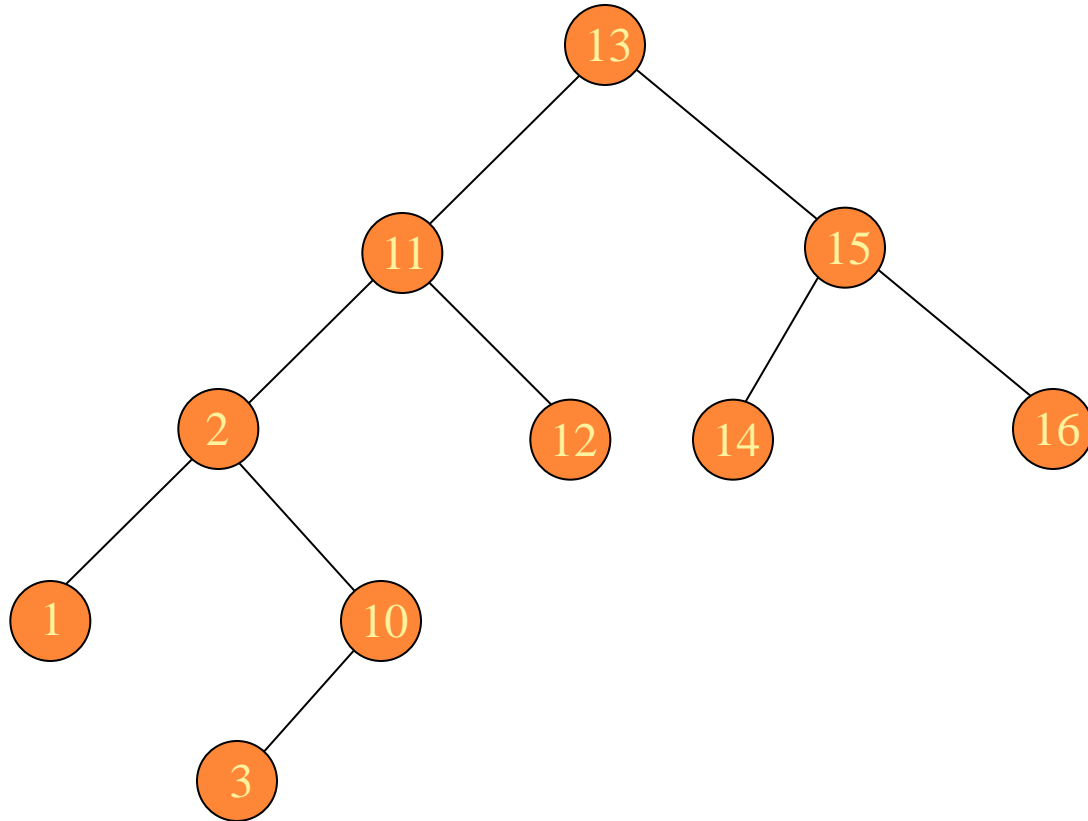
- Now insert 3.



AVL TREE ROTATIONS

Double rotations:

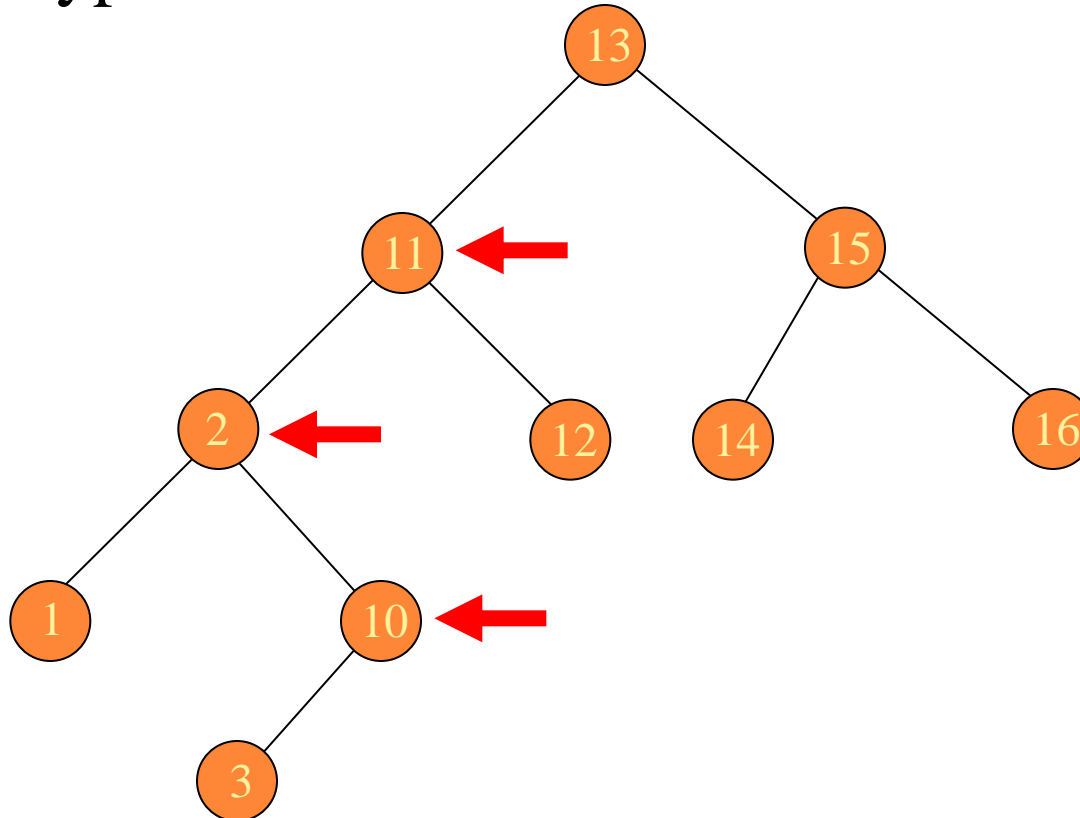
- AVL violation – rotate:



AVL TREE ROTATIONS

Double rotations:

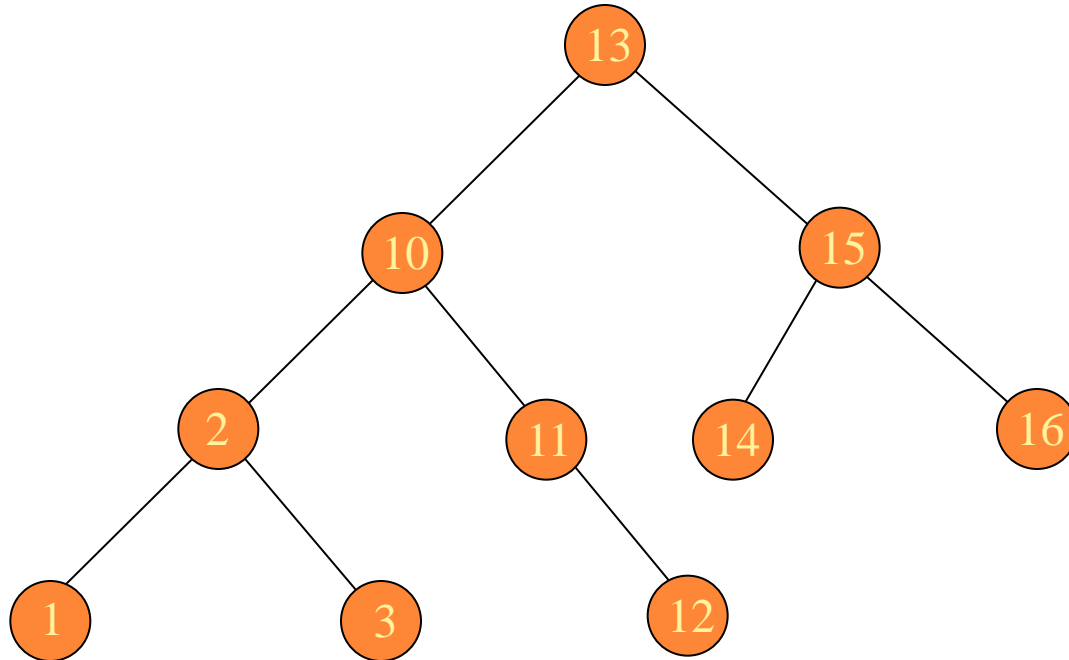
- Rotation type:



AVL TREE ROTATIONS

Double rotations:

- AVL balance restored:



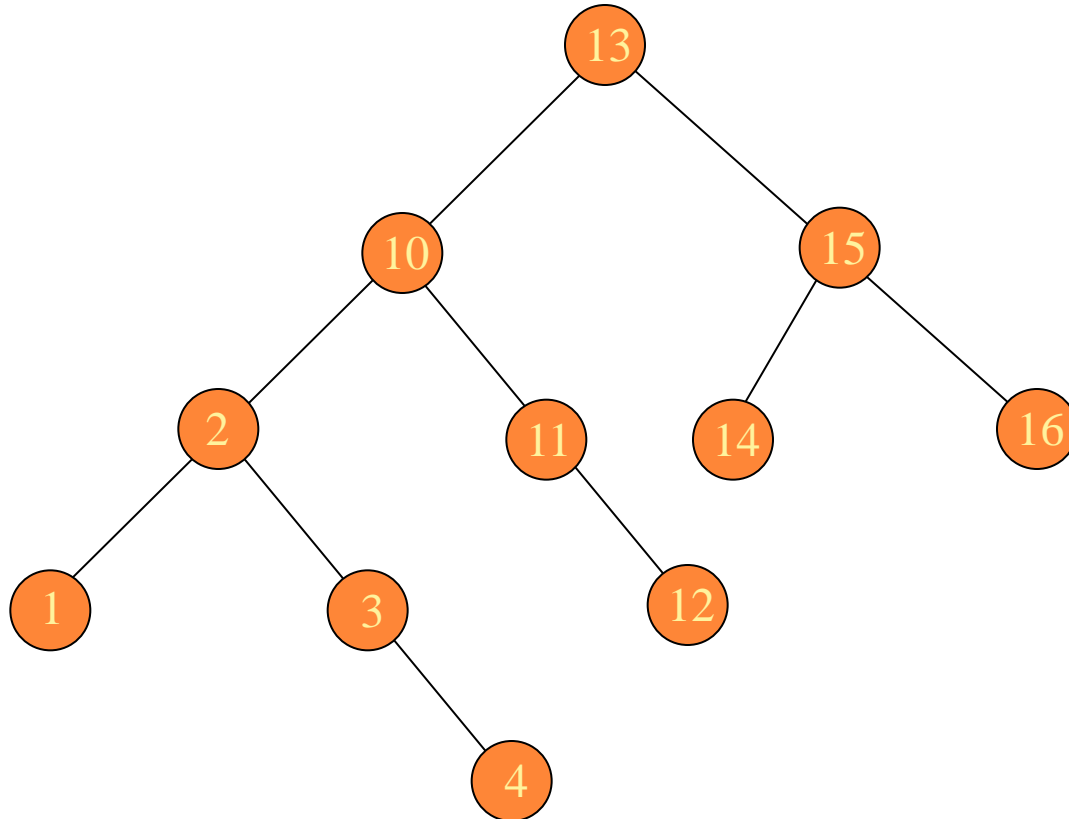
- Now insert 4.



AVL TREE ROTATIONS

Double rotations:

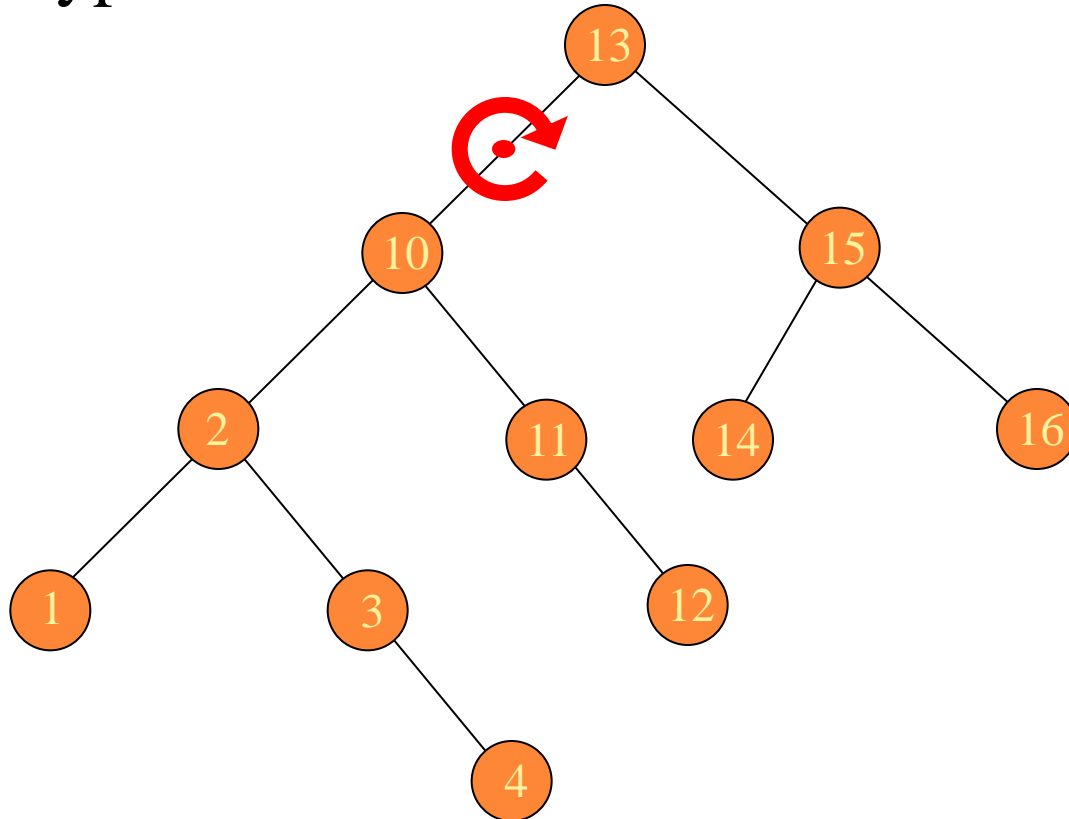
- AVL violation - rotate



AVL TREE ROTATIONS

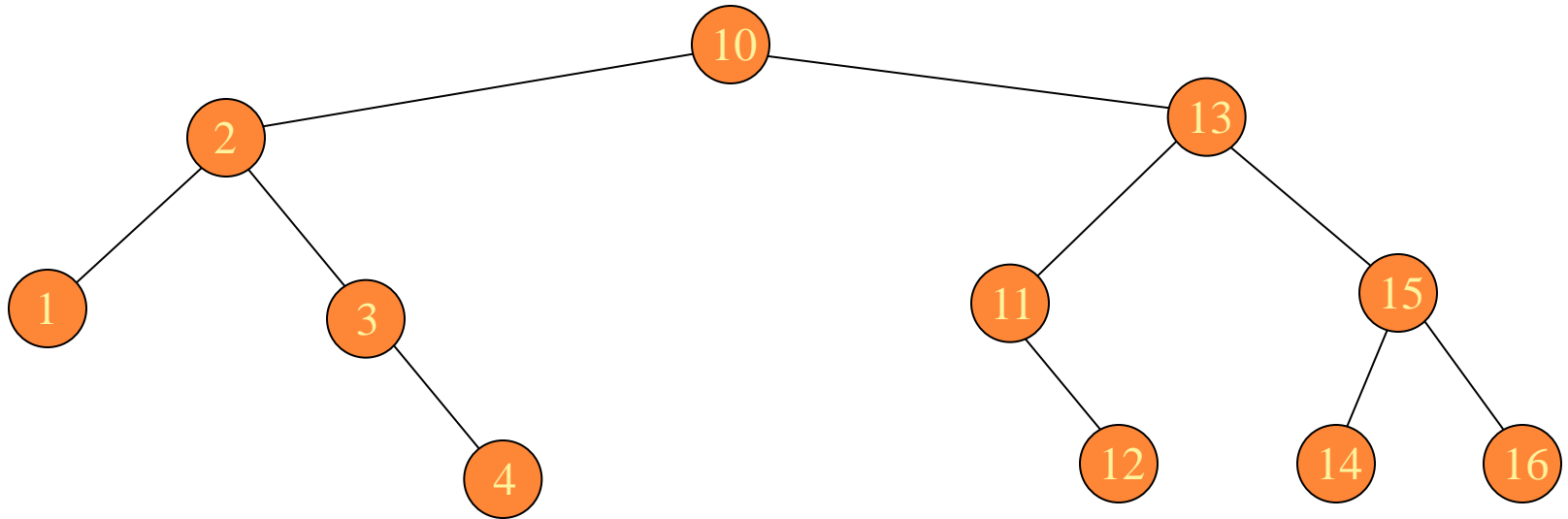
Double rotations:

- Rotation type:



AVL TREE ROTATIONS

Double rotations:

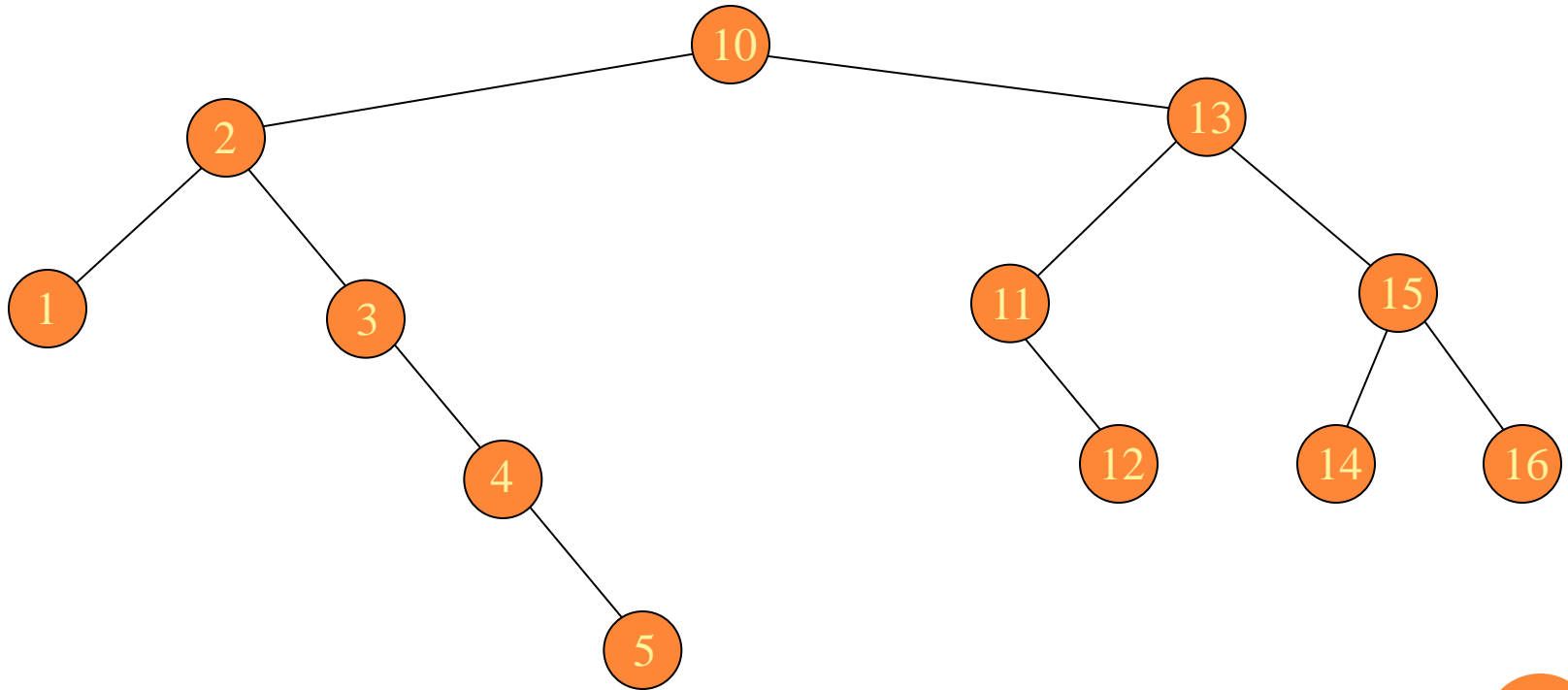


- Now insert 5.



AVL TREE ROTATIONS

Double rotations:



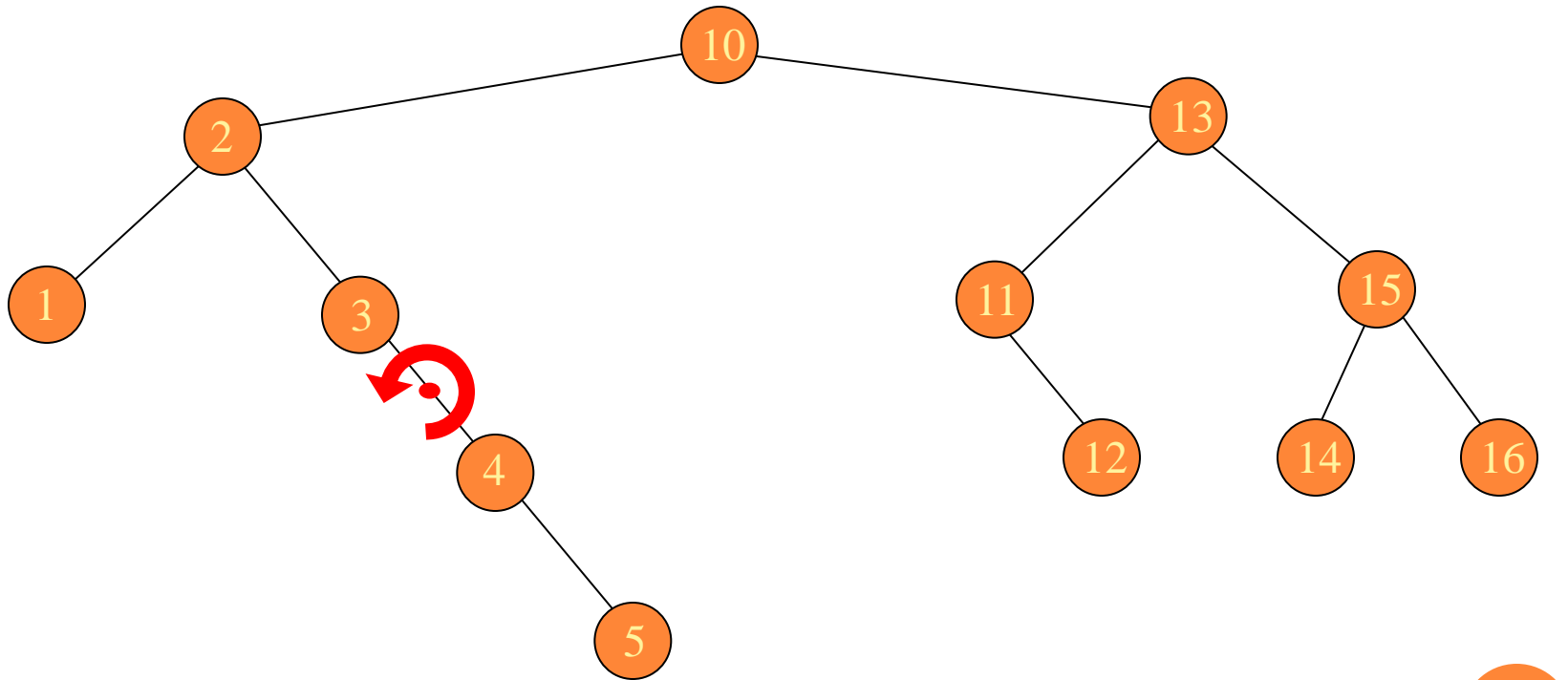
- AVL violation – rotate.



AVL TREE ROTATIONS

Single rotations:

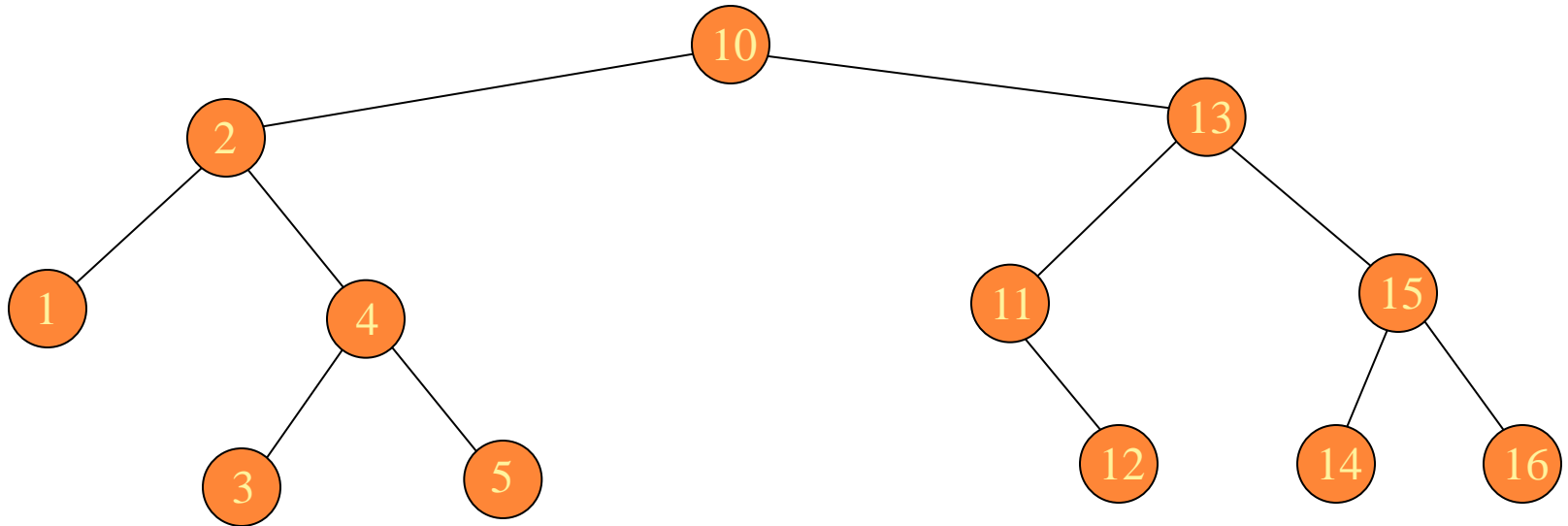
- Rotation type:



AVL TREE ROTATIONS

Single rotations:

- AVL balance restored:



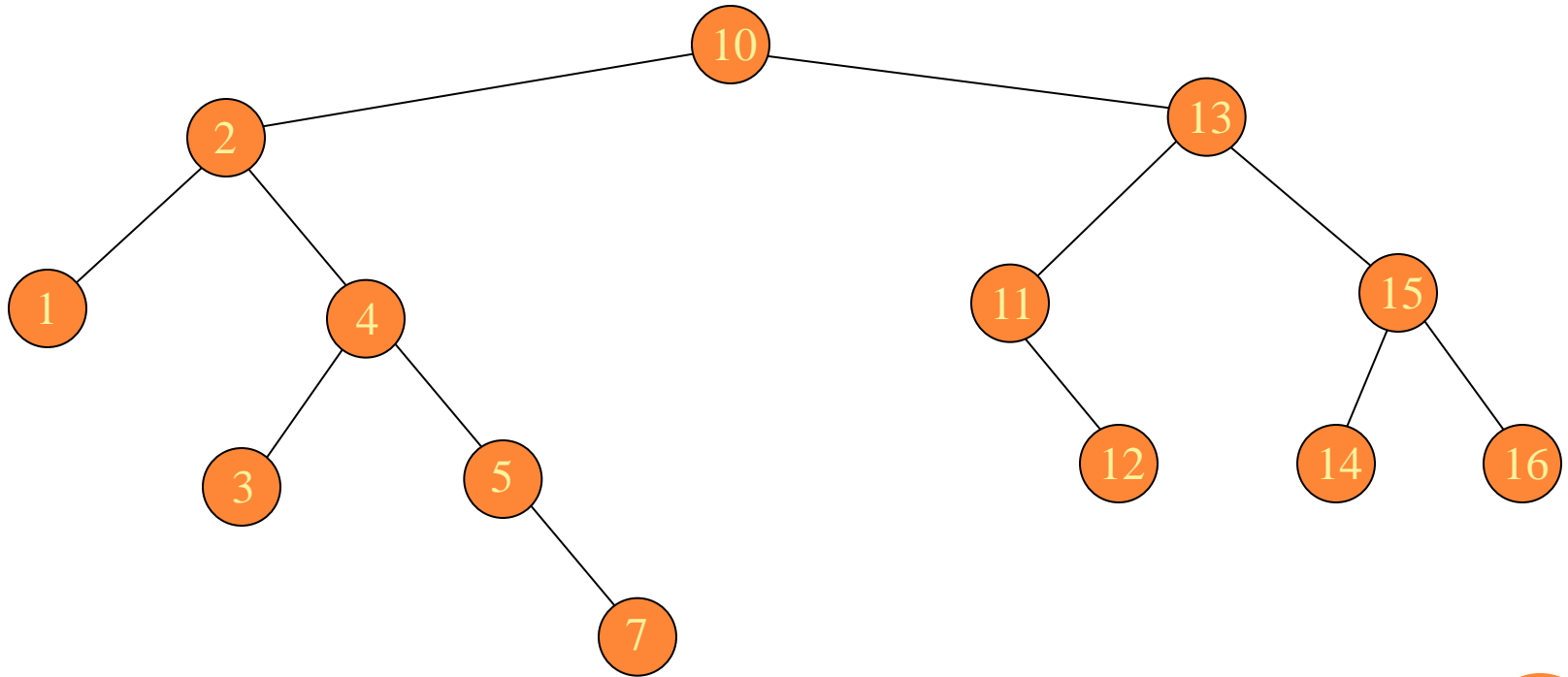
- Now insert 7.



AVL TREE ROTATIONS

Single rotations:

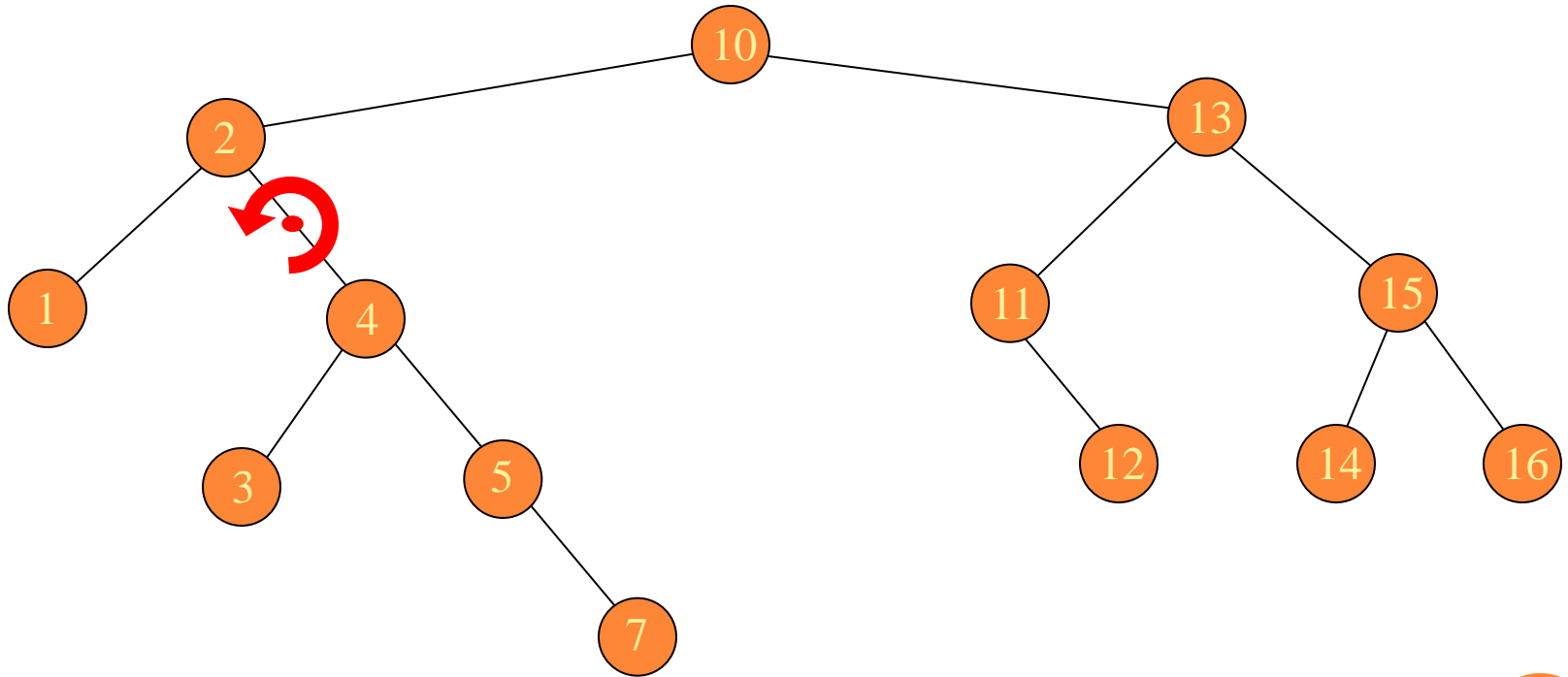
- AVL violation – rotate.



AVL TREE ROTATIONS

Single rotations:

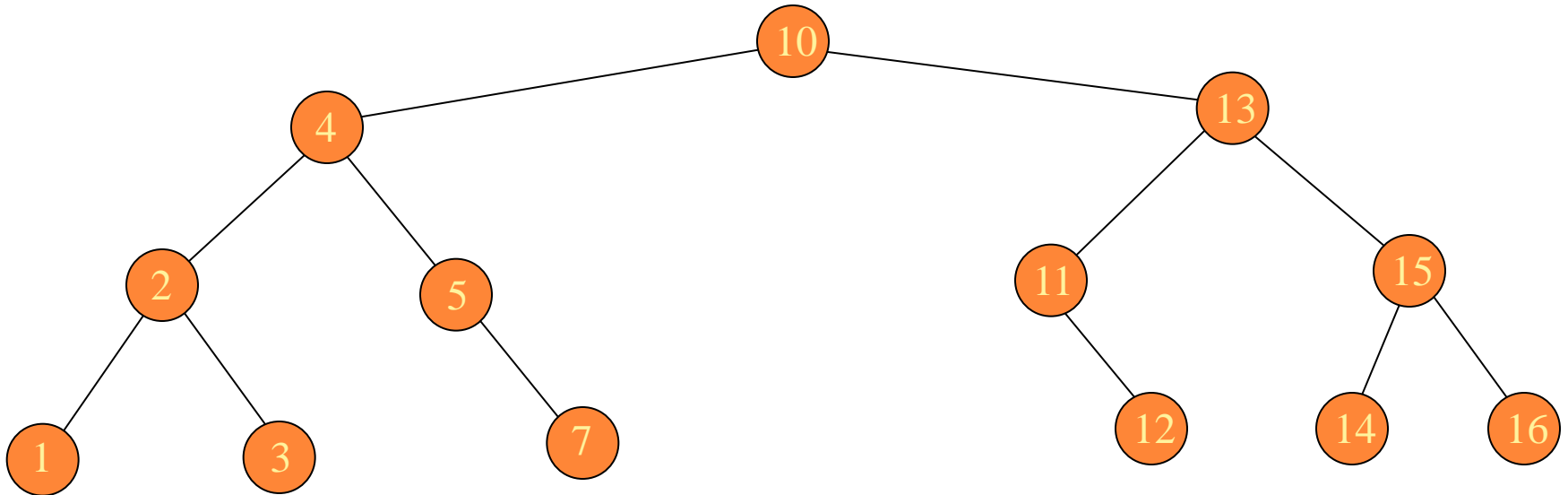
- Rotation type:



AVL TREE ROTATIONS

Double rotations:

- AVL balance restored.



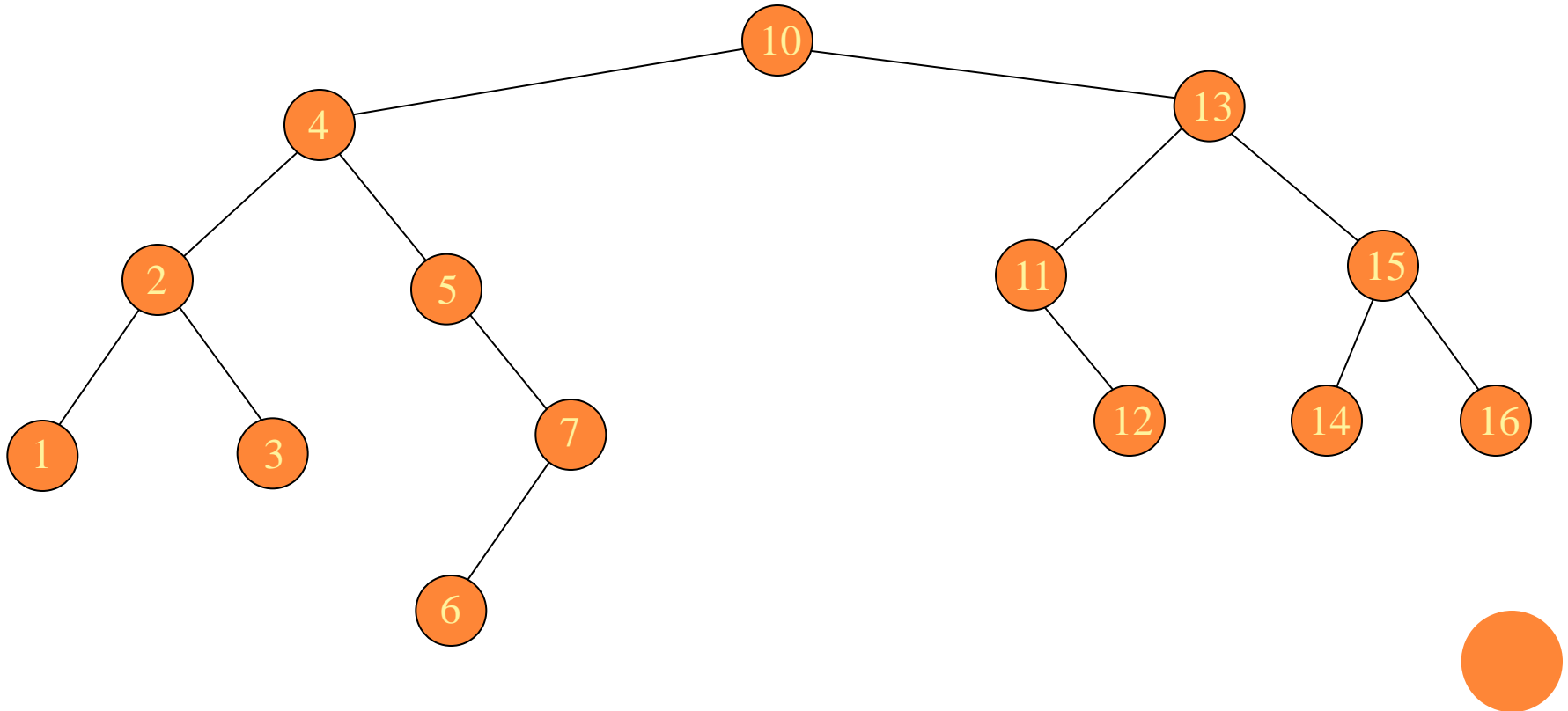
- Now insert 6.



AVL TREE ROTATIONS

Double rotations:

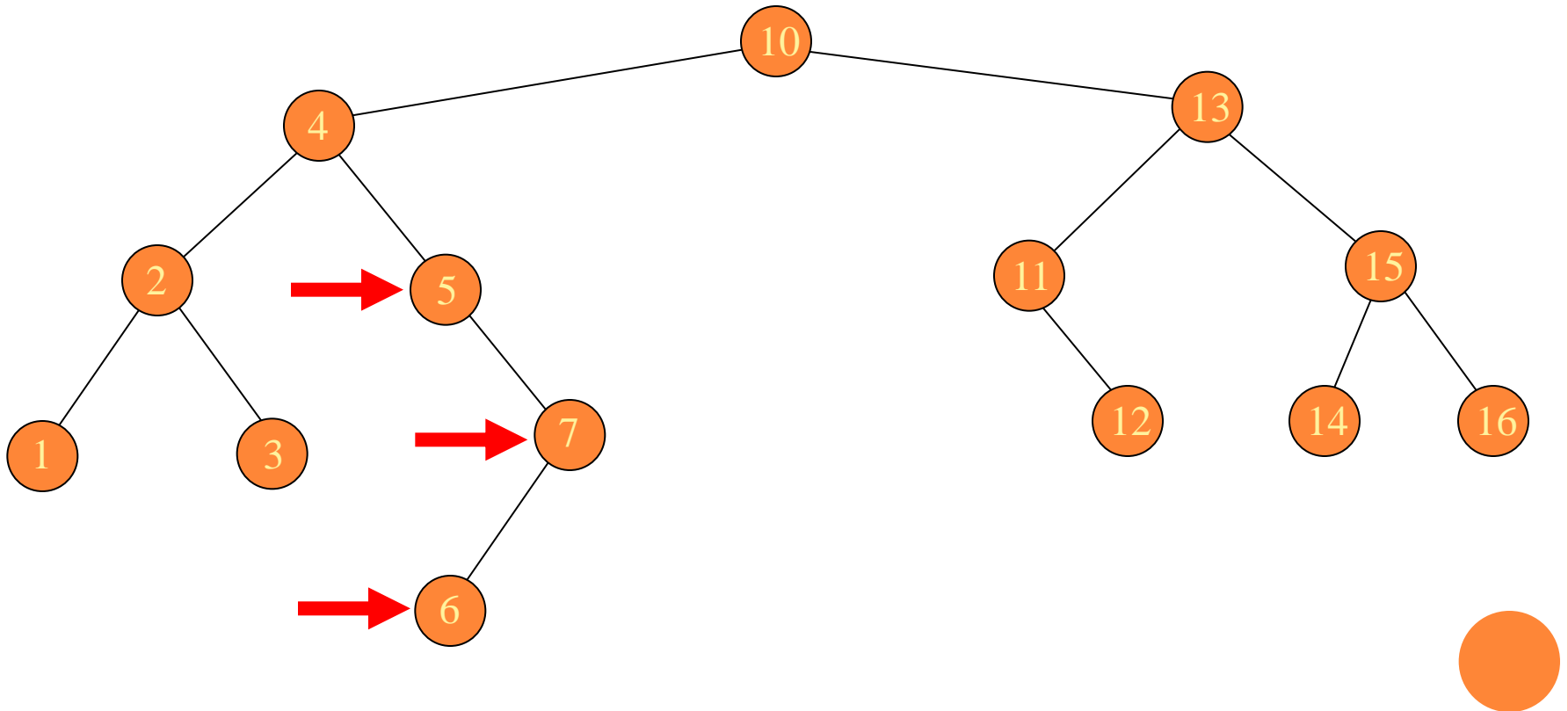
- AVL violation - rotate.



AVL TREE ROTATIONS

Double rotations:

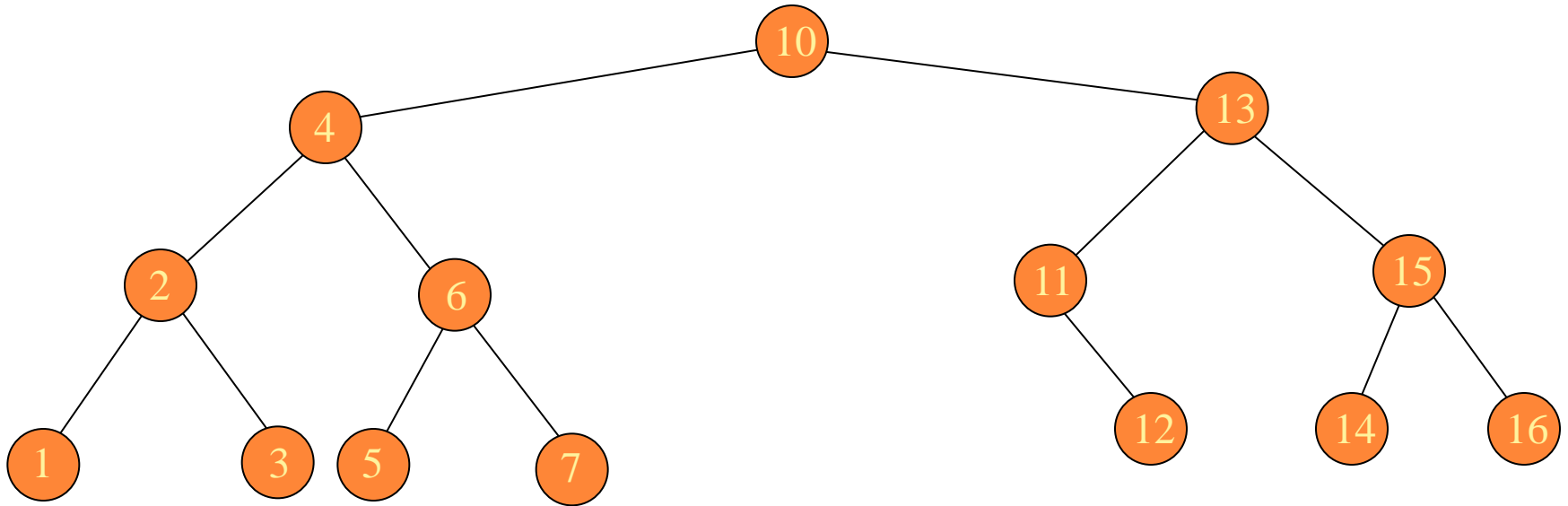
- Rotation type:



AVL TREE ROTATIONS

Double rotations:

- AVL balance restored.



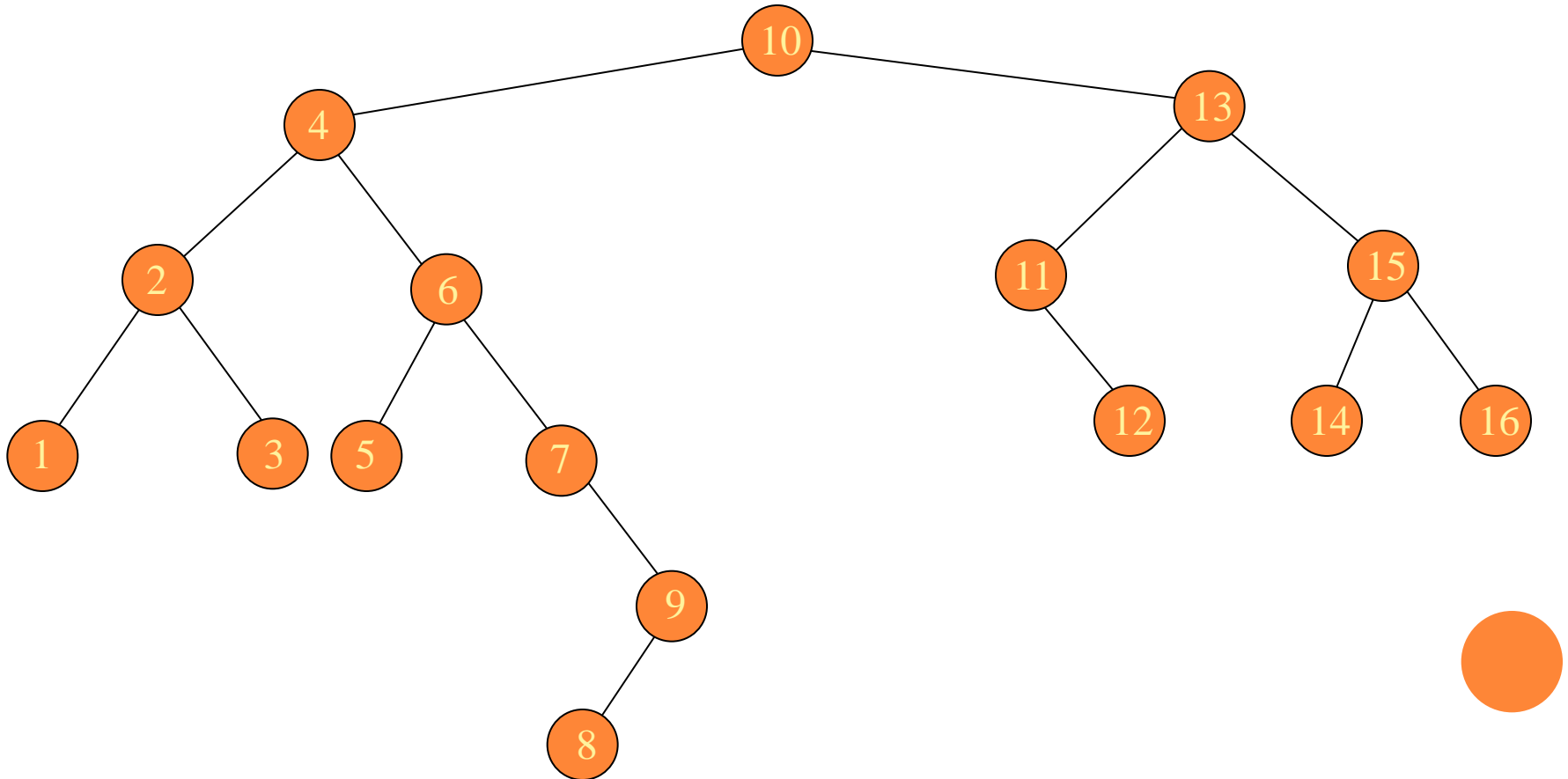
- Now insert 9 and 8.



AVL TREE ROTATIONS

Double rotations:

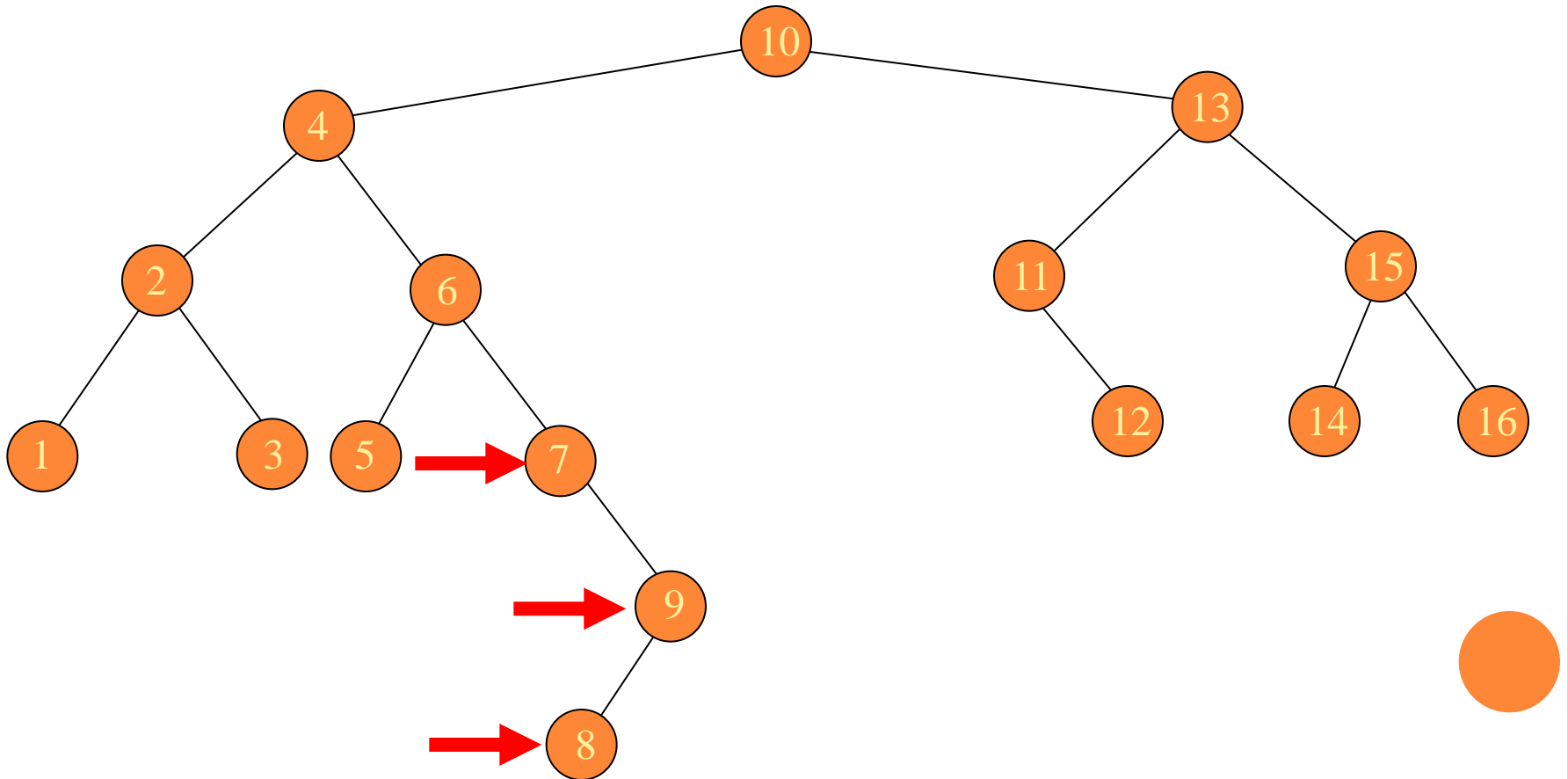
- AVL violation - rotate.



AVL TREE ROTATIONS

Double rotations:

- Rotation type:



AVL TREE ROTATIONS

Final tree:

- Tree is almost perfectly balanced

