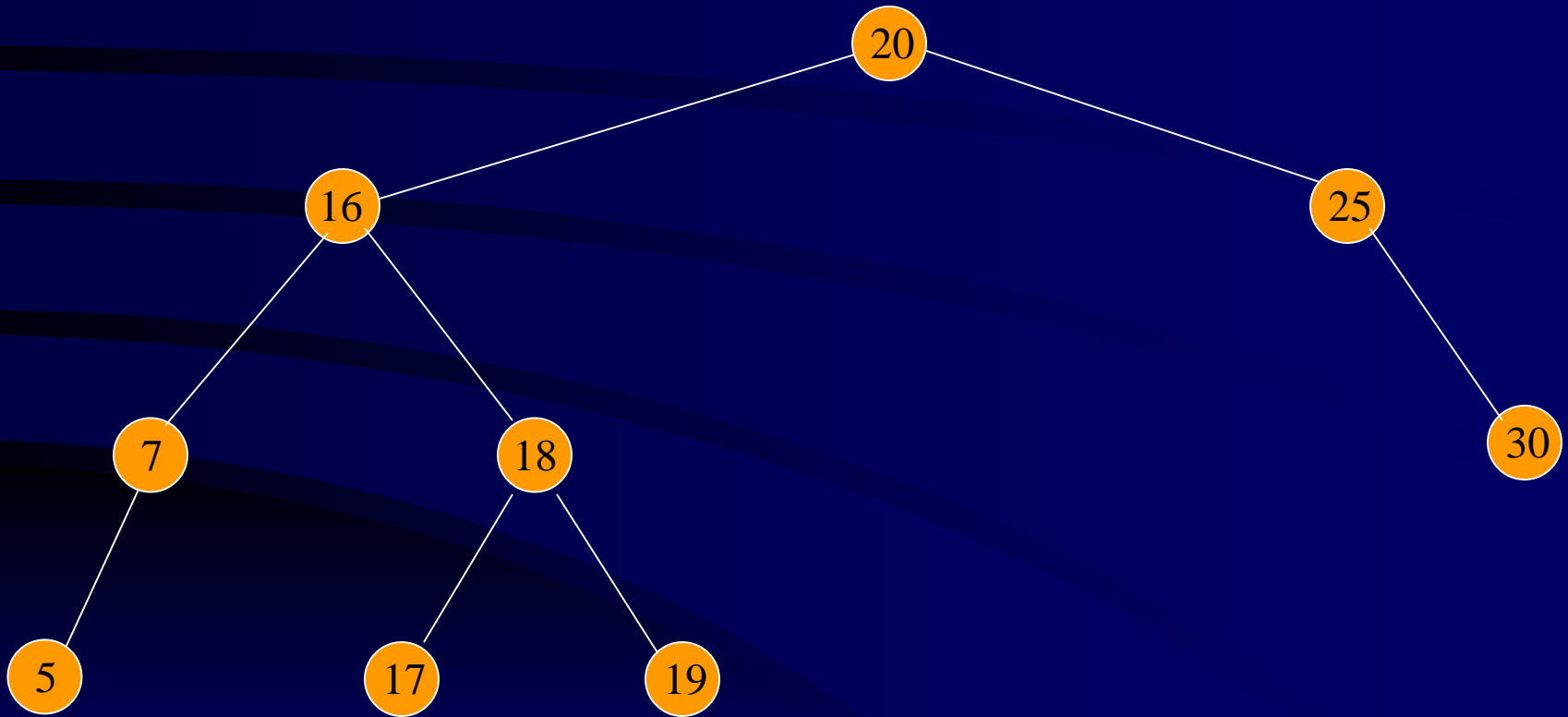


AVL Trees

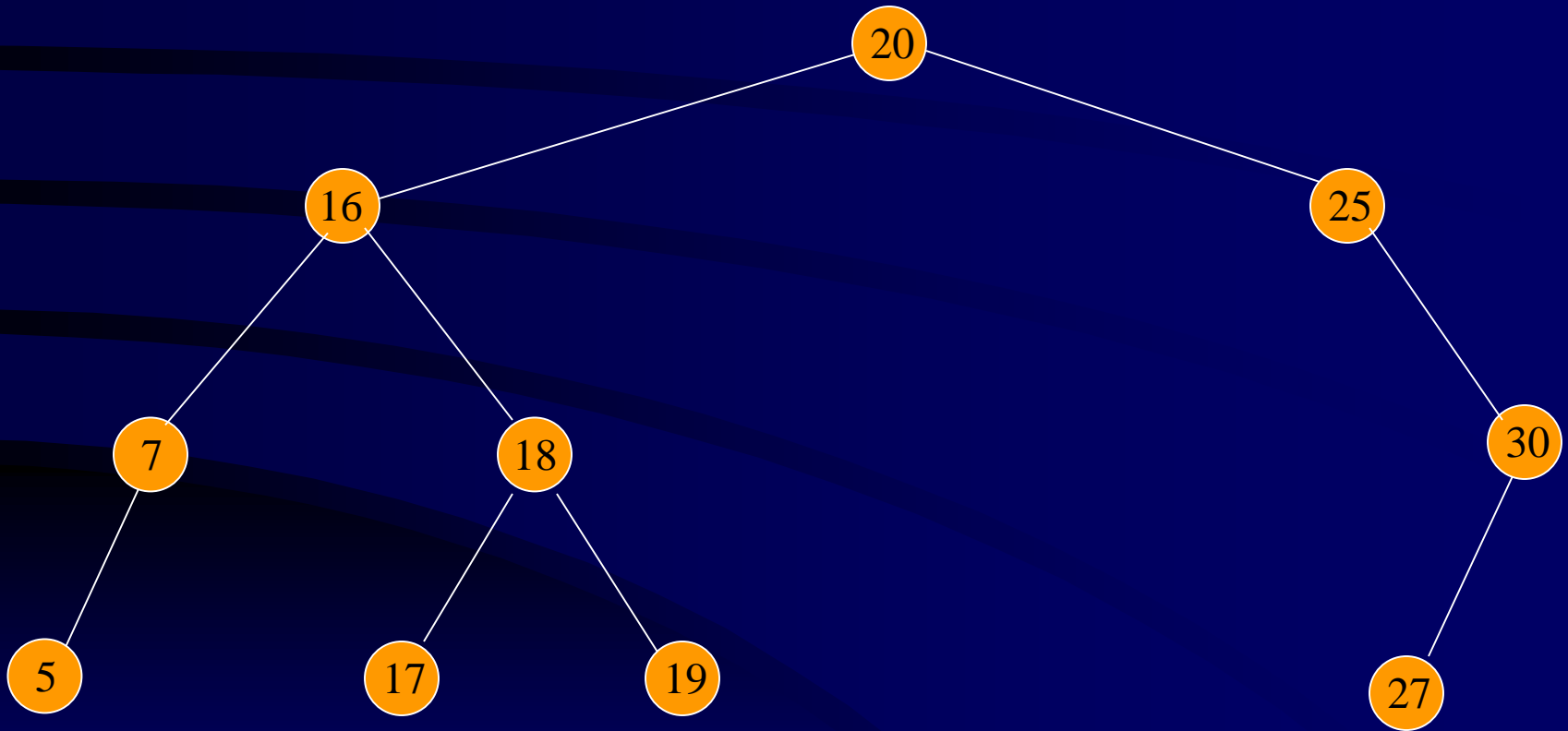
(Adelson – Velskii – Landis)

AVL tree:



AVL Trees

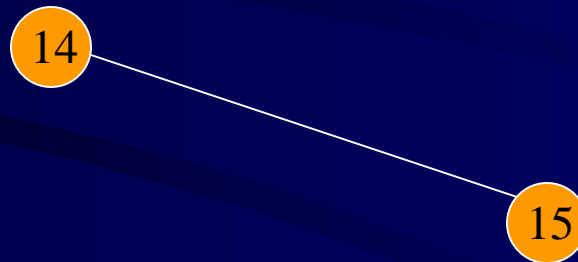
Not AVL tree:



AVL Tree Rotations

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

- First insert 14 and 15:

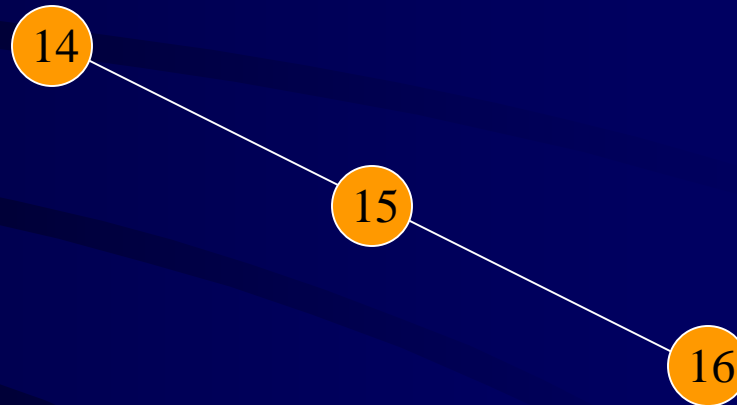


- Now insert 16.

AVL Tree Rotations

Single rotations:

- Inserting 16 causes AVL violation:

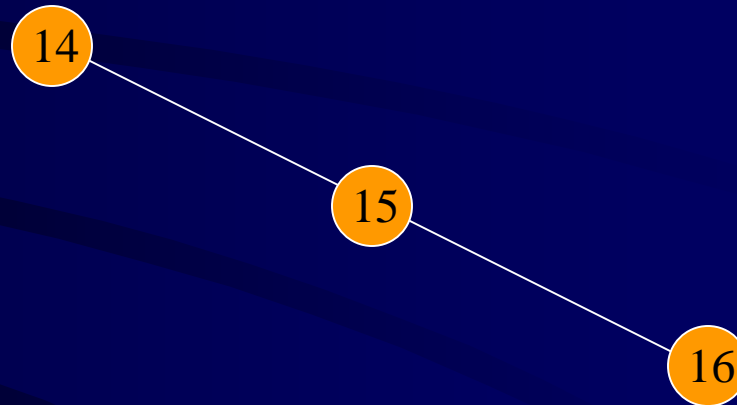


- Need to rotate.

AVL Tree Rotations

Single rotations:

- Inserting 16 causes AVL violation:

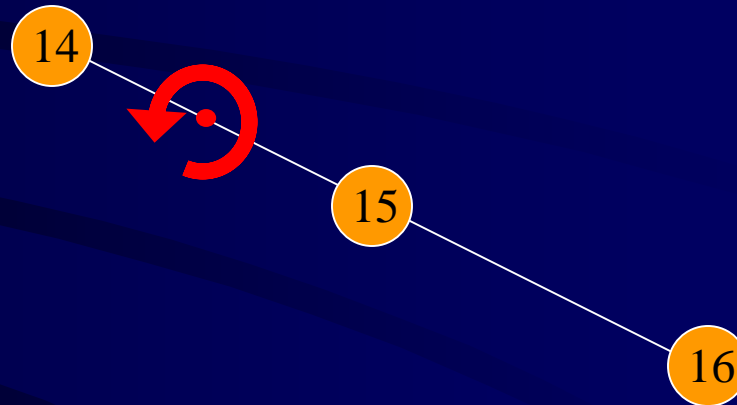


- Need to rotate.

AVL Tree Rotations

Single rotations:

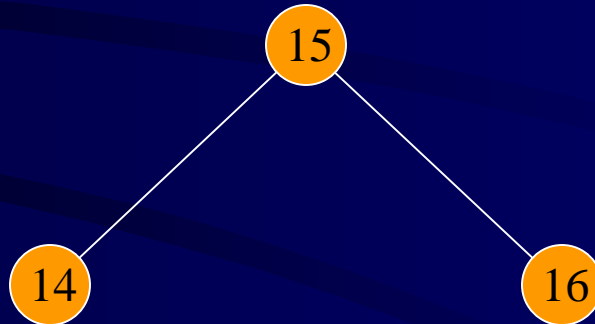
- Rotation type:



AVL Tree Rotations

Single rotations:

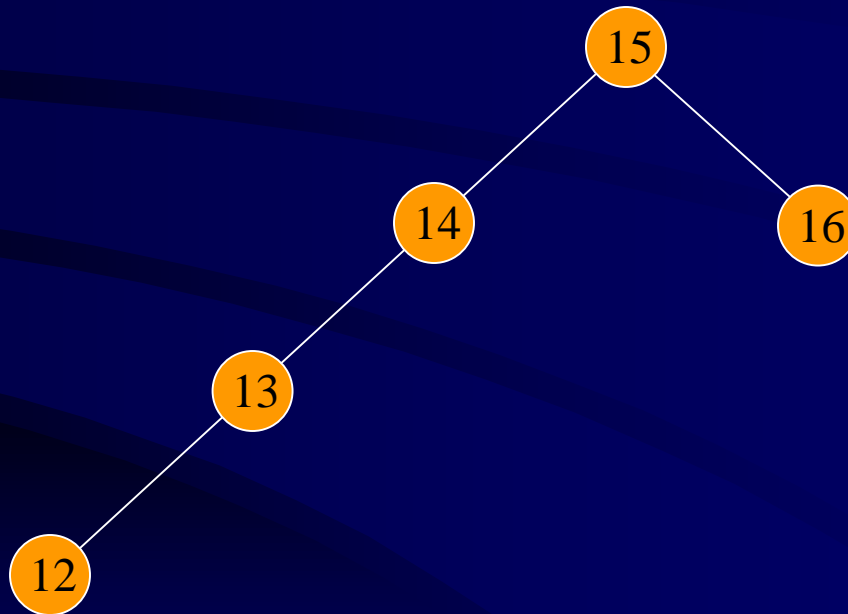
- Rotation restores AVL balance:



AVL Tree Rotations

Single rotations:

- Now insert 13 and 12:

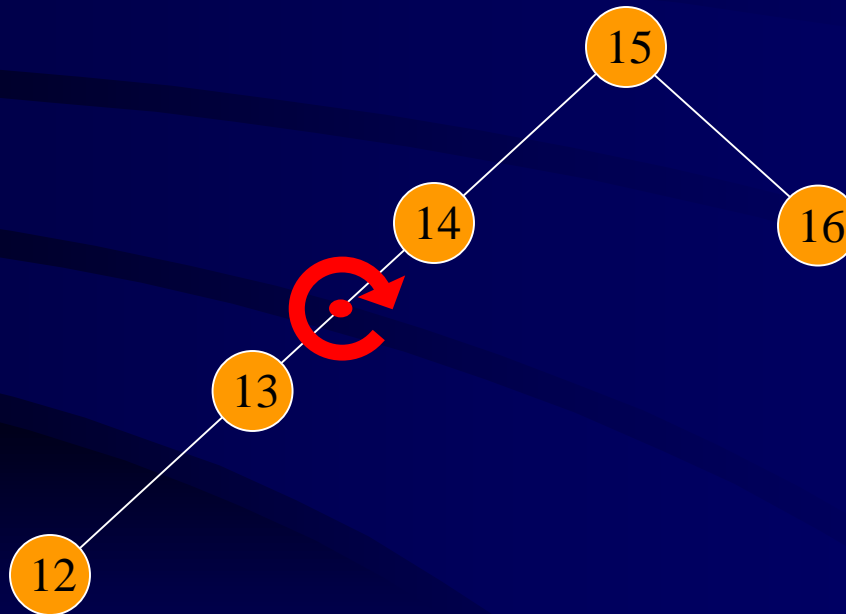


- AVL violation - need to rotate.

AVL Tree Rotations

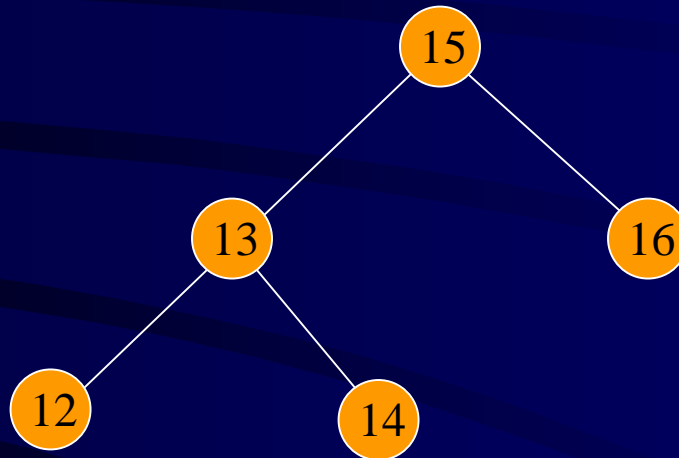
Single rotations:

- Rotation type:



AVL Tree Rotations

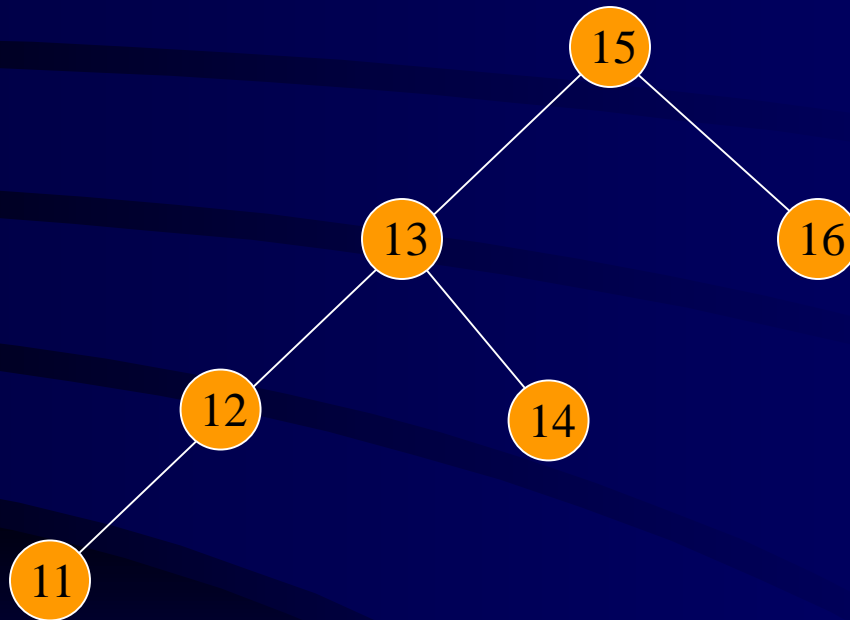
Single rotations:



- Now insert 11.

AVL Tree Rotations

Single rotations:

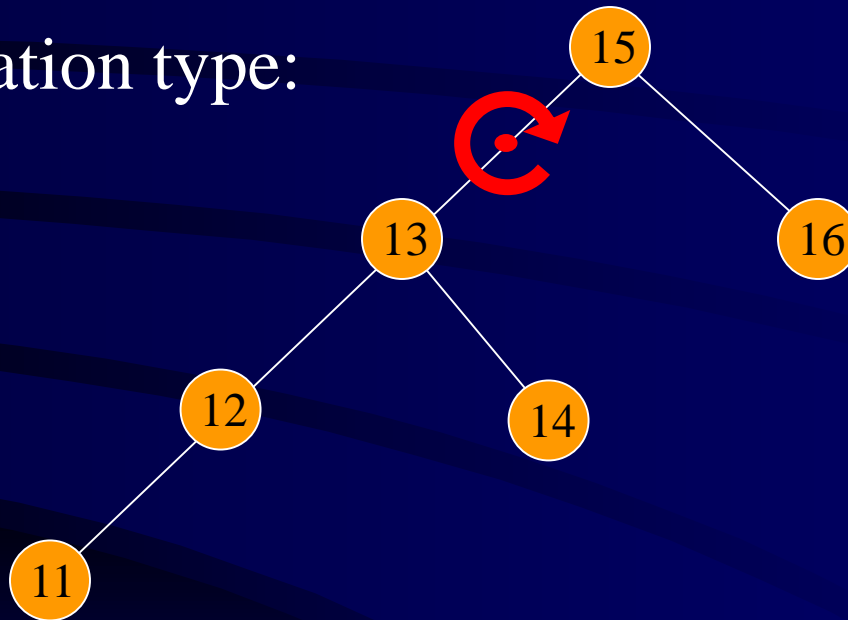


- AVL violation – need to rotate

AVL Tree Rotations

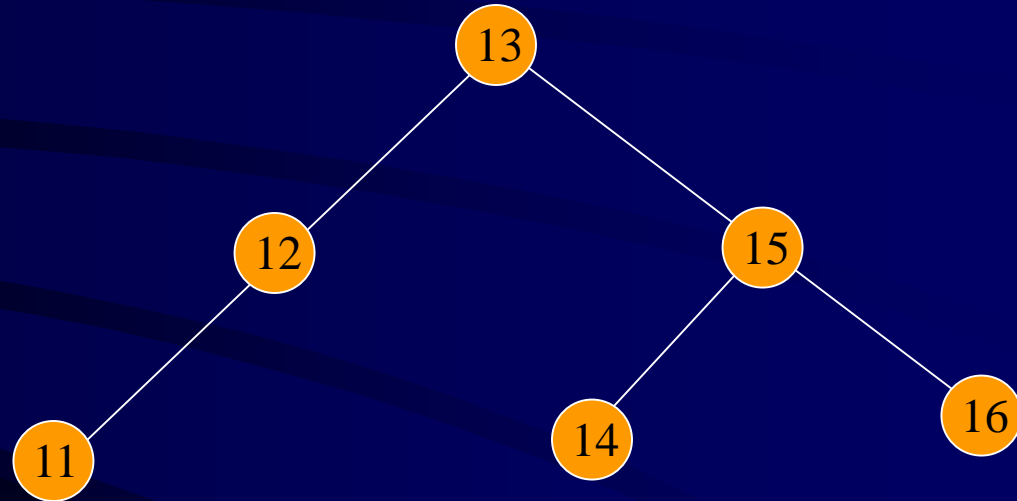
Single rotations:

- Rotation type:



AVL Tree Rotations

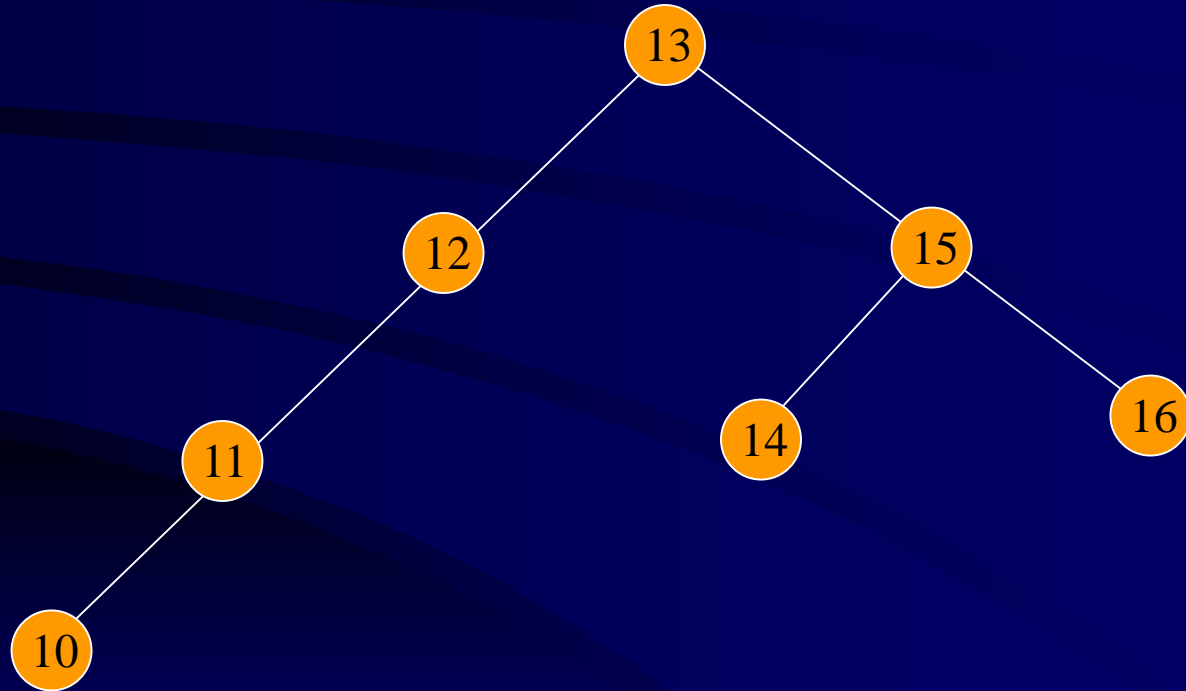
Single rotations:



- Now insert 10.

AVL Tree Rotations

Single rotations:

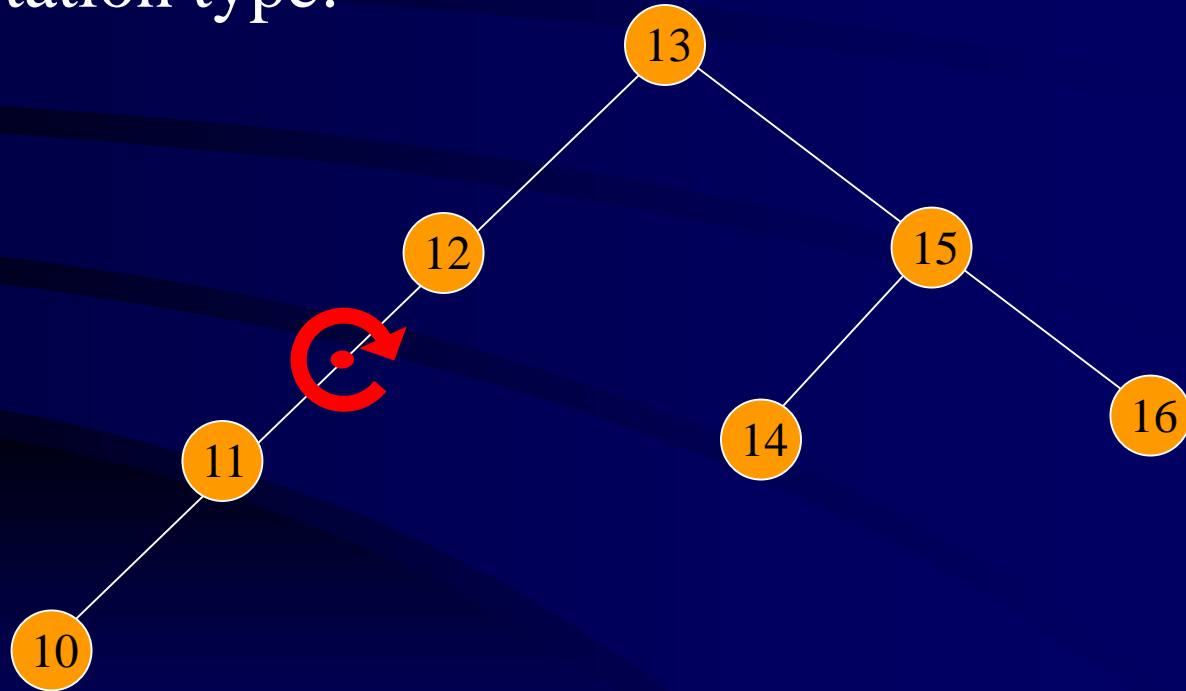


- AVL violation – need to rotate

AVL Tree Rotations

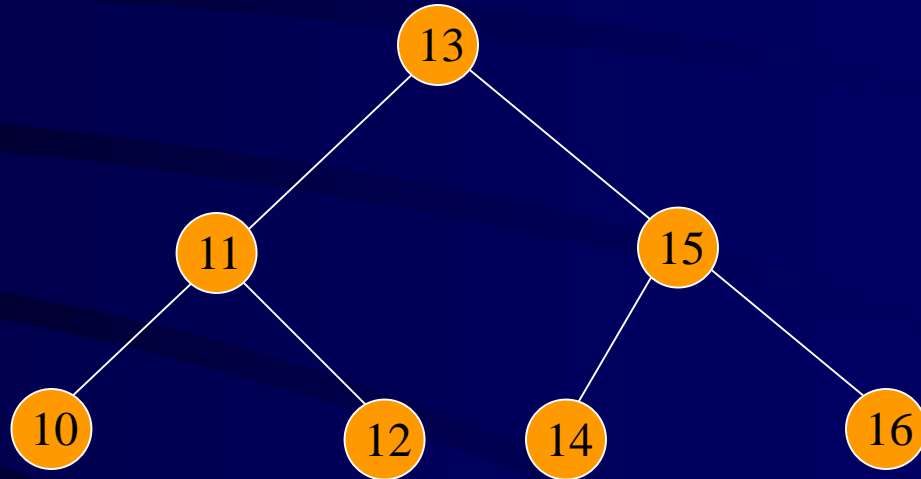
Single rotations:

- Rotation type:



AVL Tree Rotations

Single rotations:

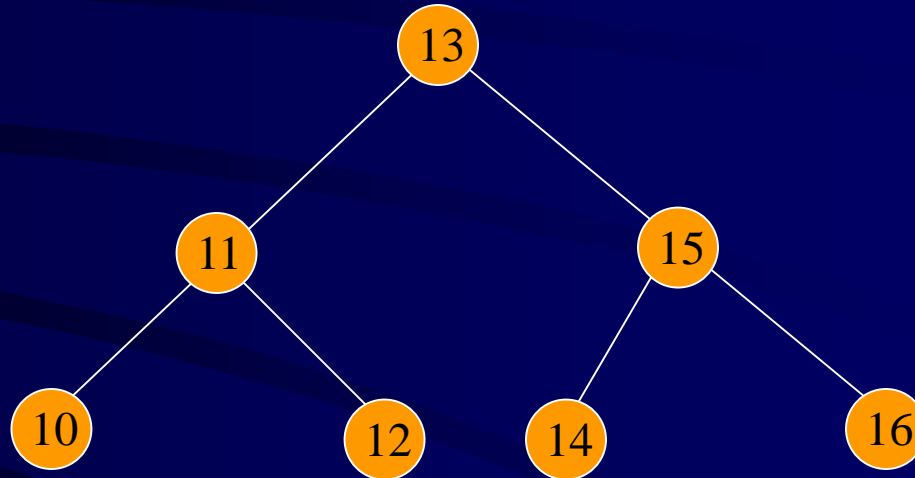


- AVL balance restored.

AVL Tree Rotations

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

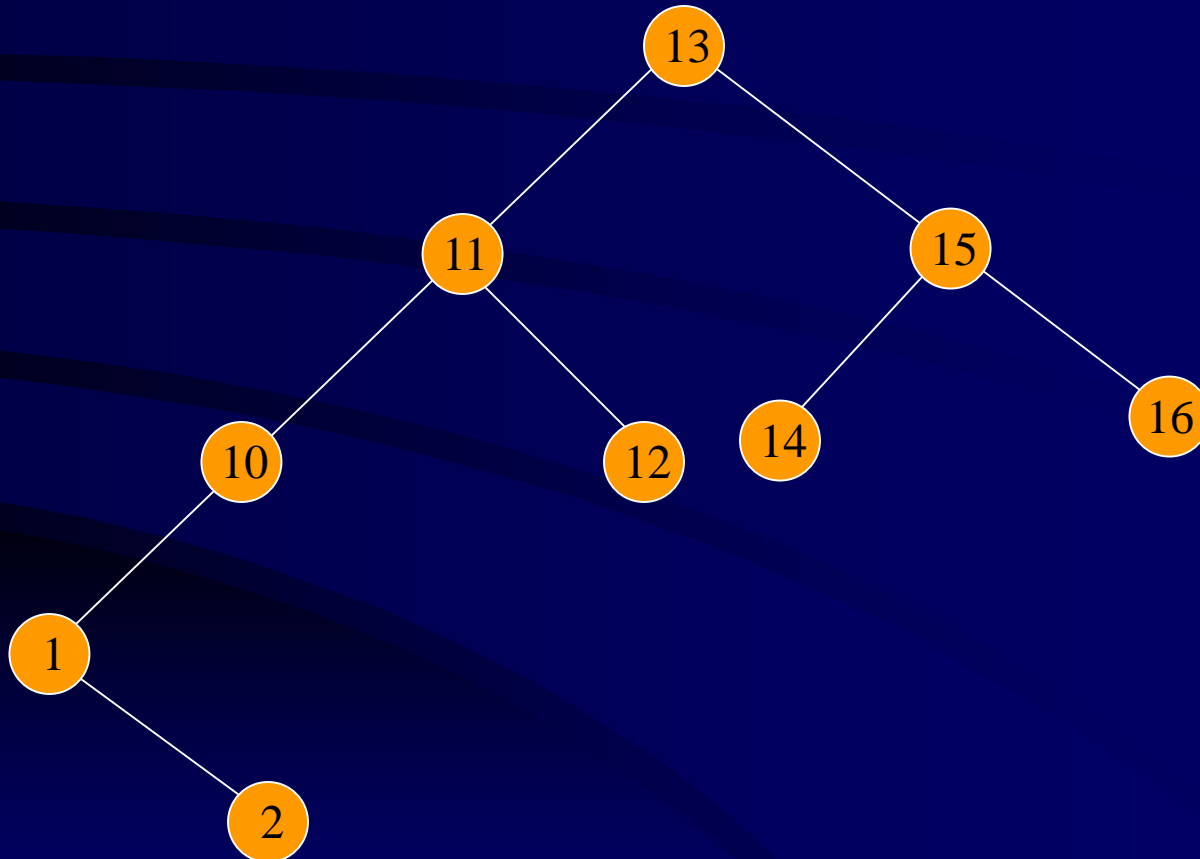
- First insert 1 and 2:



AVL Tree Rotations

Double rotations:

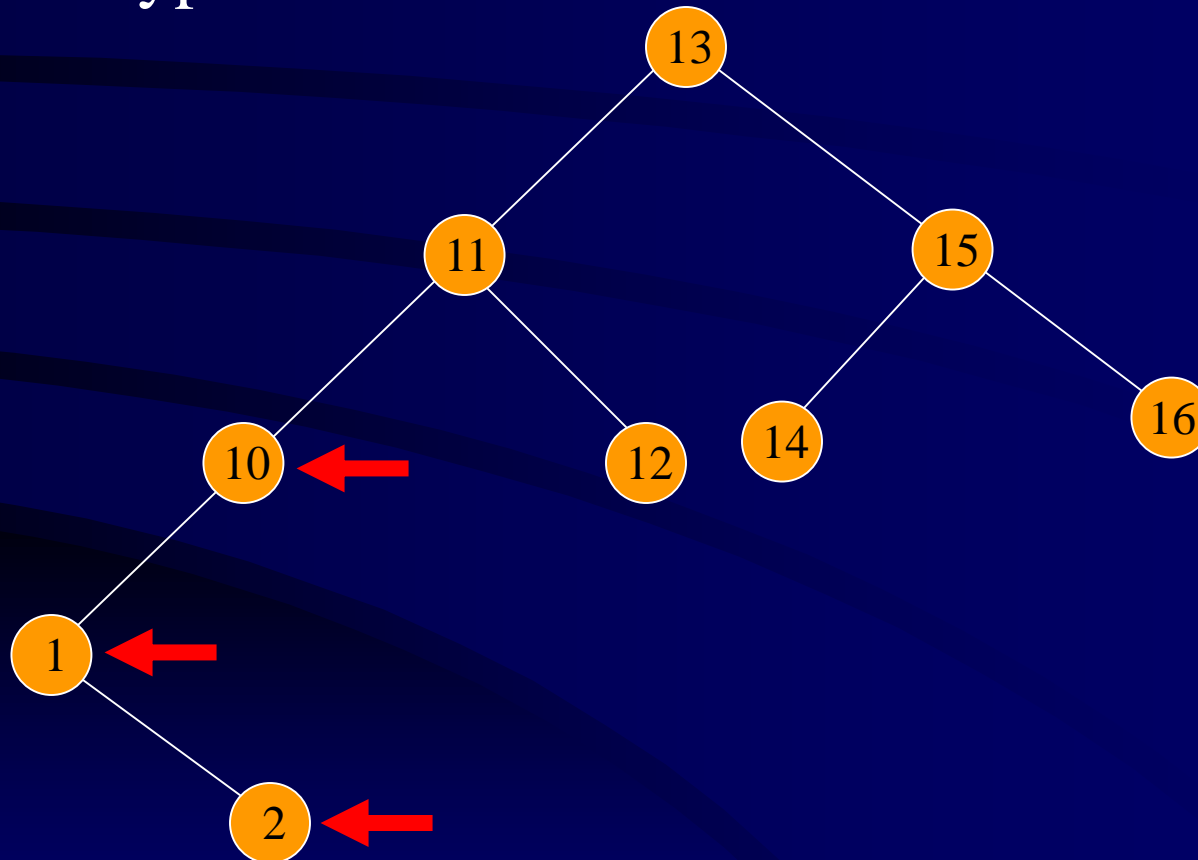
- AVL violation - rotate



AVL Tree Rotations

Double rotations:

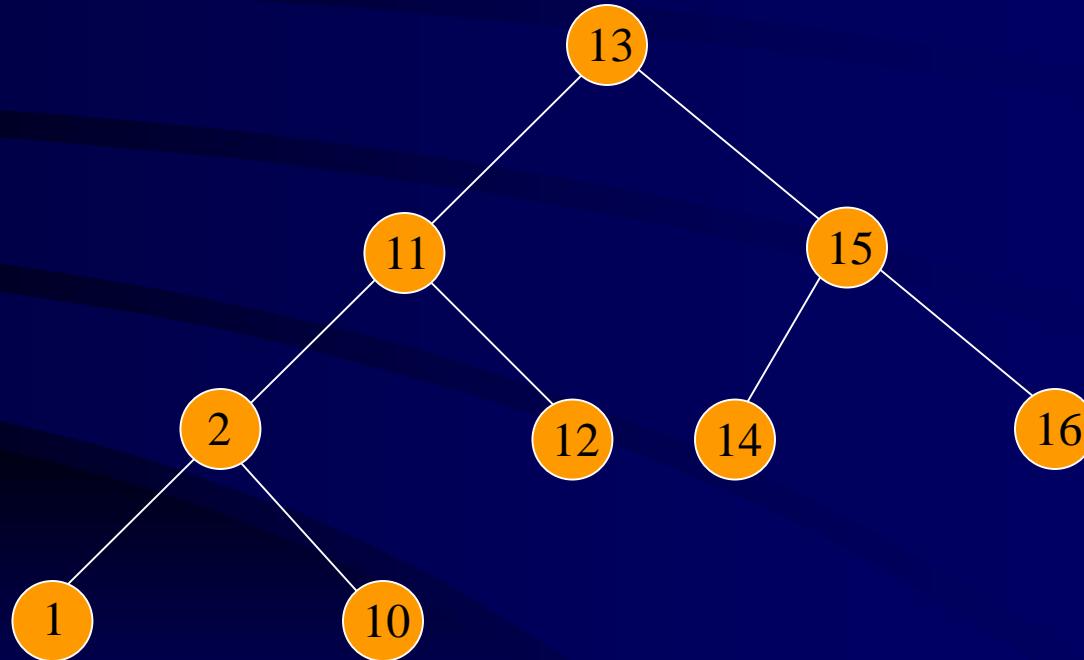
- Rotation type:



AVL Tree Rotations

Double rotations:

- AVL balance restored:

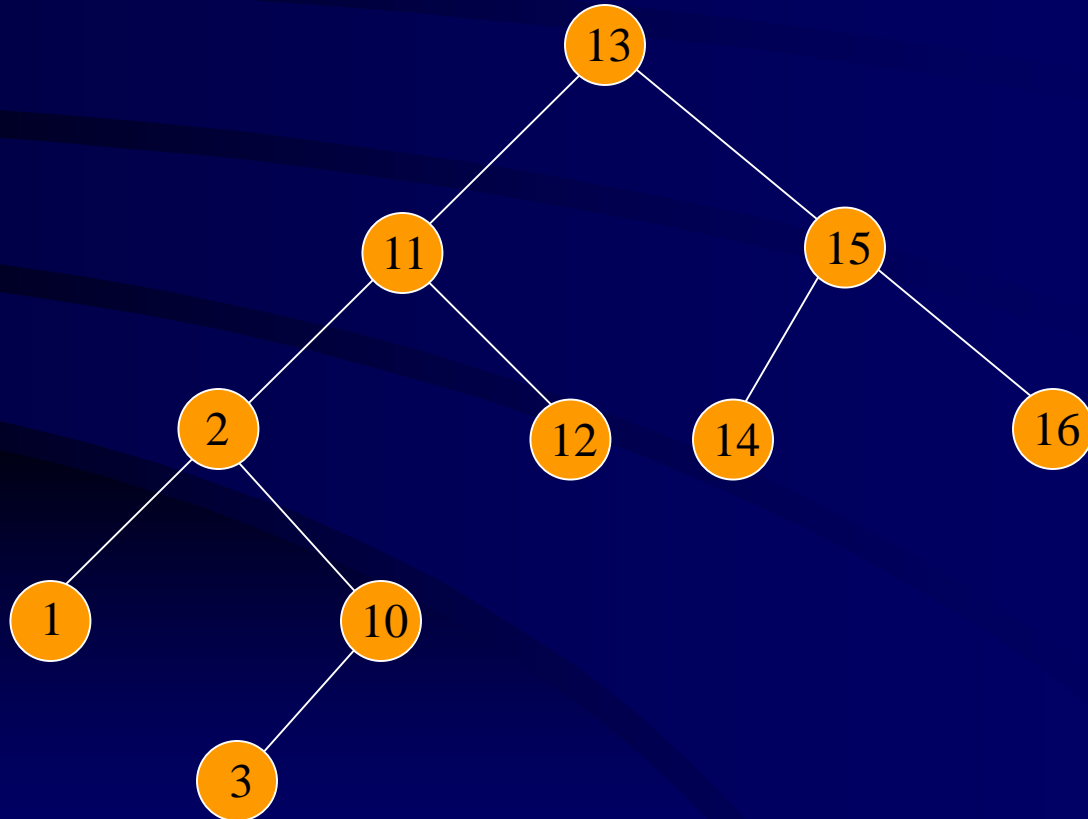


- Now insert 3.

AVL Tree Rotations

Double rotations:

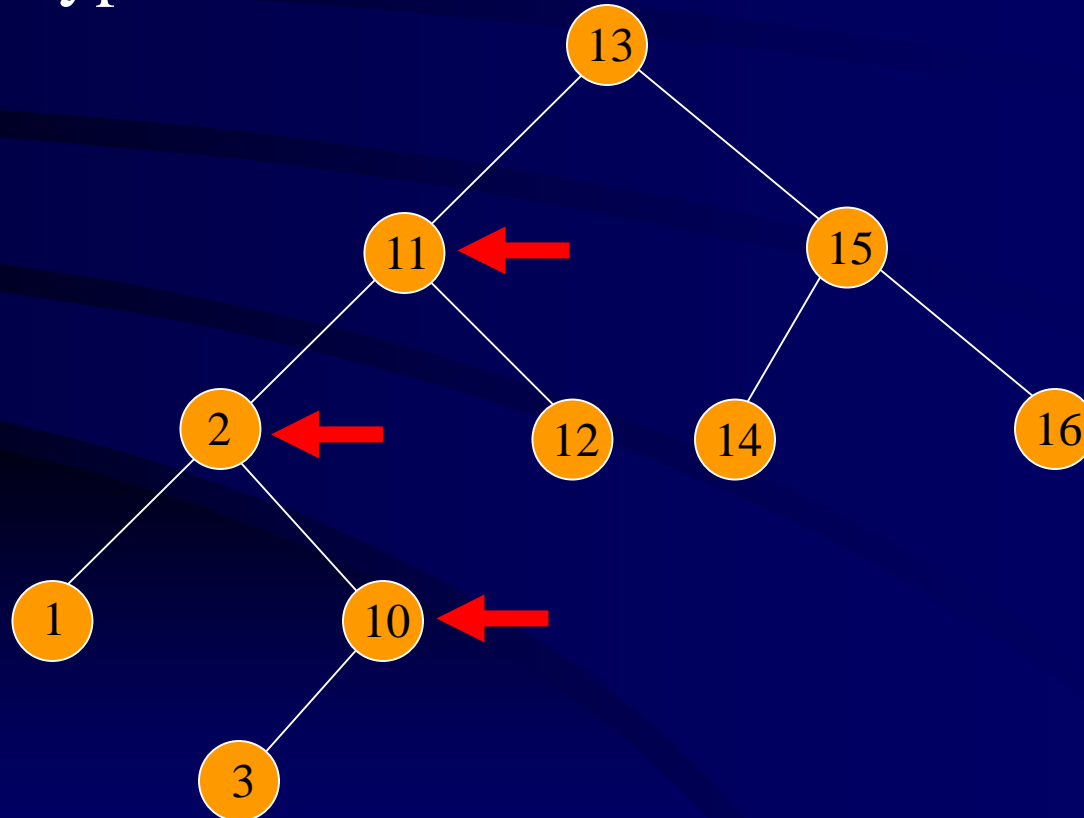
- AVL violation – rotate:



AVL Tree Rotations

Double rotations:

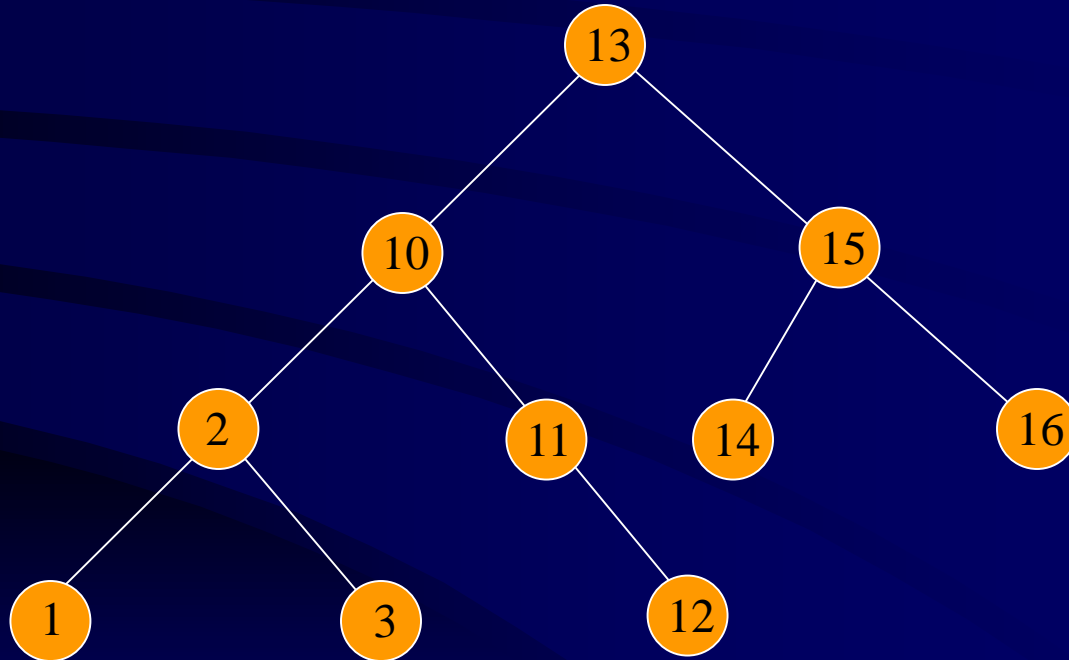
- Rotation type:



AVL Tree Rotations

Double rotations:

- AVL balance restored:

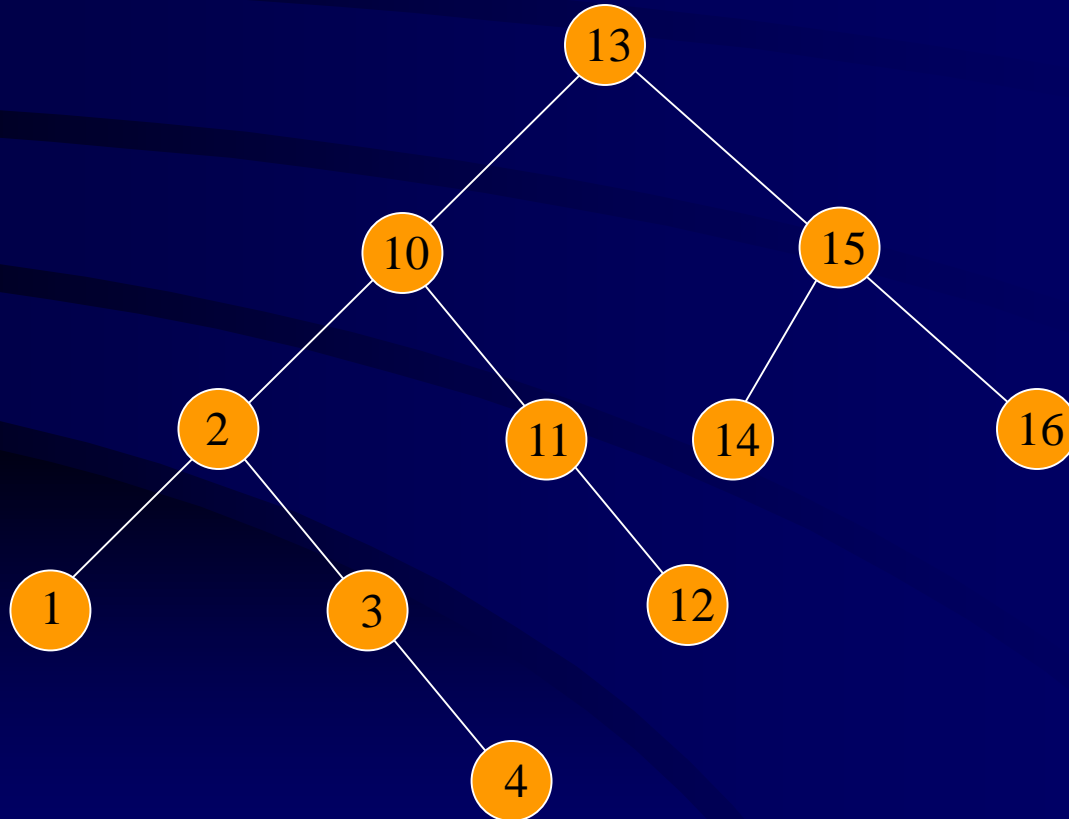


- Now insert 4.

AVL Tree Rotations

Double rotations:

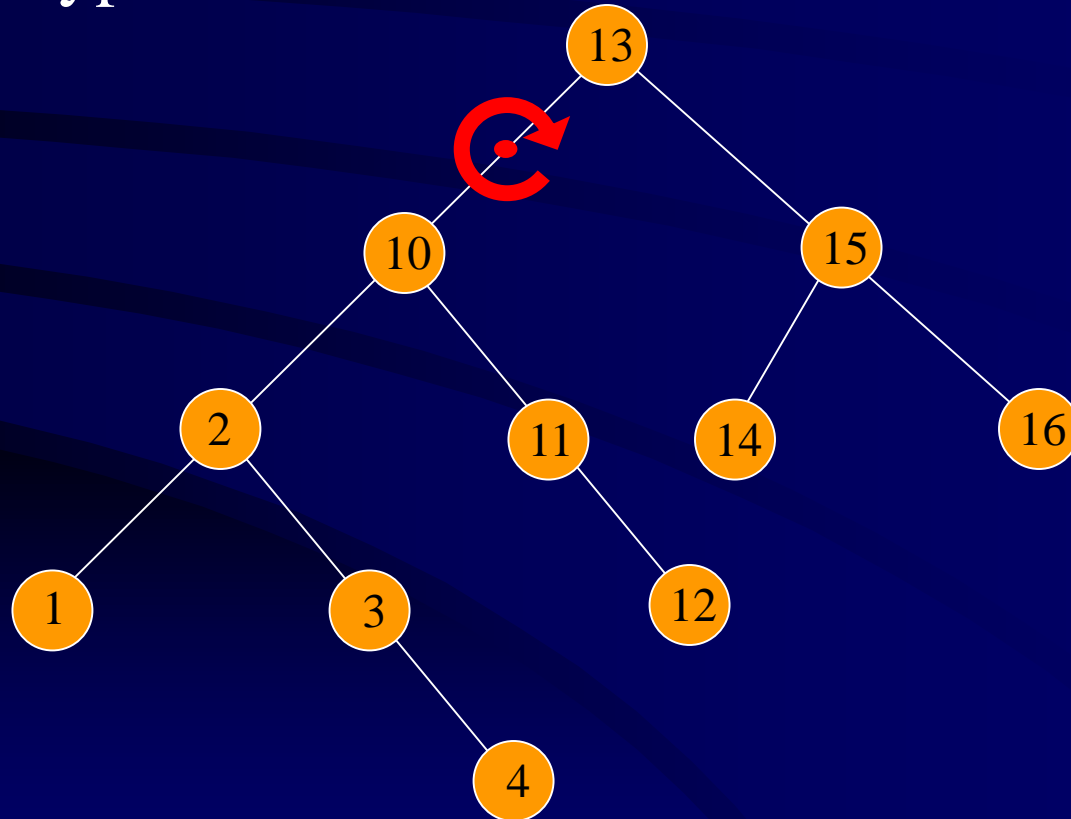
- AVL violation - rotate



AVL Tree Rotations

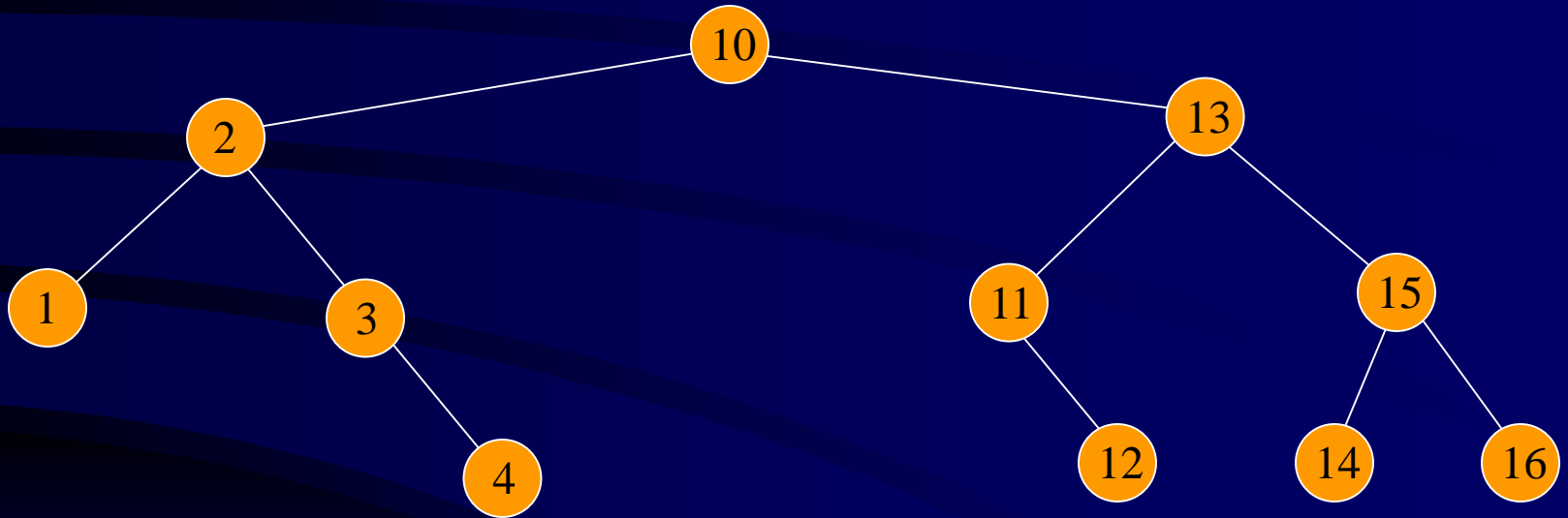
Double rotations:

- Rotation type:



AVL Tree Rotations

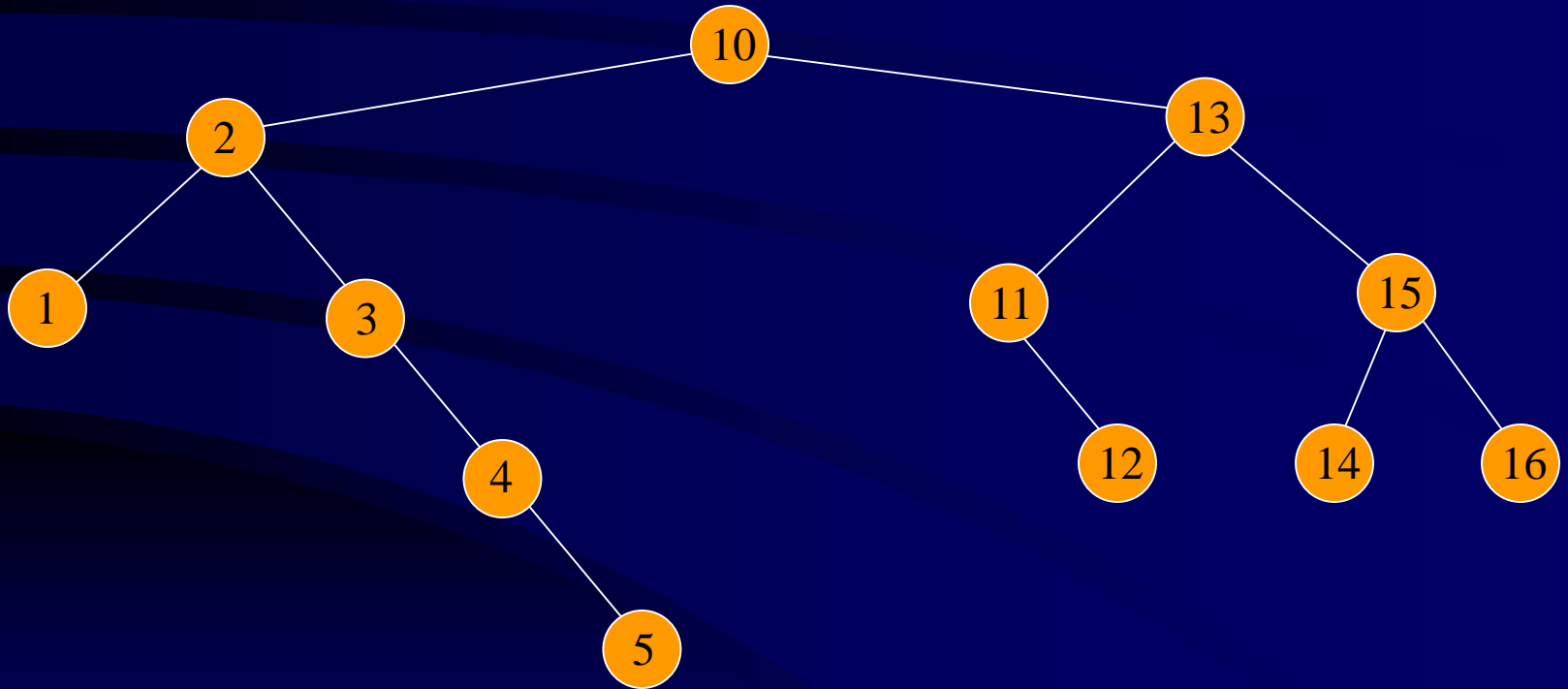
Double rotations:



- Now insert 5.

AVL Tree Rotations

Double rotations:

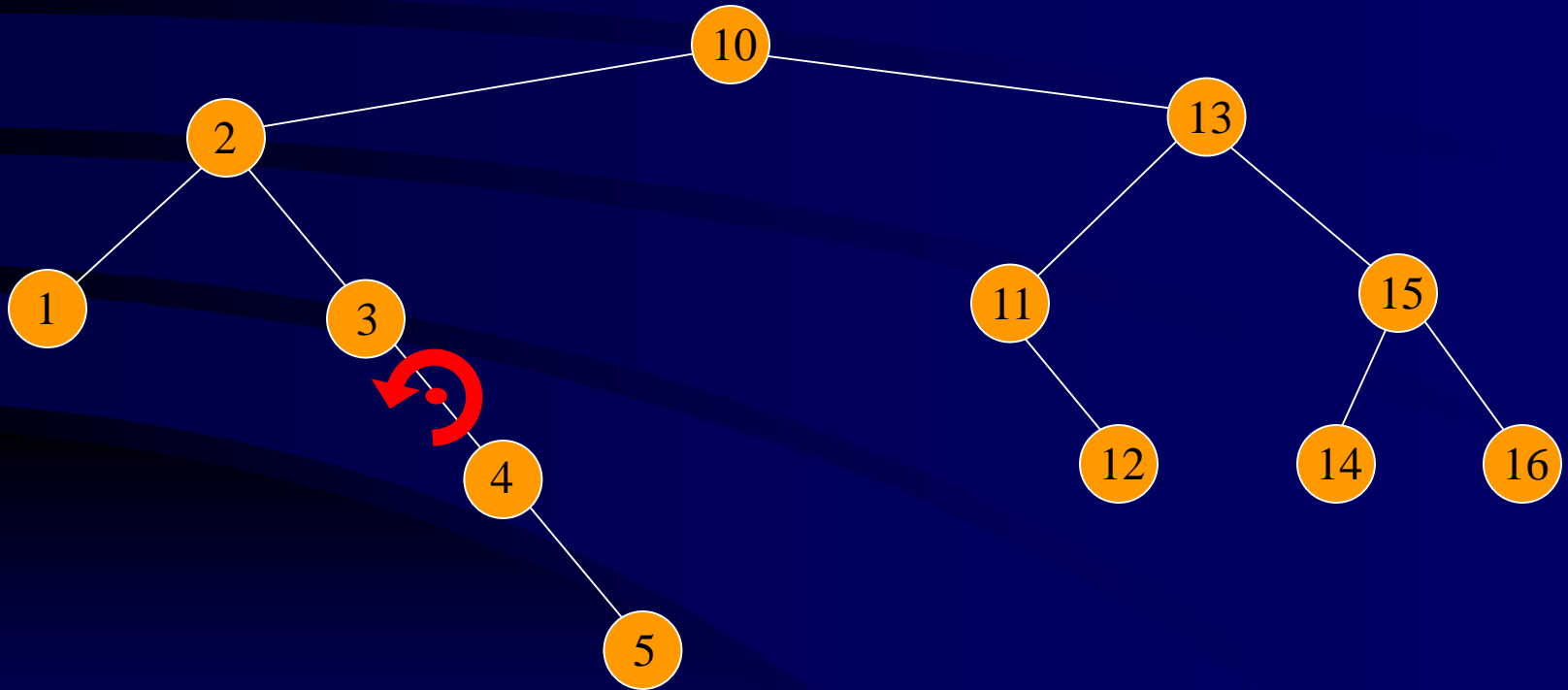


- AVL violation – rotate.

AVL Tree Rotations

Single rotations:

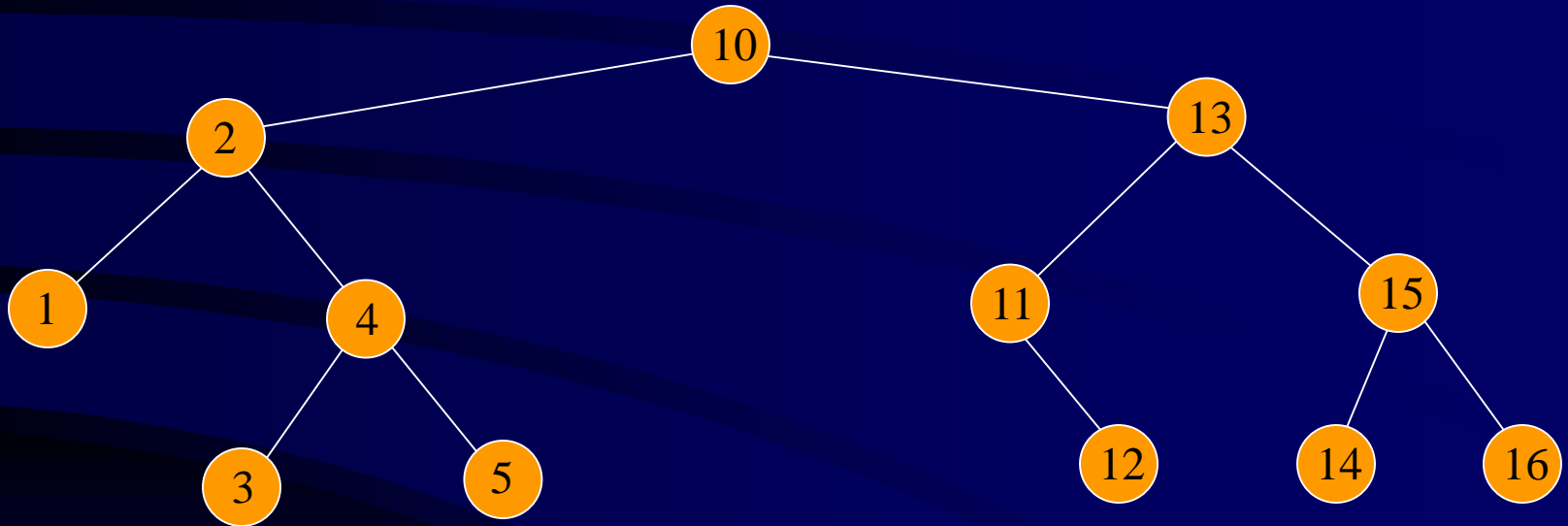
- Rotation type:



AVL Tree Rotations

Single rotations:

- AVL balance restored:

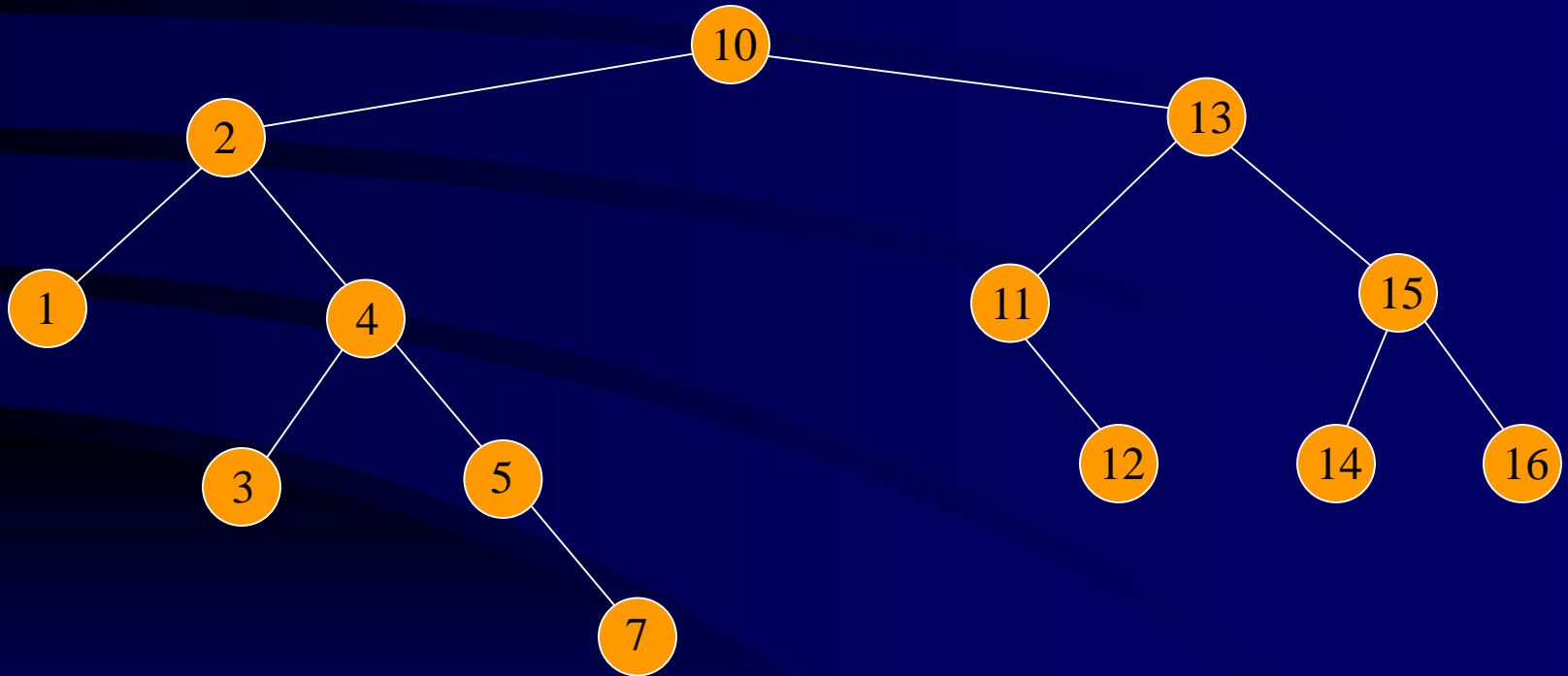


- Now insert 7.

AVL Tree Rotations

Single rotations:

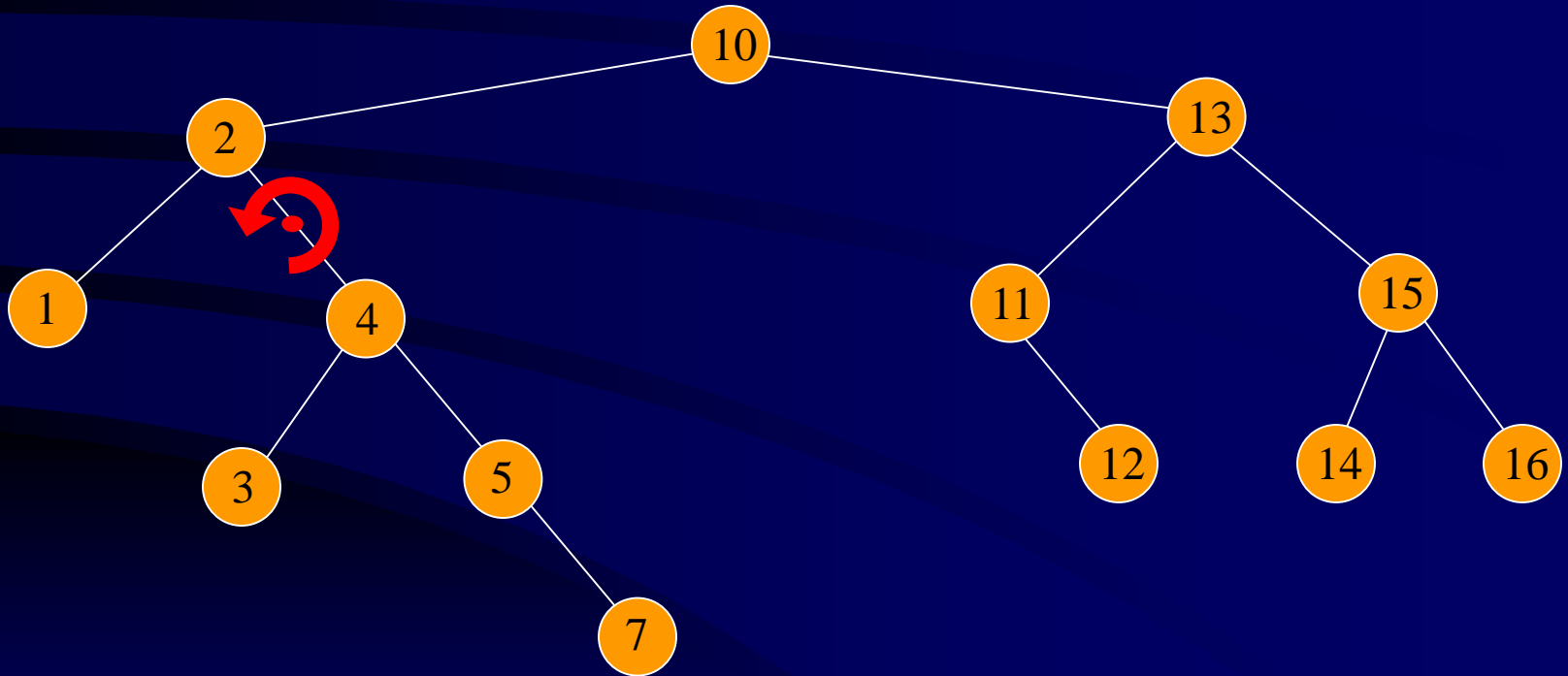
- AVL violation – rotate.



AVL Tree Rotations

Single rotations:

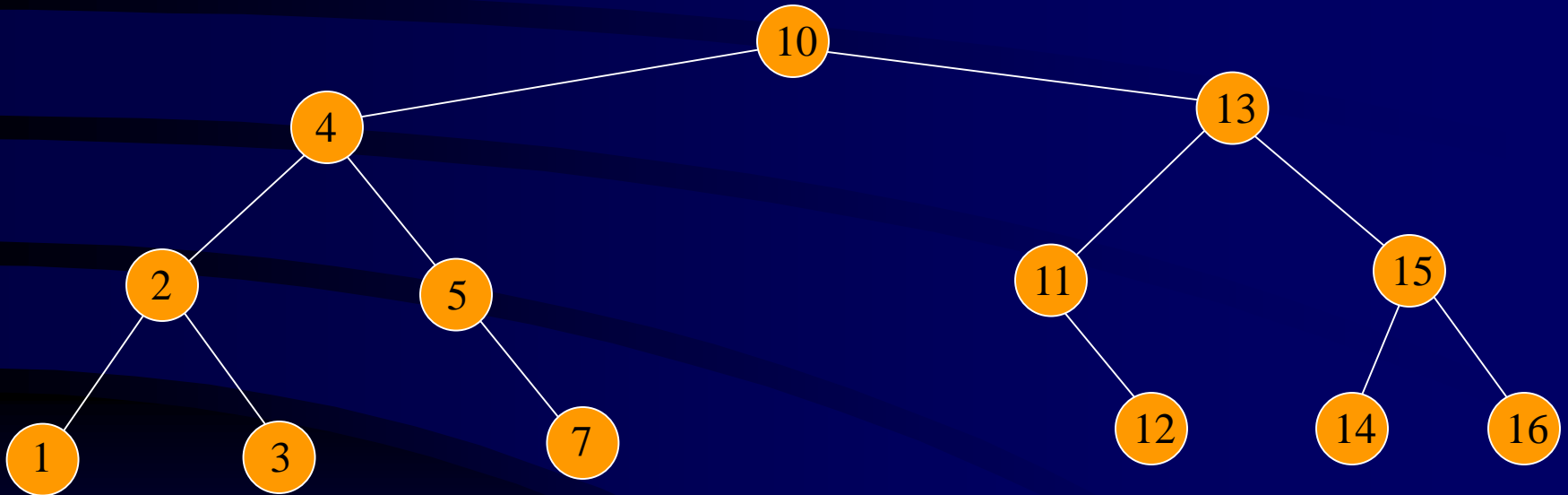
- Rotation type:



AVL Tree Rotations

Double rotations:

- AVL balance restored.

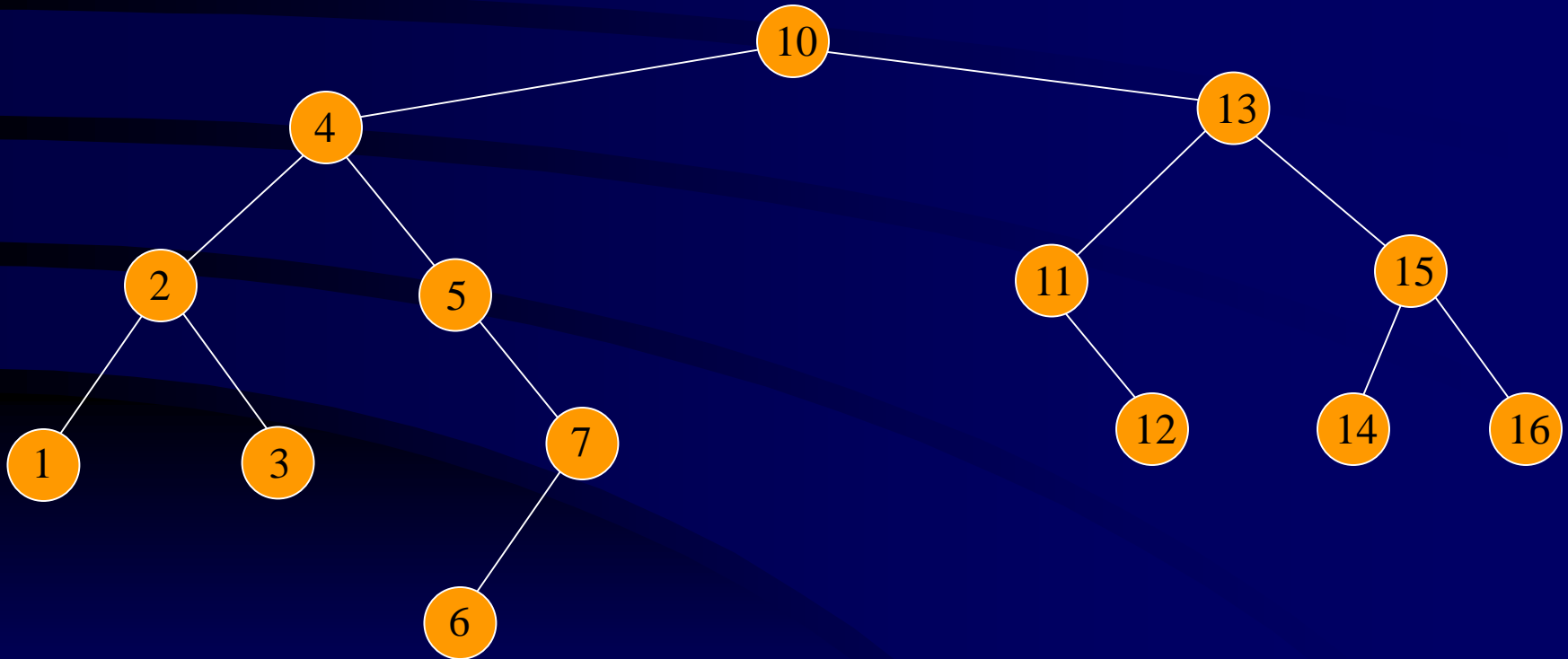


- Now insert 6.

AVL Tree Rotations

Double rotations:

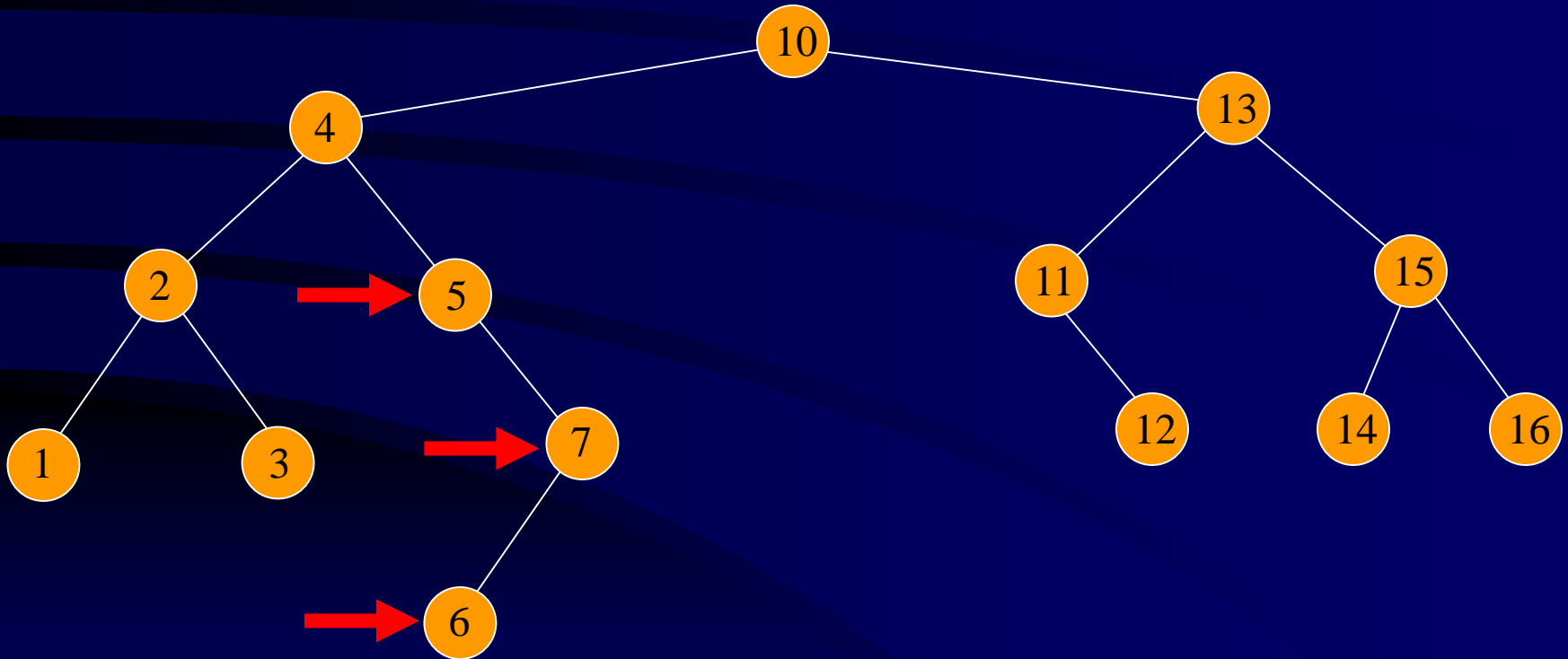
- AVL violation - rotate.



AVL Tree Rotations

Double rotations:

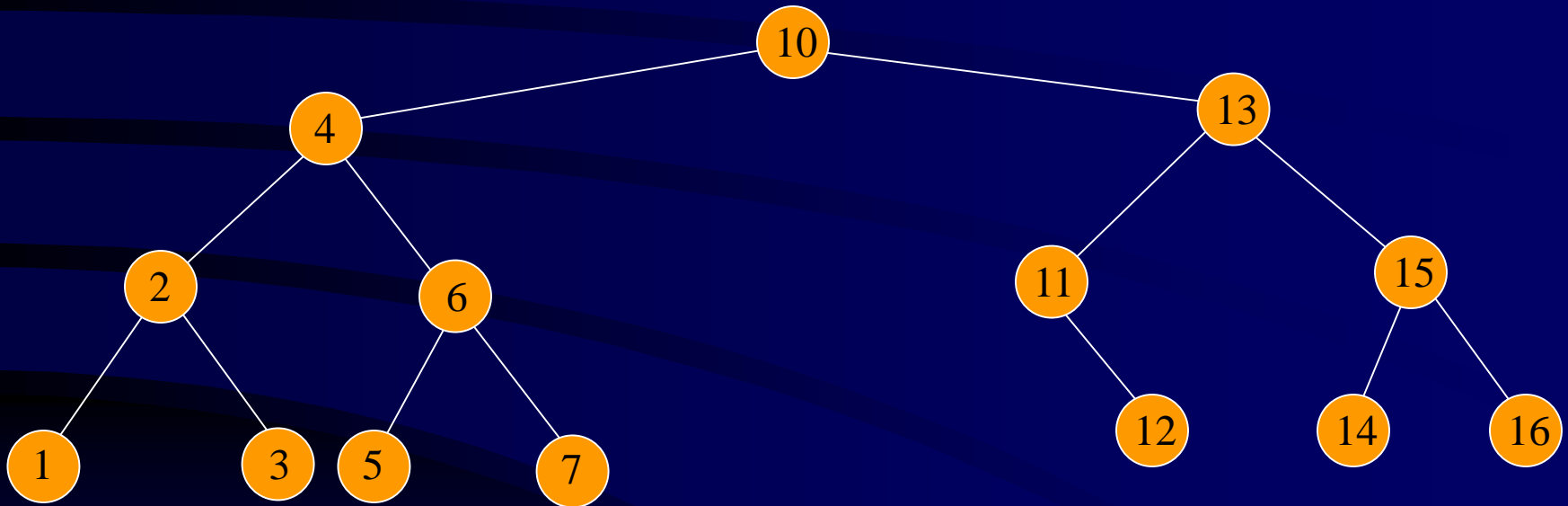
- Rotation type:



AVL Tree Rotations

Double rotations:

- AVL balance restored.

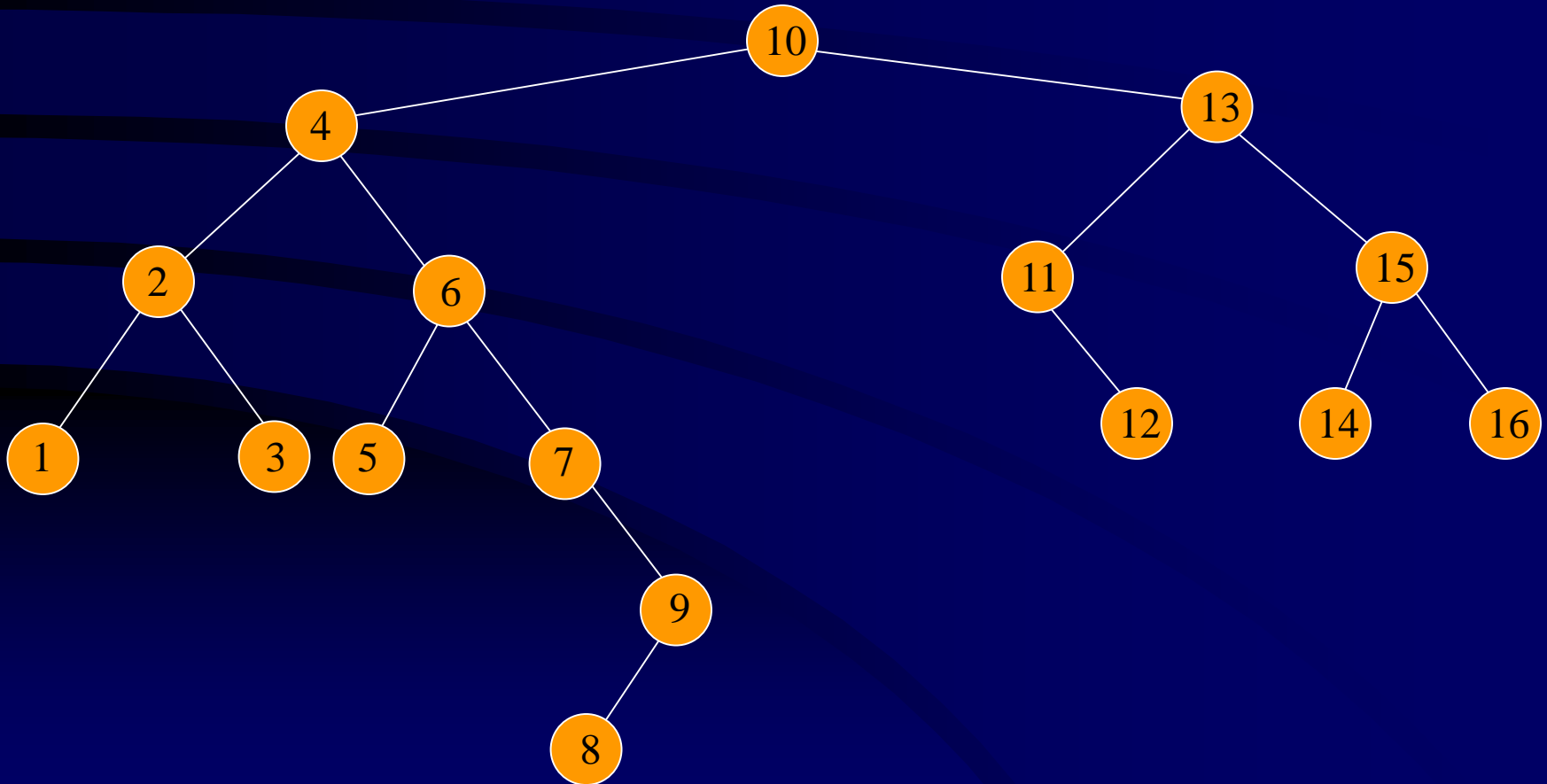


- Now insert 9 and 8.

AVL Tree Rotations

Double rotations:

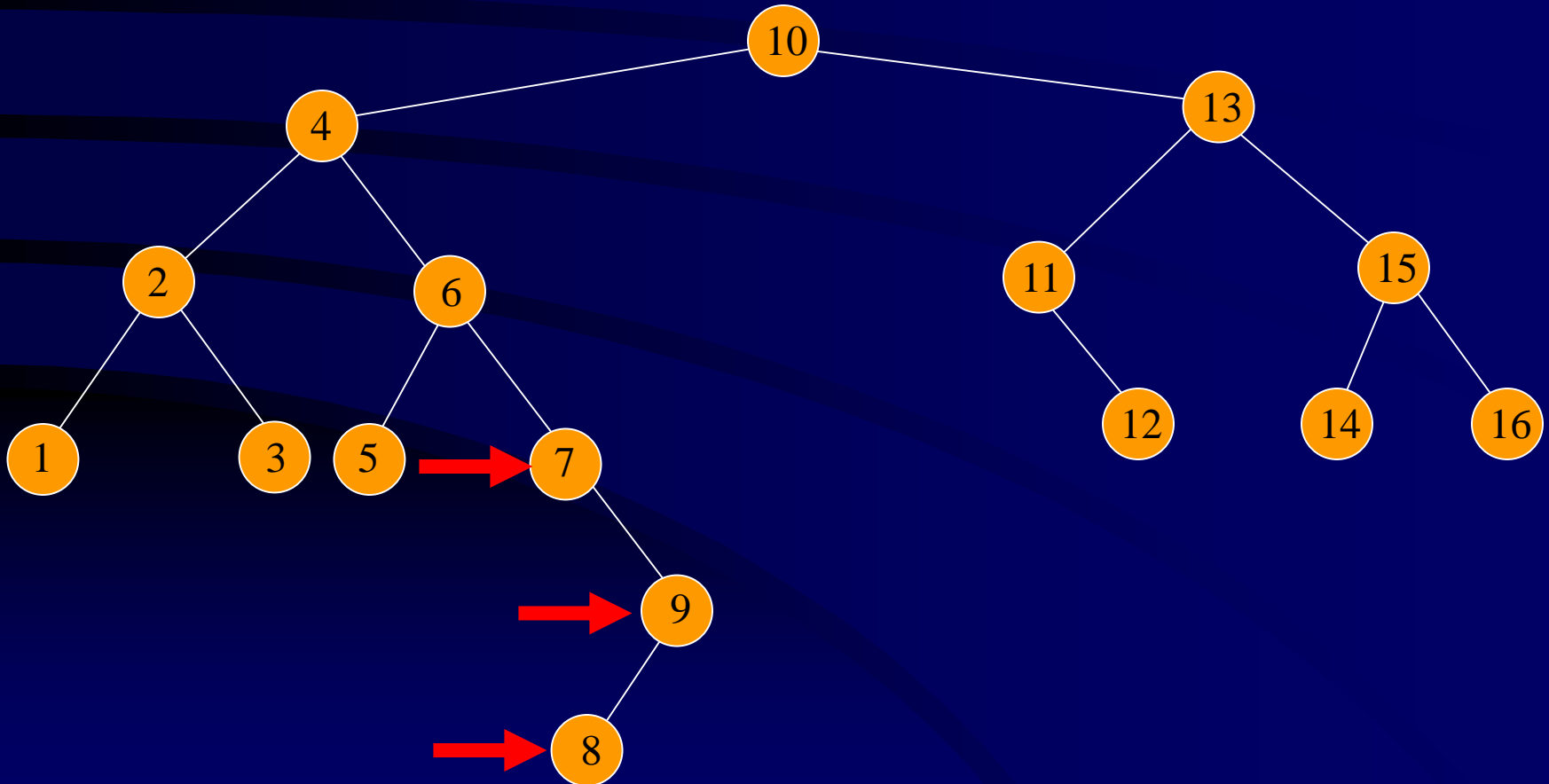
- AVL violation - rotate.



AVL Tree Rotations

Double rotations:

- Rotation type:



AVL Tree Rotations

Final tree:

- Tree is almost perfectly balanced

