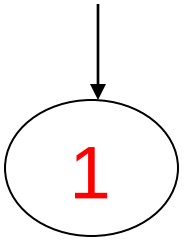
Red Black Trees

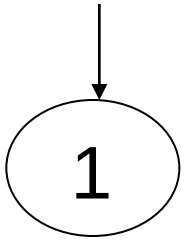
Insertion Example

Example of Inserting Sorted Numbers

- 1 2 3 4 5 6 7 8 9 10

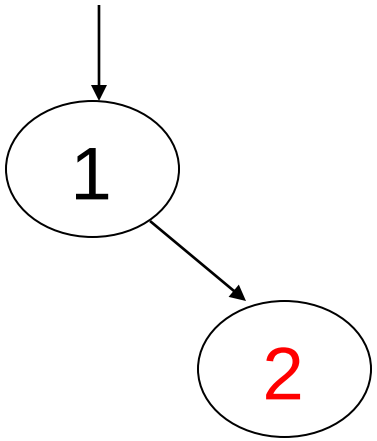


Insert 1. A leaf so red. Realize it is root so recolor to black.



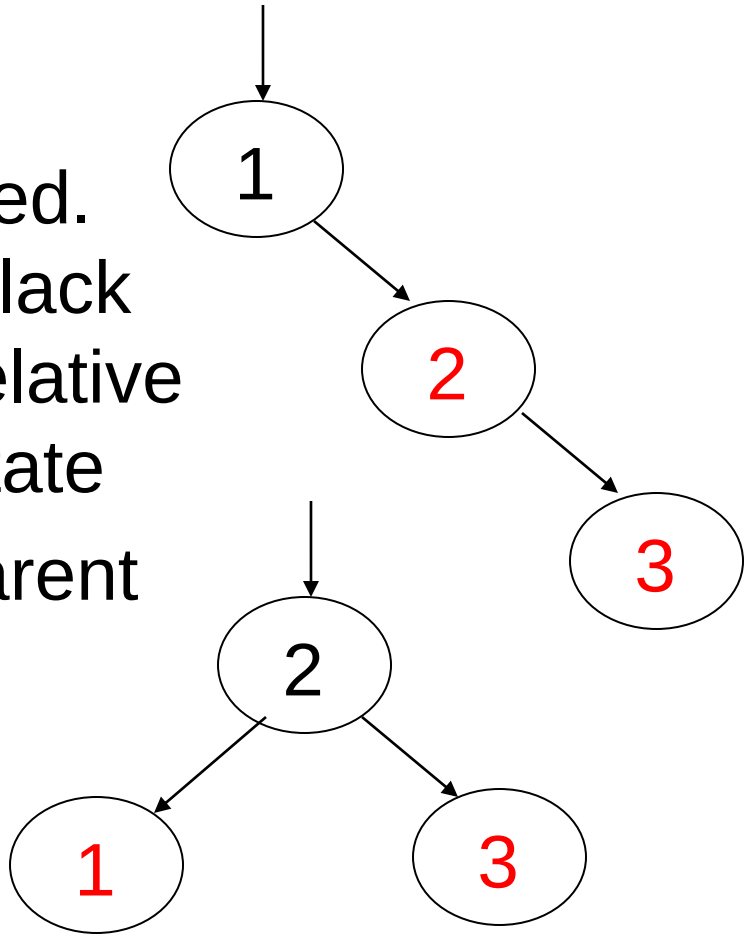
Insert 2

make 2 red. Parent is black so done.



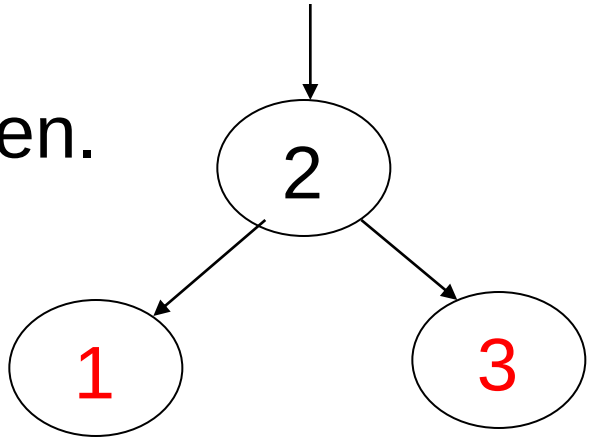
Insert 3

Insert 3. Parent is red. Parent's sibling is black (null) 3 is outside relative to grandparent. Rotate parent and grandparent

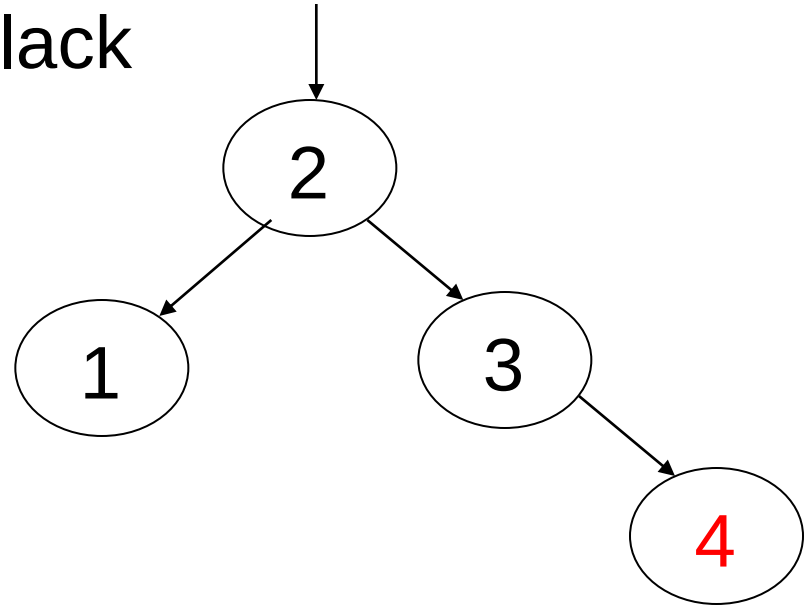


Insert 4

On way down see
2 with 2 red children.
Recolor 2 red and
children black.
Realize 2 is root
so color back to black

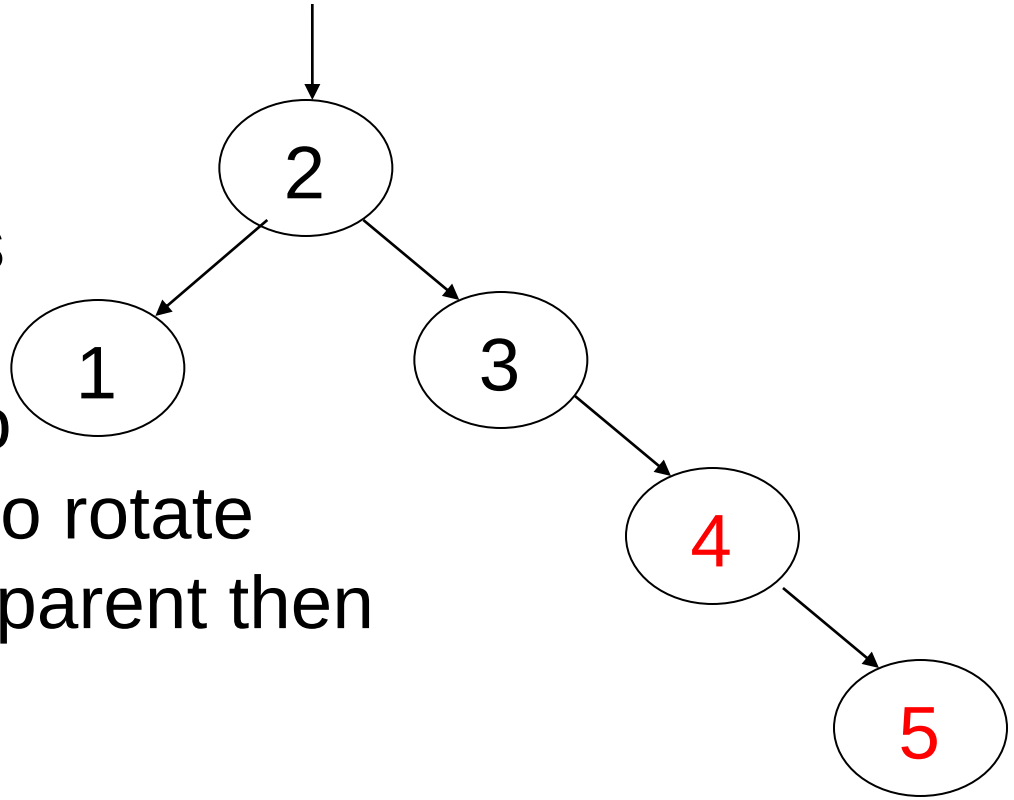


When adding 4
parent is black
so done.

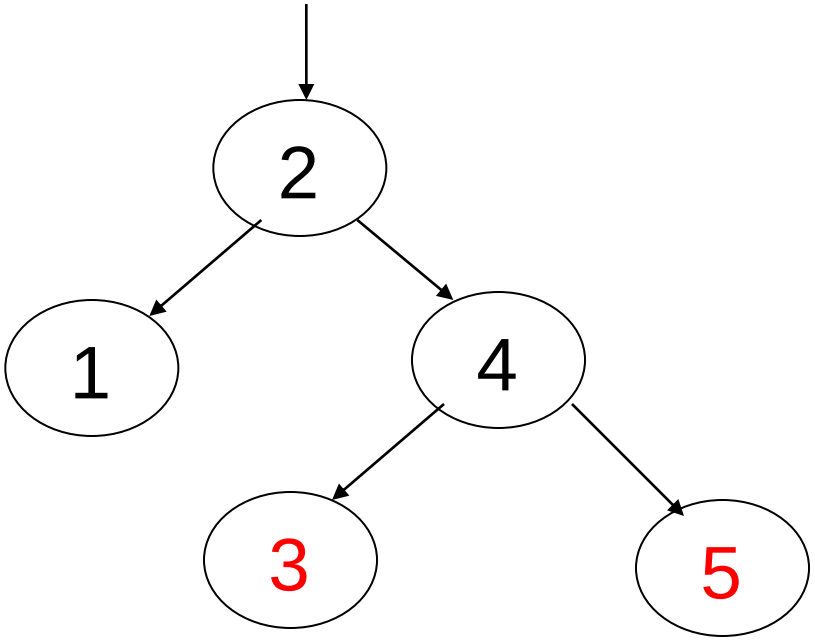


Insert 5

5's parent is red. Parent's sibling is black (null). 5 is outside relative to grandparent (3) so rotate parent and grandparent then recolor

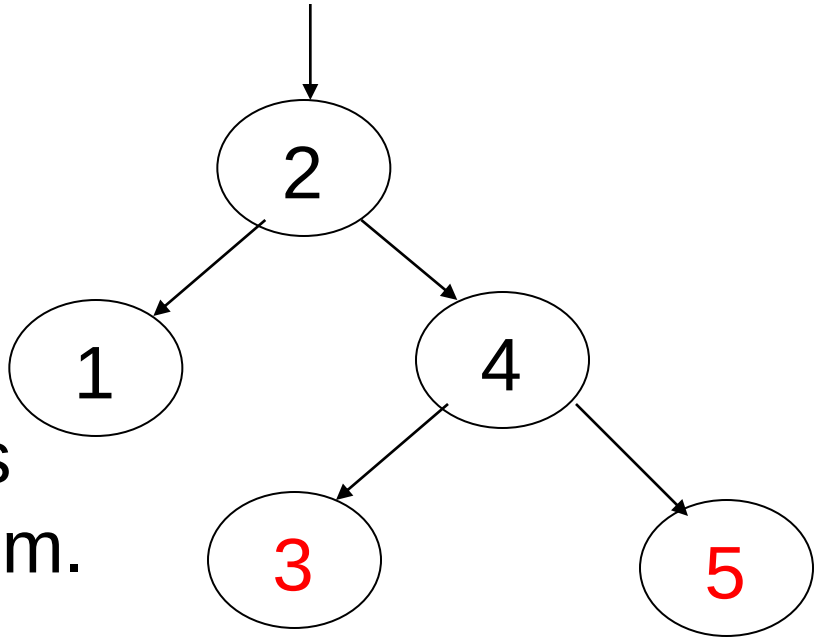


Finish insert of 5



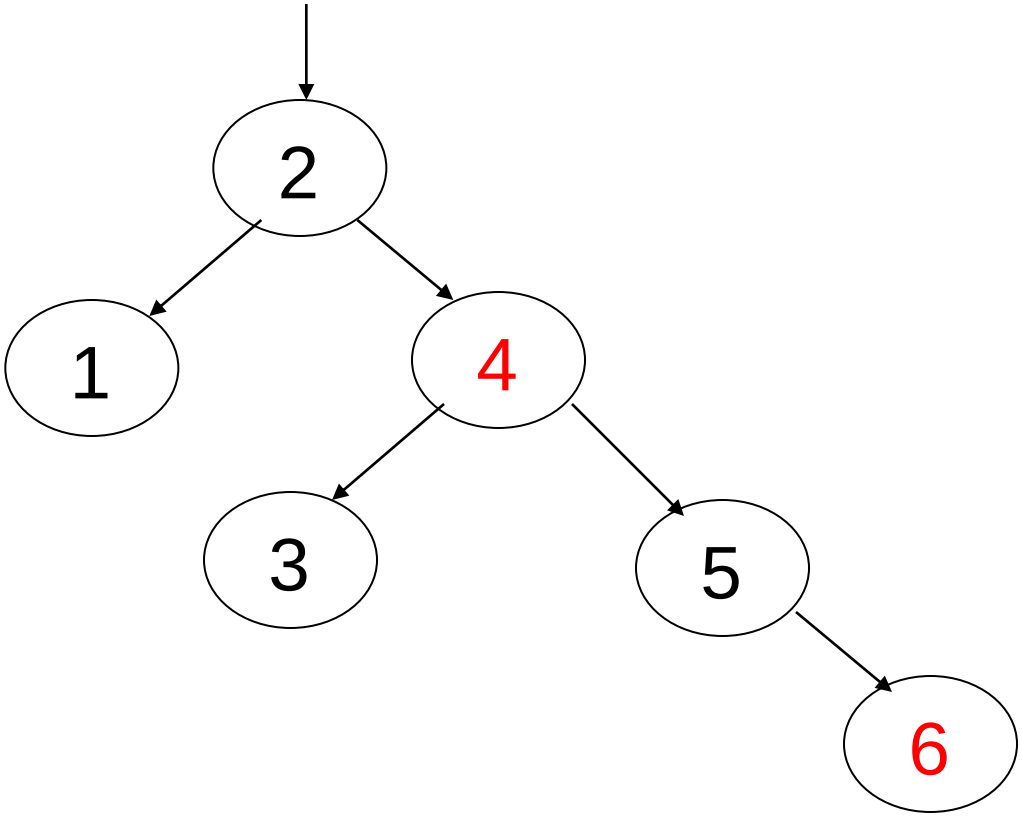
Insert 6

On way down see 4 with 2 red children. Make 4 red and children black. 4's parent is black so no problem.



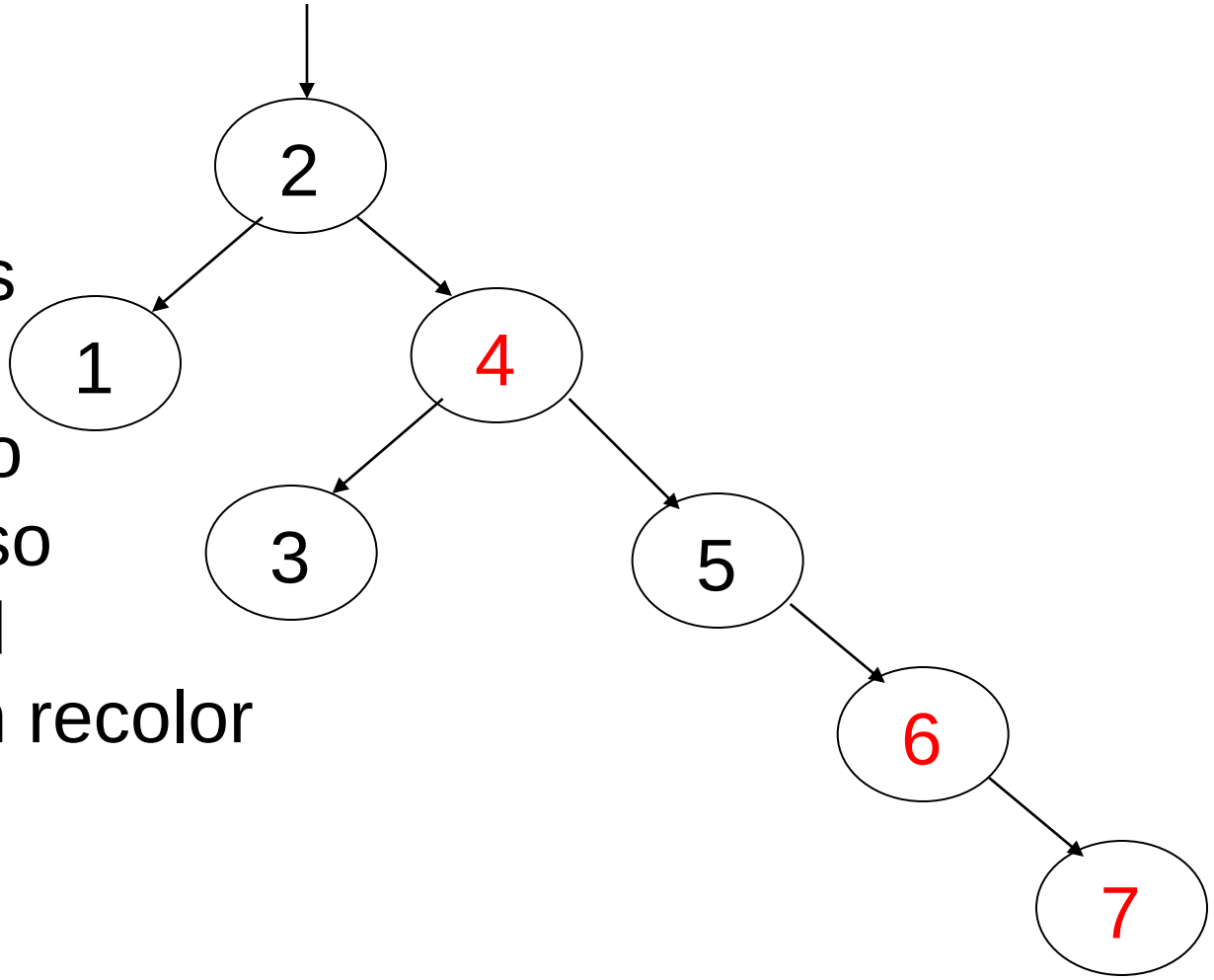
Finishing insert of 6

6's parent is black so done.

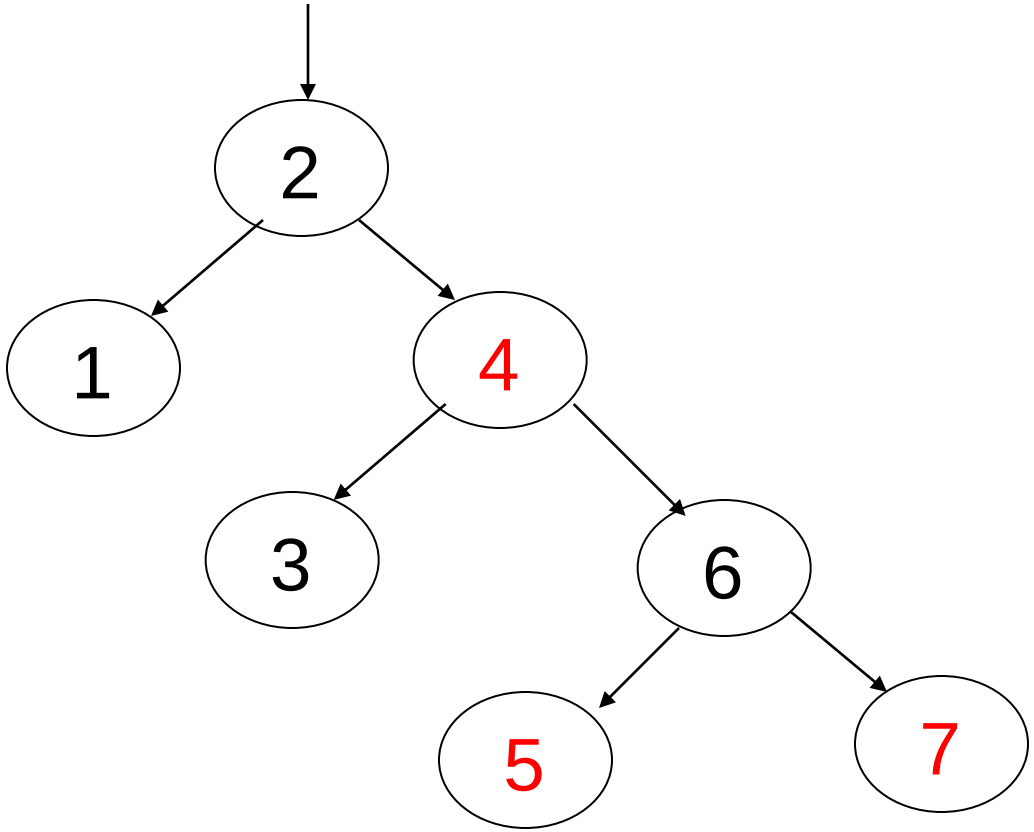


Insert 7

7's parent is red. Parent's sibling is black (null). 7 is outside relative to grandparent (5) so rotate parent and grandparent then recolor

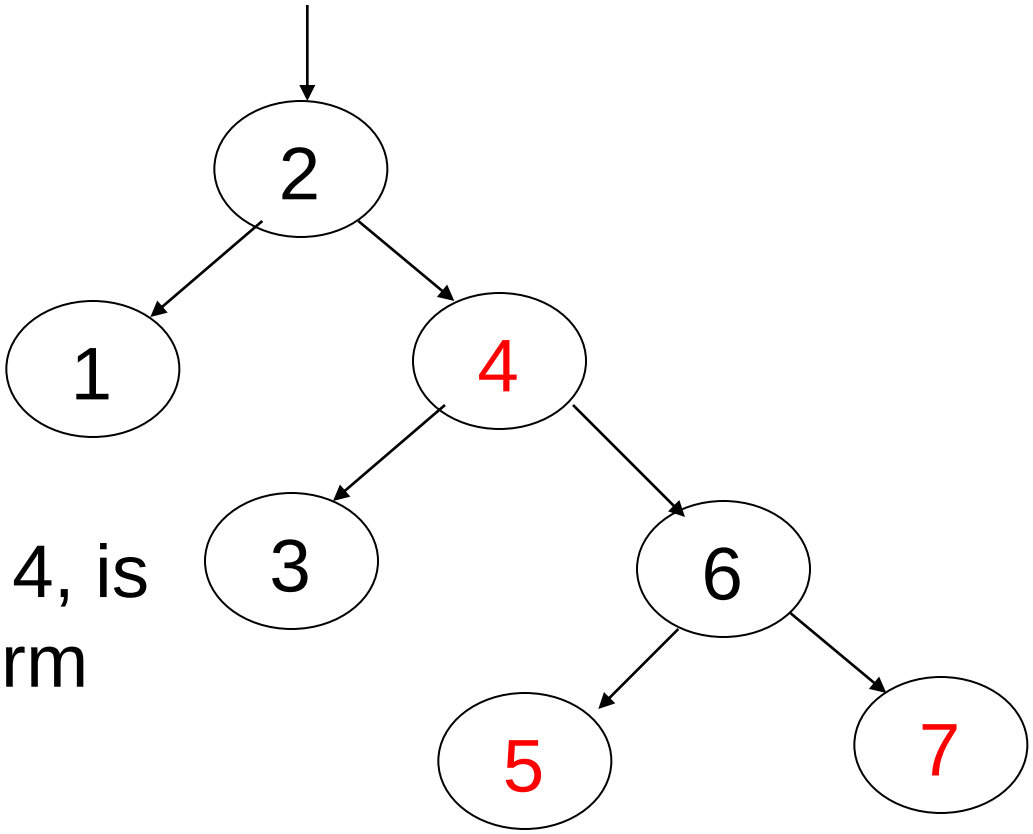


Finish insert of 7



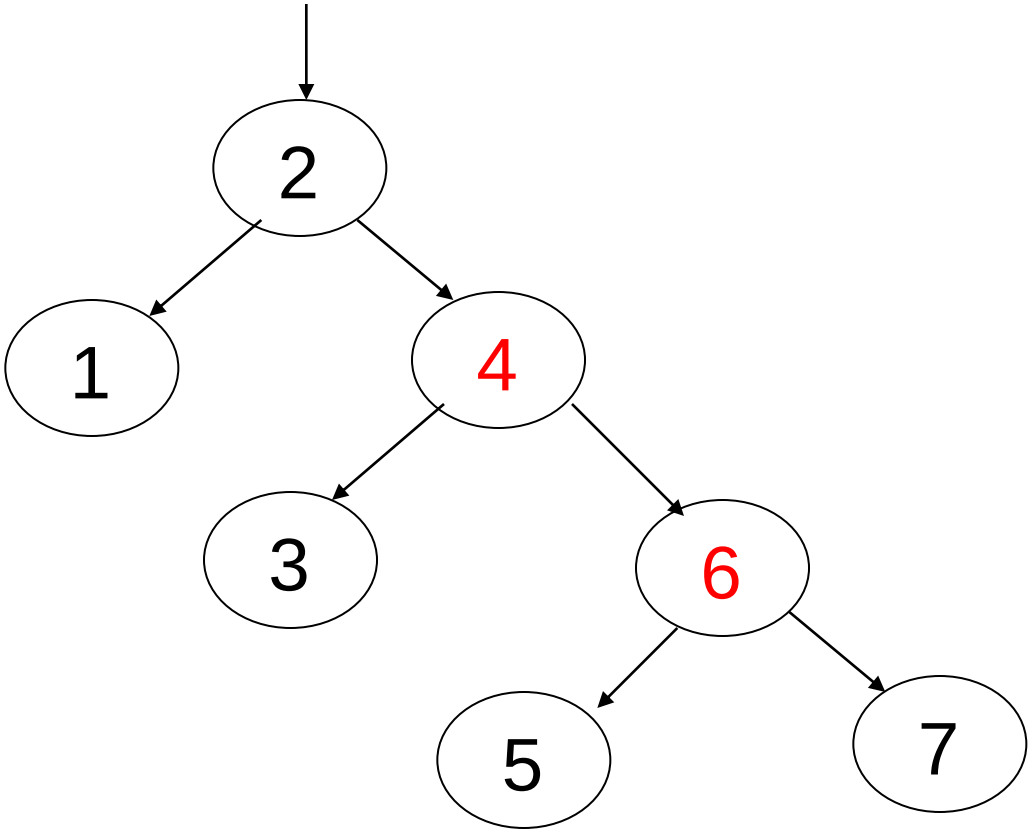
Insert 8

On way down see 6 with 2 red children. Make 6 red and children black. This creates a problem because 6's parent, 4, is also red. Must perform rotation.



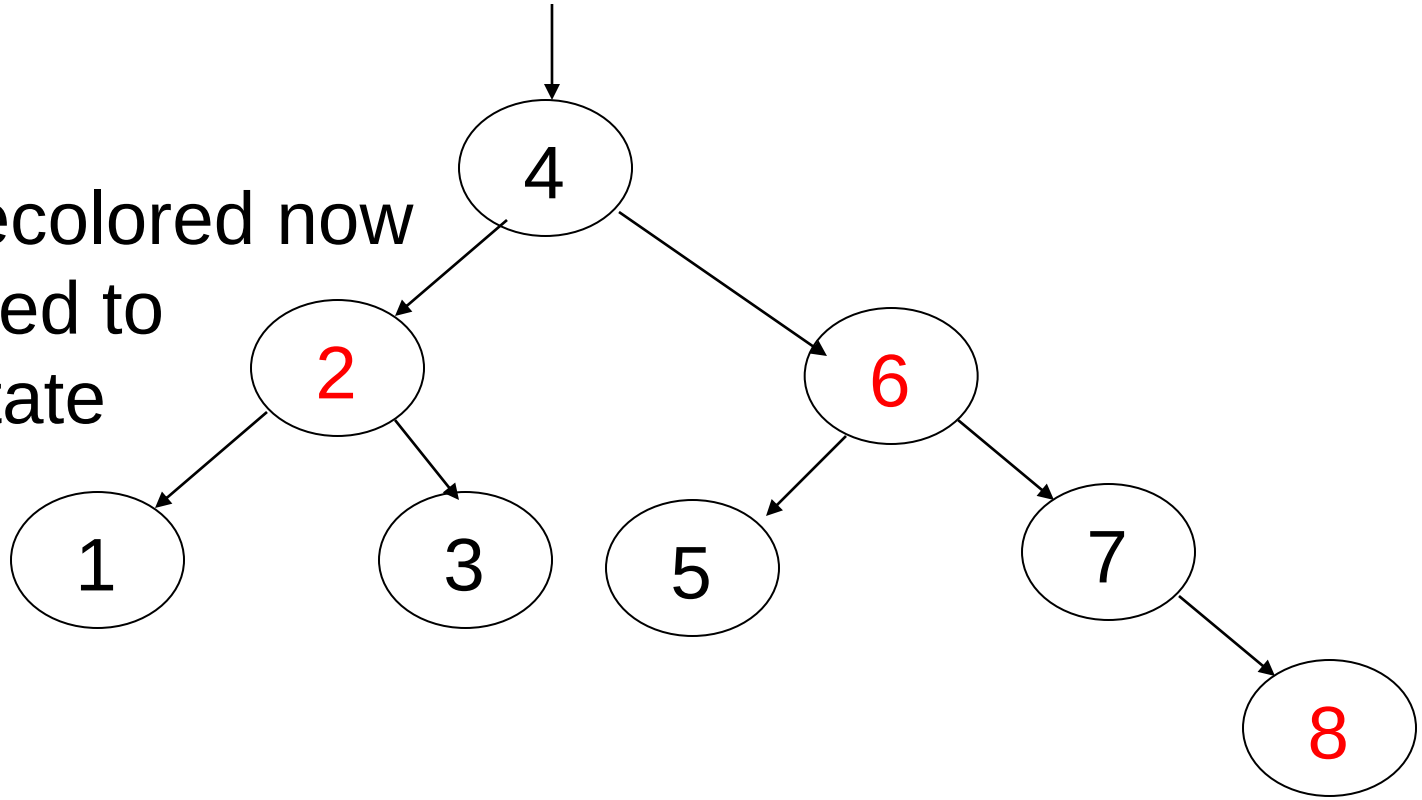
Still Inserting 8

Recolored now need to rotate

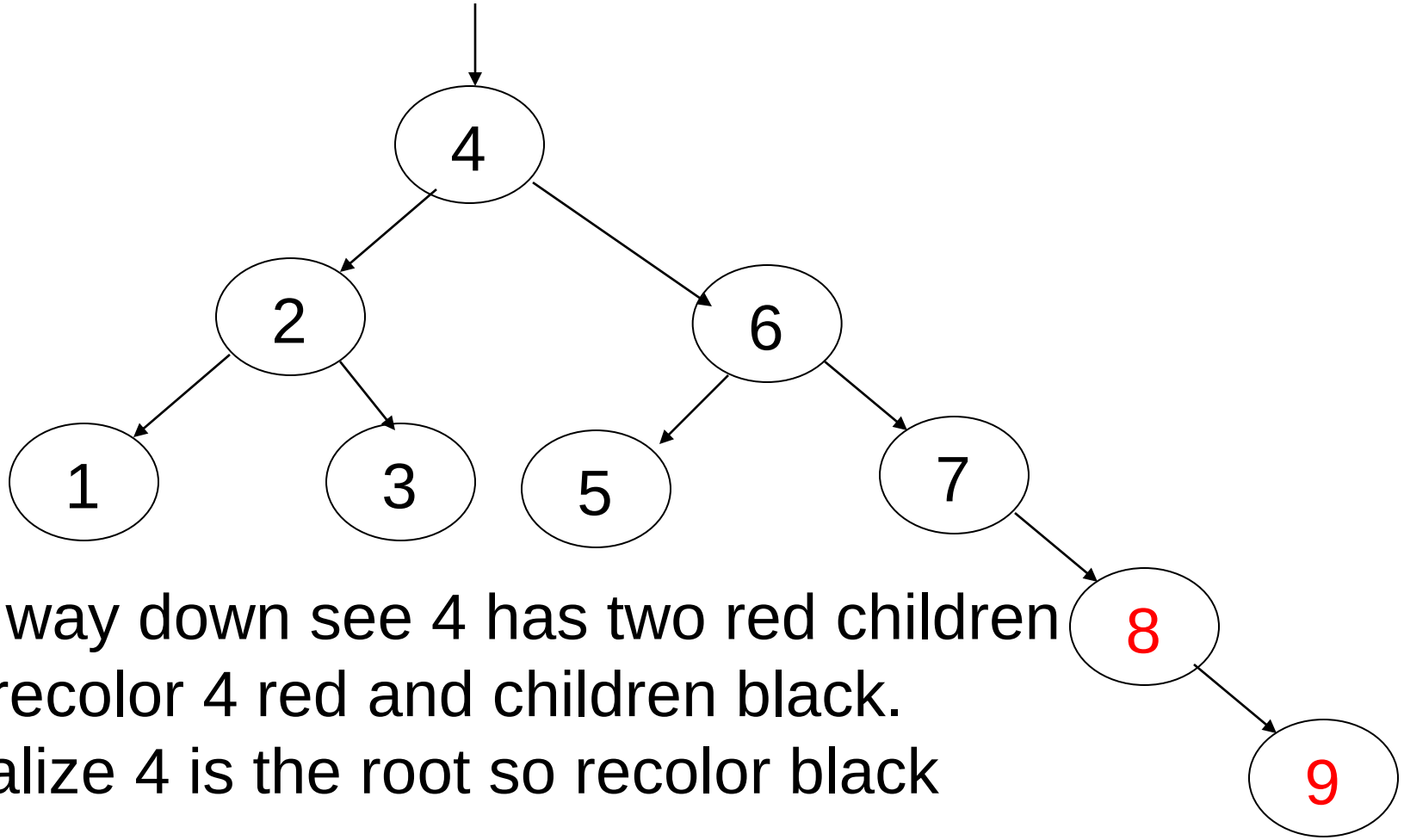


Finish inserting 8

Recolored now need to rotate

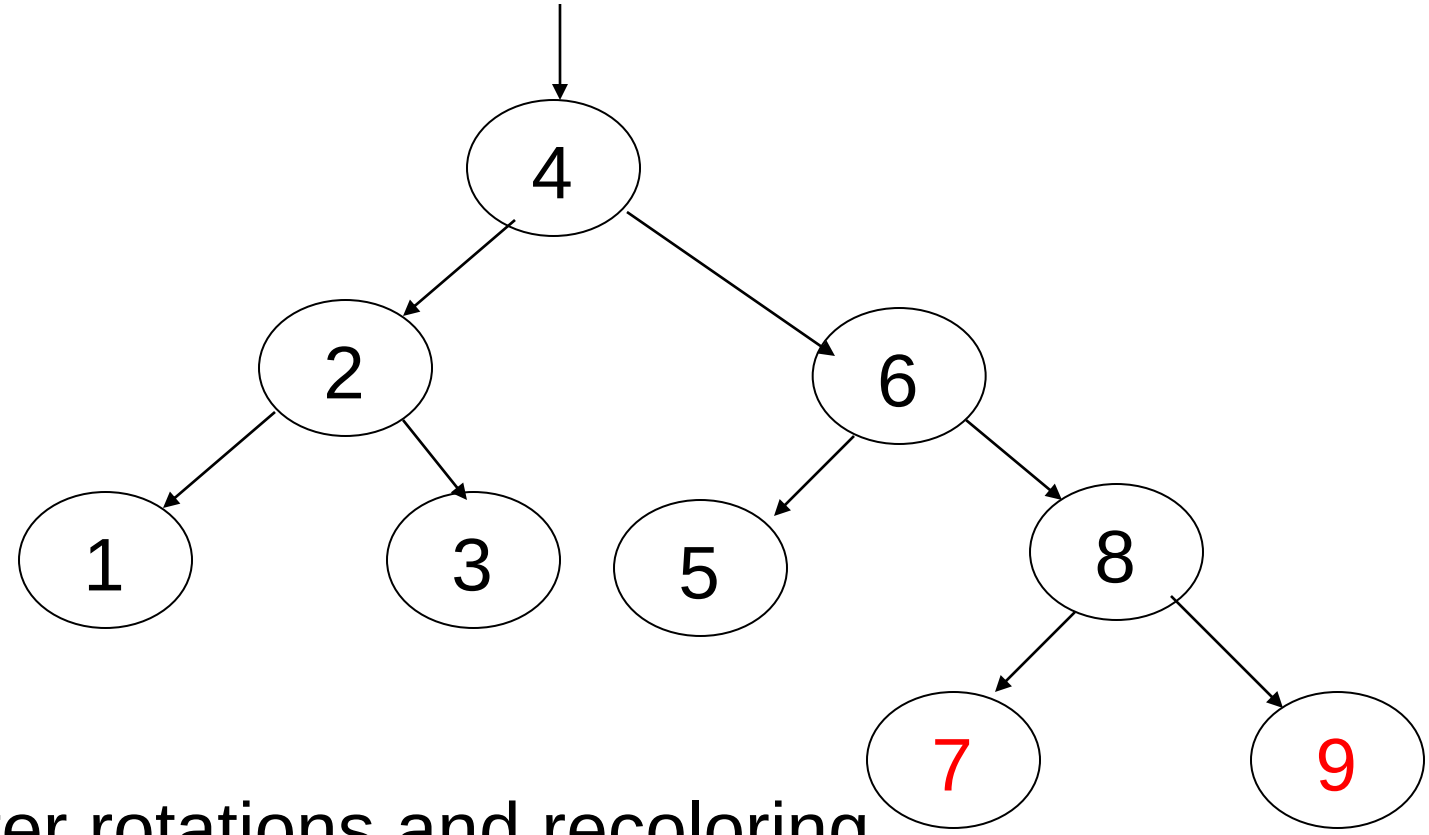


Insert 9



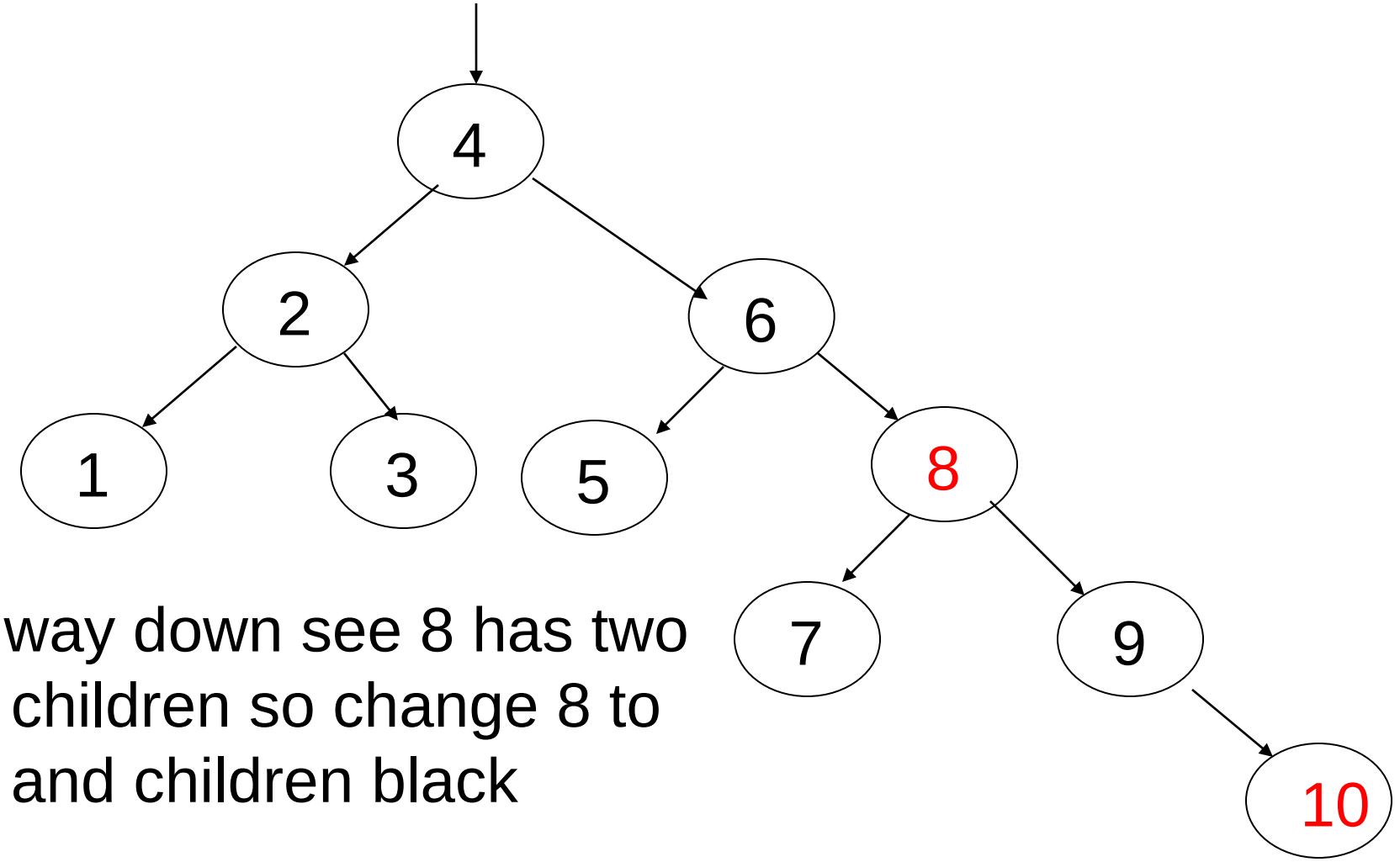
On way down see 4 has two red children so recolor 4 red and children black.
Realize 4 is the root so recolor black

Finish Inserting 9



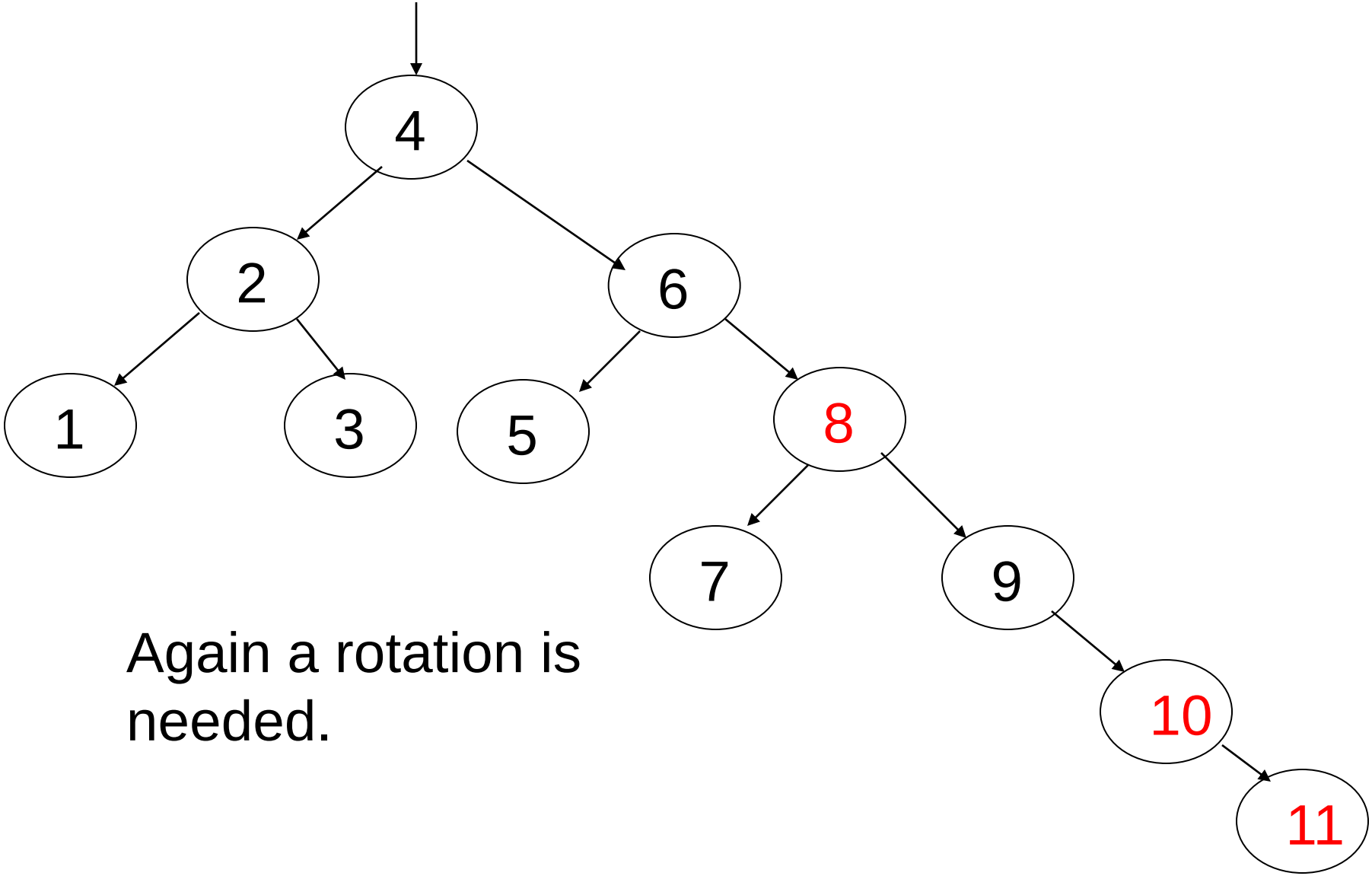
After rotations and recoloring

Insert 10



On way down see 8 has two red children so change 8 to red and children black

Insert 11



Again a rotation is needed.

Finish inserting 11