Depth First Search(DFS) on Trees

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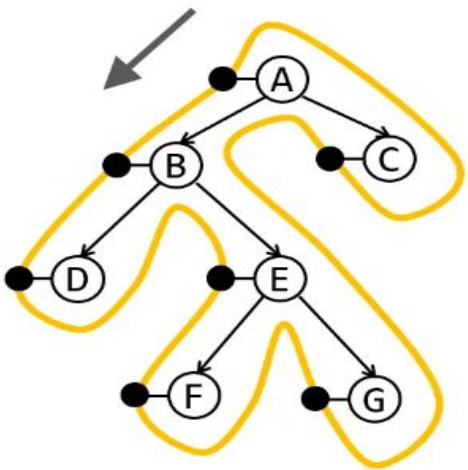
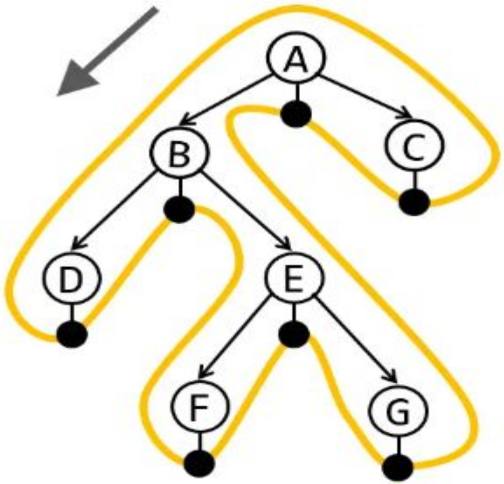
Tree Traversals

Node, Node.left, Node.right



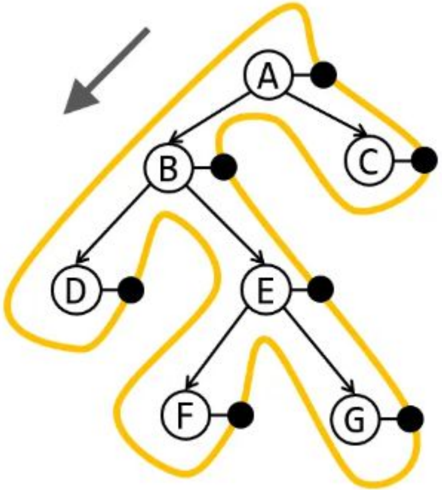
Pre-order traversal **[A, B, D, E, F, G, C]**

Node.left, Node, Node.right

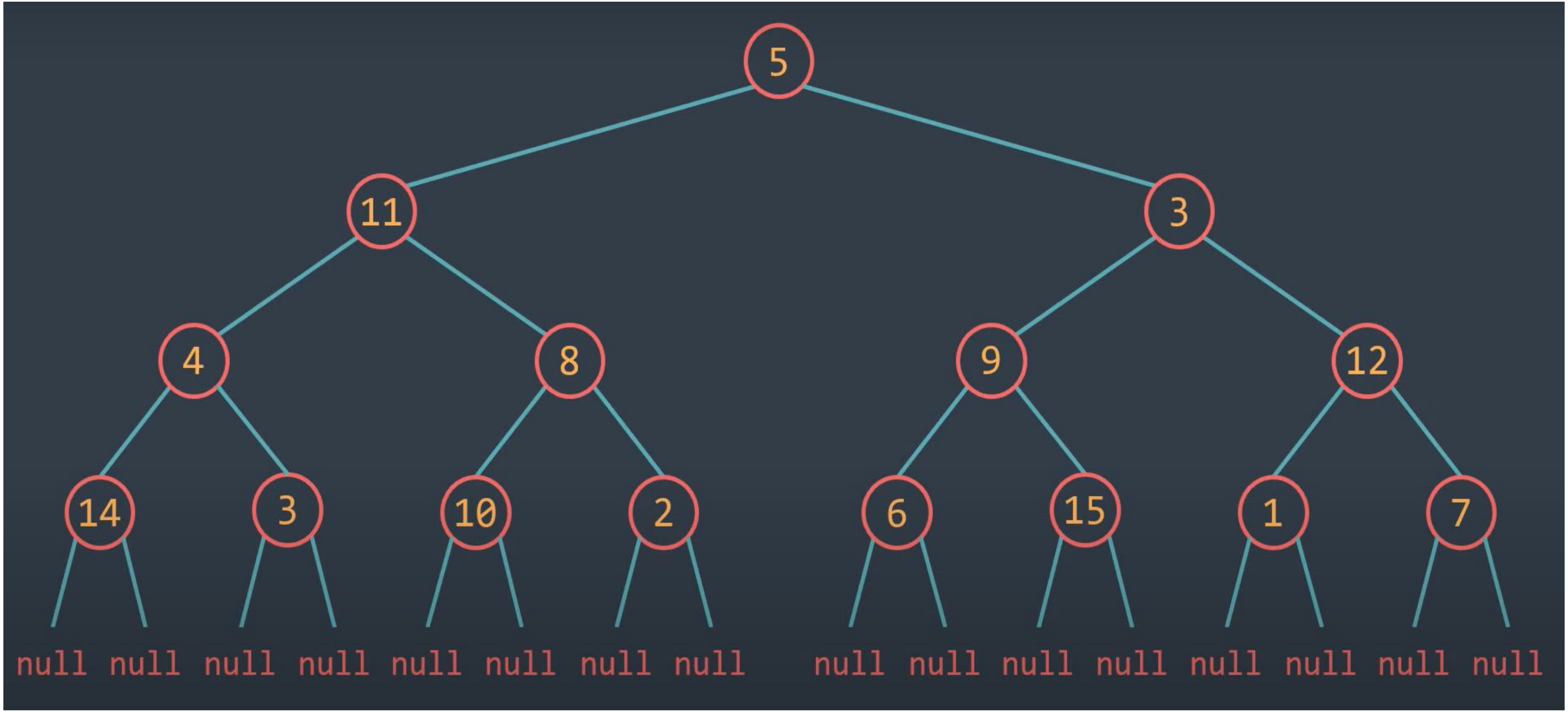


In-Order Traversal **[D, B, F, E, G, A, C]**

Node.left, Node.right, Node



Post-Order Traversal **[D, F, G, E, B, C, A]**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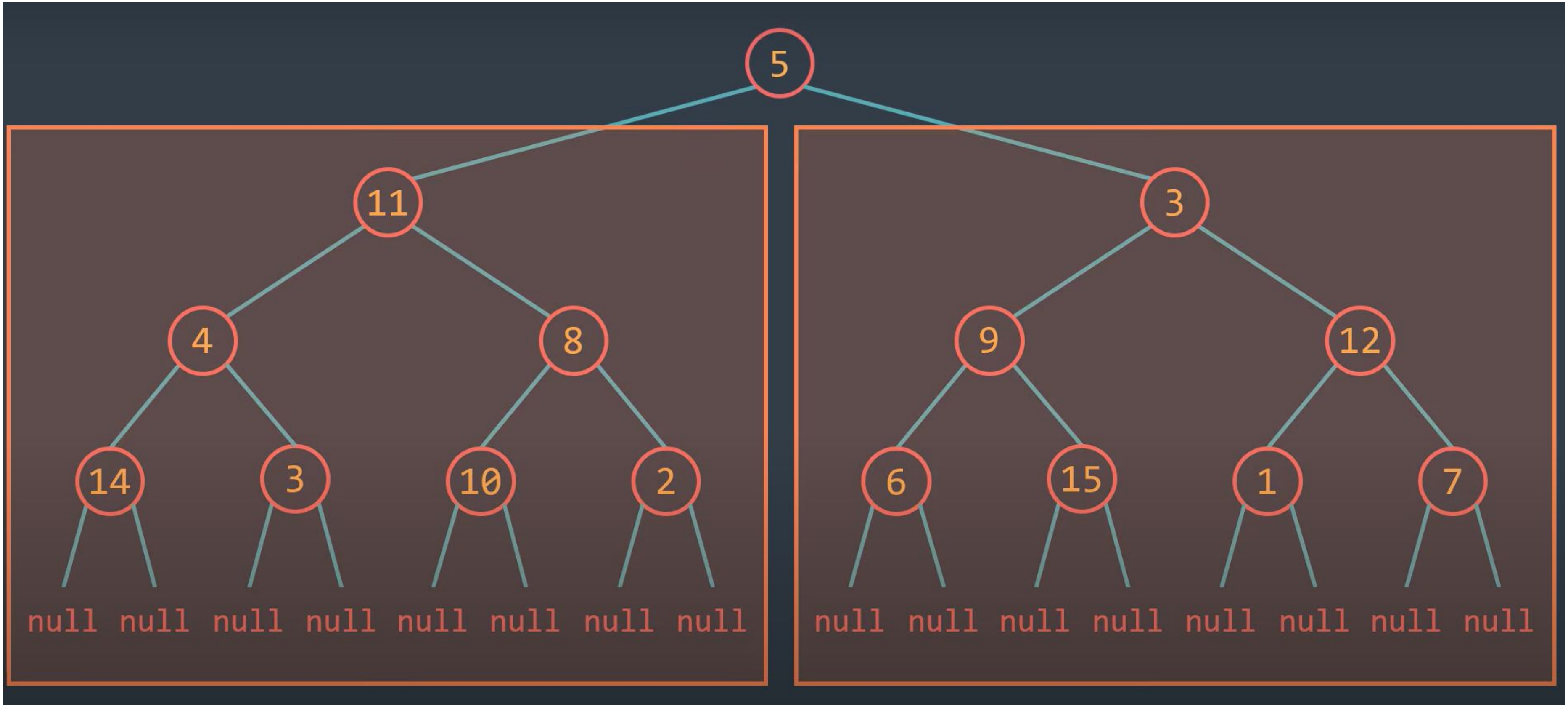
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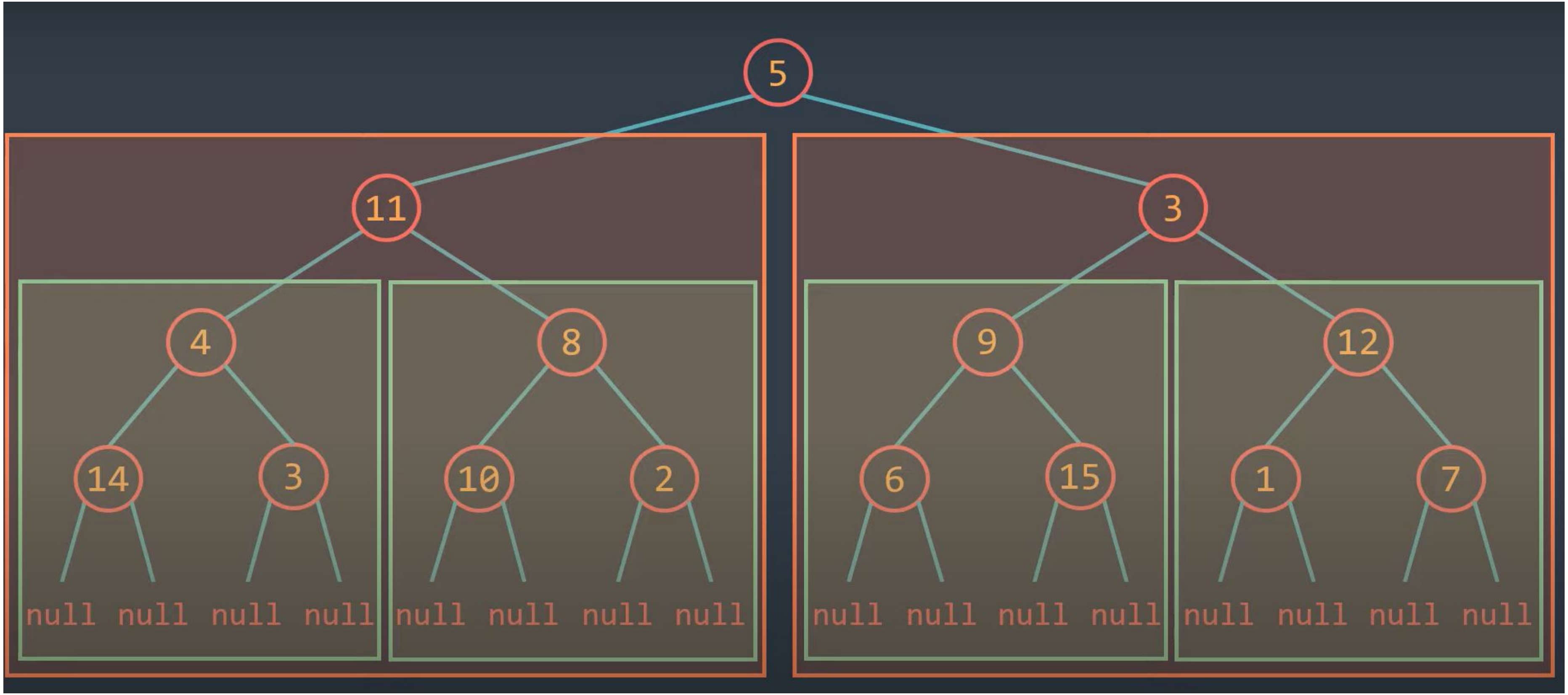
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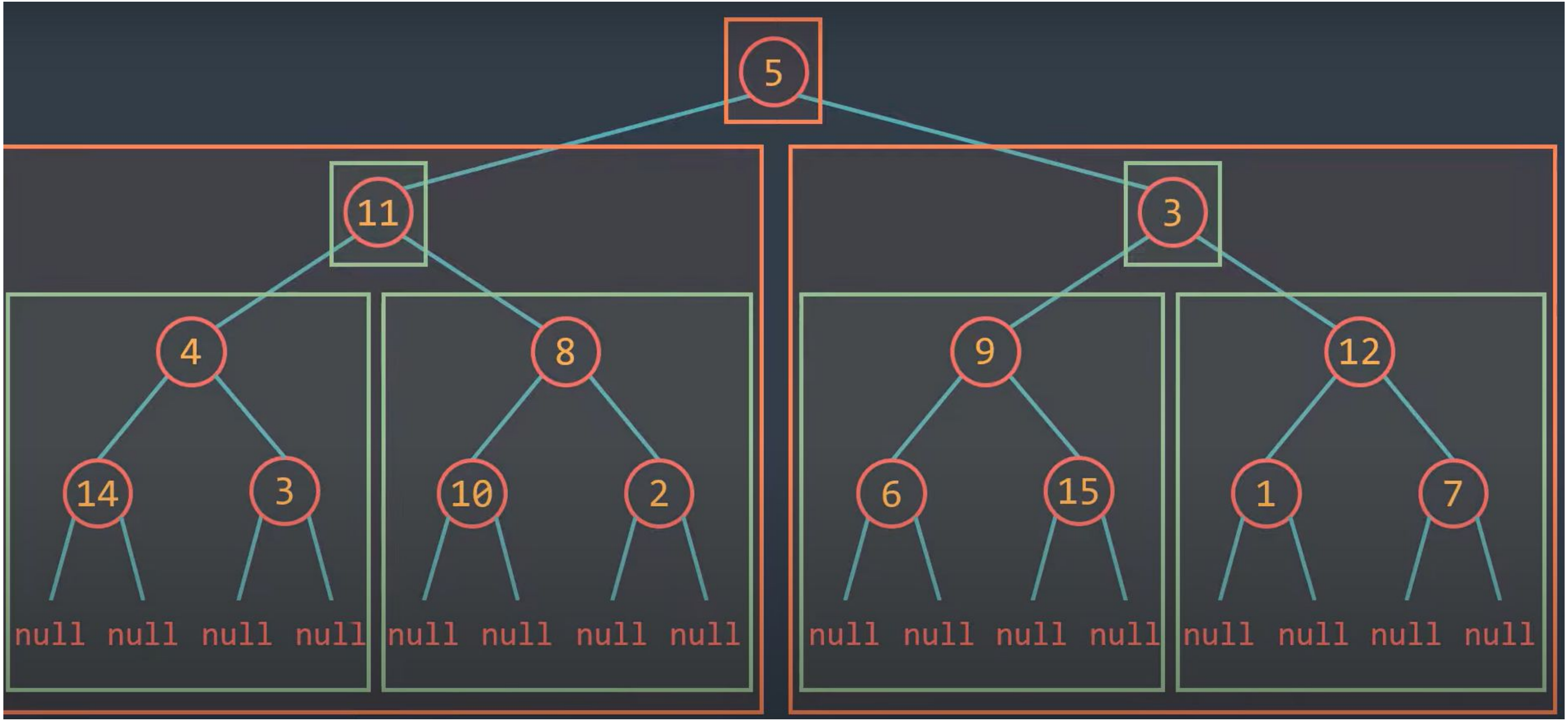
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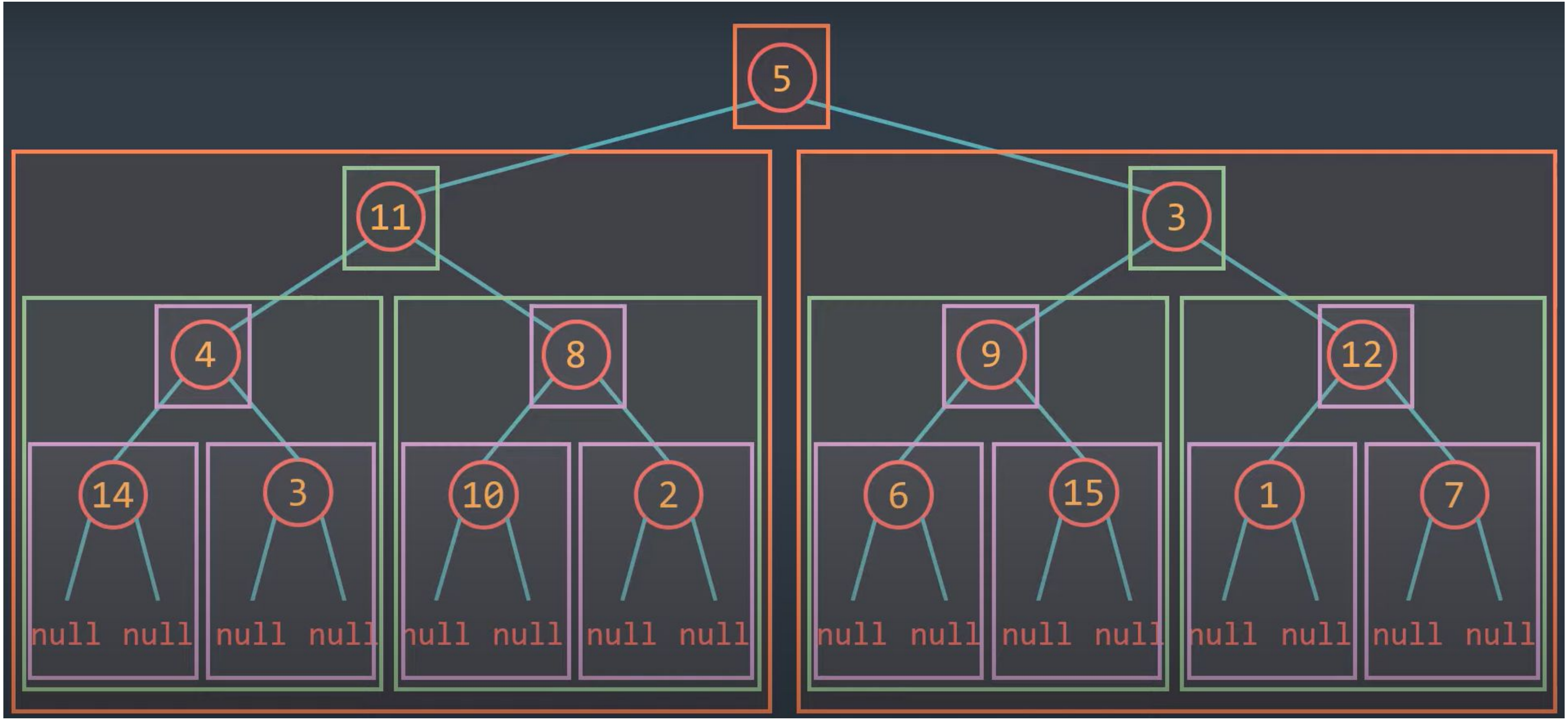
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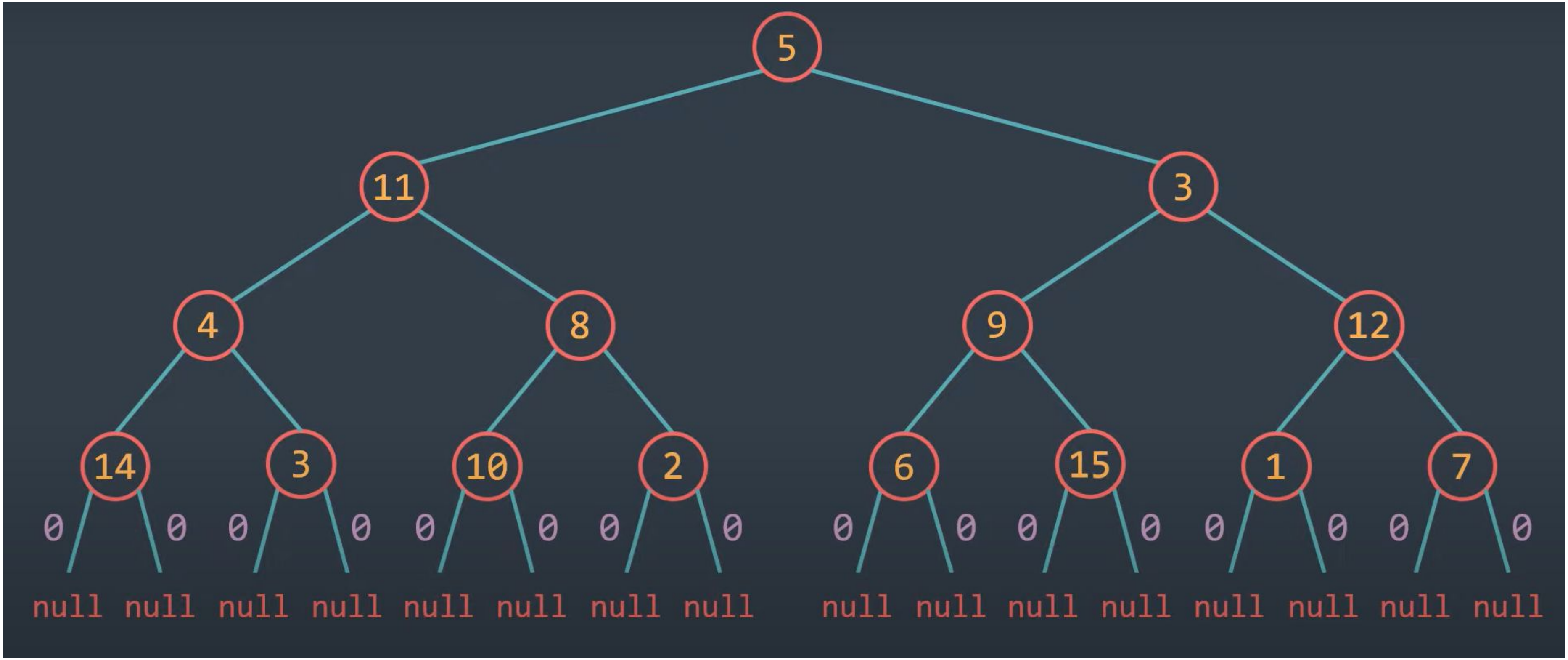
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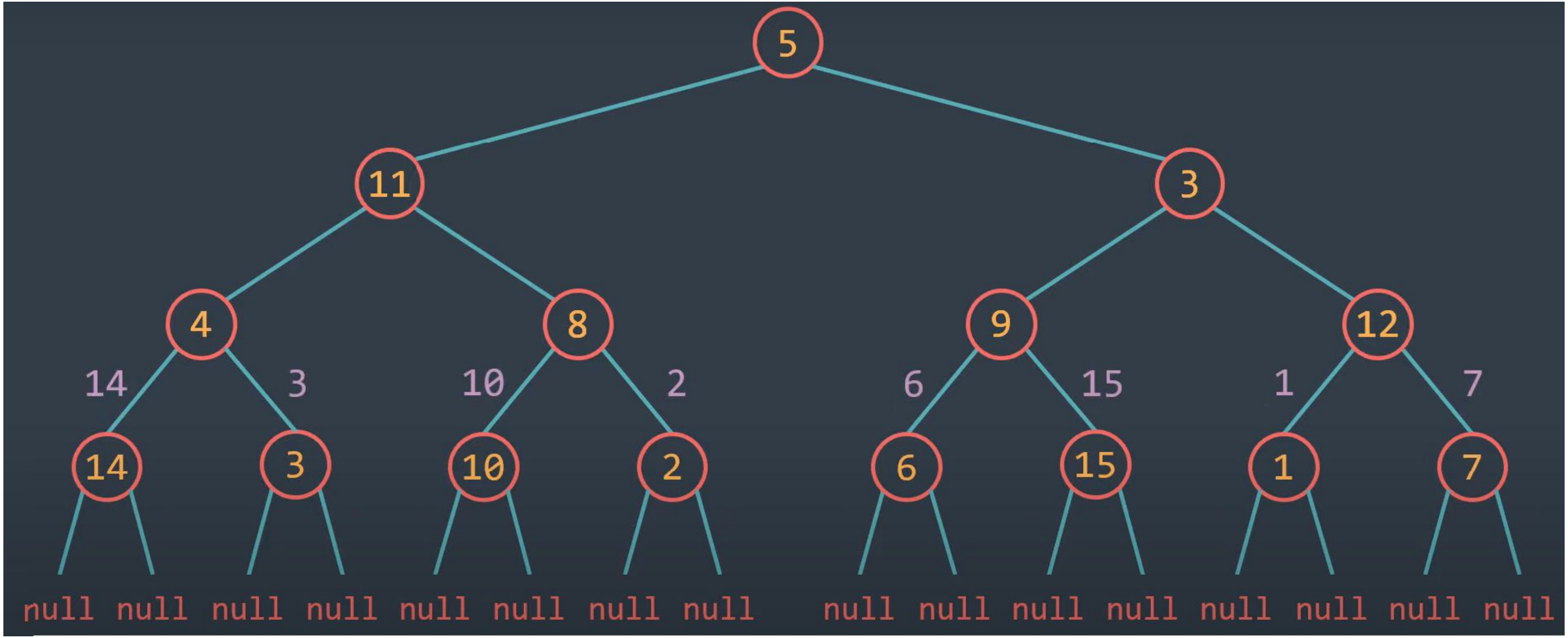
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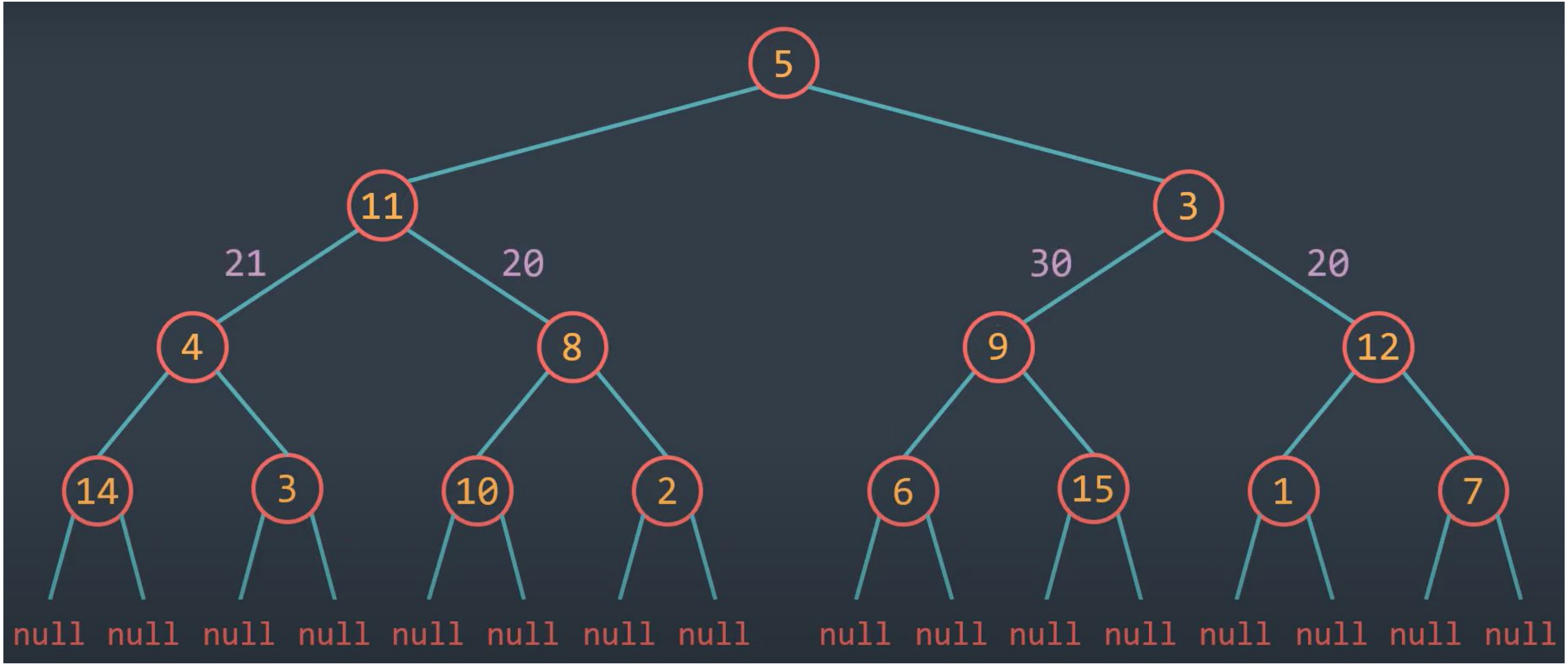
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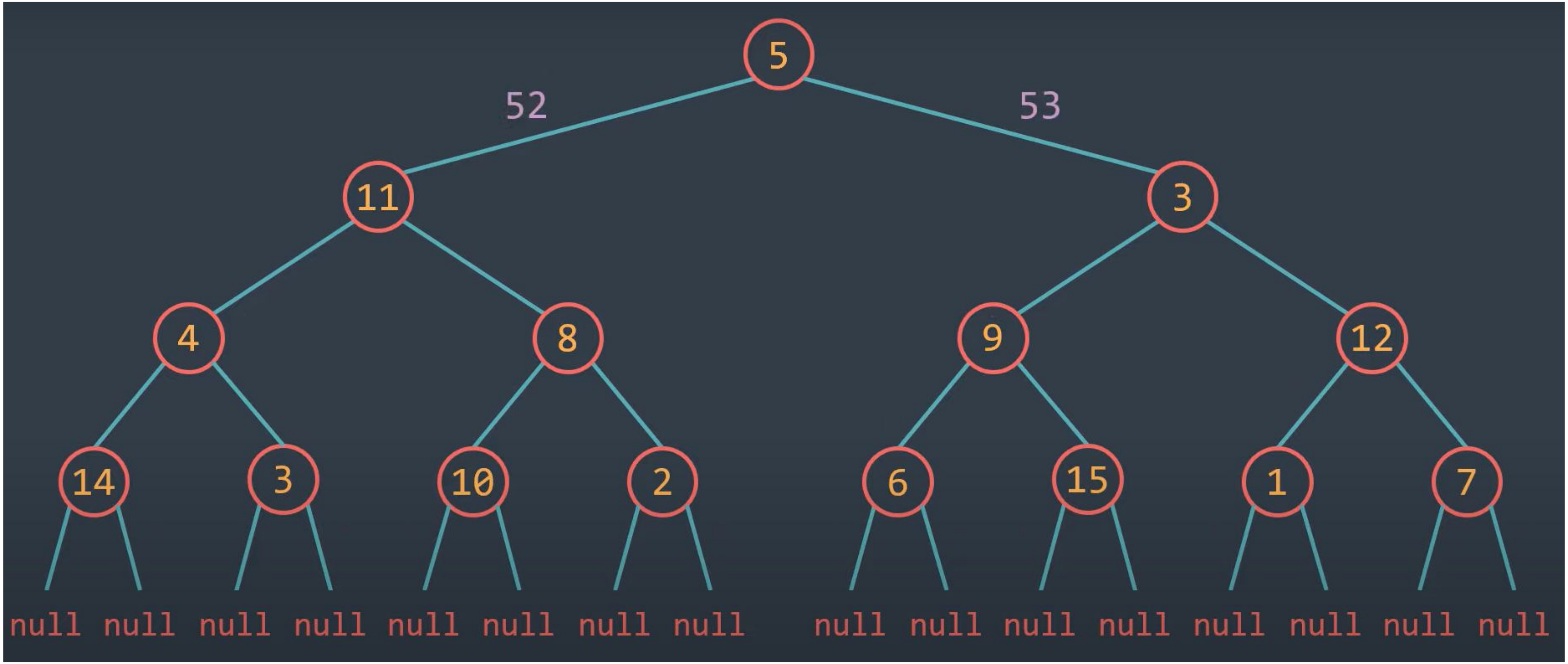
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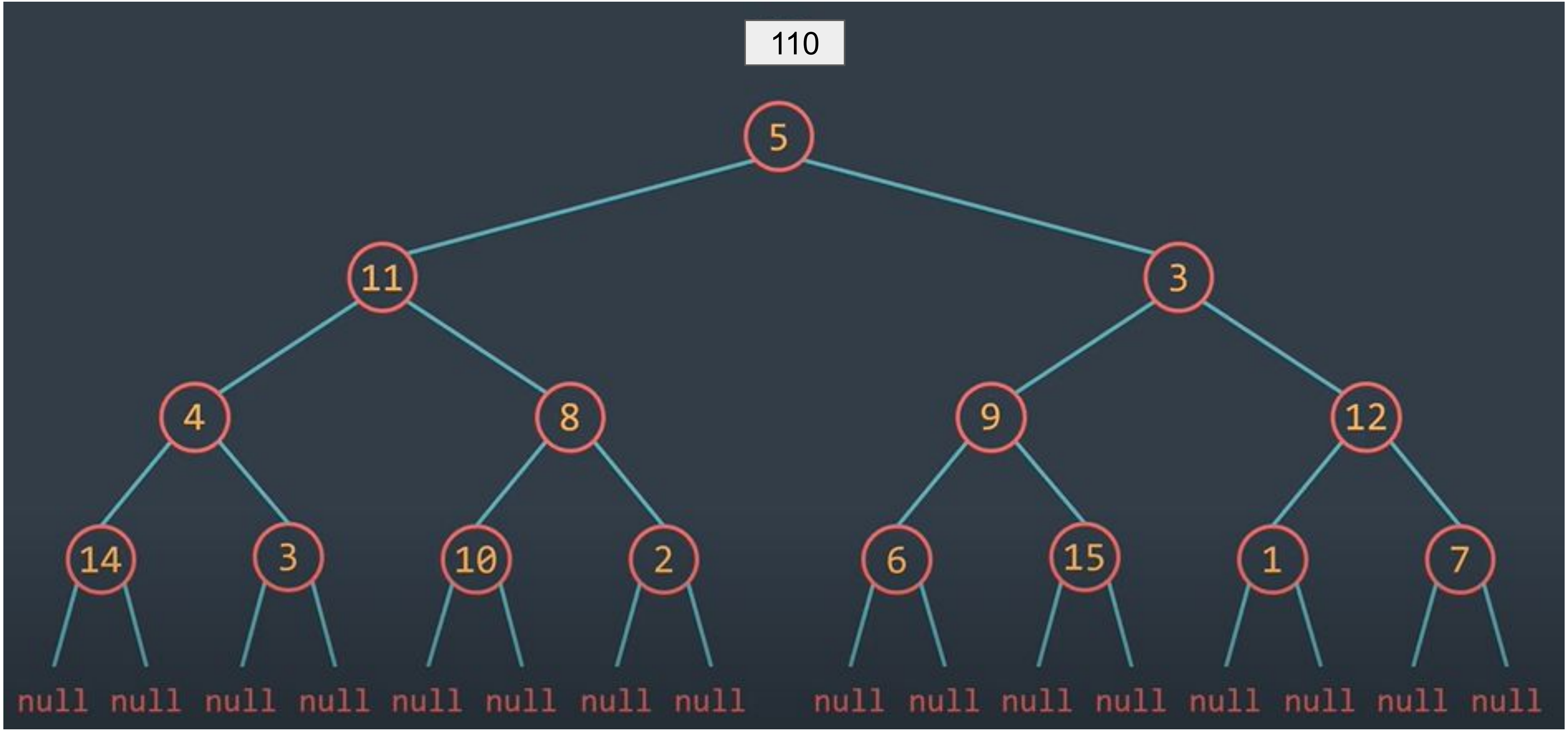
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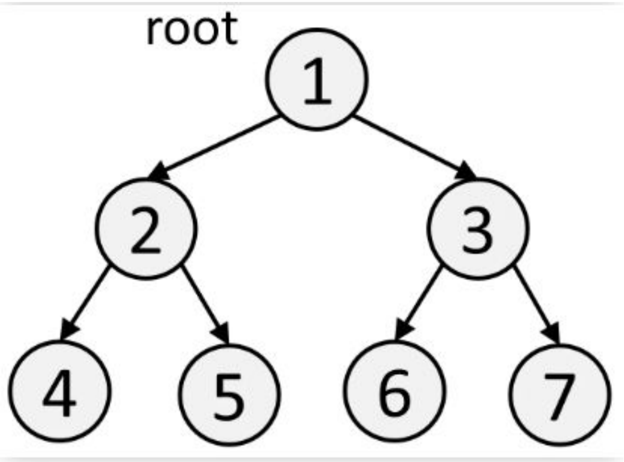
Steps in solving most DFS based Tree problems.

1. Figure out the Base conditions.
2. Call the recursive function on left sub-tree.
3. Call the recursive function on right sub-tree.
4. Combine to get the required results.

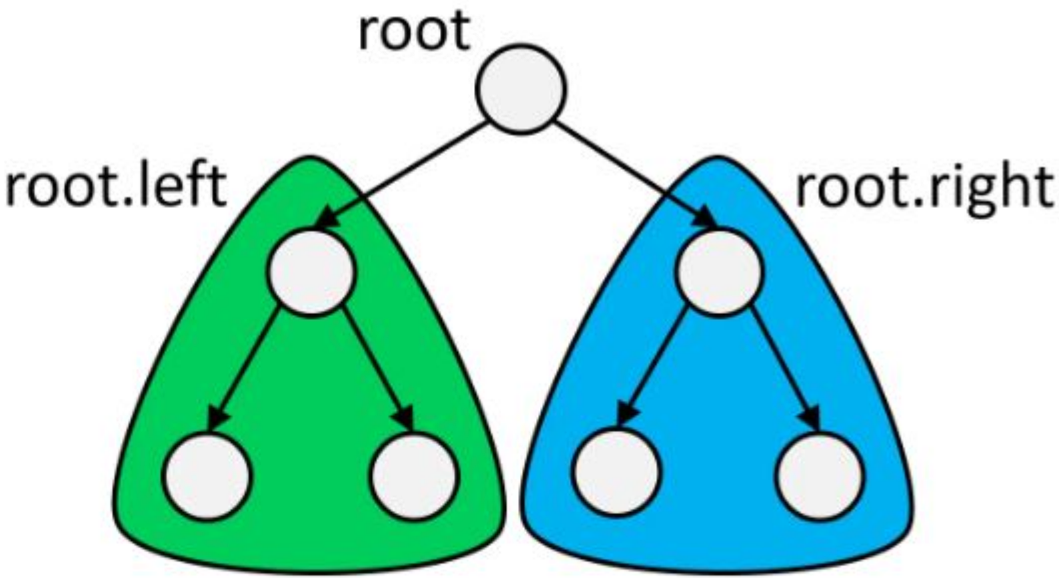
```
def sum_tree(root):

        # Base condition
        If root is None:
                return 0
        # Recursive condition
        return root.val + sum_tree(root.left) +
sum_tree(root.right)
```

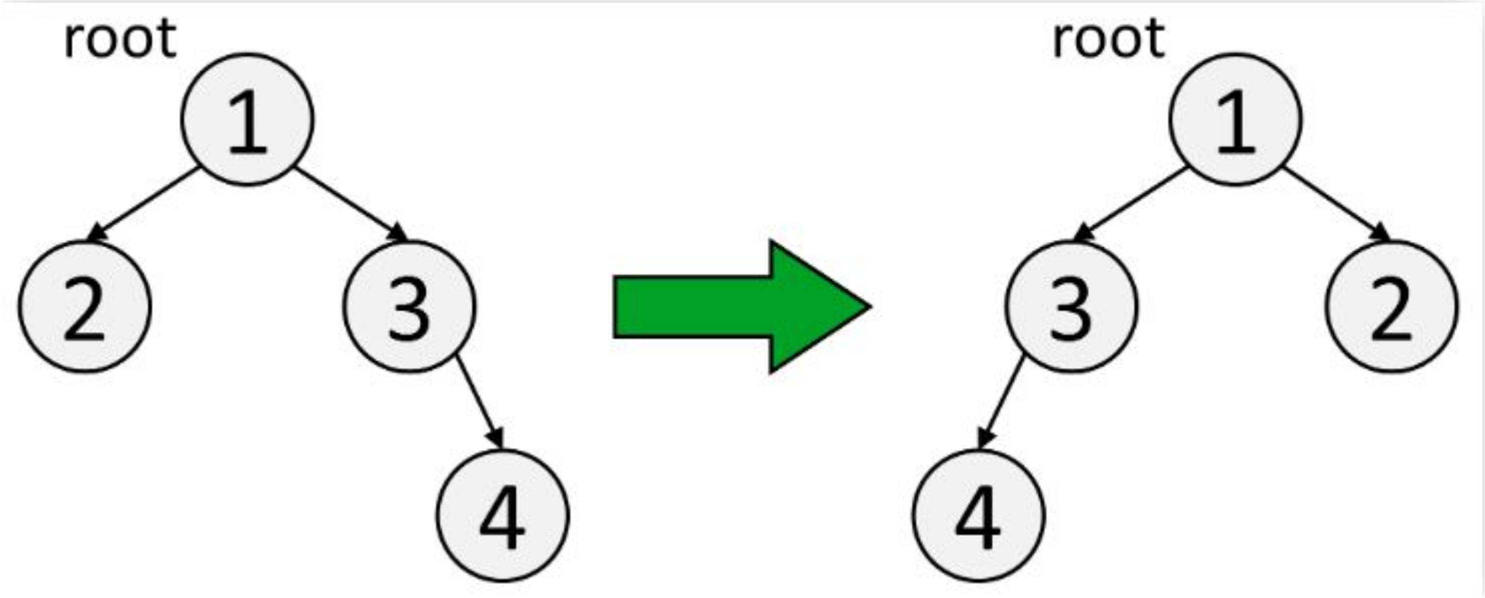
Question 1: Sum of number of nodes

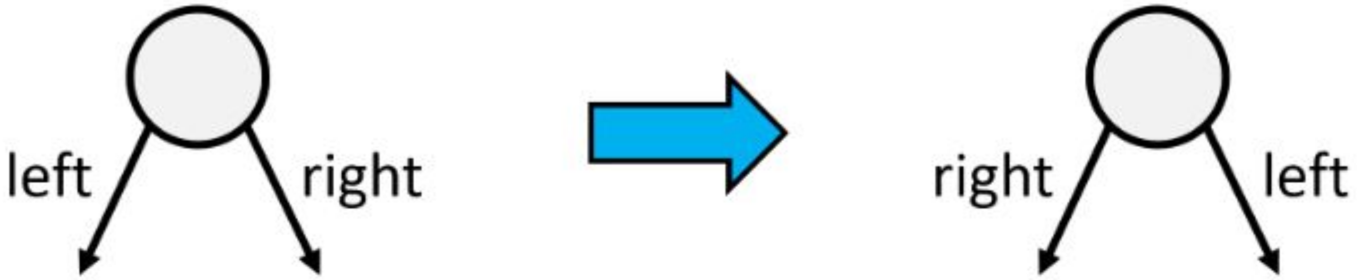


=> returns 7

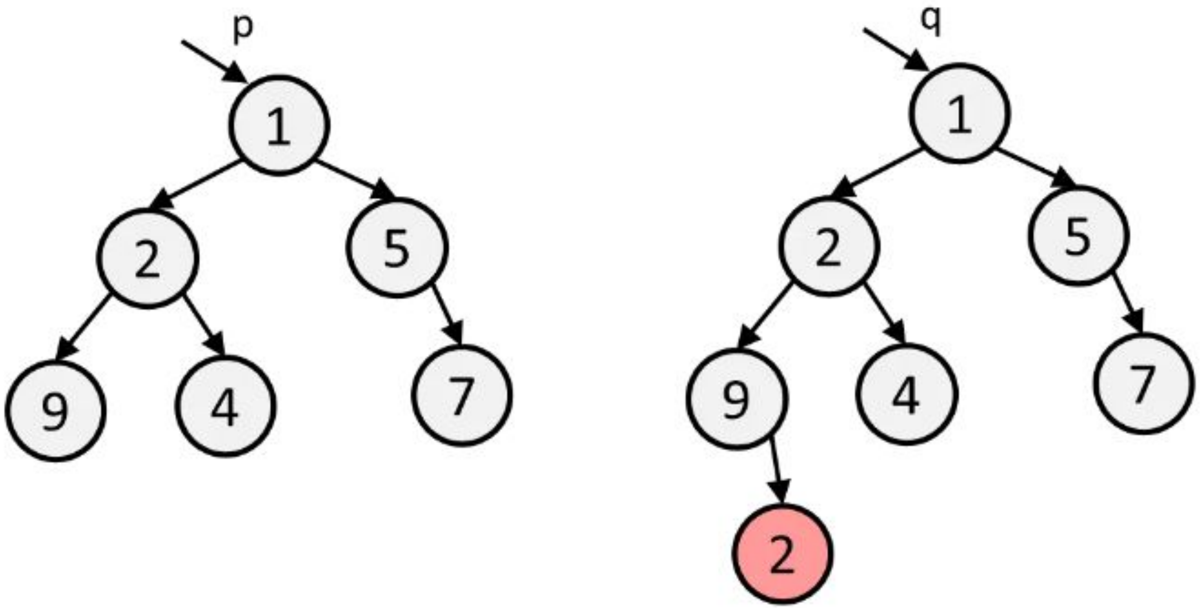

root
root.left
root.right

Question 2 : Mirror Tree




left
right
right
left

Question 3: Equal Trees?

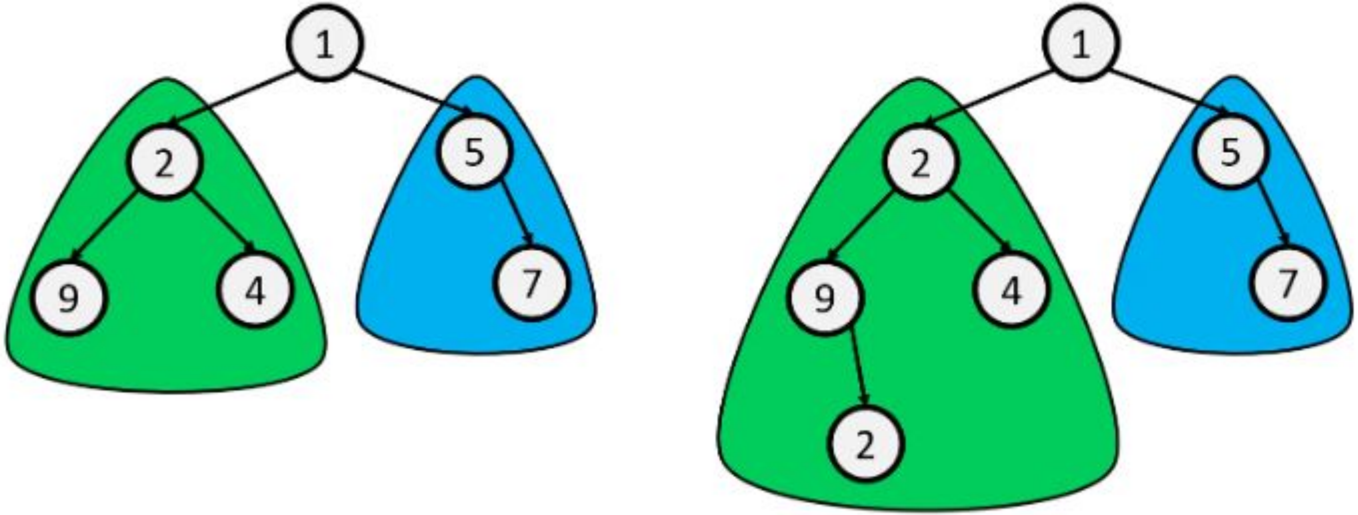


`=> returns false`

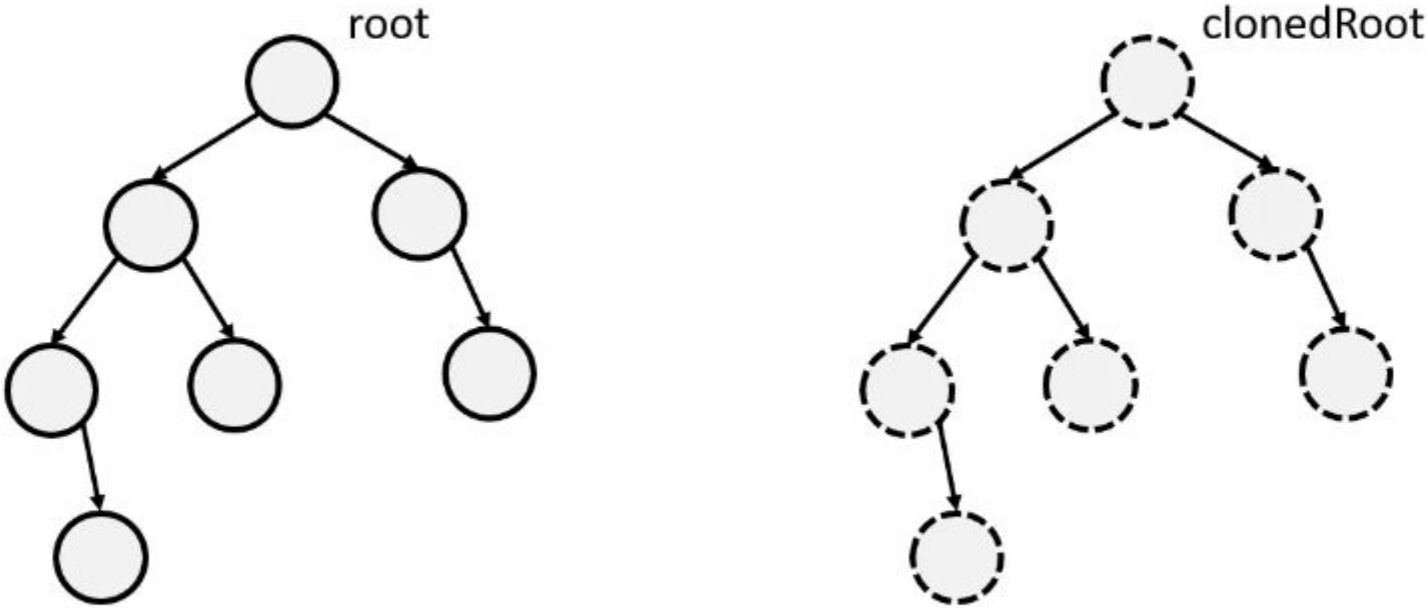
Values are equal?

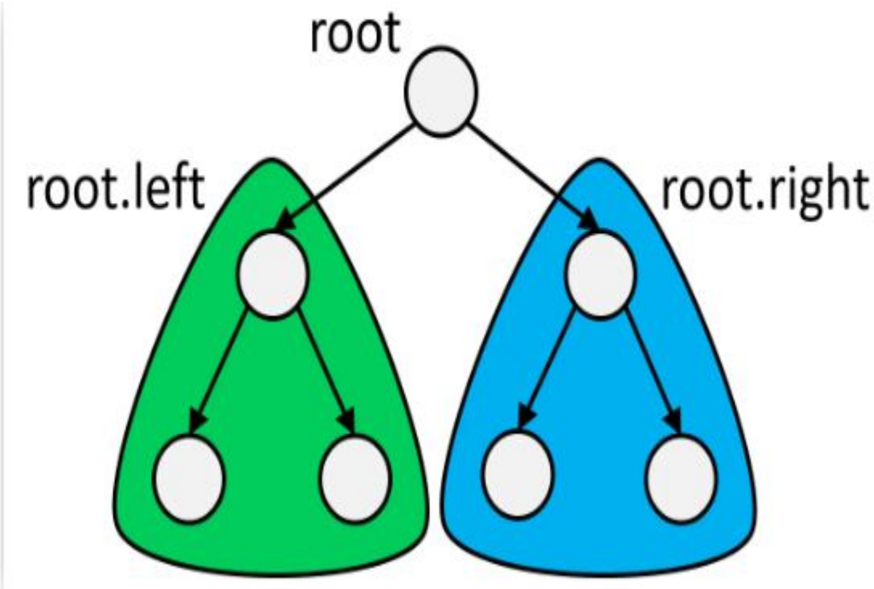
Left subtrees are the same?

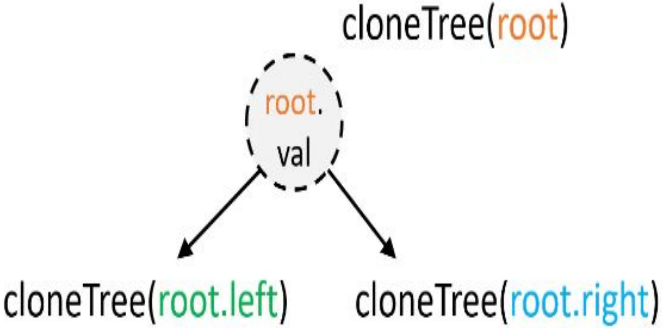
Right subtrees are the same?



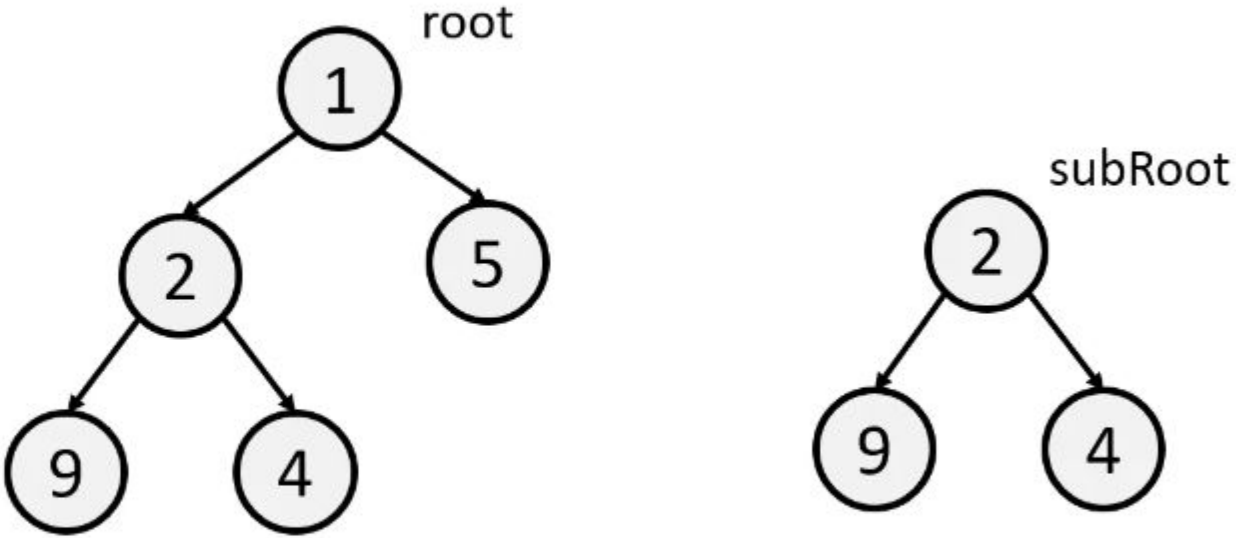
Question 4: Clone tree




root
root.left
root.right

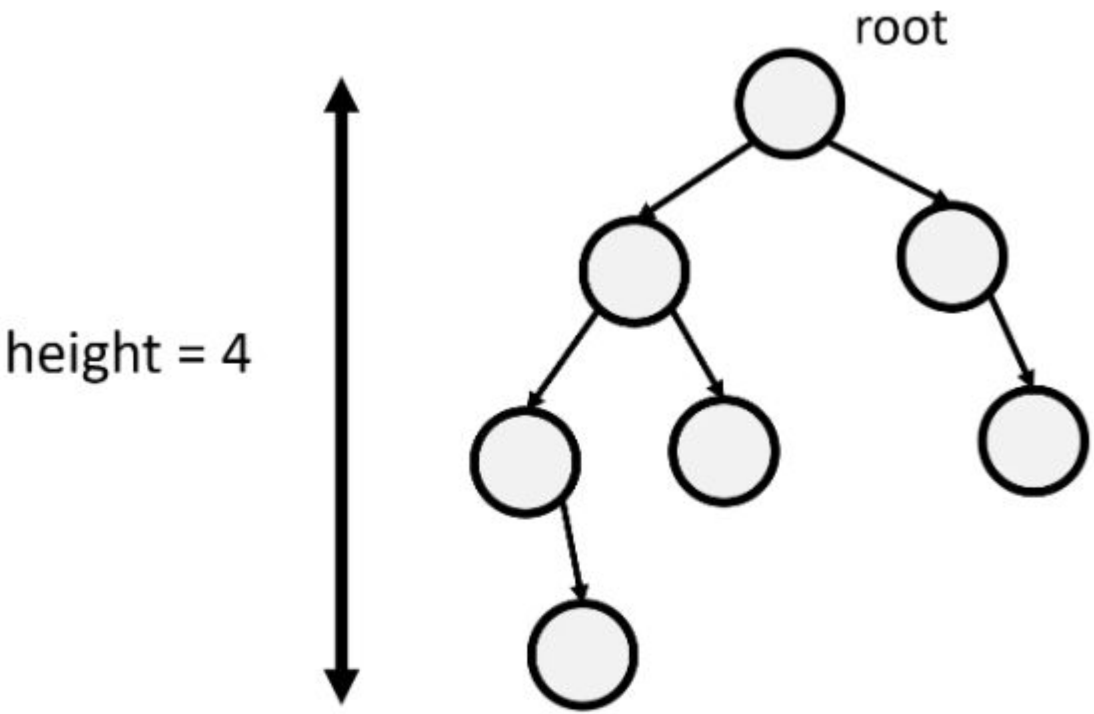

cloneTree(root)
root.
val
cloneTree(root.left)
cloneTree(root.right)

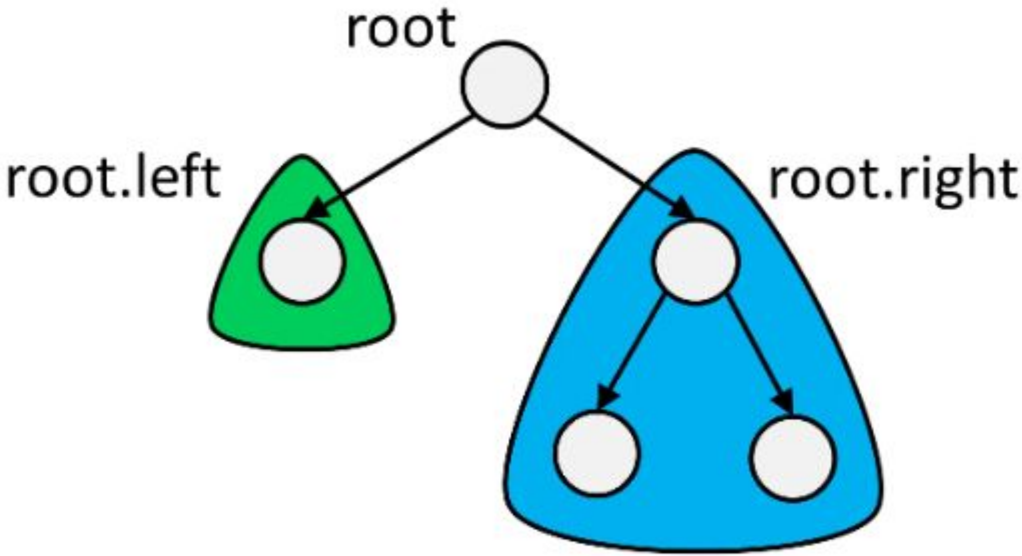
Question 5: Tree contains Sub-Tree



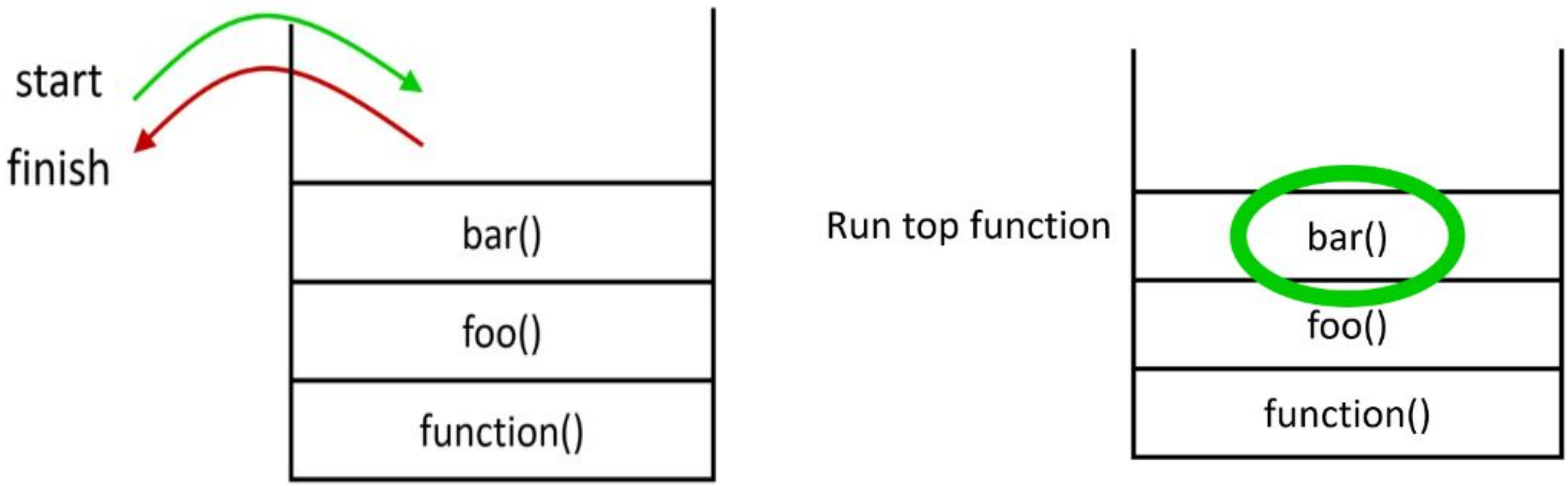
=> returns True

Question 6: Height of a tree

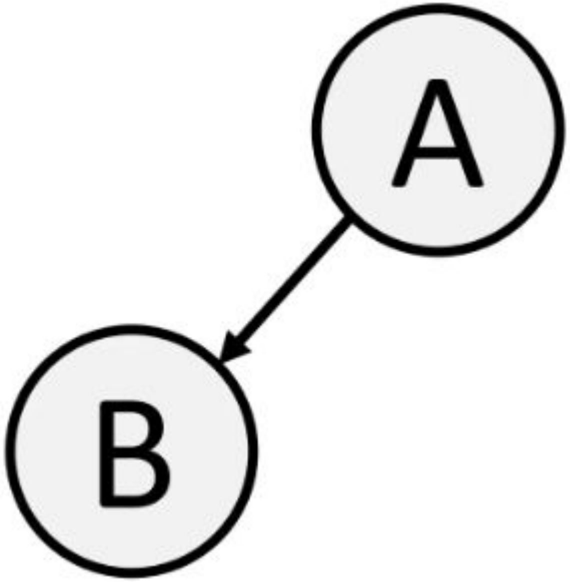



root
root.left
root.right

Call Stack: Stack of function calls.

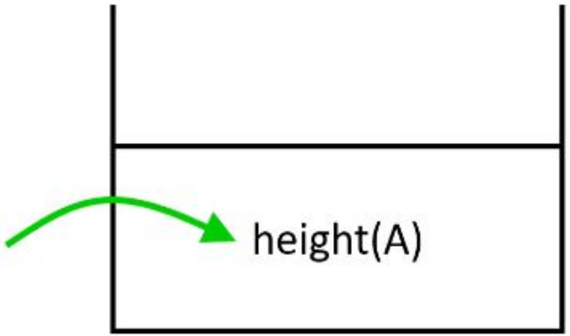


Calculate the height of the tree




```python
def height(node):
    if node == None:
        return 0
    heightL = height(node.left)
    heightR = height(node.right)
    return max(heightL, heightR) + 1
```

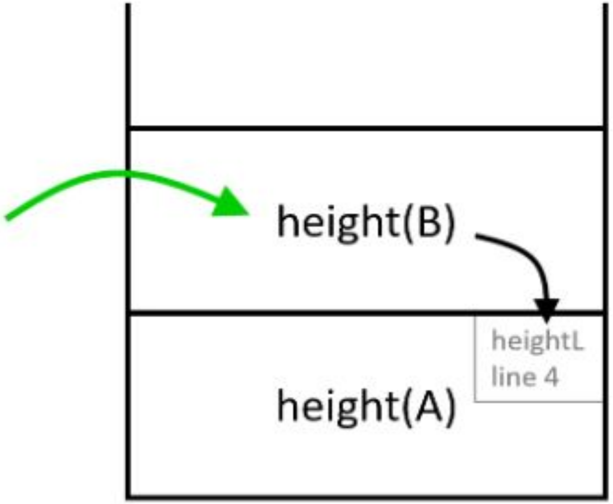
The very first thing that happens when we call `height(A)` is that the computer adds it to the Call Stack.



The computer then sees that `height(A)` is at the top of the Call Stack, so it starts computing `height(A)`. Eventually, the computer gets to line 4, and has to make *another* function call `height(B)`.

```
                 A
def height(root):
    if root == None:
        return 0                   B
    heightL = height(root.left)
    heightR = height(root.right)
    return max(heightL, heightR) + 1
```

The computer adds `height(B)` it to the Call Stack. It saves information on how to resume height(A) when height(B) finishes:



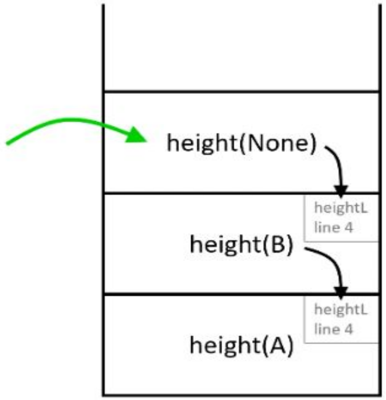
Now `height(B)` is on top of the Call Stack, so the computer starts running it. It eventually reaches another function call `height(None)`:

B

None

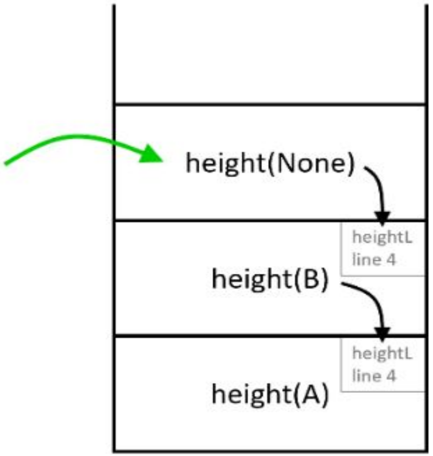
```
1  def height(root):
2      if root == None:
3          return 0
4      heightL = height(root.left)
5      heightR = height(root.right)
6      return max(heightL, heightR) + 1
```

So it and adds it to the Call Stack:



Now the function call `height(None)` is on top of the Call Stack, so the computer runs it. It gets to the base case, and returns `0`

Now `height(None)` finished, so the computer removes it from the Call Stack. It updates the variables inside of the `height(B)` function accordingly.

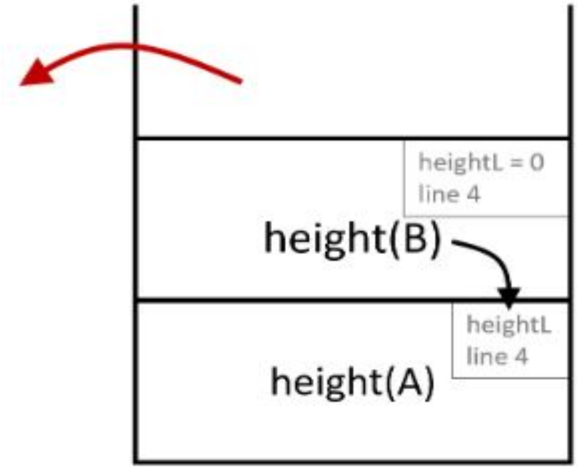


Now the function call `height(None)` is on top of the Call Stack, so the computer runs it. It gets to the base case, and returns `0`.

None

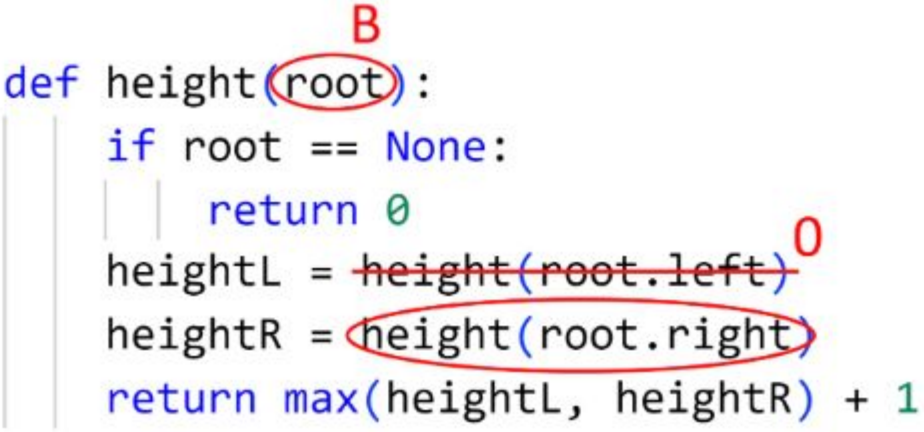
```
def height(root):
    if root == None:
        return 0
    heightL = height(root.left)
    heightR = height(root.right)
    return max(heightL, heightR) + 1
```

Now `height(None)` finished, so the computer removes it from the Call Stack. It updates the variables inside of the `height(B)` function accordingly.

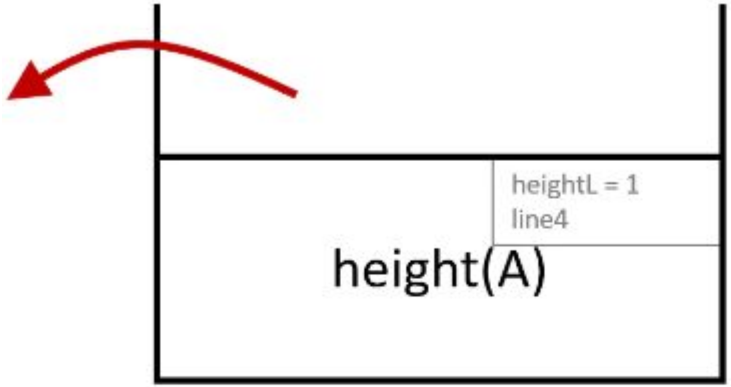


The Call Stack now has `height(B)` on top, so it resumes this function where it left off. Now it knows that `heightL = 0`.

So the computer resumes at line 5:



The computer finds that `heightR = 0`. The computer then returns `max(0, 0) + 1`, which is `1`. Since the computer finished `height(B)`, it removes it from the Call Stack. It updates the variables in `height(A)` accordingly.



It now resumes `height(A)` on line 4, and knows that `heightL = 1`.

A

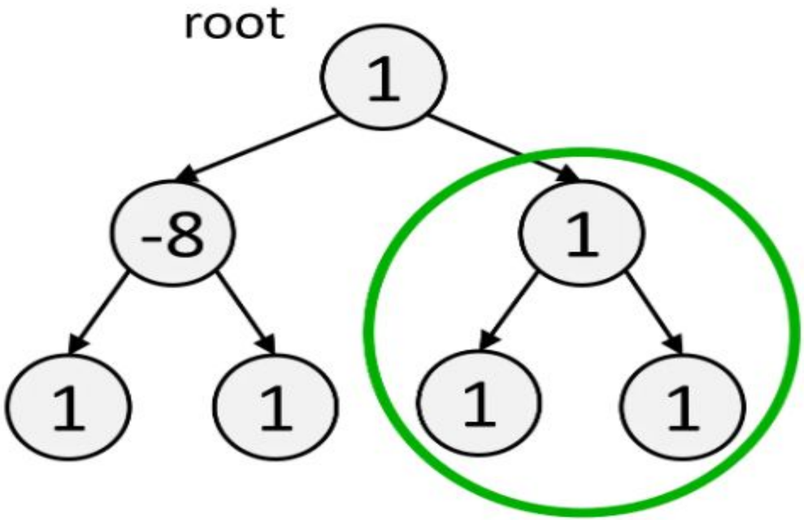
```
1   def height(root):
2       if root == None:
3           return 0                       1
4       heightL = height(root.left)
5       heightR = height(root.right)
6       return max(heightL, heightR) + 1
```

A

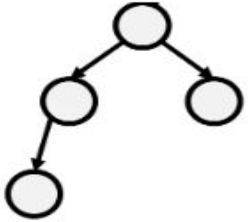
```
1   def height(root):
2       if root == None:
3           return 0                       1
4       heightL = height(root.left)
5       heightR = height(root.right)        0
6       return max(heightL, heightR) + 1       2
```

Recursion Hijacking

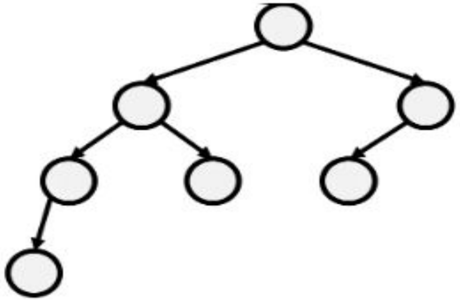
Max sub-tree sum:



Height balanced tree

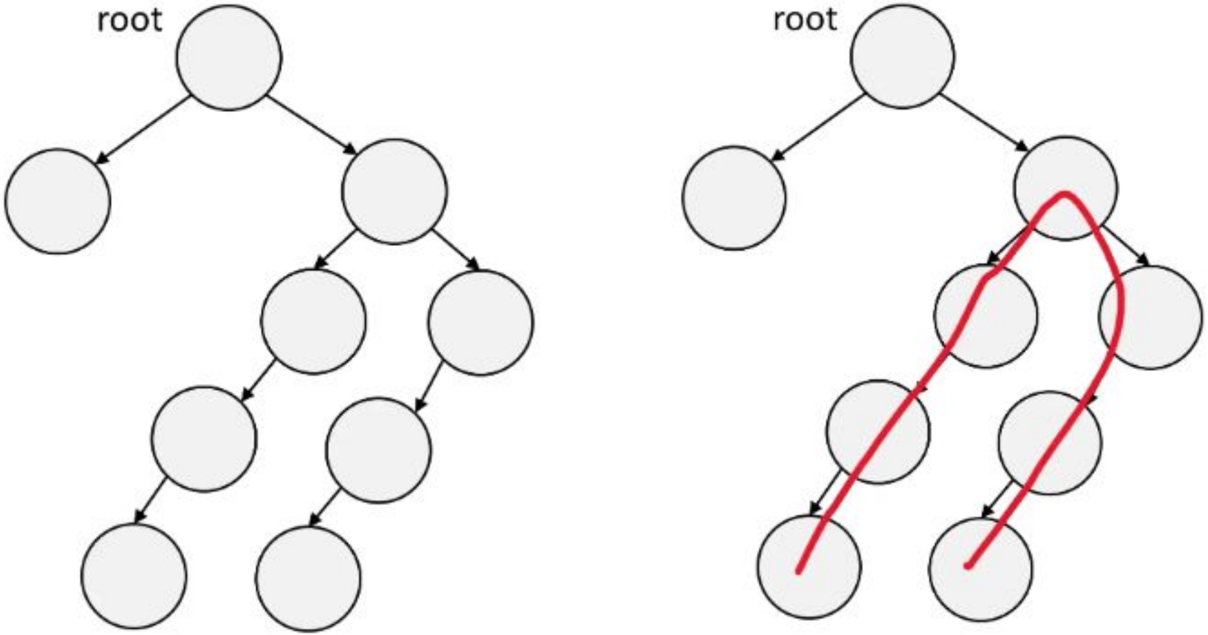


```
=> returns True
```



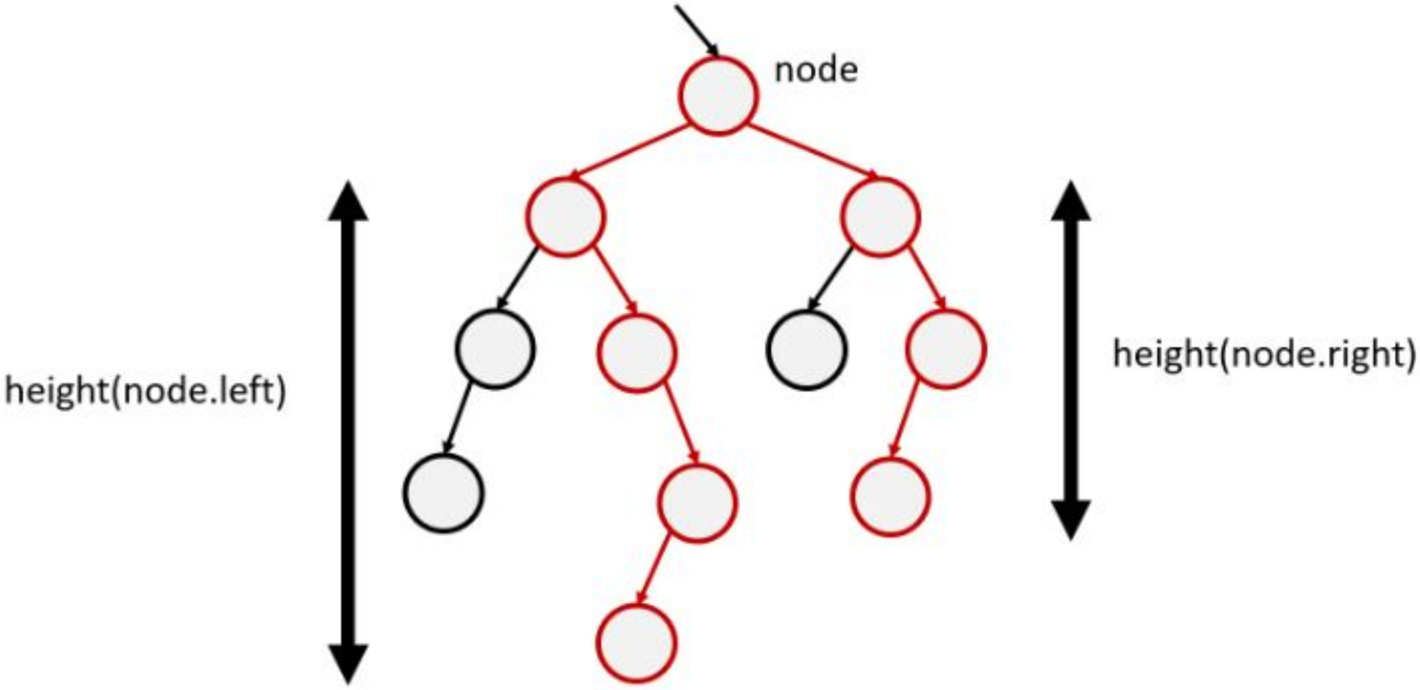
```
=> returns True
```

Diameter of a tree

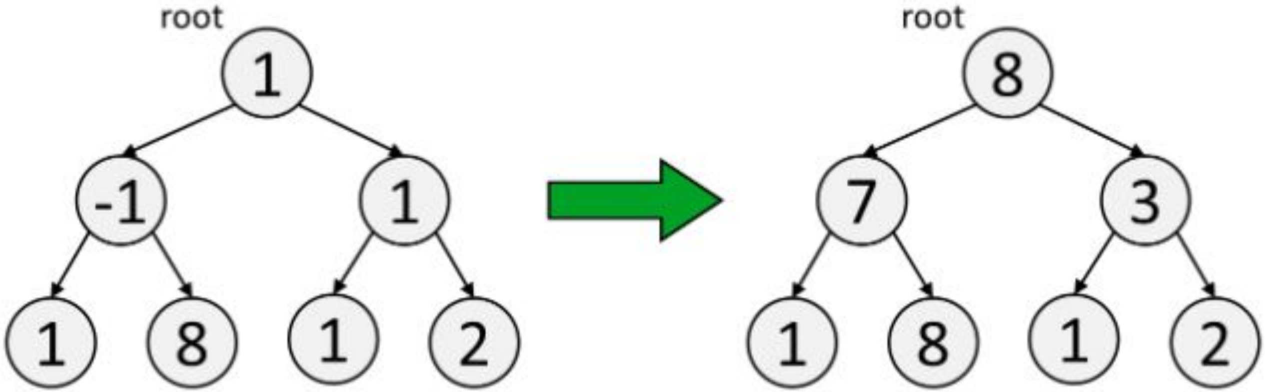


`=> returns 6 (red path)`

Diameter of a tree

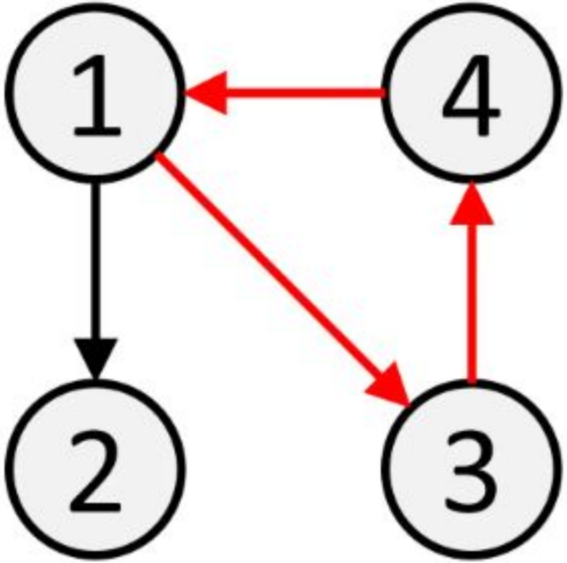


Max node to leaf sum



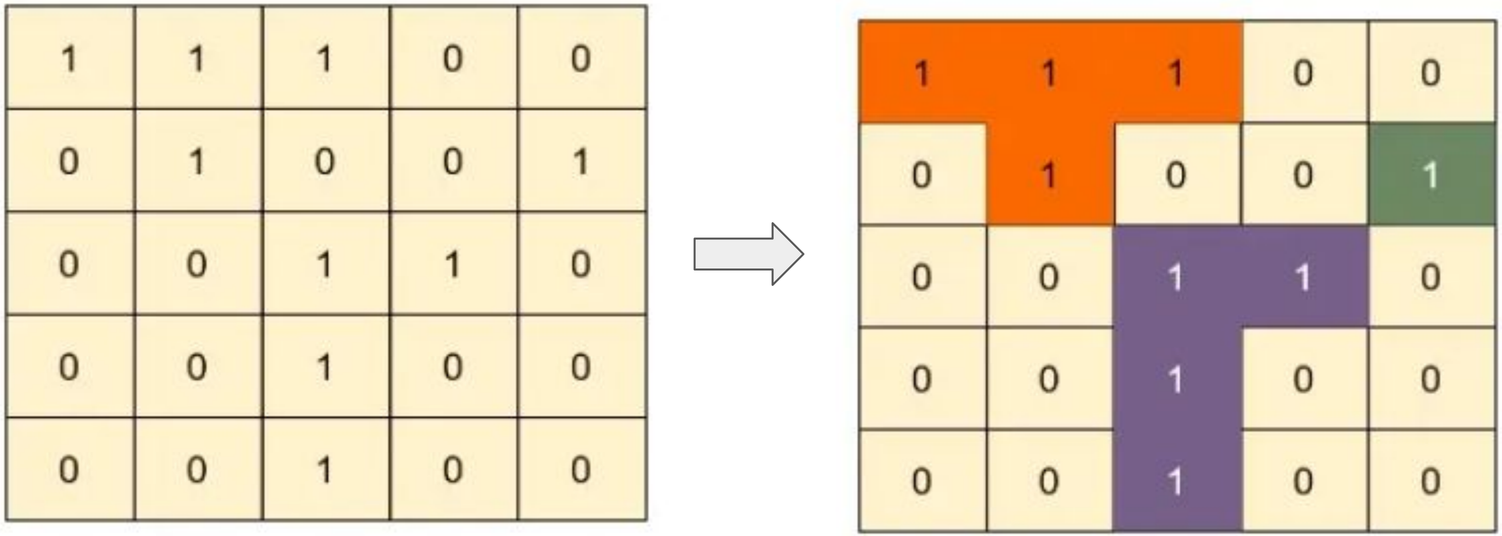
Graphs

Number of nodes in the graph

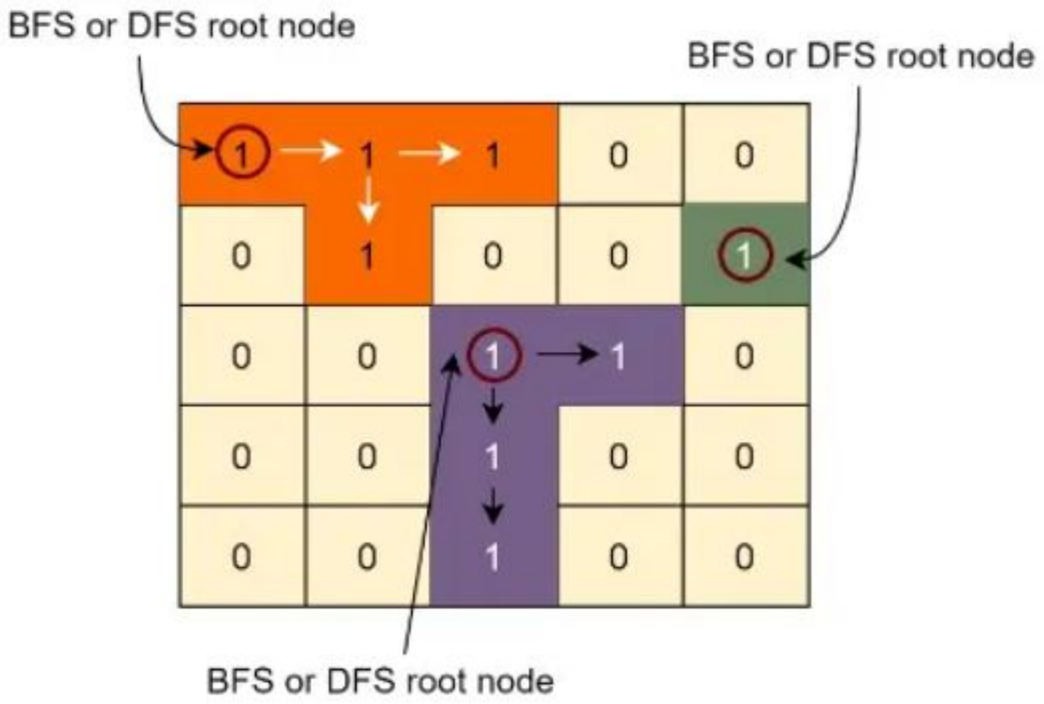


Returns 4

Calculate the number of islands

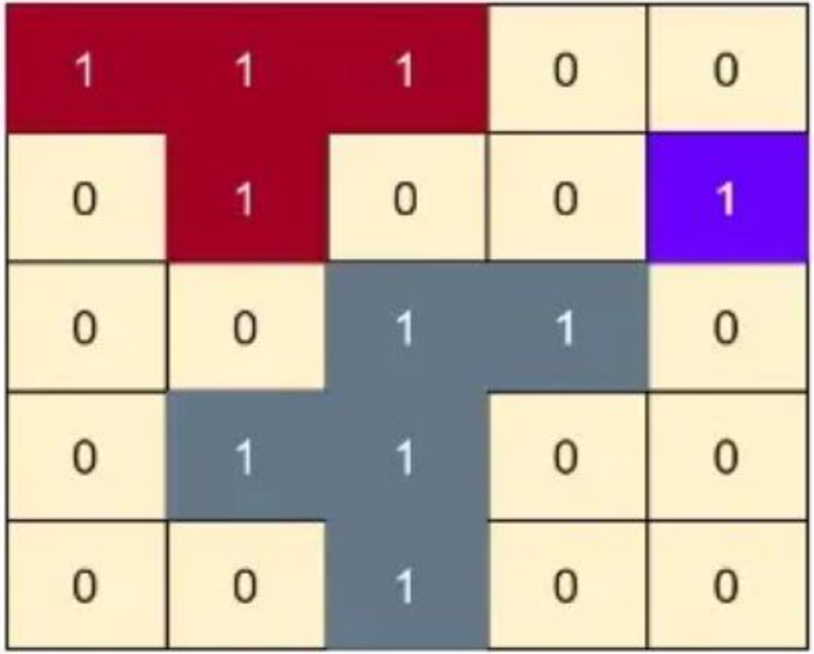


Calculate the number of islands



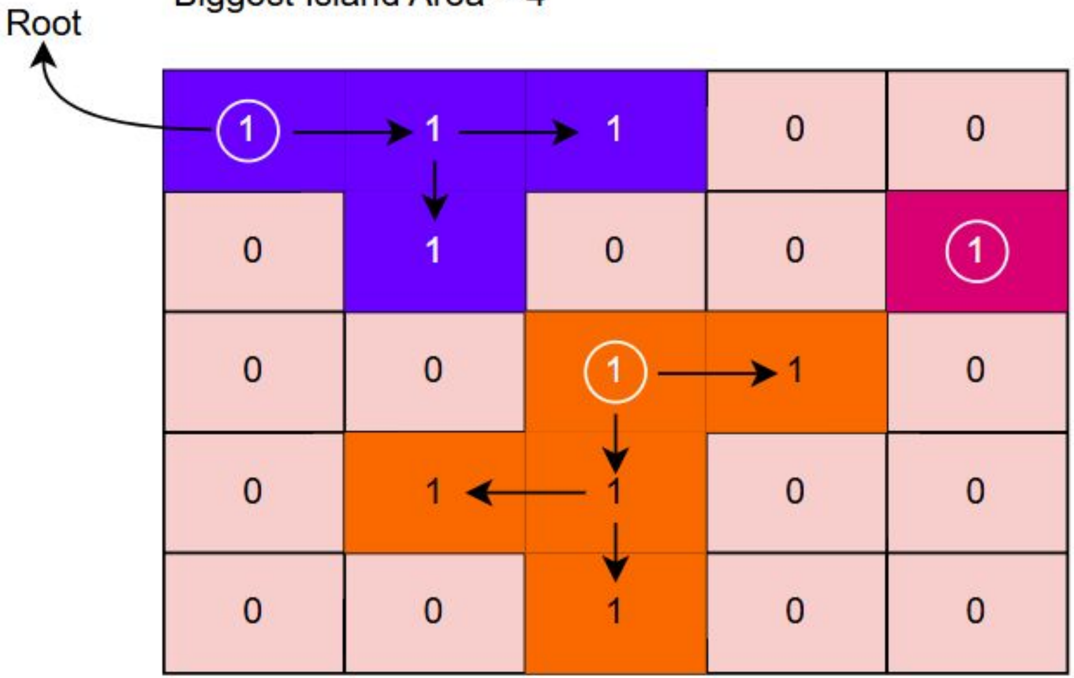
Biggest island among the different islands

1	1	1	0	0
0	1	0	0	1
0	0	1	1	0
0	1	1	0	0
0	0	1	0	0



Biggest island among the different islands

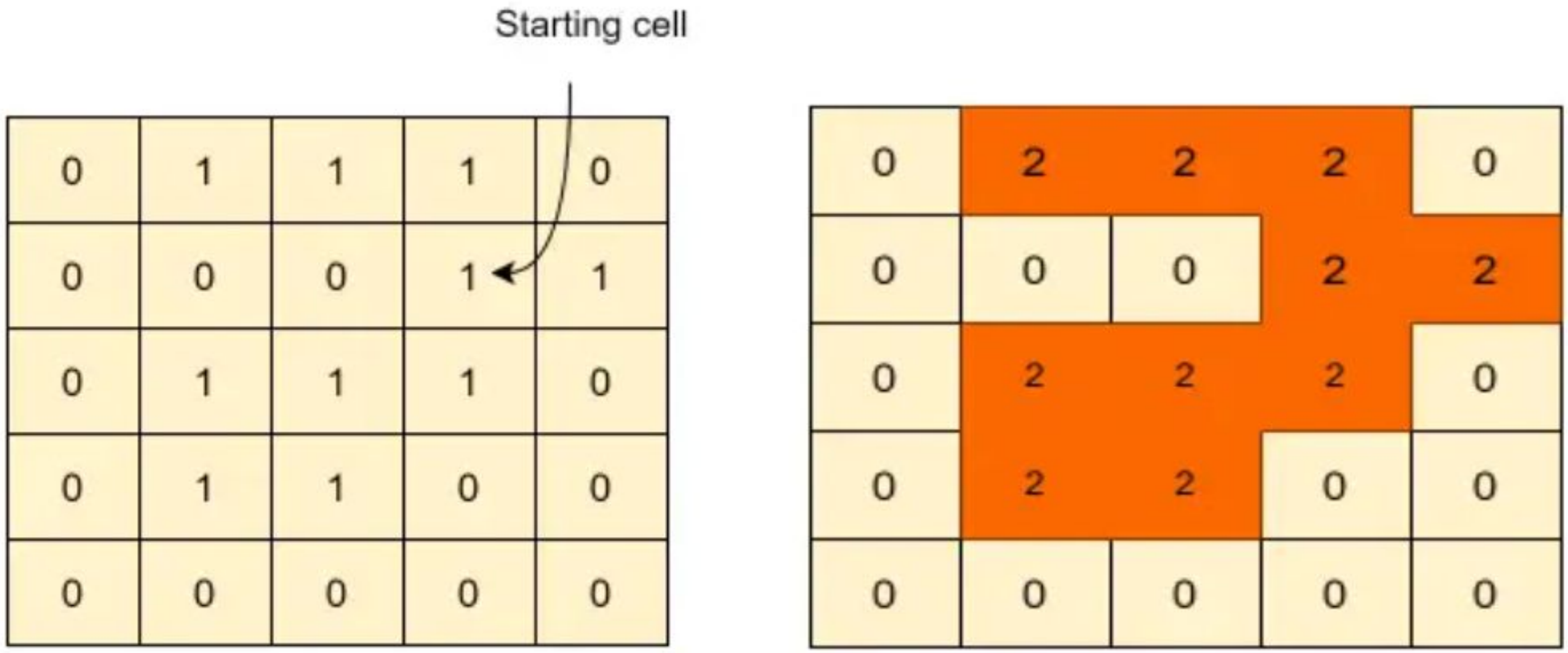
Biggest Island Area = 4



Biggest Island Area will not updated here because 4 is already max.

Here the Biggest Island Area=5 because 5 nodes are connected to each other according to the requirement.

Flood fill



starting cell = (1, 3)
new color = 2

Flood fill