CS 61BL

Lab 09

Announcements

- Project 2 released! You must lock in your partners today; make sure to add your partner on Beacon.

- Design Documents for Project 2 due Saturday, July 13 at 11:59pm.

- On Monday during lab, we will have Design Review Meetings, where your group will have a one-on-one conversation with us about your design.

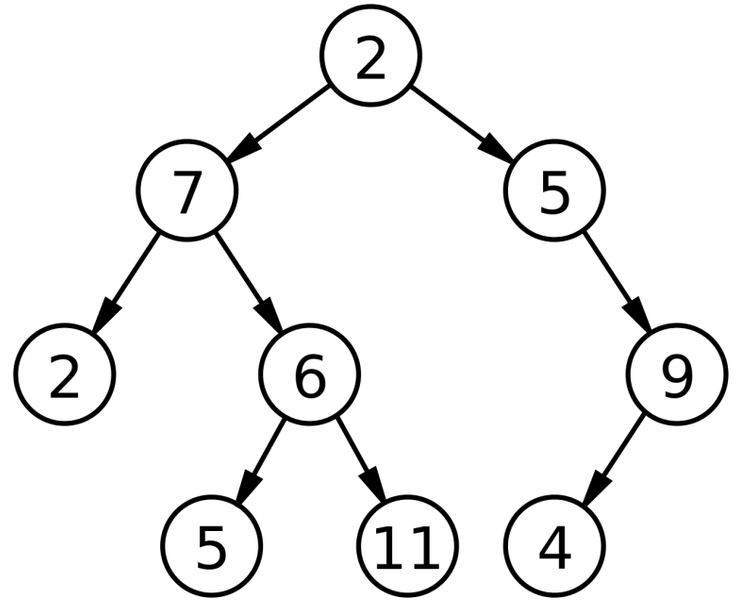
    - Sign up for a timeslot at rpurp.com/signup/ (only one partner should sign up)

Visiting Nodes

- How do we visit all of the nodes in a tree?

- ("Visit" = process the node in some way, for example, printing its value or doubling it)

- Recursion seems like a reasonable choice: after we call our visit method on the whole tree, we would want to call it on the left-and-right subtree.



Pre-order Traversal

- Idea: process the current node, and then traverse the left subtree, and then traverse the right subtree.

```
function traverse_preorder(node):
        visit the current node
        if node.left != null:
            traverse_preorder(node.left)
        if node.right != null:
            traverse_preorder(node.right)
```

```
function traverse_preorder(node):
        visit the current node
        if node.left != null:
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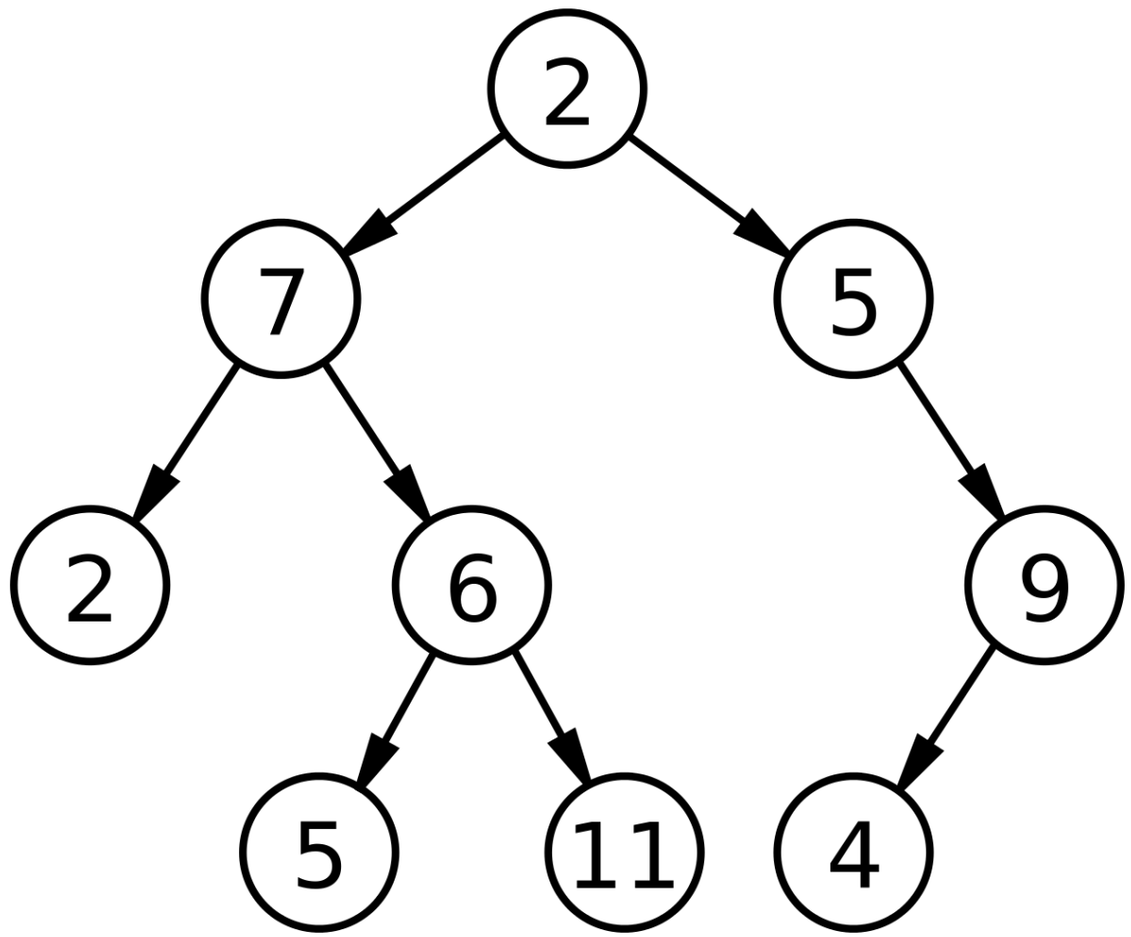

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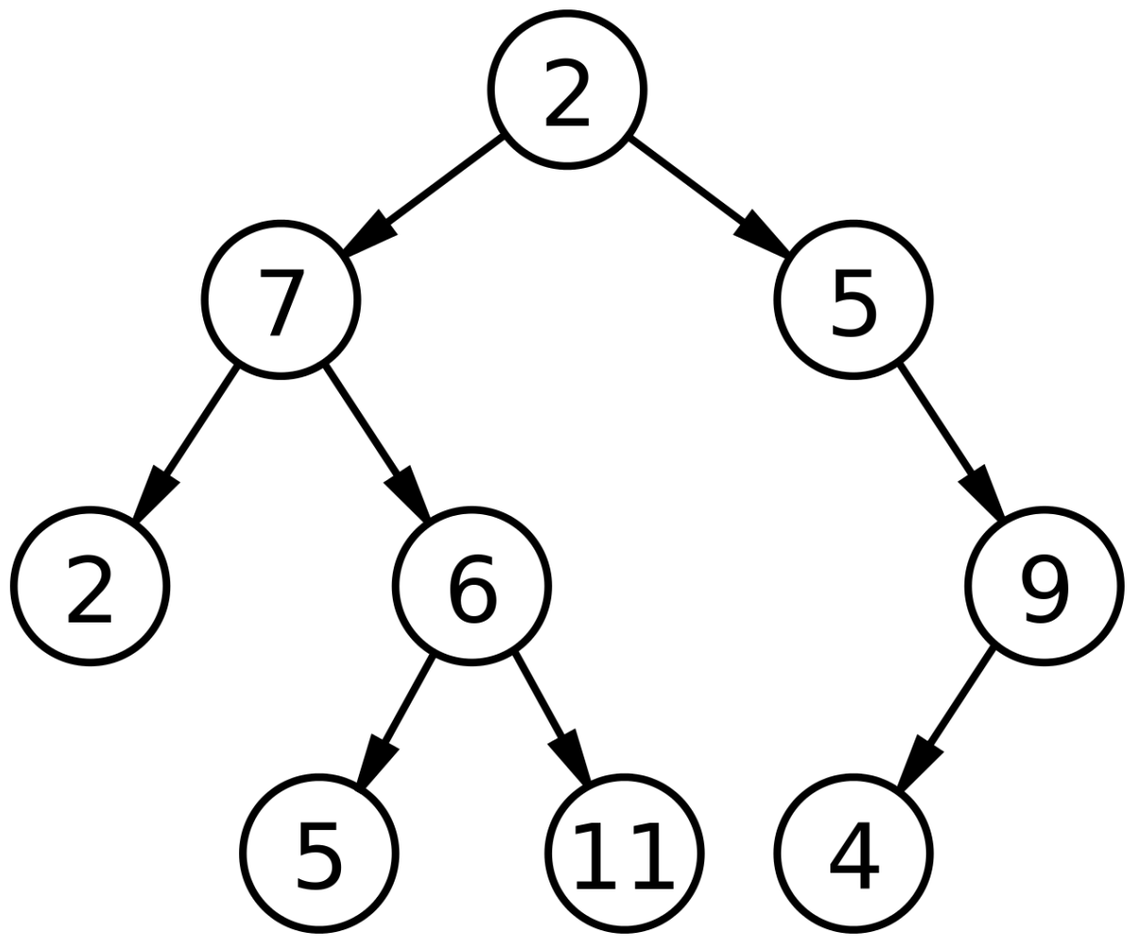
```

2



```
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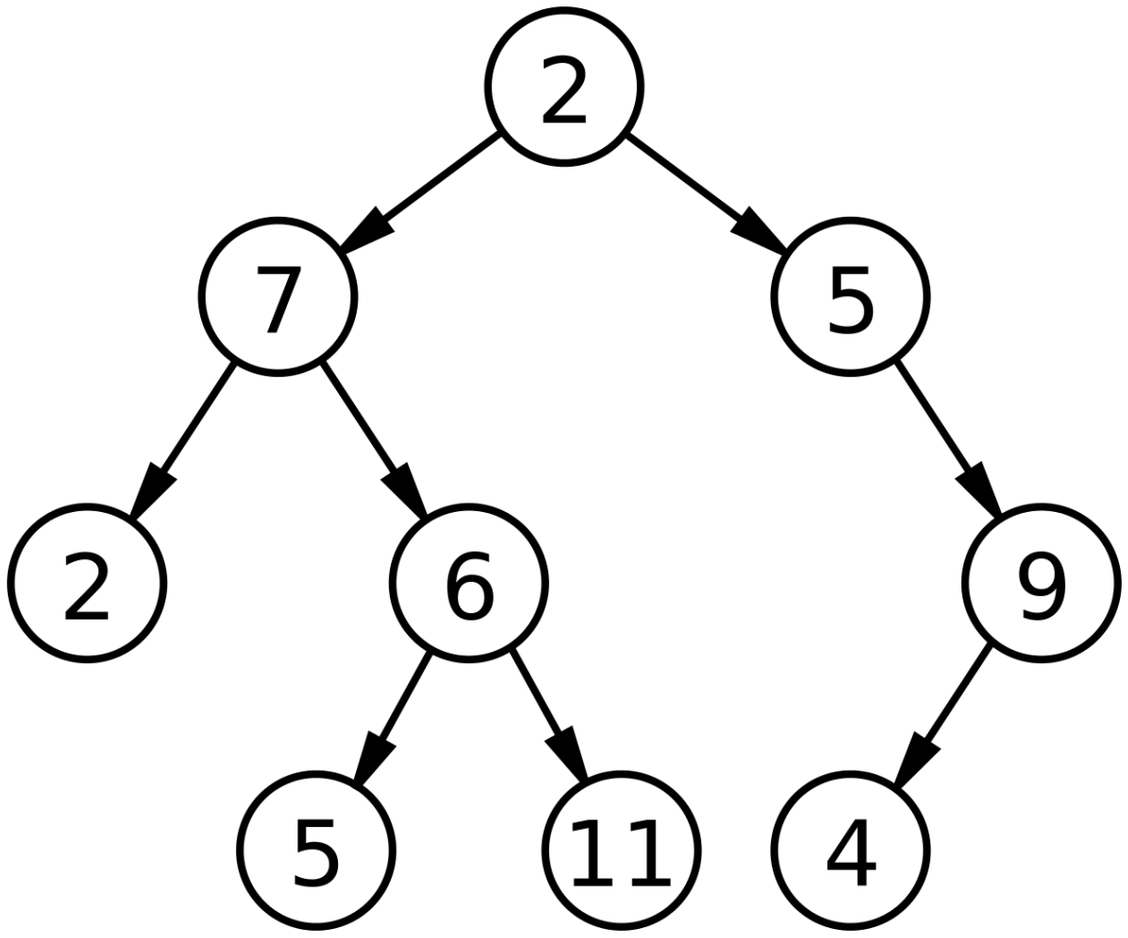
```

2
7



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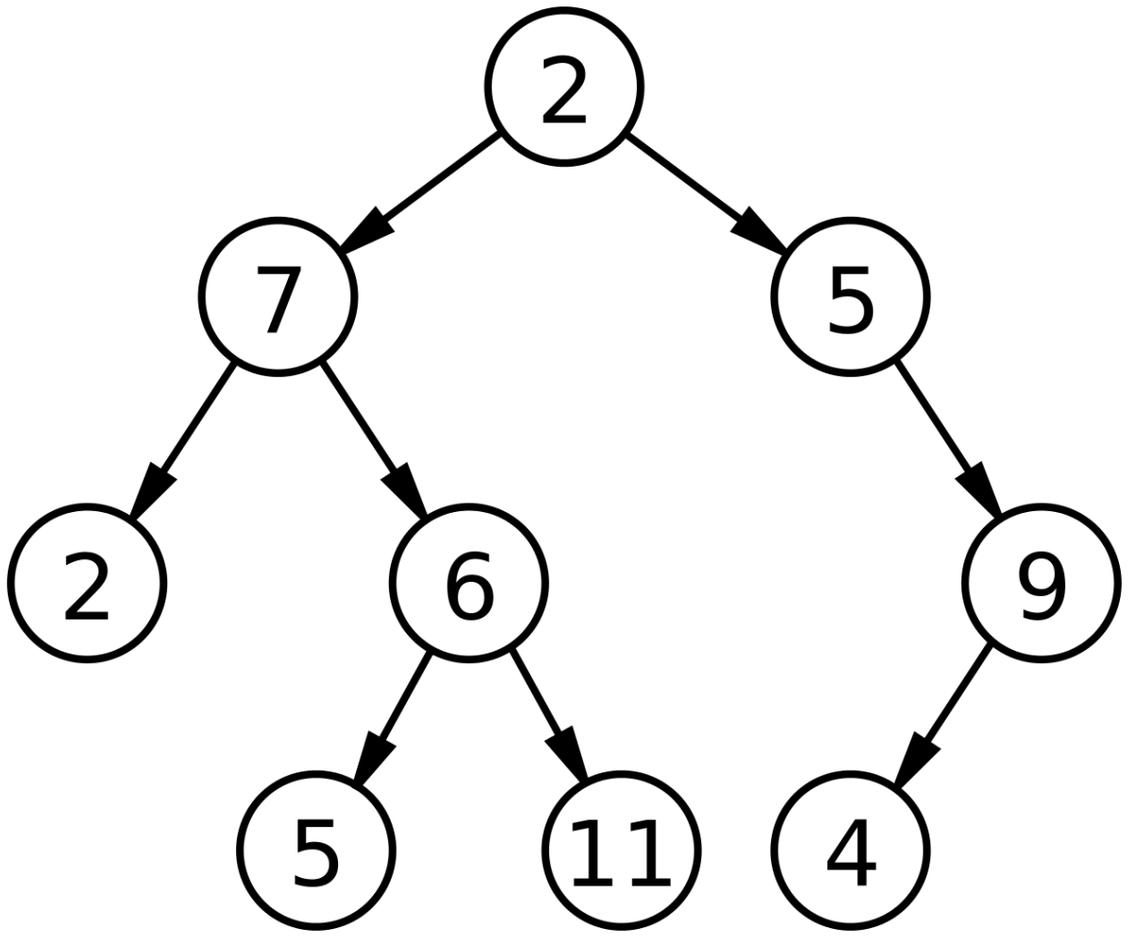
```

2
7
2



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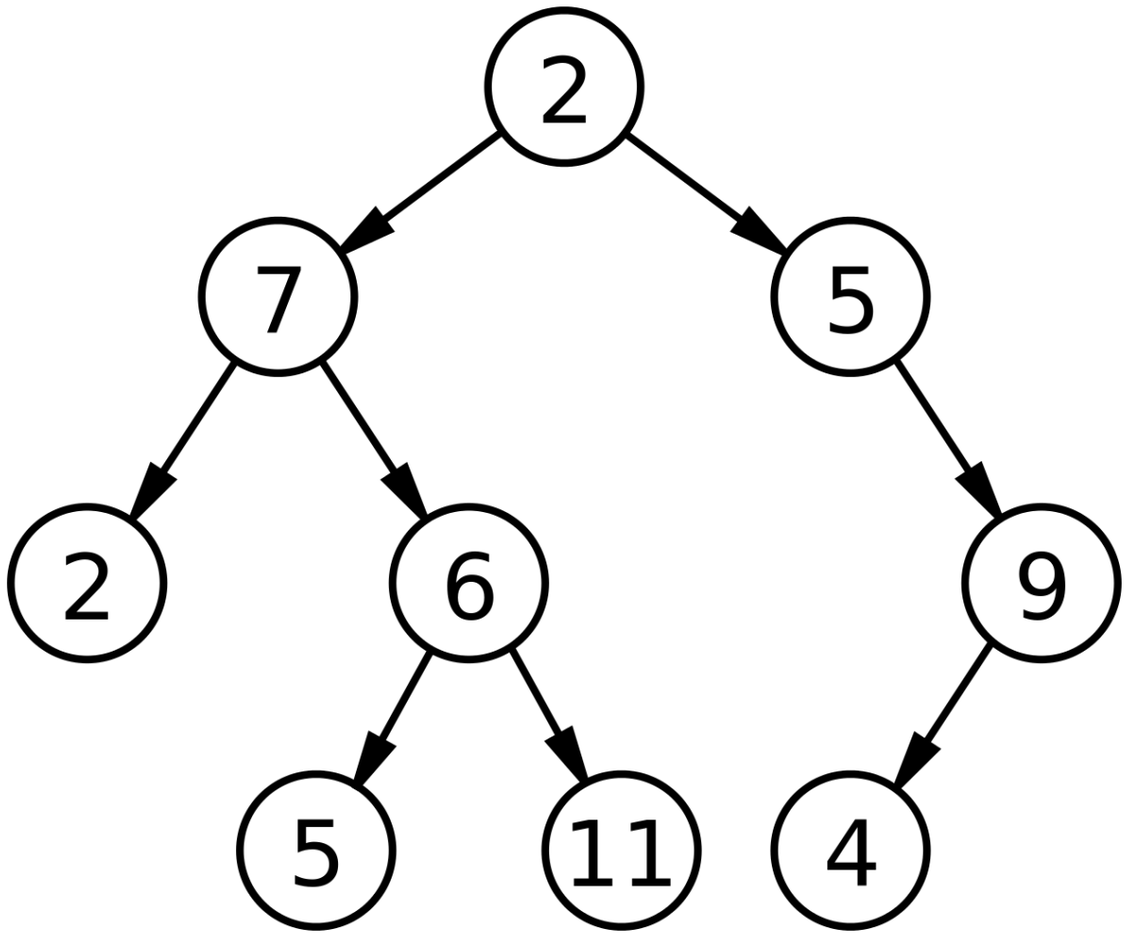
```

2
7
2
6



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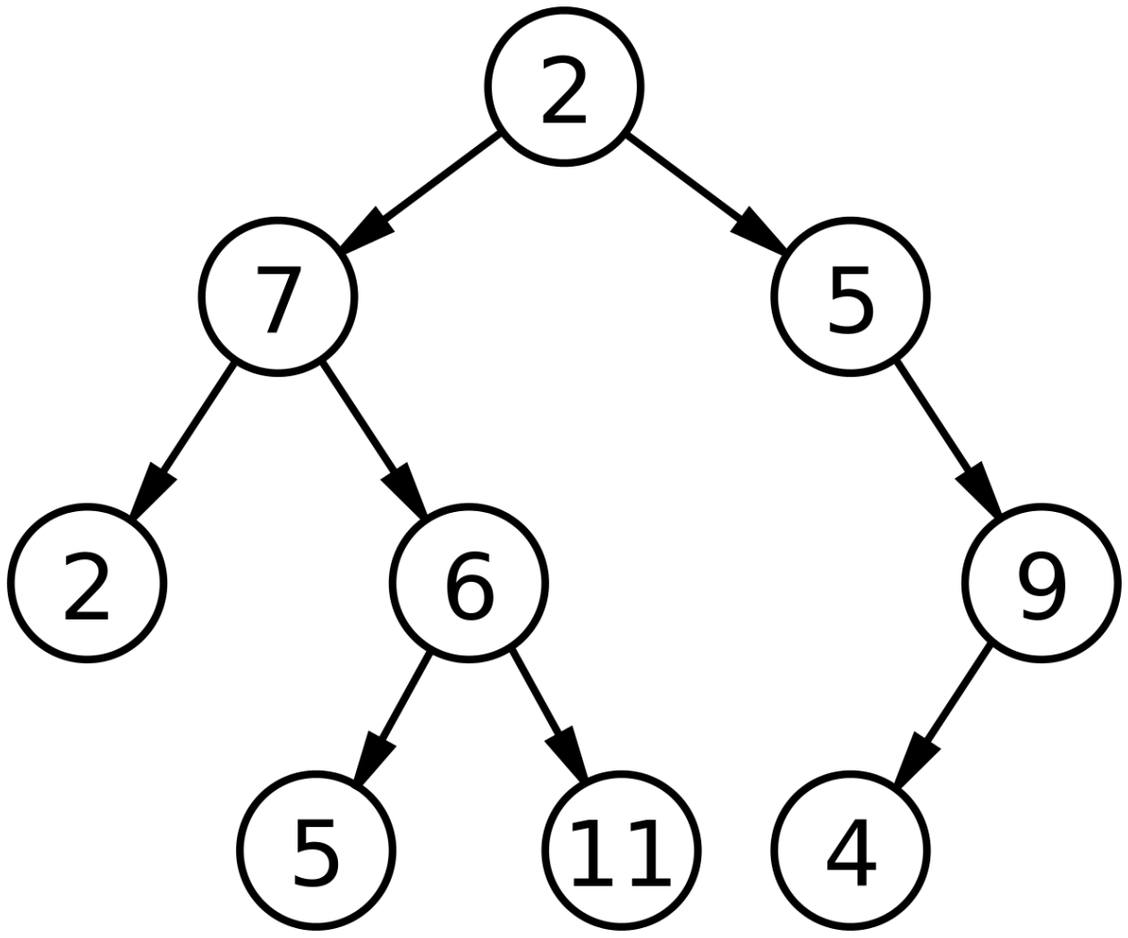
```

2
7
2
6
5



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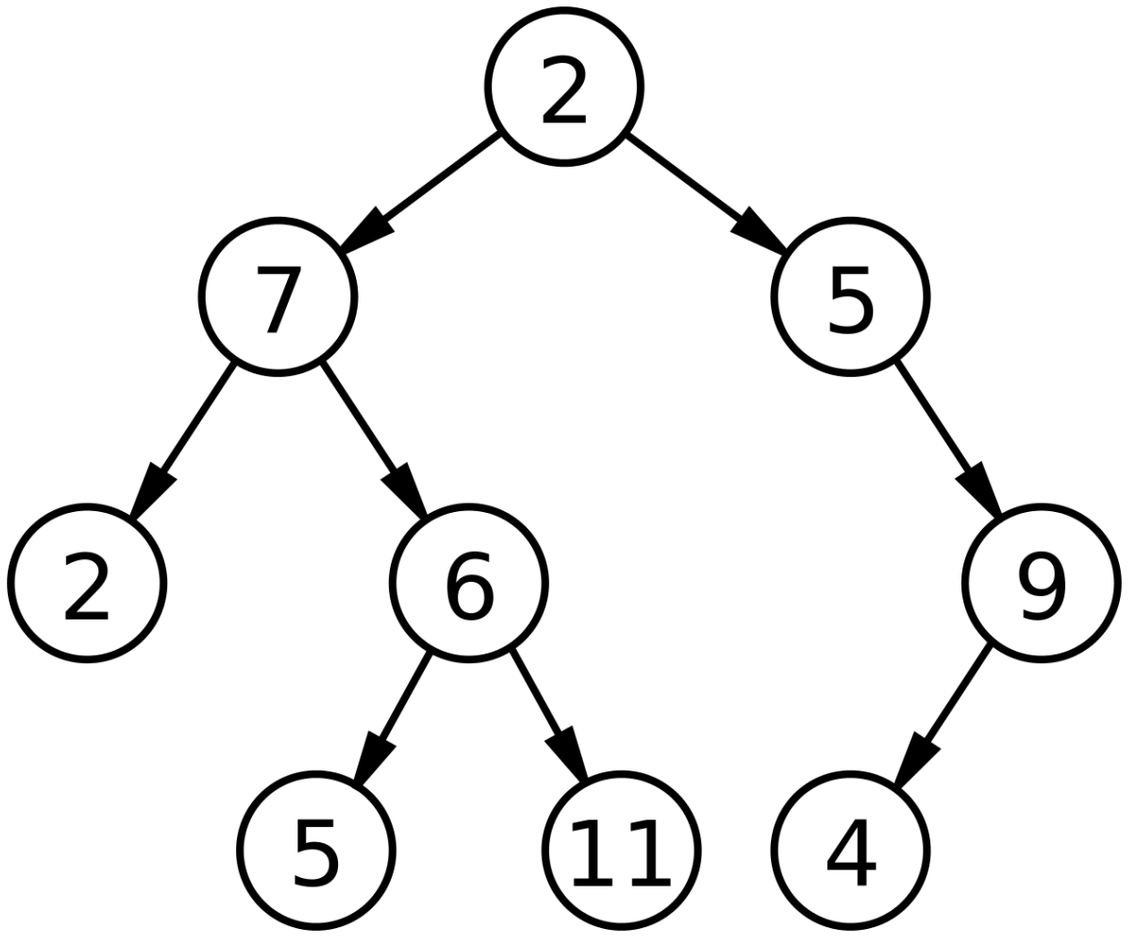
```

```
2
7
2
6
5
11
```



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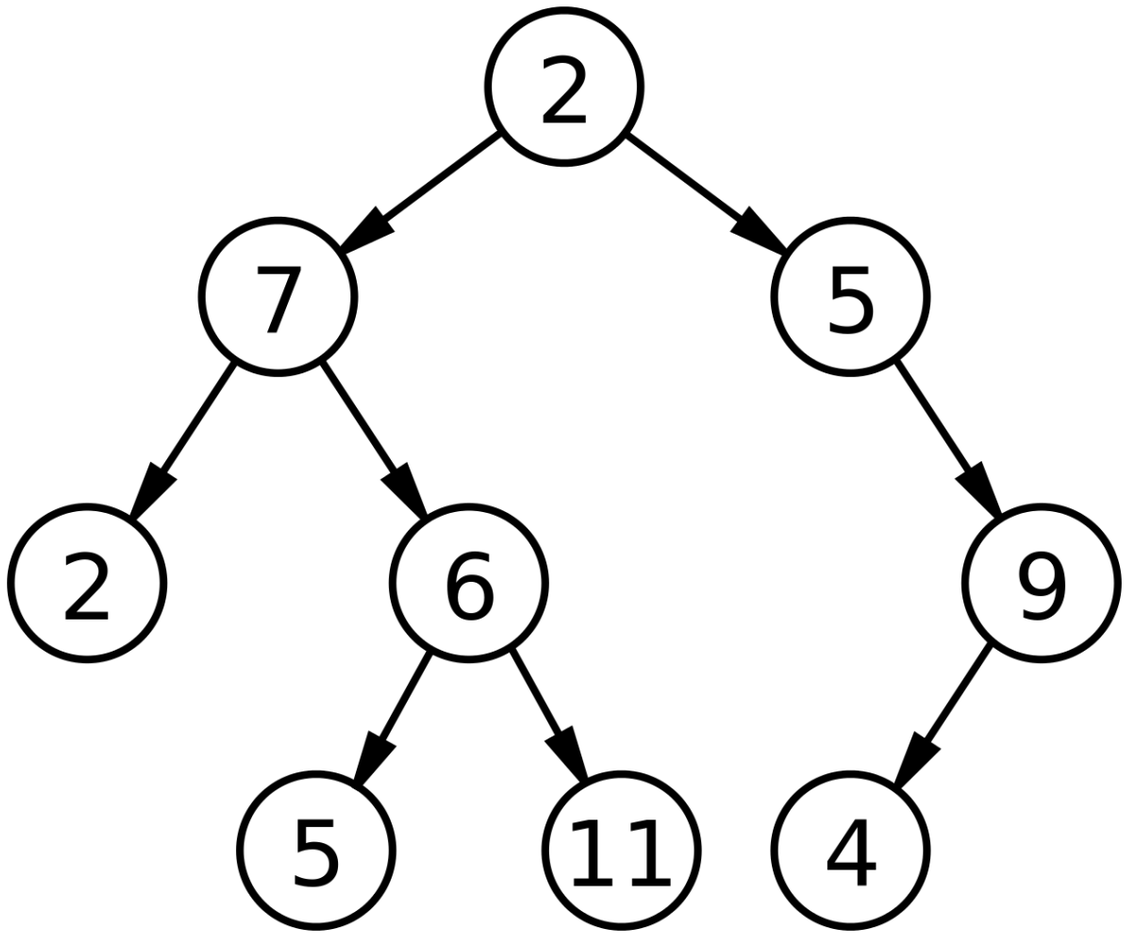
```

```
2
7
2
6
5
11
5
```



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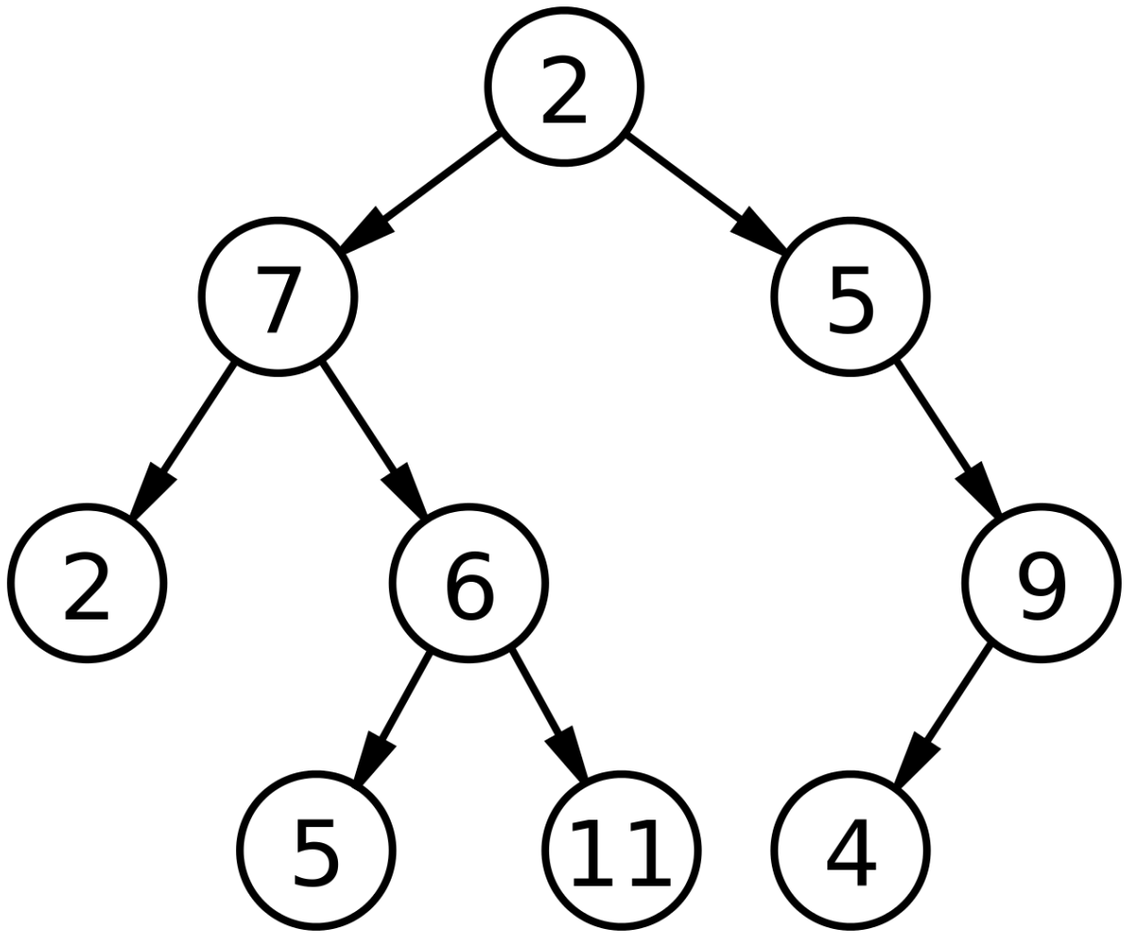
```

```
2
7
2
6
5
11
5
9
```



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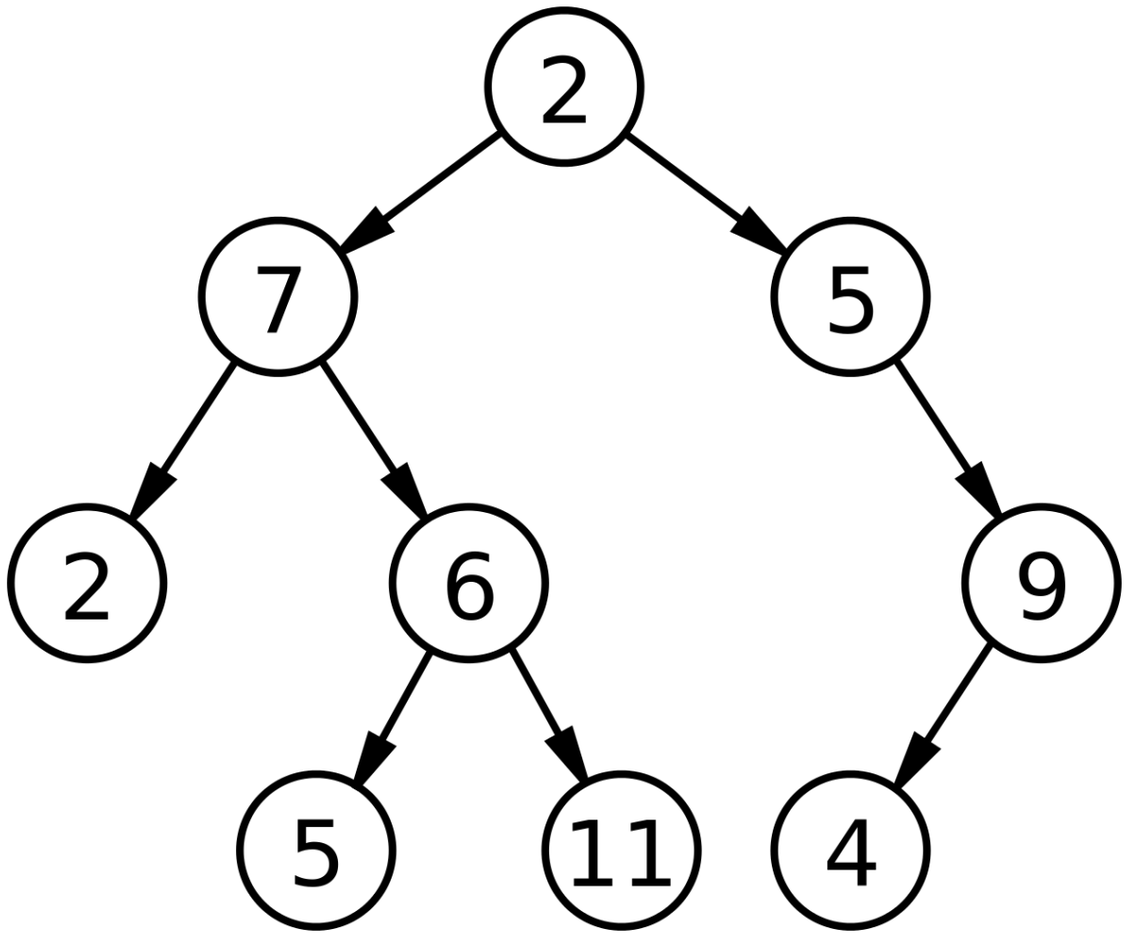
```

```
2
7
2
6
5
11
5
9
4
```

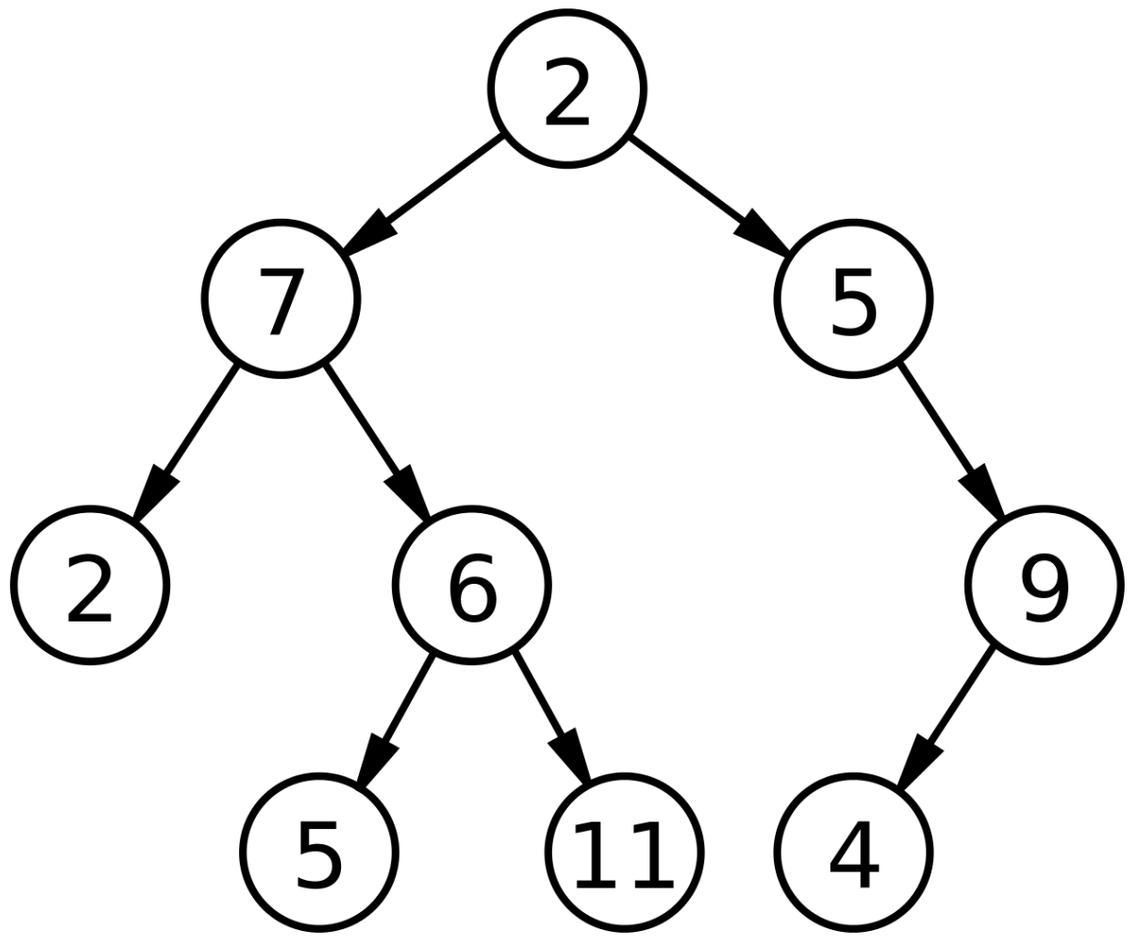


In-order Traversal

- What if we process our node after we process our left subtree but before we process our right subtree?

```
function traverse_inorder(node):
        if node.left != null:
            traverse_inorder(node.left)
        visit the current node
        if node.right != null:
            traverse_inorder(node.right)
```

```
function traverse_inorder(node):
        if node.left != null:
            traverse_inorder(node.left)
        visit the current node
        if node.right != null:
            traverse_inorder(node.right)
```



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        visit the current node
        if node.right != null:
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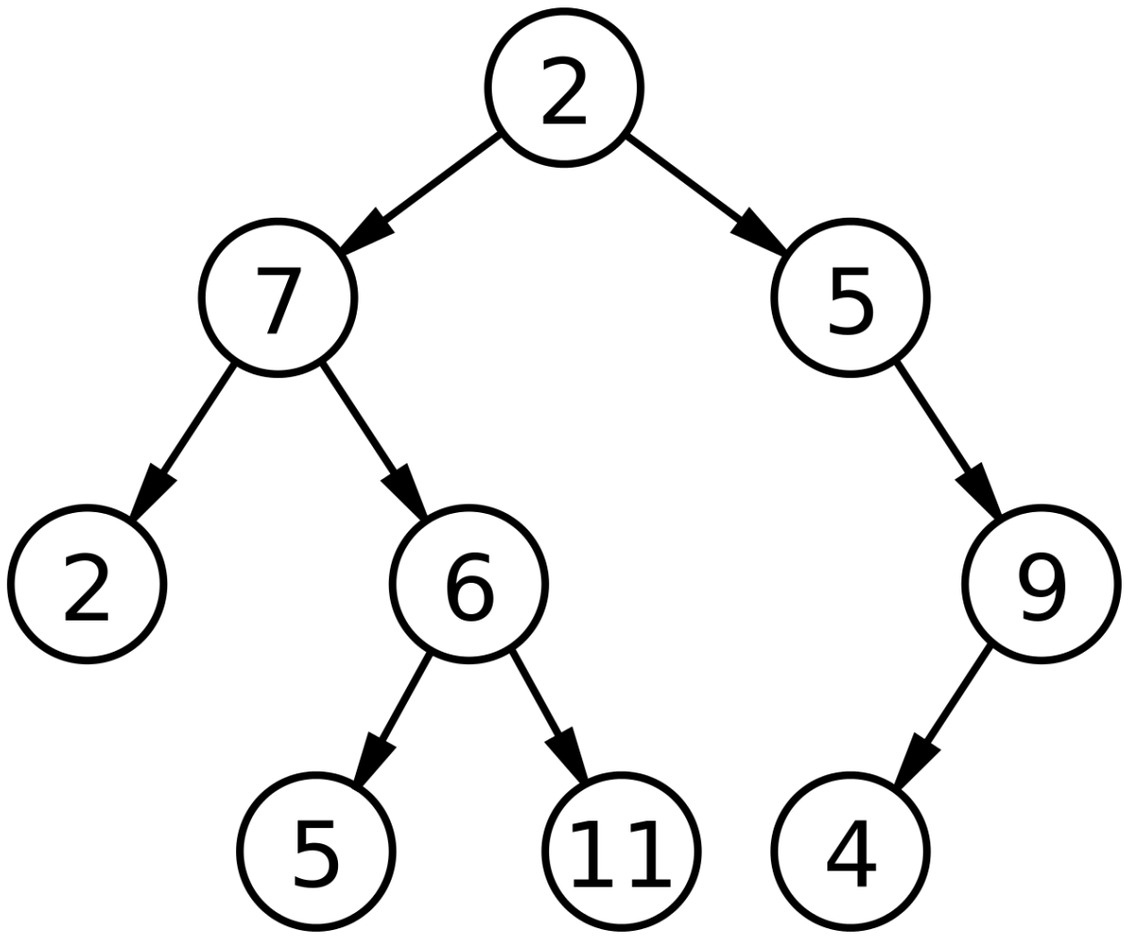
```

2



```
function traverse_inorder(node):
        if node.left != null:
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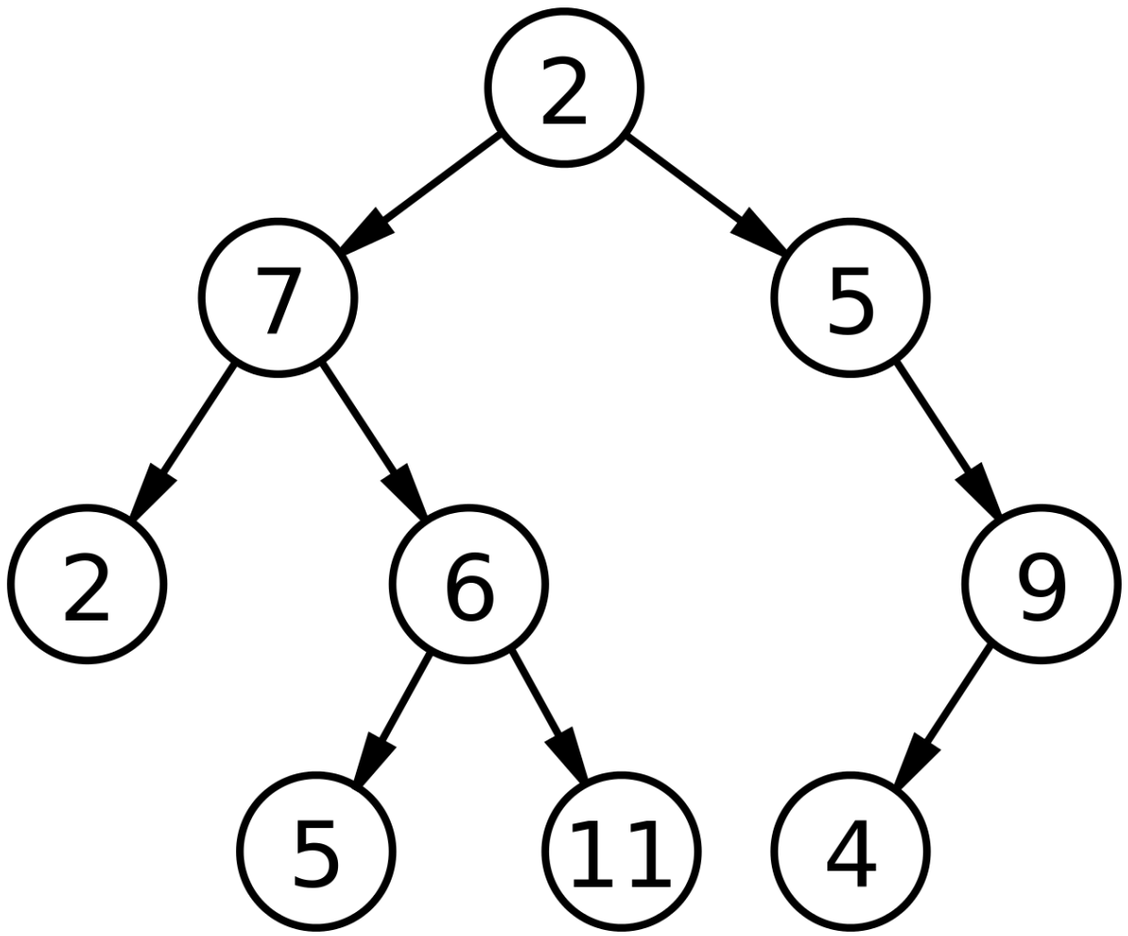
        if node.right != null:
            traverse_inorder(node.right)
```

2
7



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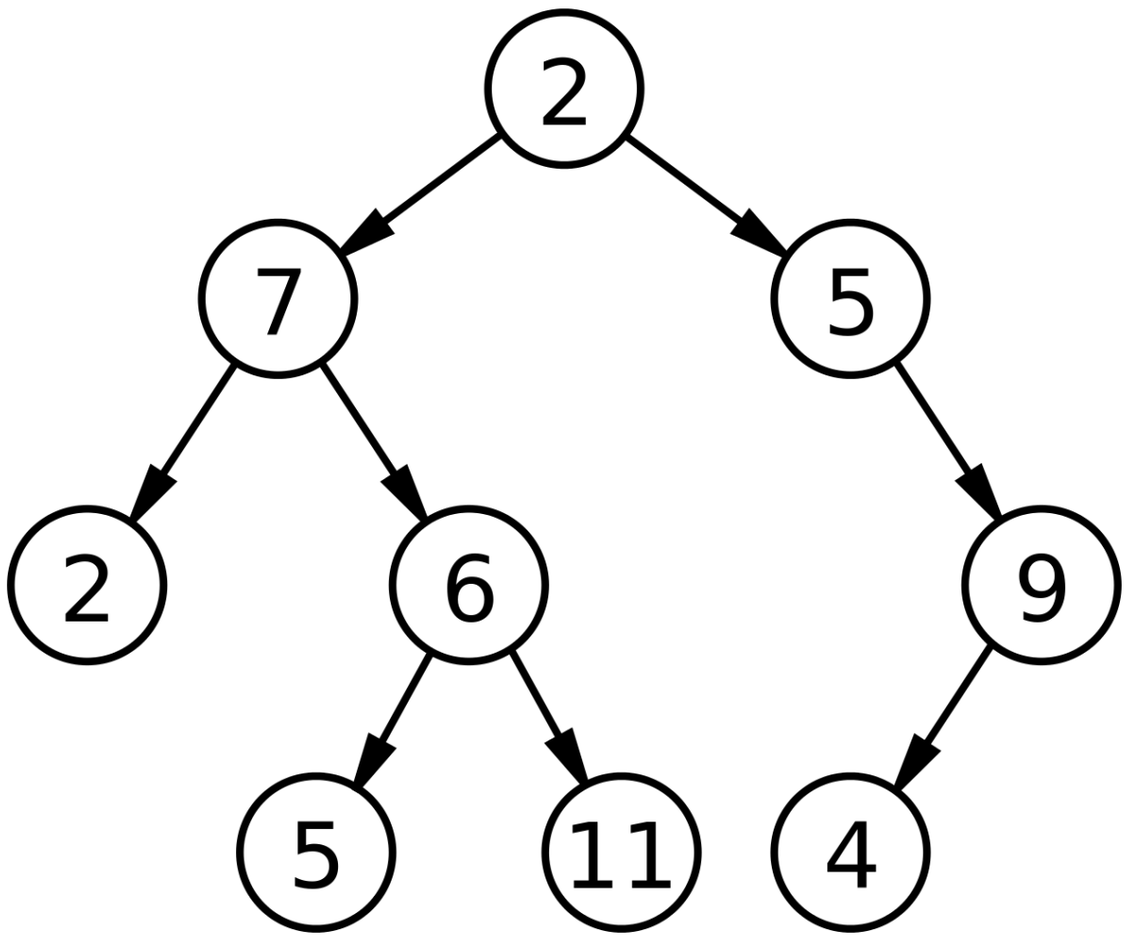
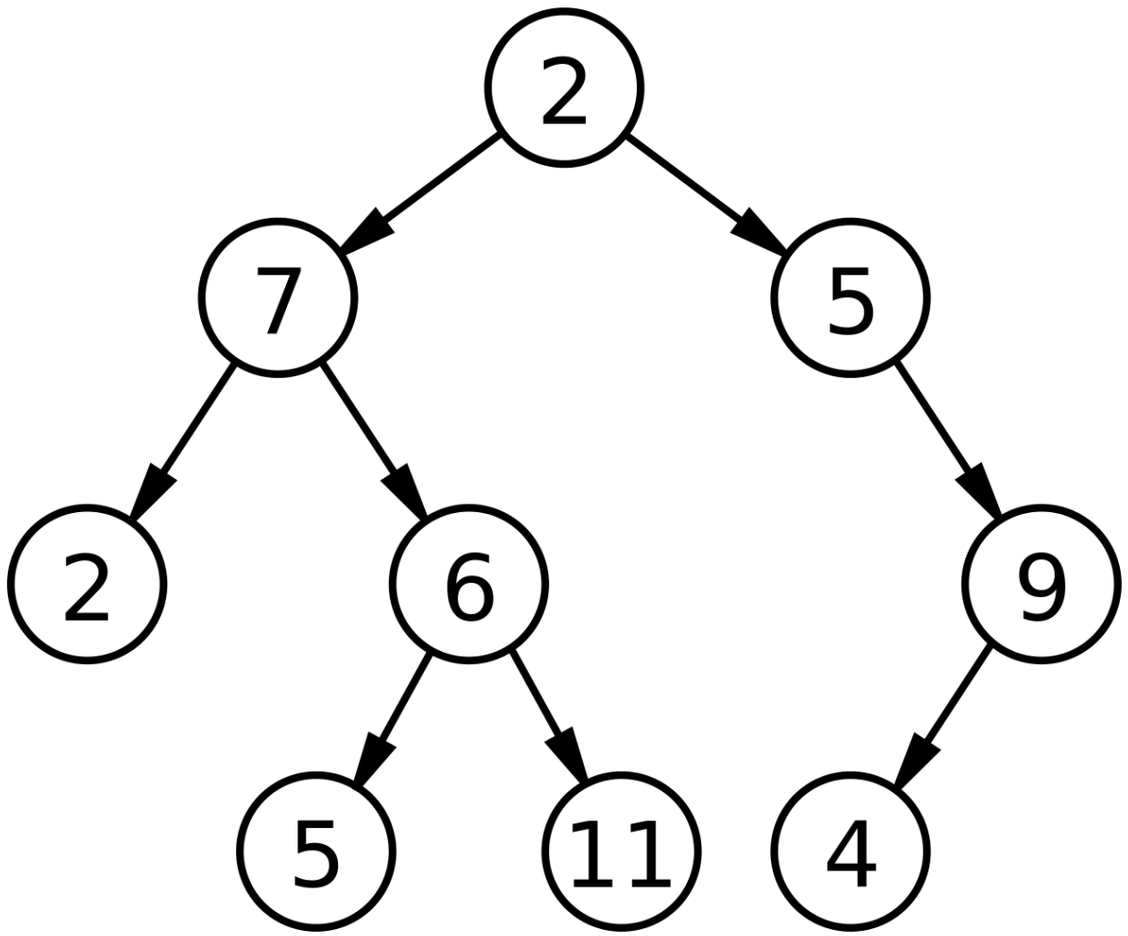
        if node.left != null:
            traverse_inorder(node.left)
        visit the current node
        if node.right != null:
            traverse_inorder(node.right)
```

2
7
5



```
function traverse_inorder(node):
        if node.left != null:
            traverse_inorder(node.left)
        visit the current node
        if node.right != null:
            traverse_inorder(node.right)
```

2
7
5
6



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        visit the current node
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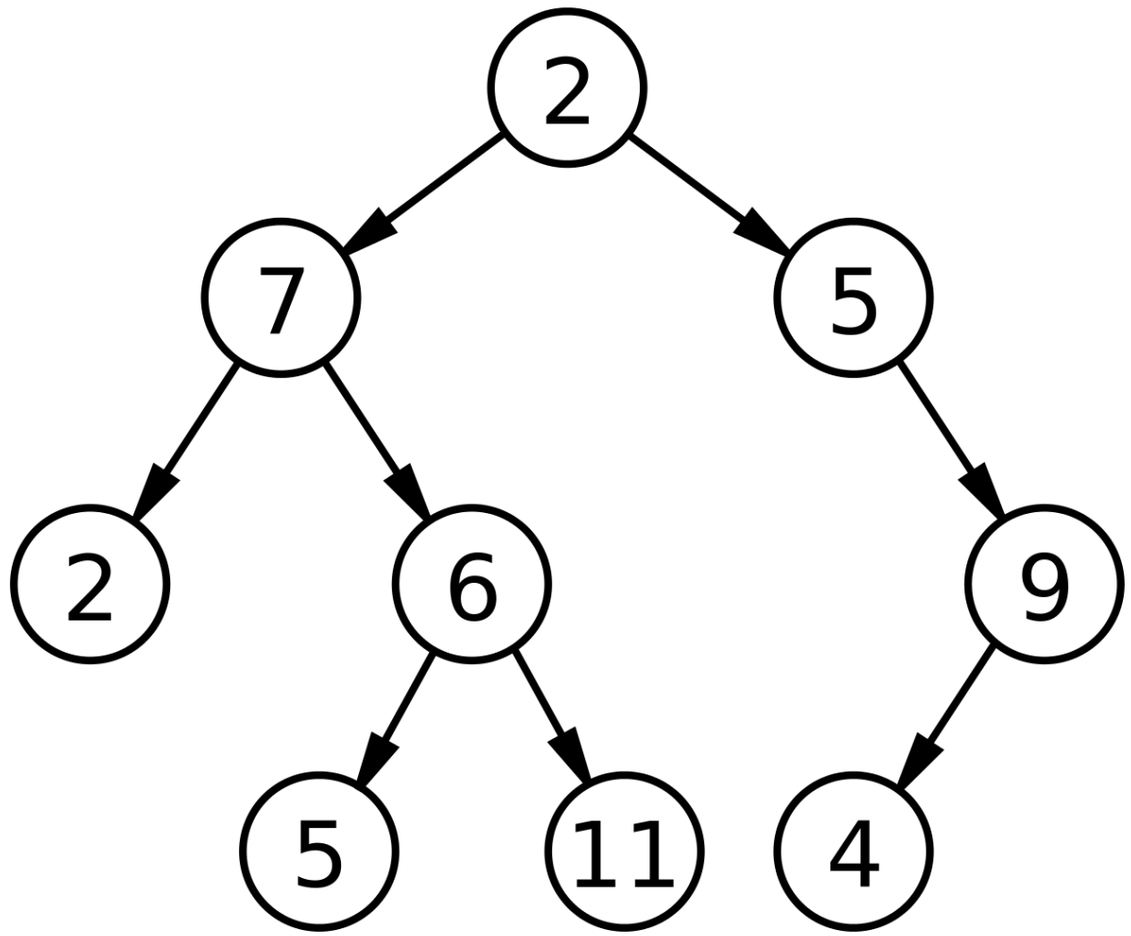
```

2
7
5
6
11



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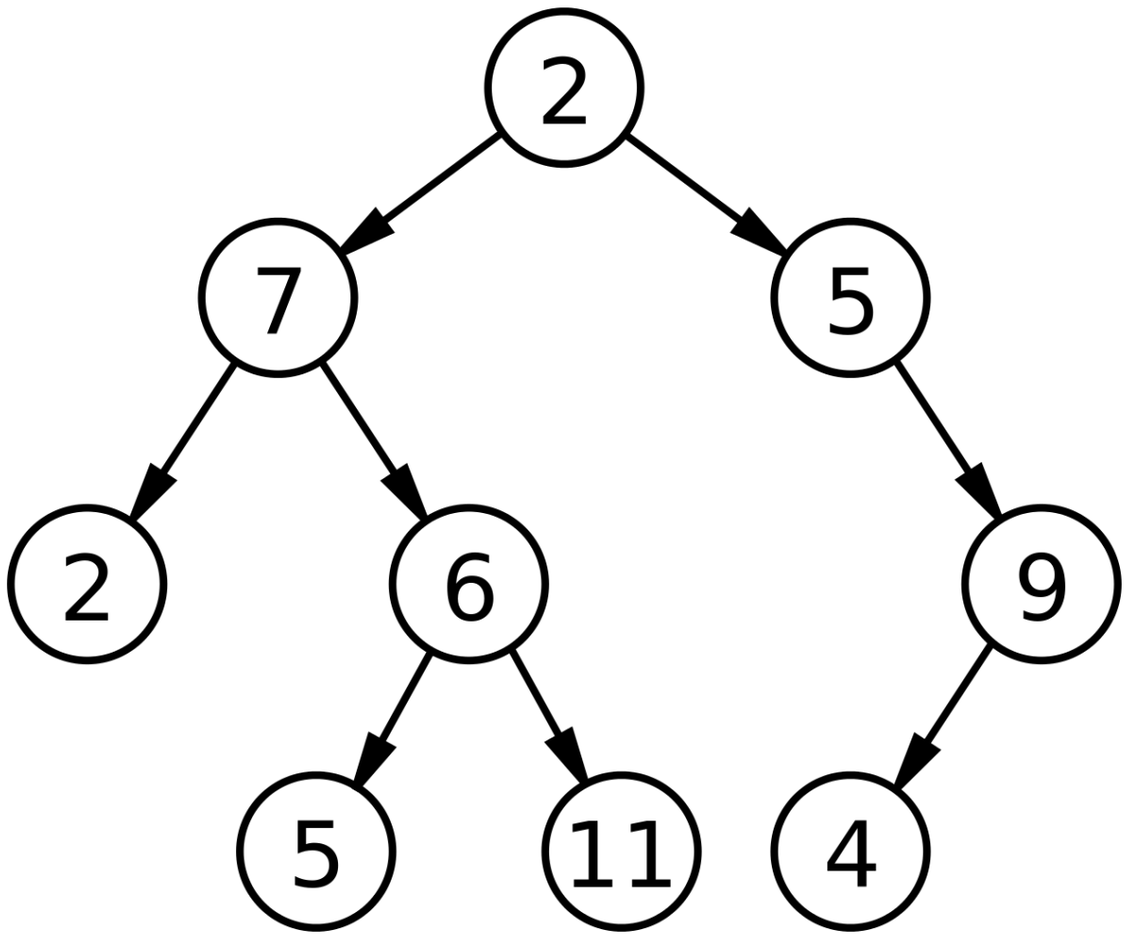
```

2
7
5
6
11
2



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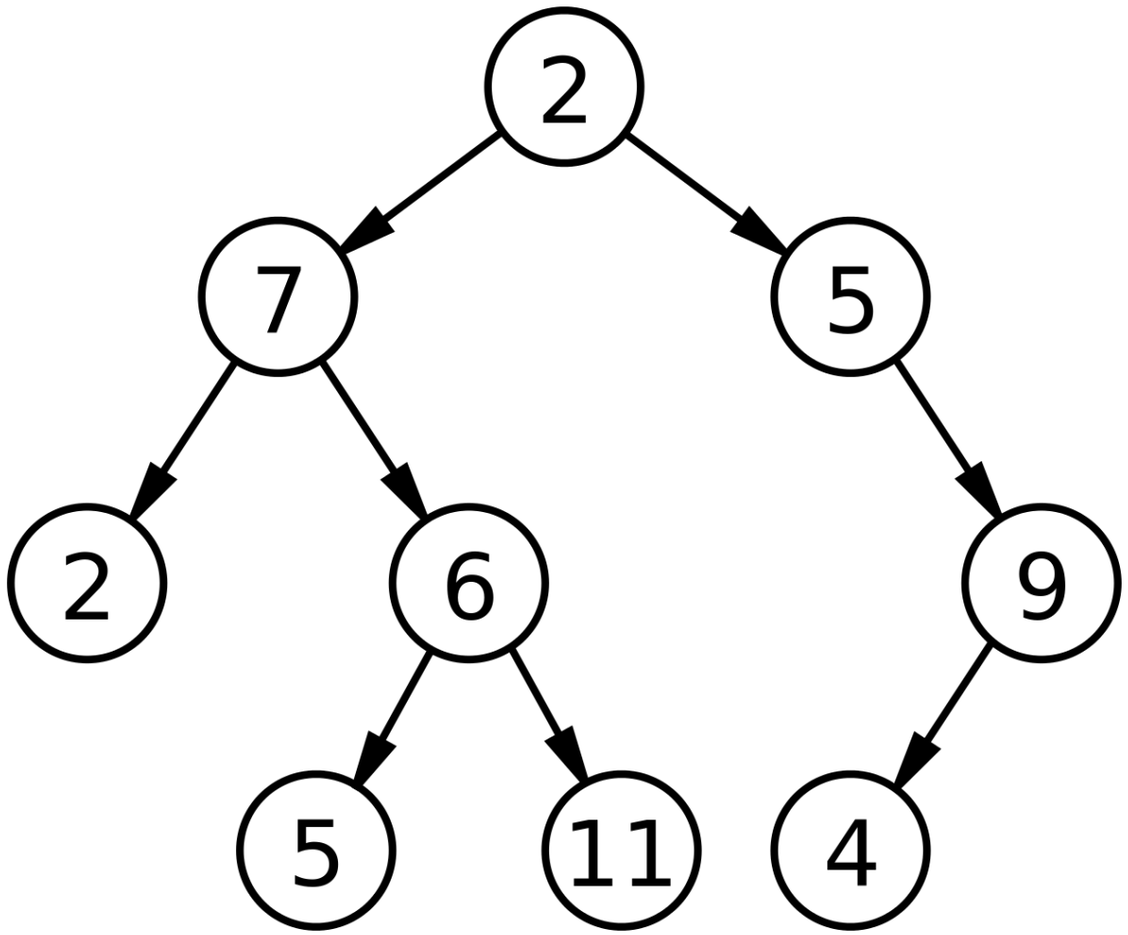
```

2
7
5
6
11
2
5



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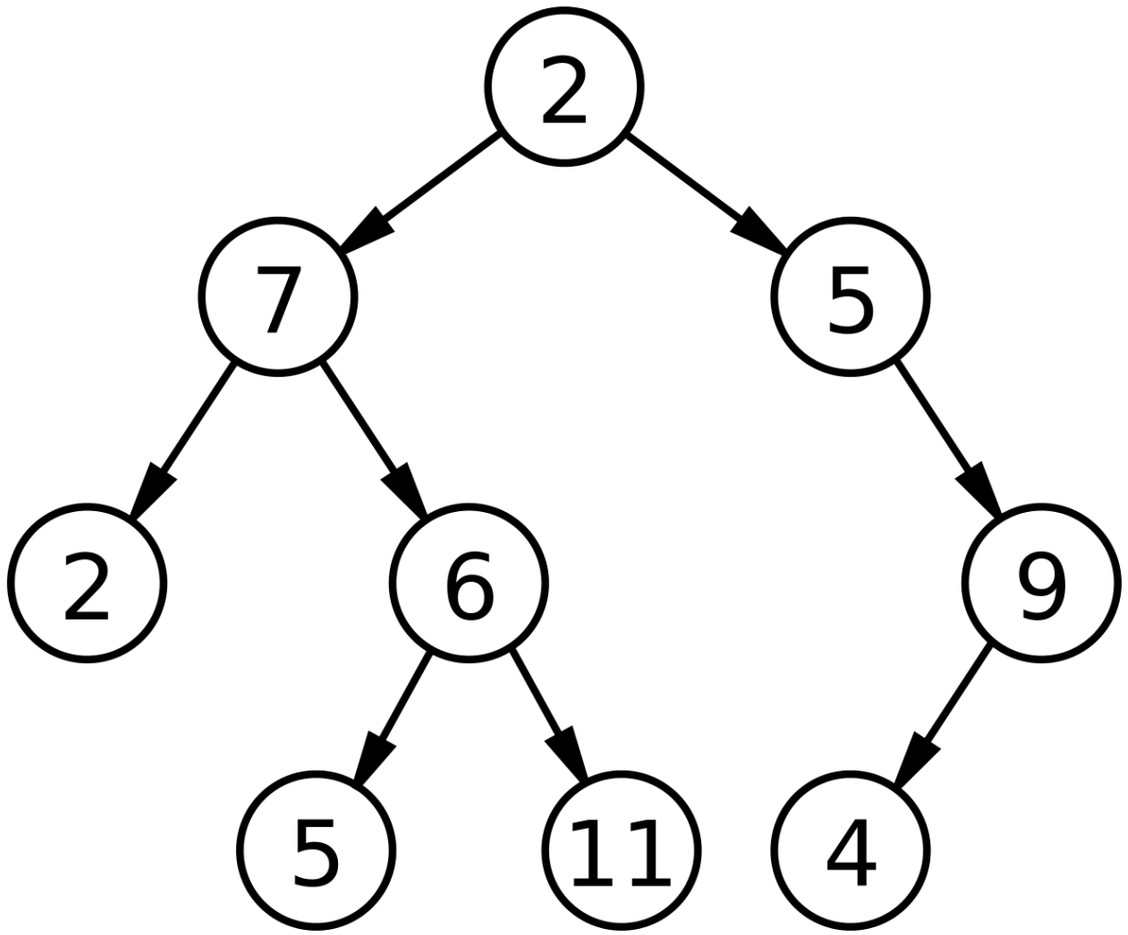
```

2
7
5
6
11
2
5
4



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```

2
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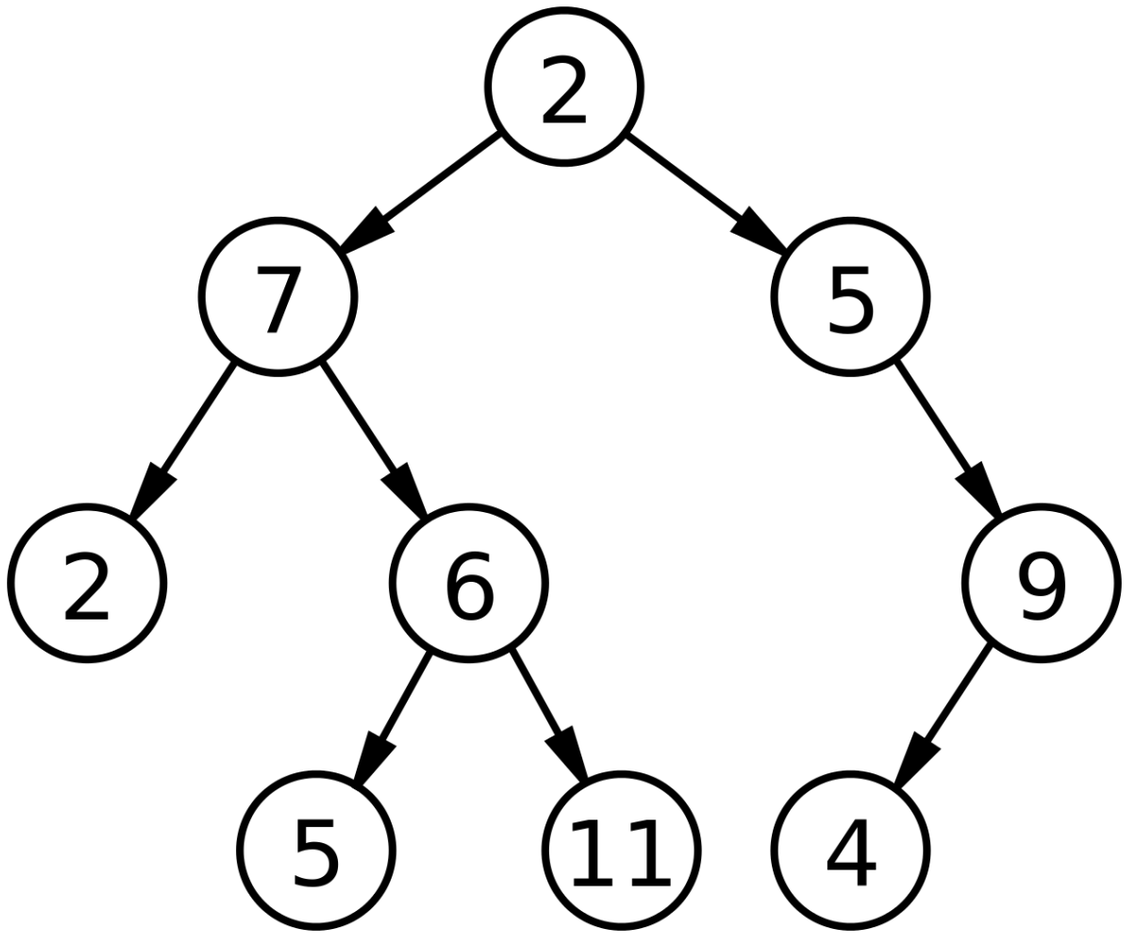
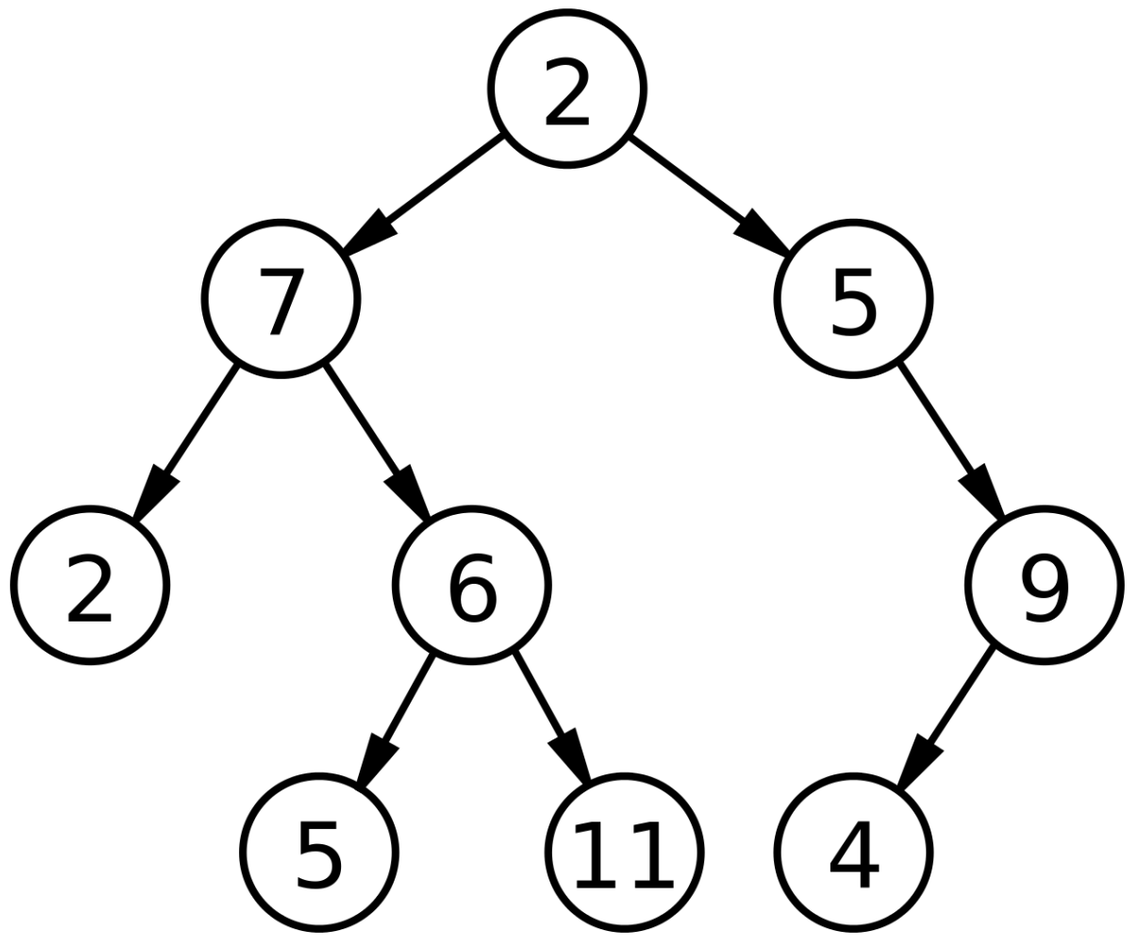


Post-order Traversal

- What if we don't process our node until after we traverse both the left *and* right subtrees?

```
function traverse_postorder(node):
        if node.left != null:
                traverse_postorder(node.left)
        if node.right != null:
                traverse_postorder(node.right)
        visit the current node
```

```
function traverse_postorder(node):
      if node.left != null:
            traverse_postorder(node.left)
      if node.right != null:
            traverse_postorder(node.right)
      visit the current node
```



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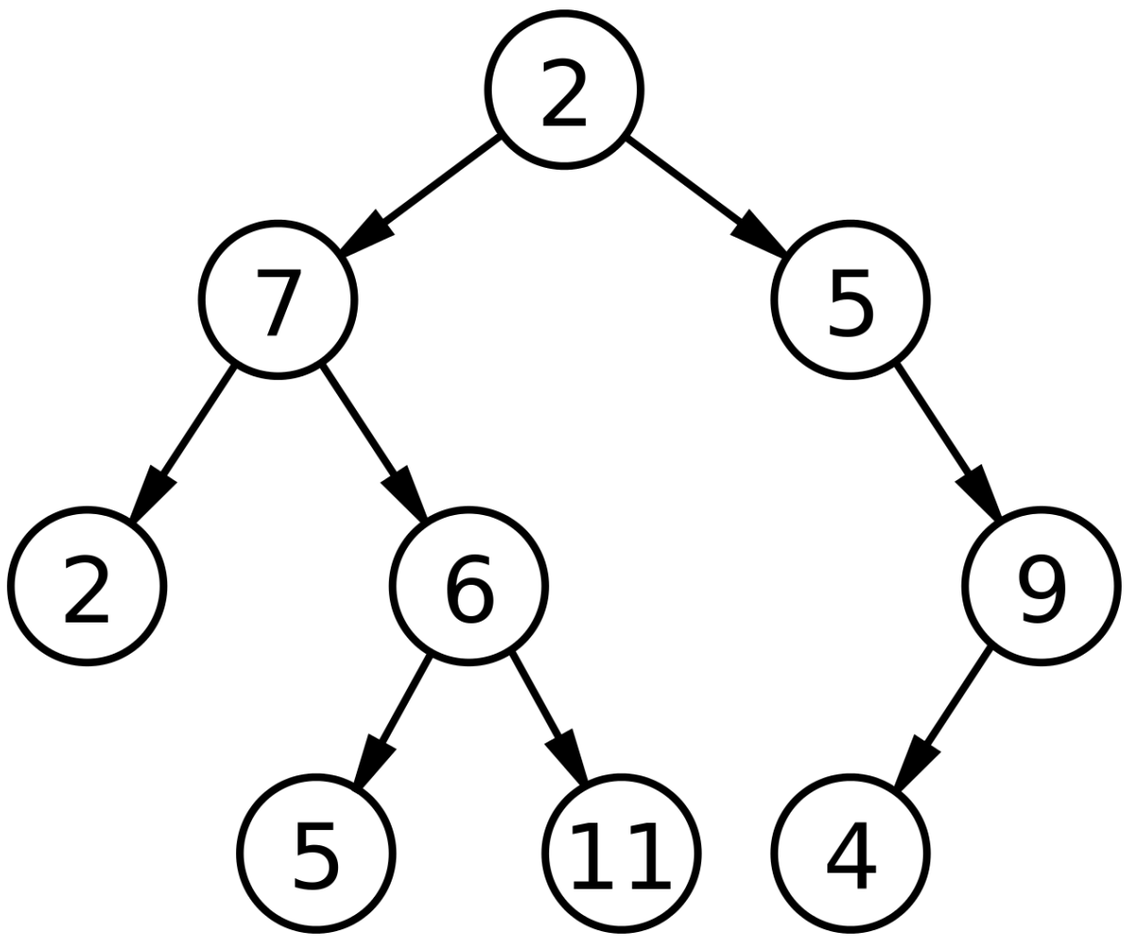
```

2



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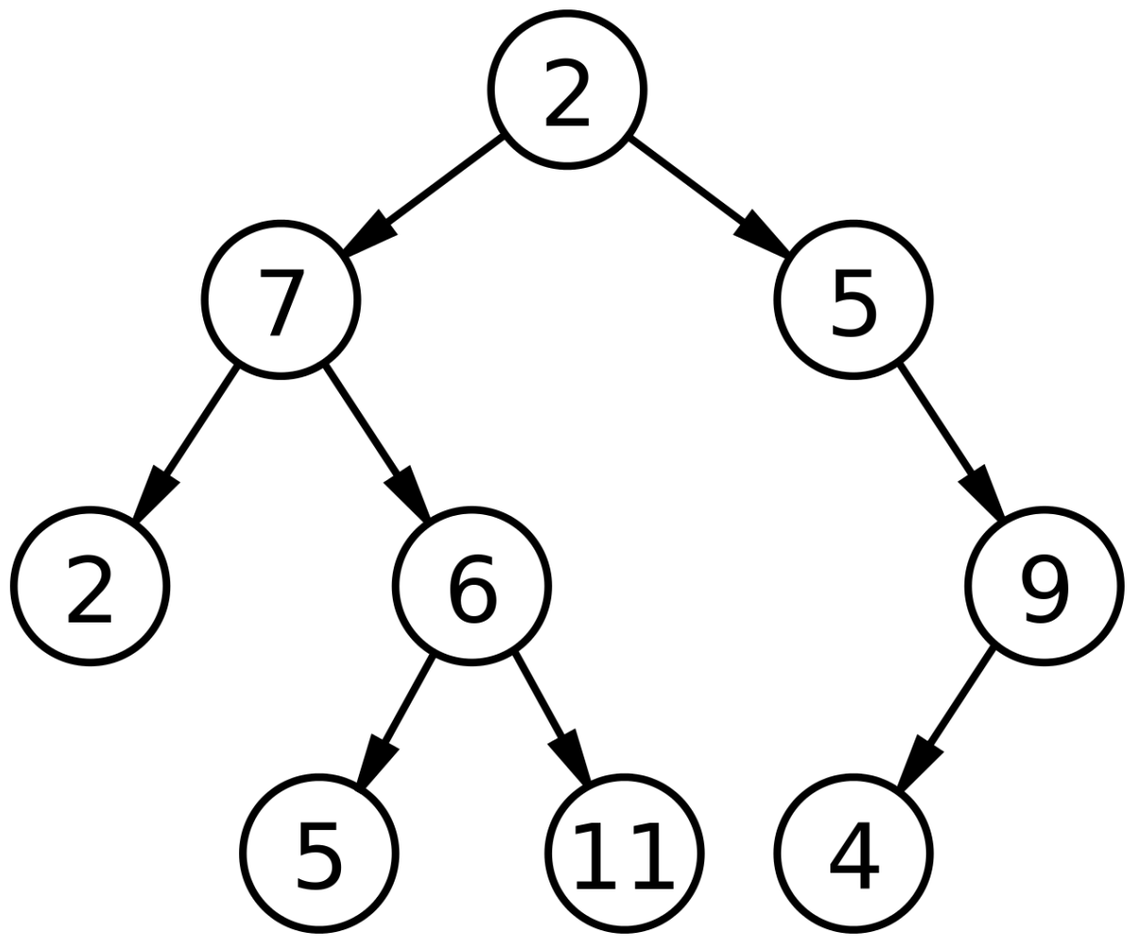
```

2
5



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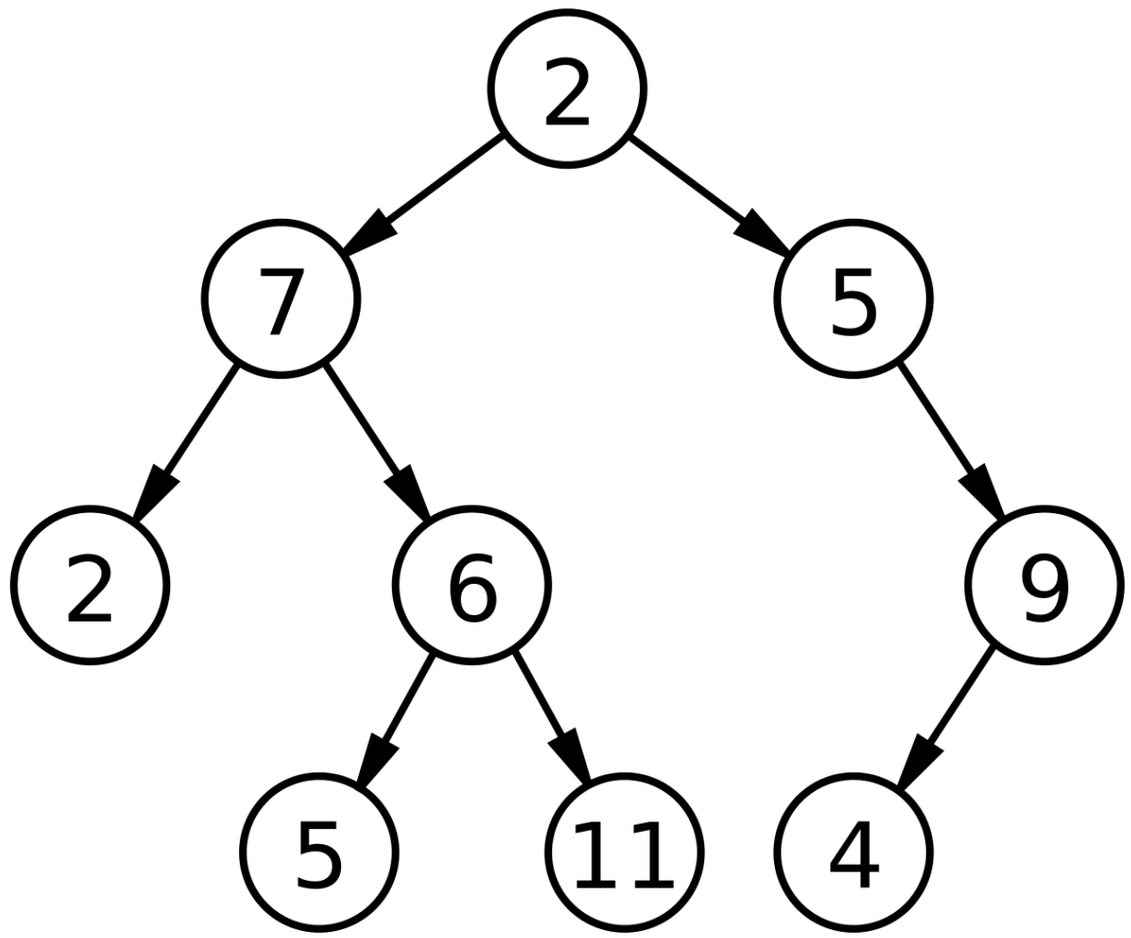
```

2
5
11



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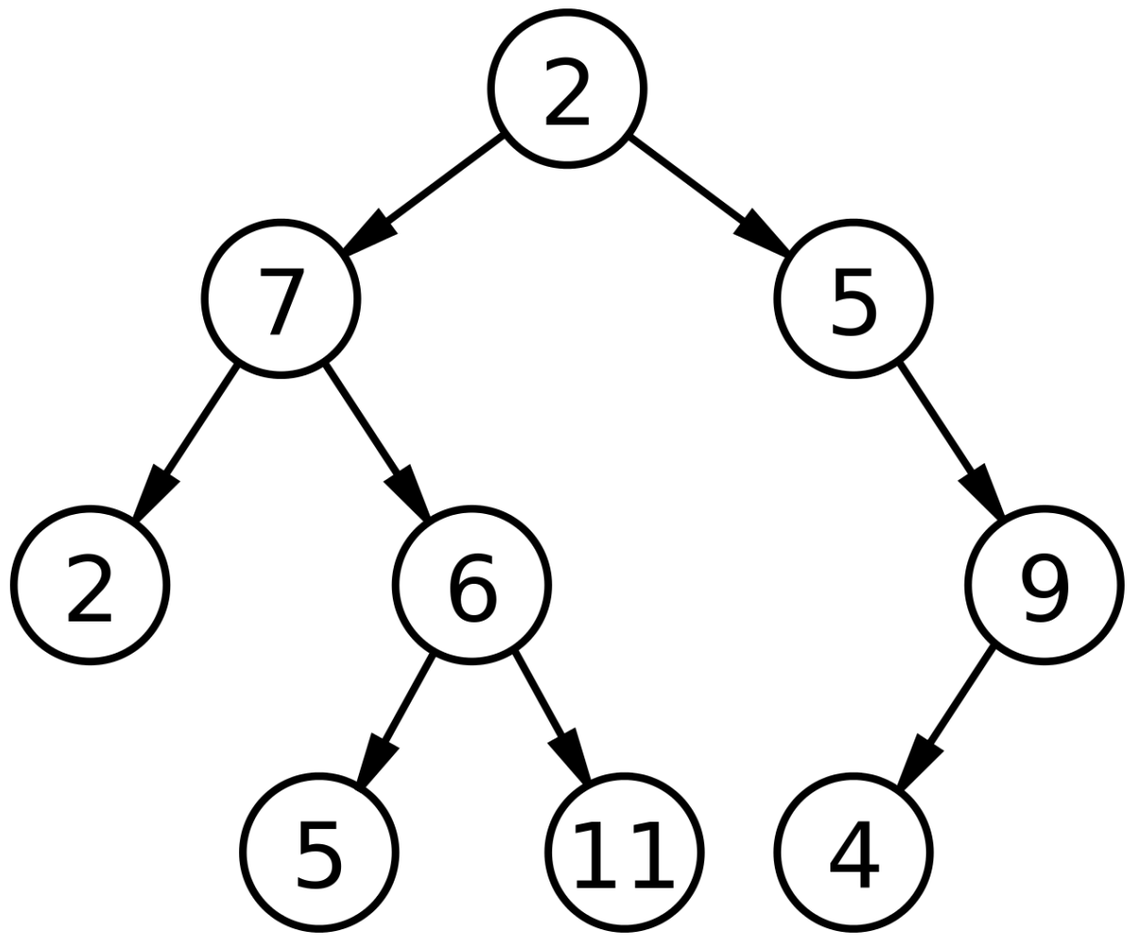
```

2
5
11
6



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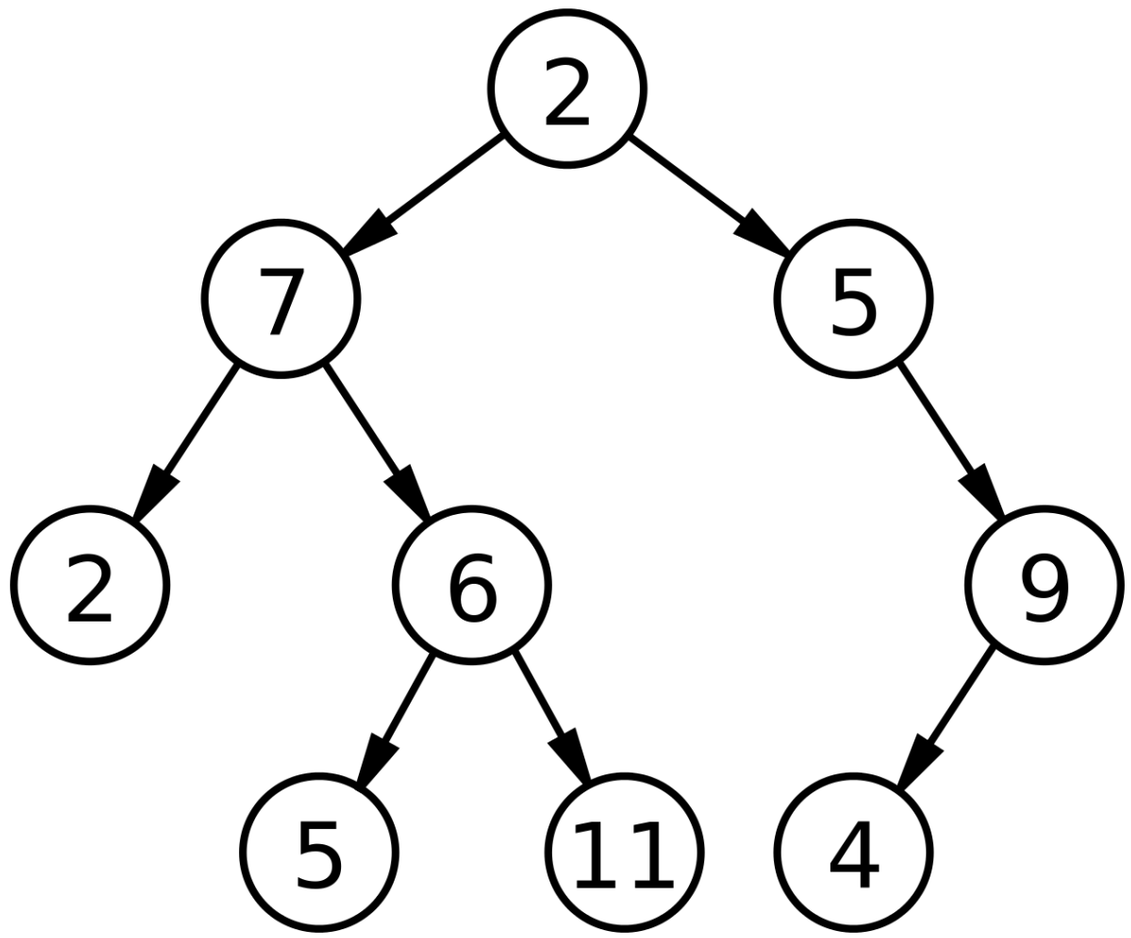
2
5
11
6
7



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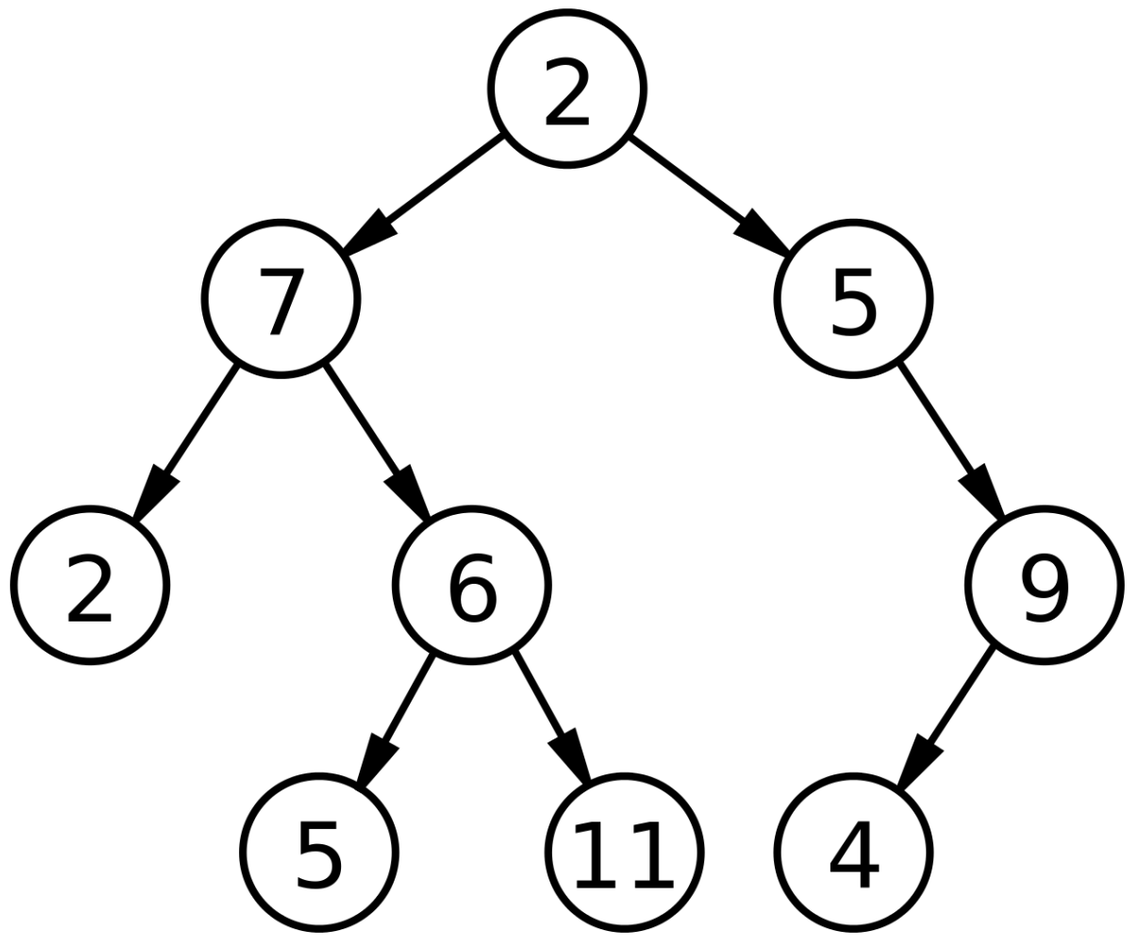
```

2
5
11
6
7
4



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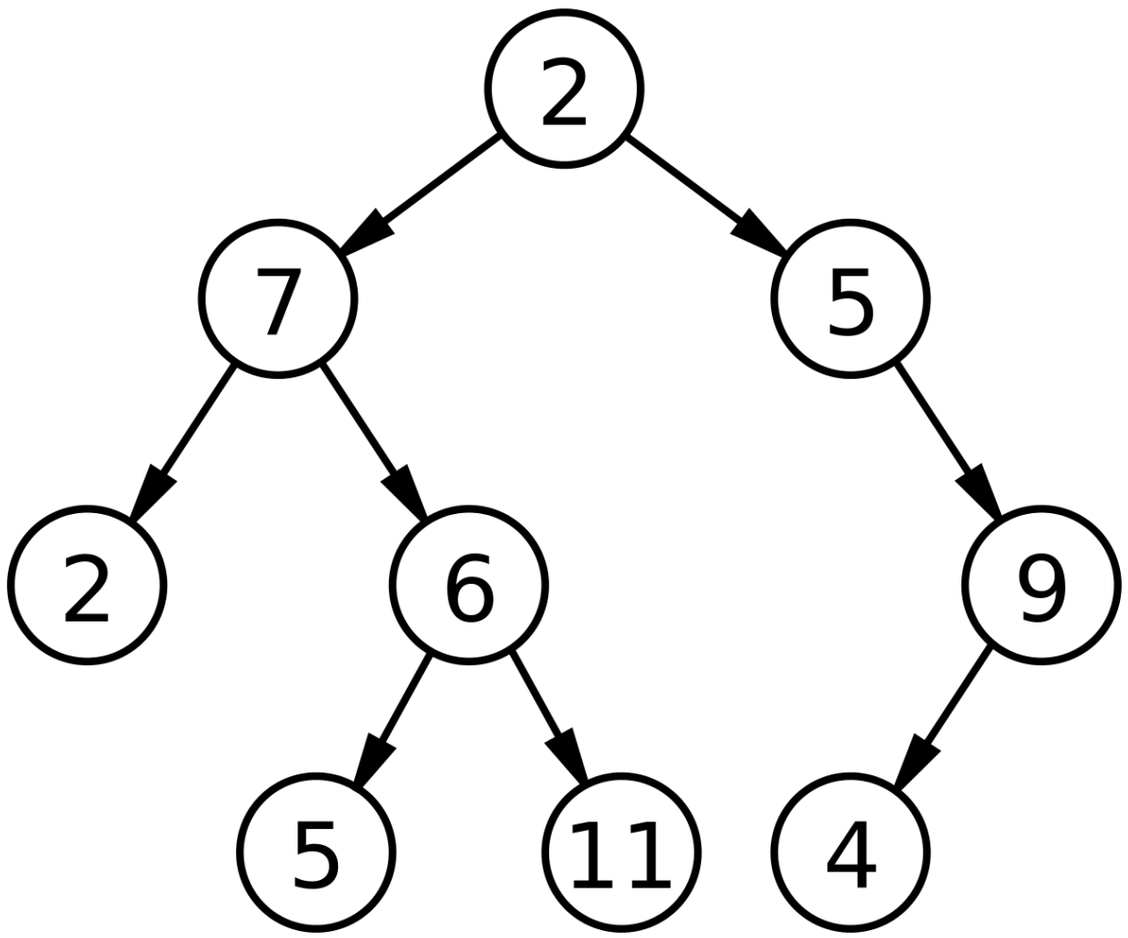
```

2
5
11
6
7
4
9



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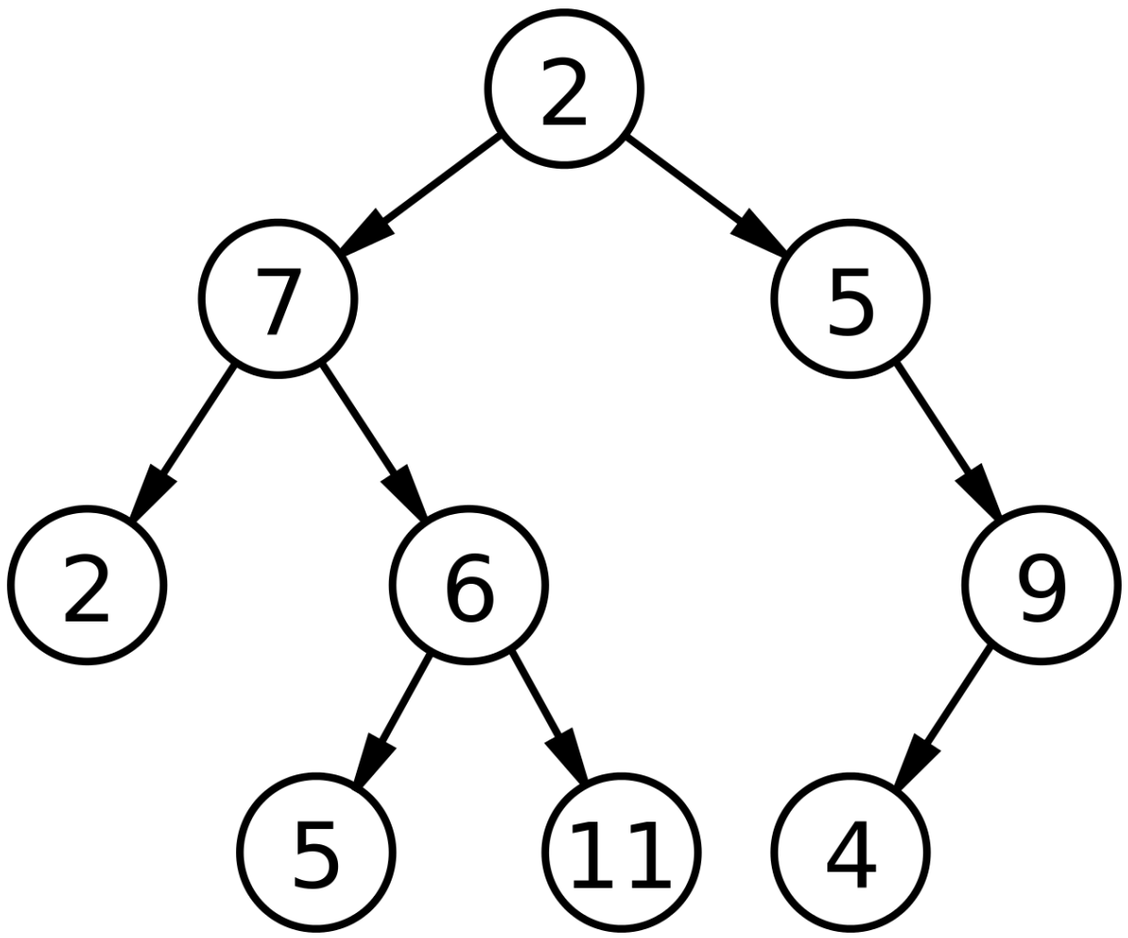
```

2
5
11
6
7
4
9
5



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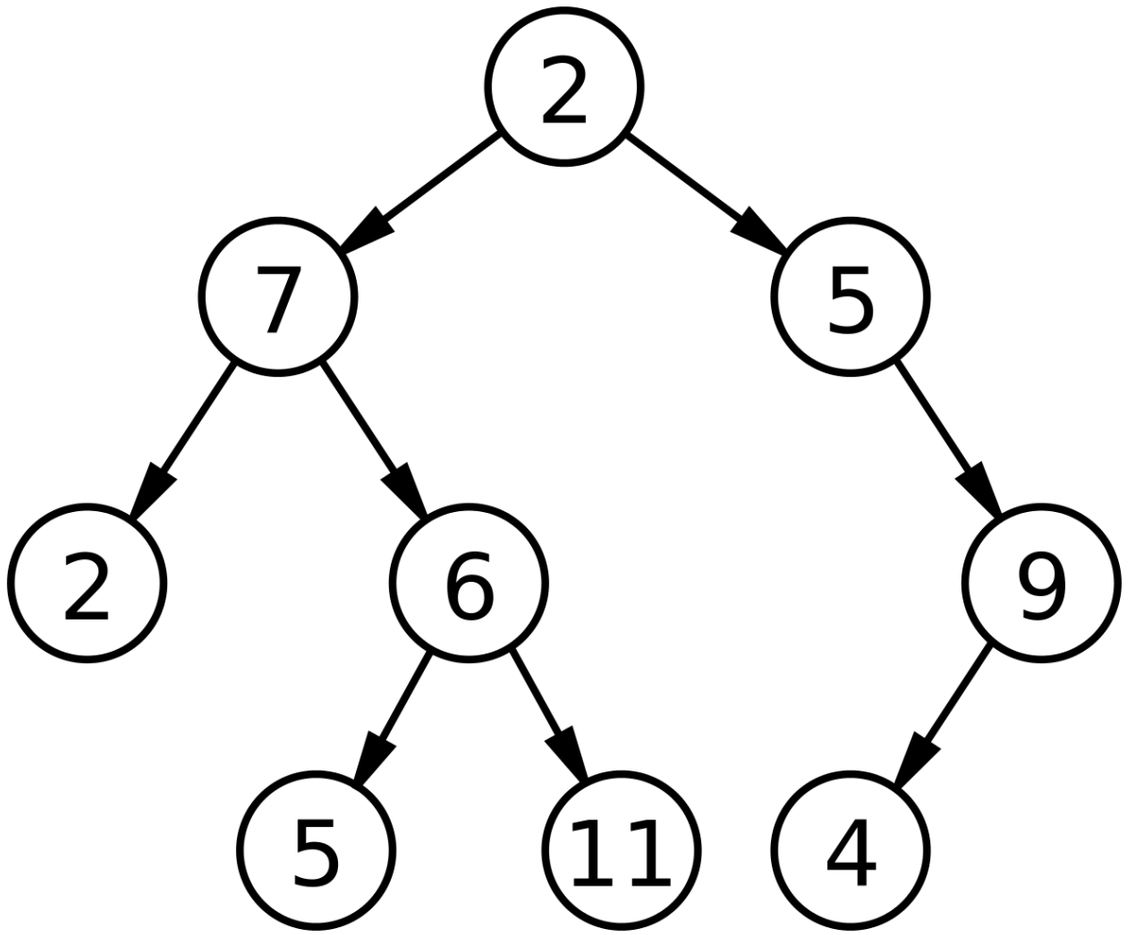
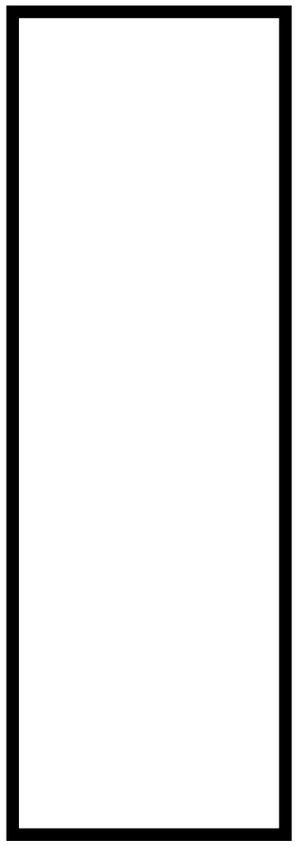
      visit the current node
```

2
5
11
6
7
4
9
5
2



Stacks

- A stack is a data type that stores a collection of items.
- You can ***push*** (add) items onto the top of the stack and ***pop*** (remove) things off the top of the stack.
- Think of it like a stack of pancakes: you can add more pancakes on top or remove the top-most pancake.



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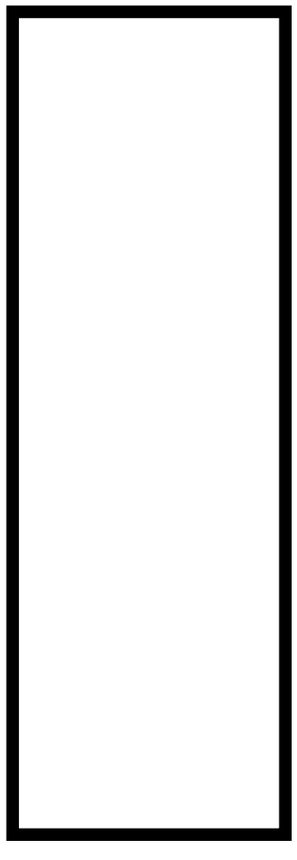
push(1)



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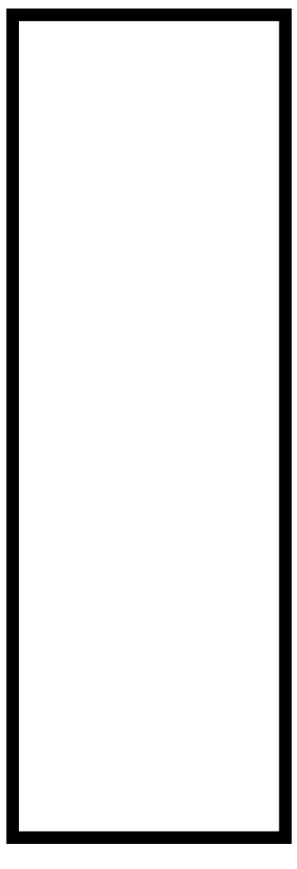
```



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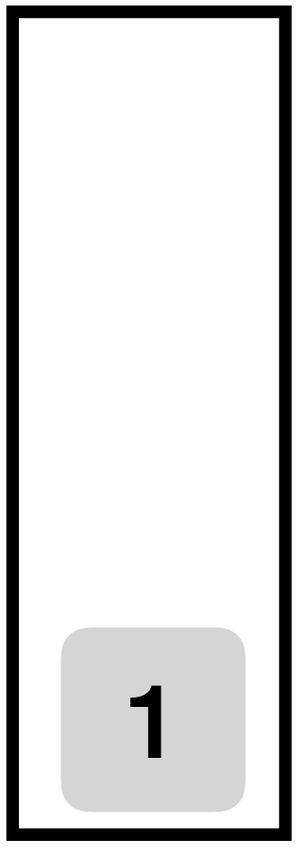

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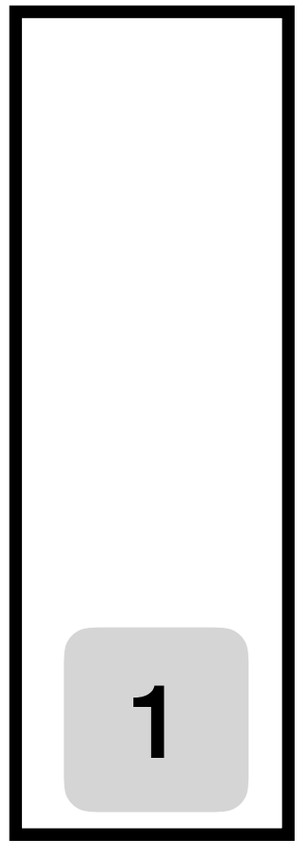
```
push(1)
push(2)
```



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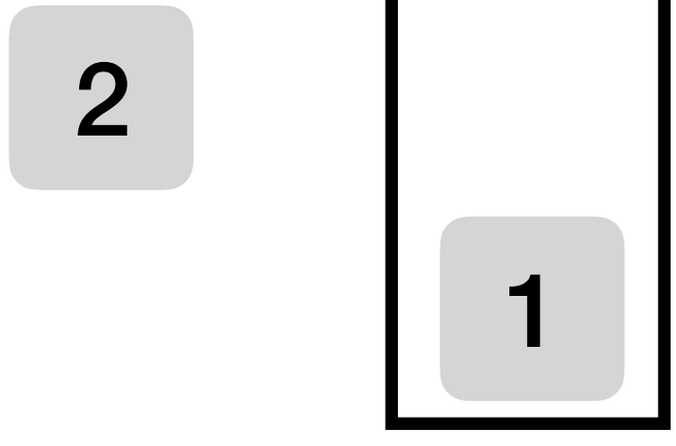

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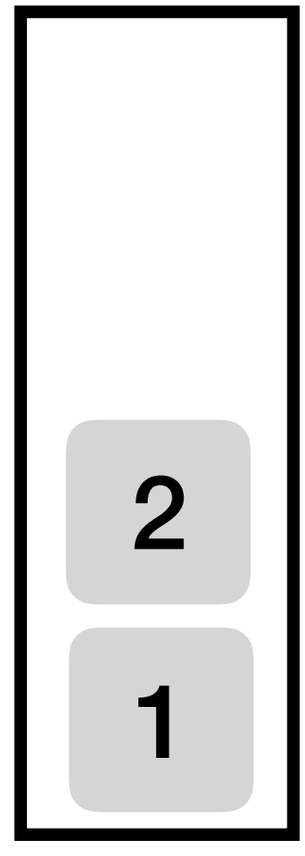

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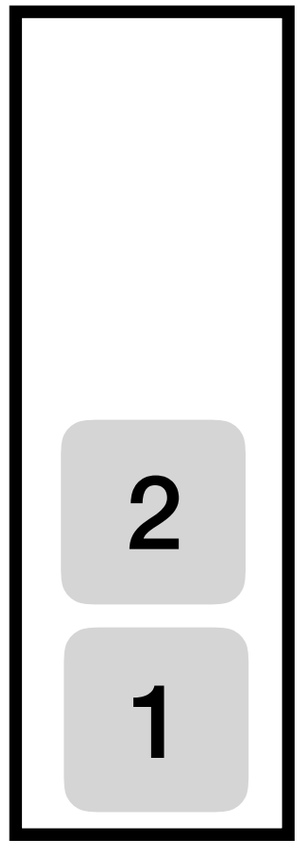

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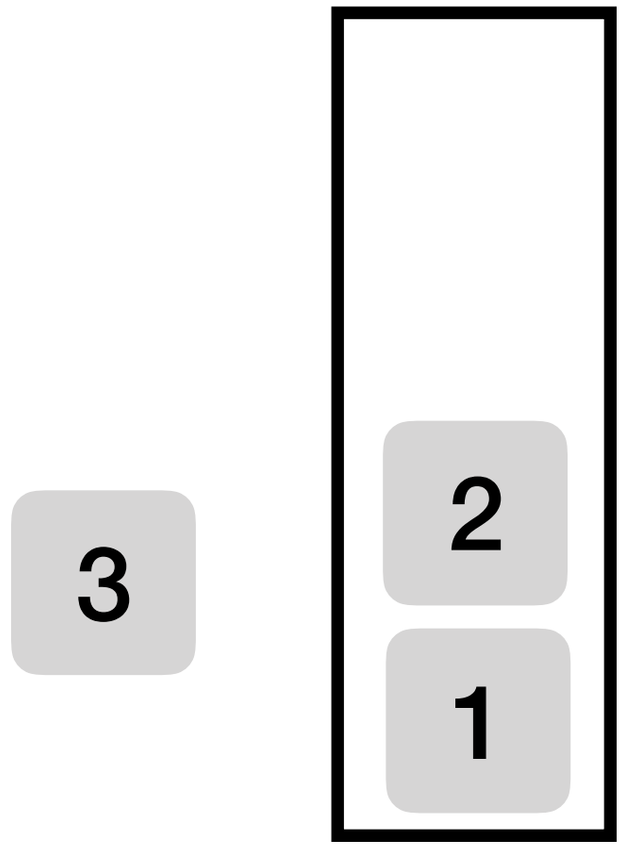

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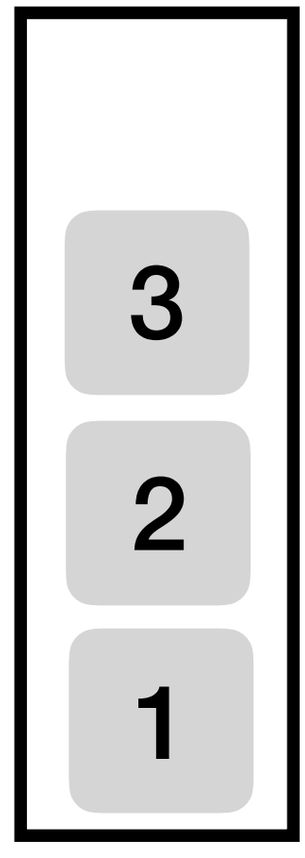

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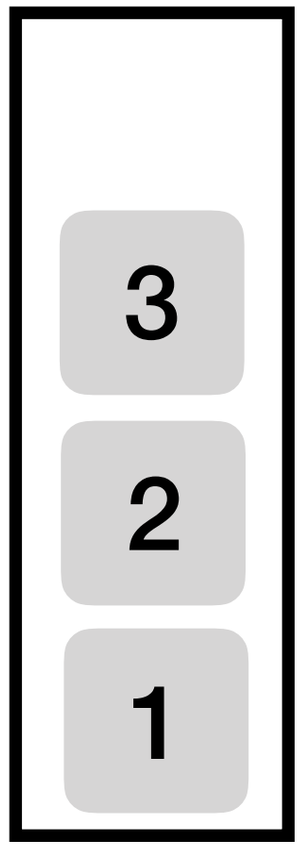

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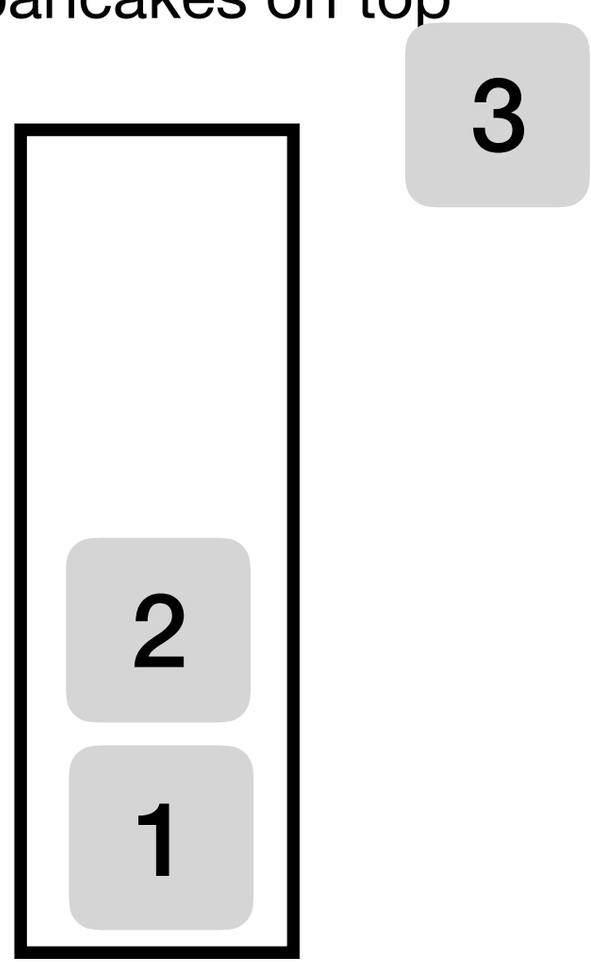

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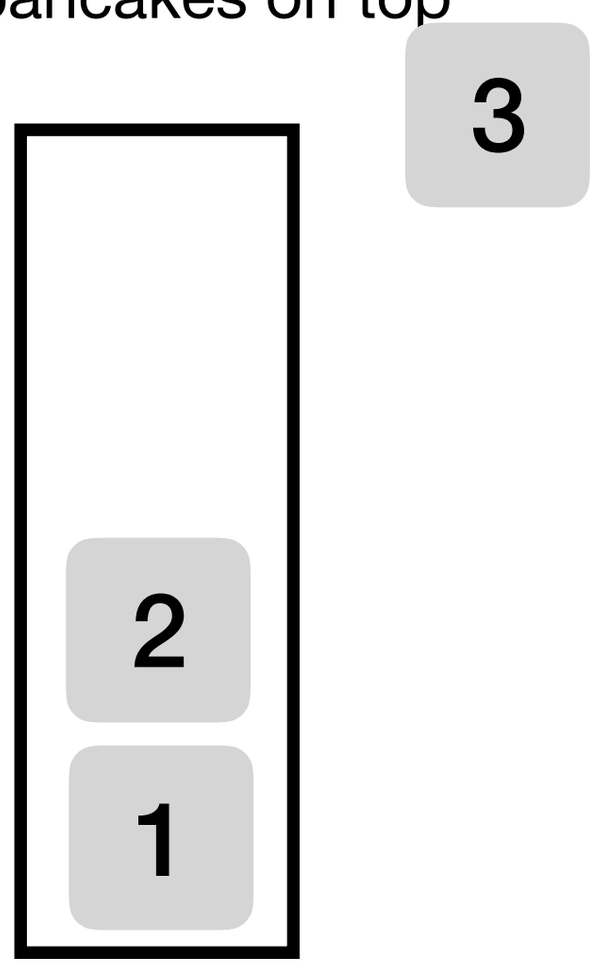

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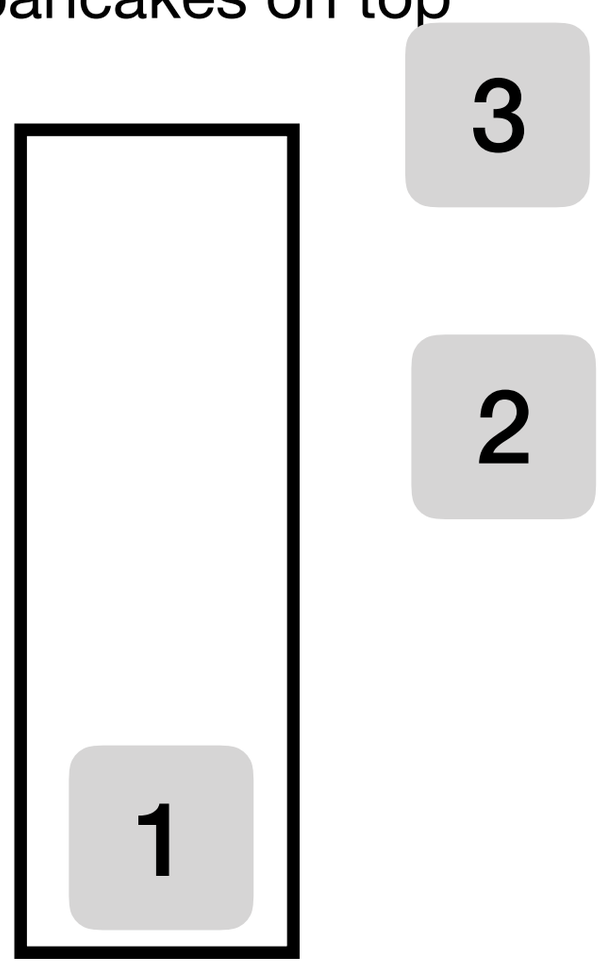

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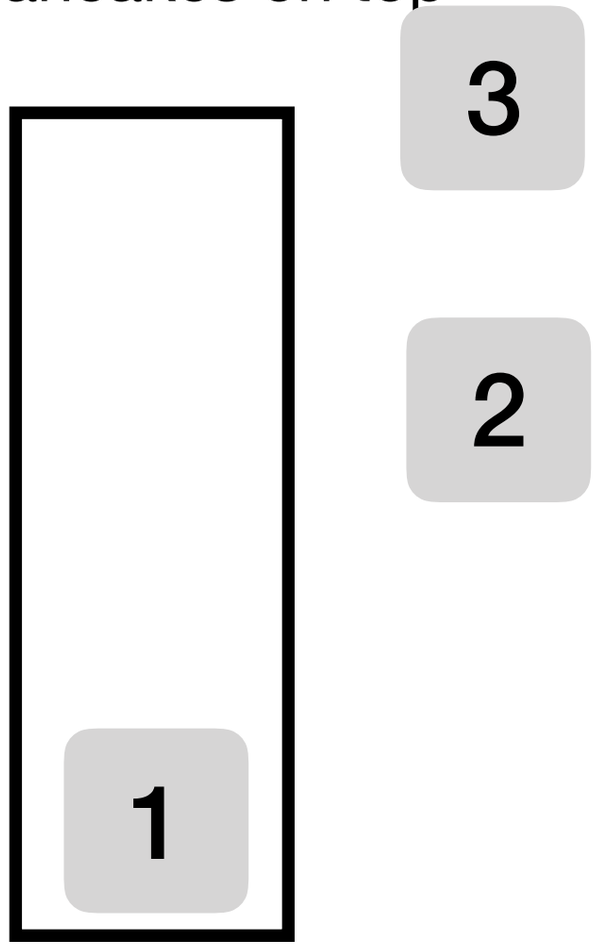

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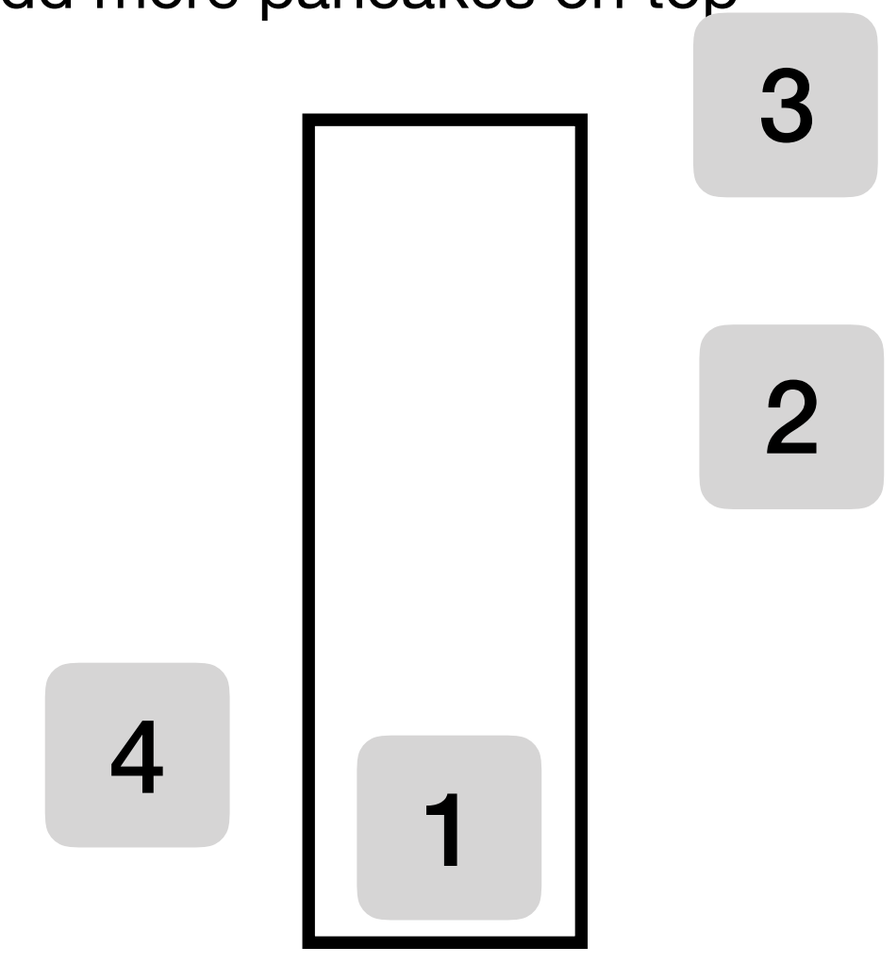

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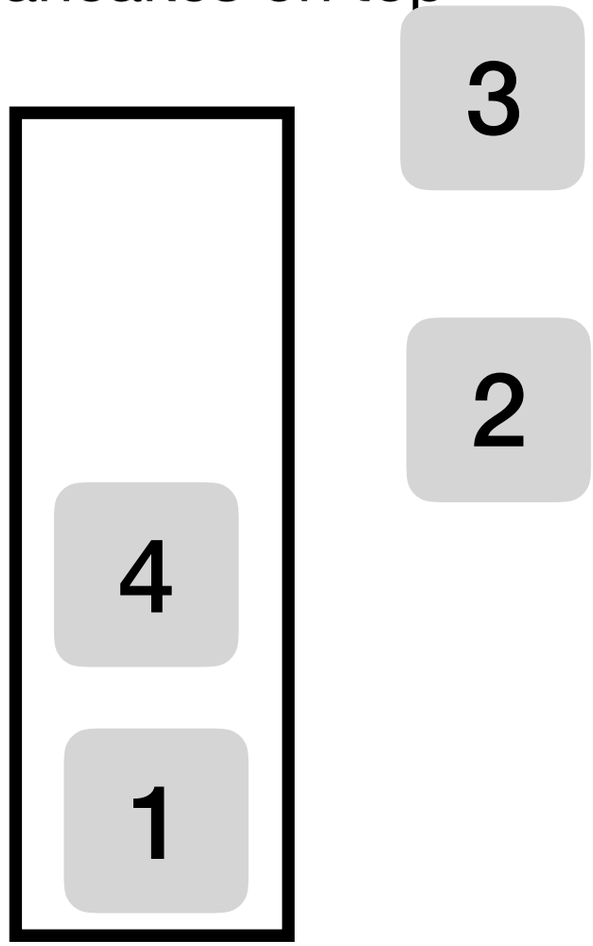

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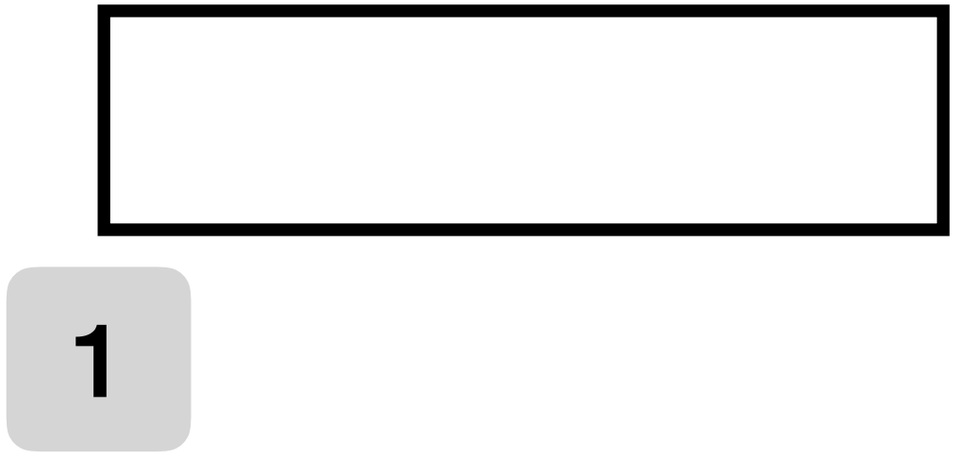

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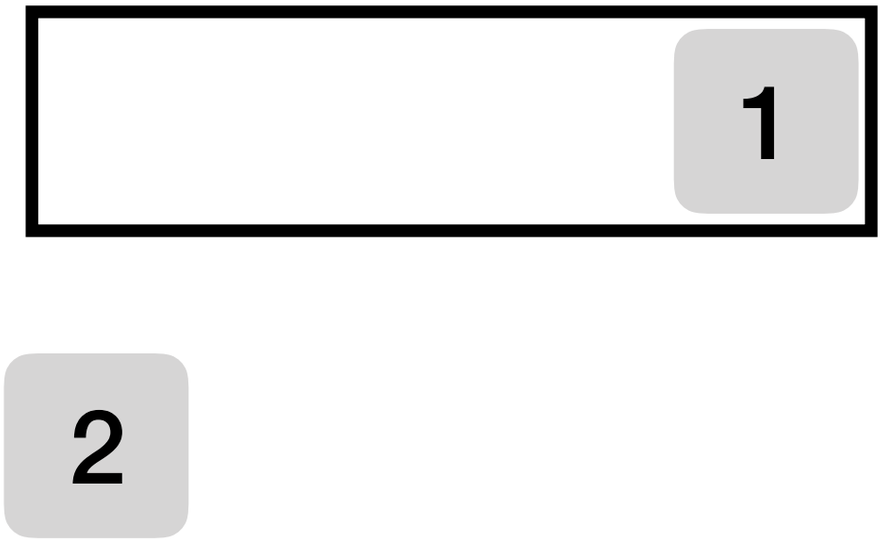

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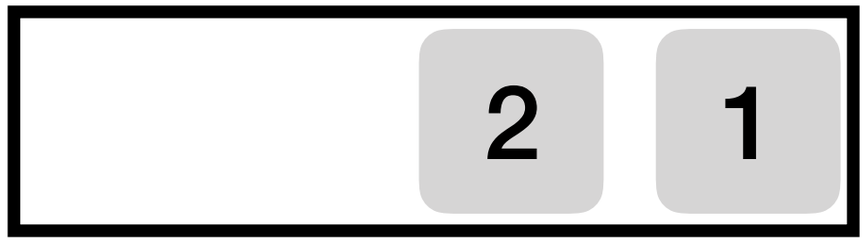

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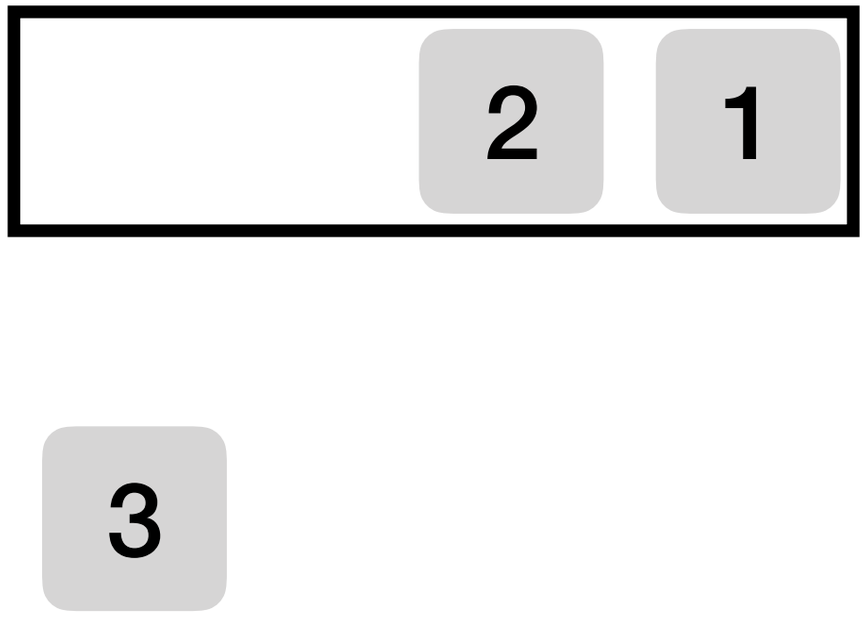

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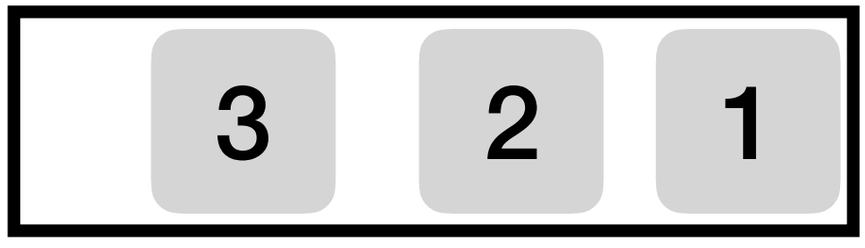

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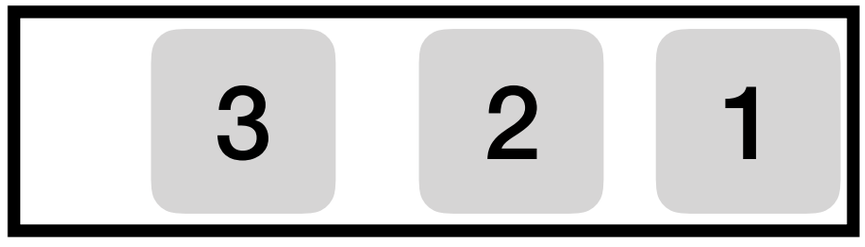

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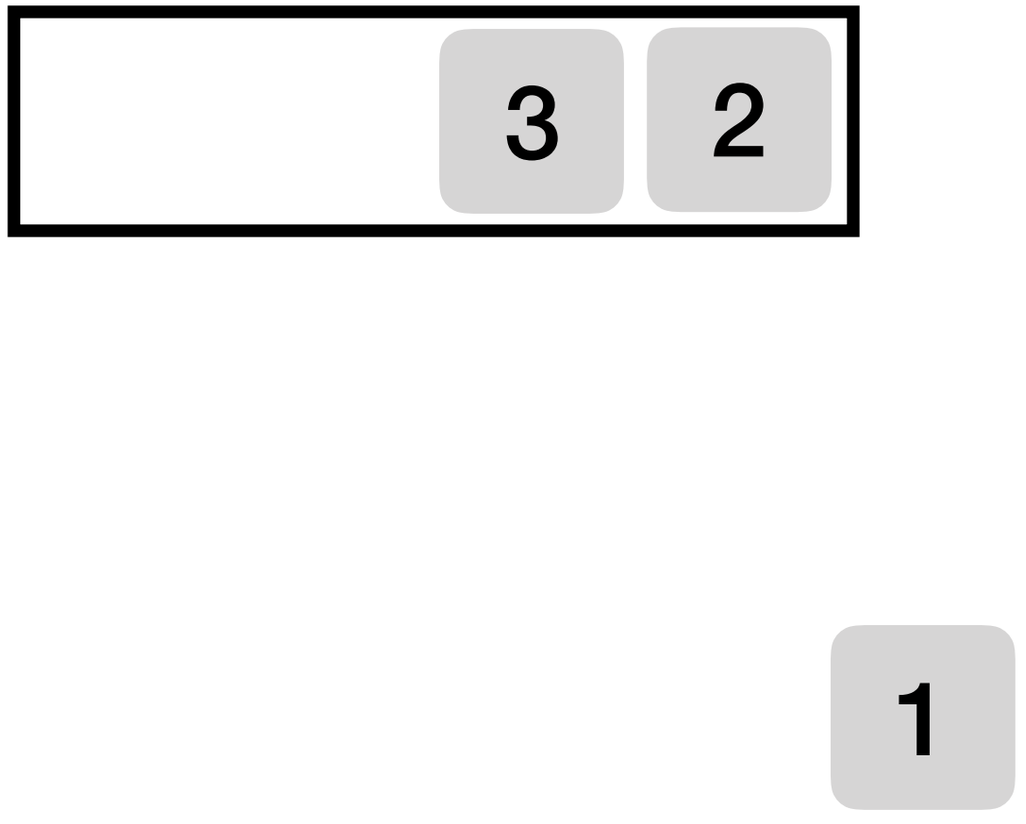

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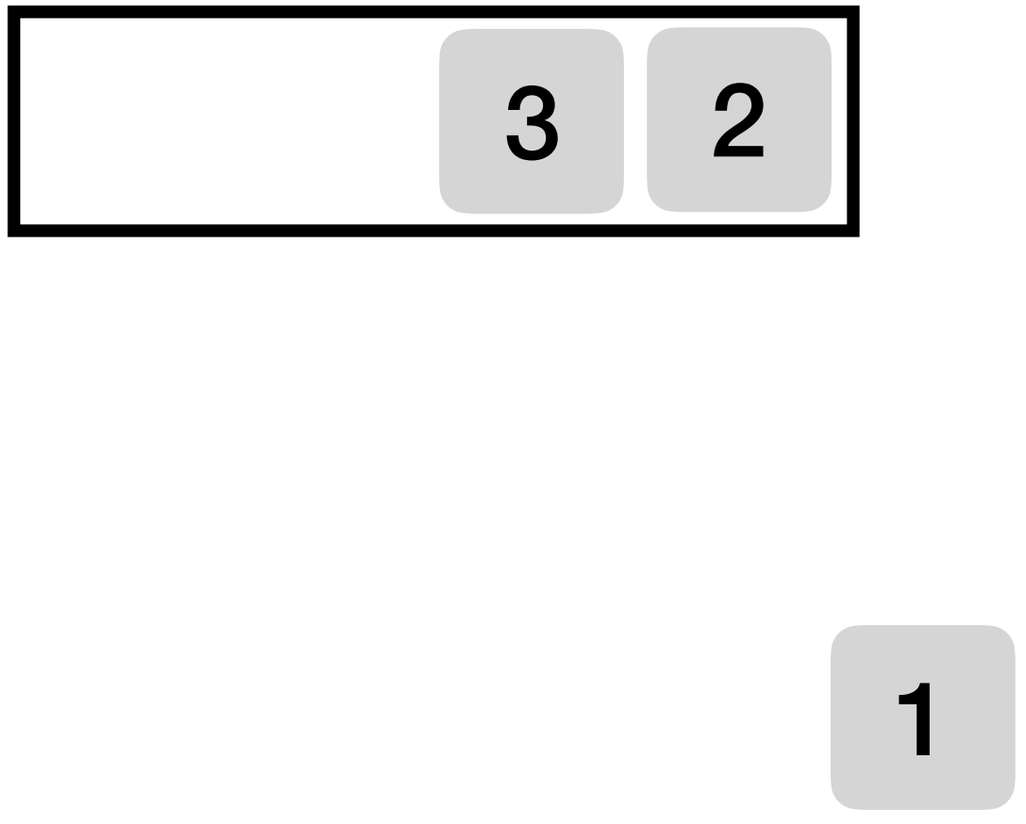

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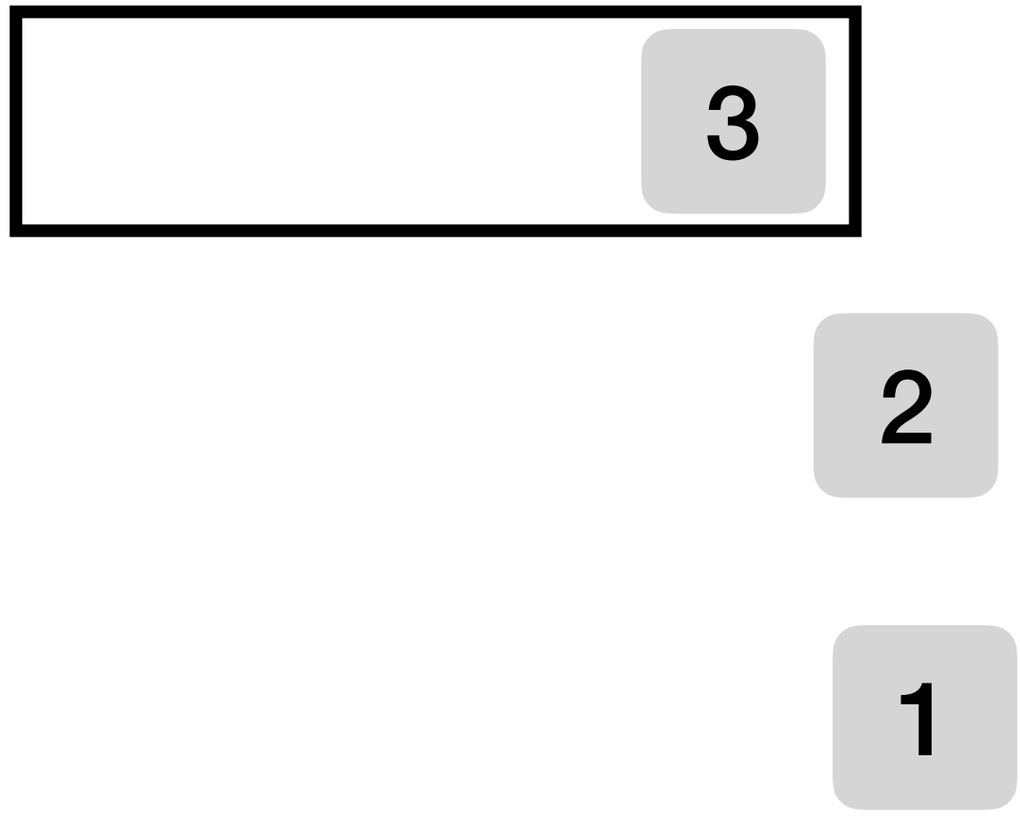

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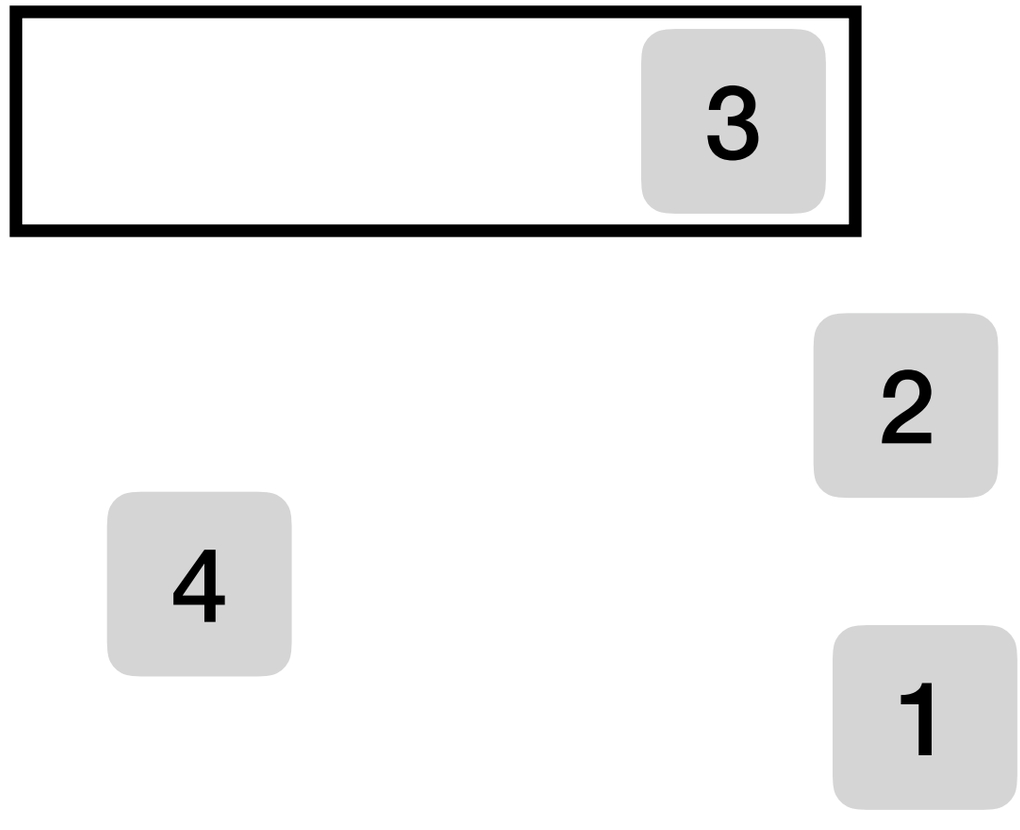

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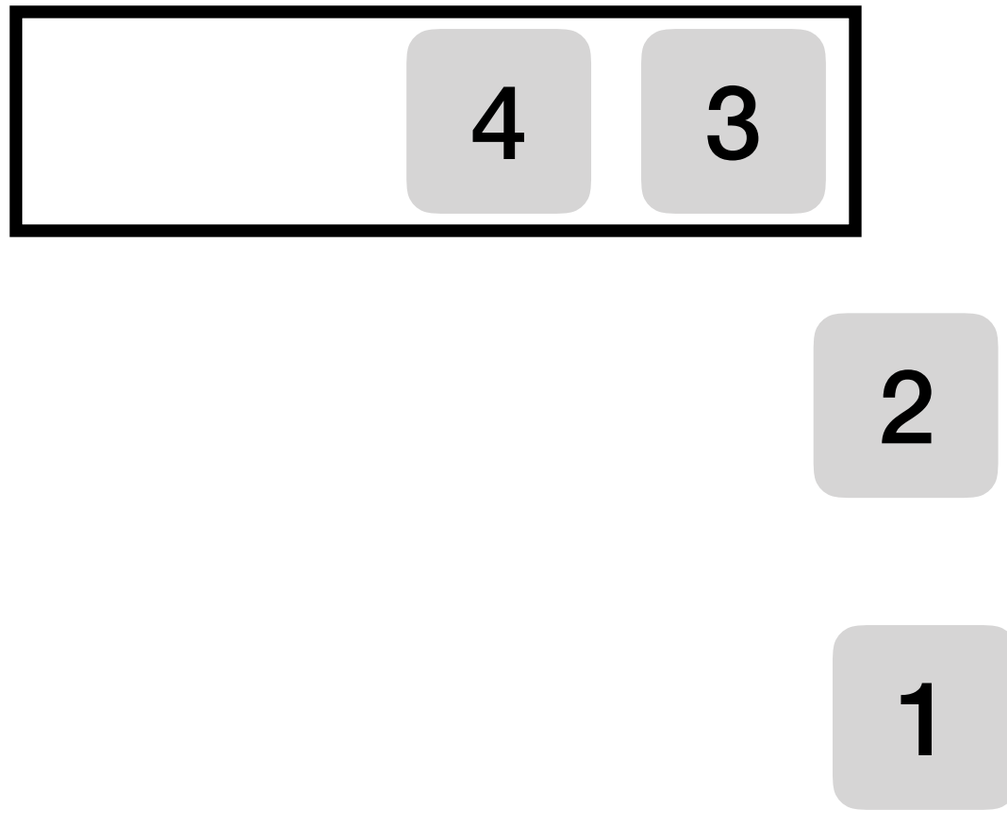
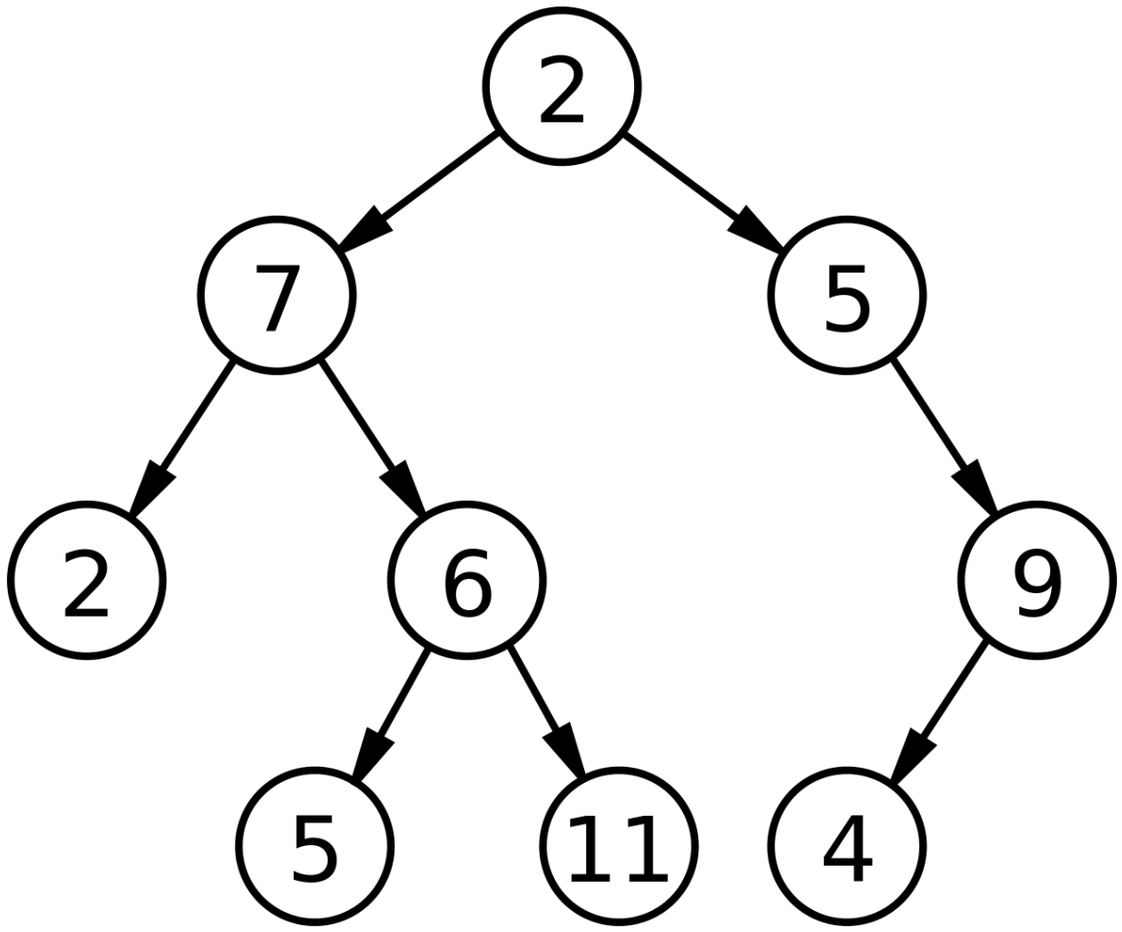


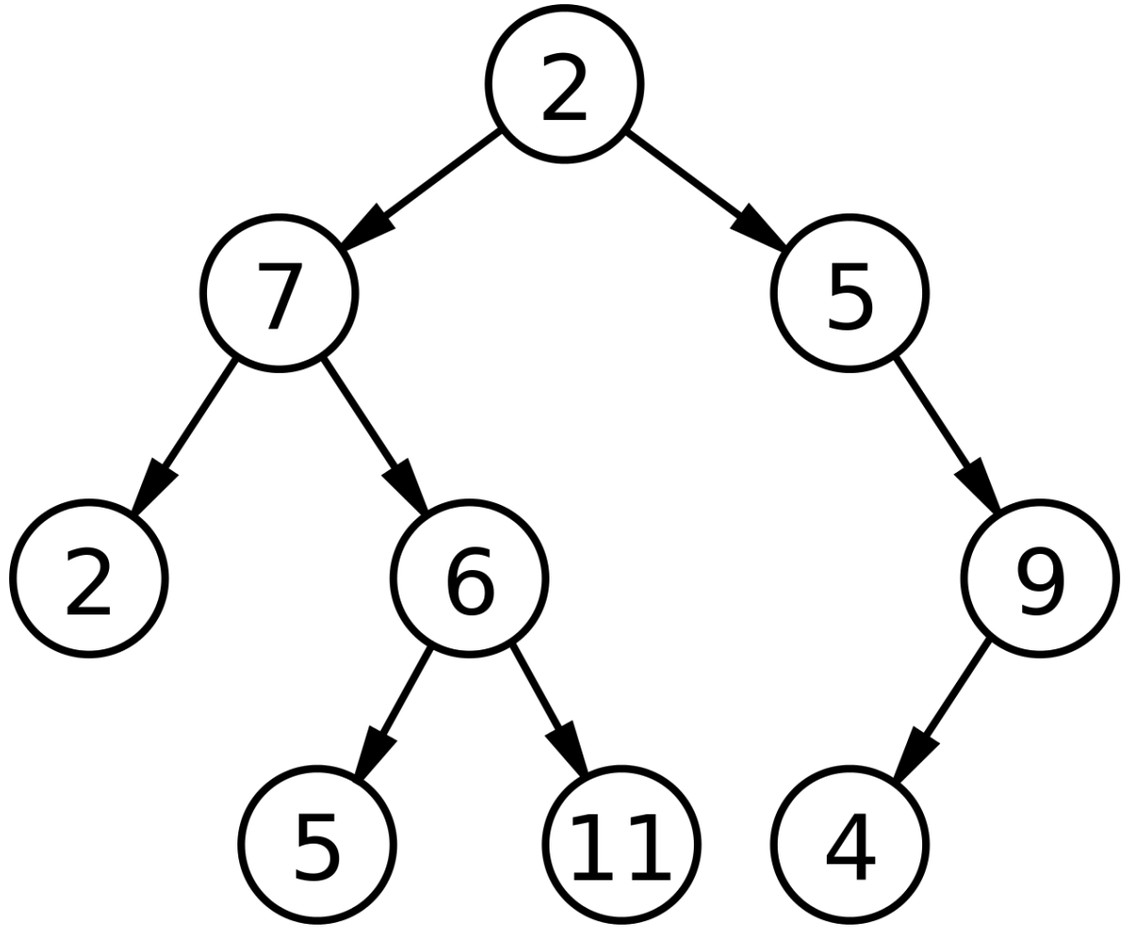
Iterative Traversals

- These data structures are great for traversing the tree iteratively!



Depth-First Search (DFS)

- Visit a node, and then completely visit each child subtree before moving on to the next child.



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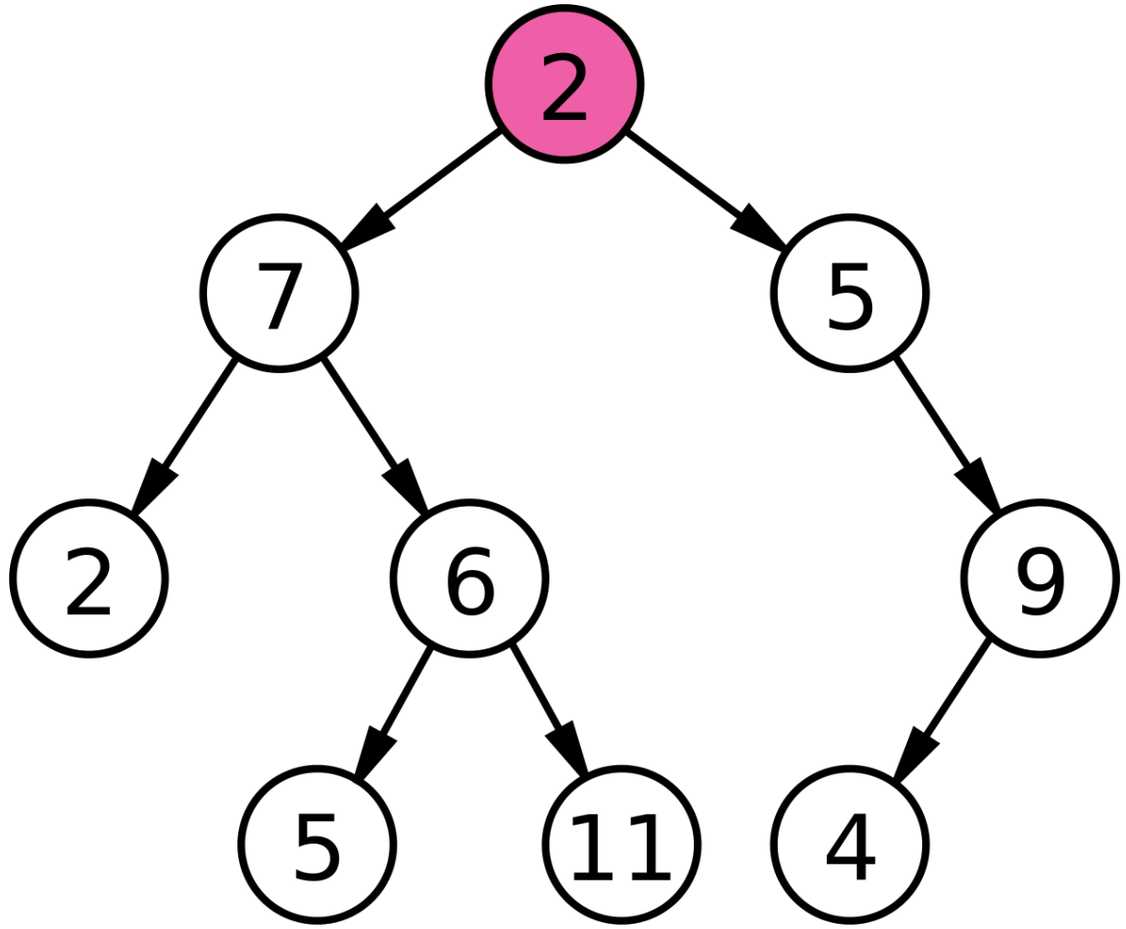

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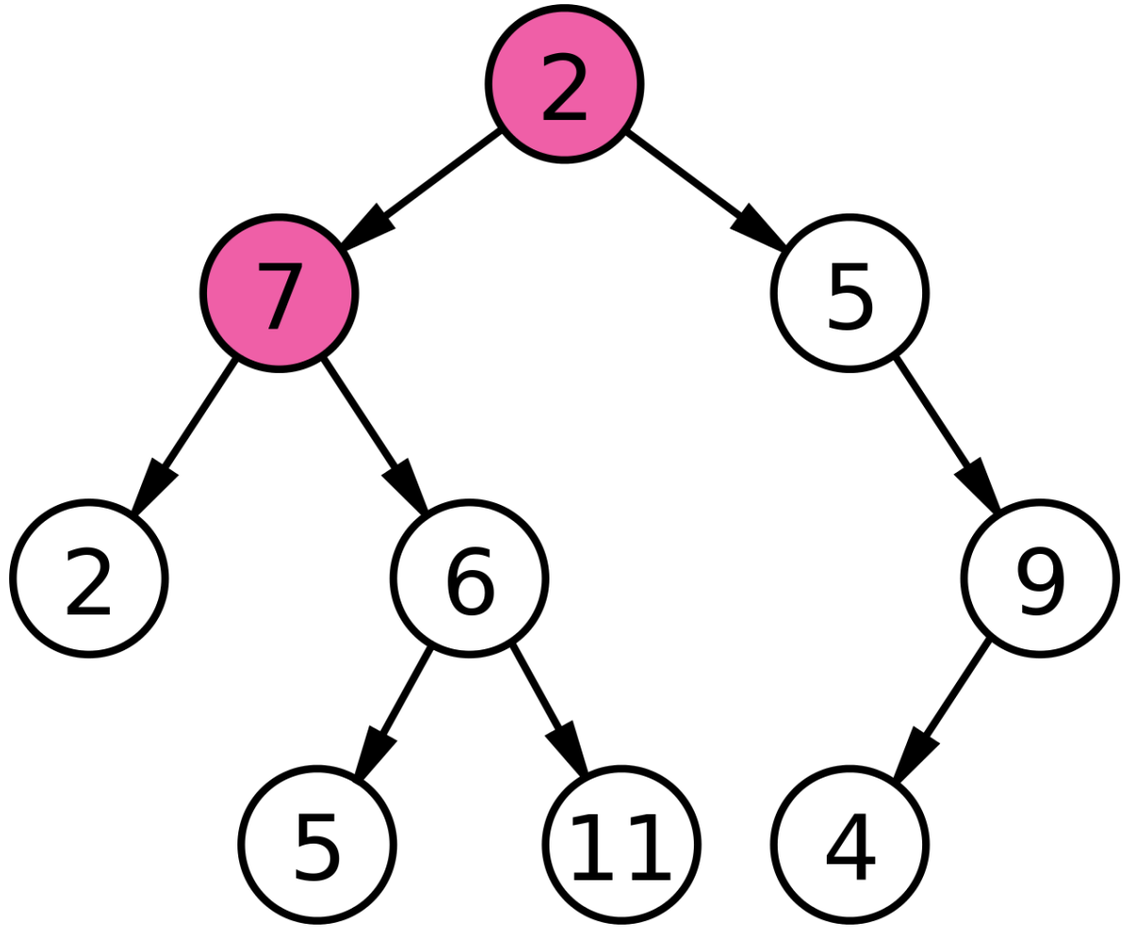

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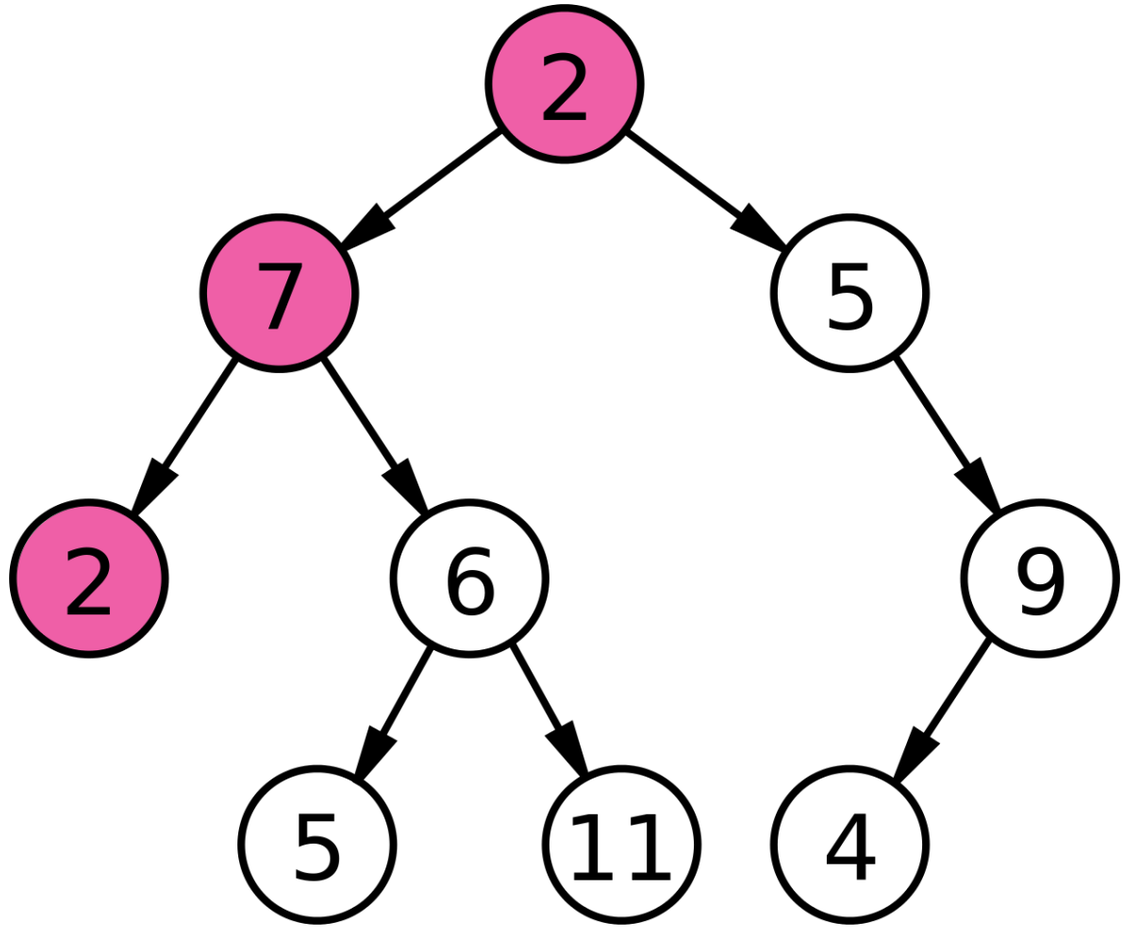

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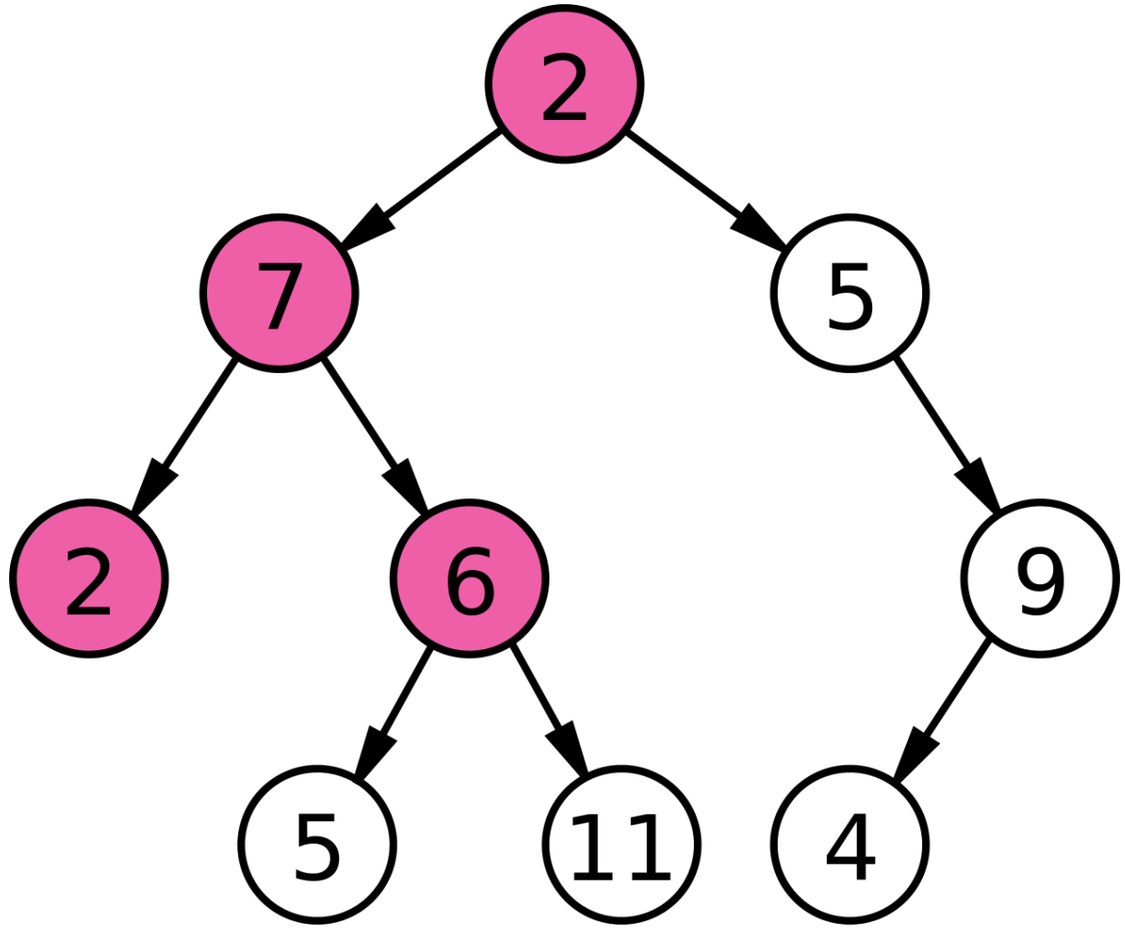

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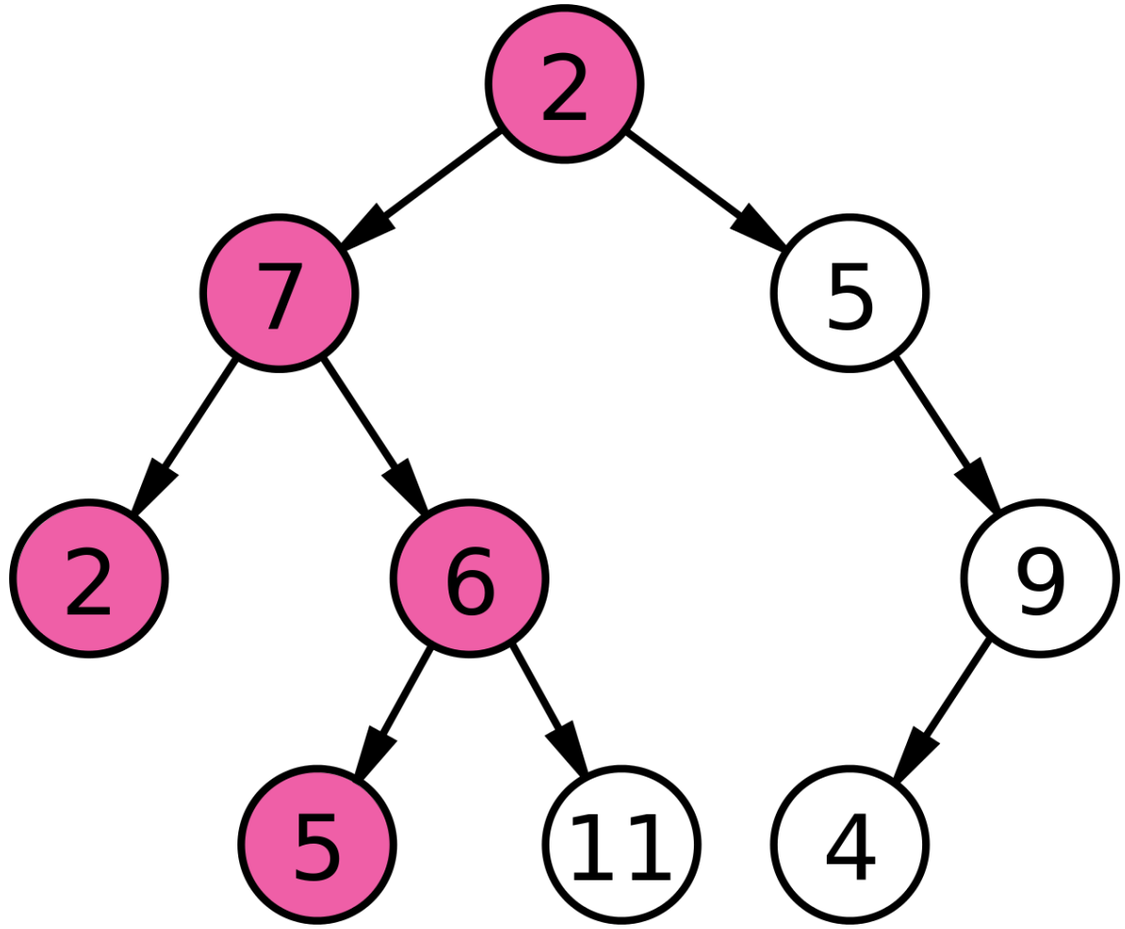

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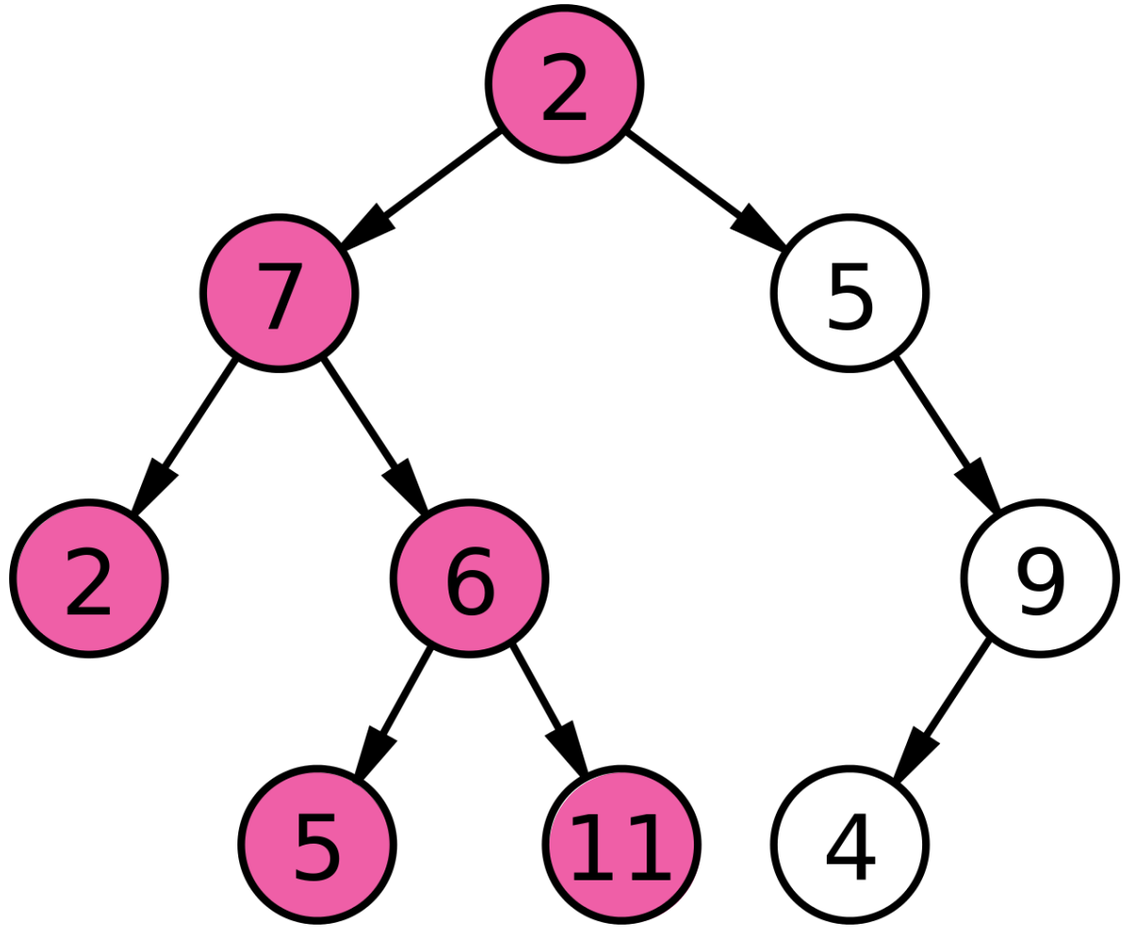

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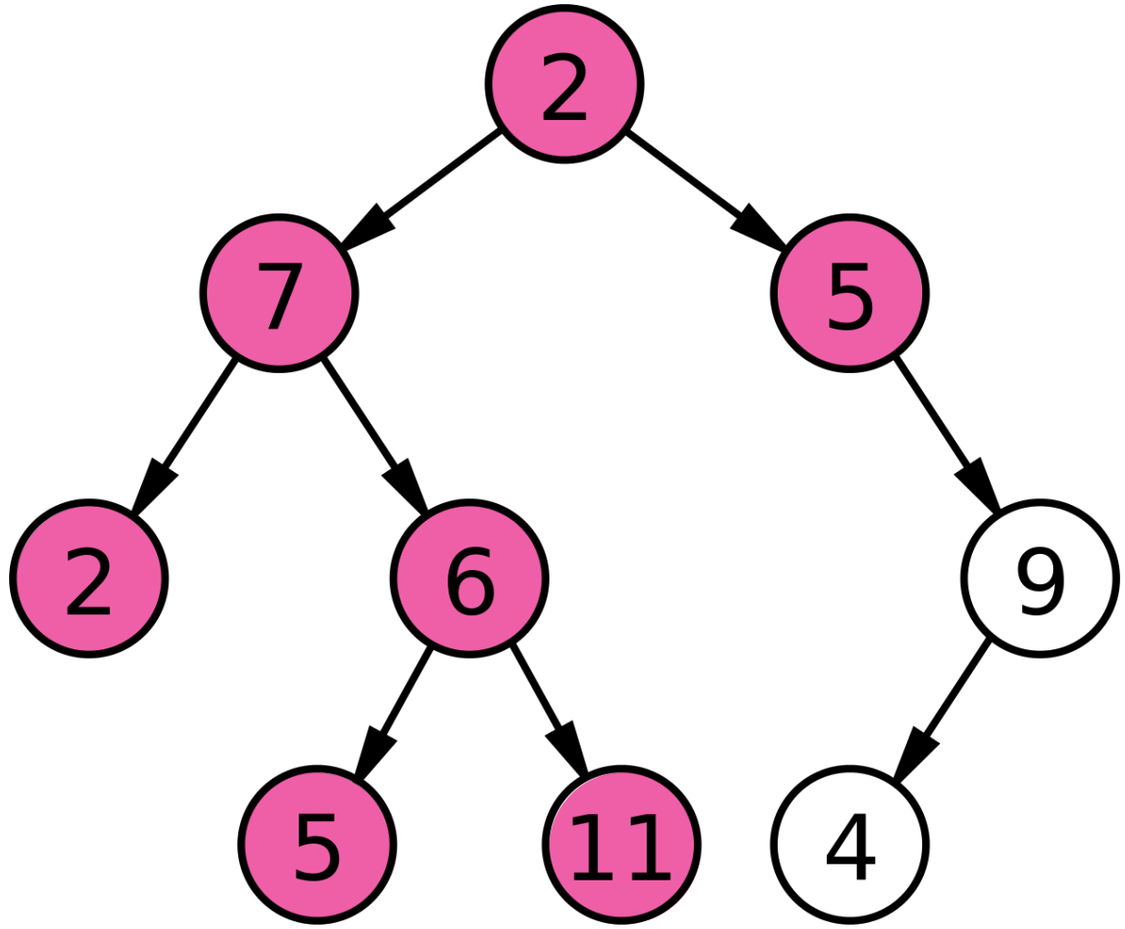

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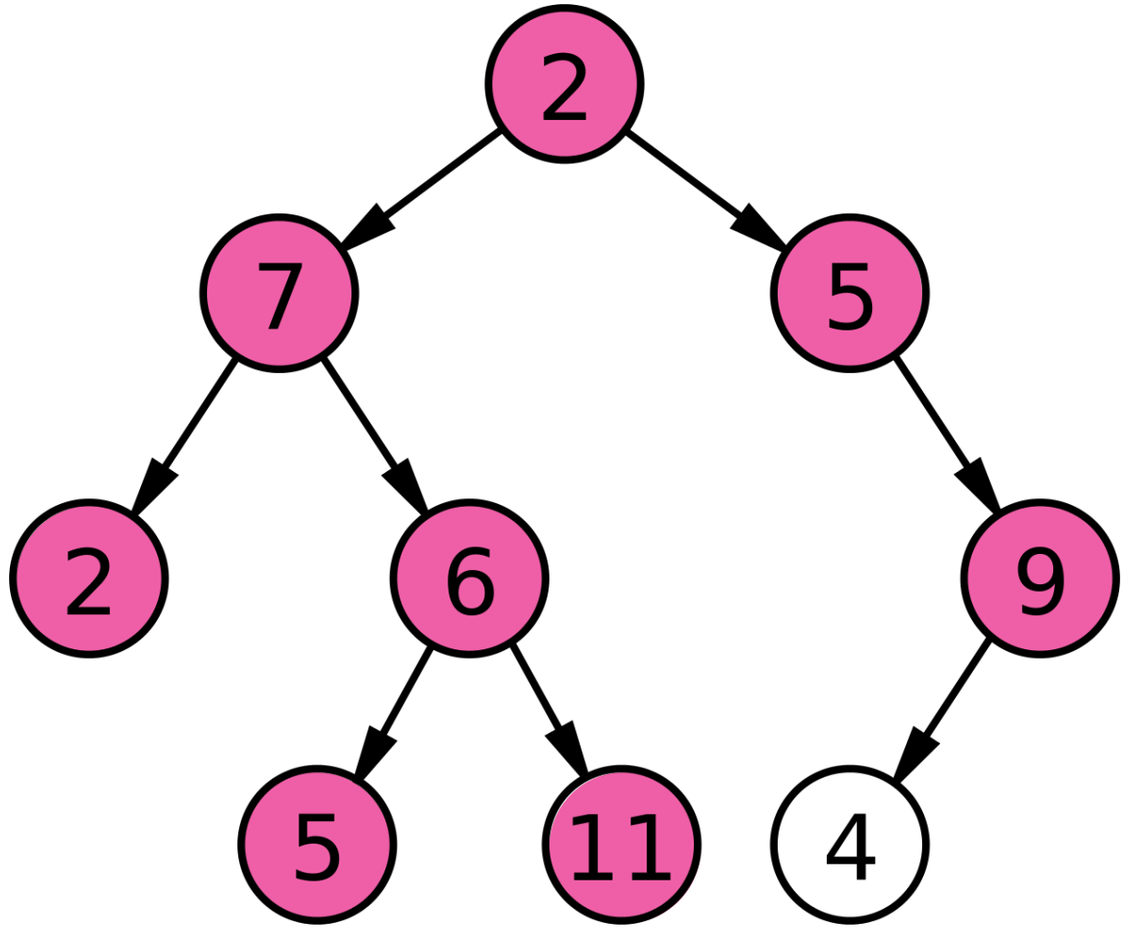

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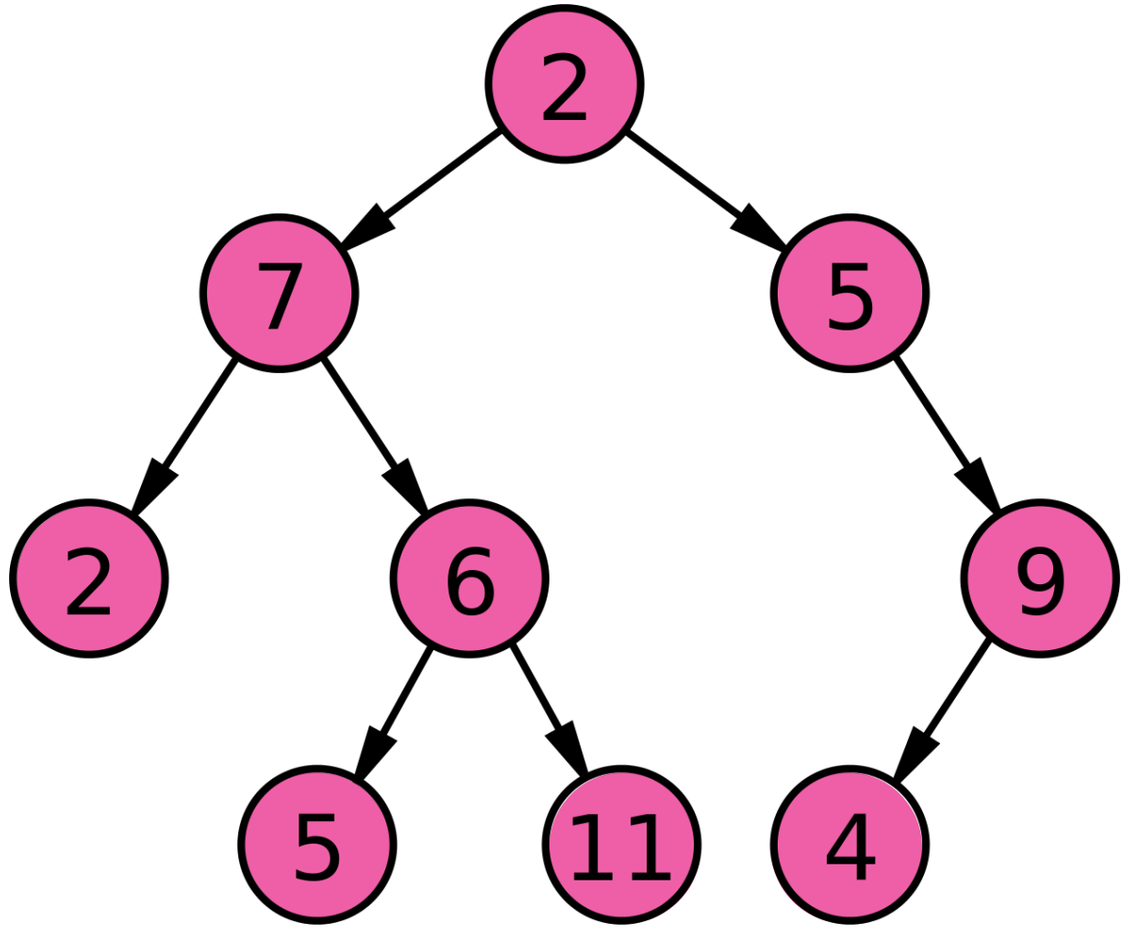


Pseudocode

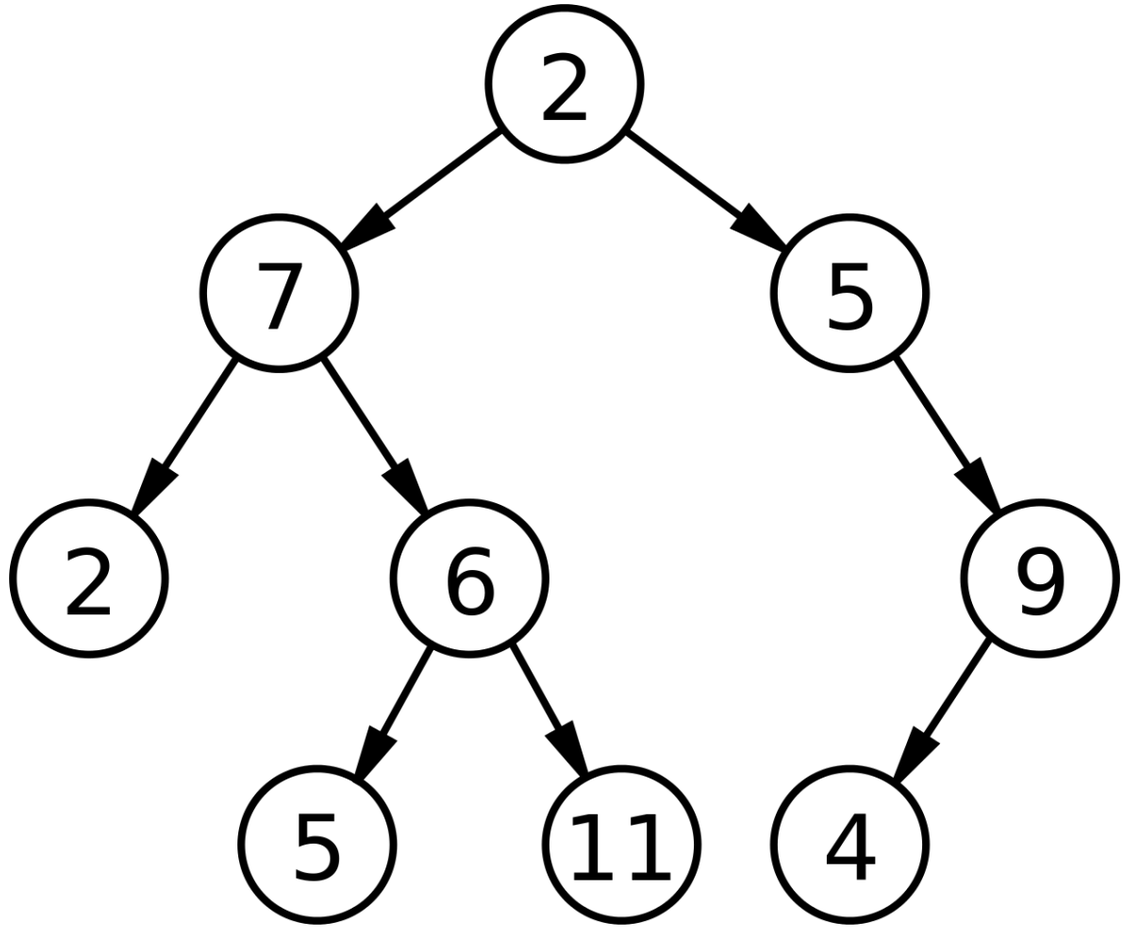
```
initialize a stack called the "fringe"

add root to the fringe

while the fringe is not empty:
    pop the topmost node from the fringe
    push all of its children onto the fringe
    Process removed node
```

Breadth-First Search (DFS)

- Visit a node, visit each children, and then visit the children's children.



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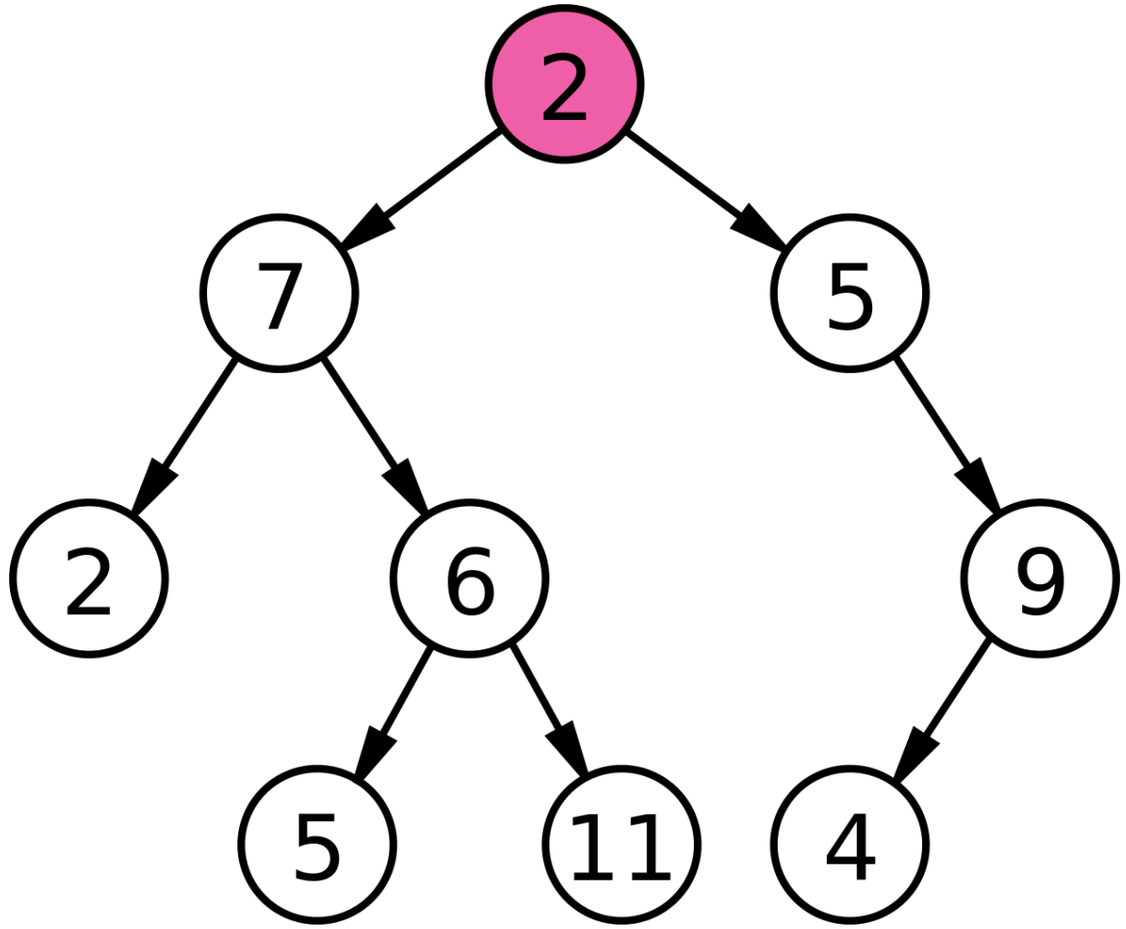

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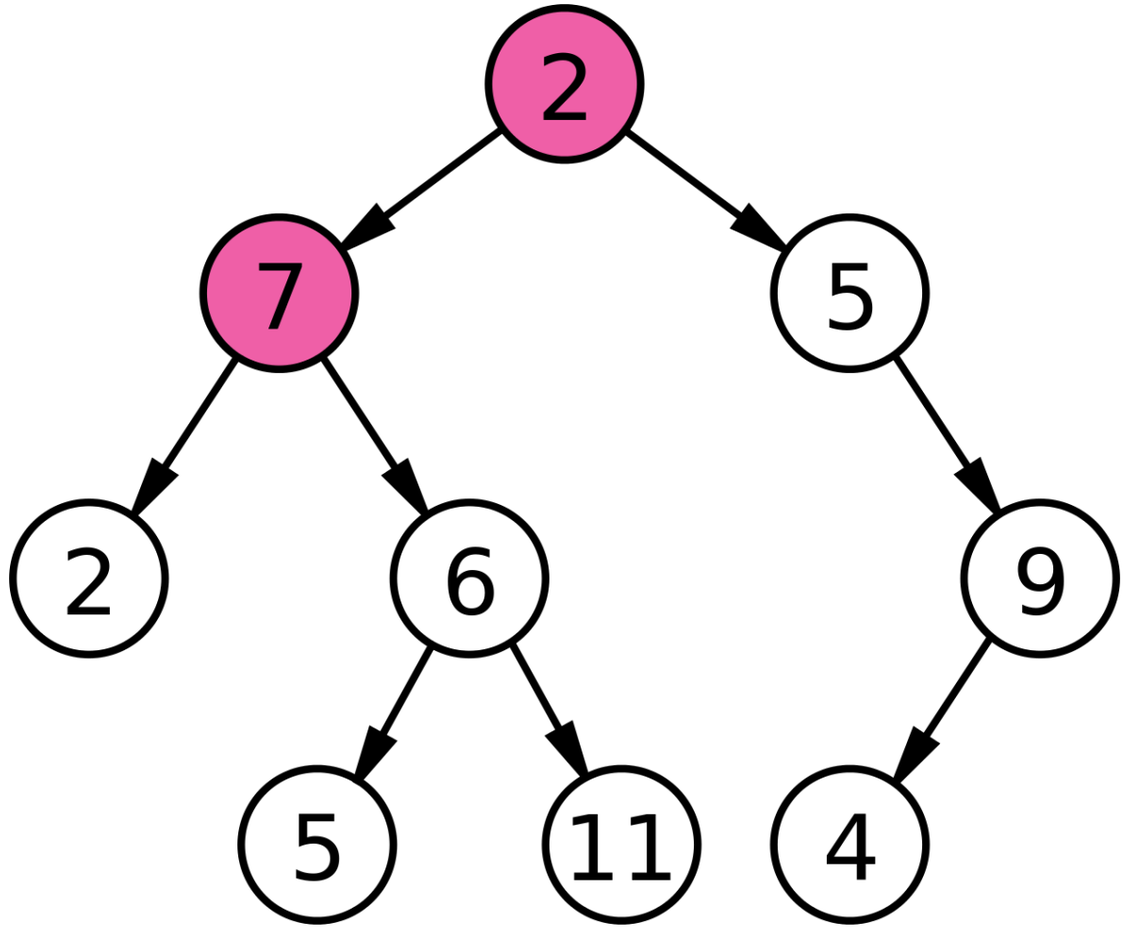

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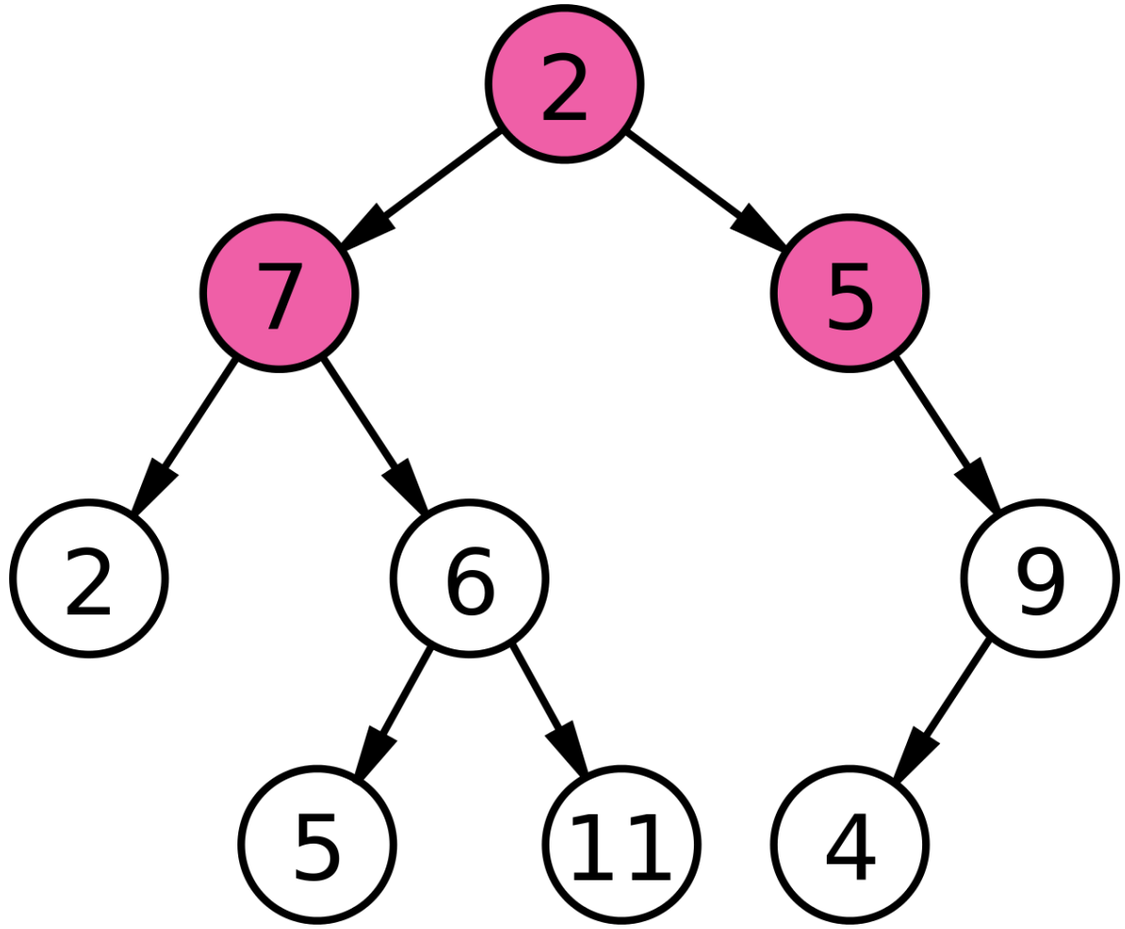

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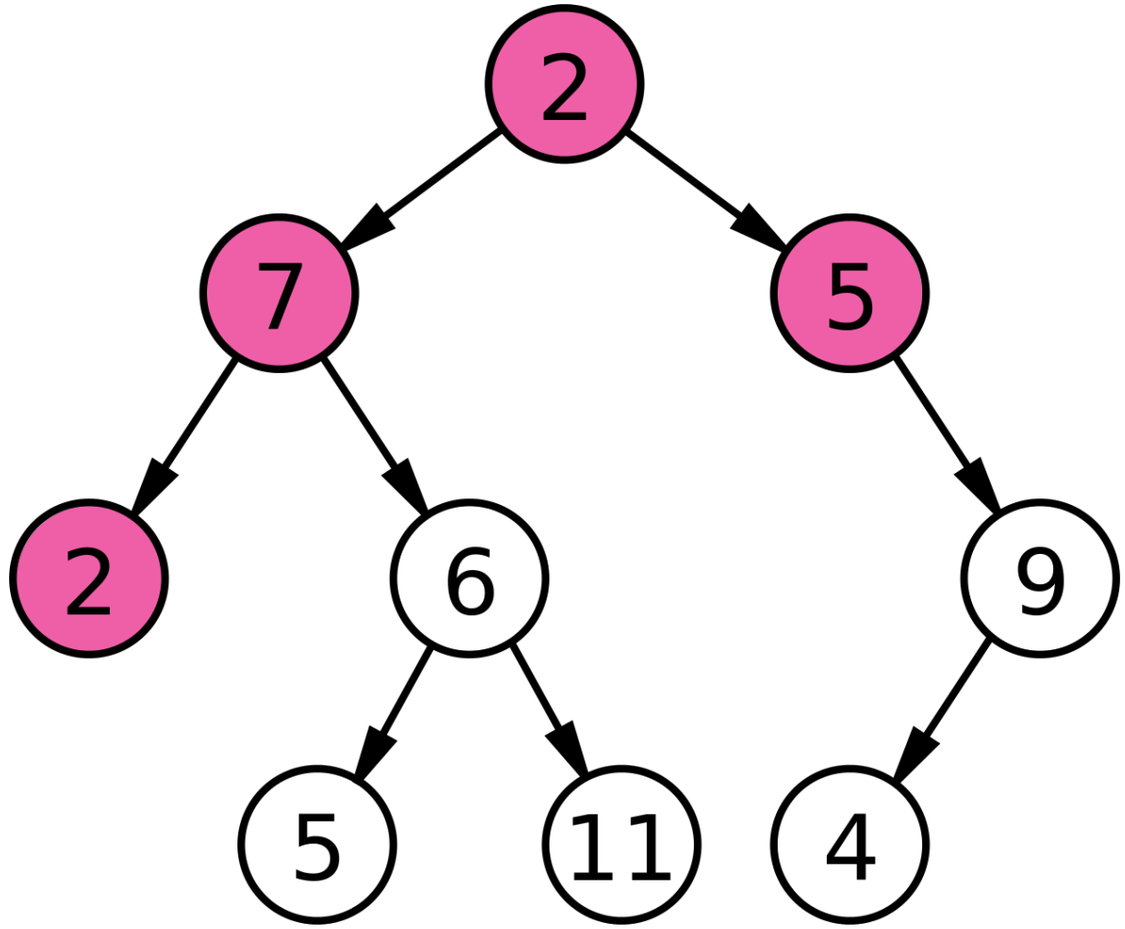

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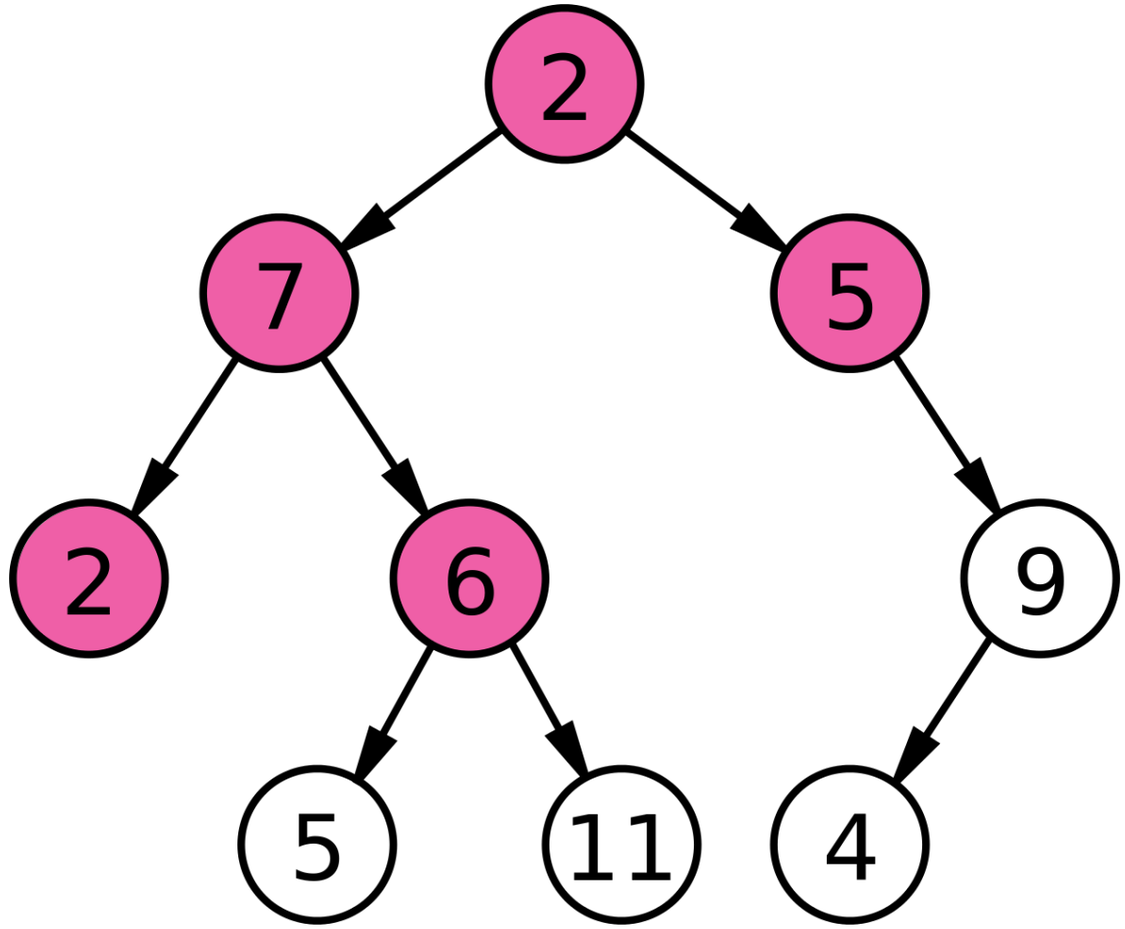

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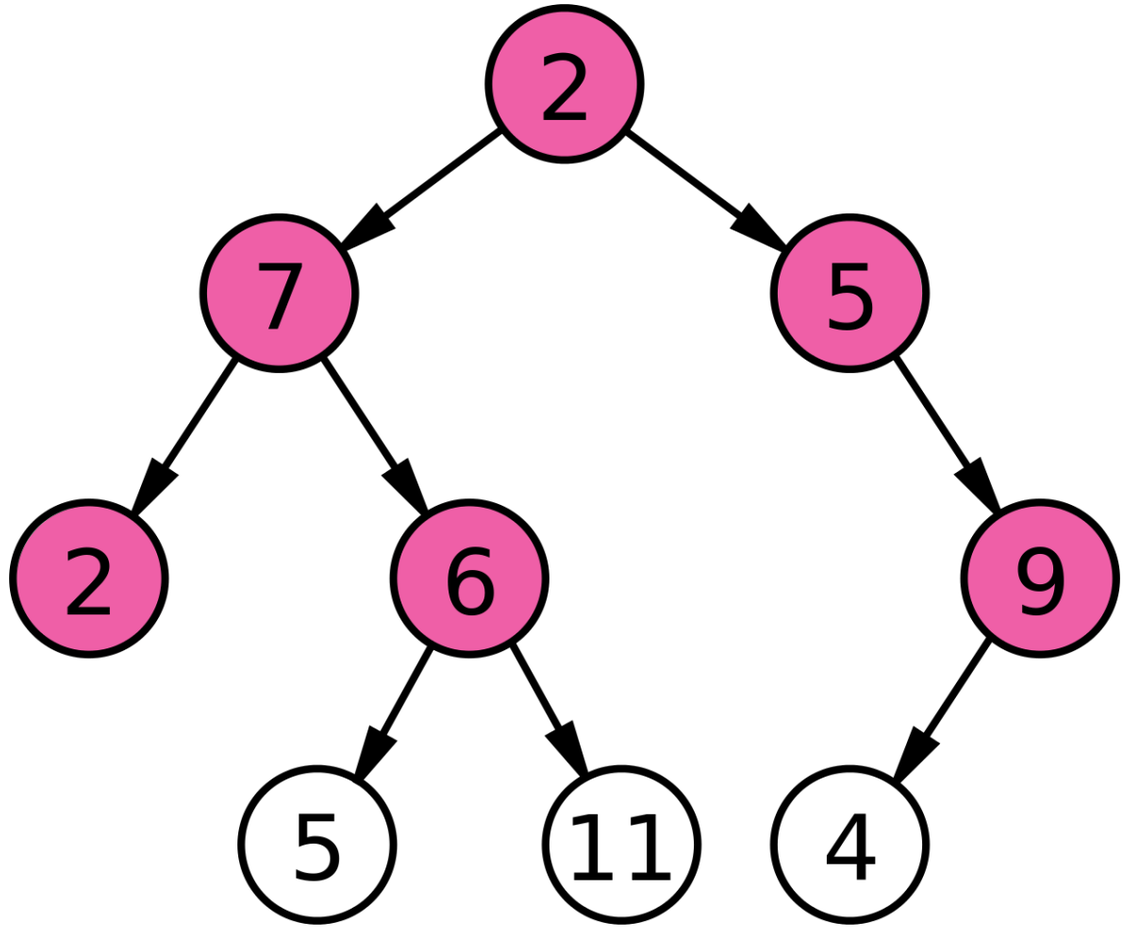

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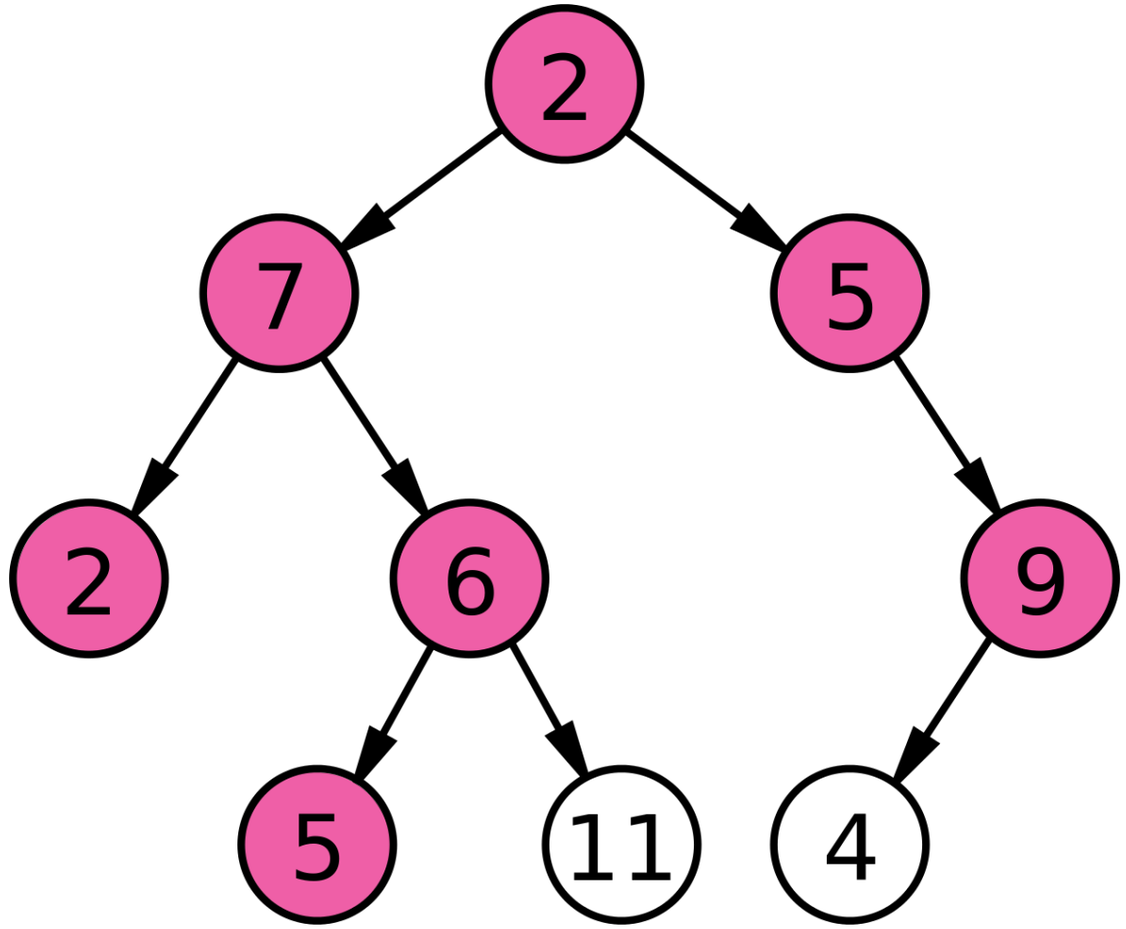

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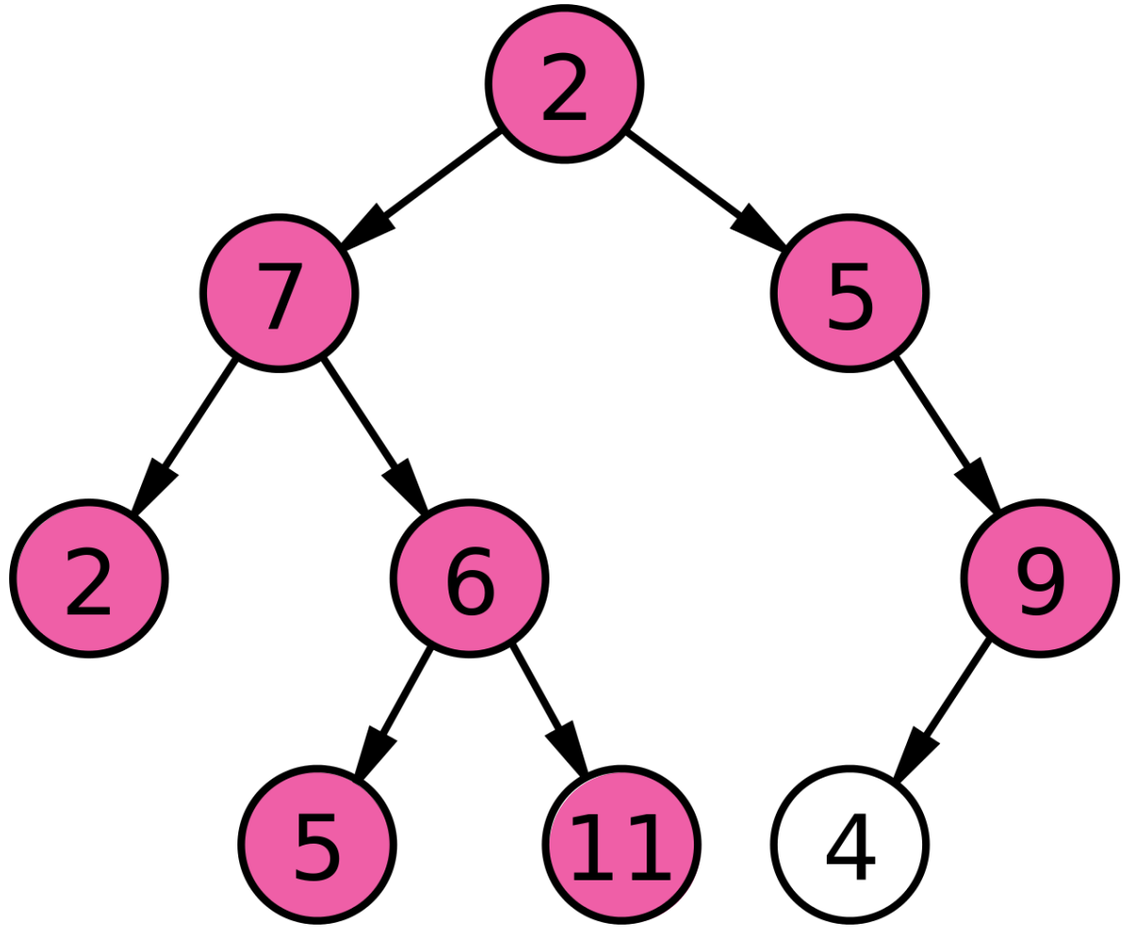

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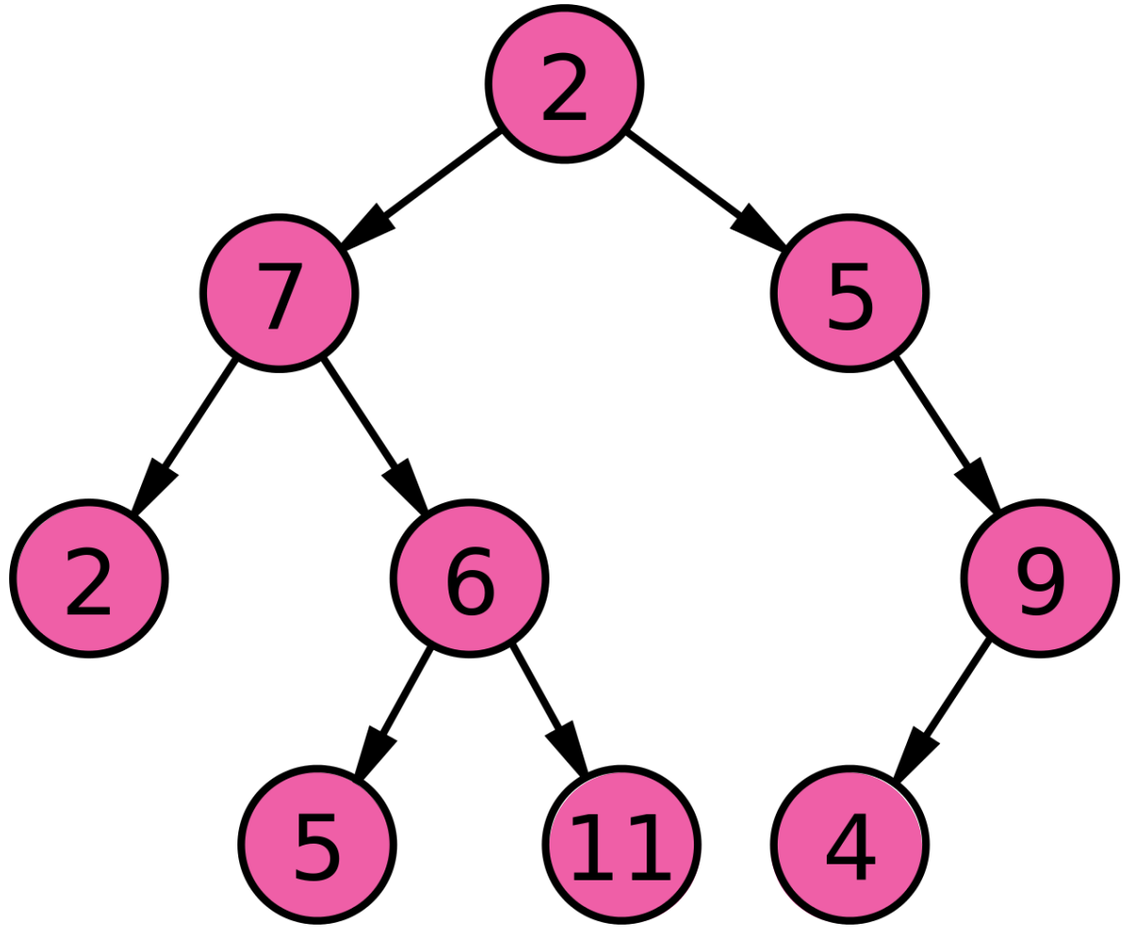

Pseudocode

```
initialize a queue called the "fringe"

add root to the fringe

while the fringe is not empty:
    dequeue the topmost node from the fringe
    enqueue its children onto the fringe
    Process removed node
```