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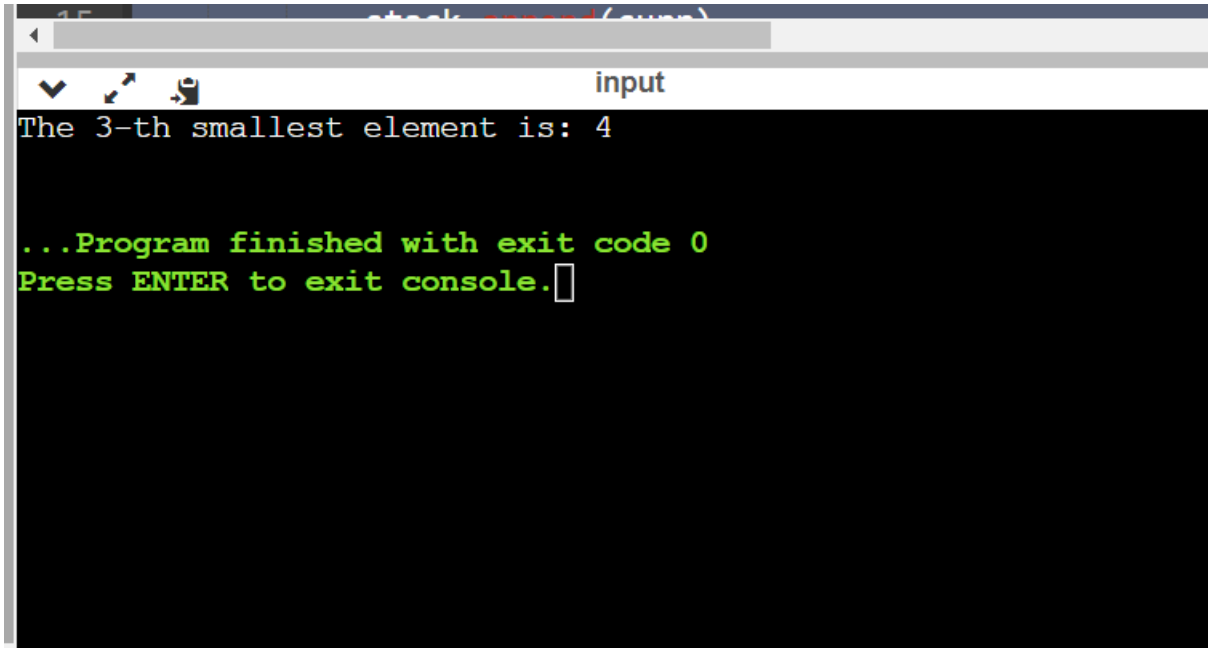
Day-19

Problem 1: Find K-th smallest element in BST

```
class Node:
    def __init__(self, value):
        self.value = value
        self.left = None
        self.right = None



def kth_smallest(root, k):
    stack = []
    count = 0
    curr = root

    while True:
        if curr:
            stack.append(curr)
            curr = curr.left
        elif stack:
            curr = stack.pop()
            count += 1
            if count == k:
                return curr.value
            curr = curr.right
        else:
            break


root = Node(5)
root.left = Node(3)
root.right = Node(7)
root.left.left = Node(2)
root.left.right = Node(4)
```

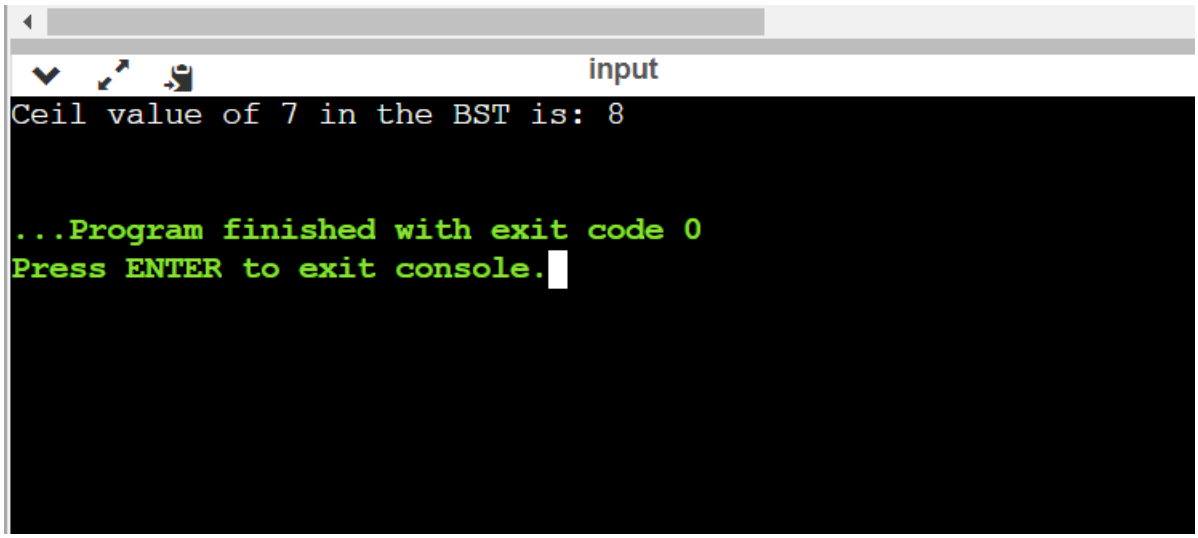
```
root.right.left = Node(6)
root.right.right = Node(8)

k = 3
result = kth_smallest(root, k)
print(f"The {k}-th smallest element is: {result}")
```



Problem 2: Ceil in a BST

```
    class TreeNode:
    def __init__(self, val=0, left=None, right=None):
        self.val = val
        self.left = left
        self.right = right


def insert(root, key):
    if root is None:
        return TreeNode(key)
    if key < root.val:
        root.left = insert(root.left, key)
    else:
        root.right = insert(root.right, key)
    return root


def ceil(root, target):
    if root is None:
        return None


    if root.val == target:
        return root.val


    if root.val < target:
        return ceil(root.right, target)


    ceil_val = ceil(root.left, target)
    if ceil_val is None or ceil_val < target:
        return root.val
    return ceil_val
```

```
root = None

root = insert(root, 8)

root = insert(root, 4)

root = insert(root, 12)

root = insert(root, 2)

root = insert(root, 6)

root = insert(root, 10)

root = insert(root, 14)


target = 7

ceil_value = ceil(root, target)

print("Ceil value of", target, "in the BST is:", ceil_value)
```



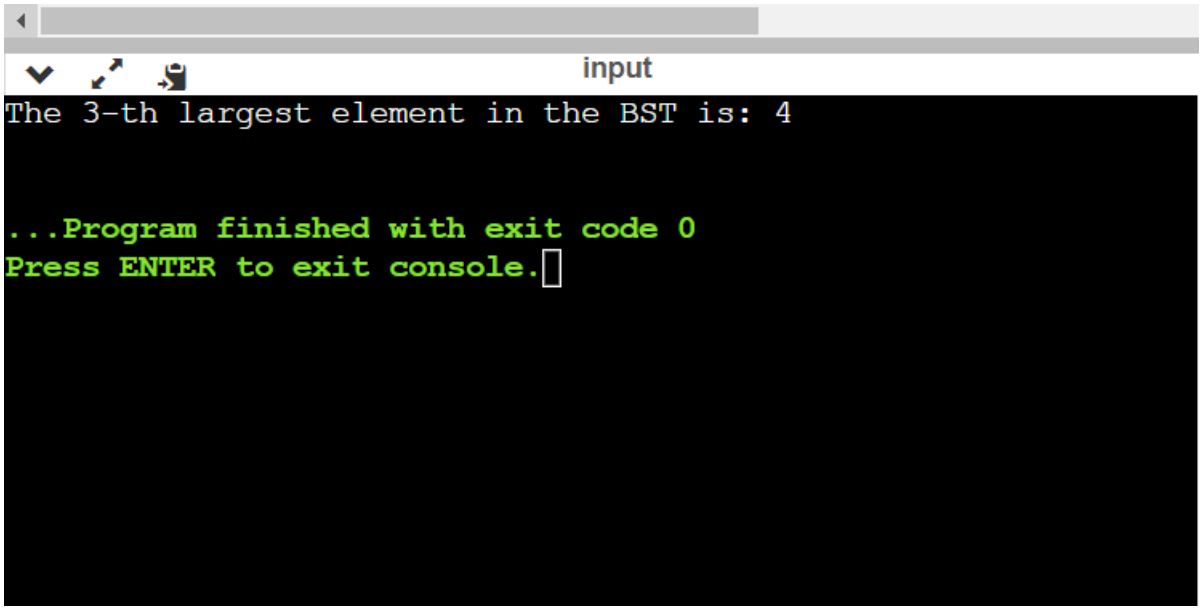
Problem 3: Find K-th largest element in BST

```
class TreeNode:
    def __init__(self, val=0, left=None, right=None):
        self.val = val
        self.left = left
        self.right = right



def kthLargest(root, k):
    stack = []
    node = root

    while node or stack:
        while node:
            stack.append(node)
            node = node.right
        node = stack.pop()
        k -= 1

        if k == 0:
            return node.val

        node = node.left

root = TreeNode(4)
root.left = TreeNode(2)
root.right = TreeNode(7)
root.left.left = TreeNode(1)
root.left.right = TreeNode(3)
root.right.left = TreeNode(6)
```

k = 3

result = kthLargest(root, k)

print(f"The {k}-th largest element in the BST is: {result}")

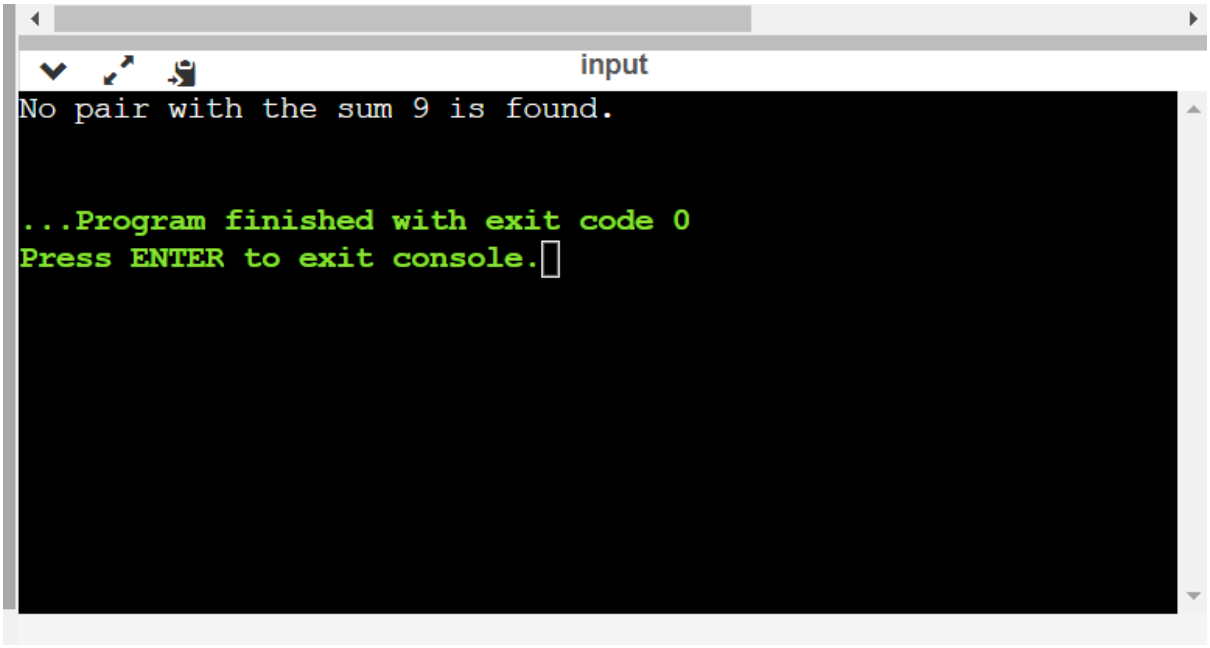


Problem 4: Find a pair with a given sum in BST

```
class Node:
    def __init__(self, val):
        self.val = val
        self.left = None
        self.right = None


def insert(root, val):
    if root is None:
        return Node(val)
    if val < root.val:
        root.left = insert(root.left, val)
    else:
        root.right = insert(root.right, val)
    return root


def in_order_traversal(root, target):
    stack_left = []
    stack_right = []
    curr_left = root
    curr_right = root

    done_left = False
    done_right = False
    val_left = None
    val_right = None

    while True:
        while not done_left:
            if curr_left is not None:
                stack_left.append(curr_left)
```

```
            curr_left = curr_left.left
        else:
            if len(stack_left) > 0:
                curr_left = stack_left.pop()
                val_left = curr_left.val
                curr_left = curr_left.right
            else:
                done_left = True

    while not done_right:
        if curr_right is not None:
            stack_right.append(curr_right)
            curr_right = curr_right.right
        else:
            if len(stack_right) > 0:
                curr_right = stack_right.pop()
                val_right = curr_right.val
                curr_right = curr_right.left
            else:
                done_right = True

    if val_left != val_right and val_left + val_right == target:
        return val_left, val_right

    if val_left >= val_right:
        return None

def find_pair(root, target):
    return in_order_traversal(root, target)
```

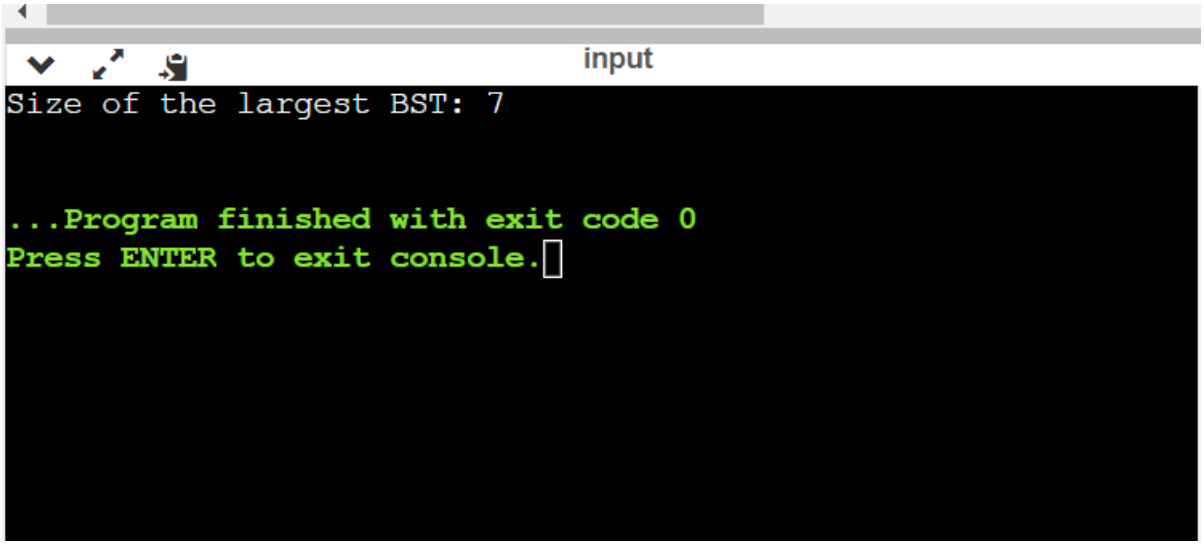
```
root = None
elements = [5,  8, 2, 6, 10]
for element in elements:
    root = insert(root, element)


target_sum = 9
pair = find_pair(root, target_sum)
if pair is not None:
    print(f"A pair with the sum {target_sum} is found: {pair[0]} and {pair[1]}")
else:
    print(f"No pair with the sum {target_sum} is found.")
```



Problem 5: Size of the largest BST in a Binary Tree

```
class Node:
    def __init__(self, value):
        self.data = value
        self.left = None
        self.right = None


def largestBSTSize(root):
    def isBST(node, min_value, max_value):
        if node is None:
            return True

        if node.data < min_value or node.data > max_value:
            return False

        return (
            isBST(node.left, min_value, node.data - 1)
            and isBST(node.right, node.data + 1, max_value)
        )

    def countNodes(node):
        if node is None:
            return 0

        return 1 + countNodes(node.left) + countNodes(node.right)

    def largestBSTSizeUtil(node):
        if isBST(node, float("-inf"), float("inf")):
            return countNodes(node)

        return max(
```

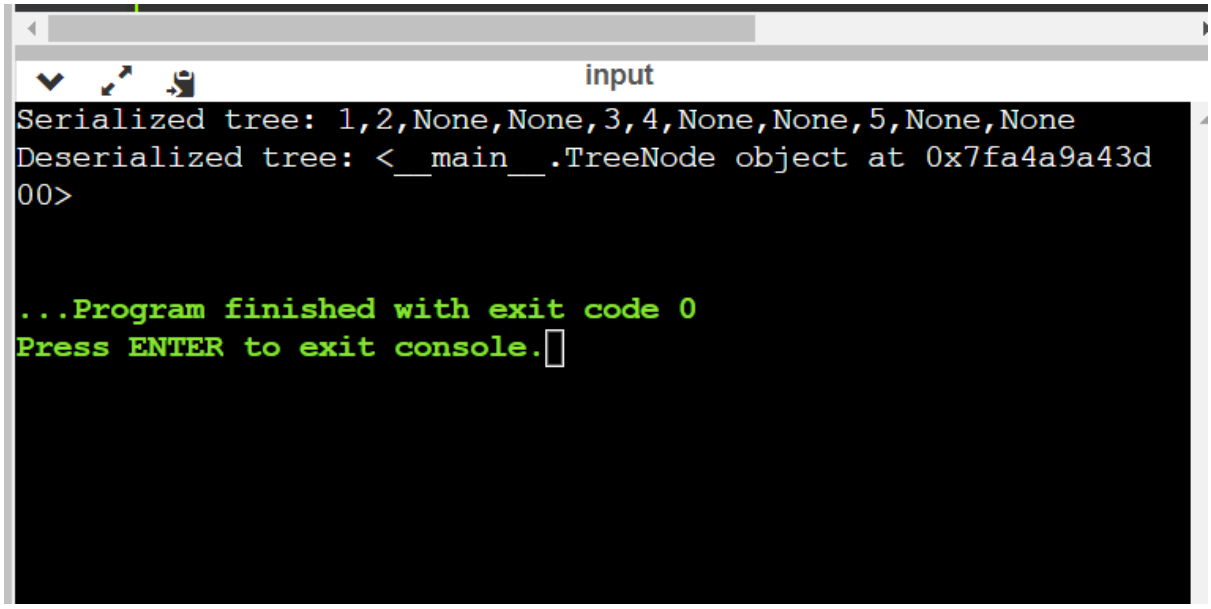
```
            largestBSTSizeUtil(node.left),
            largestBSTSizeUtil(node.right)
        )

    return largestBSTSizeUtil(root)

root = Node(6)
root.left = Node(4)
root.right = Node(7)
root.left.left = Node(3)
root.left.right = Node(5)
root.right.right = Node(9)
root.right.right.left = Node(8)

print("Size of the largest BST:", largestBSTSize(root))
```



Problem 6: Serialize and deserialize Binary Tree

```
class TreeNode:
    def __init__(self, value):
        self.val = value
        self.left = None
        self.right = None

def serialize(root):
    if not root:
        return 'None'

    left_serialized = serialize(root.left)
    right_serialized = serialize(root.right)

    return str(root.val) + ',' + left_serialized + ',' + right_serialized

def deserialize(data):
    def helper(nodes):
        if nodes[0] == 'None':
            nodes.pop(0)
            return None

        root = TreeNode(int(nodes[0]))
```

```
        nodes.pop(0)
        root.left = helper(nodes)
        root.right = helper(nodes)

        return root

    nodes = data.split(',')
    return helper(nodes)

root = TreeNode(1)
root.left = TreeNode(2)
root.right = TreeNode(3)
root.right.left = TreeNode(4)
root.right.right = TreeNode(5)

serialized_tree = serialize(root)
print('Serialized tree:', serialized_tree)

deserialized_tree = deserialize(serialized_tree)
print('Deserialized tree:', deserialized_tree)
```


input
Serialized tree: 1,2,None,None,3,4,None,None,5,None,None
Deserialized tree: <__main__.TreeNode object at 0x7fa4a9a43d
00>
...Program finished with exit code 0
Press ENTER to exit console.