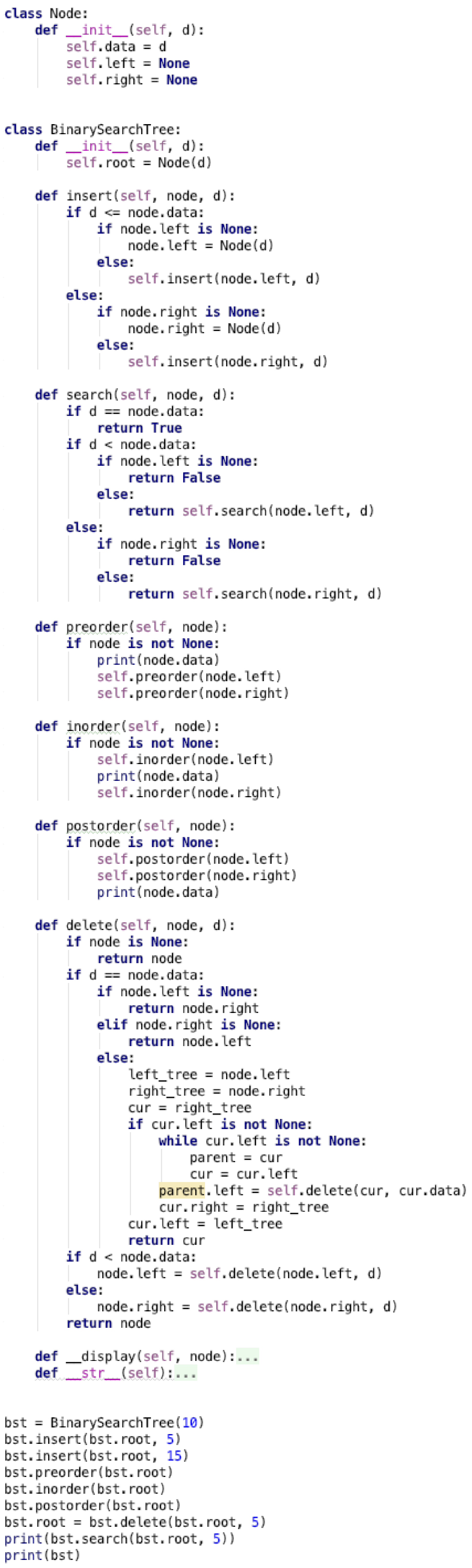
Binary Search Trees

3 Different Ways

Way 1



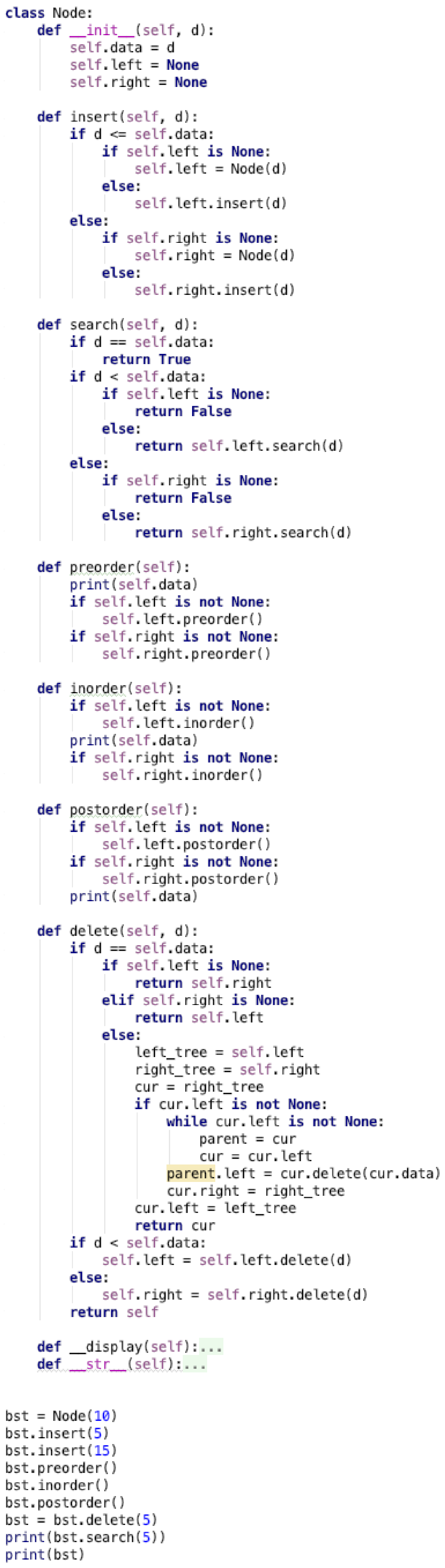
```python
class Node:
    def __init__(self, d):
        self.data = d
        self.left = None
        self.right = None


class BinarySearchTree:
    def __init__(self, d):
        self.root = Node(d)

    def insert(self, node, d):
        if d <= node.data:
            if node.left is None:
                node.left = Node(d)
            else:
                self.insert(node.left, d)
        else:
            if node.right is None:
                node.right = Node(d)
            else:
                self.insert(node.right, d)

    def search(self, node, d):
        if d == node.data:
            return True
        if d < node.data:
            if node.left is None:
                return False
            else:
                return self.search(node.left, d)
        else:
            if node.right is None:
                return False
            else:
                return self.search(node.right, d)

    def preorder(self, node):
        if node is not None:
            print(node.data)
            self.preorder(node.left)
            self.preorder(node.right)

    def inorder(self, node):
        if node is not None:
            self.inorder(node.left)
            print(node.data)
            self.inorder(node.right)

    def postorder(self, node):
        if node is not None:
            self.postorder(node.left)
            self.postorder(node.right)
            print(node.data)

    def delete(self, node, d):
        if node is None:
            return node
        if d == node.data:
            if node.left is None:
                return node.right
            elif node.right is None:
                return node.left
            else:
                left_tree = node.left
                right_tree = node.right
                cur = right_tree
                if cur.left is not None:
                    while cur.left is not None:
                        parent = cur
                        cur = cur.left
                    parent.left = self.delete(cur, cur.data)
                    cur.right = right_tree
                cur.left = left_tree
                return cur
        if d < node.data:
            node.left = self.delete(node.left, d)
        else:
            node.right = self.delete(node.right, d)
        return node

    def __display(self, node):...
    def __str__(self):...


bst = BinarySearchTree(10)
bst.insert(bst.root, 5)
bst.insert(bst.root, 15)
bst.preorder(bst.root)
bst.inorder(bst.root)
bst.postorder(bst.root)
bst.root = bst.delete(bst.root, 5)
print(bst.search(bst.root, 5))
print(bst)
```

Pros:
Keeps track of root node.
No problems with deleting the root node and then inserting new Items.

Cons:
Code is ugly
Usability is ugly

Note:
You can add extra code to make the usability of the code look nicer by creating methods that pass the root to other methods for you.

Way 2



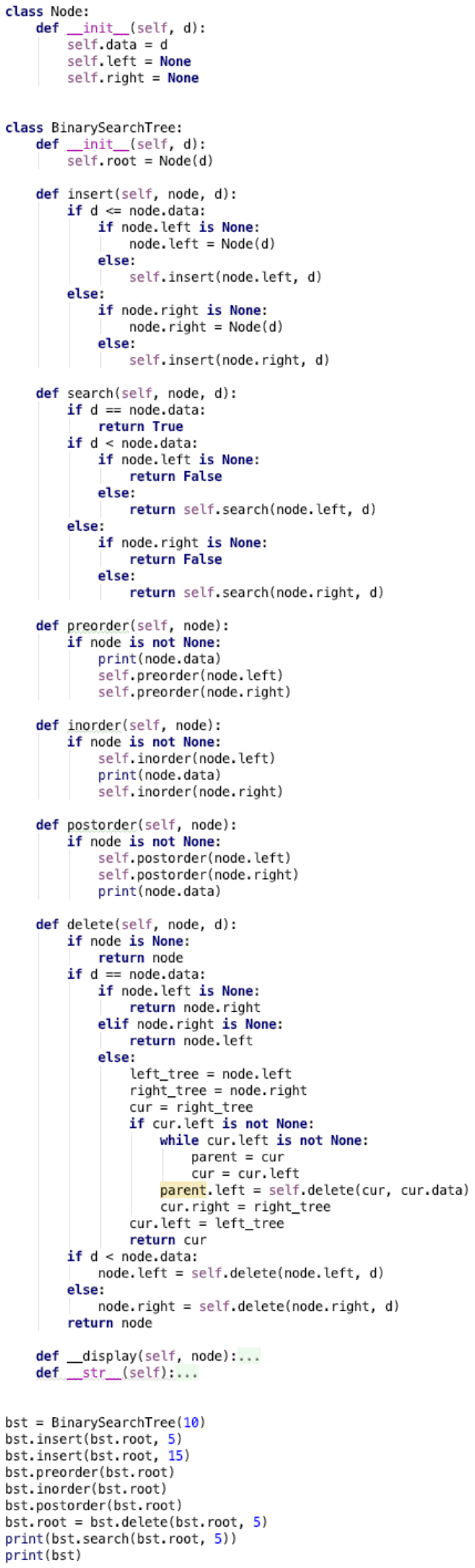
```python
class Node:
    def __init__(self, d):
        self.data = d
        self.left = None
        self.right = None

    def insert(self, d):
        if d <= self.data:
            if self.left is None:
                self.left = Node(d)
            else:
                self.left.insert(d)
        else:
            if self.right is None:
                self.right = Node(d)
            else:
                self.right.insert(d)

    def search(self, d):
        if d == self.data:
            return True
        if d < self.data:
            if self.left is None:
                return False
            else:
                return self.left.search(d)
        else:
            if self.right is None:
                return False
            else:
                return self.right.search(d)

    def preorder(self):
        print(self.data)
        if self.left is not None:
            self.left.preorder()
        if self.right is not None:
            self.right.preorder()

    def inorder(self):
        if self.left is not None:
            self.left.inorder()
        print(self.data)
        if self.right is not None:
            self.right.inorder()

    def postorder(self):
        if self.left is not None:
            self.left.postorder()
        if self.right is not None:
            self.right.postorder()
        print(self.data)

    def delete(self, d):
        if d == self.data:
            if self.left is None:
                return self.right
            elif self.right is None:
                return self.left
            else:
                left_tree = self.left
                right_tree = self.right
                cur = right_tree
                if cur.left is not None:
                    while cur.left is not None:
                        parent = cur
                        cur = cur.left
                    parent.left = cur.delete(cur.data)
                    cur.right = right_tree
                cur.left = left_tree
                return cur
        if d < self.data:
            self.left = self.left.delete(d)
        else:
            self.right = self.right.delete(d)
        return self

    def __display(self):...
    def __str__(self):...


bst = Node(10)
bst.insert(5)
bst.insert(15)
bst.preorder()
bst.inorder()
bst.postorder()
bst = bst.delete(5)
print(bst.search(5))
print(bst)
```

Pros:
Code is cleaner

Cons:
If you delete the root you will have to create a new BST if you want to insert new items.

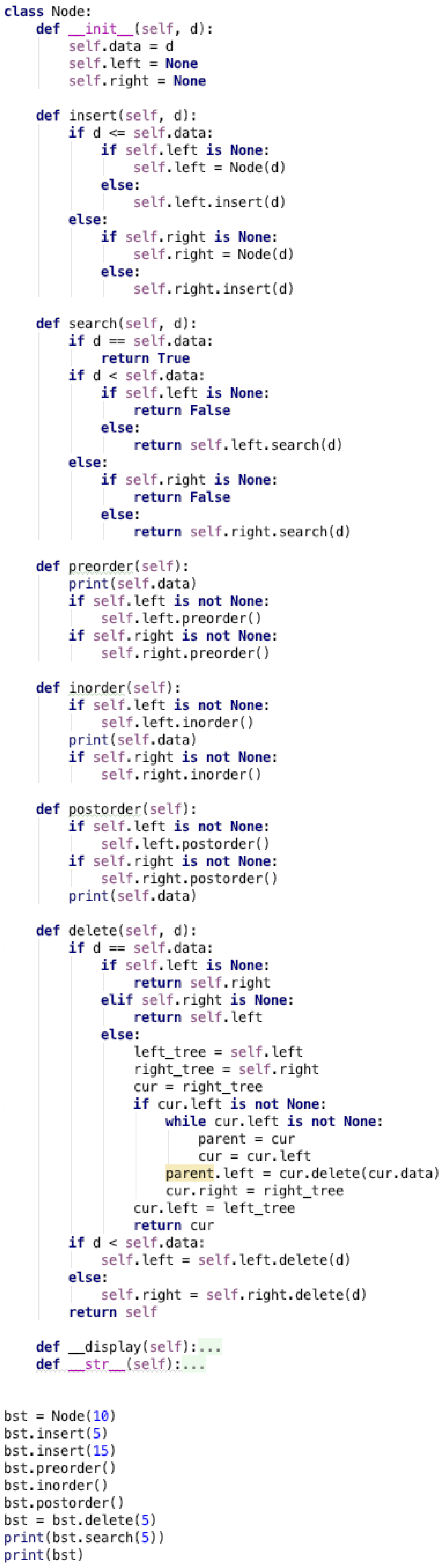
Note:
You can solve this by making it so you can't delete the root node.

Way 1



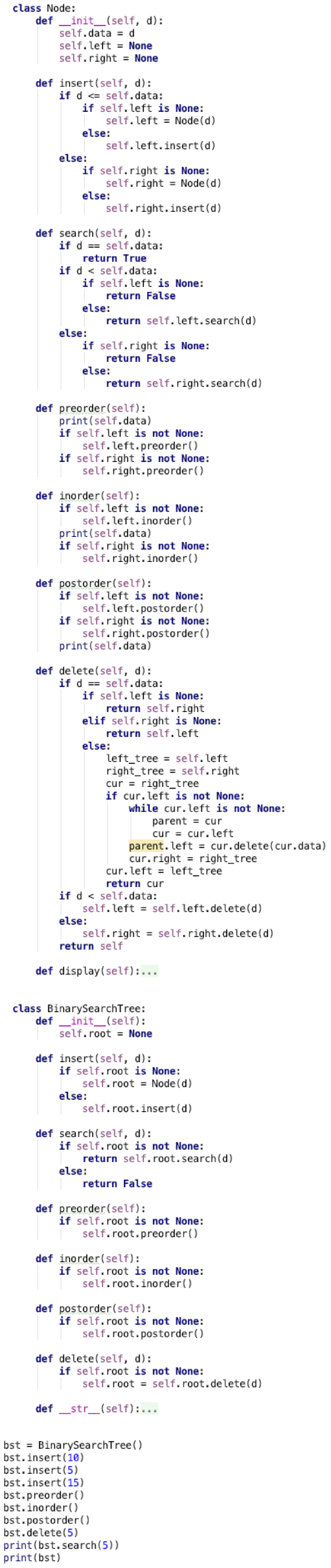
```python
class Node:
    def __init__(self, d):
        self.data = d
        self.left = None
        self.right = None


class BinarySearchTree:
    def __init__(self, d):
        self.root = Node(d)

    def insert(self, node, d):
        if d <= node.data:
            if node.left is None:
                node.left = Node(d)
            else:
                self.insert(node.left, d)
        else:
            if node.right is None:
                node.right = Node(d)
            else:
                self.insert(node.right, d)

    def search(self, node, d):
        if d == node.data:
            return True
        if d < node.data:
            if node.left is None:
                return False
            else:
                return self.search(node.left, d)
        else:
            if node.right is None:
                return False
            else:
                return self.search(node.right, d)

    def preorder(self, node):
        if node is not None:
            print(node.data)
            self.preorder(node.left)
            self.preorder(node.right)

    def inorder(self, node):
        if node is not None:
            self.inorder(node.left)
            print(node.data)
            self.inorder(node.right)

    def postorder(self, node):
        if node is not None:
            self.postorder(node.left)
            self.postorder(node.right)
            print(node.data)

    def delete(self, node, d):
        if node is None:
            return node
        if d == node.data:
            if node.left is None:
                return node.right
            elif node.right is None:
                return node.left
            else:
                left_tree = node.left
                right_tree = node.right
                cur = right_tree
                if cur.left is not None:
                    while cur.left is not None:
                        parent = cur
                        cur = cur.left
                    parent.left = self.delete(cur, cur.data)
                    cur.right = right_tree
                cur.left = left_tree
                return cur
        if d < node.data:
            node.left = self.delete(node.left, d)
        else:
            node.right = self.delete(node.right, d)
        return node

    def __display(self, node):...
    def __str__(self):...


bst = BinarySearchTree(10)
bst.insert(bst.root, 5)
bst.insert(bst.root, 15)
bst.preorder(bst.root)
bst.inorder(bst.root)
bst.postorder(bst.root)
bst.root = bst.delete(bst.root, 5)
print(bst.search(bst.root, 5))
print(bst)
```

Way 2



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

    def insert(self, d):
        if d <= self.data:
            if self.left is None:
                self.left = Node(d)
            else:
                self.left.insert(d)
        else:
            if self.right is None:
                self.right = Node(d)
            else:
                self.right.insert(d)

    def search(self, d):
        if d == self.data:
            return True
        if d < self.data:
            if self.left is None:
                return False
            else:
                return self.left.search(d)
        else:
            if self.right is None:
                return False
            else:
                return self.right.search(d)

    def preorder(self):
        print(self.data)
        if self.left is not None:
            self.left.preorder()
        if self.right is not None:
            self.right.preorder()

    def inorder(self):
        if self.left is not None:
            self.left.inorder()
        print(self.data)
        if self.right is not None:
            self.right.inorder()

    def postorder(self):
        if self.left is not None:
            self.left.postorder()
        if self.right is not None:
            self.right.postorder()
        print(self.data)

    def delete(self, d):
        if d == self.data:
            if self.left is None:
                return self.right
            elif self.right is None:
                return self.left
            else:
                left_tree = self.left
                right_tree = self.right
                cur = right_tree
                if cur.left is not None:
                    while cur.left is not None:
                        parent = cur
                        cur = cur.left
                    parent.left = cur.delete(cur.data)
                    cur.right = right_tree
                cur.left = left_tree
                return cur
        if d < self.data:
            self.left = self.left.delete(d)
        else:
            self.right = self.right.delete(d)
        return self

    def __display(self):...
    def __str__(self):...


bst = Node(10)
bst.insert(5)
bst.insert(15)
bst.preorder()
bst.inorder()
bst.postorder()
bst = bst.delete(5)
print(bst.search(5))
print(bst)
```

Way 3



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

    def insert(self, d):
        if d <= self.data:
            if self.left is None:
                self.left = Node(d)
            else:
                self.left.insert(d)
        else:
            if self.right is None:
                self.right = Node(d)
            else:
                self.right.insert(d)

    def search(self, d):
        if d == self.data:
            return True
        if d < self.data:
            if self.left is None:
                return False
            else:
                return self.left.search(d)
        else:
            if self.right is None:
                return False
            else:
                return self.right.search(d)

    def preorder(self):
        print(self.data)
        if self.left is not None:
            self.left.preorder()
        if self.right is not None:
            self.right.preorder()

    def inorder(self):
        if self.left is not None:
            self.left.inorder()
        print(self.data)
        if self.right is not None:
            self.right.inorder()

    def postorder(self):
        if self.left is not None:
            self.left.postorder()
        if self.right is not None:
            self.right.postorder()
        print(self.data)

    def delete(self, d):
        if d == self.data:
            if self.left is None:
                return self.right
            elif self.right is None:
                return self.left
            else:
                left_tree = self.left
                right_tree = self.right
                cur = right_tree
                if cur.left is not None:
                    while cur.left is not None:
                        parent = cur
                        cur = cur.left
                    parent.left = cur.delete(cur.data)
                    cur.right = right_tree
                cur.left = left_tree
                return cur
        if d < self.data:
            self.left = self.left.delete(d)
        else:
            self.right = self.right.delete(d)
        return self

    def display(self):...


class BinarySearchTree:
    def __init__(self):
        self.root = None

    def insert(self, d):
        if self.root is None:
            self.root = Node(d)
        else:
            self.root.insert(d)

    def search(self, d):
        if self.root is not None:
            return self.root.search(d)
        else:
            return False

    def preorder(self):
        if self.root is not None:
            self.root.preorder()

    def inorder(self):
        if self.root is not None:
            self.root.inorder()

    def postorder(self):
        if self.root is not None:
            self.root.postorder()

    def delete(self, d):
        if self.root is not None:
            self.root = self.root.delete(d)

    def __str__(self):...


bst = BinarySearchTree()
bst.insert(10)
bst.insert(5)
bst.insert(15)
bst.preorder()
bst.inorder()
bst.postorder()
bst.delete(5)
print(bst.search(5))
print(bst)
```