

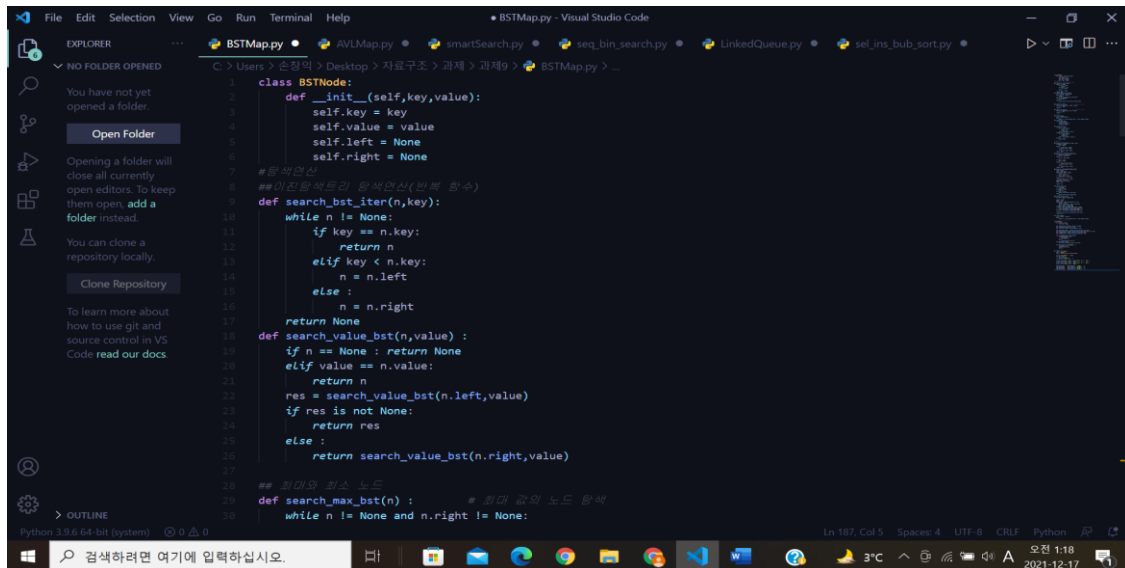
## 자료구조 9장 과제

바이오메디컬공학부

손무현

VSCode로 과제를 진행하였습니다.

### 1. 이진탐색트리를 이용한 맵 구현 및 실행



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

    # 이진탐색트리 탐색 함수 (재귀 함수)
    def search_bst_iter(n, key):
        while n != None:
            if key == n.key:
                return n
            elif key < n.key:
                n = n.left
            else:
                n = n.right
        return None

    def search_value_bst(n, value):
        if n == None: return None
        elif value == n.value:
            return n
        res = search_value_bst(n.left, value)
        if res is not None:
            return res
        else:
            return search_value_bst(n.right, value)

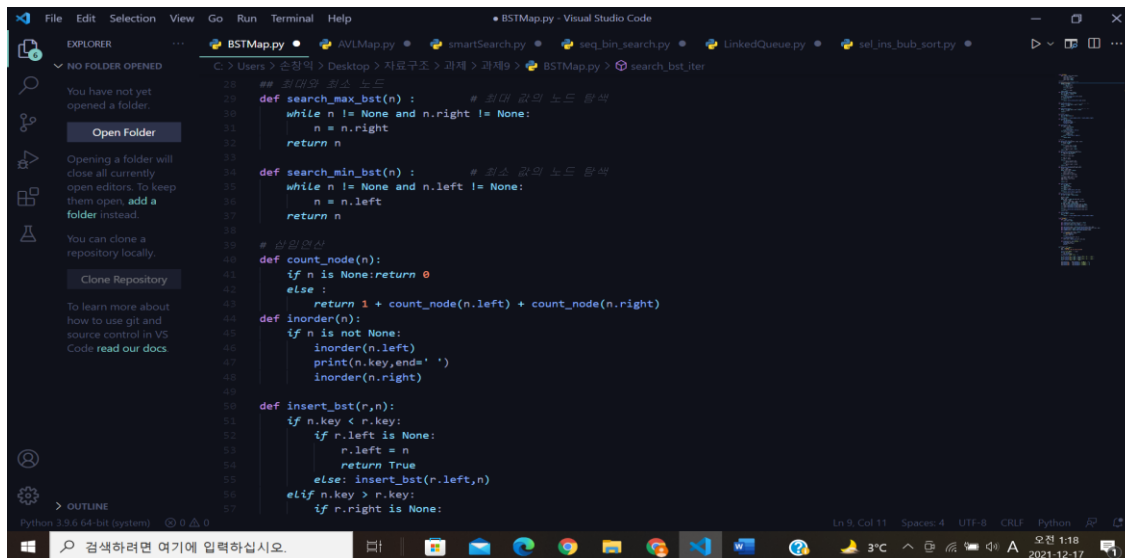
    # 최대와 최소 노드
    def search_max_bst(n):
        while n != None and n.right != None:
            n = n.right
        return n

    def search_min_bst(n):
        while n != None and n.left != None:
            n = n.left
        return n

    # 삽입 함수
    def count_node(n):
        if n is None: return 0
        else:
            return 1 + count_node(n.left) + count_node(n.right)

    def inorder(n):
        if n is not None:
            inorder(n.left)
            print(n.key, end=' ')
            inorder(n.right)

    def insert_bst(r, n):
        if n.key < r.key:
            if r.left is None:
                r.left = n
                return True
            else:
                return insert_bst(r.left, n)
        elif n.key > r.key:
            if r.right is None:
                r.right = n
                return True
            else:
                return insert_bst(r.right, n)
```



```
def search_max_bst(n):
    while n != None and n.right != None:
        n = n.right
    return n

def search_min_bst(n):
    while n != None and n.left != None:
        n = n.left
    return n

# 삽입 함수
def count_node(n):
    if n is None: return 0
    else:
        return 1 + count_node(n.left) + count_node(n.right)

def inorder(n):
    if n is not None:
        inorder(n.left)
        print(n.key, end=' ')
        inorder(n.right)

def insert_bst(r, n):
    if n.key < r.key:
        if r.left is None:
            r.left = n
            return True
        else:
            return insert_bst(r.left, n)
    elif n.key > r.key:
        if r.right is None:
            r.right = n
            return True
        else:
            return insert_bst(r.right, n)
```

```
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• BSTMap.py - Visual Studio Code

EXPLORER
C:\Users> 손정익> Desktop> 자료구조> 과제9> BSTMap.py
You have not yet opened a folder.
Open Folder
Opening a folder will close all currently open editors. To keep them open, add a folder instead.
You can clone a repository locally.
Clone Repository
To learn more about how to use git and source control in VS Code read our docs.

Python 3.9.6 64-bit (system) 0 0 0
Ln 41, Col 14, Spaces: 4, UTF-8, CRLF, Python
검색하려면 여기에 입력하십시오.
```

```
54         return True
55     else: insert_bst(r.left,n)
56     elif n.key > r.key:
57         if r.right is None:
58             r.right = n
59             return True
60         else: insert_bst(r.right,n)
61     else:
62         return False
63
64     # 삭제 연산
65     ## case1: 만약 노드 삭제
66     def delete_bst_case1(parent, node, root):
67         if parent is None:
68             root = None
69         else:
70             if parent.left == node:
71                 parent.left = None
72             else:
73                 parent.right = None
74             return root
75     ## case2: 자식인 (왼쪽인) 노드의 삭제
76     def delete_bst_case2(parent,node,root):
77         if node.left is not None:
78             child = node.left
79         else:
80             child = node.right
81         if node == root:
82             root = child
```

```
File Edit Selection View Go Run Terminal Help
• BSTMap.py - Visual Studio Code

EXPLORER
C:\Users> 손정익> Desktop> 자료구조> 과제9> BSTMap.py> delete_bst_case2
You have not yet opened a folder.
Open Folder
Opening a folder will close all currently open editors. To keep them open, add a folder instead.
You can clone a repository locally.
Clone Repository
To learn more about how to use git and source control in VS Code read our docs.

Python 3.9.6 64-bit (system) 0 0 0
Ln 89, Col 16, Spaces: 4, UTF-8, CRLF, Python
검색하려면 여기에 입력하십시오.
```

```
84     else:
85         if node is parent.left:
86             parent.left = child
87         else:
88             parent.right = child
89     return root
90     ## case3: 두 점의 자식들 가진 노드 삭제
91     def delete_bst_case3(parent,node,root):
92         succp = node
93         succ = node.right
94         while (succ.left != None):
95             succp = succ
96             succ = succ.left
97         if (succp.left == succ):
98             succp.left = succ.right
99         else:
100             succp.right = succ.right
101         node.key = succ.key
102         node.value = succ.value
103         node = succ;
104     return root
105
106     def search_bst(n,key):
107         if n == None:
108             return None
109         elif key == n.key:
110             return n
111         elif key < n.key:
112             return search_bst(n.left,key)
113
```

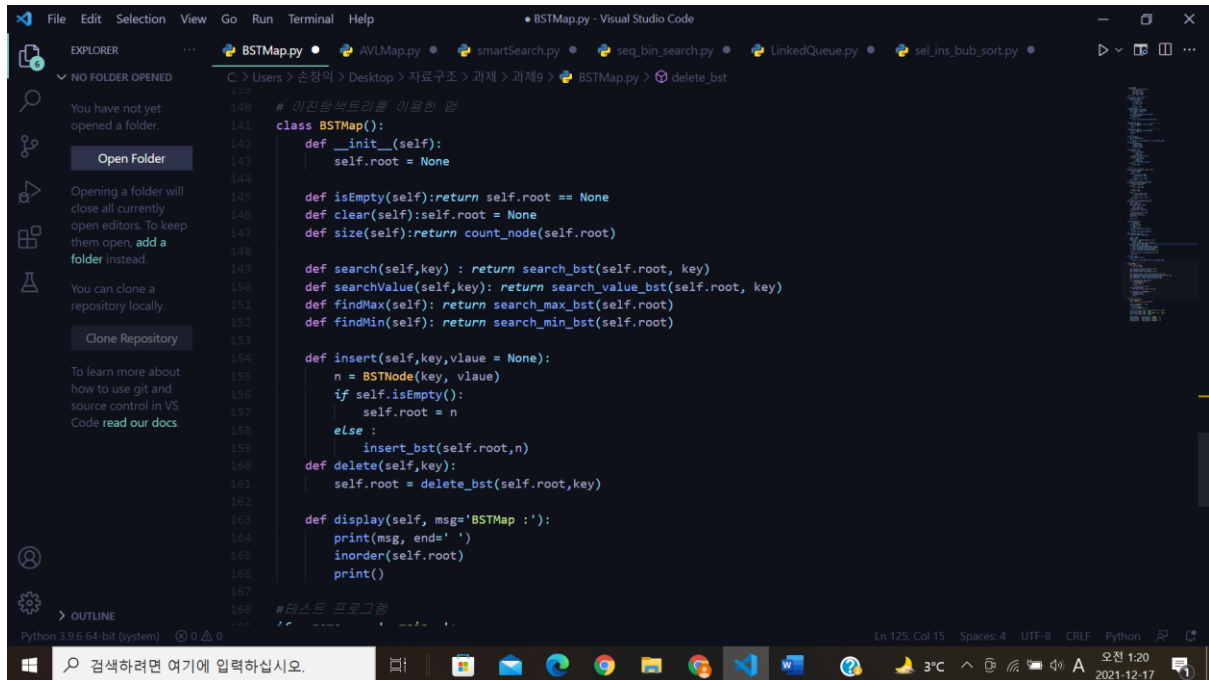
```
File Edit Selection View Go Run Terminal Help
• BSTMap.py - Visual Studio Code

EXPLORER
C:\Users> 손정익> Desktop> 자료구조> 과제9> BSTMap.py> delete_bst_case3
You have not yet opened a folder.
Open Folder
Opening a folder will close all currently open editors. To keep them open, add a folder instead.
You can clone a repository locally.
Clone Repository
To learn more about how to use git and source control in VS Code read our docs.

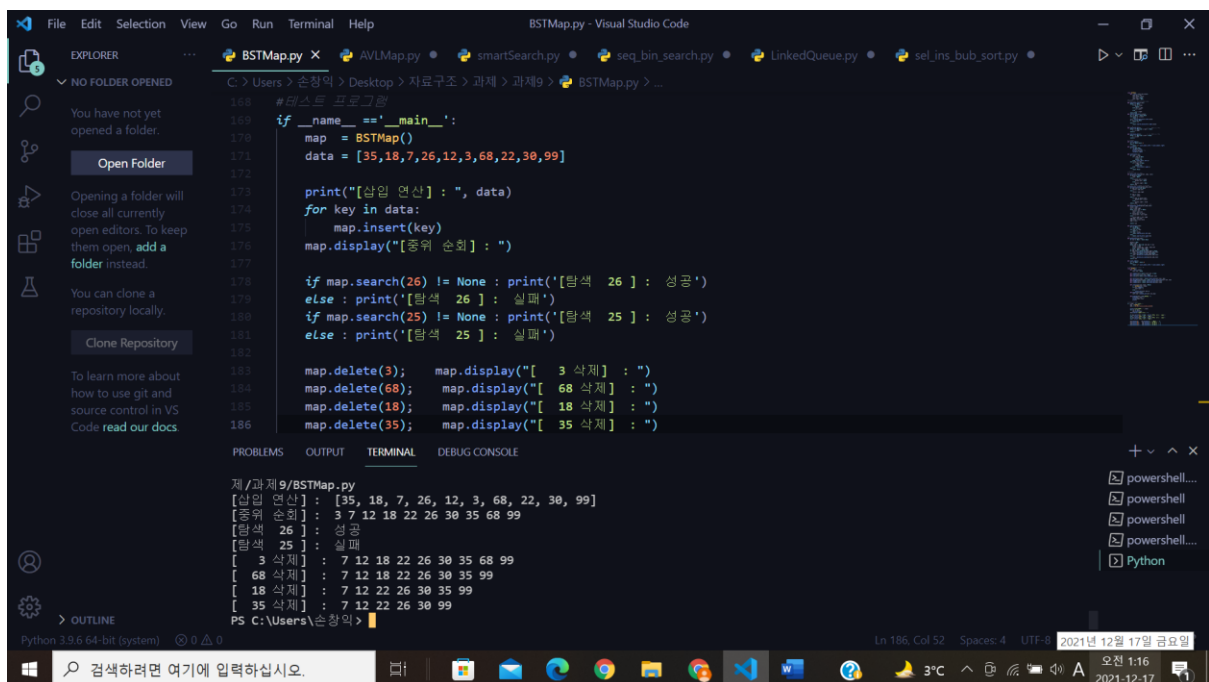
Python 3.9.6 64-bit (system) 0 0 0
Ln 96, Col 17, Spaces: 4, UTF-8, CRLF, Python
검색하려면 여기에 입력하십시오.
```

```
110         elif key == n.key:
111             return n
112         elif key < n.key:
113             return search_bst(n.left,key)
114         else:
115             return search_bst(n.right,key)
116     ## 삭제 연산 (두 점들 가진 노드 삭제)
117     def delete_bst(root,key):
118         if root == None: return None
119
120         parent = None
121         node = root
122         while node != None and node.key != key:
123             parent = node
124             if key < node.key: node = node.left
125             else: node = node.right;
126         if node == None: return None
127         if node.left == None and node.right == None:
128             root = delete_bst_case1(parent,node,root)
129         elif node.left==None or node.right==None:
130             root = delete_bst_case2(parent,node,root)
131         else:
132             root = delete_bst_case3(parent,node,root)
133         return root
134
135     def count_node(n):
136         if n is None: return 0
137         else:
138             return 1 + count_node(n.left) + count_node(n.right)
139
```

이진탐색트리의 연산에 대한 코드들입니다.

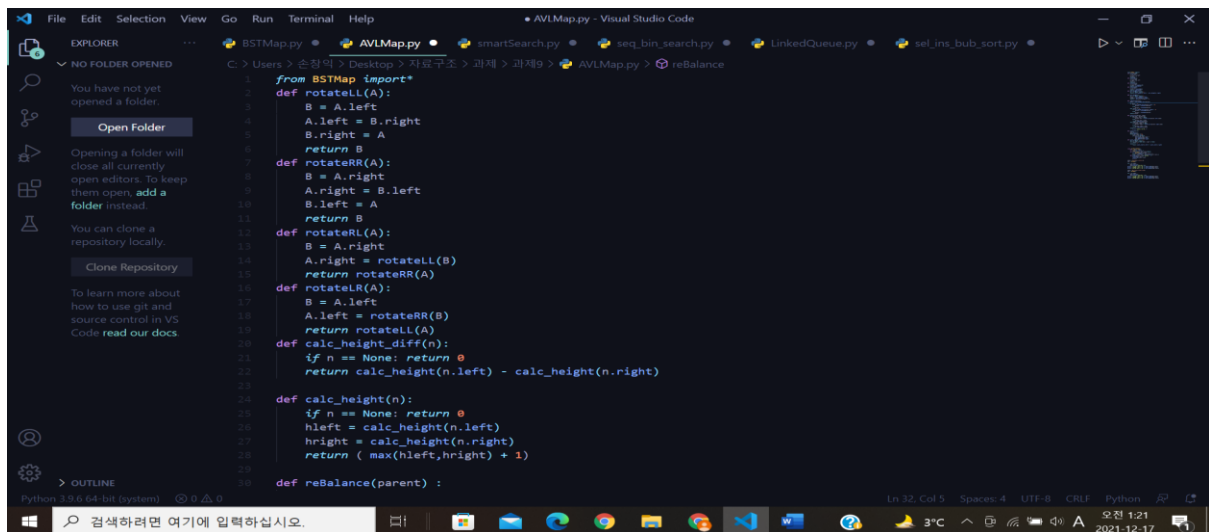


BSTMap을 class로 구현한 부분입니다.

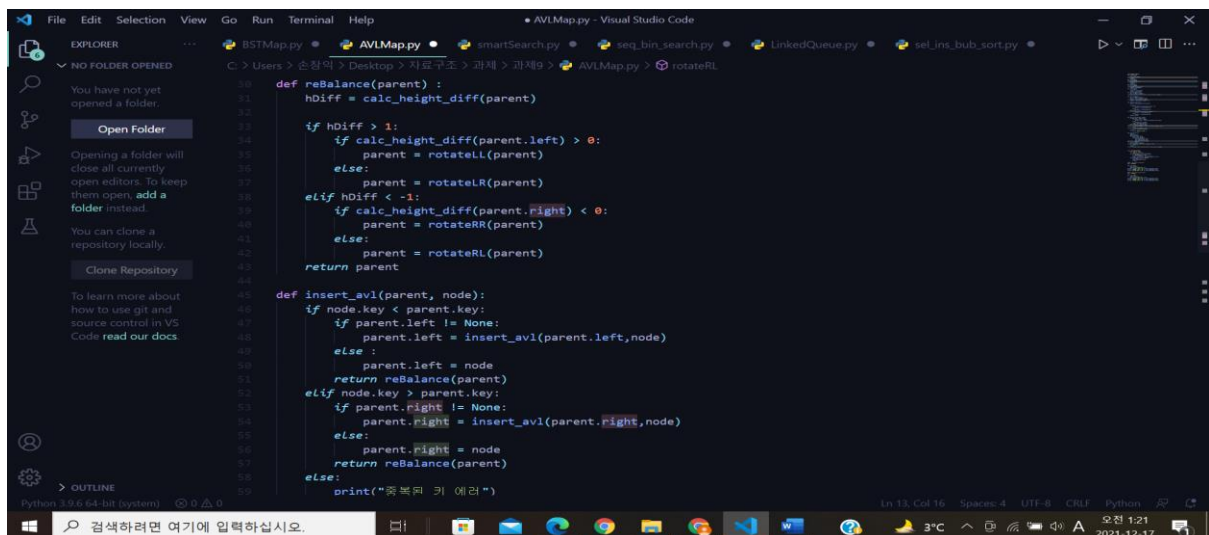


2번 문제에서 해당 파일을 import하기 위해 테스트 프로그램이 같이 실행되면 안되므로 if \_\_name\_\_ == '\_\_main\_\_':을 사용하였습니다. 수업자료에서 나온 결과와 같은 출력이 나온 것을 확인할 수 있었습니다.

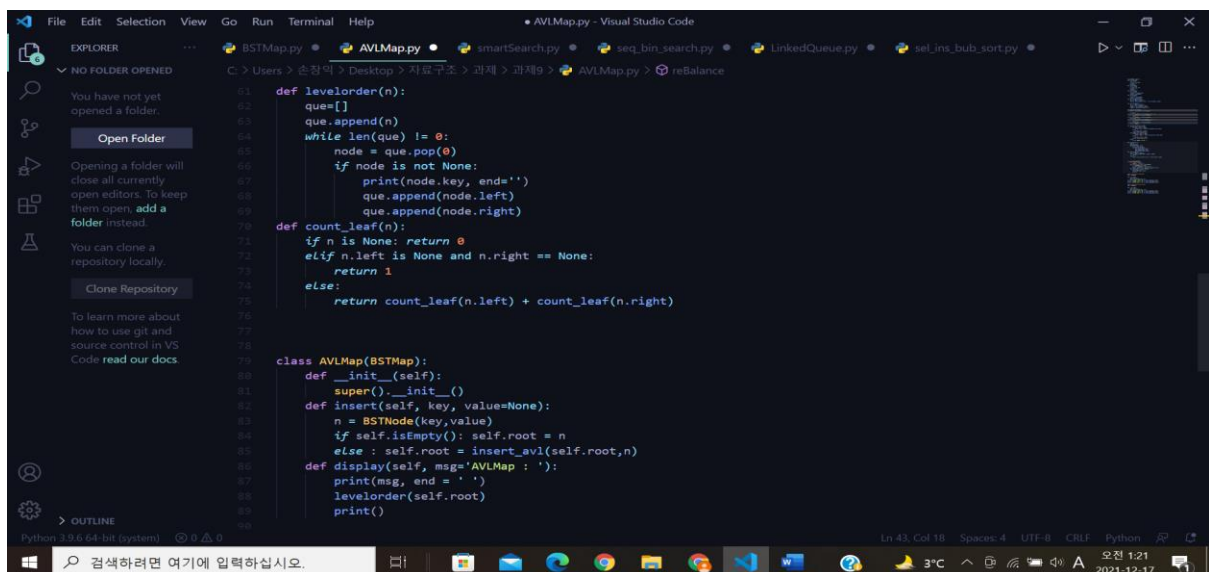
## 2. AVL 트리를 이용한 맵 구현 및 실행



```
from BSTMap import*
def rotatell(A):
    B = A.left
    A.left = B.right
    B.right = A
    return B
def rotateRR(A):
    B = A.right
    A.right = B.left
    B.left = A
    return B
def rotateRL(A):
    B = A.right
    A.right = rotatell(B)
    return rotateRR(A)
def rotatell(A):
    B = A.left
    A.left = rotateRR(B)
    return rotatell(A)
def calc_height_diff(n):
    if n == None: return 0
    return calc_height(n.left) - calc_height(n.right)
def calc_height(n):
    if n == None: return 0
    hleft = calc_height(n.left)
    hright = calc_height(n.right)
    return ( max(hleft,hright) + 1)
def reBalance(parent) :
```



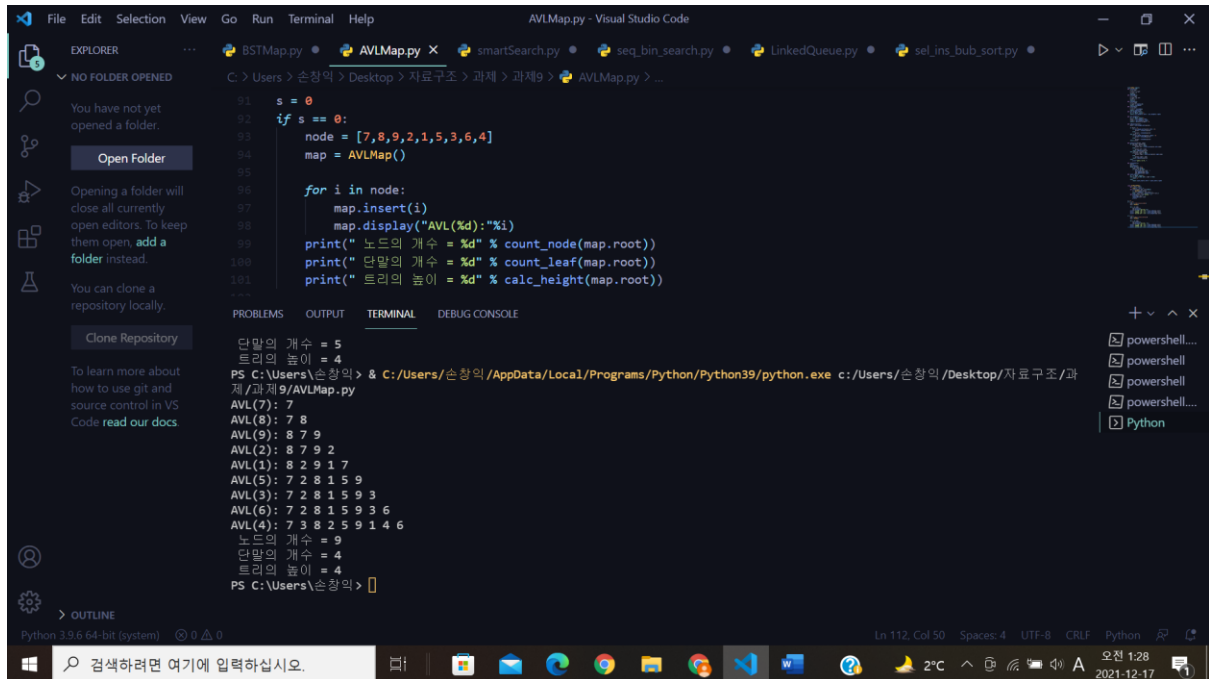
```
def reBalance(parent) :
    hDiff = calc_height_diff(parent)
    if hDiff > 1:
        if calc_height_diff(parent.left) > 0:
            parent = rotatell(parent)
        else:
            parent = rotateLR(parent)
    elif hDiff < -1:
        if calc_height_diff(parent.right) < 0:
            parent = rotateRR(parent)
        else:
            parent = rotateRL(parent)
    return parent
def insert_avl(parent, node):
    if node.key < parent.key:
        if parent.left != None:
            parent.left = insert_avl(parent.left,node)
        else:
            parent.left = node
            return reBalance(parent)
    elif node.key > parent.key:
        if parent.right != None:
            parent.right = insert_avl(parent.right,node)
        else:
            parent.right = node
            return reBalance(parent)
    else:
        print("중복된 키 예외")
```



```
def levelorder(n):
    que=[]
    que.append(n)
    while len(que) != 0:
        node = que.pop(0)
        if node is not None:
            print(node.key, end='')
            que.append(node.left)
            que.append(node.right)
def count_leaf(n):
    if n is None: return 0
    elif n.left is None and n.right == None:
        return 1
    else:
        return count_leaf(n.left) + count_leaf(n.right)
class AVLMap(BSTMap):
    def __init__(self):
        super().__init__()
    def insert(self, key, value=None):
        n = BSTNode(key,value)
        if self.isEmpty(): self.root = n
        else: self.root = insert_avl(self.root,n)
    def display(self, msg='AVLMap : '):
        print(msg, end = ' ')
        levelorder(self.root)
        print()
```

AVL트리의 연산에 대한 코드와 AVL트리를 이용한 맵 구현 코드입니다.

- node=[7,8,9,2,1,5,3,6,4]



```
AVLMap.py - Visual Studio Code
C:\Users\손창익\Desktop\자료구조\과제9\AVLMap.py
91 s = 0
92 if s == 0:
93     node = [7,8,9,2,1,5,3,6,4]
94     map = AVLMap()
95
96 for i in node:
97     map.insert(i)
98     map.display("AVL(%d):"%i)
99 print("노드의 개수 = %d" % count_node(map.root))
100 print("단말의 개수 = %d" % count_leaf(map.root))
101 print("트리의 높이 = %d" % calc_height(map.root))
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