

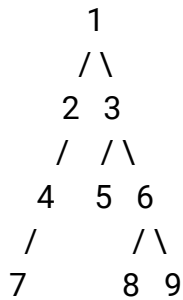
Assignment # 7: Binary Search Trees

1. Please provide your answer to the following questions.

1.1 Given a binary tree of height 5, what are the minimum and the maximum number of nodes this tree can contain? Please also include the calculation steps.

1.2 Suppose there are 16 nodes in a binary tree, what are the minimum and the maximum height this tree can have? Please also include the calculation steps.

2. Given a binary tree below, please provide your answer to the following questions.



2.1 Give the node values corresponding to the following basic elements of a tree.

Element	Value
Root	
Parents	
Children	
Siblings	
Leaves	
Degree of tree	
Degree of node 'E'	
Degree of node 'J'	
Height of tree	
Depth of node 'B'	
Depth of node 'H'	
Ancestors of 'D'	

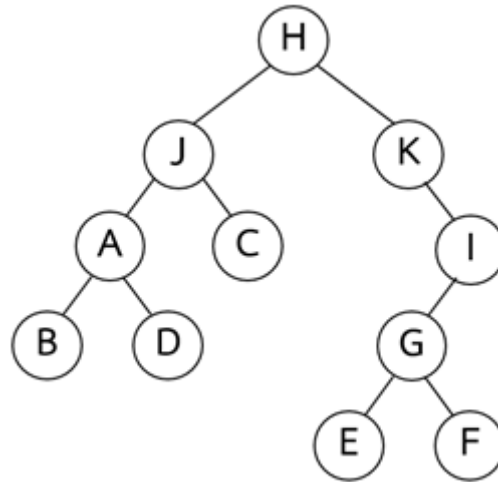
2.2 Write the sequence of nodes accessed using the **preorder** traversal algorithm.

2.3 Write the sequence of nodes accessed using the **inorder** traversal algorithm.

2.4 Write the sequence of nodes accessed using the **postorder** traversal algorithm.

2.5 Write the sequence of nodes accessed using the **breadth-first** traversal algorithm.

3. Given a binary tree below, please provide your answer to the following questions.



3.1 Give the node values corresponding to the following basic elements of a tree.

Element	Value
Root	
Parents	
Children	
Siblings	
Leaves	
Degree of tree	
Degree of node 'E'	
Degree of node 'J'	
Height of tree	
Depth of node 'B'	
Depth of node 'H'	
Descendants of 'J'	

3.2 Write the sequence of nodes accessed using the **preorder** traversal algorithm.

3.3 Write the sequence of nodes accessed using the **inorder** traversal algorithm.

3.4 Write the sequence of nodes accessed using the **postorder** traversal algorithm.

3.5 Write the sequence of nodes accessed using the **breadth-first** traversal algorithm.

4. Find a root of a binary tree from a given traversal path:

4.1 Tree with postorder traversal: FCBDG

4.2 Tree with preorder traversal: IBCDFEN

4.3 Tree with inorder traversal: CBIDFGE

5. Draw a binary tree from a given traversal path:

- Preorder: JCBADefIGH
- Inorder: ABCEDFJGIH

6. Draw a nearly complete binary tree from a given breadth-first traversal path as JCBADFIG

7. Given a class of **BinaryTree** and its insertion methods below:

```
def BinaryTree(r):
    return [r, [], []]

""" Insertion methods """
def insertLeft(root, newBranch):
    t = root.pop(1) #Obtain list that corresponds to the current
    left child of the root
    if len(t) > 1:    #If the left child is not empty, push the
    old left child as the left child of the new node.
        root.insert(1, [newBranch, t, []])
    else:
        #If the left child is empty
        root.insert(1, [newBranch, [], []])
    return root

def insertRight(root, newBranch):
    t = root.pop(2) #Obtain list that corresponds to the current
    right child of the root
    if len(t) > 1:    #If the right child is not empty, push the
    old right child as the right child of the new node.
        root.insert(2, [newBranch, [], t])
    else:
        #If the right child is empty
        root.insert(2, [newBranch, [], []])
    return root

""" Accessor methods """
def getRootVal(root):
    return root[0]

def setRootVal(root, newVal):
    root[0] = newVal

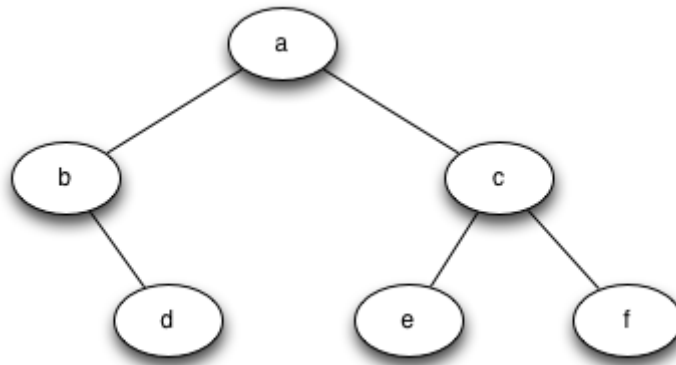
def getLeftChild(root):
    return root[1]

def getRightChild(root):
    return root[2]
```

7.1 Draw the binary tree and provide the list form of the binary tree after executing the operations provided below.

```
x = BinaryTree('A')
insertLeft(x, 'B')
insertRight(x, 'C')
insertRight(getRightChild(x), 'D')
insertLeft(getRightChild(getRightChild(x)), 'E')
```

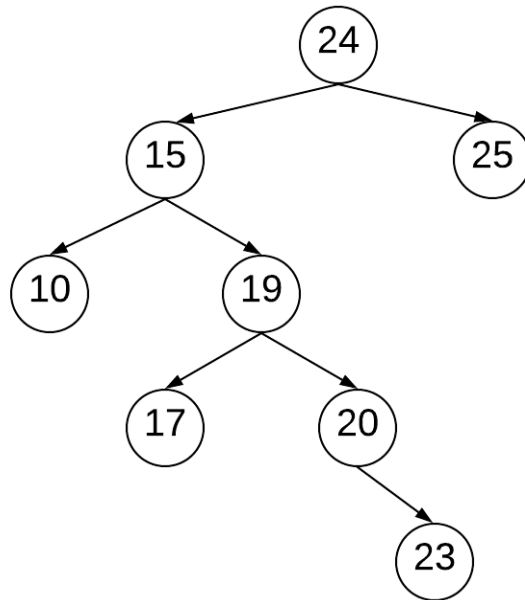
7.2 Write a Python code similar to 7.1 to implement a binary tree as depicted in the figure below using **lists** and provided insertion operations.



7.3 Using the same tree as in Question 7.2, draw an updated tree after the following operations:

```
insertLeft(getLeftChild(x), 'R')  
setRootVal(getRightChild(x), 'S')  
insertRight(getLeftChild(getRightChild(x)), 'T')  
insertLeft(getLeftChild(x), 'U')
```

8. Given the binary search tree below, provide your answer to the following questions.



- 8.1 Draw the updated binary search tree after inserting node 16.

8.2 Following the result from 8.1, draw the updated binary search tree after removing node 20.

8.3 Following the result from 8.2, draw the updated binary search tree after removing node 19.