Data Structures and Algorithms
Assignment 4: Binary Search Tree

Information: Program templates for questions 1-3 are given as separated files (**Q1_template_BST.c, Q2_template_BST.c, and Q3_template_BST.c**). You must use them to implement your functions. The program contains a main() function, which includes a switch statement to execute different functions that you should implement. You need to submit your code to the NTULearn (State your name and your lab group in your submission). **Deadline for program submission: September 28th, 2021 (Tuesday) 11.59 pm.**

1. **(inOrderIterative)** Write an iterative C function `inOrderIterative()` that prints the in-order traversal of a binary search tree using **a stack**. Note that you should **only** use `push()` or `pop()` operations when you add or remove integers from the stack. Remember to empty the stack at the beginning, if the stack is not empty.

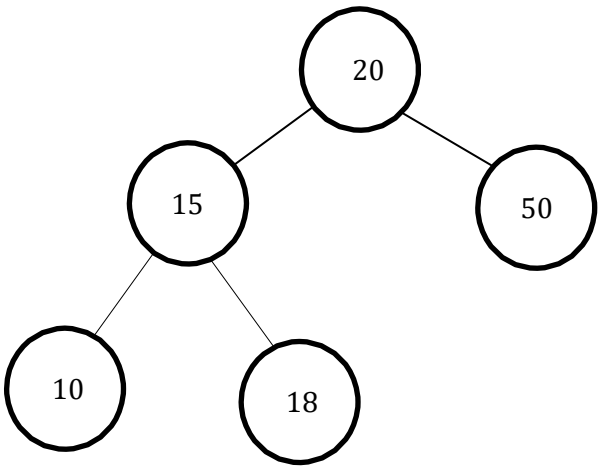
   The function prototype is given as follows:

   ```
   void inOrderIterative(BSTNode *root);
   ```

   Following is the detailed algorithm:

   ```
   1) Create an empty stack S.
   2) Initialize current node as root
   3) Push the current node to S and set current = current->left
      until current is NULL
   4) If current is NULL and stack is not empty then
        a) Pop the top item from stack
        b) Print the popped item, set current = popped_item->right
        c) Go to step 3.
   5) If current is NULL and stack is empty then you are done
   ```

   Let us consider the below tree for example.



   Iterative Inoder Tree Traversal: **10 15 18 20 50**

Some sample inputs and outputs are given as follows:

```
1: Insert an integer into the binary search tree;
2: Print the in-order traversal of the binary search tree;
0: Quit;
Please input your choice(1/2/0): 1
Input an integer that you want to insert into the Binary Search Tree: 20
Please input your choice(1/2/0): 1
Input an integer that you want to insert into the Binary Search Tree: 15
Please input your choice(1/2/0): 1
```

```
Input an integer that you want to insert into the Binary Search Tree: 50
Please input your choice(1/2/0): 1
Input an integer that you want to insert into the Binary Search Tree: 10
Please input your choice(1/2/0): 1
Input an integer that you want to insert into the Binary Search Tree: 18
Please input your choice(1/2/0): 2
The resulting in-order traversal of the binary search tree is: 10 15 18 20
50
Please input your choice(1/2/0):
```

2. **(postOrderIterativeS1)** Write an iterative C function `postOrderIterativeS1()` that prints the post-order traversal of a binary search tree using **a stack**. Note that you should **only** use `push()` or `pop()` operations when you add or remove integers from the stack.

   Remember to empty the stack at the beginning, if the stack is not empty.

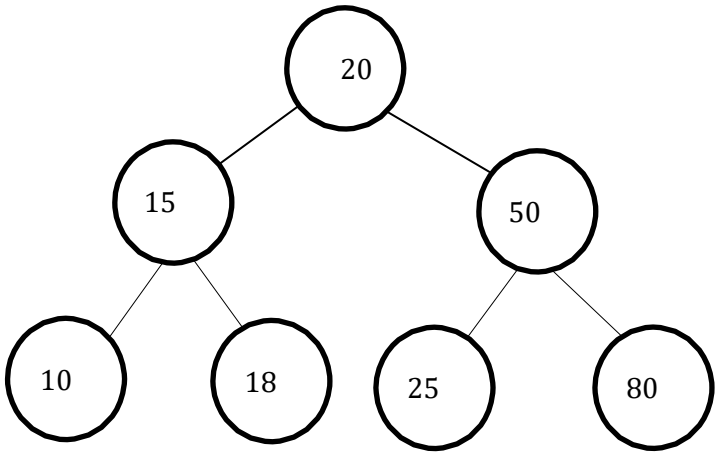
   The function prototype is given as follows:

   ```
   void postOrderIterativeS1(BSTNode *node);
   ```

   Following is the detailed algorithm:

   ```
   1.1 Create an empty stack
   2.1 Do following while root is not NULL
         a) Push root's right child and then root to stack. b)
         Set root as root's left child.
   2.2 Pop an item from stack and set it as root.
         a) If the popped item has a right child and the right
            child is at top of stack, then remove the right
            child from stack, push the root back and set root as
            root's right child.
         b) Else print root's data and set root as NULL.
   2.3 Repeat steps 2.1 and 2.2 while stack is not empty.
   ```

   Let us consider the below tree for example



   Iterative Postorder Traversal: **10 18 15 25 80 50 20**

3. **(postOrderIterativeS2)** Write an iterative C function `postOrderIterativeS2()` that prints the post-order traversal of a binary search tree using **two stacks**. Note that you should **only** use `push()` or `pop()` operations when you add or remove integers from the stacks. Remember to empty the stacks at the beginning, if the stacks are not empty.

   The function prototype is given as follows:

   ```
   void postOrderIterativeS2(BSTNode *root);
   ```

   Following is the detailed algorithm:

   ```
   1) Push root to first stack.
   ```

```
2) Loop while first stack is not empty
    2.1) Pop a node from first stack and push it to second
         stack
    2.2) Push left and right children of the popped node to
         first stack
3) Print contents of second stack
```

Iterative Postorder Traversal for following Binary Search Tree is: **10 18 15 25 80 50 20**