

Assignment #3

Data Structures Deadline - 2022/12/09

Upload your assignment to Moodle before 11:59pm.

Please consult with TA if you have any questions.

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Problem:

Implement the binary search tree (BST) operations **with linked list**.

In the beginning of each rounds, you need to print the operations menu as **Fig. 1**.

```
(I)nsert a number.  
(D)elete a number.  
(S)earch a number.  
(P)rint 4 kinds of orders.  
(E)xit
```

Fig. 1

In this assignment, you need to implement 5 operations described below:

1. Insert: Enter "i" or "I", then enter a sequence of numbers and ended with "-1" to build a BST. Noticed that the number "-1" is not a node for insertion. Show the result as **Fig. 2** and also consider that whether the number has been inserted already.

```
(I)nsert a number.  
(D)elete a number.  
(S)earch a number.  
(P)rint 4 kinds of orders.  
(E)xit  
  
Insert:  
Number 10 is inserted.  
Number 4 is inserted.  
Number 2 is inserted.  
Number 24 is inserted.  
Number 8 is inserted.  
Number 37 is inserted.  
Error! Number 10 exists.  
Number 14 is inserted.  
Number 18 is inserted.  
Error! Number 4 exists.  
Number 6 is inserted.  
Number 3 is inserted.  
Number 1 is inserted.  
Error! Number 24 exists.  
Number 9 is inserted.
```

Fig. 2

2. Delete: Enter "d" or "D", then enter a sequence of numbers ended with "-1" to delete those nodes. Show the result as **Fig. 3**.
 - (a) If the deleted node is a leaf, then delete it directly.
 - (b) If the deleted node has a child, then replace the deleted node with its child.
 - (c) If the deleted node has left and right sub-tree, then replace the deleted node with the smallest node of the right sub-tree.Also consider the error deletion case that the deleted node (number) is not existed.

```

(I)nsert a number.
(D)elele a number.
(S)earch a number.
(P)rint 4 kinds of orders.
(E)xit

Delete:
Number 4 is deleted.
Number 2 is deleted.
Number 5 is not exist.
Number 8 is deleted.
Number 19 is not exist.
Number 14 is deleted.
Number 16 is not exist.

```

Fig. 3

3. Search: Enter "s" or "S", then enter a sequence ended with -1 to search whether the number is in the BST. If the number is not in the BST then print the number is not found. Show the result as **Fig. 4.**

```

(I)nsert a number.
(D)elele a number.
(S)earch a number.
(P)rint 4 kinds of orders.
(E)xit

Search:
Bingo! 10 is found.
Sorry! 4 is not found.
Bingo! 24 is found.
Bingo! 18 is found.
Bingo! 37 is found.
Sorry! 5 is not found.
Sorry! 2 is not found.
Bingo! 3 is found.
Bingo! 1 is found.
Sorry! 14 is not found.
Bingo! 9 is found.

```

Fig. 4

4. Enter "p" or "P" to print prefix -> infix -> postfix and level order of the BST. Show the result as **Fig. 5.**

You must use queue skills in level order!

```

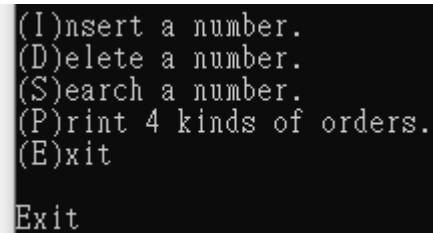
(I)nsert a number.
(D)elele a number.
(S)earch a number.
(P)rint 4 kinds of orders.
(E)xit

Print:
The tree in prefix order: 10 6 3 1 9 24 18 37
The tree in infix order: 1 3 6 9 10 18 24 37
The tree in post order: 1 3 9 6 18 37 24 10
The tree in level order: 10 6 24 3 9 18 37 1

```

Fig. 5

5. Enter "e" or "E" to exit the program. Show the result as **Fig. 6**.



```
(I)nsert a number.  
(D)delete a number.  
(S)earch a number.  
(P)rint 4 kinds of orders.  
(E)xit  
  
Exit
```

Fig. 6

Input file description:

We will enter file name of the input file (xxx.txt), and the program needs to load the corresponding file.

The input file may contain the following inputs about the 5 operations:

- (1) "I" or "i" in the first line. And the second line is a sequence of numbers ended in "-1", you need to insert all the numbers in the sequence except for "-1" to the BST.
- (2) "D" or "d" in the first line. And the second line is a sequence of numbers ended in "-1", you need to delete all the numbers in the sequence except for "-1" in the BST.
- (3) "S" or "s" in the first line. And the second line is a sequence of numbers ended in "-1", you need to search whether all the numbers in the sequence except for "-1" are in the BST.
- (4) "P" or "p" in the first line. You need to print prefix -> infix -> postfix and level order of the BST.
- (5) "E" or "e" in the first line. You need to finish the program.

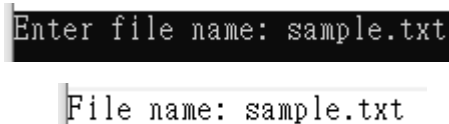
*You can check the sample input in this document and the attached file named "sample.txt".

*All the numbers of nodes are positive integer.

Output file description:

You need to output the result after each operation. The output format must be same as the figures in part 1. You must print the result in **console**. Additionally, you **must write it out to a file** named **output.txt**.

*The only difference between the console and the output file is the first line, see the **Fig. 7**. The upper is your console output and the bottom is your output file.



```
Enter file name: sample.txt  
  
File name: sample.txt
```

Fig. 7

*You can check the sample output in this document and the attached file named "output.txt".

Sample Input:

i
10 4 2 24 8 37 10 14 18 4 6 3 1 24 9 -1
d
4 2 5 8 19 14 16 -1
s
10 4 24 18 37 5 2 3 1 14 9 -1
p
e

Sample Output:

Enter file name: sample.txt

(I)nsert a number.
(D)elele a number.
(S)earch a number.
(P)rint 4 kinds of orders.
(E)xit

Insert:

Number 10 is inserted.
Number 4 is inserted.
Number 2 is inserted.
Number 24 is inserted.
Number 8 is inserted.
Number 37 is inserted.
Error! Number 10 exists.
Number 14 is inserted.
Number 18 is inserted.
Error! Number 4 exists.
Number 6 is inserted.
Number 3 is inserted.
Number 1 is inserted.
Error! Number 24 exists.
Number 9 is inserted.

(I)nsert a number.
(D)elele a number.
(S)earch a number.
(P)rint 4 kinds of orders.
(E)xit

Delete:

Number 4 is deleted.
Number 2 is deleted.
Number 5 is not exist.
Number 8 is deleted.
Number 19 is not exist.
Number 14 is deleted.
Number 16 is not exist.

(I)nsert a number.
(D)elele a number.
(S)earch a number.
(P)rint 4 kinds of orders.
(E)xit

Search:

Bingo! 10 is found.
Sorry! 4 is not found.
Bingo! 24 is found.
Bingo! 18 is found.
Bingo! 37 is found.
Sorry! 5 is not found.
Sorry! 2 is not found.
Bingo! 3 is found.
Bingo! 1 is found.
Sorry! 14 is not found.
Bingo! 9 is found.

(I)nsert a number.
(D)elele a number.
(S)earch a number.
(P)rint 4 kinds of orders.
(E)xit

Print:

The tree in prefix order: 10 6 3 1 9 24 18 37
The tree in infix order: 1 3 6 9 10 18 24 37
The tree in post order: 1 3 9 6 18 37 24 10
The tree in level order: 10 6 24 3 9 18 37 1

(I)nsert a number.
(D)elele a number.
(S)earch a number.
(P)rint 4 kinds of orders.
(E)xit

Exit

Note:

Every execution in the program except "Exit" should be able to operate for several times. For example: insert more nodes after delete some nodes, and vice versa.

For input, we will test only the characters mentioned above ("i", "I", "d", "D", "s", "S", "p", "P", "e" and "E"), note that you need to accept both uppercase and lowercase for the input.

For each operation, the first line of output is always the same. That is, the "Insert:", "Delete:", "Search:", "Print:" and "Exit" are always needed.

You can check the full output of sample.txt in the attached file named "sample_output.png".

You are only allowed to use **C++** language for this homework assignment.

Besides, you need to explain what each function does and how to call it properly (i.e. what arguments should be passed) in the **Readme.txt**. Make sure your program can be executed in **Dev c++** and write code comments. Please compress all the files, and name the compressed file as **HW3_yourstudentID.rar (or in .zip file) (e.g. HW3_P761111111.rar)**. Then upload the compressed file to the Moodle in time. Also, you shall print out the output in the output.txt after executing the .exe

The file structure should be like following figure:

```
| -HW3_P76*****.rar (.zip)
| | -HW3_P76***** (Folder)
| | | -main.cpp
| | | -sample.txt
| | | -output.txt
| | | -Readme.txt
```

Don't cheating, or you will get 0 for this assignment. If you can't finish the assignment before deadline, just hand in your unfinished code and report.