

IIT Ropar

CSL201 Data Structures

Semester 1, AY 2016/17

Lab Assignment 2 - 50 marks

Due on 12th September, 11:59 PM

Objective

To understand and implement stacks, queues, and binary trees.

Instructions

1. There are four programming questions; you have to do all four questions.
2. You are to use C++ programming language to complete the assignment.
3. Provide a Makefile to compile your final code.
4. This is an individual assignment. You can have high level discussions with other students, though.
5. Include a "Readme.txt" file on how to compile and run the code.
6. Upload your submission to moodle by the due date and time. After due date, your submission will be evaluated with 10% penalty per day for next two days. After that, your submission will not be evaluated.

Questions

1. [10 marks] In a correct C++ program, each opening group symbol should have a matching closing group symbol. For example a possible correct order of grouping symbols is `[(){()}]`, while an incorrect order is `[(){(})]`. In addition to the traditional symbols, the C++ version we are using has one more delimiting symbol, `$`, which is used to print value of an expression. We call this version EC++. For example,

```
int main(){  
    //some code  
    $5*(6+4/(3+2))$  
    //some code  
}
```

Note that the grouping symbol should be balanced between two delimiting symbols.

Write a program that takes input a EC++ file and returns true if all grouping and delimiting symbols are matching otherwise returns false. [Hint: can use two stacks].

2. [10 marks] Consider the following problem: Given an input sequence a_0, \dots, a_{n-1} of n positive numbers, output a sequence b_0, \dots, b_{n-1} where for any $i \in \{0, \dots, n-1\}$, b_i is the rightmost number to the left of a_i that is bigger than a_i in the given sequence. If no number to the left of a_i is bigger than a_i , then b_i is defined to be -1 . Thus b_0 is always -1 because there is no number to the left of a_0 . For instance, if $n = 7$ and the input sequence is 7, 2, 5, 3, 6, 9, 1, then the output sequence is $-1, 7, 7, 5, 7, -1, 9$.

Give an algorithm for computing the output sequence from the input sequence in linear (i.e., $O(n)$) time. [Hint: Use a Stack].

3. [10 marks] We define range of an integer array as the tuple of minimum and maximum elements. For example, the range of array [2, 5, 7, 3, 6, 4, 8] is (2, 8). Given a large array of size n , find range of each contiguous subarray of size k and store in a vector. For example, the subarray range vector for $k = 3$ and given array would be:
Subarray range vector = (2, 7), (3, 7), (3, 7), (3, 6), (4, 8).

Design and implement an algorithm to obtain subarray range vector for given k in $O(n)$ time. [Hint: use queue/deque].

4. [20 marks] Read a randomly ordered sequence of integers and store them in a doubly linked list. Use in-place insertion sort to sort the elements of the linked list. Now convert this list into a binary search tree with minimum height possible. Write another program to test whether a given tree is BST or not. Use this program to test the correctness of your previous program, i.e., whether or not the binary tree you have constructed is a BST.

Assessment

- You will be assessed individually in the lab session (you must attend your assigned lab!). You'll have approximately 4-5 minute Q&A session with Dr. Mukesh or one of the TAs (Raghu, Neeraj, or Shreya).
- You will have to run the code directly from your Moodle submission, you won't be allowed to bring an updated version to the lab.
- After you run the code, we will ask you anything about your code we want. Be prepared to answer the questions.