CS2710 - Programming and Data Structures Lab

Lab 2 (graded)

Aug 7, 2024

Instructions

- You are expected to solve ALL the problems in the lab, using the local computer, C++ language, and g++ compiler.
- You should submit your code to the course **moodle** on time, i.e., on/before 4.45pm (so that TAs can subsequently grade your submissions for graded lab assignments using the private test cases).
- You must strictly adhere to the following naming convention for your .cpp files and the single .zip file submission:
  For example, for a Lab Session 2 consisting of 2 questions, a student with roll number CS23B000 should
  - Name their .cpp files as **CS23B000_LAB2_Q1.cpp** and **CS23B000_LAB2_Q2.cpp**
  - Put both these .cpp files in a directory named **CS23B000_LAB2**
  - Zip this directory into a file named **CS23B000_LAB2.zip**
  - Submit only this single .zip file to moodle.
- The questions are based on your training in programming in CS1111. So no additional inputs are needed, except the changes needed to switch from C to C++.
- If you need assistance, ask your TA, not your classmate.
- Internet access and mobile devices are prohibited in the lab.
- Check course Moodle for the public test cases and the evaluation script, which you can use to test your programs.

Problems to be solved in lab

1. [MINIMUM SIZE SUBARRAY SUM] Given an array A of positive numbers, of size N and a positive number $Target$, return the minimum length of a subarray whose sum is greater than or equal to $Target$.
   If there is no such subarray, return 0 instead.

   Write a program having O(N^2) time complexity.

   Input Format:
   The first line will contain integer N (the size of array) and value $Target$.
   The next line has N elements $A_1, A_2, ..., A_N$.

Output Format:
Print minimum length of sub-array whose sum is greater than or equal to $Target$.

Constraints:
$1 \leq N \leq 1000$
$1 \leq A_i \leq 10^9$
$1 \leq Target \leq 10^9$

Sample Input 1
5 6
2 3 1 4 3

Sample Output 1
2

Sample Explanation 1
Sum of subarray [4 3] is $7 \geq 6(Target)$.
So minimum size of subarray whose sum is greater than or equal to Target is 2.

Sample Input 2
5 14
2 3 1 4 3

Sample Output 2
0

2. [MINIMUM SIZE SUBARRAY SUM] Consider the same problem statement of Q1.

   Write a program having O(N) time complexity.

   Constraints:
   $1 \leq N \leq 200000$
   $1 \leq A_i \leq 10^9$
   $1 \leq Target \leq 10^9$

3. [THE GREAT RUN] Flash loves running and often runs long distances. Flash also has a rather large group of family and friends. Flash is preparing for the Chennai marathon. Flash knows that his family and friends will be there on the sidelines of the marathon, and he wants to impress them with his awesome speed.
   The Chennai marathon runs for N kilometers. For this question, assume that it runs in a straight path. Flash's family and friends will be scattered through the path. In particular, Flash has done some homework and found out that there will be a_i number of his family and friends who will be standing between i and $i+1$ kilometers ($0 \leq i \leq N-1$). Flash believes that anyone will be impressed only if he runs at his best speed when he passes by them. But, he can run at his best speed only for a continuous stretch of K kilometers. Further, he can achieve this best speed only once in the entire marathon.

   Write a program to help Flash find the maximum number of his family and friends that he can impress.

Try to solve the problem in O(N) time-complexity. (Not O($N * K$))

Input Format:
The first line will contain integer N (the length of the marathon) and integer K. (the maximum distance that Flash can run at this best speed.)
The second line will contain N space-separated integers, the number of Flash's family and friends within each kilometer of the marathon.

Output Format:
Print an integer, denoting the maximum number of family and friends that Flash can impress.

Constraints:
$1 \leq K \leq N \leq 10^5$
$0 \leq a_i \leq 10^4$

Sample Input 1
```
7 2
2 4 8 1 2 1 8
```

Sample Output 1
```
12
```

Sample Explanation 1
Among Flash's family and friends, there are 4 people from kilometer 1 to 2, and 8 people from kilometer 2 to 3. Hence, if Flash runs at his best speed from kilometer 1 to 3, then he can impress 12 people. This is the maximum number of people that he can impress in a continuous 2 kilometer stretch.

Sample Input 2
```
17 6
8 3 9 2 4 1 5 7 19 10 56 78 29 98 40 28 90
```

Sample Output 2
```
363
```

4. [**BONUS QUESTION** - HELP TA!] The TAs of CS2710 course have 1 copy of question paper, and now they need to make n more copies before the start of the lab. They have two copiers machine, one of which copies a sheet in x seconds, and the other in y seconds. (It is allowed to use one copier or both at the same time. You can copy not only from the original question paper, but also from the copy.) Help them find out what is the minimum time they need to make n copies of the question paper.

   Input Format:
   The first line will contain integer n (number of copies required), x and y (time required by copier machines)

   Output Format:
   Print an integer, denoting the minimum time required to make n more copies of question paper.

   Sample Input 1
   ```
   4 1 1
   ```

Sample Output 1
3

Sample Input 2
5 1 2

Sample Output 2
4

Sample Explanation 2
From 0th to 1st second - Created 1 copy from original question paper using Machine x.
Now we can use these 2 copies with machine x & y, and copy in parallel.
From 1st to 3rd second - We get 2 copies using machine x(because it takes 1 sec) and we get 1 copy using machine y(because it takes 2 sec).
Now we have 4 copies and we need 1 more.
From 3rd to 4th second - we get 1 copy using machine x.
So, we created 5 copies in 4 sec.

Constraints:
$1 \leq n \leq 10^8$
$1 \leq x, y \leq 10$

General Note for all questions:
Try to solve problem using Array/Vector only. (Don't use any other data structure)
You can use built-in sort() if required. (Assuming O($N * logN$) time)