



Ben-Gurion University

Faculty of Engineering Sciences

Department of Electrical and Computer Engineering

Introduction to algorithms and data structures

Home assignment #1

Semester B / 2021

Instructions

These are the guidelines for submitting this home assignment.

1. The home assignment is submitted **only** through the moodle website! **Do not** send by email.
2. Do not ask questions regarding the project through email, Use the moodle forum only.
3. You should submit a single **.c** or **.cpp** file, in the dedicated place.
4. The template is a .cpp file and you may use it (not mandatory), even if you are writing your project in proper C language!!
5. The file name should be **YOUR_ID_NUMBER.cpp** - for example : 123456789.c or 123456789.cpp
6. There are three problems you have to provide solutions to.
7. You do not have to check the input. You can assume the input is correct.
8. The program will print the solution to the screen. For floating point answers, print only the first two digits after the point.
9. Each problem will be tested with 8 different inputs.
10. **If your solution is not correct, or your algorithm times-out (more than 1 second) you will get 0 for the test input. Otherwise, 1.**
11. For each question write as a comment in your code a tight upper bound to your solution including an explanation for it.
12. The assignment is **solo!** Each student must submit his own file with his **ID number!!**. Deadline is in moodle website.
13. The inputs are entered by the user. You can use redirect values from a text file into your program from the command-line (Google it).
14. The first input will be the number of problem you want to solve.
15. A template file is attached, you are not allowed to add any other libraries, but you may implement by yourself in your file.
16. Don't use scanf_s! Make sure it compiles with gcc 9.3.0 , C++ 11.

Good Luck!

Problem 1

CNN Max-Pooling

During the last several years, convolutional neural networks (CNN) have become one of the fields with the greatest impact on science and technology. CNN is basically a collection of convolution layers, and one of these layers is a pooling layer. The pooling layer is a form of non-linear down-sampling convolutional layer. The most common non-linear pooling functions is the max, average and min pooling as it is easy to implement - here we will consider the max pooling. For example, given the vector,

$$[1, 5, 8, 2]$$

the result of the Max-Pooling layer with a stride of 1 and a filter of size 3 will be,

$$[\max([1, 5, 8]), \max([5, 8, 2])] = [8, 8],$$

and the result of the Max-Pooling layer with a stride of 1 and a filter of size 2 will be,

$$[\max([1, 5]), \max([5, 8]), \max([8, 2])] = [5, 8, 8].$$

Obviously, filter of size 1 will return the exact same vector and a filter of size 4 will return a vector of size 1 with the value 8.

1 Task

Given an array of size n , perform the Max-Pooling function on the array with a stride of 1 for every filter size possible (from 1 to n). Find the minimum value of each result, and return the sum of all of the minimum values.

2 Input

The first line will be the size of the input array n . $1 \leq n \leq 1000000$

The second line will be space separated n values. Each value can be in the range between 1 and 1000.

3 Output

The sum of the minimum value for each Max-Pooling filter size.

4 Sample input

```
4
4 5 1 2
```

5 Sample output

```
13
```

6 Output explained

Filter with size 1 returns:

[4, 5, 1, 2]

Filter with size 2 returns:

[5, 5, 2]

Filter with size 3 returns:

[5, 5]

Filter with size 4 returns:

[5]

The minimum for filter 1 is 1. For filter 2 is 2 and for filters 3 and 4 is 5.

The sum is $1+2+5+5=13$

Problem 2

Job performance analysis

A job is considered costly not by its value, but relatively to the lowest value of all other jobs.

1 Task

You are given a stream of n integers.

If the value of the integer is positive add it to the end of the job queue.

If the value is zero remove the first job in the queue and calculate the relative cost of the removed job ($RelativeCost = CostOfJob - JobWithMinimalCostInQueue$). Return the sum of all relative costs of the removed jobs.

2 Input

First line is the number of inputs N ($1 \leq N \leq 5000000$).

Second line is a stream of values between $[0-100000]$.

3 Output

The sum of all jobs performed reduced by the minimum job existed when removed.

4 Sample Input

10

5 5 5 4 0 1 0 6 5 0

5 Sample Output

9

6 Sample Output explained

Iteration	1	2	3	4	5	6	7	8	9	10
Queue	[5]	[5,5]	[5,5,5]	[5,5,5,4]	[5,5,4]	[5,5,4,1]	[5,4,1]	[5,4,1,6]	[5,4,1,6,5]	[4,1,6,5]
Min	5	5	5	4	4	1	1	1	1	1
Sum	0	0	0	0	1	1	5	5	5	9

Problem 3

Max Palindrome

1 Task

You are given a string and you need to find the largest substring which is a Palindrome.

2 Input

The first line is the length of the string, N ($1 \leq N \leq 30$).

The second line is a string of length N .

Note - Brute force will work up to $N=27$.

3 Output

The length of the largest substring which is a Palindrome.

4 Sample input 1

HelloWorld

5 Sample output 1

3

6 Sample output explained

oWo