

PROGRAMMING TECHNIQUES, A.A. 2021/2022

Laboratory 4

Exercise 1, 2 and 3 are the home assignments that can be optionally submitted for evaluation, to obtain the exam's bonus. Deadline is **13/5/2022, 11:59 pm**, and it will be the same for laboratories 4, 5 and 6. The home assignments of Lab4+Lab5+Lab6 need to be submitted in one shot by the given deadline, following the instructions that are provided in the Portale della Didattica (see the document: Instructions for submission of assignments.pdf)

Objectives

- Solve iterative numerical problems, using arrays (mono-dimensional arrays and matrixes) (*C3b- Problem solving with arrays: part I*)

Technical content

- I/O basics
- Functions
- Conditional and iterative problems
- Operations with arrays (of int and float)

Exercise 1. (THIS EXERCISE IS TO BE SUBMITTED FOR THE EXAM BONUS)

Category: problems with numerical sequences

Numerical sequences in arrays

v is a mono-dimensional array of n integers (with $n \leq 30$). Write a C program that, after acquiring the values of the array from keyboard, calls a function with the following prototype:

```
subSequences(int v[], int n);
```

The function should print on the screen all the sub-vectors of maximum size formed by contiguous elements, containing non-zero values.

Example

If v is $[1 \ 3 \ 4 \ 0 \ 1 \ 0 \ 9 \ 4 \ 2 \ 0]$, the two sub-vectors of maximum dimension (3) with non-zero contiguous elements are $[1 \ 3 \ 4]$ and $[9 \ 4 \ 2]$.

Tips:

Note that the problem can be addressed by solving two sub-problems:

- *identify sub-vectors of non-zero elements*
 - *it is sufficient to "recognize" the beginning and the end of these sub-vectors*
- *select those with maximum length:*
 - *a simple method consists in "trying" all the possible lengths in descending order, stopping at the first length for which there exists a sub-vector*
 - *a more efficient method is to first determine the maximum length, and then search for the corresponding sub-vectors*
 - *alternatively, one could also try to do a single iteration on the main vector to recognize the sub-vectors, determine the maximum length and "remember" (using another vector) the beginnings of the sub-vectors: but the complexity / efficiency would not change (you would still need a further*

iteration to print the sub-vectors) and (probably) the program would be more complicated than in the previous version.

Exercise 2. (THIS EXERCISE IS TO BE SUBMITTED FOR THE EXAM BONUS)

Category: problems with ordered numerical sequences

Rotation of arrays

Write a function `C` capable of rotating the content of an array of n integers to the right or to the left by a number of positions p . The array is to be understood as a *circular* array, in the sense that the element to the right of the index cell $N-1$ is the one with index 0 and the element to the left of the index 0 is the index $N-1$. The following figure illustrates a right rotation by 3 positions:



The function should have the following prototype:

```
void rotate(int v[maxN], int n, int p, int dir);
```

The `main` should:

1. acquire n from keyboard ($n \leq \text{maxN}$ with `#define maxN 30`)
2. acquire the values of the array `v` from keyboard
3. perform repeated rotations of the input array, where at each iteration the user decides the value of p ($p < n$, $p=0$ to terminate the program) as well as the direction of the rotation (`dir=-1` for right, `dir=1` for left) and the resulting rotated array is printed on the screen.

Exercise 3. (THIS EXERCISE IS TO BE SUBMITTED FOR THE EXAM BONUS)

Category: problems numerical matrixes

Iterations on matrixes

A text file contains an array of integers with the following format:

- the first line of the file specifies the dimensions of the matrix (number of rows `nr` and number of columns `nc`), separated by spaces. Assume that both values are ≤ 20 .
- each of the subsequent lines contains the `nc` values corresponding to a row of the matrix, with one or more spaces as separators.

Write a C program that:

- reads this matrix from the input file (the name of the file, maximum 20 characters, is read from the keyboard)
- repeatedly asks the user for a `dim` value between 1 and the minimum between `nr` and `nc`, and prints all the square sub-matrixes of size `dim` that are contained in the input matrix
- prints the square sub-matrix, among those previously identified, that has the maximum sum of elements
- terminates the iterations if the user enters a value that is inconsistent with the size of the matrix

Example

If the content of the input file is the following:

```
3 4
1 2 3 4
5 6 7 8
9 0 1 1
```

and `dim=2`, the program should print on the screen:

The square sub-matrixes of dimension 2 are:

```
1 2
5 6
```

```
2 3
6 7
```

```
3 4
7 8
```

```
5 6
9 0
```

```
6 7
0 1
```

```
7 8
1 1
```

The submatrix with maximum sum of elements (22) is:

```
3 4
7 8
```