

## 04JCJLZ - COMPUTER SCIENCES - 2015/2016

### Laboratory 6

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#### Objectives:

- Process and manipulate the contents of a previously acquired array
- Write programs that include simple functions

#### Technical content:

- Advanced use of arrays
- Using nested loops for the analysis of arrays
- Using preliminary calculation functions with parameters passed by *value*

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#### Preferably to be solved in the laboratory:

Exercise 1. Write a C program that:

- a. Reads an array of N integer elements (with N constant default).
- b. Determine whether the sequence of the N elements is a palindrome.

Suggestion: A sequence is called palindrome if it is the same no matter read from the left to the right or from the right to the left.

For example: the following sequences are palindromes:

```
12 3 12
1 4 5 4 1
10 10 10
```

However, the following is not a palindrome:

```
1 3 4 3 2
```

Exercise 2. Write a C program that:

- a. Is able to read two arrays of N integer elements (with N predefined constant).
- b. Determine if the two arrays contain the same elements, arranged in a different order.

Example: the following two arrays are given:

v1 → 15 3 12 13 29

v2 → 15 29 13 3 12

These arrays contain the same values, even if in different positions are given. However, the two following arrays do not contain the same values:

v1 → 11 3 12 18 29

v2 → 12 29 13 4 12

Further insight: consider the possibility that there are repeated values among those stored in arrays. For example

v1 → 12 3 12 13 29

v2 → 12 29 13 3 12

These arrays contain the same values and the 12 appears 2 times per array. Instead, the two following arrays do not contain the same values:

v1 → 12 3 13 13 29

v2 → 12 29 13 3 12

To be solved at home

- Exercise 3. Write a C program that analyzes the content of an array looking for replicated values. The program will in particular:
- Obtain the values for the array from keyboard
  - Scan the array by determining whether there are repeated values, 2 or more times
  - Print the list of repeated numbers and the number of occurrences of these numbers, ensuring that each number appears only once in this list.

- Exercise 4. Write a C program that reads from the keyboard the contents of an array of length N, a sequence of N numbers. The program must sort them in ascending order as they are introduced (insertion sort) . Finally the program must print the contents of the array.

Suggestion: At first sight, it seems that the algorithm should be followed:

- Read a value
- Look for its position in the array, taking into account how many values the user has entered
- Move all subsequent values forward one position (from the end of the array)
- Insert the value in its ordered position.

On closer analysis, one realizes that the part seeking the position in which to insert the new value is redundant. You can proceed as well:

- Read a value
- Analyze the array from the bottom: if the value that the user introduced is smaller than the last value stored in the array, the latter moves to the next cell
- The last step is repeated, until a value less than the value introduced is found (could happen in the first value of the array scanned): the value has to be included in the next cell.

Example: If the program has been already given the data array {2, 5, 7, 9}. The value read is 3. In comparison with 9, 3 is less, move forward one position 9. The array becomes {2, 5, 7, ,9}. In comparison with 7, 3 is smaller, then 7 is moved forward by one place. The array becomes {2, 5, , 7, 9}. The same happens obtaining the array {2, ,5,7,9} . When The value 3 is compared with 2, the given value is greater than the stored value, thus the given value is inserted it in the next cell (which had been released the previous step). Finally the array becomes {2,3,5,7,9}. Formalize the algorithm and translate it in C.

- Exercise 5. Write a C program that reads two integers from the keyboard corresponding to the base and exponent, and performs the calculation of the power ( $\text{base}^{\text{exponent}}$ ). The program must call a function named power in the main program, which follows the following prototype:

int power(int base, int exponent);

Example: the following values are given:

base = 3

exponent = 2

the result of  $\text{base}^{\text{exponent}}$  will be 9. In another case with:

base = 2

exponent = 3

the result of  $\text{base}^{\text{exponent}}$  will be 8.

Suggestion: inside the function, calculate the power multiplying iteratively the basis for itself a number of times equal to the exponent.

(for the curious, for talent and for those who aspire to be)

Exercise 6. A number is palindrome if it can be read from left to right or from right to left. Write a program that, for every integer from 2 up to a maximum established as a parameter, for example 30, determines if there is a basis in which that number is palindrome. For example, 5 is palindromic in base 2 ( $101_2$ ), 16 is palindromic in base 3 ( $121_3$ ), etc. For this exercise, do not worry to "represent" the values, simply indicate the value (for instance, on the base 16 the value 10 is not required to be represented as A, just the value 10). Furthermore, exclude the cases of single digit 1 (the answer would be trivial): this implies that, for a generic number N, it shall be proved with base ranging from 2 to N-1.

Suggestion: Since the value of a number N and given a base b, to see if it is palindrome (in the base) must convert the number in that base, storing the digits that comprise it, and then see if it is the same to read the digits left to right or from right to left. But there is a more clever method that does not require to store the whole number.

In fact: given the value of a number, the algorithm of divisions for a base allows to derive the sequence of digits that represent it (in that base): the values are calculated starting from the least significant. Example: given  $5_{10}$ , are obtained for the base 3 digits 2, 1 (in fact  $5_{10} \rightarrow 12_3$ )

Given the sequence of digits, to derive the value of the number it starts from the most significant digit and applies the algorithm of the product (for the base) and the sum (of the current digit).

For example:  $12_3 \rightarrow 1*3+2 = 5_{10}$ .

Therefore, to verify if a number is palindromic, you can use the two previous algorithms in cascade: if the value of the starting number is equal to the value of the number formed by the combination of the two previous algorithms, it is in the presence of a palindrome. It is observed that, although the algorithm does not require the storage of the digit in a array, can be convenient if you want to store and then display.

The calculation of the value of the digits is reversed realized by a function.

Exercise 7. Write an algorithm able to tabulate the value of the function  $\arcsin(x)$  for x in the interval [a, b] with step c. The values for a, b, c are obtained from keyboard. Is not used for this purpose the function  $\arcsin()$  from a library, but realizes a function named  $\text{invsin}(z1, z2, k, e)$  able to calculate numerically by the method of bisection method of the equation  $\sin(z)=k$  with z (returned as a return value of the function), between [z1, z2] and with accuracy equal to e, assuming that the function  $\sin()$  is monotone in the interval [z1, z2]. It describes the algorithm implemented using the C programming language. The algorithm implemented has to be tested on the computer so as to verify the syntactic and semantic correctness.

Exercise 8. <sup>1</sup>Write a C program to generate and print all Pythagorean triples in the range of integers (A, B, and C form a Pythagorean triple if  $A^2 + B^2 = C^2$ ). And it is required that the test is carried out by a function that returns the value TRUE if the trio passed as a parameter is Pythagorean, FALSE otherwise.

Suggestion: Avoid overflow of the sum.

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<sup>1</sup> This exercise will be solved using a multimedia format, and its solution will be provided in the course site during the following weeks.