4. Tutorial/practical exercises

Exercise 1

Design a recursive Python function to compute:

1. The sum two positive integers without using the addition. The code can just use two functions `inc(x)` and `dec(x)` to increment ou decrement a variable (you should also write the code of theses functions).
2. The product of two positive integers without using the `*` operator.
3. The quotient and remainder of two positive integers without using the `/` operator.

Exercise 2

1) Design a recursive Python function to:
   a) Search for a value in an array
   b) Search for a value in a sorted array
   c) Compare between the complexity of the two functions.
2) Give the iterative versions of these functions.

Exercise 3

Design an iterative and a recursive Python functions that decompose a number into its prime factors as an array (the functions take two arguments: the number to decompose, and a list of prime numbers less than 1000). For instance, for the number 45, the function should produce the array `[0,2,1,0,0,...]` .

Exercise 4

Design an iterative and a recursive Python functions that compute the longest strictly increasing contiguous subsequence in an array. For instance, with the list `[7,3,2,5,4,8,11,13,0,2,7,9,12)` the result should be 5.

Exercise 5

Let n be a positive integer. Consider the number $1+\cfrac{1}{1+\cfrac{1}{1+\cfrac{1}{1+\cfrac{1}{1+\ldots}}}}$ with n fractions. Write a recursive and an iterative functions which compute this number for a given n.

Exercise 6

We consider a matrix in which each row represents information about a person in the following format `[last_name,first_name,age,hobbies...]` , where hobbies is a variable number of strings indicating the person's hobbies. Build a Python program (using functions) that shows a menu with the following items: search for people who have a particular hobby, sort by last name, sort by first name, sort by age, and display all people.

Exercise 7

Consider the following linear system:

$$\begin{cases} a_{11}x_1 + a_{12}x_2 = b_1 \\ a_{21}x_1 + a_{22}x_2 = b_2 \end{cases}$$

Write a Python program that reads the coefficients of this system, solves it, then displays the result (use the `numpy` module).

Exercise 8

Write a Python programs that reads the sales of many companies in terms of products (together with the names of the companies). The program should produce a pie chart of the parts of each company in the market (use the function `plt.pie(series,labels)`).

Exercise 9

Consider the function $f(x) = \sin(x) + \beta$ where β is a noise (represented as Gaussian distributed random numbers generated with the parameters $\mu = 0$ and $\sigma = 0.3$). x takes its values in the interval $[0, 10]$ with a step of 0.05. Write a Python a code to plot the function f.