Exercises Laboratorio di Calcolo: The Python Language

Exercise 1

Write a function that calculates the factorial of a given integer number. Check the result with the built-in function `math.factorial` from the module `math`.

Exercise 2

Write a function that displays the *n* first terms of the Fibonacci sequence, defined by:

$F_0 = 1,\ F_1 = 1,\ F_n = F_{n-1} + F_{n-2}$

Exercise 3

Write a program to generate all sentences where the subject is in ['I', 'You'] and the verb is in ['Play', 'Love'] and the object is in ['Football', 'Tennis'].

Exercise 4

Write a function that returns all items on even positions of a list.

Example: [2, 5, 7, 9, 11, 17, 222] results in [2, 7, 11, 222]

Write another function that returns all items of a list, except the first and last one, in reversed order.

Example: [2, 5, 7, 9, 11, 17, 222] results in [17, 11, 9, 7, 5]

Hint: use list slicing.

Exercise 5

Write a function that calculates the values of Q according to the formula:

$$Q = \sqrt{\frac{2 \cdot C \cdot D}{H}}$$

The values of C and H are fixed: $C = 50$ and $H = 30$. The values of D should be input to your function as a list. Return all corresponding values of Q in a list.

Hint: use list comprehension.

Exercise 6

Write a program that finds all integer numbers which are divisible by 7 but are not a multiple of 5, between 200 and 300 (both included). Return these numbers in a list.

Exercise 7

Write a function that finds the positions of all the numbers other than zero in a given list. Return these positions in a list.

Exercise 8

Write a function that generates a matrix of size (n, m) for given integer numbers n, m. The element value in the i-th row and j-th column of the matrix should be $i \cdot j$.

Example: for $n = 3$, $m = 5$ the output should be

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 2 & 3 & 4 \\ 0 & 2 & 4 & 6 & 8 \end{bmatrix}$$

Hint: a matrix can be represented as a list of lists.

Exercise 9

Write a function that accepts a list of words as input, and returns the words after removing all duplicate words and sorting them alphanumerically.

Write another function that accepts a sentence, and manipulates the words in the sentence in the same way as described before.

Example: 'hello world and practice makes perfect and hello world again' should return
'again and hello makes perfect practice world'

Hint: use the string methods `split` and `join`.

Exercise 10

A robot moves in a plane starting from the original point (0,0). The robot can move in the directions UP, DOWN, LEFT and RIGHT with a given number of steps. Write a function to calculate the distance from the original point to the current position after a list of movements. Movements are indicated as a tuple ('DIRECTION', steps).

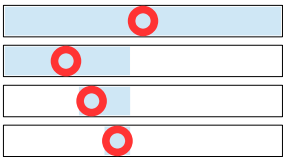
Example: the output should be approximately 2.236 for the following list of tuples:
('UP', 5)
('DOWN', 3)
('LEFT', 3)
('RIGHT', 2)

Exercise 11

Write a binary search function that checks whether an item is in a sorted list or not. The function should return True if the item is in the list.

The idea of binary search is:

- Assuming a sorted list, from small to large values
- Comparing any element in the list with the given item:
  - If larger, then not after
  - If smaller, then not before



For comparison reasons, write also a naive search function that runs over all elements in the list and checks each one separately against the item given in input.

Then, make a comparison between the two functions and check the run time. For that, create a list with 1000000 integer numbers, randomly generated in the range [1, 1000], and check whether the value 951 is contained in the list or not.

Hint: timing of code can be done with the magic function `%timeit`, and random integer numbers can be generated by the function `random.randint` from the module `random`.

Exercise 12

Project Euler is a website with mathematical problems that should/could be solved by computers. Go to the website http://projecteuler.net/ and solve some of the problems using Python.

Euler problem 6: sum square difference

The sum of the squares of the first ten natural numbers is

$$1^2 + 2^2 + ... + 10^2 = 385.$$

The square of the sum of the first ten natural numbers is

$$(1 + 2 + ... + 10)^2 = 55^2 = 3025.$$

Hence the difference between the sum of the squares of the first ten natural numbers and the square of the sum is

$$3025 - 385 = 2640.$$

Find the difference between the sum of the squares of the first one hundred natural numbers and the square of the sum.

Euler problem 16: power digit sum

$2^{15} = 32768$ and the sum of its digits is $3 + 2 + 7 + 6 + 8 = 26$. What is the sum of the digits of the number 2^{1000}?

Hint: the built-in function `sum` could be useful.