Computational Methods - Lesson 2 (Luxembourg, 23.09.2020)

Integration and Differentiation - Laboratory

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1. Introduction to Python 3

1.1. Numbers and Variables. In Python there are four numerical types that are respectively: integers with sign (`int`), real numbers in double precision (64 bit) (`floats`) and real complex numbers (`complex`). Since we will not use this last type let us focus on the first three. In the file `example01.py` you can see how Python automatically recognizes the file type during the definition. For integers we can write:

```
num_int1=1
num_int2=0
num_int3=-1
```

while for real numbers we can use different methods to define the same number:

```
num_dbl1=1.0
num_dbl2=1.
num_dbl3=0.1e1
num_dbl4=0.1e+01
num_dbl5=100.0e-2
```

We can convert a variable of a certain type into another type, see `example02.py`, being careful about the fact that some conversions produce loss of information. Let us assume that x is a real number, then:

```
x=-1.3
y=int(x)
```

will convert `x` to `-1` loosing information. A the same time if we convert an integer to a float no information is lost: if `x=1` then after `y=float(x)` we will have `y=1.0`
Finally it is possible to delete a variable in Python by simply calling the command `del` like for example in the following lines of code

```
x=1.3
del x
x = 1
```

By deleting the variable it is possible to redefine it of a different type. Initially the variable is a float, while afterwards it is defined as an integer (see this in `example02.py`).

1.2. Basic operators. Examples of the basic operations defined for the integer and real variables can be found in `example03.py`. We must underline that Python automatically assigns to the variable of the operation's result the most accurate type, so that the ratio between two integer numbers is always a real number.

1.3. Conditions and Logical operators. The `example04.py` file contains the examples regarding the comparing conditions in Python. And some examples on the `if (condition): elif (condition): else:` statement. Each 'condition' in the statement represents a logical variable that might be `True` or `False` according to the conditions and to the logical operators that chain them (`or`, `and`, `not`). Examples on the way the logical operators act can be found in `example05.py`

1.4. Lists of 'numerical' variables. In python lists are 'arrays' that can contain different types of objects, for example: different types of numbers, strings, other lists. In our case we can focus on the examples reported in the `example06.py` file the refer only to integer and real numbers. It is important to notice that the indexes of a list of n elements go from 0 to $n-1$. Some useful operations defined for the lists are shown in the file `example07.py`.

1.5. Loops. Two types on loops are present in Python `for` loops and `while` loops. Please refer to file `example08.py` for some examples on these two types of loops.

1.6. Functions. Functions are operations defined through the structure

```
def function( listOfInputVariables ):
    operations
    return someVariable
```

that given a set of input variables, execute some operations and eventually return a results (which is optional). In `example09.py` we can find the basic example for the construction of a function.
The functions are defined at the beginning of the file, before they are called.

1.7. Plots. In this section we propose two examples of plotting in python through the library mathplotlib. A tutorial of this library can be found in https://matplotlib.org/tutorials/introductory/pyplot.html. For this lesson it is sufficient to learn the basic examples in `plotData.py` and `plotFunction.py`. In the first example, given two lists of the same length containing values of the x and y coordinates of some datapoints, we do a scatter plot of these points.
In the second example, we consider the function $sin(x)$, we discretize it, and we plot it again as a scatter plot of connected dots.