



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

Programming in Python¹

Mattia Monga

Dip. di Informatica
Università degli Studi di Milano, Italia
mattia.monga@unimi.it

Academic year 2025/26, I semester

¹© 2025 M. Monga. Creative Commons Attribuzione — Condividi allo stesso modo 4.0 Internazionale. <http://creativecommons.org/licenses/by-sa/4.0/deed.it>

1



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

Lecture I: Programming in Python for quantitative biologists

2



PyQB

Monga

Why Python

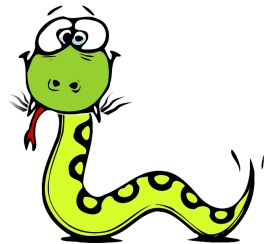
Python
fundamentals

Fundamentals

Programming in Python (for quantitative biologists)

The course introduces imperative programming by referring to the Python language.

- ① Python3 and its object-oriented features;
- ② Python3 libraries that can be useful in scientific computation and data analysis, in particular NumPy and pandas.



Everything will be available on:
<https://mameli.docenti.di.unimi.it/pyqb>

3



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

Course schedule

- Tuesdays: 10:30 **V7**, Thursdays: 8:30 **V7**, Fridays: 8:30 Lab
- Lectures: 40h, Labs: 16h **Not every week we will have three lectures, check the schedule on the web site**
- Labs will start end of October (jointly with a computer science master student as a tutor)
- We will explore different setups: (1) a “scaffolded” one for the first steps, (2) the plain python interpreter, and finally (3) the notebooks popular in scientific practice
- Text: every Python3 reference/book/tutorial is ok, you can access freely to the book linked on the website
- Final test: write (small) python programs without help

4



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

Lecture II: Programming in Python for quantitative biologists

5

Why Python?



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

Programming can be approached in many “languages”, the fundamental skills are general. . . but you cannot learn without referring to a specific language.

- A precise requirement of the teaching committee
- Very popular in the scientific landscape
- Easy to learn, many useful libraries, free software
- Alternatives: Fortran, C, Matlab, Mathematica, R, Julia, . . .
- Python is slower, but it is considered easier to understand and manage

6



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

Which Python?

We will use Python3 (current version is 3.13): be careful when looking around, Python2 is still common (but deprecated) and incompatible. Python supports different “paradigms”, we will focus on:

- Imperative programming: programs describe **changes** in *registers* and the *executing environment*;
- Object-oriented: complex (imperative) programs are organized around objects in order to hide and isolate complexity.

This is a **programming course**: I will try to propose example that I believe could be useful in your daily practice, but I’m not a biologist.

7

Programming



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

Programming in science can serve two (almost opposite) goals:

- ① Understanding every detail of a computational process;
- ② Compose computational process by assembling powerful build blocks of which you understand very little.

Most of the current popularity of programming is related to goal 2. . . with many *sorcerer’s apprentices*. But this course will focus mainly on goal 1. In the last part of the course we will bend towards 2, hopefully with a solid background.

Programming can be both hard and addictive: Teach Yourself Programming in Ten Years

8

Fundamental concepts of Python



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

The programmer describes computational processes in terms of:

objects : all the entities manipulated by the program, each has an identity (can be distinguished) and a value, that is an element in a specific type (a set of values together with the operations that make sense on them)

basic types : integers (`int`), floats, strings (`str`), functions; they can be composed in more complex, user-defined, types

variables : **names** used to refer to objects; the same name can refer to different objects during the same process

special commands : the only way to change the execution environment (i.e., the “virtual machine” provided by the operating system) is to use system calls; syscalls change from system to system (e.g., Linux vs. Windows), but Python wraps them and they appear like the functions written by the programmers (e.g., `print`), even if they could not be programmed in Python.

9

Let's try!



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

<https://python.di.unimi.it/>

You can use it without any personal account, but if you want support you must create one, putting me as the “guru”: `mmonga`

This platform will be used for the first lessons, since it requires no setup at all: everything happens in the browser (and the server).

(Thanks to the University of Waterloo, Canada for providing the CS Circles)

10

Fundamental concepts of Python



PyQB

Monga

Why Python

Python
fundamentals

Fundamentals

The programmer describes computational processes in terms of:

objects : all the entities manipulated by the program, each has an identity (can be distinguished) and a value, that is an element in a specific type (a set of values together with the operations that make sense on them)

basic types : integers (`int`), floats, strings (`str`), functions; they can be composed in more complex, user-defined, types

variables : **names** used to refer to objects; the same name can refer to different objects during the same process

special commands : the only way to change the execution environment (i.e., the “virtual machine” provided by the operating system) is to use system calls; syscalls change from system to system (e.g., Linux vs. Windows), but Python wraps them and they appear like the functions written by the programmers (e.g., `print`), even if they could not be programmed in Python.

11

The onion model



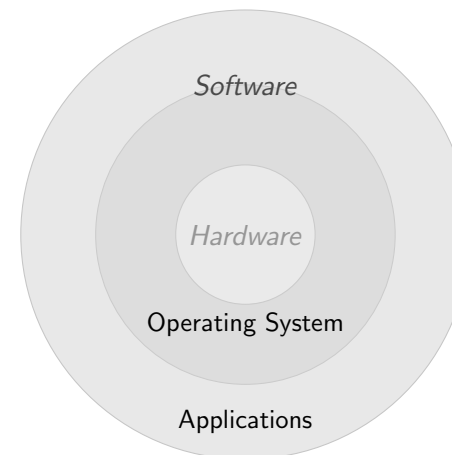
PyQB

Monga

Why Python

Python
fundamentals

Fundamentals



- **Operating System:** it is the only program interpreted directly by the hardware; other pieces of software get interpreted by the virtual machine provided by it.
- **Applications:** programs (e.g., the python interpreter or python programs) executed within the protected environment created by the operating system.

12

What we want to do



- Programming means to instruct an (automatic) interpreter with a precise description of a computational process.
- (In fact, the only way to make a description precise is to specify exactly the interpreter)
- We use a software interpreter, itself a program interpreted by the operating system (the stack of interpreters can be much deeper).
- Our interpreter (Python3) manipulates objects taken from types (that define which manipulations are possible), referred by variables, with special commands to ask the services provided by the operating system.

PyQB

Monga

Why Python

Python
fundamentals

Fundamentals