



PyQB

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Fundamentals

Assignment

Basic operations

Homework

Programming in Python¹

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Lecture II: Fundamentals

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Fundamental concepts of Python

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 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.

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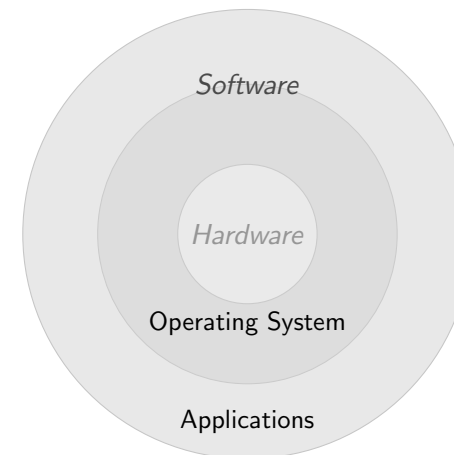
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The onion model



- **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.

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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.

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This is the fundamental statement for imperative programming:

- A **name**, known as variable, is needed to refer to objects.
`professor = "Mattia"`
- **= is not symmetrical**, read it as becomes: Left-hand-side is always a variable, right-hand-side is an object, that can be either a literal or anything referred by another variable.
- A variable can change its value with another, following, assignment. Thus, the same variable may refer to different objects.
`professor = "Violetta"`
- Basic objects (numbers, strings, Boolean values) are **immutable** (the variable change, not the object; different objects have always different identity)
- Tracking a program means to track the values of all the variables of a program during its execution.

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Type hints



Since Python 3.4 it is possible (and indeed desirable, especially for novices) to hint any reader of a program about the type of a variable.

- A variable has always a type (a string in this case)
`professor = 'Mattia'`
- Type hints make clear the intention of the programmer (can be checked by external programs) `professor: str = 'Mattia'`
- Assigning to an object of another type is still possible (there is no syntax error raised), but it should be regarded with suspicion `professor = True`

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- Binary operators: `5 + 2`, they compute a new object by using the two objects on which they apply;
- Unary operators: `-(-5)`;
- Functions: `max`, they compute a new object by using an arbitrary number of objects (in general 0-... , `max` takes at least 1) passed as parameters (or arguments) when the function is called (`max(3, 6, something_else)`); sometimes the object computed is `None`;
- Syntactically appear as functions, but *commands* like `print("Hello!")` are actually used to request side effects in the executing environment.

Official Python docs (3.11)

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Different approaches



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Problem: exchange the name of two objects (Chapter 1, last exercise).

- Know the basic syntax of variables and assignment =
- Know the semantics of what you write: assigning an object to a variable delete any previous assignment;
- Natural strategy: use a temporary name to “save” the value during the exchange;
- “Fox” strategy: know language or library tricks For example Python has a “multiple assignment” construct $x, y = y, x$, or a special library function `swap(x, y)` could exist;
- “Hedgehog” strategy: study the problem in depth, e.g., if objects are numbers you can exploit arithmetic.

```
x = x + y
y = x - y
x = x - y
```

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Basic types



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```
bool False, True Logical operations
int 1, -33, 1_000_000_000 ... Arithmetic
operations, no upper or lower limit
float 1.0, .1, 1.2e34 ... Arithmetic operations,
limited but you have float('infinity') (and
float('nan'))
sys.float_info(max=1.7976931348623157e+308,
↳ , max_exp=1024, max_10_exp=308,
↳ min=2.2250738585072014e-308,
↳ min_exp=-1021, min_10_exp=-307,
↳ dig=15, mant_dig=53,
↳ epsilon=2.220446049250313e-16,
↳ radix=2, rounds=1)
str 'aaaa\nthis is on a new line',
"bbb'b\"b" ... Concatenation, alphabetical
ordering, replication, ...
```

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Finish chapters 1, 1E, 2, 2X, 3, 4.

It shouldn't take more than a couple of hours, but exercising continuously is **crucial**.

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