Fundamentos de Programação

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Topics

- Getting started with *Python*
- Values and types
- Variables
- Keywords
- Operators, expressions and statements
- Functions
- Console input/output
- Scripts

Getting started with *Python*

- *Python* is a ***general purpose*** programming language well known for its elegant syntax and readable code.
- With *Python* it is possible to do everything from GUI development, web applications, system administration tasks, data analysis, visualization, etc.
- *Python* is an ***interpreted*** language - an interpreter parses and executes a *Python* program on a line by line basis. This is usually slower than *compiled* languages.
- In *Python*, basic data structures and small utility functions are built-in, you don't need to define them.
- Moreover, *Python* has hundreds of extension libraries (modules) available at `https://pypi.Python.org/`

Python in interactive mode

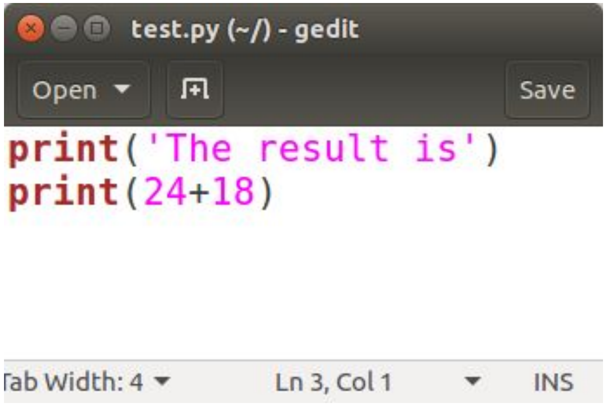
- There are two ways to use the interpreter: *interactive mode* and *script mode*.
- Execute `python3` with no argument to run in **interactive mode.** Then, type *Python* statements and the interpreter displays the result:

```
$ python3
>>> 1 + 1
2
>>>
```

- The chevron, >>>, is the ***prompt*** the interpreter uses to indicate that it is ready.
- When you type an expression, the interpreter prints the result. Then, it shows the prompt again.

Python in script mode

- Alternatively, you can store the statements in a file, which is called a ***script*** or ***program***, and use the interpreter to execute it. By convention, *Python* scripts have names that end in `.py`.



```
print('The result is')
print(24+18)
```

- To execute the script, just call the interpreter and pass it the name of the file. For example:

```
$ python3 test.py
The result is
42
```

- In **script mode**, Python does not show the prompt and does not print results automatically. You need to call `print()`!
- The details of executing scripts may differ.

Script mode programming

- Invoking the interpreter with a script parameter begins the execution of the script. *Python* files have extension `.py`
- Lines and indentation - Blocks of code are denoted by line **indentation**, which is rigidly enforced. The number of spaces in the indentation is variable, but all statements within the block must be indented the same amount.
- Statements in *Python* typically end with a new line. However, a backslash (\ ) in the end of the line indicates that the statement continues in the next line.
- The semicolon (**;**) allows multiple statements on a single line.
- A line containing only whitespace is known as a blank line and *Python* totally ignores it.

What is a program?

- A program is a sequence of statements that specifies how to perform a computation. The details look different in different languages, but a few basic types of statement appear in just about every language:
  - **assignment**: Store values in variables, to recall later on.
  - **math**: Perform basic mathematical operations.
  - **input**: Get data from the keyboard, a file, or some other device.
  - **output**: Display data on the screen or send data to a file.
  - **conditional execution**: Check for certain conditions and execute the appropriate code.
  - **repetition**: Perform some action repeatedly, usually with some variation.
- That is pretty much all there is to it. Every program, no matter how complicated, is made up of statements like these.

Errors and debugging

- Programming errors are called **bugs**.
- Tracking down and correcting bugs is called **debugging**.
- There are three kinds of errors: syntax errors, runtime errors, and semantic errors.
- A **syntax error** occurs if the program contains code that does not respect the syntactical rules of the programming language.
- A **runtime error** only appears after the program has started running. They are often caused by *type* mismatches or failure to deal with special cases (such as division by zero). These errors are also called **exceptions**.
- If there is a **semantic error** in a program, it may run with no error messages, but it will produce the wrong results. The program is not doing what the programmer *intended*. It is doing *exactly* what it was *told* to do.

Values and types

- A **value** is a piece of data in a program, such as a letter or a number: `33, 3.14, 'ola', 1+2j`.
- Values belong to different **types** (or **classes**): `int, float, str, complex`.
- Use the `type` function to find the type of a value:

```
>>> type('Hello, World!')
<class 'str'>
>>> type(17)
<class 'int'>
>>> type(3+5j)
<class 'complex'>
```

- Types determine what you can do with values. For instance, you cannot add ints and strings:

```
>>> 3 + 'cats'
TypeError: unsupported operand type(s) for +: ...
```

Data types

- Python has several *built-in data types*, including:
  - Numeric types: `int`, `float`, `complex`
  - Boolean: `bool` (with values `True` and `False`).
  - Strings: `str`, e.g. `'Hello'`
  - Lists: `list`, e.g. `[1, 3, 1]`
  - Tuples: `tuple`, e.g. `(3, 'May', 1981)`
  - Sets: `set`, e.g. `{2, 3, 5}`
  - Dictionaries: `dict`, e.g. `{'eggs': 6, 'beer': 0.33}`
- You can also define new data types – called classes – but we'll leave that for another course.

Conversion between types

- Sometimes we need to convert values to a different type.
- We use type conversion functions: `str`, `int`, `float`, ...
- Just about any kind of value may be converted to string:

```
>>> str(1+2)
'3'
>>> str(1.0/2)
'0.5'
```

- In fact, this happens *implicitly* when you `print` values.
- Some strings may be converted to int or float:

```
>>> 100 + int('33')
133
>>> float('0.12') / 10000
1.2e-05
```

- Converting a float to int *truncates* towards zero:

```
>>> int(2.78)
2
```

Variables and assignment

- A **variable** is a name (aka identifier) that refers to a value.
- An **assignment statement** assigns a value to a variable.

```
>>> n = 5
>>> pi = 3.14
```

- In an expression, a variable is substituted by its value.

```
>>> 2*pi*n
31.4000
```

- Variable names may include both letters and digits, but they must begin with a letter.
- Some *keywords* cannot be used as variable names, such as: `def`, `if`, `not`, `and`, etc.
- If you give a variable an illegal name, you get a syntax error:

```
>>> 76trombones = 'big parade'
SyntaxError: invalid syntax
```

Reassignment

- You can assign a new value to an existing variable.

```
>>> n = 5
>>> print(n)
5
>>> n = n + 1   # Is this valid? YES!
>>> print(n)
6
```

Play ▸

- The variable forgets the old value and stores the new one until the next assignment!
- This implies that a variable may take different values during the execution of a program and the **order of operations is important**!

Variable assignment is fundamental
in imperative programming languages!

More on assignment

- Python allows *simultaneous assignment* like this:

```
name, age, height = "Maria", 21, 1.63
```

- There are special *augmented assignment operators*:

`n += 1`	equivalent to	`n = n + (1)`
`x -= pi`	equivalent to	`x = x - (pi)`
`n *= 1+p`	equivalent to	`n = n * (1+p)`
`x /= 2.2`	equivalent to	`x = x / (2.2)`
`n %= 3`	equivalent to	`n = n % (3)`

Keywords

- The interpreter uses **keywords** to recognize the structure of the program.
- Keywords are *reserved* words: they cannot be used as variable names or any other identifier.
- In Python3, the keywords are:

```
False class finally  is       return
None     continue for      lambda      try
True     def      from     nonlocal while
and      del      global   not         with
as    elif     if    or       yield
assert   else     import   pass
break except   in    raise
```

Operators, expressions and statements

- **Operators** are special symbols that represent computations (`+, -, *, /, **, %, <=, or`).
- The values combined by operators are called **operands**.
- For a given operator, operands must have compatible types. The result type depends on the operand types.
- An **expression** is a combination of values, variables, and operators that results in a value.
- A **statement** is a unit of code that the Python interpreter can execute.
- The important difference is that an expression has a value (even if `None`); pure statements do not.
- In script mode, an expression, all by itself, has no visible effect (unlike interactive mode).

Arithmetic Operators: descending precedence (same color □ same precedence)

Operator	Example	Meaning	Result
+ (unary)	+a	**Unary Positive**	a
– (unary)	-a	**Unary Negation**	a with opposite sign
**	a ** b	**Exponentiation**	a raised to the power of b
*	a * b	**Multiplication**	Product of a and b
/	a / b	**Division**	Quotient when a is divided by b. The result always has type float.
%	a % b	**Modulo**	Remainder when a is divided by b
//	a // b	**Floor Division** (or **Integer Division**)	Quotient when a is divided by b, rounded to the next smallest whole number
+ (binary)	a + b	**Addition**	Sum of a and b
– (binary)	a - b	**Subtraction**	b subtracted from a

Operators and precedence

- When more than one operator appears in an expression, the *order of evaluation* depends on the rules of precedence (mnemonic: *PEMDAS*).
- Use parentheses to make it obvious!
- The `+` operator performs concatenation in **strings**.
- The `*` operator also works on **strings**; it performs repetition. For example, `'Ah'*3` is `'AhAhAh'`.
- It is a good idea to add notes to a program to explain in natural language what the program is doing. These notes are called **comments**, and they start with the **#** symbol.

Calling functions

- In the context of programming, a **function** is a named sequence of statements that performs a computation.
- We’ll see how to *define* functions later in the course.
- Functions are **called** (or **invoked**) by name:

```
>>> print(10*t, "km")
30 km
```

- The name of the function is `print`.
- The expressions in parentheses are called the *arguments* of the function. There are two, in this case.
- A function “takes” zero or more arguments and “returns” a result and/or produces some *effect* (such as *printing* something or *storing* something).

Math functions

- Python has a math module that provides most of the familiar mathematical functions.
- A *module* is a Python file that defines a collection of functions and objects.
- Before using a module, you must import it:

```
>>> import math
```

- To access one of the functions, specify the name of the module and the name of the function, separated by a dot.

```
>>> degrees = 45
>>> radians = degrees / 360.0 * 2 * math.pi
>>> math.sin(radians)
0.707106781187
```

Receiving input from the console

- The `input` function is used to get input from the console.
- It has an optional argument called the *prompt* and returns a string.

```
>>> name = input("What's your name? ")
What's your name? tim
>>> name
'tim'
```

- To get other types of values, you must convert!

```
>> age = int(input("Age? "))
Age? 22
>>> age
22
>>> type(age)
<class 'int'>
```

Sending output to the console

- To output text to the screen, use the `print` function:

```
print("Hello World")
```

- To write multiple lines, add the `‘\n’` character:

```
print("Hello World\nThis is a message")
```

- To print multiple values (separated by blanks):

```
print("speed =", v)
```

- The print function has some optional keyword arguments:

```
print(..., sep=' ',end='\n',file=sys.stdout,flush=False)
```

- Use `sep=` and `end=` to change how arguments are separated and terminated in the output.

- Use `file=` to send output to a different stream (e.g. file).

```
>>> fh = open("data.txt", "w")
>>> print("Some text", file=fh)
>>> fh.close()
```