Lezione 3

Introduzione alla programmazione con Python

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Reference sources

Main references

- Campbell et al. [2009]
- Schuerer et al. [2008]
- Schuerer and Letondal [2008]

Useful readings

- Chapman [2003]
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Why Python ?

- It is free and well documented
- It runs everywhere
- It has a clean syntax
- It is relevant. Thousands of companies and academic research groups use it every day;
- It is well supported by tools

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What is Python? Executive Summary

Extracted from [van Rossum, 2002]

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics

- high-level data structures, with dynamic typing, make it very attractive for Rapid Application Development
- simple, easy to learn syntax emphasizes readability
- supports modules and packages, which encourages program modularity and code reuse
- available free for all major platforms

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What is Python? increased productivity

Extracted from [van Rossum, 2002]

- Since there is no compilation step, the edit-test-debug cycle is incredibly fast
- Debugging Python programs is easy: a bug or bad input will never cause a segmentation fault
- Instead, when the interpreter discovers an error, it raises an exception
- When the program doesn't catch the exception, the interpreter prints a stack trace
- A source level debugger allows inspection of local and global variables, evaluation of arbitrary expressions, setting breakpoints, stepping through the code a line at a time, and so on
- The debugger is written in Python itself, testifying to Python's introspective power
- On the other hand, often the quickest way to debug a program is to add a few print statements to the source: the fast edit-test-debug cycle makes this simple approach very effective

Comparing Python to Other Languages

Extracted from [van Rossum, 1997]

- [Campbell et al., 2009]
- see Campbell et al. [2009]

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on Mac OS X and Windows

- The suggested book [Campbell et al., 2009] on Python programming is

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Numerical Python

NumPy is the fundamental package needed for scientific computing with Python

It contains:

- a powerful N-dimensional array object
- sophisticated broadcasting functions
- basic linear algebra functions
- basic Fourier transforms
- sophisticated random number capabilities
- tools for integrating Fortran code.
- tools for integrating C/C++ code.

NumPy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined.

This allows NumPy to seamlessly and speedily integrate with a wide variety of databases.

Scientific Python

SciPy: Scientific Library for Python

- open-source software for mathematics, science, and engineering
- It is also the name of a popular conference on scientific programming with Python
- The SciPy library depends on NumPy
- The SciPy library provides many user-friendly and efficient numerical routines

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Python tools for computational molecular biology

- Biopython is a set of freely available tools for biological computation written in Python
- It is a distributed collaborative effort to develop Python libraries and applications
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Useful step-by-step instructions are in Biopython Installation

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Python comments

Comments are to clarify code and are not interpreted by Python

- Comments start with the *hash* character, `#`, and *extend to the end* of the line
- A comment may appear at the start of a line or following whitespace or code, but *not within a string* literal[1]

```
# this is the first comment
SPAM = 1        # and this is the second comment
                # ... and now a third!
STRING = "# This is not a comment."
```

[1] *Literal* ≡ according with the letter of the scriptures; expression that returns itself by evaluation.

Using Python as a calculator

including comments

```
>>> 2+2
4
>>> # This is a comment
... 2+2
4
>>> 2+2  # and a comment on the same line as code
4
>>> (50-5*6)/4
5
>>> # Integer division returns the floor:
... 7/3
2
>>> 7/-3
-3
```

Contents

Variables and assignment

- 3.4. Declaring variables[2]

[2] from: "DIVE INTO PYTHON – Python from novice to pro", http://www.diveintopython.org/index.html

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Using Python as a Calculator

Numbers

- The interpreter acts as a simple calculator: you can type an expression at it and it will write the value
- Expression syntax is straightforward: the operators +, -, * and / work just like in most other languages
- parentheses can be used for grouping

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Using Python as a Calculator

Numbers

- The equal sign ('=') is used to assign a value to a variable
- Afterwards, no result is displayed before the next interactive prompt:

```
>>> width = 20
>>> height = 5*9
>>> width * height
900
```

Using Python as a Calculator

Numbers

- A value can be assigned to several variables simultaneously:

```
>>> x = y = z = 0  # Zero x, y and z
>>> x
0
>>> y
0
>>> z
0
```

Using Python as a Calculator

Numbers

- Variables must be “defined” (assigned a value) before they can be used, or an error will occur:

```
>>> # try to access an undefined variable
... n
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'n' is not defined
```

Using Python as a Calculator

Numbers

- There is full support for floating point
- operators with mixed type operands convert the integer operand to floating point

```
>>> 3 * 3.75 / 1.5
7.5
>>> 7.0 / 2
3.5
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Using Python as a Calculator

Numbers

- Complex numbers are also supported
- imaginary numbers are written with a suffix of j or J
- Complex numbers with a nonzero real component are written as (real+imagj), or can be created with the complex(real, imag) function.

```
>>> 1j * 1J
(-1+0j)
>>> 1j * complex(0,1)
(-1+0j)
>>> 3+1j*3
(3+3j)
>>> (3+1j)*3
(9+3j)
>>> (1+2j)/(1+1j)
(1.5+0.5j)
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Numbers

- Complex numbers are always represented as two floating point numbers, the real and imaginary part
- To extract these parts from a complex number z, use z.real and z.imag.

```
>>> a=1.5+0.5j
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Using Python as a Calculator

Numbers

- The conversion functions to floating point and integer (float(), int() and long()) don,Ät work for complex numbers
- there is no one correct way to convert a complex number to a real number
- Use abs(z) to get its magnitude (as a float) or z.real to get its real part.

```
>>> a=3.0+4.0j
>>> float(a)
Traceback (most recent call last):
  File "<stdin>", line 1, in ?
TypeError: can't convert complex to float; use abs(z)
>>> a.real
3.0
>>> a.imag
4.0
>>> abs(a)  # sqrt(a.real**2 + a.imag**2)
5.0
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Numbers

- In interactive mode, the last printed expression is assigned to the variable _
- This means that when you are using Python as a desk calculator, it is somewhat easier to continue calculations

```
>>> tax = 12.5 / 100
>>> price = 100.50
>>> price * tax
12.5625
>>> price + _
113.0625
>>> round(_, 2)
113.06
>>>
```

- This variable should be treated as read-only by the user
- Don,Ät explicitly assign a value to it
- you would create an independent local variable with the same name masking the built-in variable with its magic behavior.

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Strings

- Besides numbers, Python can also manipulate strings, which can be expressed in several ways
- They can be enclosed in single quotes or double quotes:

```
>>> 'spam eggs'
'spam eggs'
>>> 'doesn\'t'
"doesn't"
>>> "doesn't"
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>>> '"Yes," he said.'
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Strings

- String literals can span multiple lines in several ways
- Continuation lines can be used, with a backslash as the last character on the line indicating that the next line is a logical continuation of the line:

```
hello = "This is a rather long string containing\n\
several lines of text just as you would do in C.\n\
    Note that whitespace at the beginning of the line is\
 significant."

print hello
```

- newlines still need to be embedded in the string using \n
- the newline following the trailing backslash is discarded
- This example would print the following:

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- strings can be surrounded in a pair of matching triple-quotes: """ or '''
- End of lines do not need to be escaped when using triple-quotes, but they will be included in the string

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print """
Usage: thingy [OPTIONS]
     -h                        Display this usage message
     -H hostname               Hostname to connect to
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- produces the following output:

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- If we make the string literal a ‚Äòraw‚Äô string, sequences are not converted to newlines, but the backslash at the end of the line, and the newline character in the source, are both included in the string as data.
- Thus, the example:

```
hello = r"This is a rather long string containing\n\
several lines of text much as you would do in C."

print hello
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- would print:

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Strings

- Strings can be concatenated (glued together) with the + operator, and repeated with *:

```
>>> word = 'Help' + 'A'
>>> word
'HelpA'
>>> '<' + word*5 + '>'
'<HelpAHelpAHelpAHelpAHelpA>'
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- Two string literals next to each other are automatically concatenated
- the first line above could also have been written word = 'Help' 'A'
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Strings

Strings can be subscripted (indexed)

- the first character has index 0
- there is no separate character type
- a character is simply a string of size one
- substrings can be specified with the slice notation: two indices separated by a colon.

```
>>> word[4]
'A'
>>> word[0:2]
'He'
>>> word[2:4]
'lp'
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- Slice indices have useful defaults
- an omitted first index defaults to zero
- an omitted second index defaults to the size of the string being sliced.

```
>>> word[:2]    # The first two characters
'He'
>>> word[2:]    # Everything except the first two characters
'lpA'
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Strings

- Unlike a C string
- Python strings cannot be changed
- Assigning to an indexed position in the string results in an error:

```
>>> word[0] = 'x'
Traceback (most recent call last):
  File "<stdin>", line 1, in ?
TypeError: object does not support item assignment
>>> word[:1] = 'Splat'
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Strings

- However, creating a new string with the combined content is easy and efficient:

```
>>> 'x' + word[1:]
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>>> 'Splat' + word[4]
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- Here,Äs a useful invariant of slice operations: s[:i] + s[i:] equals s.

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Strings

- Degenerate slice indices are handled gracefully:
- an index that is too large is replaced by the string size
- an upper bound smaller than the lower bound returns an empty string.

```
>>> word[1:100]
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>>> word[10:]
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- Indices may be negative numbers, to start counting from the right:

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>>> word[-1]     # The last character
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>>> word[-2]     # The last-but-one character
'p'
>>> word[-2:]    # The last two characters
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>>> word[:-2]    # Everything except the last two characters
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- But note that -0 is really the same as 0, so it does not count from the right!

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>>> word[-0]     # (since -0 equals 0)
'H'
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Strings

- think of the indices as pointing between characters
- with the left edge of the first character numbered 0
- Then the right edge of the last character of a string of n characters has index n
- The slice from i to j consists of all characters between the edges labeled i and j

```
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 0   1   2   3   4   5
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Strings

- For non-negative indices, the length of a slice is the difference of the indices
- if both are within bounds
- For example the length of word[1:3] is 2.

The built-in function len() returns the length of a string:

```
>>> s = 'supercalifragilisticexpialidocious'
>>> len(s)
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Sequence Types

str, unicode, list, tuple, buffer, xrange

strings String literals are written in single or double quotes: 'xyzzy', "frobozz".

Unicode strings specified using a preceding 'u' character: u'abc', u"def"

lists constructed with square brackets, separating items with commas: [a, b, c]

tuples Tuples are constructed by the comma operator (not within square brackets), with or without enclosing parentheses, but an empty tuple must have the enclosing parentheses, such as a, b, c or (). A single item tuple must have a trailing comma, such as (d,).

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