Input and output

Inteligencia Artificial en los Sistemas de Control Autónomo
Máster en Ciencia y Tecnología desde el Espacio

Departamento de Automática

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Objectives

1. Being able to apply output formatting methods in Python.
2. Being able to manipulate files in Python.
3. Being able to understand the usefulness of Python serialization (*pickles*).

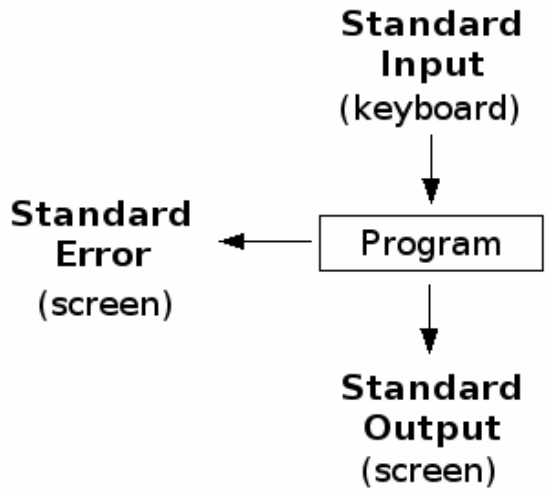
Table of Contents

Input and output

Introduction

Input/output: How the program can read and export data.

- So far, we have used two methods to output information:
  - Expressions statements and the `print()` function.
- A third method: Standard input and output.



Source: `http://labor-liber.org/en/gnu-linux/introduction/input_output`

I/O interactive

Data input

Enter data by keyboard (version 2.X)

```
>>> x = raw_input('Introduzca un numero:   ')
64.5
>>> y = float(x) ** 2
```

Enter data by keyboard (version 3.X)

```
>>> x = input('Introduzca un numero:   ')
64.5
>>> y = x ** 2
```

I/O interactive

Data output (I)

Print **not formatted** data (version 2.X):
Needs () for version 3.X

```
>>> print 'message', var1, var2, ..., vark
```

Prints on the screen: message var1 var2 vark

```
>>> name = 'John'
>>> age = 37
>>> print 'Name, age= ', name, age
Name, age= John 37
>>> print 'Name = ', name, ' age = ', age
Name = John age = 37
```

I/O interactive

Data output (II)

Print **formatted** data (version 2.X):

```
>>> print 'msg1 = %type1 msg2 = %type2' % (var1, var2)
```

where `type1` and `type2` indicate how to represent the variable:

%i and %d: integer number.

%f: real number with decimal point.

%e: real number in exponential format.

%g: remove not significant zeros.

%s: string.

```
>>> name = 'John'
>>> daybal = 55.5
>>> print '%s earns per month %6.2f euros' % (name,  daybal *30.)
John earns per month 1515.00 euros
```

Methods

Custom output

- Two methods to create custom output:
  - String manipulation.
  - The `str.format()` method.
- **Convert values to strings:**
  - `str()`: Human-readable format.
  - `repr()`: Interpreter-readable format.
  - Both, are quite similar. But, strings have two representations:

```
>>> str1 = ``Hellow\n"
>>> str(str1)
'Hellow\n'
>>> repr(str1)
``'Hellow\\n'"
>>> repr([234, ('hellow', 'bye')])
"[234, ('hellow', 'bye')]"
>>> str([234, ('hellow', 'bye')])
"[234, ('hellow', 'bye')]"
```

Examples of fancy output

Table of squares and cubes I

```
1 for x in range(1, 11):
2     print(repr(x).rjust(2), repr(x*x).rjust(3),end=' ')
3     print(repr(x*x*x).rjust(4))
```

Table of squares and cubes II

```
1 for x in range(1, 11):
2   print('{0:2d} {1:3d} {2:4d}'.format(x, x*x, x*x*x))
```

Useful methods

Method	Description
`str.rjust(n)`	Right justification `n` characters
`str.ljust(n)`	Left justification `n` characters
`str.center(n)`	Center `n` characters
`str.zfill(n)`	Fill left with `n` zero

The `format()` method

Use (I)

- Basic usage:

```
>>> print('{} and {}'.format('spam', 'eggs'))
spam and eggs
>>> print('{1} and {0}'.format('spam', 'eggs'))
eggs and spam
```

The `format()` method

Use (II)

- Additional formatting:

```
>>> import math
>>> math.pi
3.14159265358979 3
>>> print('PI values {0:.3f}'.format(math.pi))
PI values 3.142
```

- It's also possible to left or right justify data with the format method preceding the format with the options '<' (left justify) or '>' (right justify).

For more examples, *Click Here!*

The `format()` method

Use (III)

```
>>> table = {'Sjoerd': 4127, 'Jack': 4098, 'Dcab': 7678}
>>> for name, phone in table.items():
...     print('{0:10} ==> {1:10d}'.format(name, phone))
...
Jack       ==>       4098
Dcab       ==>       7678
Sjoerd     ==>       4127
```

Path

- On Linux, the path is denoted by:

```
path = '/tmp/prueba.txt'
```

- On Windows, the path is denoted by:

```
path = 'C:\Windows\Temp'
```

And it is represented in Python by:

```
path = 'C:\\Windows\\Temp'
```

But by also using *raw string*:

```
path = r'C:\Windows\Temp'
```

Opening files

- All file operations are made through a *file object*.
- A file is a sequence of bytes. But ..., it's often useful to treat it as a sequence of lines.
- First of all: Call the `open()` function.

The `open()` function

`open(filename[, mode])`

Description: The function returns an object file.

- *filename*: String with the file name.
- *mode*: Characters describing how the file will be used:
  - r: Reading mode, *w*: Writing mode, +: Reading/Writing mode.
  - *b*: Binary mode, *a*: Appending mode.

Remember: Always, always, always close the file: `f.close()`

Methods of file objects

Reading files (I)

The `read()` function

`f.read([size])`

- *size*: The number of bytes to be read from the file.
- Return value: The bytes read in string.

Option r: Read the entire file (`f.read()`)

```
>>> f = open("/tmp/file", 'r+')
>>> f.read()
'This is the entire file.\\n'
>>> f.read()
''
>>> f.close()
```

Methods of file objects

Reading files (II)

Option 2: Read a single line (`f.readline()`)

```
>>> f = open("/tmp/file2", 'r+')
>>> f.readline()
'This is the first line of the file.\n'
>>> f.readline()
'This is the second line of the file\n'
>>> f.readline()
''
>>> f.close()
```

Methods of file objects

Reading files (III)

Option 3: Read lines as list (`f.readlines()`)

```
>>> f = open("/tmp/file2", 'r+')
>>> f.readlines()
['This is the first line of the file.\n',
'This is the second line of the file\n']
>>> f.close()
```

Option 4: Read in a loop

```
f = open("/tmp/file2", 'r+')
for line in f:
    print(line, end='')
f.close()
```

Methods of file objects

Writing files (I)

The `write()` function

`f.write(string)`

- *string*: String to write in file.
- Return value: The number of written bytes.

Example 1: Write a line

```
>>> f = open("/tmp/file", 'w+')
>>> f.write('This is a test\n')
15
>>> f.read()
''
>>> f.close()
```

Methods of file objects

Writing files (II)

Example 2: Write a number

```
>>> f = open("/tmp/file", 'w+')
>>> f.write(str(42))
2
>>> f.close()
```

Others file management methods

Useful methods

Method	Description
`f.tell()`	Returns the pointer's position
`f.seek(n)`	Moves the pointer `n` bytes
`f.close()`	Closes a file. Use it always!

```
>>> f = open("/tmp/file", 'rb+')
>>> f.write(b'0123456789abcdef')
16
>>> f.seek(5)
5
>>> f.read(1)
b'5'
```

Example 1

Calculating the average of characters per line of file `example.txt`

```
1 file_ex = open('example.txt', 'r')
2 num_total_char = 0
3 count_line= 0
4
5 for line in file_ex:
6   count_line += 1
7   num_total_char += len(line)
8 file_ex.close()
9 print('average', float(num_total_char) / float(count_line))
```

Example 2

Reading a line each time

```
1 count_line = 0
2 with open('/Users/julia/code/names.txt') as arch_names:
3     for line in arch_names:
4         count_line += 1
5         print('{:<10}{}'.format(count_line, line.rstrip()))
```

names.txt

```
1 Juan
2 Laura
3 Pablo
4 Enrique
5 Javier
```

Output

```
1         Juan
2         Laura
3         Pablo
4         Enrique
5         Javier
```

The `pickle` module

Introduction

- What happens if we need to store complex data structures?
  - Think about lists, dictionaries or even objects ...
  - The `pickle` module comes to help.
- *Pickling*: Transform an object to string representation.
- *Unpickling*: Reconstruct an object from its string representation.
- Given an object `x` and a file object `f`.

```
>>> pickle.dump(x, f)
>>> x = pickle.load(f)
```

The `pickle` module

Example: Save/load data structure to/from a file

Save a list to a file

```
1 import pickle
2
3 list_number = [2, 5, 7, 8]
4
5 pickle.dump(list_number, open('file1_list.txt', 'wb'))
```

Load a list from a file

```
1 import pickle
2
3 list_number = pickle.load(open('file1_list.txt', 'rb'))
4 print(list_number)
```

Bibliographic references I

[van Rosum, 2012] G. van Rossum, Jr. Fred L. Drake.
Python Tutorial Release 3.2.3, chapter 7.
Python Software Foundation, 2012.

[Pilgrim, 2004] M. Pilgrim.
Dive into Python, chapter 6.
Ed. Prentice Hall, 2004.

[Marzal, 2014] A. Marzal Varó, I. Gracia Luengo, P. García Sevilla.
Introducción a la programación con Python 3, capítulo 8.
Universidad Jaime I.

Bibliographic on scientific programming I


[Langtangen, 2008] H. Petter Langtangen.
Python Scripting for Computational Science.
Ed. Springer, 2008.


[McKinney, 2013] W. McKinney
Python for Data Analysis.
Ed. O'Reilly, 2013.