

# Input and output

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

Departamento de Automática

## 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

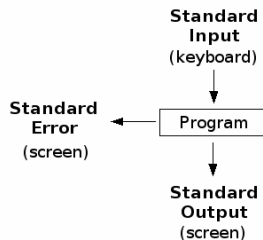
1. Input and output
  - Introduction
  - Input and Output interactive
2. Fancier output formatting
  - Methods
  - Examples of fancy output
  - Useful methods
  - The `format()` method
3. Reading and writing files
  - Path
  - Opening files
  - Methods of file objects
  - Useful methods
  - Examples
4. The pickle module
  - Introduction
  - Example

# 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](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:  ')\n64.5\n>>> y = float(x) ** 2
```

Enter data by keyboard (version 3.X)

```
>>> x = input('Introduzca un numero:  ')\n64.5\n>>> 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 = `Hello\n`
>>> str(str1)
'Hello\n'
>>> repr(str1)
`'Hello\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
<code>str.rjust(n)</code>	Right justification <code>n</code> characters
<code>str.ljust(n)</code>	Left justification <code>n</code> characters
<code>str.center(n)</code>	Center <code>n</code> characters
<code>str.zfill(n)</code>	Fill left with <code>n</code> 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
```

```
3.141592653589793
```

```
>>> 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
<code>f.tell()</code>	Returns the pointer's position
<code>f.seek(n)</code>	Moves the pointer <code>n</code> bytes
<code>f.close()</code>	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.