Data Science tools in Python

Aprendizaje Automático para la Robótica
Máster Universitario en Ingeniería Industrial

Departamento de Automática

Universidad de Alcalá
ISG

Objectives

1. Introduce Data Science
2. Setup a Data Science development environment
3. iPython basic commands

Bibliography

Jake VanderPlas. *Python Data Science Handbook*. Chapter 1. O'Reilly. (Link).

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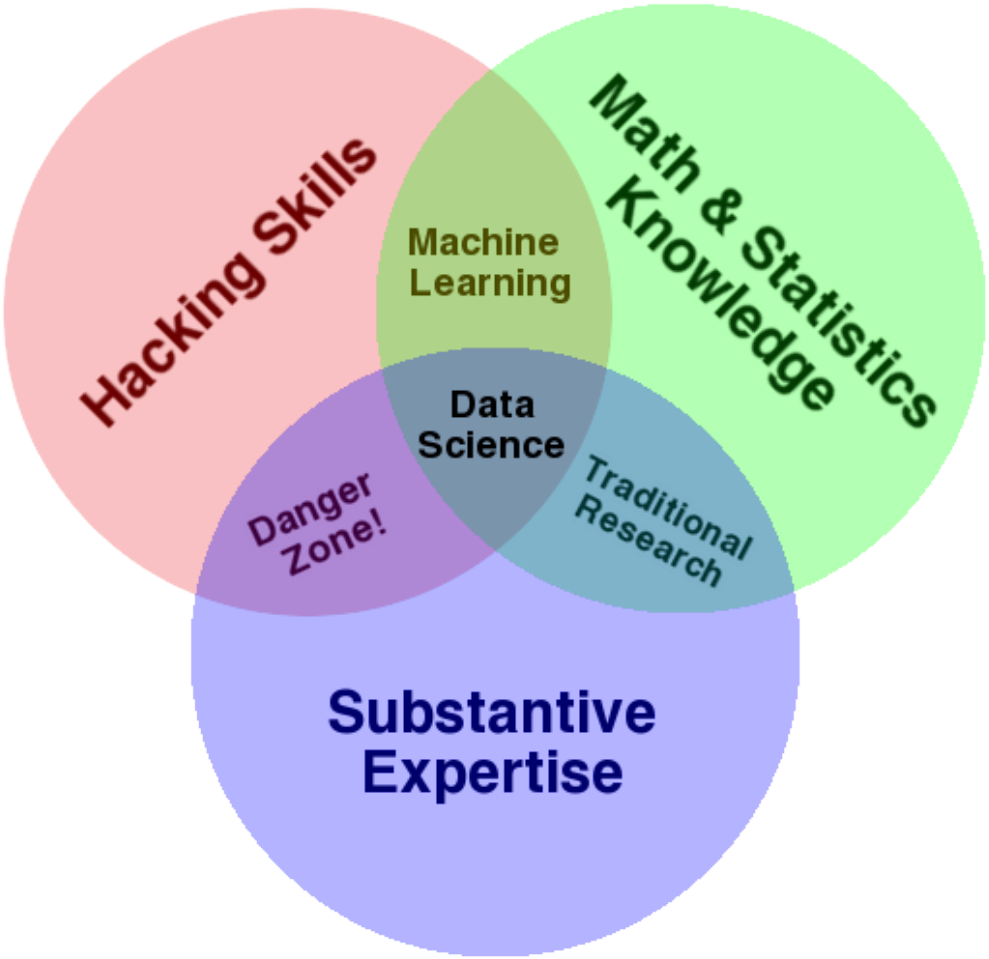
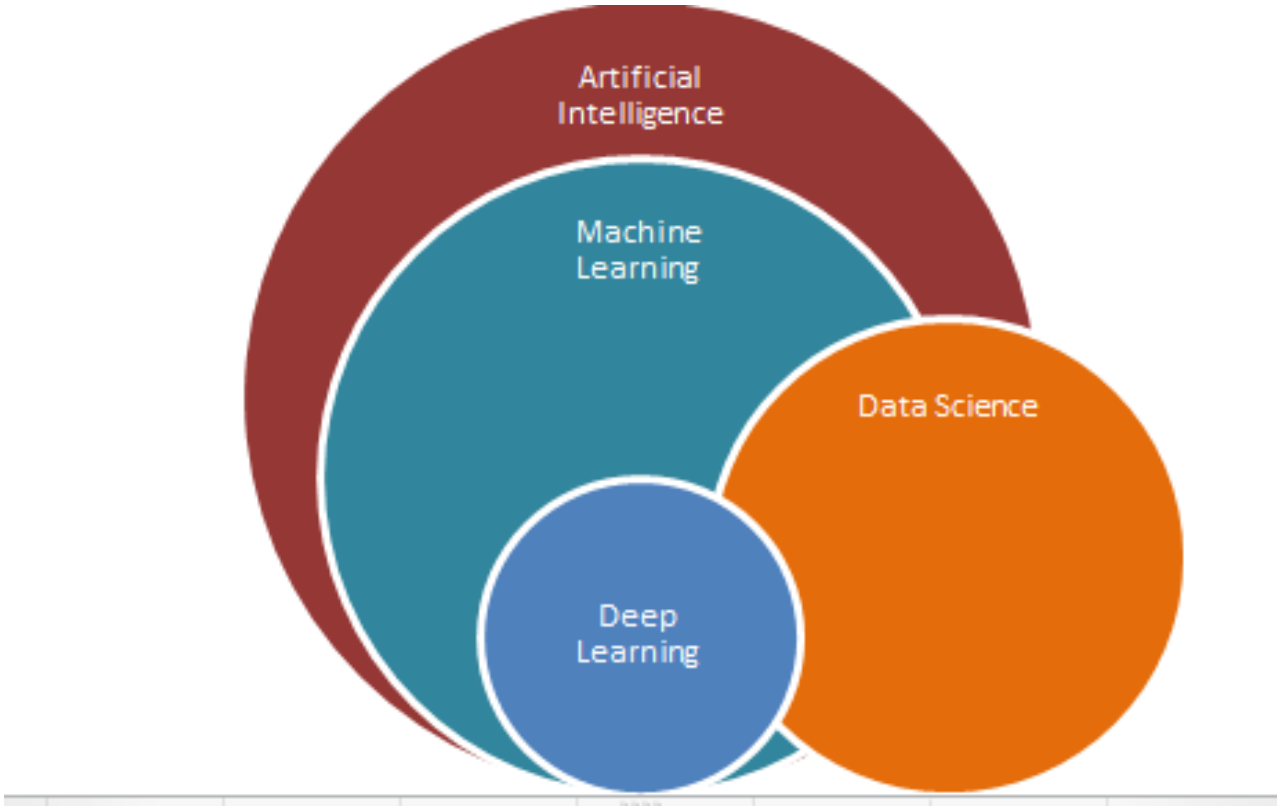
Overview (I)


Hacking Skills
Math & Statistics Knowledge
Machine Learning
Data Science
Danger Zone!
Traditional Research
Substantive Expertise

Overview (II)



(Source)

The data scientist toolkit

Motivation

Data science is about manipulating data

- Need of specialized tools
- Two main languajes: R and Python

Python is a general purpose programming language

- Easy integration
- Huge ecosystem of packages and tools

Need of data-oriented tools

- Features provided by third-party tools

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Overview

Tool	Type	Description
`conda`	Software	Python environments and packages management
`iPython`	Software	Advaced Python interpreter
`Jupyter`	Software	Python notebooks (Python interpreter)
`Numpy`	Package	Efficient array operations
`Pandas`	Package	Dataframe support
`Matplotlib`	Package	Data visualization
`Seaborn`	Package	Data visualization with dataframes
`Scikit-learn`	Package	AI/ML package for Python
`TensorFlow`	Package	Neural Networks for Python
`Keras`	Package	Neural Networks for Python
`PyTorch`	Package	Neural Networks for Python

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Anaconda

Most of those tools are packaged in *Anaconda*

- Python distribution for Data Science
- Environment management for Python
- Package management system

Anaconda provides `conda`

- Packages management tool
- Environment management for Python

In addition, Anaconda provides `Spyder`

- Python IDE designed for Data Science

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Conda crush introduction

Conda environment for Data Science

1. `conda create --name ml`
2. `conda activate ml`
3. `conda install jupyter`
4. `conda install scikit-learn`
5. `conda install matplotlib`
6. `conda install seaborn`

List environments:

```
conda info --envs
```

Create env.:

```
conda create --name <env>
```

Activate environment:

```
source activate <env>
```

Install package:

```
conda install <package>
```

List packages:

```
conda list
```

Remove environment:

```
conda remove --name <env>
--all
```

Exit environment:

```
conda deactivate
```

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Python IDEs for Data Science

iPython

iPython = Interactive Python

- Extended funcionality
- Enhanced UI
- External editor

Spyder

Matlab-like IDE

- Default IDE in Anaconda
- Uses iPython

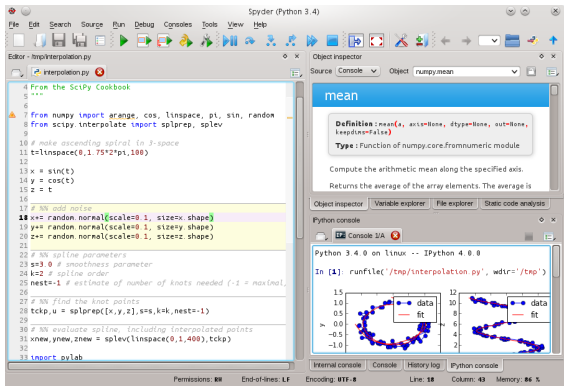
Rodeo

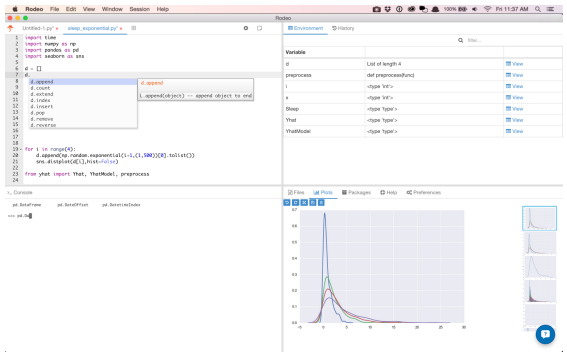
Python version of RStudio

- Good for R developers
- Not included in Anaconda
- Uses iPython

Running iPython:

```
$ ipython
```





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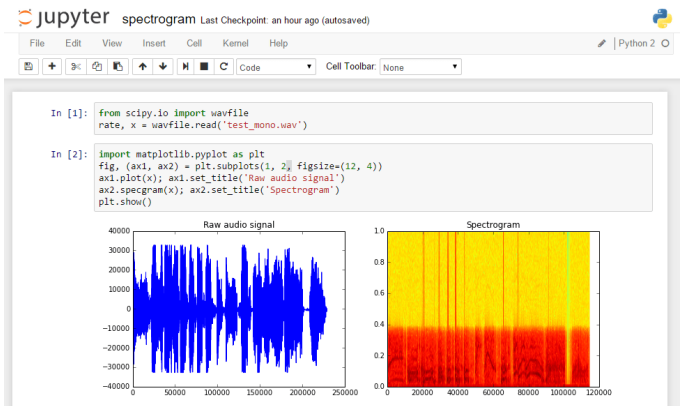
Notebooks (I)

Jupyter

Python notebooks

- Web-based IDE, uses iPython
- Code, text and graphs
- Integration with GitHub
- Single notebook



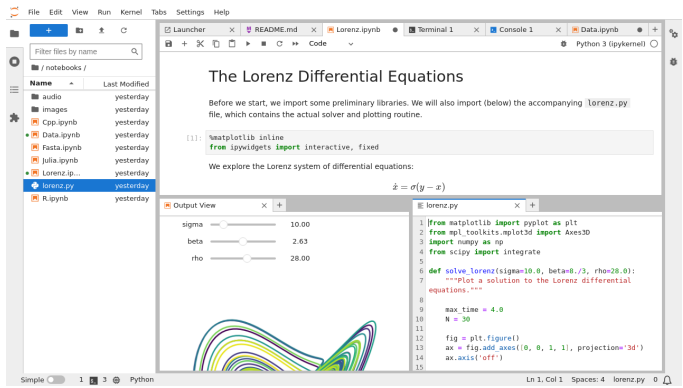
Running Jupyter:

```
$ jupyter notebook
```

Jupyter-lab

Multi-window Jupyter

- Latest version of Jupyter
- Rich UI
- Multiple notebooks
- Uses iPython



Running Jupyter-lab:

```
$ jupyter-lab
```

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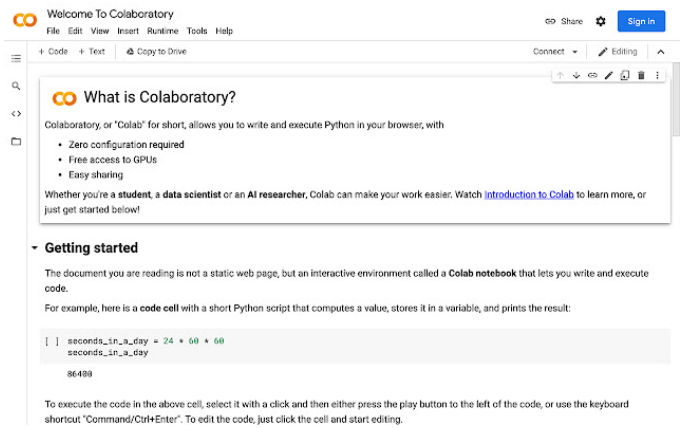
Python IDEs for Data Science: Notebooks (II)

Google Colab

Hosted notebooks

- Includes a virtual machine
- GPU/TPU support
- Integration with Google Drive
- Free version



(Google Colab)

Other notebooks

- MS Visual Studio

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Exercises

Exercises

Write a Python script that shows the multiplication table of the number 5. Write the script using each one of the following tools:

1. iPython + text editor of your choice.
2. Jupyter.
   - Bonus track: Publish the notebook in GitHub.
3. Google Colab.
4. Spyder (optional).
5. Rodeo (optional).

iPython

iPython

Basics (I)

In regular Python ...

- most objects come with a docstring attribute
- docstring accesible thorugh `help()`

iPython provides '`?`', a shortcut to `help()`

- `len?`, `list?`, `list.append?`
- Try to type just '`?`'

Easy access to source code with '`??`'

- `help??`
- Does not work with most buildin functions!

iPython

Basics (II)

Press <tab> to complete almost everything

- Object contents

```
In [21]: a = [1,2,3]

In [22]: a.
         a.append  a.count   a.insert  a.reverse
         a.clear   a.extend  a.pop     a.sort
         a.copy    a.index   a.remove
```

- Packages

```
In [26]: import num
         numba     numpy
         numbers   numpydoc
         numexpr
```

- Wildcards

```
In [29]: *Warning?
         %%!                        BaseException
         ArithmeticError            BlockingIOError
         AssertionError             BrokenPipeError
         AttributeError             BufferError
```

iPython

Keyboard shortcuts

Navigation

Keystroke	Action
`Ctrl-a`	Move cursor to the beginning of the line
`Ctrl-e`	Move cursor to the end of the line
`Ctrl-b`	Move cursor back one character
`Ctrl-f`	Move cursor forward one character

History

Keystroke	Action
`Ctrl-p` (↑)	Previous command
`Ctrl-n` (↓)	Next command
`Ctrl-r`	Reverse-search

Text entry

Keystroke	Action
`Ctrl-d`	Delete next character in line
`Ctrl-k`	Cut text from cursor to end of line
`Ctrl-u`	Cut text from beginning of line to cursor
`Ctrl-y`	Yank (paste) previously cut text

iPython

Magic commands

Magic commands: iPython extension of Python syntax

- Not valid in regular Python
- Provides handly features
- Widely used in DS and ML

Two flavours

- % prefix: Line magics - single line
- % % prefix: Cell magics - several lines

Help available

- `%magic`: Magic commands
- `%lsmagic`: List of magic commands

iPython

Pasting code blocks: %paste and %cpaste

Pasting code in Python is troublesome

- %paste: Paste one time
- %%cpaste: Paste several times

```
def donothing(x):
    return x
```

%paste

```
In [20]: %paste
    def donothing(x):
        return x

## -- End pasted text --
```

%cpaste

```
In [25]: %cpaste
Pasting code; enter '--' alone on the line
to stop or use Ctrl-D.
:       def donothing(x):
            return x:
:--
```

iPython

Running external code: %run and %timeit

%run: Execute script

- Many optional arguments
- Checkout %run?

```
In [40]: %run donothing.py

In [41]: donothing(10)
Out[41]: 10
```

%timeit: Computes execution time

- Executes a single line
- Automatic adjustment of runs
- Shows basic statistics

```
In [33]: %timeit [n ** 2 for n in range(200)]
71.6 µs ± 1.84 µs per loop
(mean ± std. dev. of 7 runs, 10000 loops each)

In [34]: %timeit [n ** 2 for n in range(2000)]
753 µs ± 16.2 µs per loop
(mean ± std. dev. of 7 runs, 1000 loops each)
```

%%timeit: Several lines

iPython

Input and output history (I)

iPython stores its history as objects

- `In`: Input commands
  - List storing commands
- `Out`: Commands output
  - *Dictionary* storing outputs
  - Not all commands have outputs

```
In [1]: a = 2
In [2]: b = 2
In [3]: a + 1
Out[3]: 3
In [4]: b + 1
Out[4]: 3
In [5]: Out[3] * Out[4]
Out[5]: 9
In [6]: len(In)
Out[6]: 10
In [7]: Out.keys()
Out[7]: dict_keys([3, 4, 5, 6])
```

iPython

Input and output history (II)

Fast access to history: Underscore (_)

- Variable containing the last output
- Example: `print(_)`

Double and triple underscores

- Example: `print(__)`
- Example: `print(___)`

Trick: Shortcut to access (_n)

- Out[n] = _n, with n=number
- Example: `print(_2)`

```
In [1]: a = 1
In [2]: a + 1
Out[2]: 2
In [3]: a + 2
Out[3]: 3
In [5]: print(_)
3
In [6]: print(__)
2
In [7]: print(_2)
2
```

iPython

Input and output history (III)

Magic command to show history

- `%history`
- `%history -n`
- `%history?`

Supressing command output (`;`)

- Example: `4 * 2;`

iPython

iPython shell commands

iPython provides easy interaction with the shell

- Execution of shell commands from iPython
- Use prefix '`!`'
- Example: `!ls`, `!pwd`

Save shell output in Python variables

- Example: `files = !ls`

Use Python variables in shell

- Example: `!echo {files}`

iPython

Automagic

Problems with some shell commands

```
In [23]: !pwd
/repositorios/pythonCourse

In [24]: !cd ..

In [25]: !pwd
/repositorios/pythonCourse
```

Some magic commands here to help

- `%cd`, `%ls`, `%mkdir`, `%pwd`, ...

Those magics are regularly used ...

- ... so common that % is no longer required (automagic)
- Working with iPython is almost like working with a Unix-like shell

Automagic commands

`cat`, `cp`, `env`, `ls`, `man`, `mkdir`, `more`, `mb`, `pwd`, `rm` and `rmdir`