Data Science tools in Python

Big Data
Kristiania University College

Departamento de Automática

Objectives

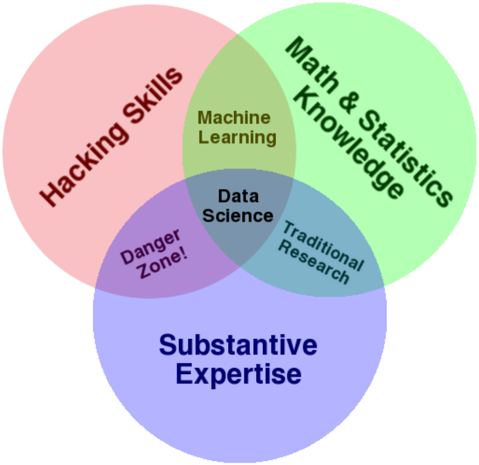
1. Introduce Data Science
2. Setup a Data Science development environment
3. iPython basic commands

Bibliography

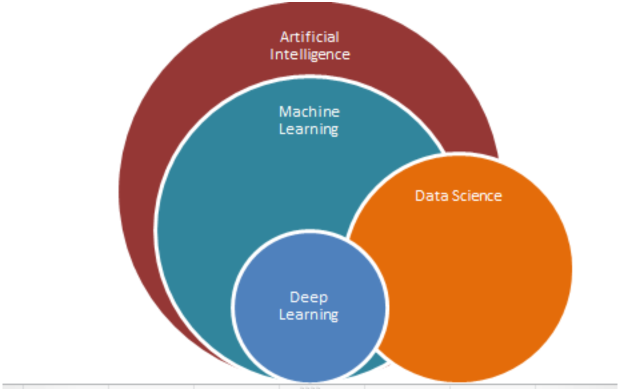
Jake VanderPlas. *Python Data Science Handbook*. Chapter 1. O'Reilly. (Link).

Table of Contents

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

The data scientist toolkit

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

The data scientist toolkit

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

The data scientist toolkit

Conda crush introduction

Conda environment for Data Science

1. `conda create --name ml seaborn=0.9.0`
2. `source activate ml`
3. `conda install ipython`
4. `conda install nb_conda`
5. `conda install scikit-learn`

List environments:

```
conda info --envs
```

Create env.:

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

Activate environment:

```
source activate <env>
```

Install package:

```
conda install <package>
```

List packages:

```
conda list
```

Exit environment:

```
conda deactivate
```

The data scientist toolkit

Python IDEs for Data Science (I)

iPython

iPython = Interactive Python

- Extended funcionality
- Enhanced UI
- External editor

Running iPython:

```
$ ipython
```

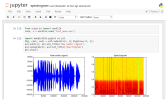
Jupyter

Python notebooks

- Web-based IDE
- Documentation
- Integration with GitHub
- Uses iPython

Running Jupyter:

```
$ jupyter notebook
```

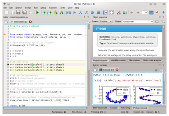

jupyter spectrogram Last Checkpoint: an hour ago (autosaved)
File Edit View Insert Cell Kernel Help
Python 2
Code
Cell Toolbar: None
Raw audio signal
Spectrogram

```
In [1]: from scipy.io import wavfile
        rate, x = wavfile.read('test_mono.wav')

In [2]: import matplotlib.pyplot as plt
        fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(12, 4))
        ax1.plot(x); ax1.set_title('Raw audio signal')
        ax2.specgram(x); ax2.set_title('Spectrogram')
        plt.show()
```

Spyder

Matlab-like IDE

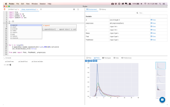
- Default IDE in Anaconda
- Uses iPython



Rodeo

Python version of RStudio

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



The data scientist toolkit

Python IDEs for Data Science (II)

Exercises

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

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

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 '`??`'

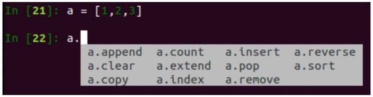
- Does not work with most buildin functions!

iPython

Basics (II)

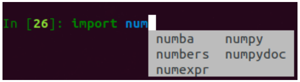
Press `<tab>` to complete almost everything

- Object contents



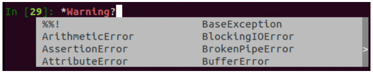
```
In [21]: a = [1,2,3]

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
^^I^^I
```

%paste

```
In [20]: %paste
   def donothing(x):
 ^^I  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:
:--
^^I
```

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
^^I
```

%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]: import math
In [2]: math.sin(2)
Out[2]: 0.9092974268256817
In [3]: math.cos(2)
Out[3]: -0.4161468365471424
In [4]: Out[2] ** 2 + Out[3] ** 2
Out[4]: 1.0
```

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)`

Magic command to show history

- `%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`