Politecnico di Torino

Data Science Lab

Introduction to Python

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Summary

- **Python engine**
  - Basic components and setup
- **Python language**
  - Data types, object oriented programming
- **NumPy library**
  - Computation with multi-dimensional arrays
- **Pandas library**
  - Tabular data and data preprocessing
- **scikit-learn library**
  - Machine learning and data science tools

- Python language
  - Clean and concise syntax
    - No semi-colons to end instructions
    - No braces to define if clauses and for loops
    - No need to specify variable types
    - …

Java

```java
List<String> l = new LinkedList<>();
for (int i=0; i<10; i++) {
    l.add(i);
}
```

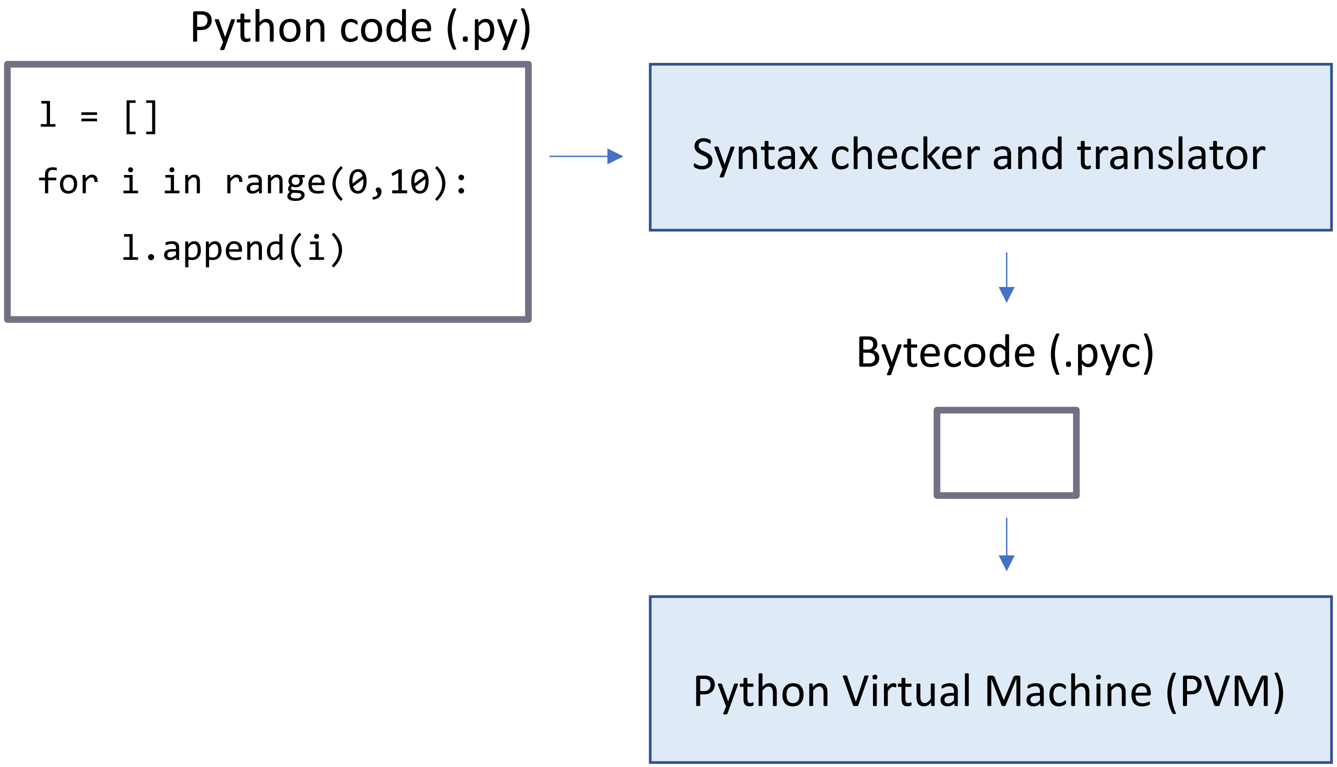
Python

```python
l = []
for i in range(0,10):
    l.append(i)
```

- Python is an **interpreted** language
  - Code is not compiled to machine language
  - However the source code is compiled to an intermediate level, called **bytecode**
  - For this reason, to run Python programs, you need an **interpreter** that is able to execute the bytecode

Introduction to Python

- Sequence of operations executed by the interpreter



Python code (.py)

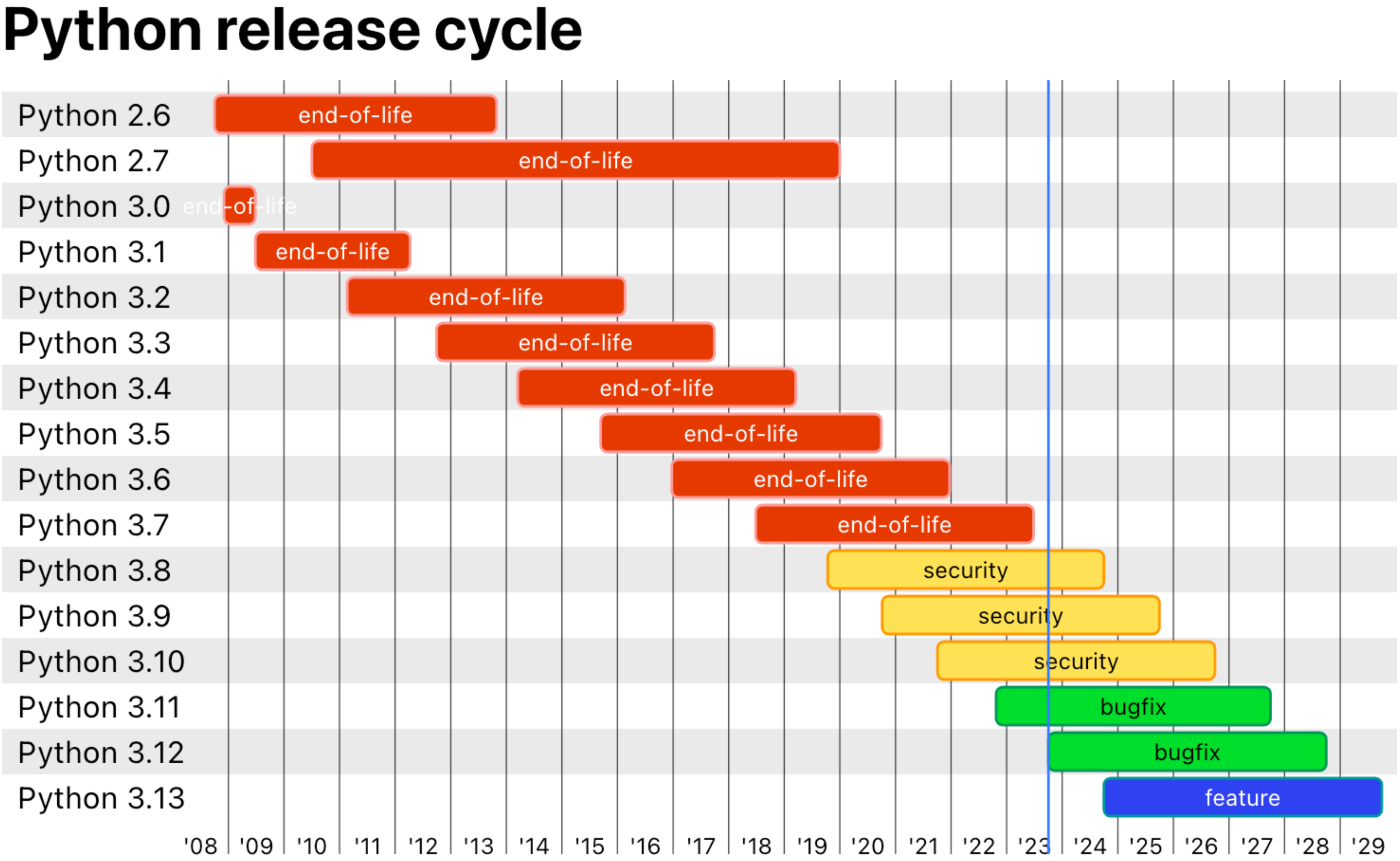
```
l = []
for i in range(0,10):
    l.append(i)
```

Syntax checker and translator

Bytecode (.pyc)

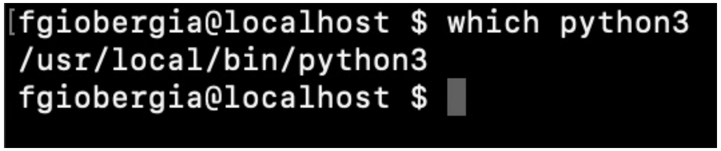
Python Virtual Machine (PVM)

Python 3



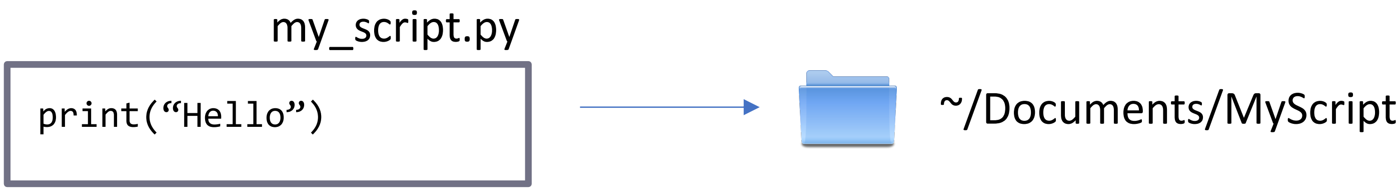
https://devguide.python.org/versions/

- A common Python 3 setup on a **Linux** System
- Typically in the /usr/bin folder:
  - “**python**” executable: run Python programs
  - “**pip**” executable: install Python packages
  - “**ipython**” executable: run programs line by line
  - “**jupyter**” executable: run a jupyter notebook
  - “**<name>3**” if your system defaults to Python 2
    - (hopefully it does not)
- To find where your python commands live:
  - `which <command>`



```
[fgiobergia@localhost $ which python3
/usr/local/bin/python3
fgiobergia@localhost $ ▌
```

- Executing a Python program



my_script.py

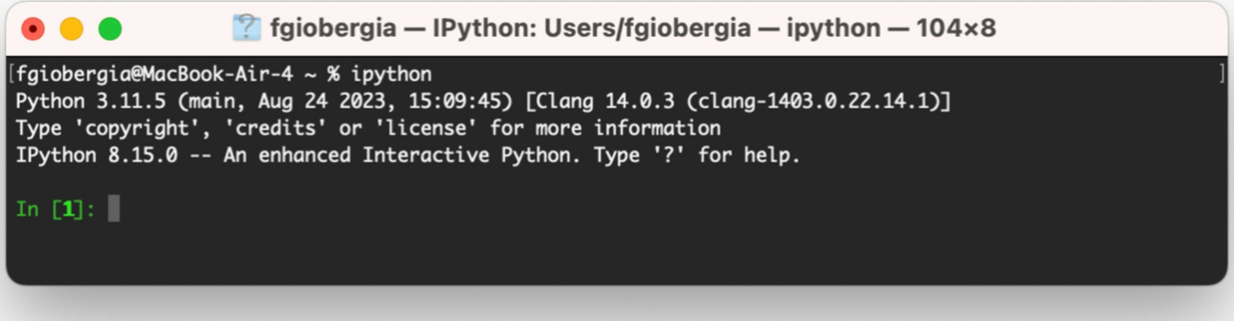
```
print(“Hello”)
```

~/Documents/MyScript

- Type in your terminal:
  - `cd ~/Documents/MyScript`
  - `python my_script.py`

Introduction to Python

- Running Python line by line with IPython
- Type in your terminal:
  - `ipython` (or `ipython3`, depending on your installation)



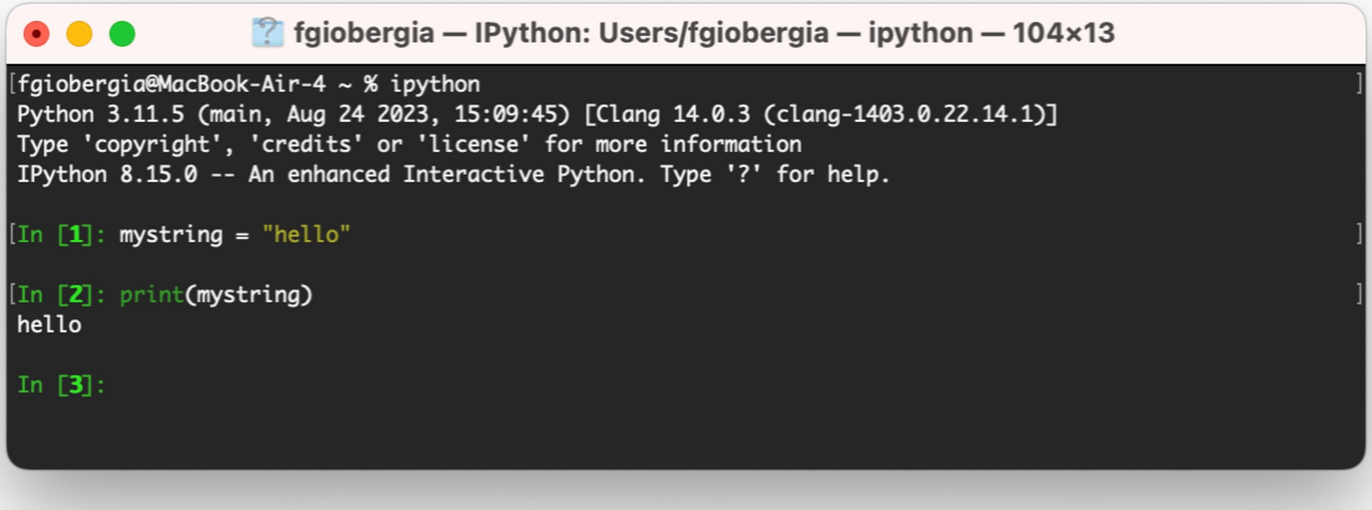
fgiobergia — IPython: Users/fgiobergia — ipython — 104×8

```
fgiobergia@MacBook-Air-4 ~ % ipython
Python 3.11.5 (main, Aug 24 2023, 15:09:45) [Clang 14.0.3 (clang-1403.0.22.14.1)]
Type 'copyright', 'credits' or 'license' for more information
IPython 8.15.0 -- An enhanced Interactive Python. Type '?' for help.

In [1]: 
```

Introduction to Python

- Write your program line by line to see the results step by step…



```
[fgiobergia@MacBook-Air-4 ~ % ipython
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Type 'copyright', 'credits' or 'license' for more information
IPython 8.15.0 -- An enhanced Interactive Python. Type '?' for help.

[In [1]: mystring = "hello"

[In [2]: print(mystring)
hello

In [3]:
```
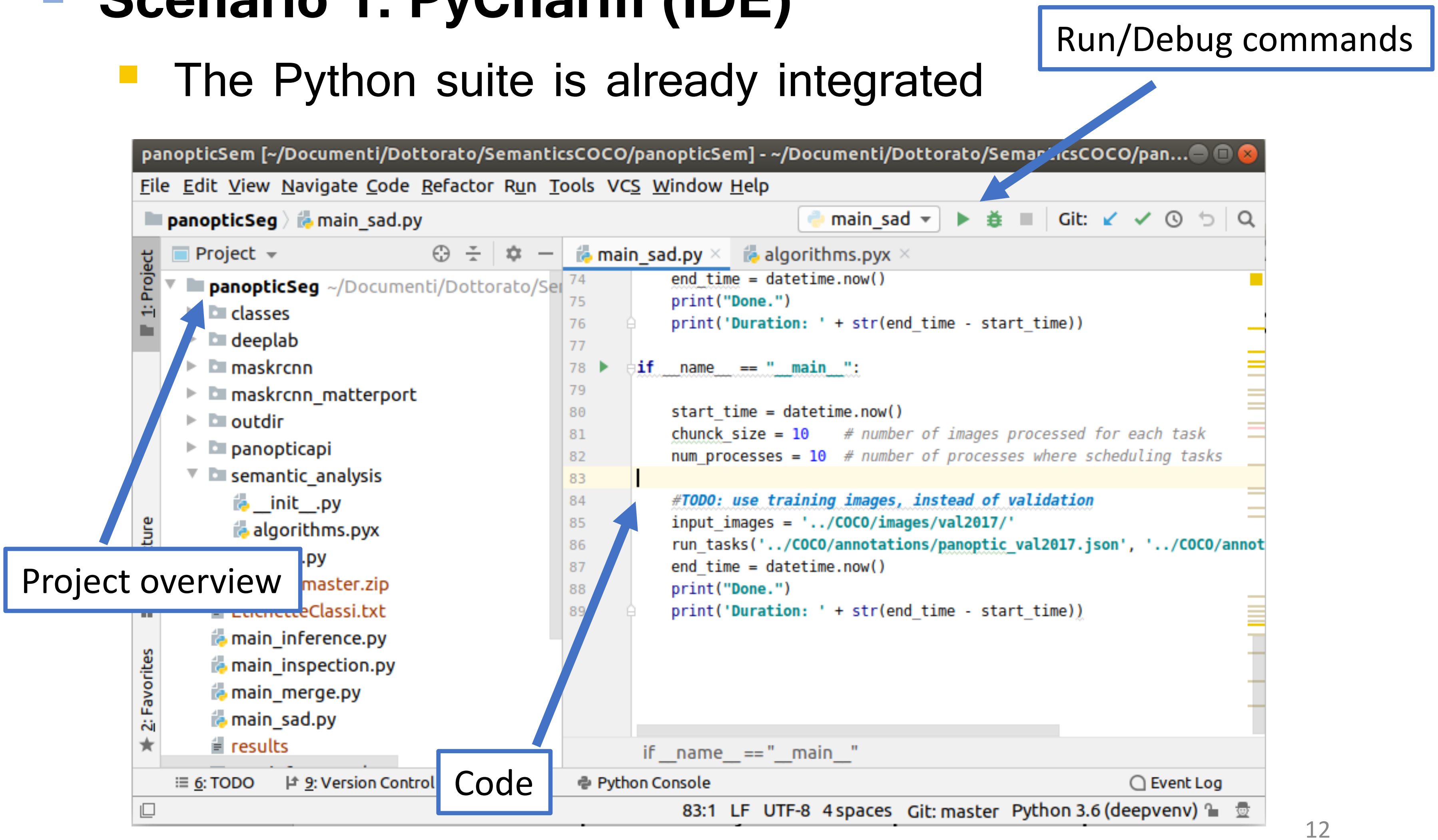

- **Python** and **IPython** programs are the core for executing scripts, but…
- There are two typical scenarios:
  1. Develop your Python **project** with an Integrated Development Environment (**IDE**)
     - Example: Visual Studio Code, PyCharm
     - **Debug** and **run** your code inside the IDE
  2. Develop and test a Python **script** with **Jupyter notebook**
     - Inspect **step by step** the results
     - Keep the history of the output of the script

Scenario 1: PyCharm (IDE)

- The Python suite is already integrated



```python
        end_time = datetime.now()
        print("Done.")
        print('Duration: ' + str(end_time - start_time))

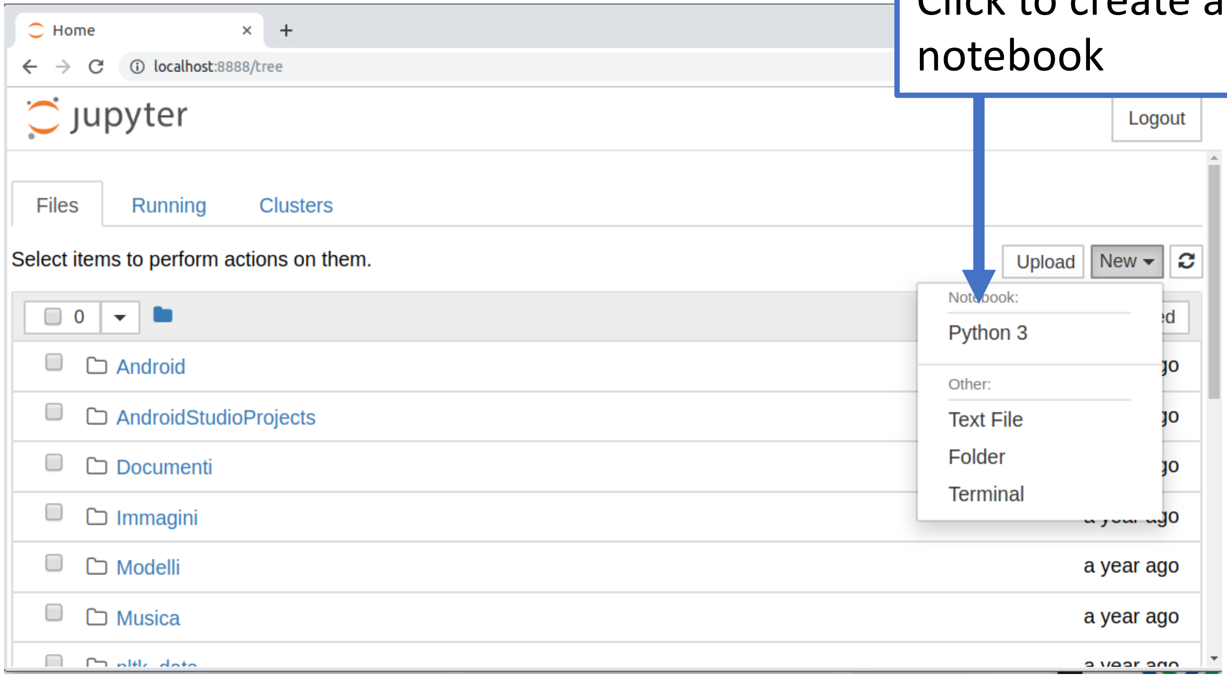
if __name__ == "__main__":

    start_time = datetime.now()
    chunck_size = 10    # number of images processed for each task
    num_processes = 10  # number of processes where scheduling tasks

    #TODO: use training images, instead of validation
    input_images = '../COCO/images/val2017/'
    run_tasks('../COCO/annotations/panoptic_val2017.json', '../COCO/annot
    end_time = datetime.now()
    print("Done.")
    print('Duration: ' + str(end_time - start_time))
```

Scenario 2: Jupyter notebook

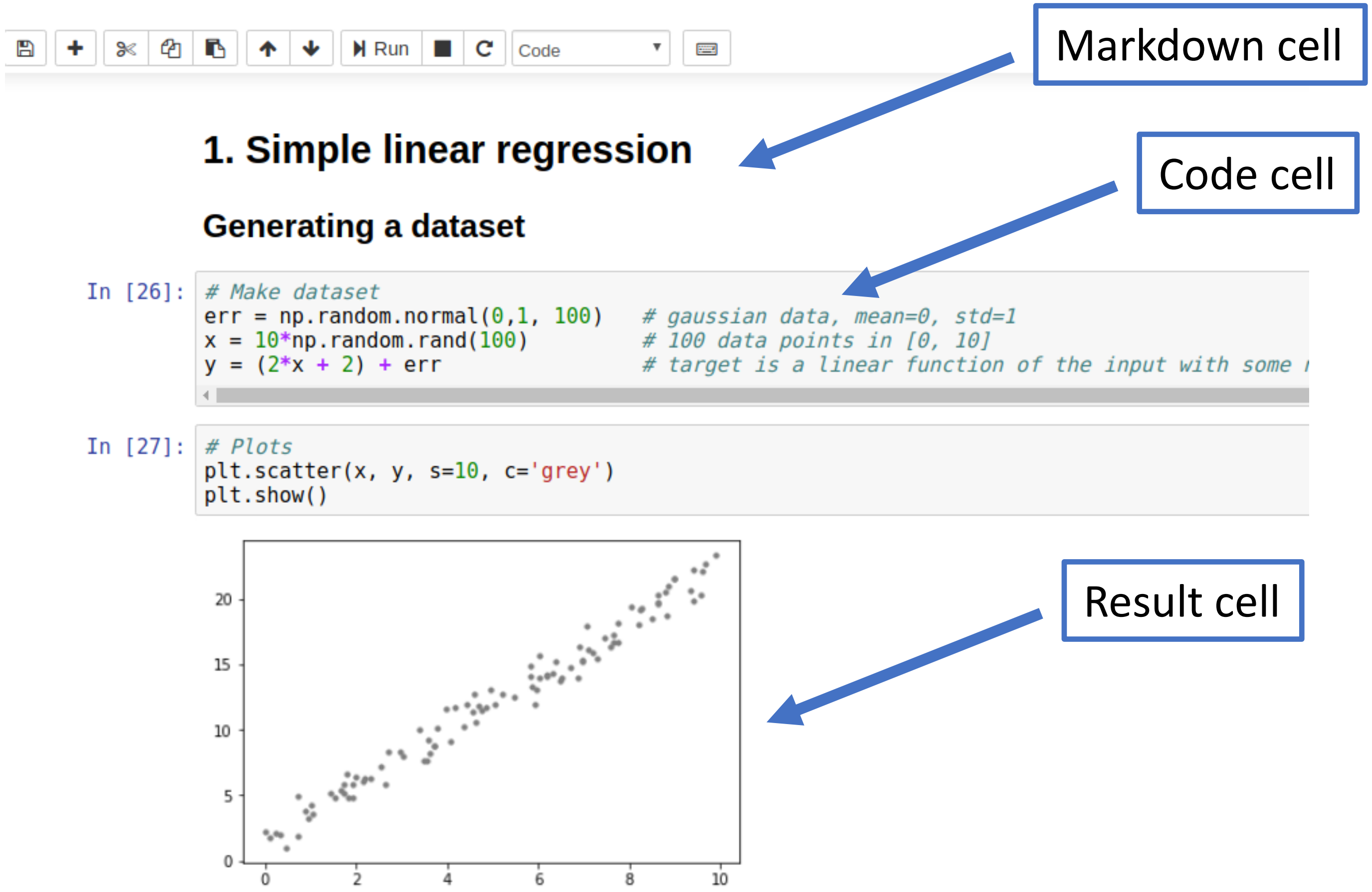
- Type in your terminal
  - jupyter notebook
- Jupyter will open on your browser



Click to create a new notebook

Select items to perform actions on them.

Scenario 2: Jupyter notebook



1. Simple linear regression

Generating a dataset

```
In [26]: # Make dataset
         err = np.random.normal(0,1, 100)    # gaussian data, mean=0, std=1
         x = 10*np.random.rand(100)          # 100 data points in [0, 10]
         y = (2*x + 2) + err                 # target is a linear function of the input with some
```

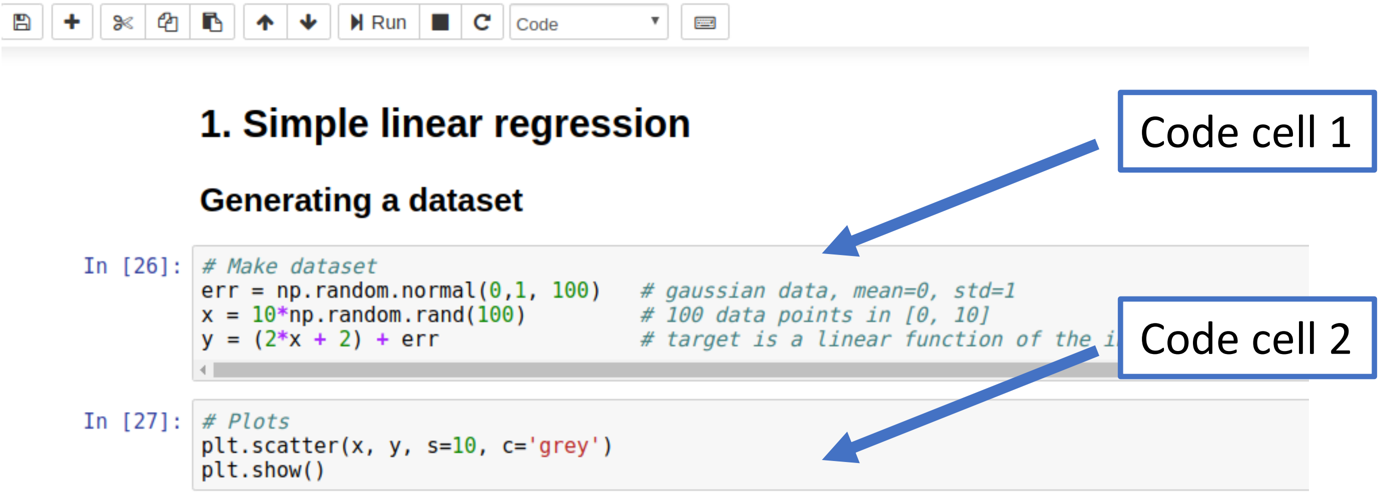
```
In [27]: # Plots
         plt.scatter(x, y, s=10, c='grey')
         plt.show()
```

Markdown cell

Code cell

Result cell

- **Scenario 2: Jupyter notebook**
  - Based on **IPython** command
  - Each code **cell** can be executed **separately** by pressing CTRL + ENTER



1. Simple linear regression

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```

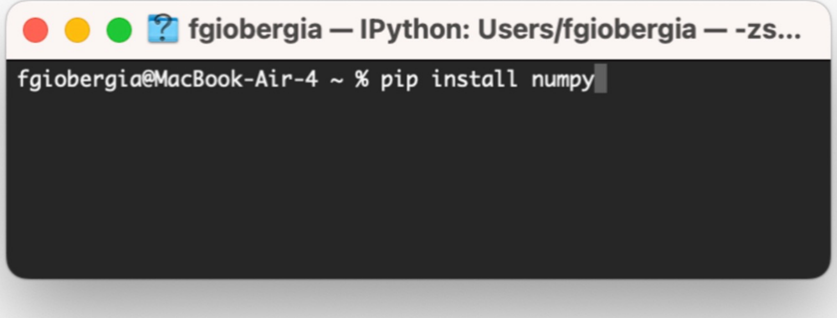
Code cell 1

Code cell 2

- **IDE vs Jupyter notebook**
  - IDE
    - For **complex** projects (many files)
    - More powerful debug commands
    - More powerful code editing tools
  - Jupyter notebook
    - For simple scripts and prototypes
    - Great **visualization** tool
      - Example: **report** with Python code and text for explanations

Installing libraries

- Python language is provided with many useful libraries:
  - Numpy, Pandas, Matplotlib, Scikit-learn, SciPy, …
- To use any of them you first have to install it with the **pip** command: `pip install <package>`
  - `pip install numpy`
  - `pip install pandas`

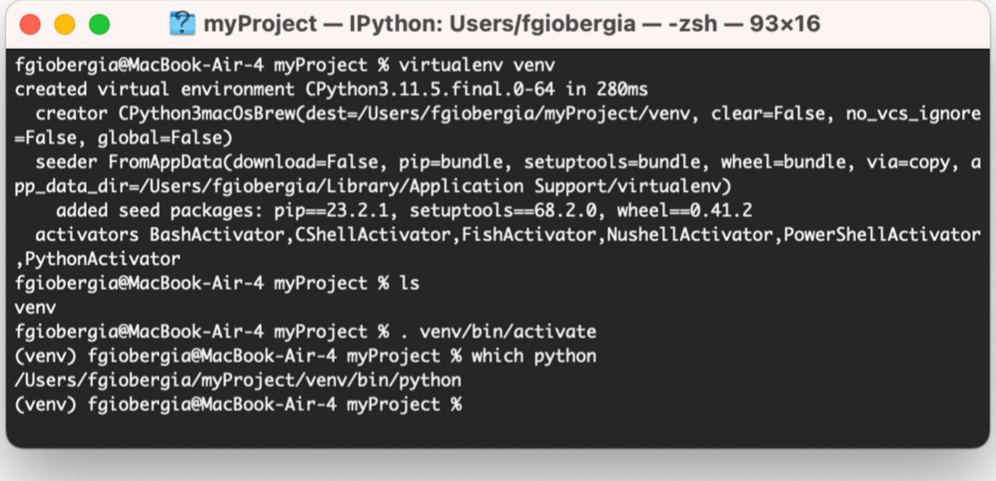


```
fgiobergia@MacBook-Air-4 ~ % pip install numpy
```

- **Virtual environments**
  - The pip command will associate the libraries to your **default Python installation**
  - A more powerful way of managing libraries is to use a Python **environment (virtualenv)**
    - Designed when you want to design **different projects** that use different libraries and **configurations (e.g. versions)**
      - Each projects is associated to a virtual environment

Virtual environments

- To create and use a new environment:
  - `cd ~/myProject` → move to project directory
  - `virtualenv venv` → *create* virtual environment called venv
  - `. venv/bin/activate` → *activate* environment “venv”
- Python & libraries used will be from venv (not global)



```
fgiobergia@MacBook-Air-4 myProject % virtualenv venv
created virtual environment CPython3.11.5.final.0-64 in 280ms
  creator CPython3macOsBrew(dest=/Users/fgiobergia/myProject/venv, clear=False, no_vcs_ignore
=False, global=False)
  seeder FromAppData(download=False, pip=bundle, setuptools=bundle, wheel=bundle, via=copy, a
pp_data_dir=/Users/fgiobergia/Library/Application Support/virtualenv)
    added seed packages: pip==23.2.1, setuptools==68.2.0, wheel==0.41.2
  activators BashActivator,CShellActivator,FishActivator,NushellActivator,PowerShellActivator
,PythonActivator
fgiobergia@MacBook-Air-4 myProject % ls
venv
fgiobergia@MacBook-Air-4 myProject % . venv/bin/activate
(venv) fgiobergia@MacBook-Air-4 myProject % which python
/Users/fgiobergia/myProject/venv/bin/python
(venv) fgiobergia@MacBook-Air-4 myProject %
```

- **Virtual environments**
  - After activation you can use the terminal to work within the environment
  - Install libraries in the *current* environment
    - `pip install my_library`
  - Execute a script/notebook within the environment
    - `python my_script.py`
    - `jupyter notebook`
  - To deactivate the environment
    - `deactivate`