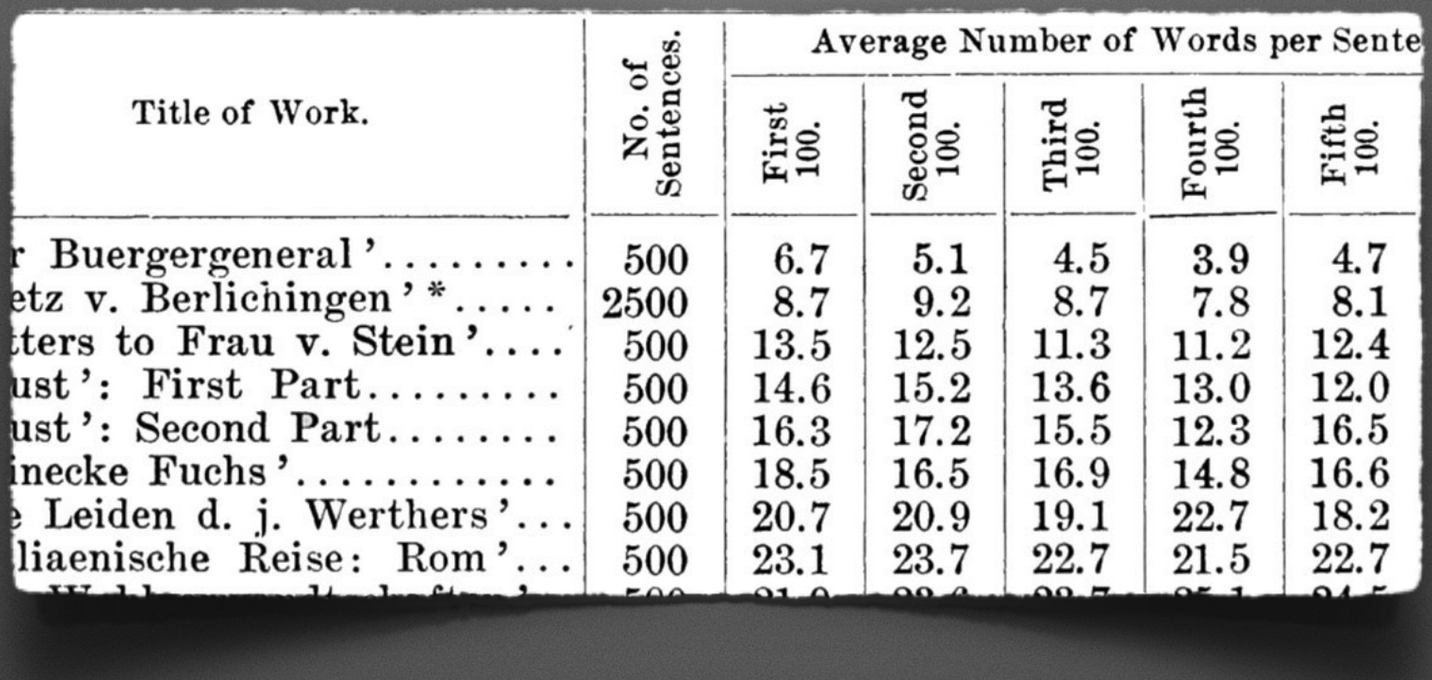


Title of Work.	No. of Sentences.	Average Number of Words per Sente				
		First 100.	Second 100.	Third 100.	Fourth 100.	Fifth 100.
r Buergergeneral'.....	500	6.7	5.1	4.5	3.9	4.7
etz v. Berlichingen'*.....	2500	8.7	9.2	8.7	7.8	8.1
tters to Frau v. Stein'....	500	13.5	12.5	11.3	11.2	12.4
ust': First Part.....	500	14.6	15.2	13.6	13.0	12.0
ust': Second Part.....	500	16.3	17.2	15.5	12.3	16.5
inecke Fuchs'.....	500	18.5	16.5	16.9	14.8	16.6
e Leiden d. j. Werthers'...	500	20.7	20.9	19.1	22.7	18.2
liaenische Reise: Rom'...	500	23.1	23.7	22.7	21.5	22.7

Introduction to Data Analysis with Python

Jordi Vitrià, PhD
Universitat de Barcelona

UNIVERSITAT DE BARCELONA

Syllabus

Data Science Steps & Python Data Science Stack

Data Science Plumbing & Agile Data Science

Why Python?

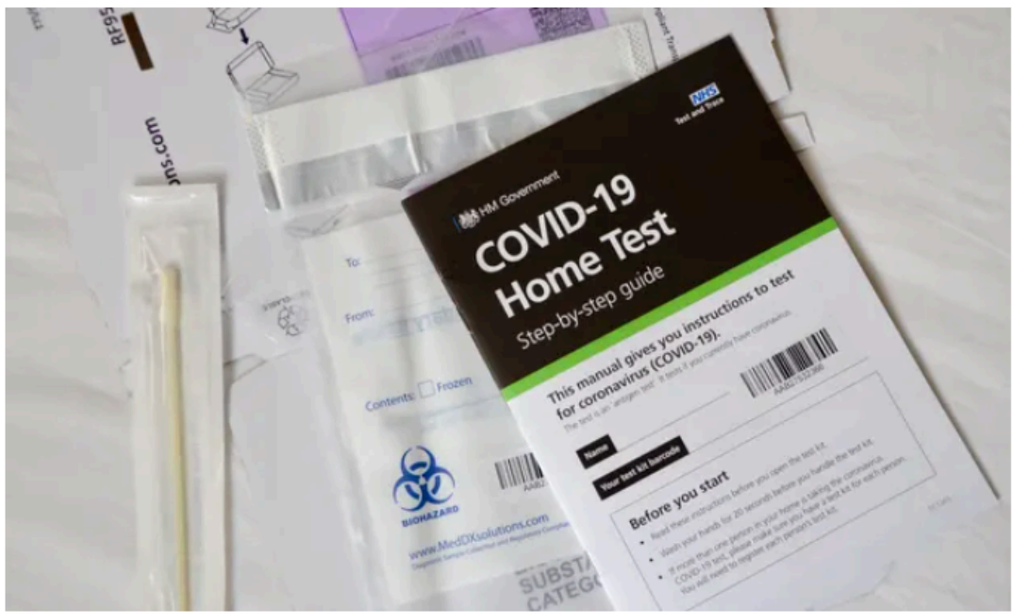
What is IPython?

Health policy

Covid: how Excel may have caused loss of 16,000 test results in England

Public Health England data error blamed on limitations of Microsoft spreadsheet

- Coronavirus - latest updates
- See all our coronavirus coverage



▲ More than 50,000 potentially infectious people may have been missed by contact tracers after 15,841 positive tests were left off the daily figures. Photograph: Simon Leigh/Alamy

Health policy

Covid: how Excel may have caused loss of 16,000 test results in England

...

But while CSV files can be any size, Microsoft Excel files can only be 1,048,576 rows long – or, in older versions which PHE may have still been using, a mere 65,536. When a CSV file longer than that is opened, the bottom rows get cut off and are no longer displayed. That means that, once the lab had performed more than a million tests, it was only a matter of time before its reports failed to be read by PHE.

...

Data Science Steps

What do I want?
Does it have sense?

Question

What are my data sources? How reliable are they?

Acquire

How do I develop an understanding of the content of my data?

Describe

What are the key relationships in my data?

Discover

How do I develop an understanding of the content of my data?

Analyze

What are the likely future outcomes?

Predict

Are my expectations fulfilled?

Evaluate

Acquire: How do I get my data?
- Web Scraping.
- Data Base.
- Data Pipelines.
- APIs

Processing: How I do clean and separate my data?
- Identification: filter data.
- Outliers.
- Imputation: missing value processing.
- Reduction: dimensionality reduction.
- Normalization: duplicates, ranges, format, coordinates, units, etc.
- Feature extraction.

Aggregation: How do I collect and summarize my data?
- Basic Statistics: mean, std, box plots, scatter plots, counts, etc.
- Distribution fitting.
- Feature aggregation.

Enrichment: How do I add more information to my data?
- Feature engineering.
- Search for additional data sources.

Discover: What are the key relationships in my data?
- Clustering (How do I segment the data to find natural groupings?)
- Visualization (Are there unexpected relationships?)

Analyze: How do I model my data?
- Variable selection (How do I determine important variables?)
- Probabilistic modeling (How are my variables related?)

Predict: What are the likely future outcomes?
- Regression (How do I predict the future?)
- Classification (How do I predict a category?)
- Recommendation (How do I predict relevant conditions?)

Evaluate: Are the outcomes generic and robust?
- Statistical Testing.
- Model performance.

Python Data Stack

Scrapy
PyDB
PyMongo
Numpy
Pandas
SciPy
SciKit Learn
MatplotLib
SymPy
IPython
Cython
Bokeh
Blaze
PySpark
StatsModels
Shogun
PyMC
seaborn
PyTables
cvskit
sqlite3
plotly
NetworkX
nltk
gensim
twython

Data Science Plumbing

Agile Development & Model Deployment

Logs from servers, sensors, transactions, etc. Events must be **serialized** in a common format.

Events

Events are collected from different sources and **aggregated** to bulk storage.

Collector

This is a **filesystem** capable of parallel access by concurrent processes.

Bulk Storage

Data processing with scripting languages with **out-of-core** processing capabilities.

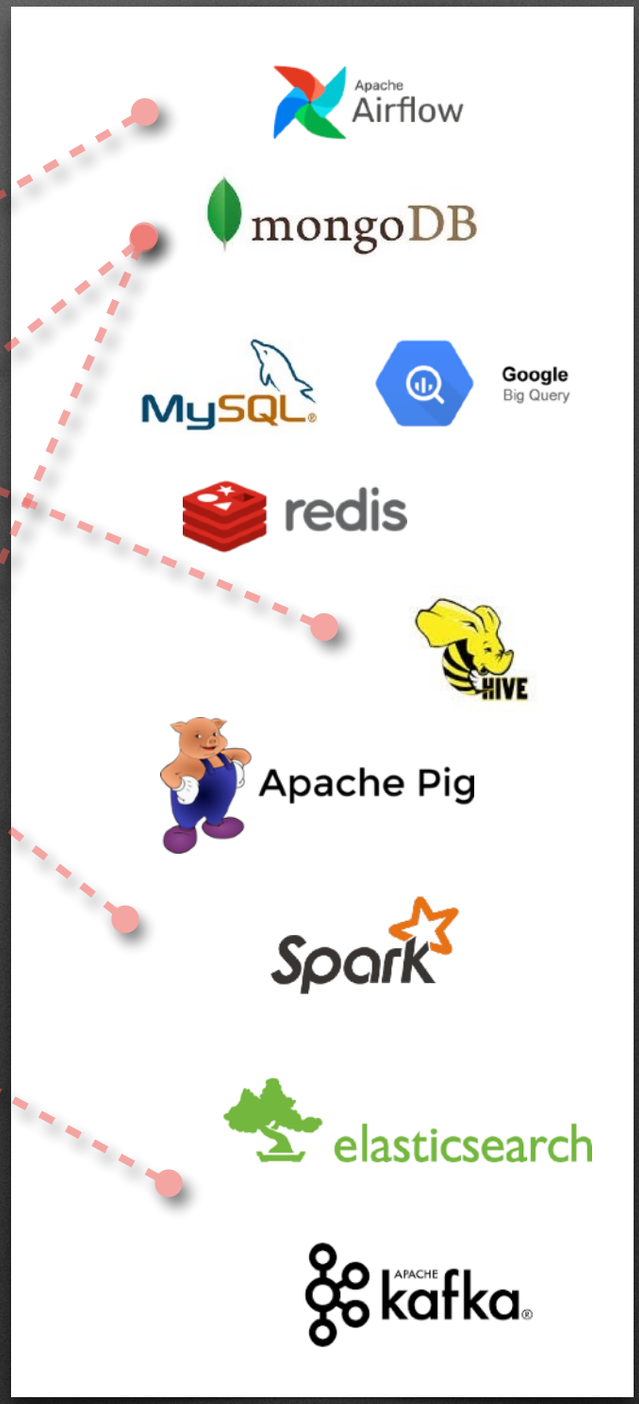
Batch Processing

These are multinode stores to **publish data** for consumption by web apps.

Distributed Store

Application server.

Application Server



Why Python?

- Python is a modern, open source, **object-oriented programming** language, created by a Dutch programmer, Guido van Rossum, in 1991.
- Officially, it is an **interpreted scripting language**. There are several implementations, being the most used the one implemented in C.
- It offers the power and flexibility of lower level (i.e. compiled) languages, without the steep learning curve, and without most of the associated debugging pitfalls.
- The language is very **clean and readable**, and it is available for almost every modern computing platform.
- It is widely used: Google, DropBox, Deutsche Borse, NASA, etc.

Why Python?

In Data Science, **programming is mostly about discovering solutions by writing code and using a language to express them**.

Python offers a number of advantages to data scientists:

- Powerful and easy to use.
- Anything that can be coded in C, FORTRAN, or Java can be done in Python, almost always in fewer lines of code, and with fewer debugging headaches.
- Its standard library is extremely rich, including modules for string manipulation, regular expressions, file compression, mathematics, scientific programming, profiling and debugging.
- Unnecessary language constructs, such as END statements and brackets are absent, making the code efficient and easy to read.
- Python is object-oriented, which allows data structures to be abstracted in a natural way.

Why Python?

- It is interactive
  - Python may be run interactively on the command line. Commands may entered serially followed by the Return key.
  - This is useful for exploratory programming.
- It is extensible
  - Python is often referred to as a “glue” language, meaning that it is a useful in a mixed-language environment. C or FORTRAN code can be compiled directly into Python programs.
  - Sometimes, it can be slow relative to compiled languages. In many cases this performance deficit is due to a short loop of code that runs thousands or millions of times. Such bottlenecks may be easily removed by coding a function in C or Cython that can be compiled into a Python module.

Why Python?

- There is a vast body of Python third party modules:
  - **NumPy**: Numerical Python (NumPy) is a set of extensions that provides the ability to specify and manipulate array data structures.
  - **SciPy**: An open source library of scientific tools for Python, SciPy supplements the NumPy module. SciPy includes modules for graphics and plotting, optimization, integration, special functions, signal and image processing, genetic algorithms, ODE solvers, and others.
  - **Matplotlib**: Matplotlib is a python 2D plotting library which produces publication-quality figures.
  - **pandas**: A module that provides high-performance, easy-to-use data structures and data analysis tools. In particular, the DataFrame class is useful for spreadsheet-like representation and mannipulation of data.
  - **IPython**: An enhanced Python shell, designed to increase the efficiency and usability of coding, testing and debugging Python.
  - **Tensorflow, PyTorch**.

Why Python?

- Strong points:
  - Viable alternative to SAS/Matlab/R/…
  - Uptake in the several sectors.
  - Upcoming generation of programmers with Python as a first language.
  - Strong Python communities in HPC/Scientific Computing/Data Science.

- Weak points
  - Weak support.

Why Python?

Python in Big Data Workflows

Cloud

Counting/ETL-ELT

HDF5
Spark
Hadoop
SQL
…

My Machine

Insight/Reporting

pandas
scikit-learn
Blaze
PySpark
PyMongo
…

Why Python?

Python

Core Computing

IPython

Multicore Computing

Dask

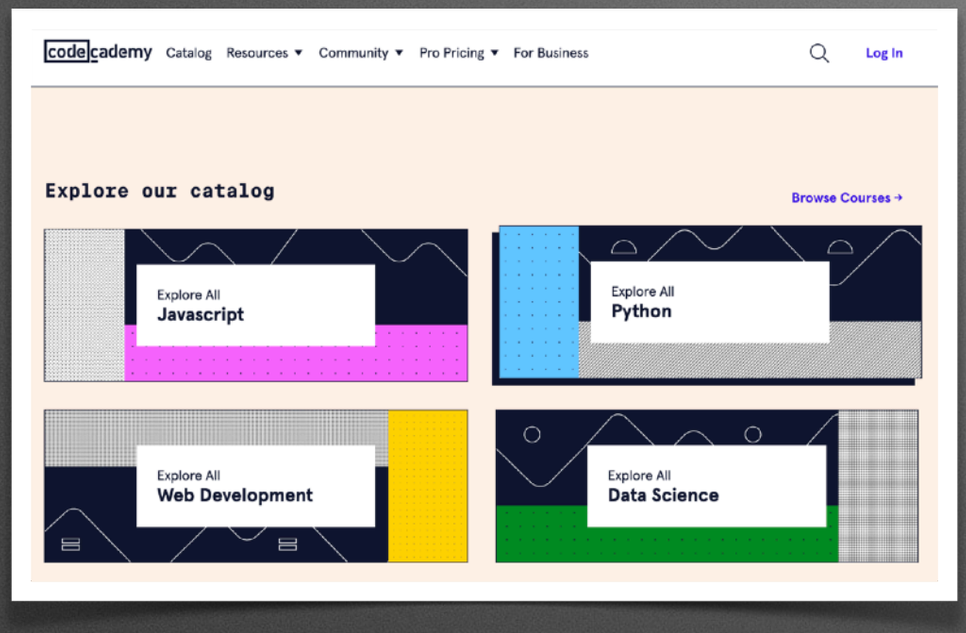
Out-of-core Computing

PySpark/Dask

Distributed Computing

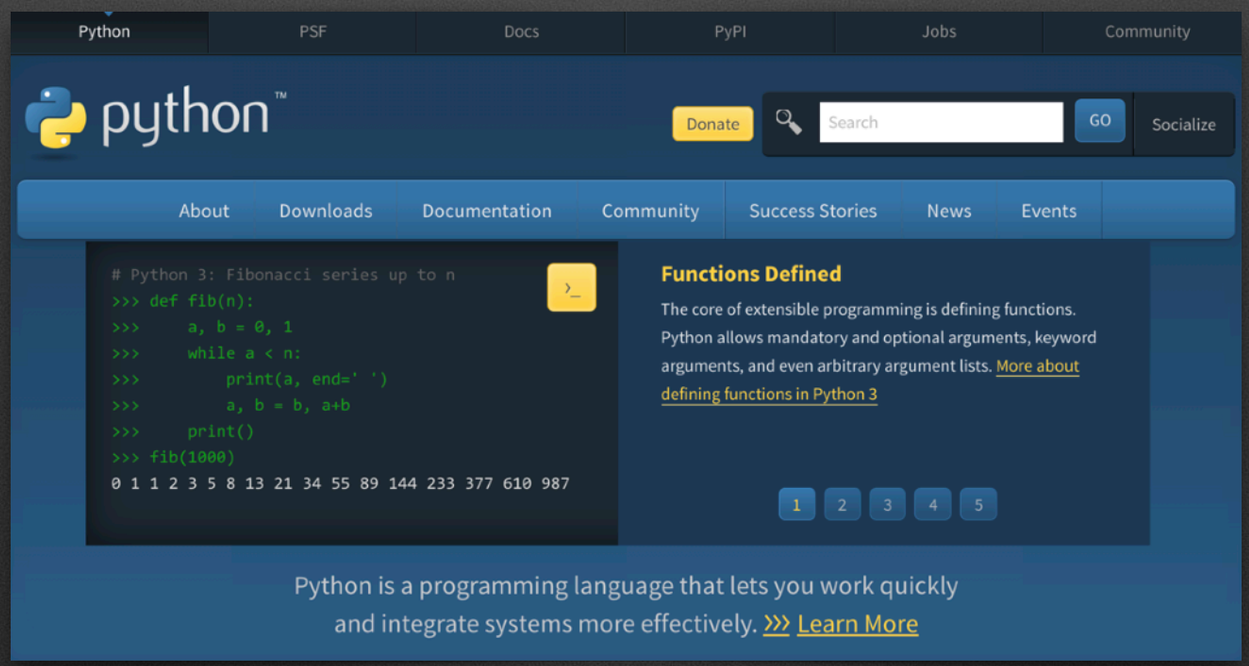
More on Python

www.codecademy.com



http://anandology.com/python-practice-book/

www.python.org



What is IPython/Jupyter?

I is for interactive

In this class, we will use **notebooks** for teaching and programming assignments.

A jupyter notebook lets you write and execute Python code in your web browser.

Jupyter notebooks make it very easy to tinker with code and execute it in bits and pieces; for this reason jupyter notebooks are widely used in scientific computing and data science.

Jupyter Notebooks

For new users who want to get up and running with minimal effort, we suggest you to download and install Anaconda (https://www.anaconda.com/products/individual) which provide a setup based on Python 3.8

Anaconda is a free collection of powerful packages for Python that enables large-scale data management, analysis, and visualization for Business Intelligence, Scientific Analysis, Engineering, Machine Learning, and more.

ANACONDA.

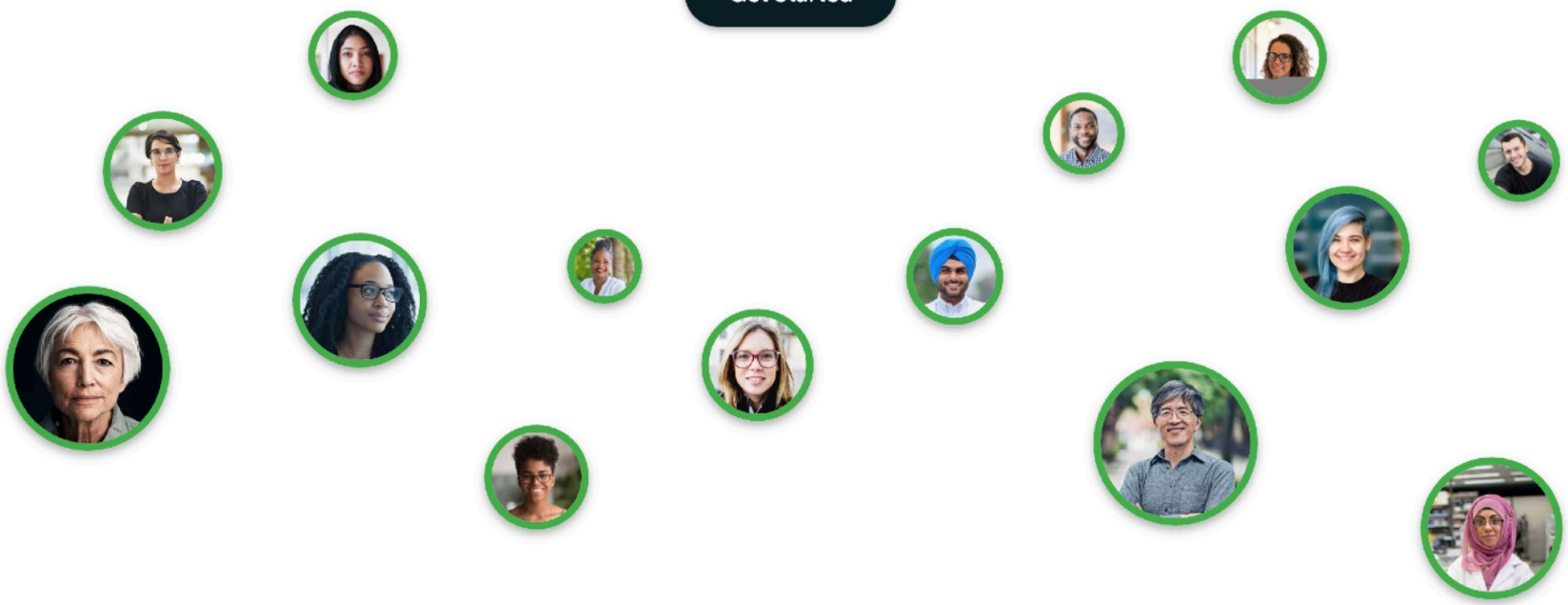
Products Pricing Solutions Resources Blog Company

Get Started

Data science technology for human sensemaking.

A movement that brings together millions of data science practitioners, data-driven enterprises, and the open source community.

Get Started



Jupyter Notebooks

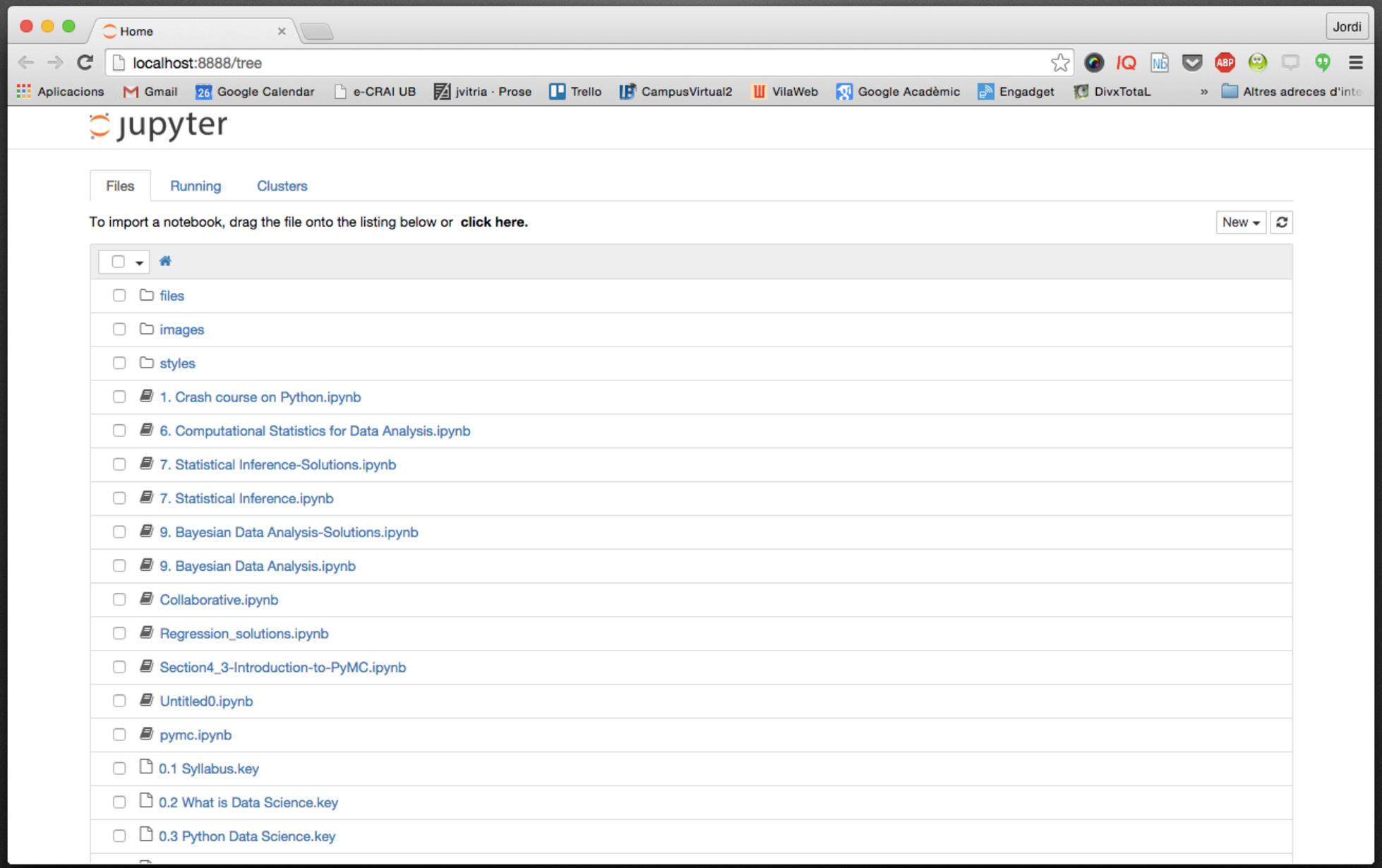
To run a notebook,

(1) Using the command line, navigate to the directory you want to store notebooks, and

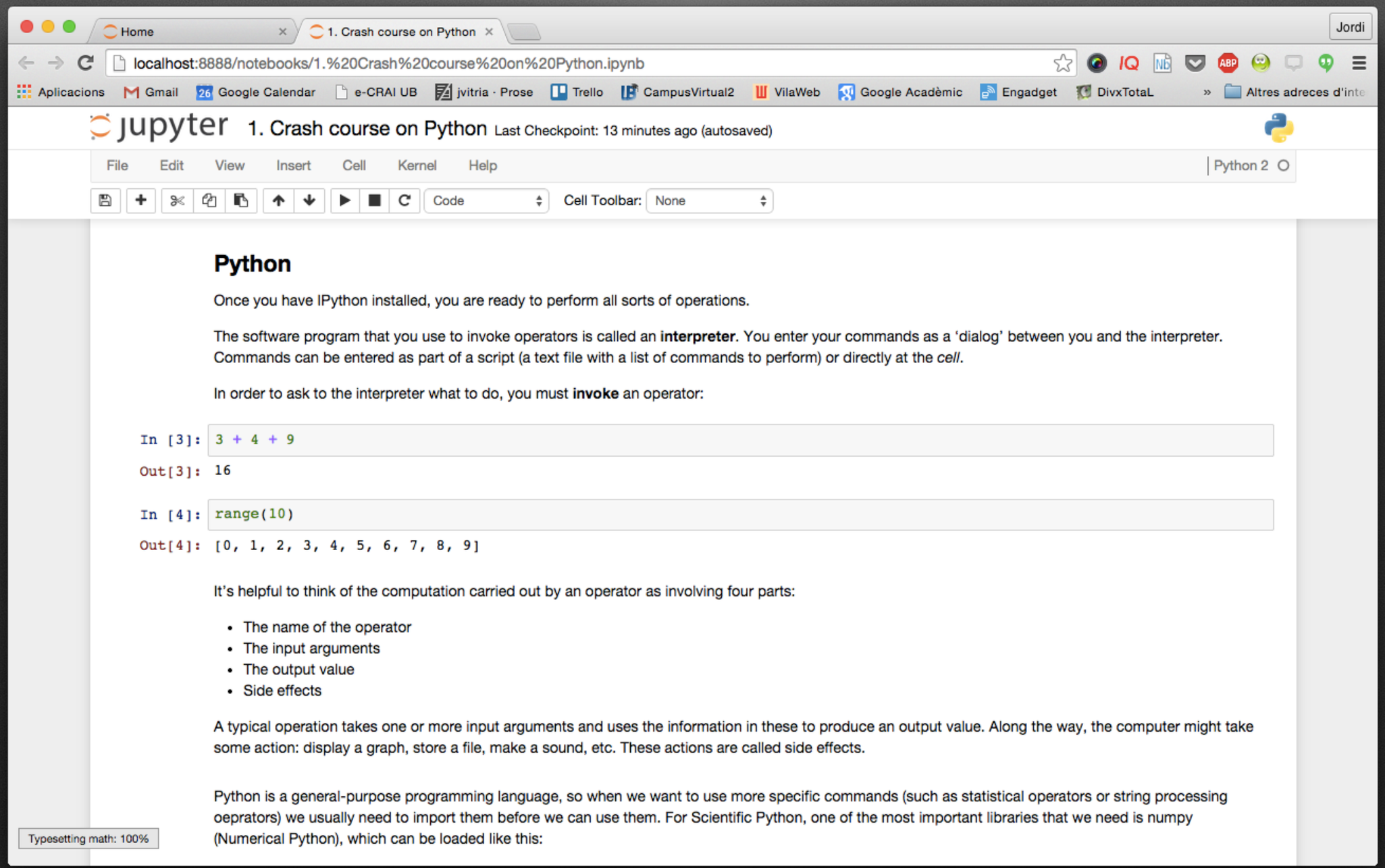
(2) Start running a notebook server from the command line using the following command:

```
jupyter notebook
```

Jupyter Notebooks

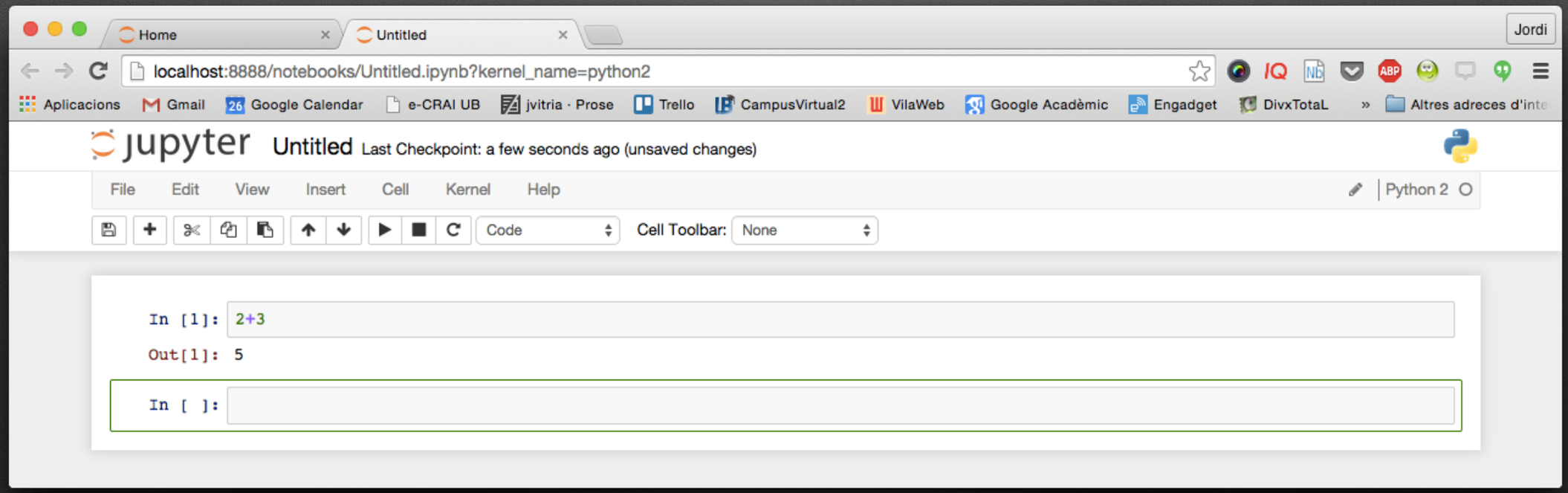


Jupyter Notebooks



Jupyter Notebooks

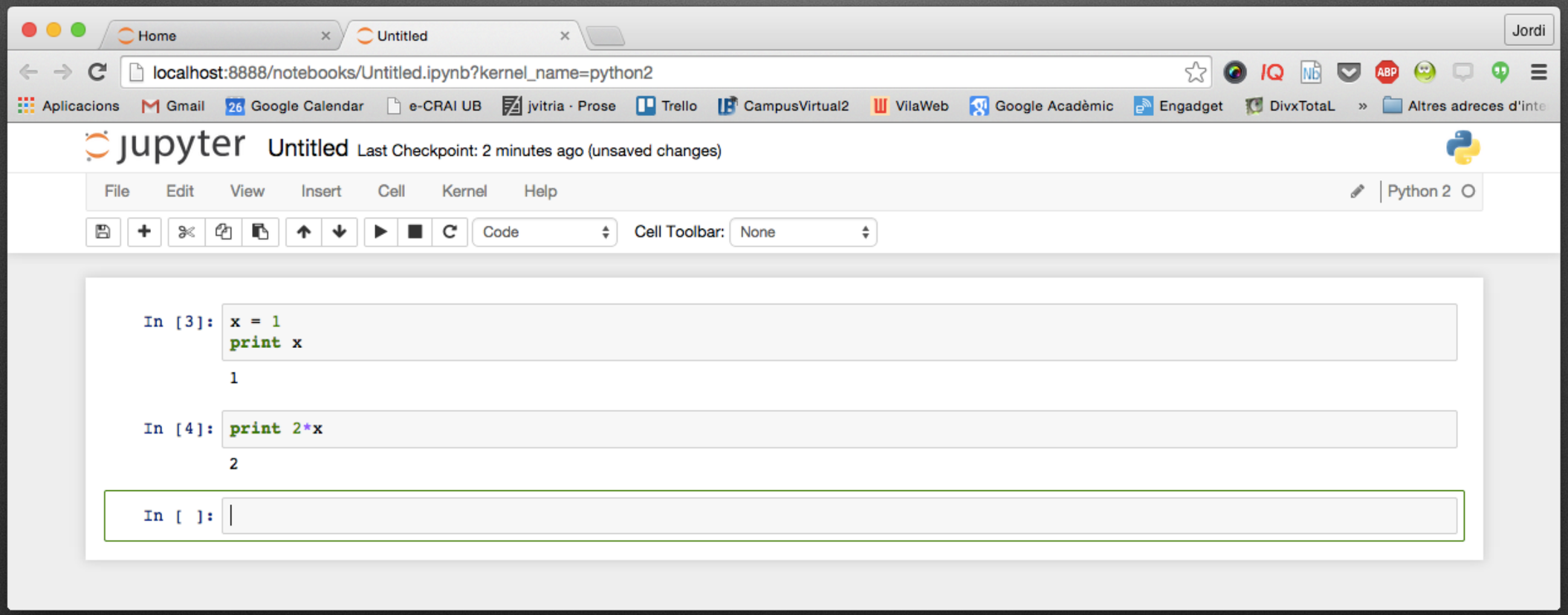
An IPython notebook is made up of a number of cells. Each cell can contain Python code.



You can execute a cell by clicking on it and pressing Shift-Enter. When you do so, the code in the cell will run, and the output of the cell will be displayed beneath the cell.

Jupyter Notebooks

Global variables are shared between cells. Executing the second cell thus gives the following result:



By convention, jupyter notebooks are expected to be run from top to bottom. Failing to execute some cells or executing cells out of order can result in errors.

Jupyter Notebooks

After you have modified a jupyter notebook for one of the assignments by modifying or executing some of its cells, remember to save your changes!