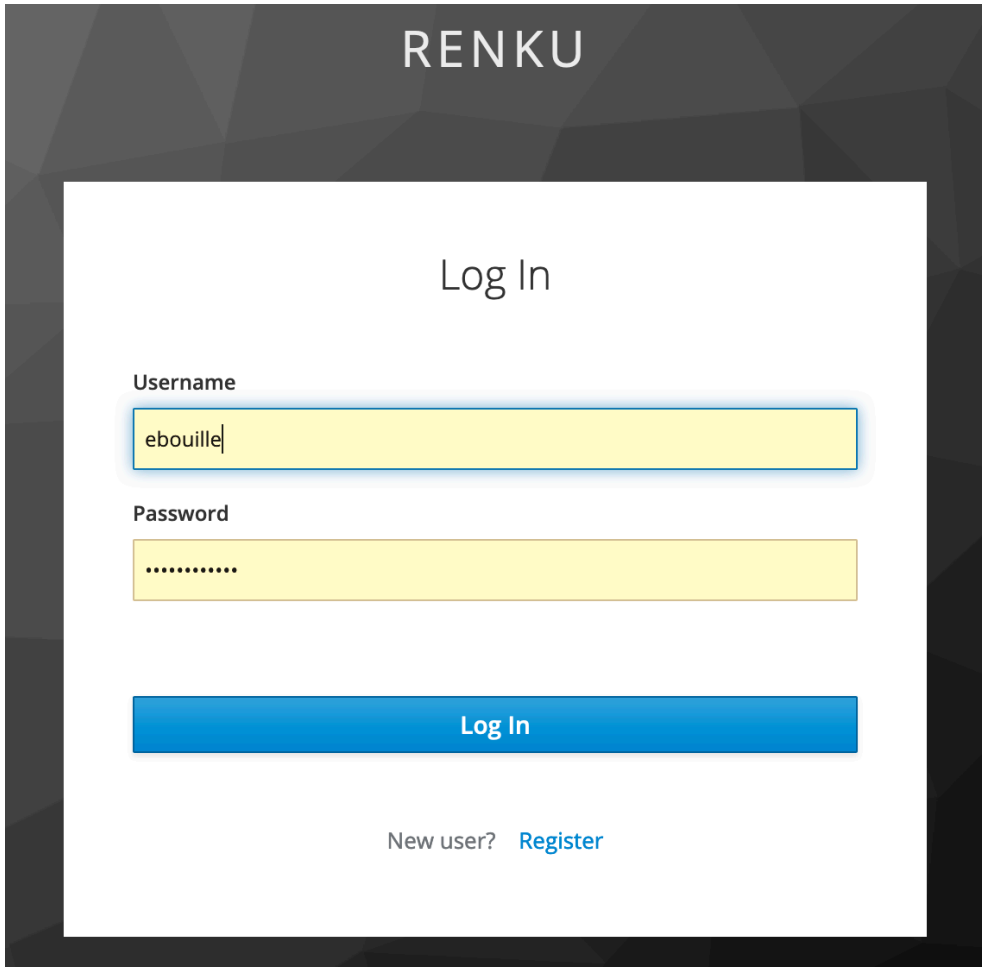
Overview Jupyter notebook
Crash course Python 3.x

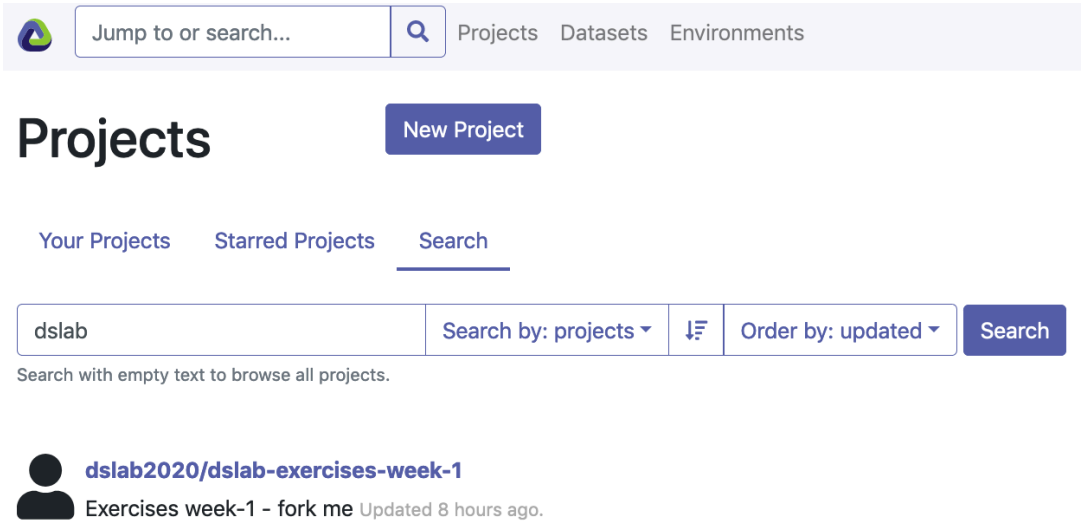
Start your engines

- Head over to the RENKU webpage
  - https://renku.iccluster.epfl.ch
  - You will need the EPFL VPN if connecting from outside the EPFL network

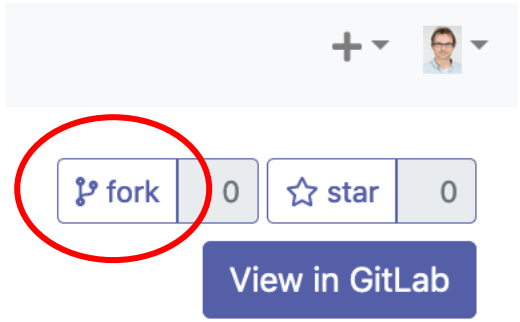
1. Login with your gaspar accounts



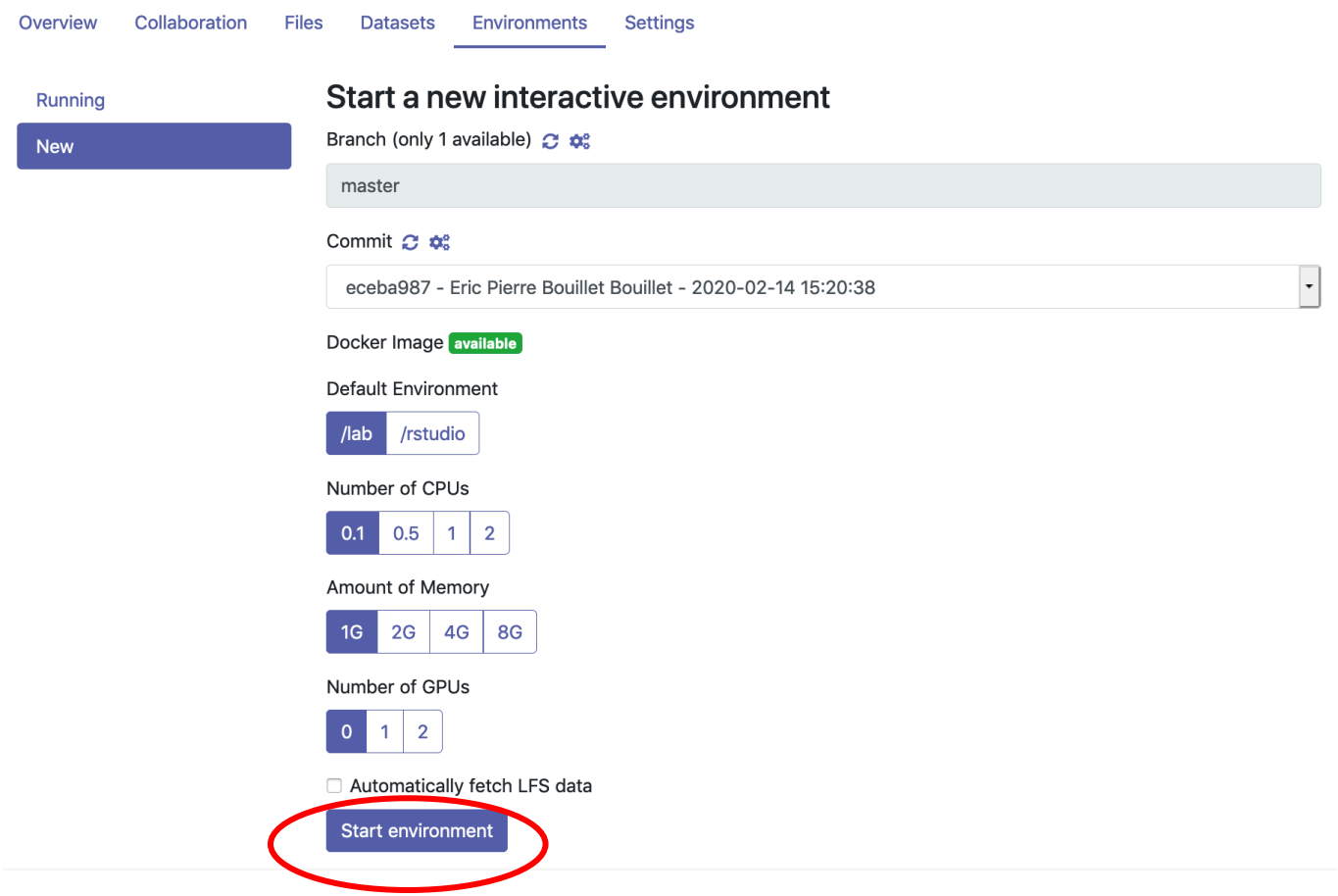
2. Find project **dslab2020**/dslab-exercises-week1



3. Open and fork project

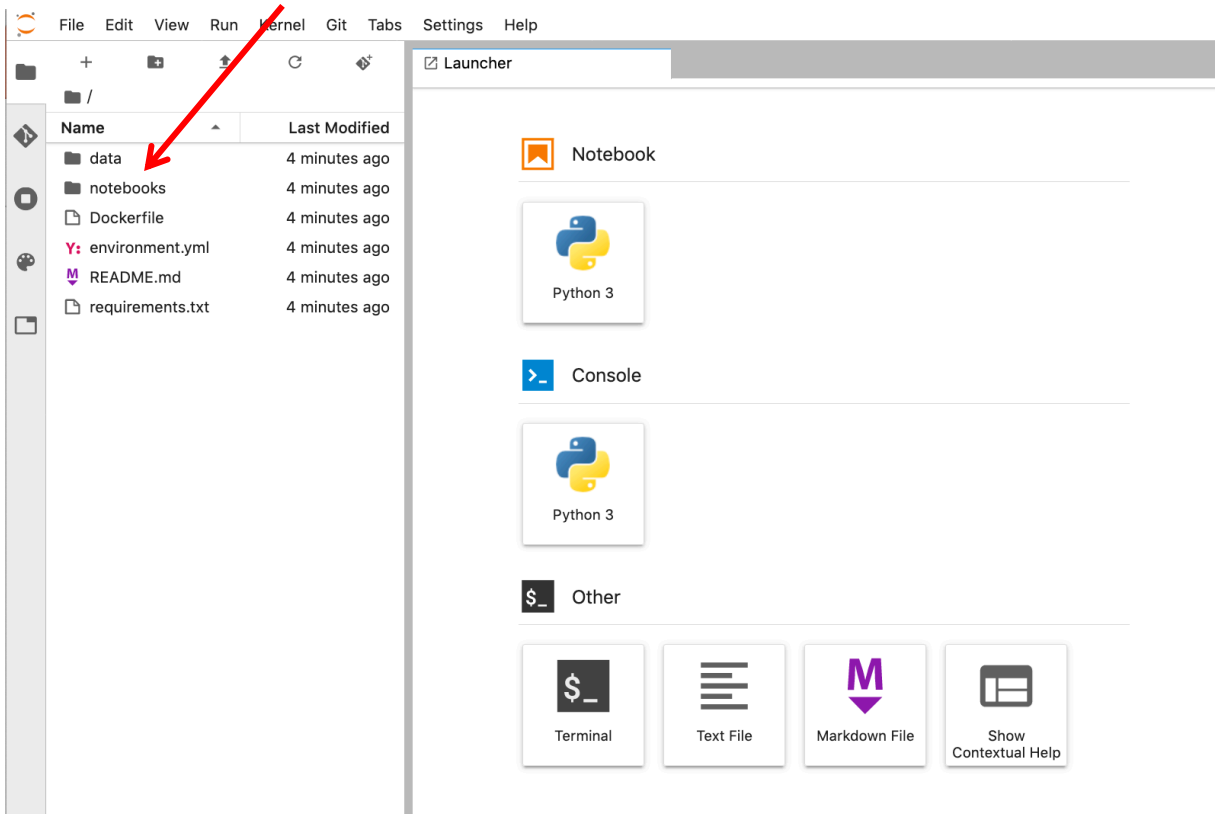


4. Open forked project and start environment (1 CPU max)



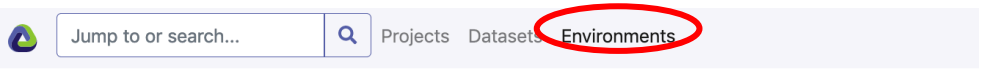
5. Open Jupyter Notebook

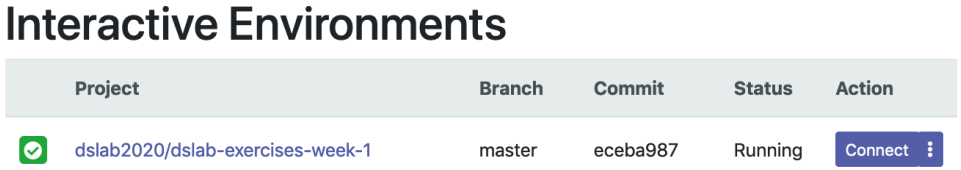
6. In Jupyter notebook, exercises are in notebook folder



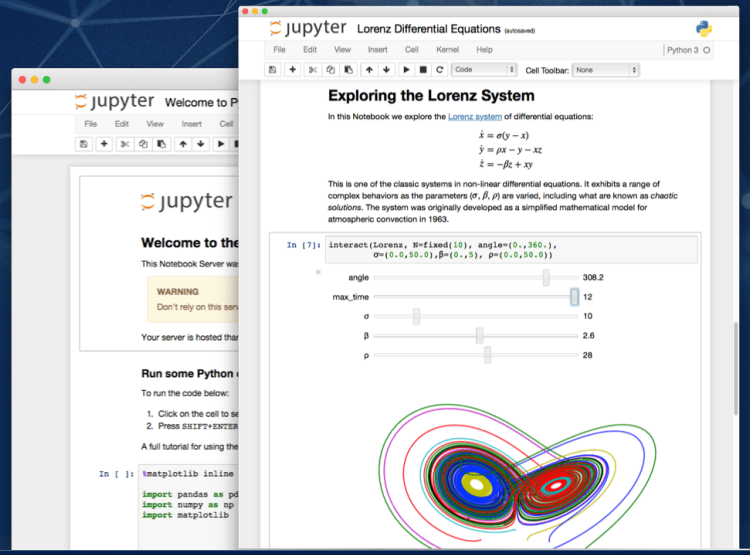
7. Stop the environment when you are done

8. You can also access all your active environments





Overview Jupyter notebook



EPFL

What is a Jupyter notebook?

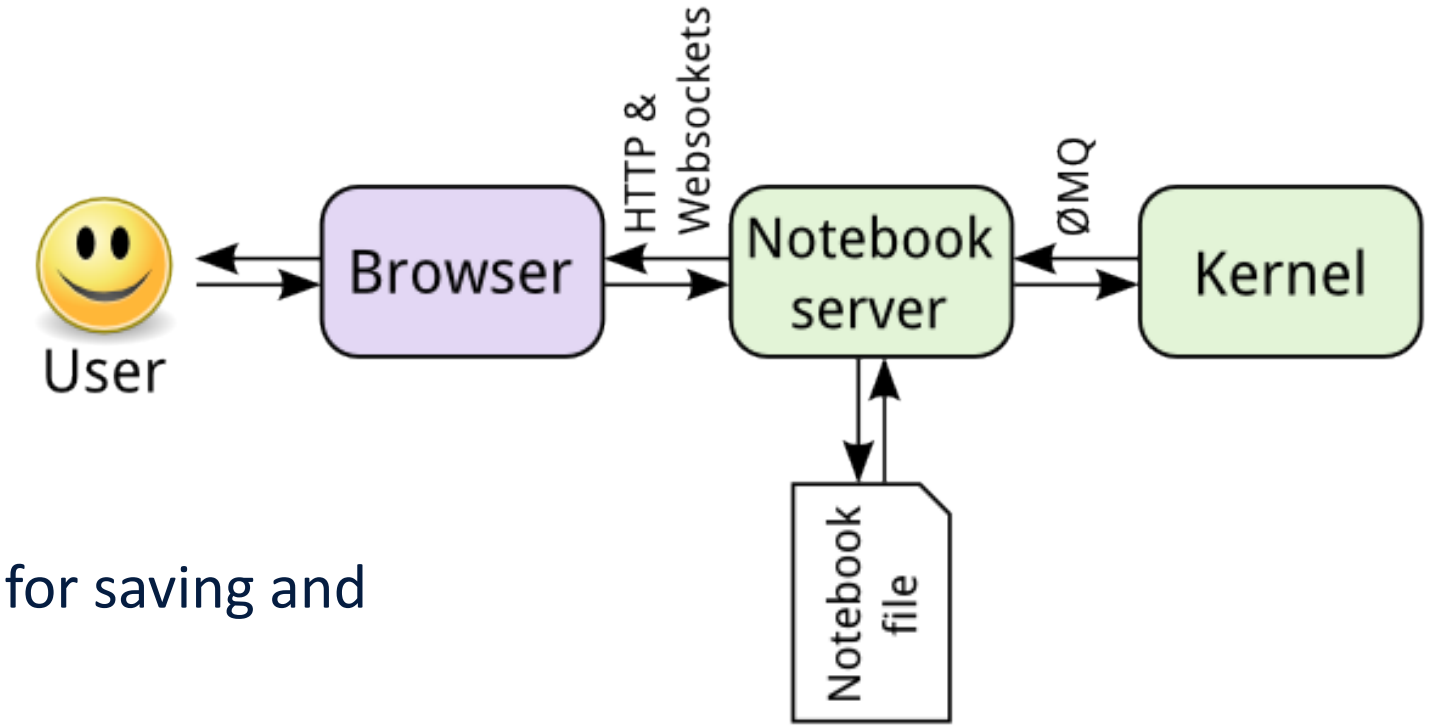
- Open source web application
- Development started in 2014 as spin-off from IPython

- Notebooks denotes documents that contain both
  - Code, and rich text elements (figures, links, equations, etc)

- Notebook documents produced by the Jupyter Notebook App
  - Client-server application to edit and run notebooks
  - Two main components: the kernels and a dashboard

- Jupyter is a loose acronym meaning Julia, Python and R
- Nowadays, Jupyter supports many other languages

Jupyter is language-agnostic



- The **notebook server** is responsible for saving and loading notebooks
- The notebook is saved as a JSON file
- The **kernel** gets sent cells of code to execute

Crash-course in Python 3.x

Spring 2020 - **week #1**

EPFL

Brief history of Python

- Open source programming language
- Conceived in the Netherlands by Guido van Rossum
- Implementation started in December 1989

- *Python 2.x is legacy, Python 3.x is the present & future of the language*
- Python 2.0 released on October 16, 2000 (current: 2.7.15)
- Python 3.0 released on December 3, 2008 (current: 3.7.3)

- High-level, portable, interpreted, object-oriented

Why Python?

- Easy, Fast & Broad
- Python Has a Healthy, Active and Supportive Community
  - Plenty of documentation, guides, tutorials and more
  - Incredibly active developer community
- Python Has Some Great Corporate Sponsors
  - Google!
- Python has Extensive Libraries

Python 3.x references

- https://docs.python.org/3.7/tutorial/
- Books include:
  - Learning Python by Mark Lutz
  - Python Essential Reference by David Beazley
  - Python for Data Analysis by William McKinney
  - https://github.com/justmarkham/DAT8#python-resources
- Python Quick Reference
  - https://github.com/justmarkham/python-reference

Common pitfalls in Python

1. Incorrect indentation, tabs and spaces
   - Never use tabs, only spaces (4)
2. Using a mutable value as a default value
   - ```
     def foo(param=[]):
         param.append(10)
         return(param)
     ```
3. Scoping (local vs global variable)
   - ```
     bar = 42
     def foo():
         print(bar)
         bar = 0
     foo()
     ```
4. Copying vs referencing (mutable types)
   - ```
     a    = [1, 2 ,3]
     b    = a
     a[1] = 4

     print(b)
     ```
     ```

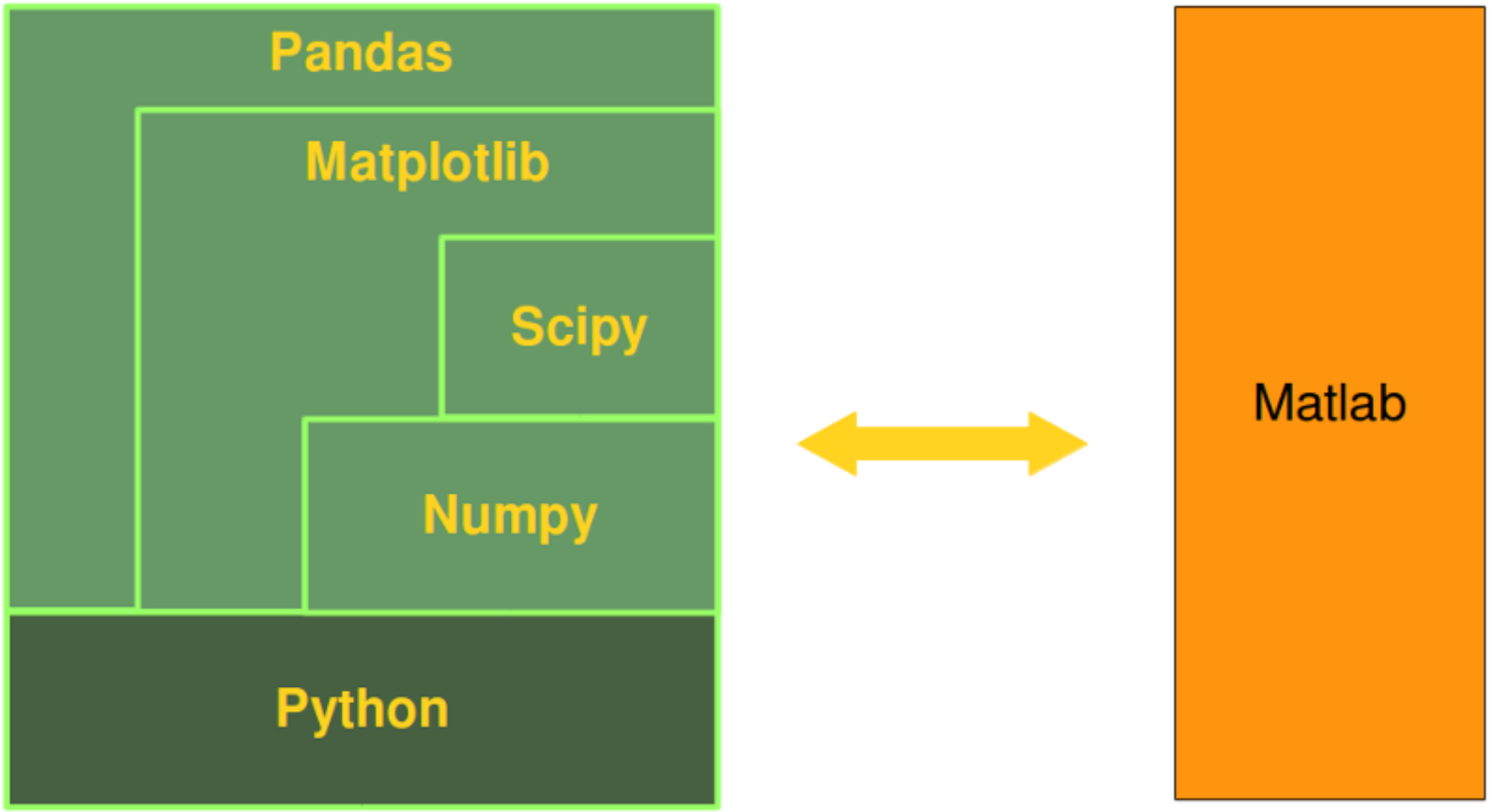
A few exercises in Python

- Open the **DSLab Week 1-1** Jupyter notebook
  ./notebooks/DSLab_week1_1.ipynb

1. Generators
2. List comprehension
3. Lambda Operator and the functions map() and reduce()
4. Lists of characters and the functions join() and append()

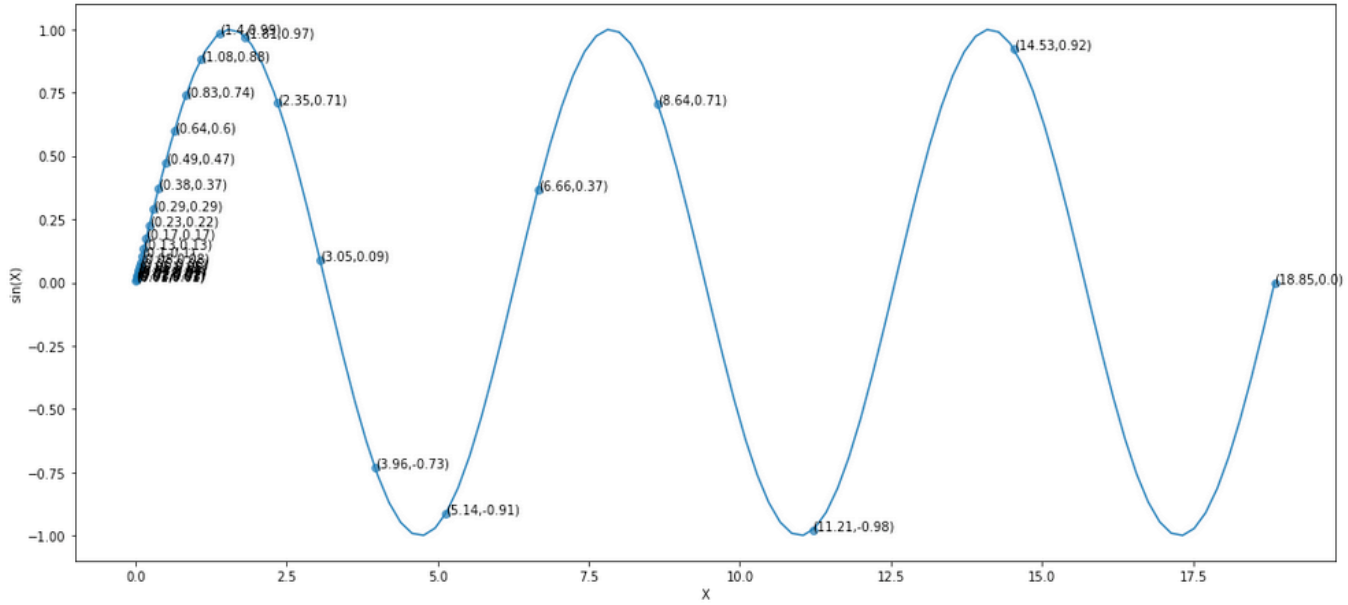
NumPy, Pandas, scikit-learn & Matplotlib

Python alternative to Matlab



Python libraries for (aspiring) data scientists

- **NumPy**: Work with large multidimensional arrays and matrices
- **Pandas**: Do data wrangling
- **Matplotlib**: Make line graphs, pie charts, histograms, etc
- **Scikit-learn**: Build machine learning models



NumPy & Data Types

- Core library for scientific computing in Python
- Provides a high-performance multidimensional array object, and tools for working with these arrays
- A **NumPy array** (ndarray) is a grid of values, all of the same type
  - indexed by a tuple of nonnegative integers
  - the *shape* of an array is the size of the array along each dimension

```
1 import numpy as np
2 a = np.array([[1,2,3], [4,5,6]])
3 print("Shape of matrix a: ", a.shape)
4 print("Value of a[0,2]:", a[0,2])
```

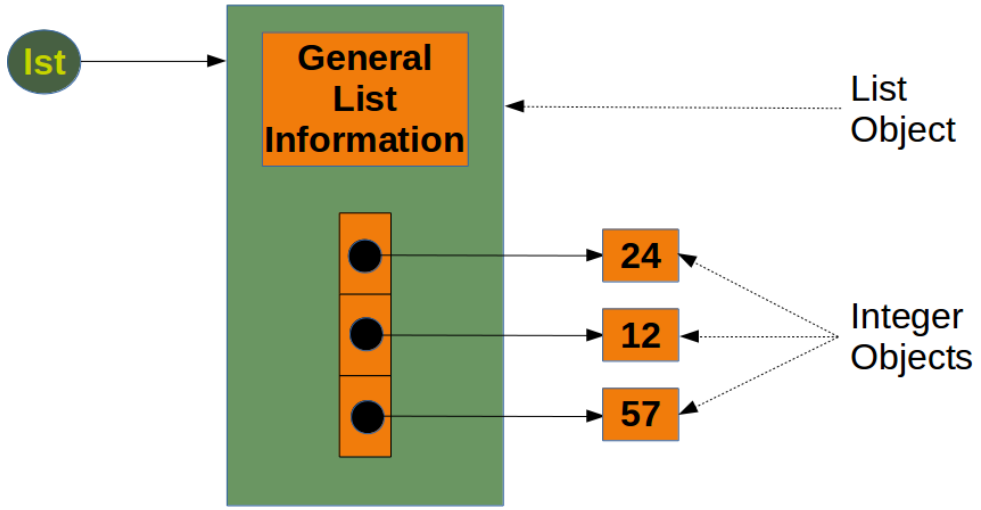
```
Shape of matrix a:  (2, 3)
Value of a[0,2]: 3
```

Python lists vs NumPy arrays

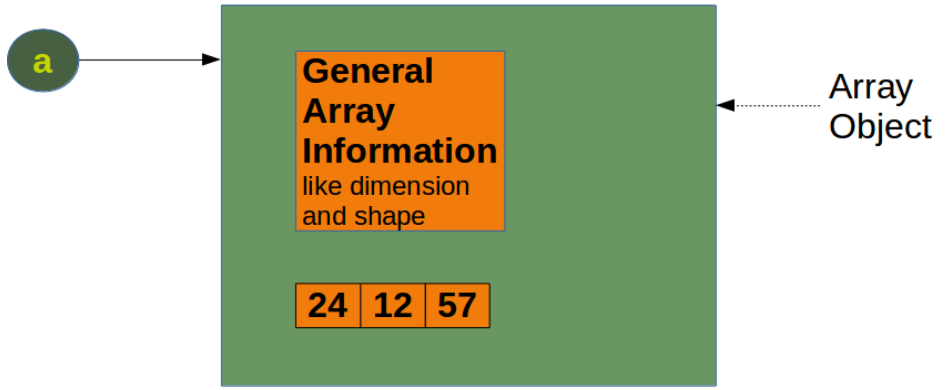
1. **Functionality**: SciPy and NumPy have optimized functions such as linear algebra operations built in
2. **Performance**: need for speed and are faster than lists

3. **Size**: Numpy data structures take up less space
   a. list: 64 + n*8 + n*28 bytes
   b. ndarray: 96 + n*8 bytes

a.



b.



Relevant NumPy functions

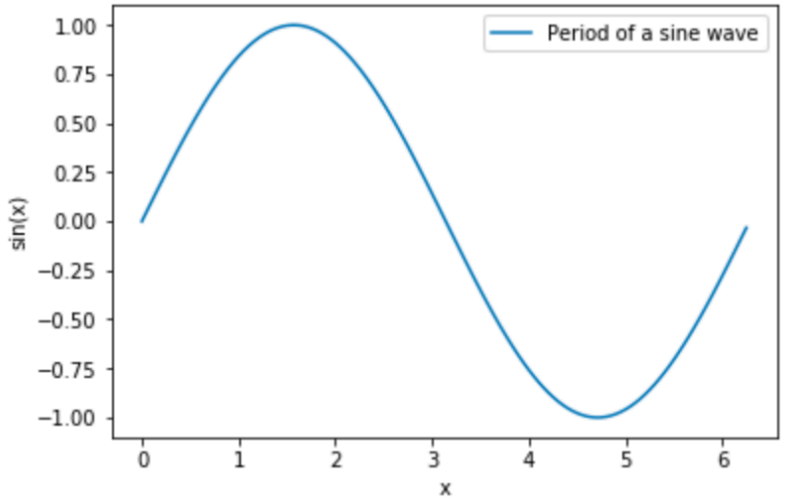
- **arange**([start,] stop[, step], [, dtype=None])
- **linspace**(start, stop, num=50, endpoint=True, retstep=False)
  - Checkout logspace & geomspace
- **reshape**(array, newshape, order='C')
- **copy**(obj, order='K')

+ Indexing and slicing arrays

What is Matplotlib?

- Plotting library

```
1  import numpy as np
2  from matplotlib import pyplot as plt
3
4  %matplotlib inline
5
6  x = np.arange(0, 2*np.pi, 0.05, np.float32)
7  y = np.sin(x)
8
9  plt.plot(x,y)
10
11 plt.xlabel("x")
12 plt.ylabel("sin(x)")
13 plt.legend(['Period of a sine wave'])
14 plt.show()
15
```



Relevant Matplotlib functions

- **Functions**: plot, subplot, scatter and annotate

- %matplotlib {inline, notebook}
- matplotlib.get_backend()

Other visualization libraries

1. **Seaborn**: Python's Statistical Data Visualization Library
   - high-level interface to draw statistical graphics
   - https://seaborn.pydata.org/

2. **Bokeh**: Python interactive visualization library
   - interactive plots, dashboards, and data applications
   - https://bokeh.pydata.org/en/latest/

Pandas & Pandas Data Frames

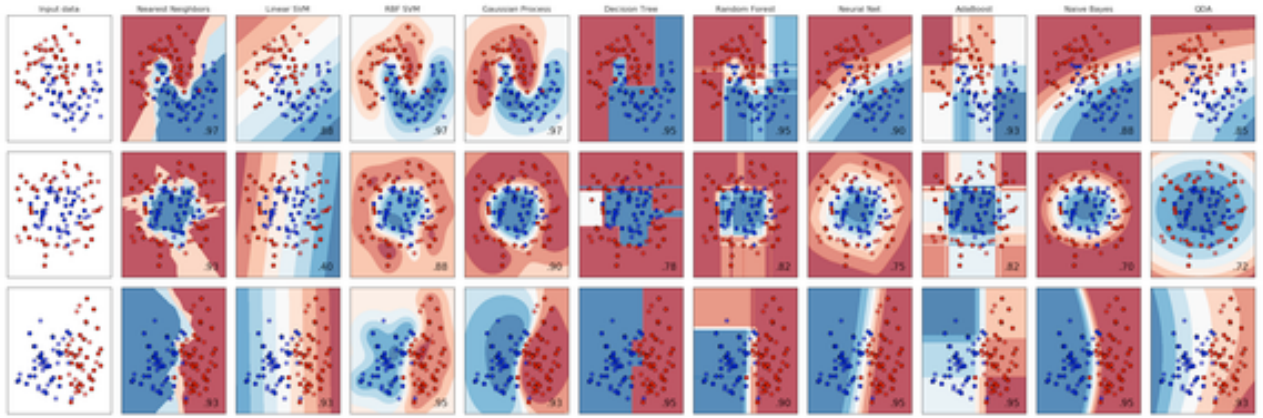
- Powerful & flexible data munging library
- Pandas was built on NumPy
  - NumPy stores your data in arrays
  - Pandas takes the NumPy Array…

    … and gives you a labeled index to it
- Pandas DataFrame is a 2-D labeled data structure with columns of potentially different types
  - Basically, dictionary-based NumPy arrays
- Recommended reading (before doing the exercises)
  - https://chrisalbon.com/python/data_wrangling/pandas_apply_operations_to_groups/

Scikit-learn: Machine Learning in Python

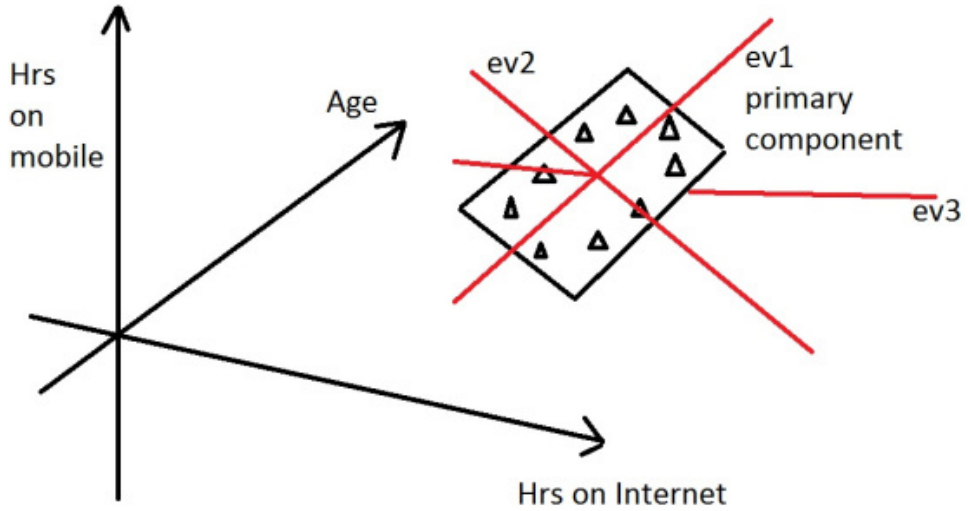
- http://scikit-learn.org/stable/index.html
- Open source, built on NumPy, SciPy, and matplotlib

1. Classification
2. Regression (Logistic Regression)
3. Clustering (KMeans)
4. Dimensionality reduction (PCA)
5. Model selection
6. Preprocessing



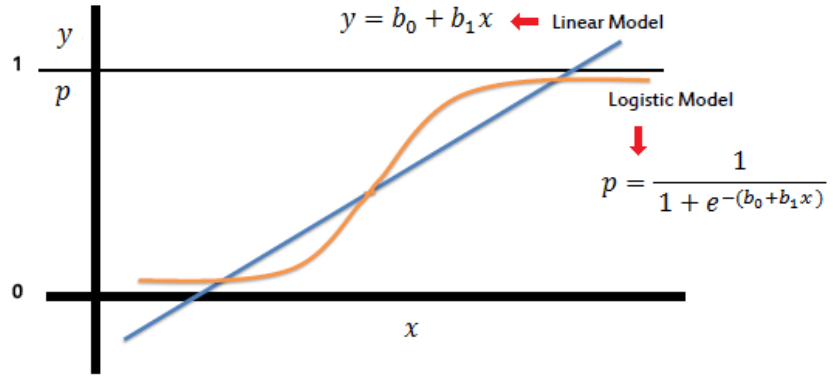
Principal Component Analysis (PCA)

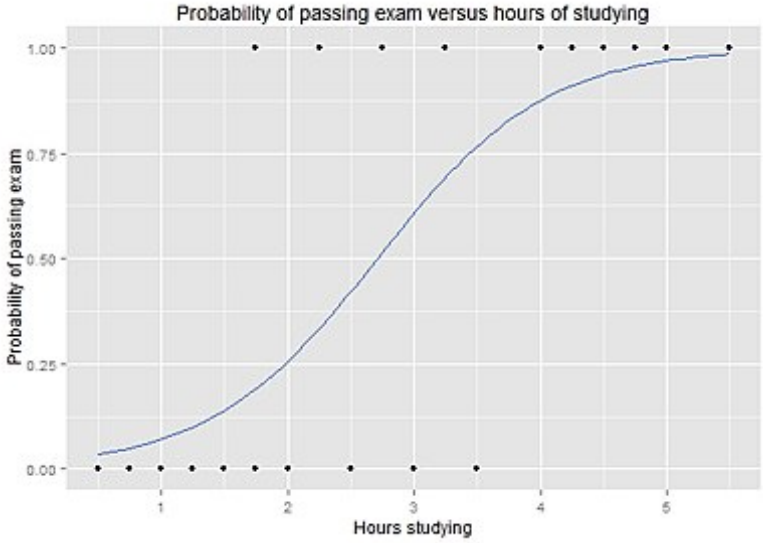
- sklearn.decomposition.PCA()
- (Linear) dimensionality reduction using SVD of the data to project it to a lower dimensional space
- Maximize the variance in the low-dimensional representation
- Take e.g. th
  - Example



Logistic Regression

- sklearn.linear_model.LogisticRegression()
- Model used for prediction of the probability of occurrence of an event by fitting data to a logistic curve
- Standard industry workhorse!

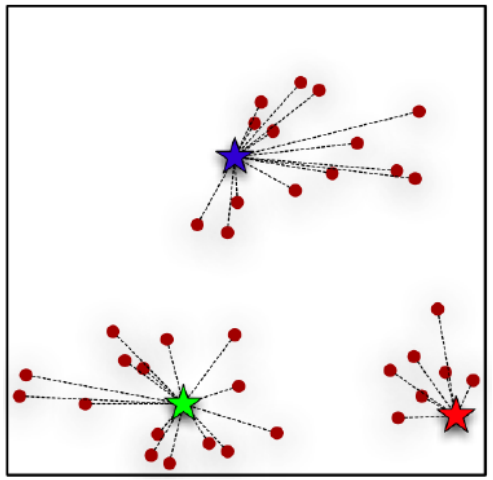


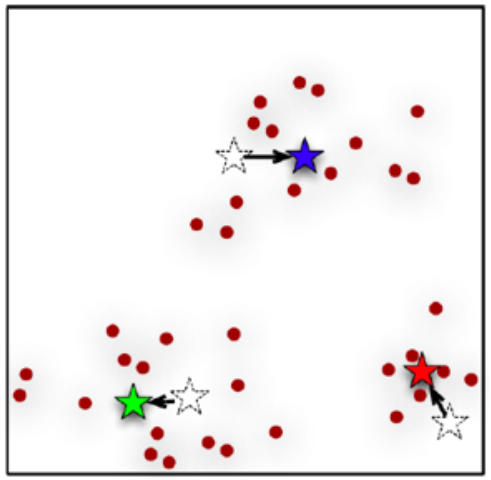


- Chaining a PCA and a logistic regression

Kmeans – Clustering algorithm

- sklearn.cluster.KMeans()
- Find similarity groups in a data, called clusters
- Randomize K points, then two-step iterative algorithm:
  - 1. Cluster assignment step
  - 2. Move centroid step.





Exercises … a bit harder/longer

Open **DSLab Week 1** Jupyter notebooks in Renku

1. ./notebooks/DSLab_week1-2.ipynb
   a. NumPy arrays & Matplotlib
2. ./notebooks/DSLab_week1-3.ipynb
   a. Getting familiar with Pandas
   b. Simple Machine Learning problems

Thank you!