

Image Processing in Physics

Tutorials, part 0: Introduction

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Homework

Exercises:

- New homework is uploaded to Moodle on Monday: Download the files and complete the code!
- Do homework until the following Sunday evening
- Upload homework in Moodle
- Exercises will be very important in the exam!

Tutorials:

- Mondays: solution of old exercise + explanation video uploaded to Moodle
- Live Sessions:

Wednesday 11:00 : Live session where we answer your questions about exercises & programming via Zoom



<https://www.python.org/>

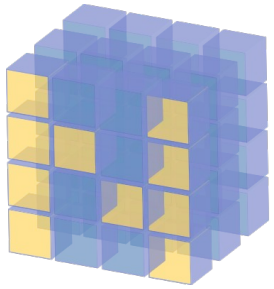
High-level programming language for general-purpose programming

- Easily **readable** code (<https://www.python.org/dev/peps/pep-0008/>)
- **Fewer lines of code** required than in C++ or Java
- Comprehensive standard library (**lots of “built-in” functions**)
- **External libraries** are available for almost anything
- Interpreted language → **no compiling**
- Dynamic type system and automatic memory management
- Supports object-oriented or functional programming

Documentation: <http://docs.python.org>

Moodle: Python intro part1.pdf





NumPy

<http://www.numpy.org/>

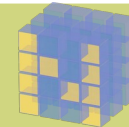
NumPy is **the fundamental package for scientific computing** with Python.

It contains among other things:

- A powerful **N-dimensional array** object
- Sophisticated (broadcasting) functions
- Tools for integrating C/C++ and Fortran code → **fast calculations**
- Useful linear algebra, Fourier transform, and random number capabilities

Documentation: <https://docs.scipy.org/doc/numpy/>

Moodle: Python intro part2.pdf



NumPy



pythonTM



<https://www.scipy.org/>

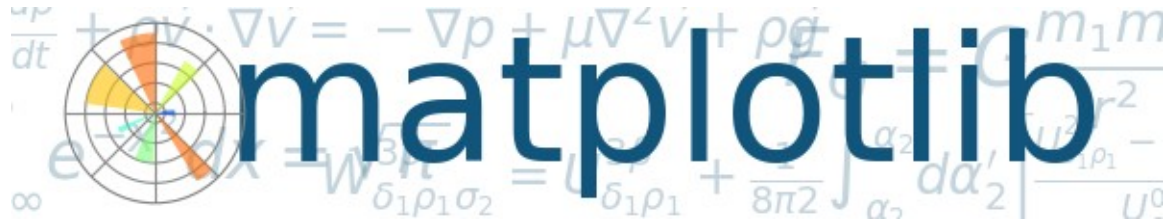
Python library for scientific and technical computing

- Built on the NumPy array object
- Modules for optimization, linear algebra, integration, interpolation, special functions, FFT, signal, image processing, ODE solvers

Documentation: <https://docs.scipy.org/doc/scipy/reference/>

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<https://matplotlib.org/>

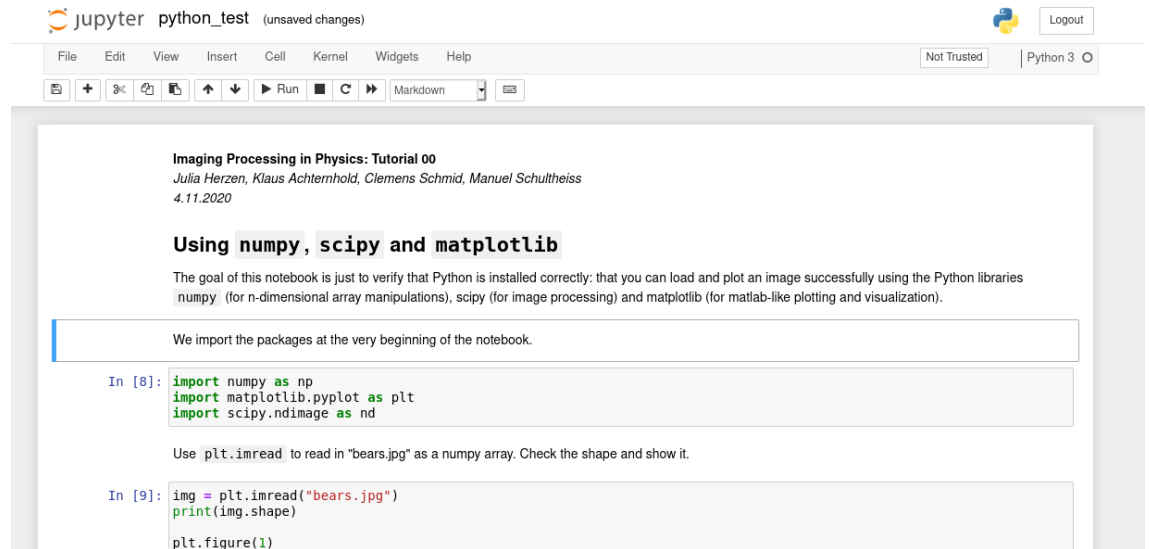
Plotting library for Python and NumPy

- Plotting of 1D data (**graphs**) and 2D data (**images**)
- Highly customizable (line styles, colors, fonts, sub-figures, etc.)
- **Two usage modes**: similar to MATLAB (easy), and object-oriented (more structured)

Documentation: <https://matplotlib.org/contents.html>

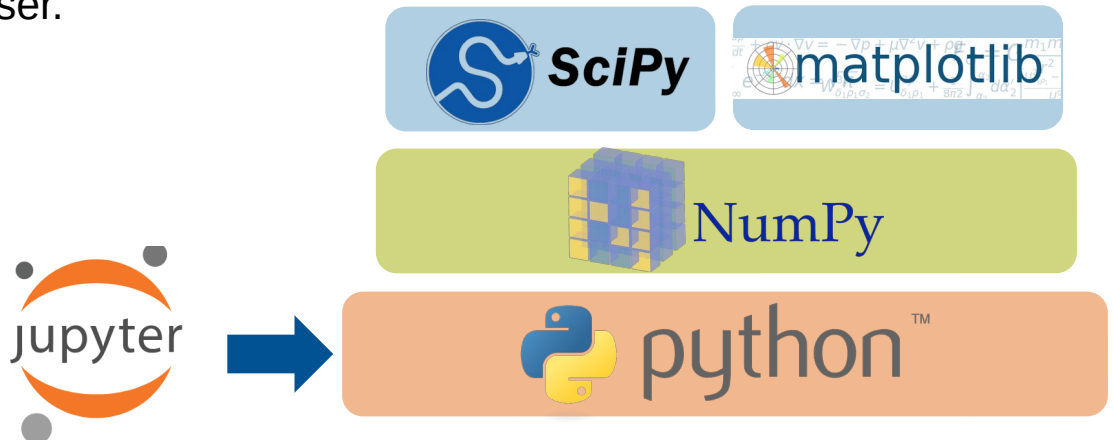
Moodle: Python intro part2.pdf





Interactive Python shell with lots of features

- Enter code line by line, use Python e.g. like a **calculator**
- Syntax highlighting, pasting of blocks of code, profiling, etc.
- Use Python interactively in browser.



Installing Python and the external libraries

Linux:

Ubuntu / Debian: use **apt** from the command line:

```
sudo apt install python  
python3-numpy  
python3-scipy  
python3-matplotlib  
python3-imaging  
python3-ipython  
sudo apt install python3-pip  
pip3 install jupyter
```

Fedora Linux: Replace apt with dnf in the above commands

Windows

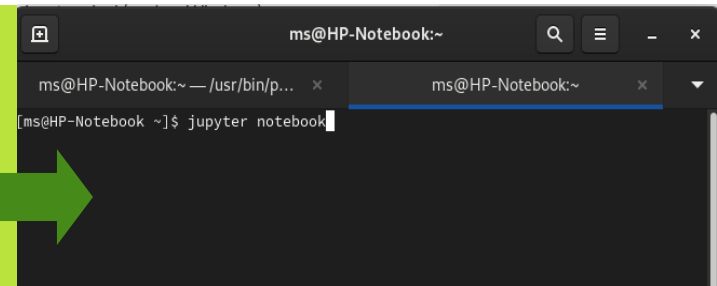
Anaconda (<https://www.anaconda.com/products/individual>)

Make sure to get the **Python 3.8** version

<https://docs.anaconda.com/ae-notebooks/user-guide/basic-tasks/apps/jupyter/>

Mac OS

To start jupyter notebook enter
“jupyter notebook” in a command line



Using Jupyter

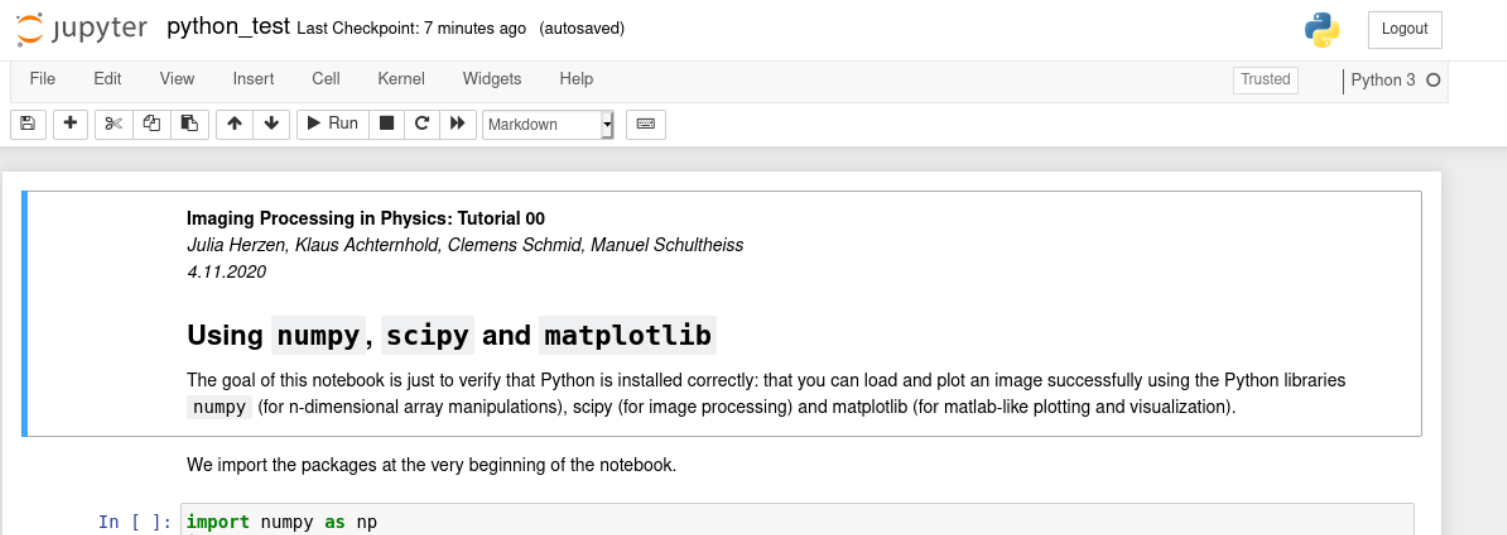
This should open a filemanager in a webbrowser:



The Jupyter File Manager interface shows a breadcrumb path: / Lehre / Exercise 1 / exercise_00_python_test. Below the path is a table of files and folders. The table has columns for Name, Last Modified, and File size. The files listed are: .. (seconds ago), python_test.ipynb (Running, 5 minutes ago, 2.94 kB), and bears.jpg (7 months ago, 23.2 kB). There are buttons for Upload, New, and a refresh icon at the top right.

	Name ↓	Last Modified	File size
<input type="checkbox"/>	..	seconds ago	
<input type="checkbox"/>	python_test.ipynb	Running 5 minutes ago	2.94 kB
<input type="checkbox"/>	bears.jpg	7 months ago	23.2 kB

Click on a notebook to open it:



The Jupyter Notebook interface shows the notebook titled 'python_test' with a last checkpoint 7 minutes ago. The notebook content includes a title 'Imaging Processing in Physics: Tutorial 00', authors 'Julia Herzen, Klaus Achternhold, Clemens Schmid, Manuel Schultheiss', and a date '4.11.2020'. The main heading is 'Using numpy, scipy and matplotlib'. The text describes the goal of the notebook: to verify that Python is installed correctly by loading and plotting an image using numpy, scipy, and matplotlib. The first code cell is partially visible, showing 'In []: import numpy as np'.

Imaging Processing in Physics: Tutorial 00

Julia Herzen, Klaus Achternhold, Clemens Schmid, Manuel Schultheiss
4.11.2020

Using numpy, scipy and matplotlib

The goal of this notebook is just to verify that Python is installed correctly: that you can load and plot an image successfully using the Python libraries numpy (for n-dimensional array manipulations), scipy (for image processing) and matplotlib (for matlab-like plotting and visualization).

We import the packages at the very beginning of the notebook.

```
In [ ]: import numpy as np
```

If you have questions,

- ask in the forum in Moodle
- or ask me live on Wednesday @ 11:00

See you Wednesday @ 11:00!
(will be announced in Moodle)