

Exercise Sheet 1

Submission by Friday 24th 17:00 via Moodle.

Corrections due by Tuesday 28th 17:00 via Moodle.

Format for questions 2 and 3: individual Jupyter notebooks .ipynb.

1 Getting started (not marked)

The aim of this exercise is to get yourself set up with an environment that allows you to run certain packages which are essential to perform future exercises. Please ensure that you have the following packages installed.

1. python3
2. Packages: `numpy`, `matplotlib`, `scikit-learn`, `jupyter notebooks`
3. `Tensorflow`
4. ★¹ If you have a CUDA-capable GPU available, install and check the tensorflow GPU version.

To check your results, please execute the Jupyter notebook `getting_started.ipynb`.

2 Visualising data (peer correction)

This exercise shall familiarise yourself with `matplotlib`², an excellent library to visualise data. Ability to visualise your results efficiently is key in data science and data analysis.

1. Plot $f(x) = x^2$ for the interval $(-5, 5)$.
2. Generate a dataset of 100 points drawn at random from a 2D Gaussian with mean $(1, 0.5)$ and standard deviation $(0.4, 0.4)$.
3. Now, highlight the mean and $1\text{-}\sigma$ contour lines in a plot with your data points.

3 Linear regression (peer correction)

Here we familiarise ourselves with linear regression of simple polynomial models in python.

1. Take the function $f(x) = 7.2 - 3.1x + 4.3x^3$. For 100 equally spaced bins in the interval $(-5, 8)$ add a Gaussian noise (independent in each bin) with respective means 0 and standard deviation $\sigma = 150$ to the data points.
2. Now fit polynomials of degree 1, 2, 3, 5, 10 to the entire dataset, using linear regression with ordinary least squares.
3. Repeat the same fitting but with reduced data sets. Visualise your findings and describe the differences? How do they depend on the interval you pick the data from?
4. ★ Take a cubic polynomial but now in terms of a complex variable and complex coefficients. Repeat steps a) and b) with the modified function. Output your respective best-fit polynomial.

¹Exercises with a ★ are not required to be completed and might be more challenging.

²Note that `matplotlib` among other python based packages which we will use in this course have been vital to produce the images released from the EHT collaboration.