Programming and Visualisation

This exercise sheet is to familiarize yourself with the programming and visualization. Recommended options are Python, R, Julia or MATLAB. For more details, see the programming resources on ISIS.

Exercise 0.6: Scatter and Line Plots (3 points)

(a) Read the data in the file `expDat.txt` (available on ISIS). Each row contains the number of events (of 20 observed processes) counted in one of 100 subsequent time intervals. The first column contains the respective time index. Each other column corresponds to one of 20 different observed processes.

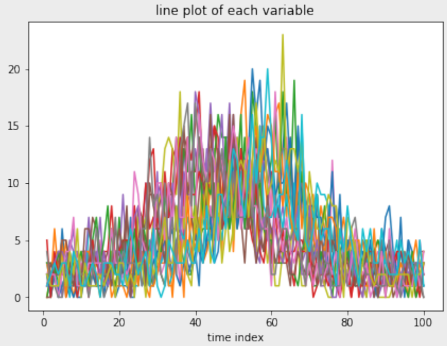
(b) Create a line plot – one line for each column where the x-axis represents the index of time intervals.

(c) Create a scatter plot “grid" for the first 5 columns (i.e. 25 pairwise scatter plots).

(d) Compute the covariance matrix by centering & matrix multiplication – without looping over the data. Plot this matrix with a heatplot and compare it to the result when using inbuilt functions such as `cov` or `cor`.

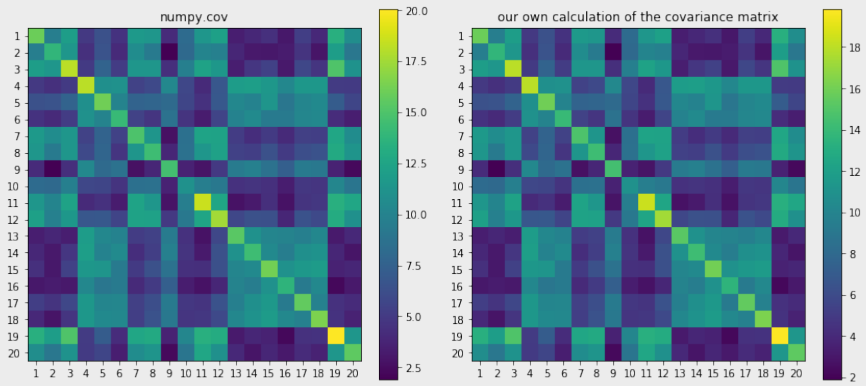
Solution

(b)



(c)

(d)



Exercise 0.7: Plotting 3d (3 points)

(a) Read the data contained in the file `pca-data-3d.txt`.

(b) Make a scatter plot matrix for all the columns.

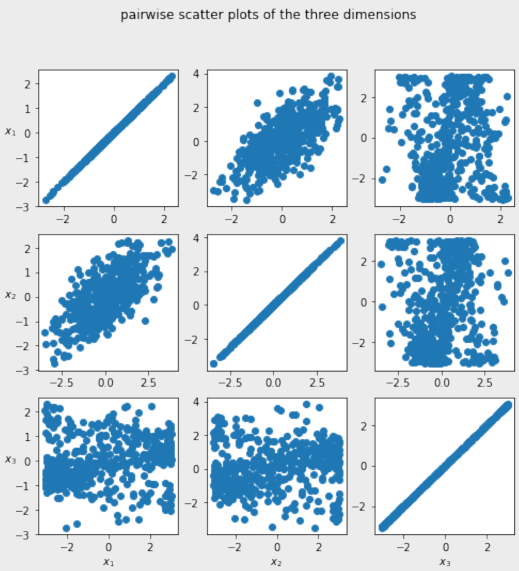
(c) Visualize the data in 3d. How do you interpret your results?

(d) Pick the first two dimensions and plot the data in a scatter plot.

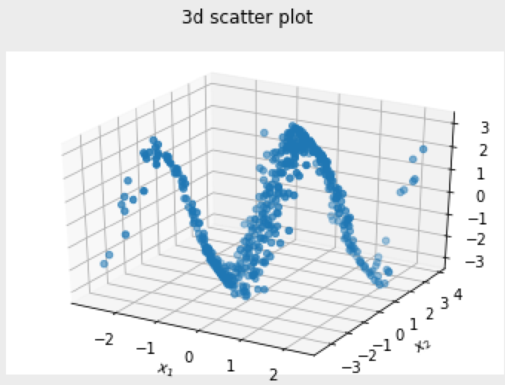
(e) Project the 2d data onto the unit vectors with angles 0, 15, ..., 180 degrees from the x-axis and compute the variance along these directions. Plot variance against the angle.

<u>Solution</u>

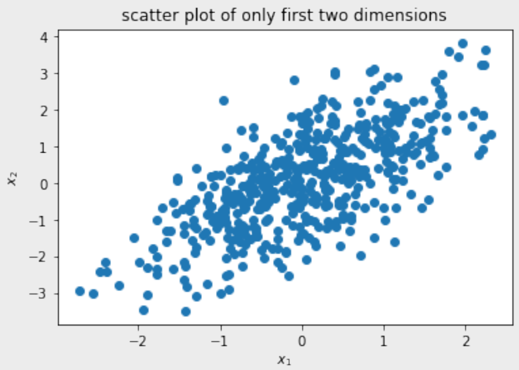
(b)



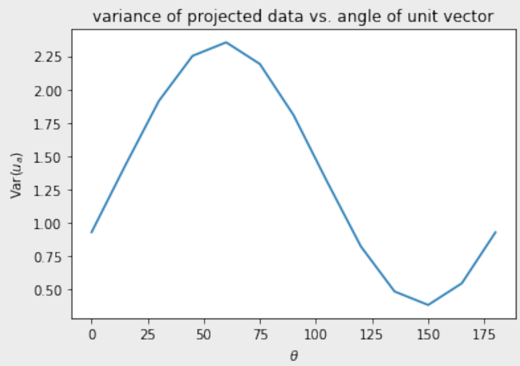
(c)



(d)



(e)



Exercise 0.8: Data Processing: Image data (2 points)

(a) Read in the data from the file `natIMG.jpg`.

(b) Plot the data using a heatmap with a 'color' scale ranging from black (minimal value of all image pixels) to white (maximal occuring pixel value).

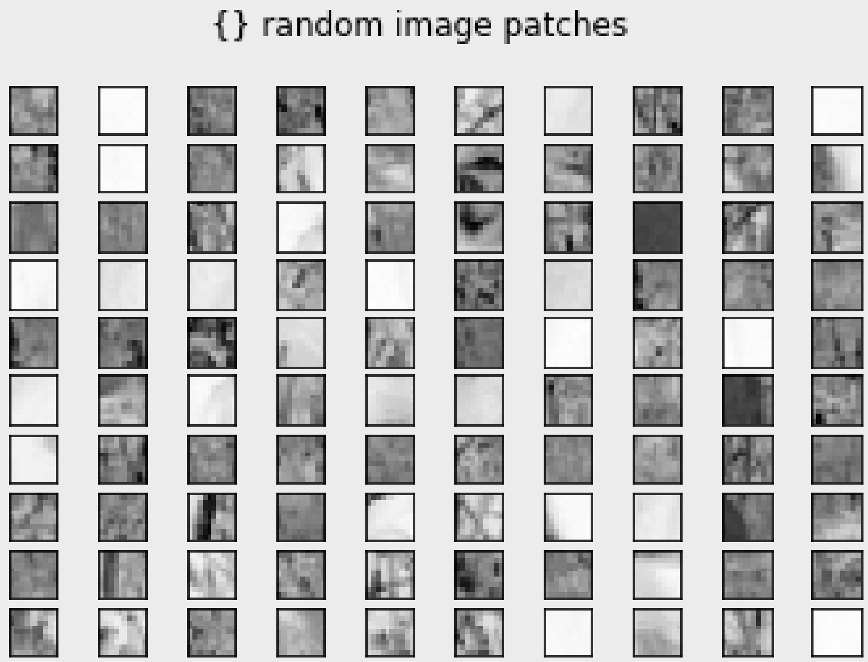
(c) Sample 100 image patches, each of size 10×10 pixels.

(d) Plot these patches using the same color scheme as above.

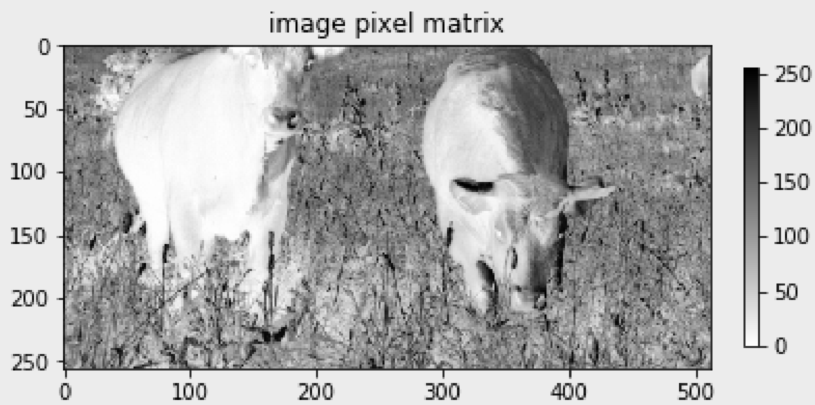
(e) Plot these patches using the inverted color scheme (white for lowest and black for highest pixel value).

<u>Solution</u>

(d)



(e)



Exercise 0.9: The Gaussian function (2 points)

Let the Gaussian function be defined as

$$h(\underline{\mathbf{x}}) := \exp\left(- \frac{\|\underline{\mathbf{x}} - \underline{\mu}\|_2^2}{2\,\underline{\mathbf{I}}_N \sigma^2} \right)$$

where

$\underline{\mathbf{x}}, \underline{\mu} \in \mathbb{R}^N$, $\sigma > 0$

and $\underline{\mathbf{I}}_N$ is the identity matrix with shape $N \times N$.

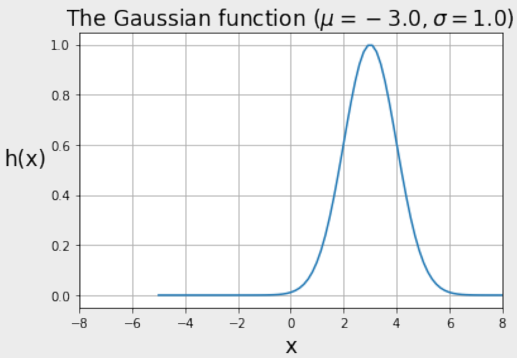
Evaluate and plot the Gaussian function using for

(a) the case of $N = 1$ and $x \in [-8, 8)$, $\mu = -3$ and $\sigma = 1$ using a simple line plot.

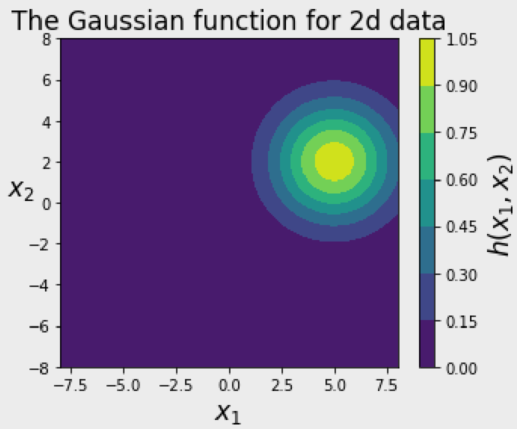
(b) the case of $N = 2$ and $x_i \in [-8, 8)$ for $i = 1, 2$, $\underline{\mu} = (5, 2)^\top$ and $\sigma = 0.25$ using a contour plot (e.g. `matplotlib.pyplot.contourf`).

Solution

(a)



(b)



Total 10 points.