Exercise 1

You will learn some basic Matlab-functions in this exercise.

(1P) Subtask 1.1
Write a Matlab-function that can display two images at the same time.¹

(2P) Subtask 1.2
Reimplement the following MatLab-function:

```matlab
function [M] = randmat(n,m, p)
```

The function should generate a random matrix \( M \in \{1;0\}^{n \times m} \) with \( n,m \in \mathbb{N} \). \( p \in [0;1] \) is the probability how often a 1 occur in \( M \). If \( p = 1 \) then all the elements in \( M \) are 1 and vice versa all elements are 0 for \( p = 0 \).

(2P) Subtask 1.3
Implement a filter that manipulates the pixels of a gray-scale image in the following way:

\[
\begin{align*}
tmp(x,y) &= \begin{cases} 
255 & S(x,y) == 1 \\
img(x,y) & \text{else}
\end{cases} \\
out(x,y) &= \begin{cases} 
0 & P(x,y) == 1 \\
tmp(x,y) & \text{else}
\end{cases}
\end{align*}
\]

(1)

(2)

\( S \) and \( P \) are random matrices with parameters \( s \) and \( p \) that you can produce with the function of subtask 1.2. Could you imagine where to use this filter?

¹Have a look in the matlab-help: “imread(‘filename’);”, “imshow(image)”, “subplot”.

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Write a Matlab-script, that verifies your implementation. Make some experiments with different sets of parameters $s$, $p$. You find two images on our webpage.

**Exercise 2**

This Exercise is about speaker localisation. Using the *Generalized Cross Correlation* method we can estimate the time delay of arrival (TDOA) $\tau_{ij}$ between two microphones $i$ and $j$

$$\phi_{x_i,x_j}(\tau_{ij}) = \sum_{k=0}^{L-1} \frac{X_i(k)X_j(k)^*}{|X_i(k)||X_j(k)|} \exp(j2\pi k\tau/L) \quad (3)$$

where $X_i$ is the spectrum of the signal $x$ at the microphone $i$ and $L$ is the fft size. Based on Eq.(3) the time delay of arrival can be obtained as follows

$$\hat{\tau}_{ij} = \arg \max_{\phi_{x_i,x_j}(\tau_{ij})} \quad (4)$$

On the homepage you can find a paper about this approach. Implement in Matlab a function

```matlab
function tau_{ij} = getGCC(sig_i, sig_j)
```

which computes the TDOA between two microphones using Eq.(3) and Eq.(4).

Implement a test script, that provides the TDOA’s for all possible microphone pairs of a multi-channel signal based on the method `getGCC`. For testing you can download the 8-channel audio signal from the homepage.

Make a good documentaion about your experiments and evaluate your results. Try to estimate - if possible - the speaker direction.

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2*Microdisplacement: 2cm; Matlab-function to readin audio-signals: “auread()”

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