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Summer Term 2022

Pattern Matching and Machine Learning for Audio Signal Processing
Exercise sheet 1

To be uploaded in eCampus till: 15-04-2022 22:00 (strict deadline)

The solutions of the exercises have to be handed in via eCampus (you have to upload them) till the date and time reported on top of each exercise sheet. Please note that the deadline is strict: solutions handed in later will be rejected by the system and cannot be considered.
Programming tasks must be solved in Matlab or Python. Please note that, for simplicity, on this and on the following exercise sheets we will usually only refer to 'Matlab', although equivalent solutions in Python will be accepted.
The University of Bonn offers a campus license for Matlab, so that you do not have to buy it. For more information please look at the following link:
`https://www.hrz.uni-bonn.de/en/services/software-hardware/computer_apps/math.anwendungen/matlab?set_language=en` .
If you have some problems or questions you can contact us at:
alessia.cornaggia-urrigshardt@t-online.de.

Exercise 1.1

[$2+2+2+2=8$ points]

(a) Calculate (without using a calculator) the polar coordinates representation of the following complex number:
$z = \left(\frac{\sqrt{2}}{2} + i\frac{\sqrt{2}}{2}\right)^3$.

(b) Write down the following complex number in Cartesian coordinates:
$z = \frac{e^{\frac{5\pi}{3}i}}{e^{\frac{4}{3}\pi i} \cdot 2e^{\frac{11\pi}{6}i}}$.

(c) Calculate explicitly
$\mathrm{Re}\left[5e^{\frac{\pi}{4}i} + \sqrt{2}e^{\pi i}\right]$, where $\mathrm{Re}[z]$ indicates the real part of a complex number z.

(d) Using the Euler formula, prove the following statement:
$\sin(z)^2 + \cos(z)^2 = 1, \qquad z \in \mathbb{C}$.

Exercise 1.2

$[2 + 2 + 2 + 1 = 7$ points$]$

In this exercise you will have to solve small programming tasks. When sending your solutions for a programming task, you do not have to copy the code on the solutions sheet, but you have to provide an .m file or a jupyter notebook file.
Please note that you have to adhere to the following rules:

- For each programming task you have to hand in an .m file which has the same name as the task (for example Sheet1Exercise2.m).
- The .m files you send have to be executable. In the code you also have to give an example of how to call your functions to get the desired result and explain each input/output.

(a) Create a 5 seconds long discrete sine wave of frequency 1000 Hz.The sampling rate is 44100 Hz.

(b) In the introductory slides you have seen that you can illustrate a signal using a time-frequency representation, the windowed Fourier Transform. This can be done in Matlab using the command `spectrogram` (type in Matlab `help spectrogram` to have more information). Plot the spectrogram of the signal you created in (a).

(c) Repeat (a) and (b) with a cosine wave of frequency 1000 Hz. Compare the two spectrograms. What can you see?

(d) Save the signal you created in (a) in a .wav file.