Exercise 1

You will implement some basic parts of JPEG-Coding in this exercise. On our website is an image that you can use.

(2P) Subtask 1.1
Implement the function `colortrans`, that transforms a given RGB-image to a YCbCr-image and vice versa.

\[
\begin{bmatrix}
Y \\
Cb \\
Cr
\end{bmatrix}
= \begin{bmatrix}
0 & 128 & 128 \\
0, 299 & -0, 168736 & -0, 331264 & 0, 5 \\
0, 5 & -0, 418688 & -0, 081312 & 0
\end{bmatrix}
\begin{bmatrix}
R \\
G \\
B
\end{bmatrix}
\]

(2P) Subtask 1.2
Implement a function `quanmat` which quantizes a matrix \( M \in \mathbb{R}^{n \times m} \) with the given quantization matrix \( Q \in \mathbb{R}^{n \times m} \).

\[
Q = \begin{bmatrix}
8 & 16 & 19 & 22 & 26 & 27 & 29 & 34 \\
16 & 16 & 22 & 24 & 27 & 29 & 34 & 37 \\
19 & 22 & 26 & 27 & 29 & 34 & 34 & 38 \\
22 & 22 & 26 & 27 & 29 & 34 & 37 & 40 \\
22 & 26 & 27 & 29 & 32 & 35 & 40 & 48 \\
26 & 27 & 29 & 32 & 35 & 40 & 48 & 58 \\
26 & 27 & 29 & 36 & 38 & 46 & 56 & 69 \\
27 & 29 & 35 & 46 & 46 & 56 & 69 & 83 \\
\end{bmatrix}
\]

Hint for subtask 1.3 and 1.4:
It is common to implement the general function `submatproc`. This function splits the given matrix \( I \in \mathbb{R}^{n \times m} \) into submatrices with size \( b \in \mathbb{N}^2 \). Apply the delivered function \( \text{fun} : \mathbb{R}^b \rightarrow \mathbb{R}^b \) to each of the submatrices. Finally, rebuild a matrix \( O \in \mathbb{R}^{n \times m} \) out of all the submatrices.

\[
\text{function } [O] = \text{submatproc}(I,b,\text{fun})
\]

(2P) Subtask 1.3
Compute \( Y' \) out of the brightness control \( Y \) using the JPEG-method. You should use a block-size of \( 8 \times 8 \) Pixel and the quantization of subtask 1.2. Compare \( Y \) and \( Y' \).

How can we use this method for compression? Do we lose quality?

\[
^1\text{You can use “@” to deliver functions as reference; Matlab-Help: “function_handle”}
\]

\[
^2\text{You can use the Matlab functionen dct2 and idct2.}
\]
(2P) Subtask 1.4
Implement a function for downsampling the \( CbCr \)-channels by a factor of \( w \) in vertical and horizontal direction. Show the influence of \( w \) with the help of images.
How can we use this method for compression? Do we lose quality?

(1P) Subtask 1.5
Rebuild a \( RGB \)-image out of all the preceding results. Compare this image with the original one.

(3P) Exercise 2
A cyclic correlation can be easily computed via a discret Fourier transform. Proof by hand that:
\[
corr(x, y) = \text{DFT}^{-1}(\text{DFT}(x) \cdot \text{DFT}^*(y))
\] (3)

Script 3
For this lecture is a german script available. A small groupe have a look on it. You can join this group and contribute articles, error corrections or figures.
Chapter “1.1.4” is about image-compression and it describe the JPEG-Method briefly. A lot of figures and formulas are missing.
If you have a good mind to take active part in writing a script, then feel free and send an email to Your tutor.