Arab Academy for Science, Technology and Maritime Transport
College of Artificial Intelligence

Lecturer: Dr. Mohamed Waleed Fakhr
Course: Digital Image Processing & Pattern Recognition (IN322) *Total marks: 20*
Date: 5th of April 2023 *Time allowed: 80 min.*

Question 1 – Part a:

An Image Run-length-coding step produced the following 5 symbols shown in the table below with their number of occurrences in the image:

Symbol	Number of occurrences
S1: (0,0)	160
S2: (0,1)	20
S3: (1,1)	10
S4: (2,1)	5
S5: (3,1)	5

i. Explain the meaning of the RLC representations (0,1), (3,1) and (0,0).
ii. Design a Huffman code using the given data showing the binary codes for all the 5 possible symbol values.
iii. Find the total number of bits required to store this image using the designed Huffman encoder and the total number of bits required if we are using a fixed-length encoder.

Question 1 - Part b:

i. for the 8-by-8 image below, apply the given Gaussian filter **(after making it proper filter)** on pixel **f(4,4)=200** and find the pixel's new value
ii. What would be the exact filter weight values if it were a Box filter?

70	70	100	70	87	87	150	187
85	100	96	79	87	154	87	113
100	85	116	79	70	87	86	196
136	69	87	200	79	71	117	96
161	70	87	200	103	71	96	113
161	123	147	133	113	113	85	161
146	147	175	100	103	103	163	187
156	146	189	70	113	161	163	197

f(i, j)

0.04	0.065	0.04
0.065	0.1	0.065
0.04	0.065	0.04

Question 1 – part c:

A digital image has **300 rows and 300 columns**, calculate its size in **Bits** for the following cases:

i. The image Y is standard true color.
ii. If the image Y is converted to 128-colors indexed image (include the LUT size)
iii. If the 4:2:0 Chroma sub-sampling is used.

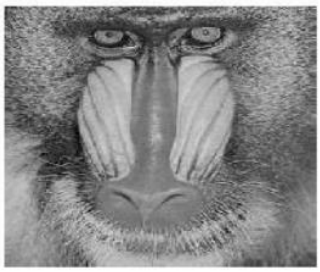
Question 1 – Part d:

Explain how the K-means clustering is used to convert a 300-by-200 true color image to a 128-indexed-color image, showing the K-means algorithm internal steps; how you make sure K-means found a good solution?

Question 2 – part a:

For the figures shown below explain:

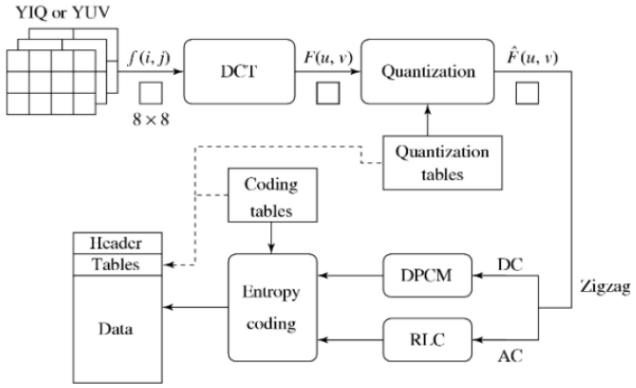
i. What is the domain of each figure shown below and how do we convert from one to another?
ii. What do the x-axis and y-axis represent in each of them?
iii. Why are the bright values in the upper left corner only in the right-hand figure?



Question 2 – part b:

For the JPEG image compression system shown on the right, explain briefly using equations when needed:

i. Explain why the JPEG system works on the YIQ image instead of the RGB.
ii. Explain why the image is divided into 8-by-8 blocks?
iii. Explain why and how the DCT block is used.
iv. Explain the quantization and rounding process and why it is the reason JPEG is lossy?
v. Explain why we use Entropy coding in the JPEG system.



Question 2 – part c:

An image is quantized so that each pixel takes value between (0-3). The table below shows the number of occurrences of the pixels:

Pixel value	Number of occurrences
0	150
1	40
2	10
3	0

i. Compare histogram equalization and contrast stretching in image enhancement.
ii. Plot the **Normalized Histogram** as well as the **cumulative distribution** of the image in the above table
iii. Apply the **histogram equalization** algorithm on this image and find the new pixel values
iv. Plot the histogram for the **histogram-equalized** image.