



HW6 Deadline: 1403/03/31 **Support mail:** mobashershaghayegh@gmail.com

Theoretical

1. Answer the following questions:

- a. How can the erosion of A lie completely or partially outside A? [3 points]
- b. The time complexity of morphological dilation and erosion operations depends on both the image and the structuring element size. Describe a method of computing binary morphological dilation/erosion using FFT so that the time complexity depends only on the image size. [7 points]

2. Consider the given image:

0	0	2	2	7	7	7	7
0	0	2	0	3	6	6	4
0	2	1	3	6	6	5	4
1	1	1	6	5	5	4	4

- a. Compute its entropy. [2 points]
- b. Construct the Huffman code for this image, and determine the coding efficiency and the coding redundancy of this coding. [6 points]



- c. Evaluate the efficiency of Huffman coding for this image. What should the characteristics of the image histogram be in order to be Huffman-coded efficiently? [3 points]
- d. What lossless technique could you use to make the image be more suitable for Huffman coding? Compute the resulting code. [7 points]
- e. How else would you compress this image without loss of information? Provide the compressed result. Identify the type(s) of redundancies targeted by your method. [7 points]

Practical

- 3. Compress cameraman.jpg using Walsh-Hadamard Transform and Discrete Cosine Transform with block sizes of $N = 8$ ensuring that their compression ratios are identical.
 - a. Try five different compression ratios. [14 points]
 - b. Determine which transform retains more information about the image. Compute at least three different metrics for each ratio to support your conclusion. [7 points]
 - c. For the compression ratio of 16:1, encode the DCT-compressed result via arithmetic coding. [10 points](You're permitted to utilize the `dct()` function from `scipy` or any similar packages, but all other components must be implemented from scratch.)



4. For every part, implement the morphological operations by yourself without utilizing any image processing libraries. Every step (except for the thresholding) must be done using morphological image processing.
 - a. For the gray-scale andromeda-galaxy.png, only keep the tiny stars in the image. [8 points]
 - b. Segment the organs in MRI.png. (Hint: Binarize by thresholding, then separate and define the organs as much as possible and color each one distinctly.) [14 points]
 - c. Color every instance of the letter "I" red in text.jpg. [12 points]