



INFO449 E

Image, Video & Audio

Final 2017- 2018
Date: 25 June 2018
Duration: 2 hours

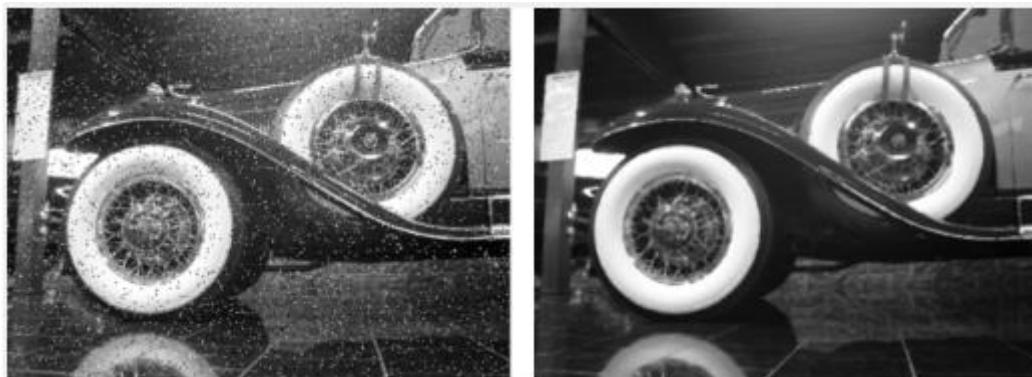
Lebanese University
Faculty of Sciences 5

Exercise I: Multiple choices [15 pts]

Fill the following table with the correct answer.

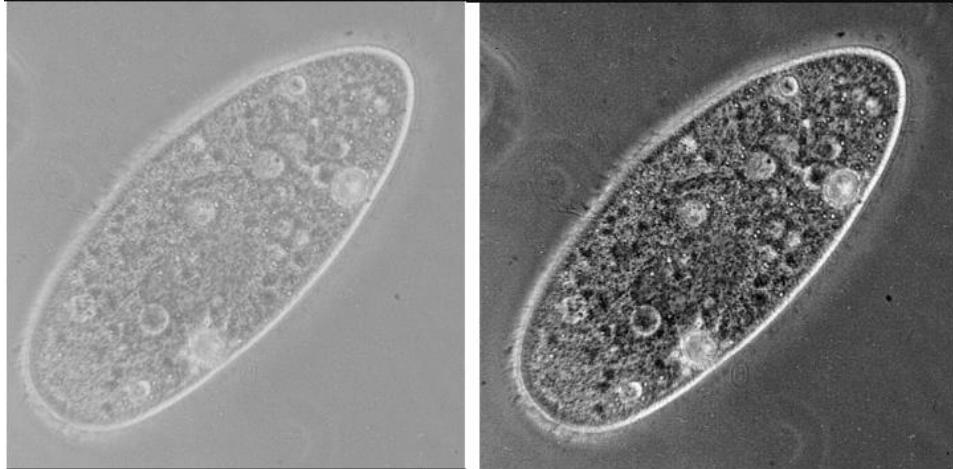
1	2	3	4	5	6	7	8	9	10

1. What is the most likely filter that has been applied on the left image to obtain the right one?



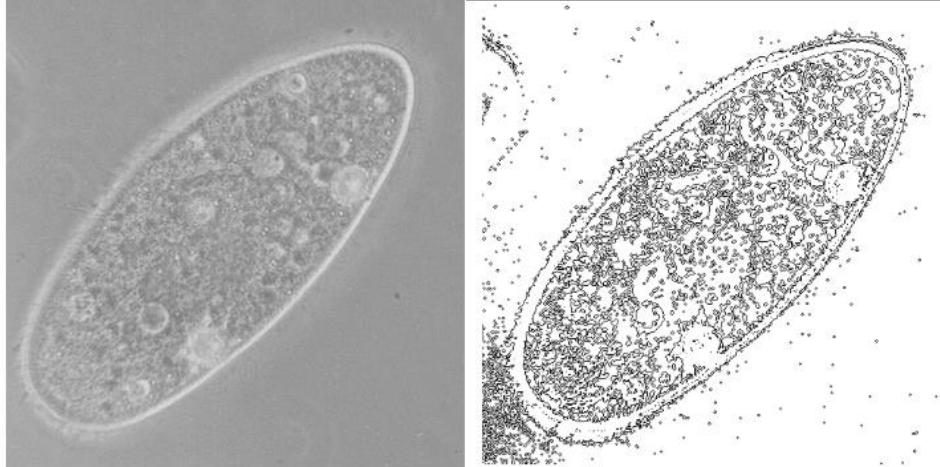
- a. Average
b. Gaussian
c. Median
d. Laplacian

2. What is the most likely operation that has been applied on the left image to obtain the right one?



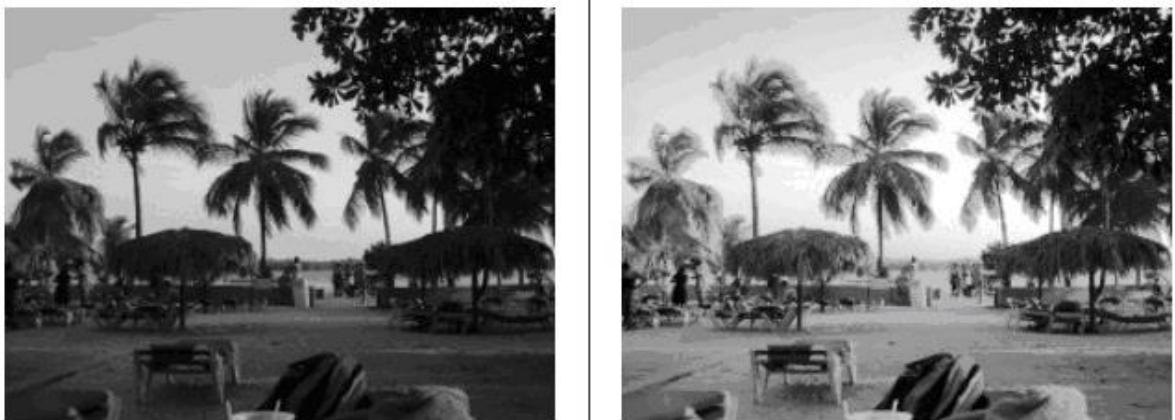
- a. Thresholding
b. Contrast adjustment
c. Brightness adjustment
d. Logarithmic transformation

3. What is the most likely operation that has been applied on the left image to obtain the right one?



- a. Edge detection
- b. Noise filtering
- c. Histogram equalization
- d. None of the above

4. What is the most likely operation that has been applied on the left image to obtain the right one?



- a. Contrast compression
- b. Negative
- c. Histogram equalization
- d. Extraction of the most significant bit

5. What is the most likely operation that has been applied on the left image to obtain the right one?



- a. Negative
- b. Binary thresholding
- c. Histogram equalization
- d. Quantization

6. The highest amount of compression can be obtained using:

a. Lossy algorithms	b. Lossless algorithms
c. Combination of (a) and (b)	d. Quantization

7. We have two sources of symbols to compare their entropies. Source-1 has three symbols a_1, a_2 and a_3 with probabilities $P(a_1)=0.4, P(a_2)=P(a_3)=0.3$. Source-2 also has three symbols a_1, a_2 and a_3 , but with probabilities $P(a_1)=0.9, P(a_2)=P(a_3)=0.05$.

- a. Entropy of source-1 is higher than that of source-2
- c. Entropy of source-1 and source-2 are the same.
- b. Entropy of source-1 is lower than that of source-2
- d. It is not possible to compute the entropies from the given data.

8. In order to reduce the number of bits per pixel:

- a. The Y channel is sub-sampled
- c. The Y and V channels are subsampled
- b. The U channel is sub-sampled
- d. The U and V channels are sub-sampled

9. A given colored image with aspect ratio 4:3 has 640 pixels horizontally and its color depth is 16. What is the approximate size of the image?

- a. 600Kbytes
- c. 6 Mbits
- b. 60KBytes
- d. 60Mbits

10. Entropy measures amount of randomness, entropy is high when randomness is:

- a. High
- c. Average
- b. Low
- c. None of them

Exercise II: True or False [10 pts]

For each of the following questions, fill the table with true or false.

1	2	3	4	5	6	7	8	9	10

1. The entropy of a source gives the minimum compression ratio.
2. In arithmetic coding, a message is represented by an integer number.
3. The max filter is used to remove pepper noise.
4. The median filter cannot be implemented using convolution operation.
5. Two different images may have same histograms.
6. DCT and DFT have the same efficiency in image compression.
7. Laplacian filter is a first order derivative filter.
8. Prewitt and Sobel filters are used to detect edges in images.
9. Huffman and Arithmetic encoding both require symbol frequencies.
10. A quantizer at the encoder performs a many-to-one mapping.

Exercise III: Image Filtering [8 pts]

Filter the following given 4×4 gray level image with:

- a. 3×3 mean filter using zero padding.

$$\begin{matrix} 1 & 2 & 4 & 5 \\ 5 & 2 & 5 & 2 \\ 1 & 1 & 3 & 6 \\ 2 & 4 & 6 & 7 \end{matrix}$$

- b. 3×3 median filter while this time consider only the intersection between the area and the filter instead of zero padding.

- c. 3×3 weighted median filter using the following weights: $\begin{pmatrix} 1 & 2 & 0 \\ 2 & 3 & 2 \\ 0 & 2 & 1 \end{pmatrix}$

- d. Laplacian filter with zero padding using the following mask: $\begin{pmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{pmatrix}$

Exercise IV: Histograms [14 pts]

- A. Given the following images, associate each of them to one of the histograms below. Fill your answers in the table below.

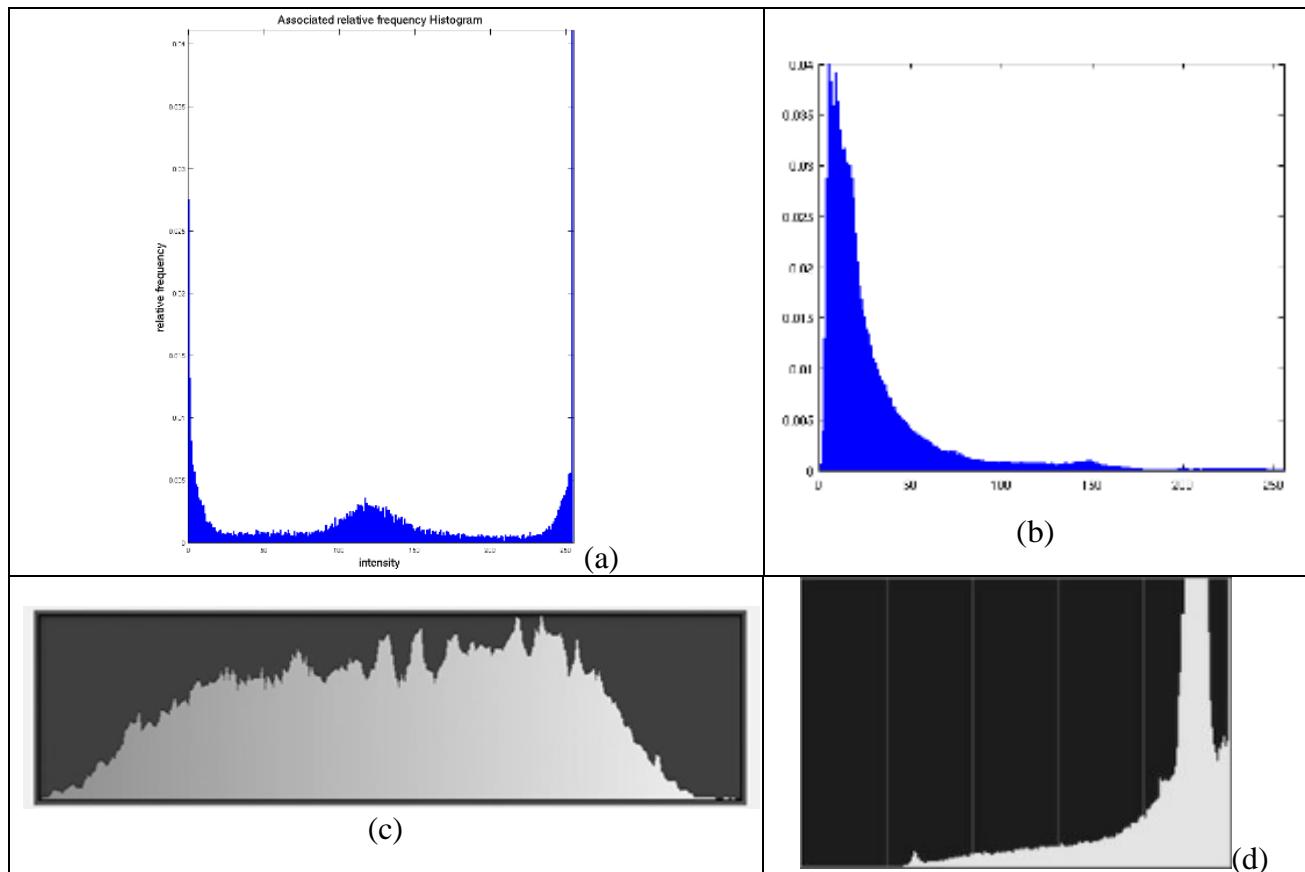
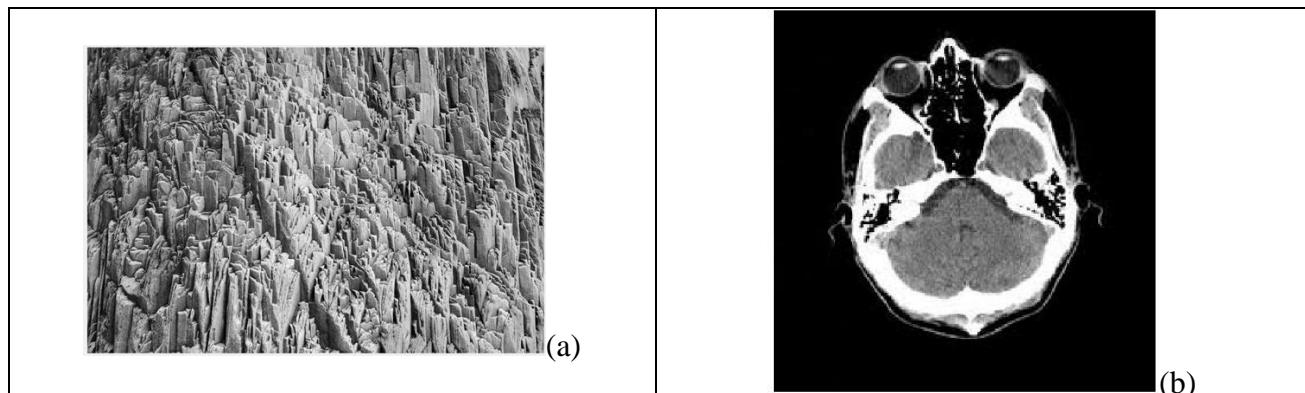


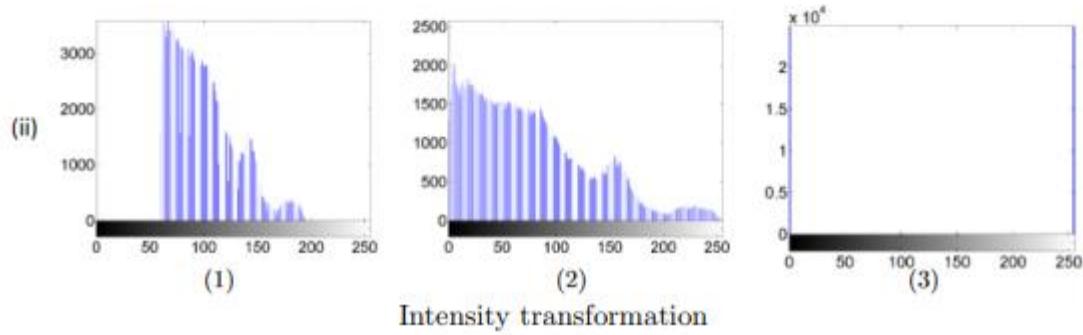
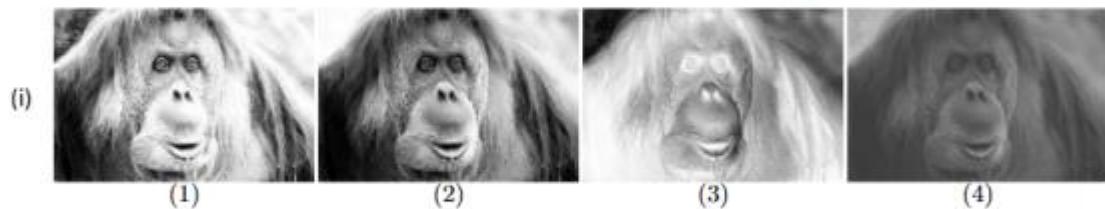
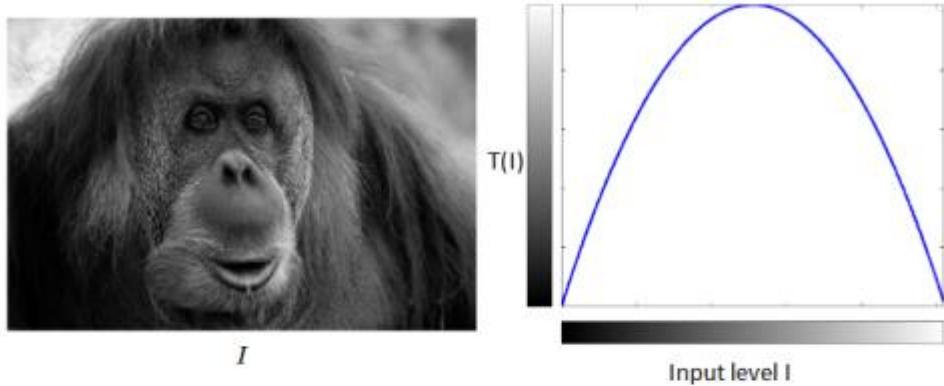
Image	Histogram
(a)	
(b)	
(c)	
(d)	

Answer table

B. Given the image I and the intensity transformation $T(I)$ shown in the below figure, indicate with justification:

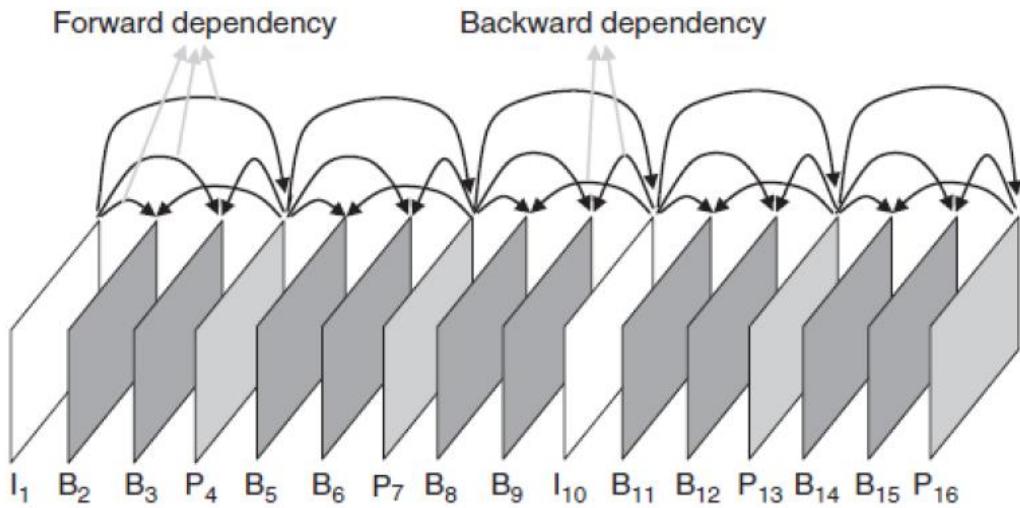
a. Which among the images in the middle row of the figure is $T(I)$.

b. Which among the histograms in the bottom row corresponds to I .



Exercise V: GOP [5 pts]

Consider the following sequence of I, P and B frames.



- a. What is an I frame? P frame? B frame? And the advantages of each type.
- b. The order shown in the above figure represents the display order of frames. Give the transmission order with which the frames will be transmitted by the encoder

Exercise VI: Motion Vectors [18 pts]

Suppose that we want to stream video from YouTube with 4K high quality (3840×2160 , 24 bits per pixel) at 30 fps using I, P and B frames. For B frames, the best motion vector between the previous and the next frames is chosen. To encode the P and B frames, we consider 16x16 macroblocks and a search area of $k = 16$.

- a. How many MADs is done to find the best motion vector for each macro-bloc in a P and B frames if the search method is sequential? Logarithmic? Hierarchical with 4 levels?

- b. What is the total number of macroblocks in each frame ? Deduce the total number of MADs that you should perform for each type of frames (I, P, B).

- c. Suppose that the size of the GOP is 15 frames in which we have 4 P frames and 10 B frames. What is the total number of MADs to be calculated per GOP? Per second?

- d. Given the following two frames of a video for which you should show how MPEG estimate the motion of the macro-block highlighted in the first frame (Frame n) to the next frame (Frame n+1).

1	1	1	1	1	1	1	1
1	1	2	3	3	2	1	1
1	1	2	2	2	2	1	1
1	1	2	4	5	2	1	1
1	1	2	5	3	2	1	1
1	1	2	3	3	2	1	1
1	1	1	3	3	2	1	1
1	1	1	3	3	1	1	1

1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	2	1	2	2	2	2
1	1	2	1	4	3	3	2
1	1	2	1	4	3	4	3
1	1	2	1	4	4	5	4
1	1	2	1	4	5	4	5
1	1	2	1	2	4	4	4

To simplify the computation, we assume here that the macro-block matching is performed over a 4 x 4 window. The window of search is restricted to +2/-2 pixels in horizontal and vertical directions around the original macro-block.

- e. Write a function that takes as input two consecutive frames and the value of k and returns the motion vectors and the error image.

