



INFO449 E

Image, Video & Audio

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

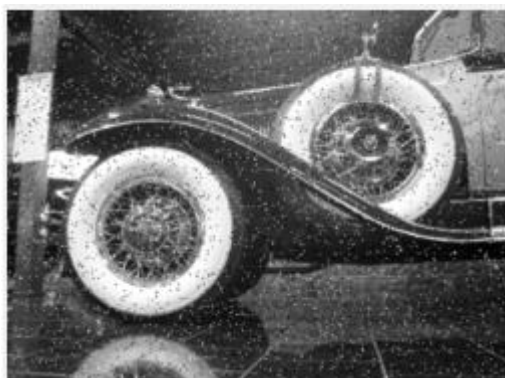
Lebanese University
Faculty of Sciences 5

Exercise I: Multiple choices [15 pts]

Fill the following table with the correct answer.

1	2	3	4	5	6	7	8	9	10

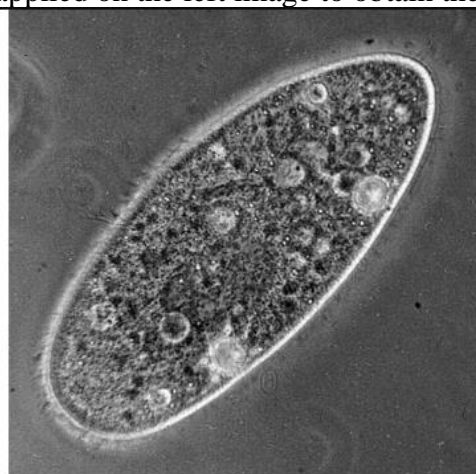
1. What is the most likely filter that has been applied on the left image to obtain the right one?



- a. Average
- c. Median

- b. Gaussian
- d. Laplacian

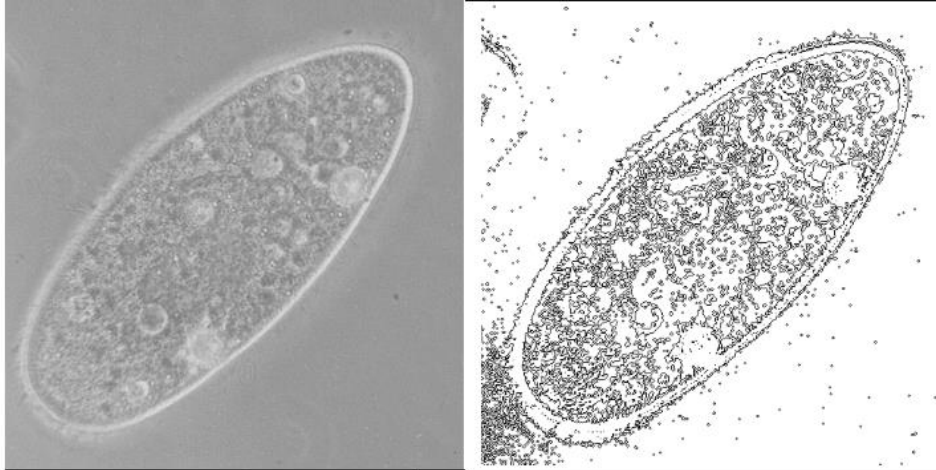
2. What is the most likely operation that has been applied on the left image to obtain the right one?



- a. Thresholding
- c. Brightness adjustment

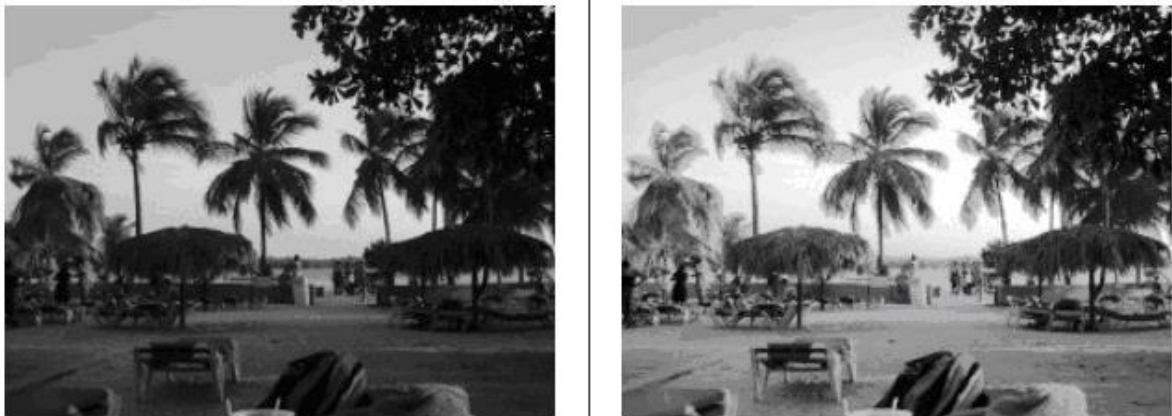
- b. Contrast adjustment
- d. Logarithmic transformation

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 | b. Entropy of source-1 is lower than that of source-2 |
| c. Entropy of source-1 and source-2 are the same. | 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 | b. The U channel is sub-sampled |
| c. The Y and V channels are subsampled | 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 | b. 60KBytes |
| c. 6 Mbits | d. 60Mbits |

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

- | | |
|------------|-----------------|
| a. High | b. Low |
| c. Average | 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

- The entropy of a source gives the minimum compression ratio.
- In arithmetic coding, a message is represented by an integer number.
- The max filter is used to remove pepper noise.
- The median filter cannot be implemented using convolution operation.
- Two different images may have same histograms.
- DCT and DFT have the same efficiency in image compression.
- Laplacian filter is a first order derivative filter.
- Prewitt and Sobel filters are used to detect edges in images.
- Huffman and Arithmetic encoding both require symbol frequencies.
- 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:

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

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

 <p>(a)</p>	 <p>(b)</p>
<p>Input Image</p>  <p>(c)</p>	 <p>(d)</p>

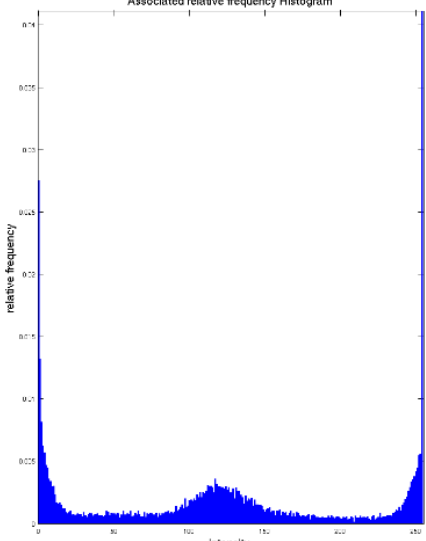
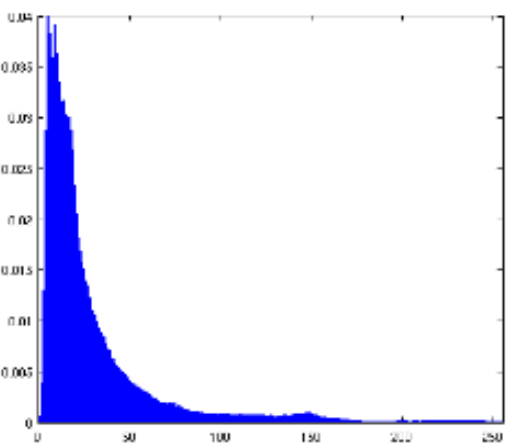

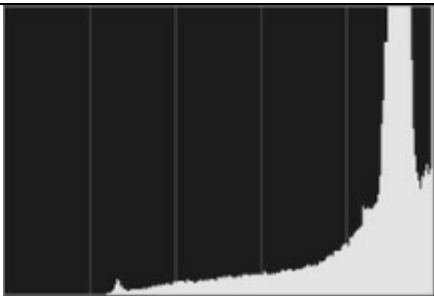
<p>Associated relative frequency Histogram</p>  <p>(a)</p>	 <p>(b)</p>
 <p>(c)</p>	 <p>(d)</p>

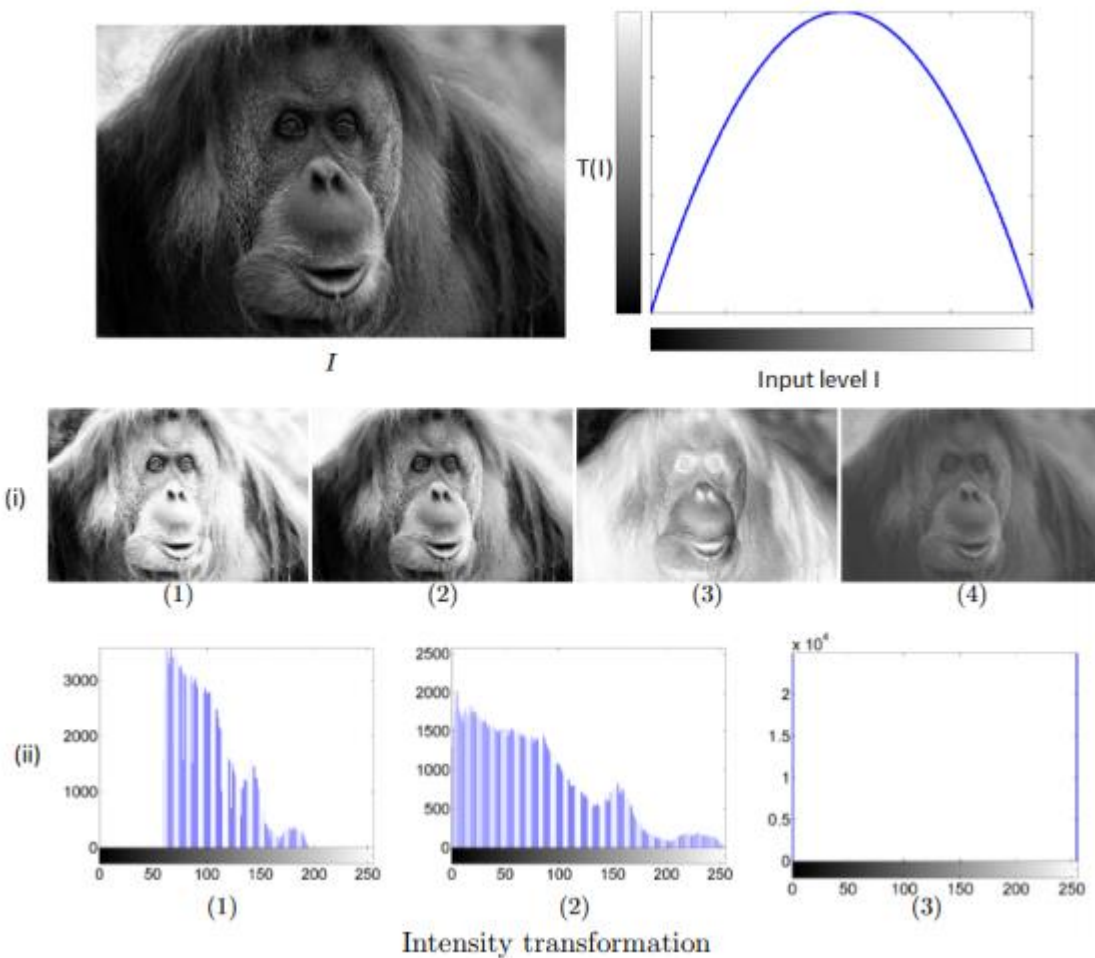
Image	Histogram
(a)	
(b)	
(c)	
(d)	

Answer table

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

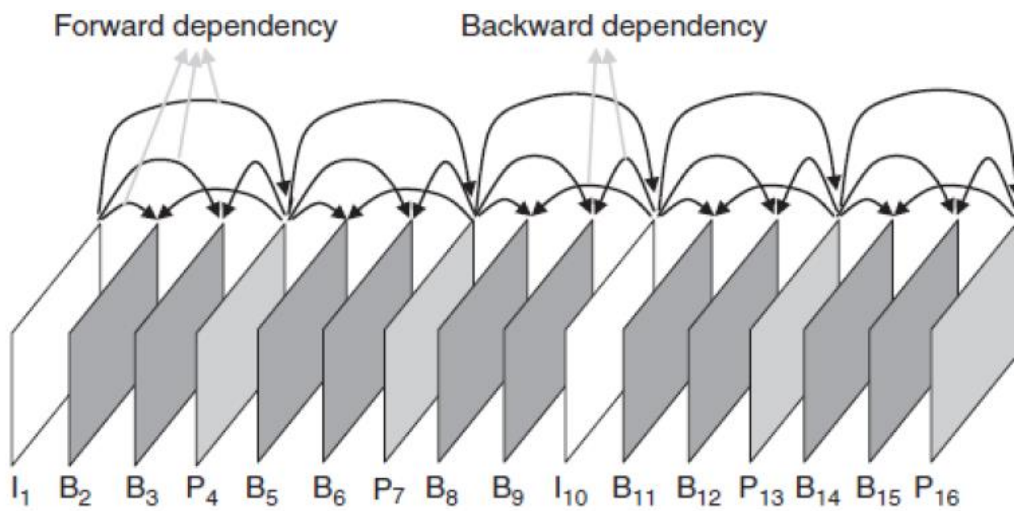
a. Which among the images in the middle row of the figure is $T(I)$.

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.



- What is an I frame? P frame? B frame? And the advantages of each type.
- 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 are done to find the best motion vector for each macro-block in I and P 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.

