INFO449 E
Image, Video & Audio

Final 2020- 2021
Date: 5 July 2021
Duration: 90 minutes

Lebanese University
Faculty of Sciences 5

Exercise I: Multiple choices [30 pts]

Fill the following table with the correct answer.

1. A given colored image has 250 pixels horizontally and 200 pixels vertically and its color depth is 16. What is the approximate size of the image? ($250 \times 200 \times 16$) $\div 8$ B $\div 100 =$ 100KB
   a. 1 kBytes   b. 10 kBytes   c. 100 kBytes   d. 1000 kBytes

2. What number of colors may be stored in a pixel of a graphic that has a color depth of 8? 2^8
   a. 8   b. 16   c. 64   d. 256

3. Match the following:
   a. Hue   1. Amount of color
   b. Saturation   2. Intensity
   c. Brightness   3. Name of color

4. Entropy measures amount of randomness, entropy is high when randomness is:
   a. High   b. Low   c. Null   d. None of the above

5. The entropy of a source gives:
   a. The minimum average symbol length   b. The maximum average symbol length
   c. The minimum compression ratio   d. None of the above

6. Consider four information sources S1, S2, S3, S4 of vocabulary 4 with symbol probabilities P1={0.5, 0.25, 0.25, 0}, P2={0.125, 0.125, 0.25, 0.5}, P3={0.25, 0.25, 0.25, 0.25} and P4={0, 0, 1, 0} respectively, their corresponding entropies His are sorted as the following (answer without any calculation):
   a. H1>H2>H3>H4   b. H2>H1>H4>H3   c. H1>H2>H4>H3   d. H3>H2>H1>H4

7. A source of 4 symbols a_1, a_2, a_3, a_4 having probabilities $P(a_1)=0.4$, $P(a_2)=0.35$, $P(a_3)=P(a_4)=0.125$ are encoded by four different encoding schemes and the corresponding codes are shown below. Which of the following gives us the best coding efficiency?
   a. $a_1 = 00$, $a_2 = 01$, $a_3 = 10$, $a_4 = 11$
   b. $a_1 = 0$, $a_2 = 10$, $a_3 = 110$, $a_4 = 111$
   c. $a_1 = 00$, $a_2 = 100$, $a_3 = 1100$, $a_4 = 1101$
   d. $a_1 = 111$, $a_2 = 110$, $a_3 = 10$, $a_4 = 0$

8. A 4-symbol alphabet has the following probabilities $P(a_1)=0.2$, $P(a_2)=0.4$, $P(a_3)=0.25$, $P(a_4)=0.15$ and following codes are assigned to the symbols $a_1 = 111$, $a_2 = 0$, $a_3 = 10$, $a_4 = 111$. The average code word length for this source is:
   a. 1.25   b. 1.5   c. 1.75   d. 2.0

9. Encode the bit stream 0000000111111111110000000110101110001111111111000000 using run-length coding, which always starts with runs of 1s. The corresponding code is:
   a. 8,11,6,,2,1,1,1,3,3,9,6.
   b. 0, 8,11,6,,2,1,1,1,3,3,9,6.
   c. 0, 8,11,6,,2,1,1,3,3,9,6
   d. 0, 8,11,6,,2,1,1,1,3,3,9,6,0.

10. Which of the following statements is not true for arithmetic coding:
   a. Integral number of bits is assigned to each symbol.
   b. A real number in the interval [0, 1) indicates the entire coding sequence.
   c. Coding requires a priori knowledge of the probabilities of source symbols.
   d. Longer sequence of source symbols leads to longer code words.

Exercise II: Video [12 pts]

A monochrome video sequence uses a frame-size of 176 x 144 pixels and is having 8-bits/pixel. It is captured at a frame rate of 10 frames/ sec with a 4:2:0 subsampling schema. The video is transmitted through a line of 32 Kbits/ sec bandwidth.

a. What is the size of a video of 10 minutes?
b. Une vidéo d'une seconde peut-elle être transmise en une seconde ? *No beds: 95.04 size for insee Mb reduced. if video of 45 can be transm in 1 sec ?*
c. Calculez le taux de compression nécessaire pour envoyer une vidéo d'une seconde en une seconde.
   Calcul the comp rate needed month 95.04 of one 45sec to send a video in 1 sec

Exercise III: Subsampling [8 pts]

Consider the following array of Luminance Y and colour values (U,V) of an image, where each pixel is represented by the three channels (Y,U,V).
Give Chroma sub-sampling results with (a) 4:2:2 and (b) 4:2:0 schemes.

(50,90,60)	(70,100,30)	(80,96,30)	(120,42,35)
(20,80,60)	(80,18,50)	(95,82,40)	(100,78,85)
(90,44,60)	(70,62,80)	(80,52,50)	(70,38,65)
(60,28,60)	(90,23,30)	(70,48,70)	(90,22,45)

Exercise IV: Compression [30 pts]

Suppose having an alphabet composed of 5 symbols {a, b, c, d, e} and given the following symbol probabilities:

Lettres	a	b	c	d	e
Probabilité	0.2	0.4	0.2	0.1	0.1

a. Without taking into account the above probabilities and without any calculation, what is the value of the entropy.   *b: 0 a: 10 c: 110 d: 1110 e: 1111*
b. Assign Huffman codes to the above symbols.
c. Calculate the entropy of the source. *2.12*
d. Calculate the average code word length obtained from Huffman coding. *$0.4 \times 1 + 0.2 \times 2 + 3 \times 0.2 + 0.1 \times 4 + 0.1 \times 4$*
e. Calculate the coding efficiency.
f. Encode the message "b a c b a b".
g. Suppose that due to a channel error, you have received the message with an error on the left most significant bit. What is the decoded message?   *1 c c d b a b*

Exercise V: Video Coding [20 pts]

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) taking the whole image as the window.

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

Frame n

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

Frame n+1