Lebanese University
Faculty of Sciences 5

INFO449 E
Image, Video & Audio

Session2 2017- 2018
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Duration: 2 hours

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. 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?
   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?
   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 0000000111111111110000001101011100011111111000000 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 4:4:4 subsampling schema. The video is transmitted through a line of 64 Kbits/ sec bandwidth.

a. Calculate the compression ratio (Ratio of raw bit rate to the compressed bit rate) which will be necessary.
b. What will happen if the compression ratio is higher than that obtained in (a)?
c. What will happen if the compression ratio is lower than that obtained in (a)?

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) 4:1:1 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 [20 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. Assign Huffman codes to the above symbols.
c. Calculate the entropy of the source.
d. Calculate the average code word length obtained from Huffman coding.
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?

Exercise VI: Video Coding [15 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*