LARBI BEN M'HIDI OUM EL BOUAGHI UNIVERSITY
INSTITUTE OF APPLIED SCIENCES AND TECHNIQUES
NETWORKS AND TELECOMMUNICATIONS DEPARTMENT

M1 RT S1

Module: coding and compression

First & Last Name :.....

First Exam

Exercise 01 (Course question): (08 points)

A. Choose the correct answer(s)

1. What are the properties of entropy?
   a . Positive
   b. Negative
   d. All the possibilities
2. In the process of transmitting information, the noise is the disruptive element. In which part of a transmission chain?
   a. Source
   b. Code
   c. User
   d. Channel
   e. Decode
3. For which value the entropy will be maximum.
   a. pi=1/n
   b. pi=1
   c. pi=0
   d. pi=1+ε
   e. pi=1-ε
4. In variable size source encoding (VLC), a symbol with minimum probability will have the fewest bits.
   a. TRUE
   b. False
5. A Huffman encoder takes a set of characters of fixed length and produces a set of characters of:
   a) Variable length,
   b) Random length,
   c) Fixed length,
   d) Constant length
6. For which value(s) of p is the binary entropy function H(p) maximized?
   a. 0
   b. 0.5
   c. 1
   d. 0.8

B. Give a block diagram of the different stages of Jpeg data compression

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Exercise 02: 04 points

Consider a linear code C(n.k) whose generating matrix is given below

$$G = \begin{pmatrix} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{pmatrix}$$

1. Find the length of the message (source) blocks, the length of the codewords and the number of parity bits
2. Deduce the control matrix H
3. find the code words
4. Deduce the minimum distance d_{min}, the number of errors (e) that the code can detect and can correct.

Exercise 03: 04 points

A discrete channel has as input the alphabet X ={ a, b, c} and the output alphabet Y={r, s, t, u}. Its transition matrix is as follows:

$$Q = \begin{bmatrix} 1/2 & 1/2 & 0 & 0 \\ 0 & 1/2 & 1/2 & 0 \\ 0 & 0 & 1/2 & 1/2 \end{bmatrix}$$

What is its capacity?

Exercise 04: 04 points

Using arithmetic coding, code the word CALCUL

Note: take 4 digits after the decimal point

GOOD LUCK

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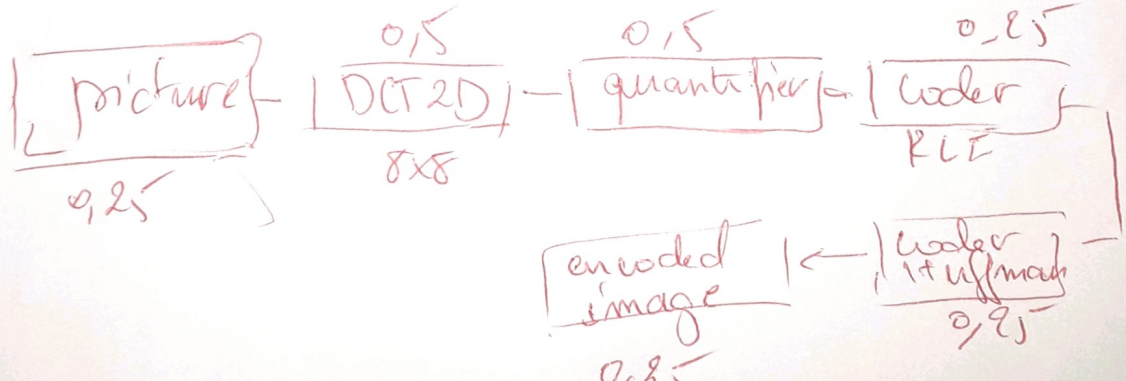


Exercise 02 :

$$G = \underset{k}{\left[\begin{array}{ccc|ccc} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{array}\right]}_{n} = \left[\begin{array}{c} I_k \\ \hline P \end{array}\right]$$

1/ $C(n,k) \Rightarrow n = 6, k = 3 \Rightarrow R = 6 - 3 = 3$ (0,75)

2/ $H = \left[P^T \; \Sigma_{n-k}\right] = \left[\begin{array}{ccc|ccc} 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 1 \end{array}\right]$

(0,5) (0,5)

3/ $C_D = D \cdot G$ (0,25)

$$D = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 & 1 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 1 & 1 \end{bmatrix}$$ (1)

4/ $d_{min} = 2$; $e = d_{min} - 1 = 1$ error. (0,5) (0,5)

Can't correct any error.

Exercise 03 :

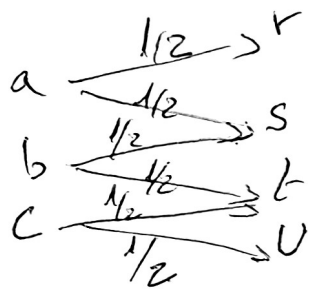
$$Q = \begin{bmatrix} 1/2 & 1/2 & 0 & 0 \\ 0 & 1/2 & 1/2 & 0 \\ 0 & 0 & 1/2 & 1/2 \end{bmatrix}.$$

$$Q^T = \begin{bmatrix} 1/2 & 1/2 & 0 \\ 1/2 & 0 & 0 \\ 0 & 0 & 1/2 \end{bmatrix} \begin{bmatrix} 0 \\ 1/2 \\ 1/2 \end{bmatrix}$$; the matrix is symmetrical. (0,1)

$$p(a) = p(b) = p(c) = \frac{1}{3}$$ (0,25)

1/ $C = \max I(X;Y)$ (0,5)

$I(X;Y) = H(Y) - H(Y|X)$ (0,25)



$$H(Y) = \sum_i P_{y_j} \log_2 \left(\frac{1}{P_{y_j}}\right)$$ (0,25)

$P_{y_r} = 1/2\, P(x_a) = \frac{1}{6}$ (0,25)

$P_{y_s} = \frac{1}{2}(P_{x_a} + P_{x_b}) = \frac{1}{3}$ (0,25)

$P_{y_t} = \frac{1}{2}(P_{x_b} + P_{x_c}) = \frac{1}{3}$ (0,25)

$P_u = \frac{1}{2} P(x_c) = \frac{1}{6}$ (0,25)

$H(Y) = 2 \cdot \frac{1}{6} \log_2(6) + 2 \cdot \frac{1}{3} \log_2(3) = \frac{1}{3}\left[\log_2 6 + 2\log_2 3\right] = 1,92$ (0,25)

$H(Y|X) = \sum P(X_i)\, H(Y|X_i)$ (0,25)

$= P(x_a) H(Y|x_a) + P(x_b) H(Y|x_b) + P(x_c) H(Y|x_c)$

$H(Y|X) = \frac{1}{3}\left[6 \cdot 1/2 \log_2(2)\right] = 1$ (0,25)

$C = 1,92 - 1 = 0,92.$ (0,5)

Exercise 4:

CALCUL ⇒ C → 1/3 (0,25), A → 1/6 (0,25), L → 1/3 (0,25), U → 1/6 (0,25)

C → [0,00 ; 0,33[0,25
A → [0,33 ; 0,50[0,25
L → [0,50 ; 0,83[0,25
U → [0,83 ; 1,00[0,25

$B_{sup} = B_{inf-1} + (B_{s-1} - B_{inf-1}) \cdot B_{sup\ caractere}$ (0,25)

$B_{inf} = B_{inf-1} + (B_{s-1} - B_{inf-1}) \cdot B_{I\ caracter}$ (0,25)

	[0,0000	1,0000 [	
C	[0,0000	0,3333 [	0,25
A	[0,1111	0,1667 [	0,25
L	[0,1389	0,1574 [	0,25
C	[0,1389	0,1451 [	0,25
U	[0,1440	0,1451 [	0,25
L	[0,1451	0,1449 [	0,25

CALCUL → 0,1449