COMP 5422 Additional Problem Set

Question 1 Given a color represented in RGB color space as (R, G, B)=(1, 0.5, 0.3) what is its representation in the CMY color model?

Answer: (0, 0.5, 0.7)

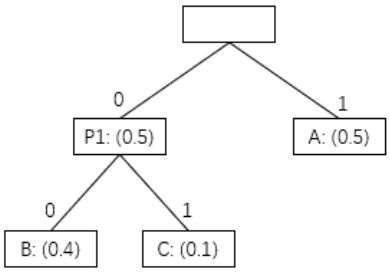
Question 2 What are the problems of MSE (mean square error) in measuring the image visual quality?

Answer: MSE is poorly correlate with human perception of visual system.

Question 3 Suppose the alphabet is [A, B, C], and the known probability distribution is $\mathrm{P_A} = 0.5, \mathrm{P_B} = 0.4, P_C = 0.1$.

a) Encode the message ABC by Huffman coding.

Answer:



Resulting code

A	B	C
1	00	01
1	01	00
0	10	11
0	11	10

ABC could possibly be, 10001, 10100, 01011, 01110

b) If Arithmetic coding is used, what are the lower and higher bounds of the interval after encoding BBB and ABC, respectively.

Answer:

Start by assigning each symbol to the probability range [0, 1). Sort symbols with the highest probability first.

Symbol	Range
A	[0, 0.5)
B	[0.5, 0.9)
C	[0.9, 1.0)

- For the stream BBB,

Symbol	Low	High	range	Low=Low+range*range_low(Symbol) High=Low+range*range_high(Symbol)
	0	1	1	
B	0.5	0.9	0.4	Low=0+1*0.5=0.5 High=0+1*0.9=0.9
B	0.7	0.86	0.16	Low=0.5+0.4*0.5=0.7 High=0.5+0.4*0.9=0.86
B	0.78	0.844	0.064	Low=0.7+0.16*0.5=0.78 High=0.7+0.16*0.9=0.844

- So the Range of stream BBB is [0.78,0.844).
- The lower and higher bounds are 0.78 and 0.844, respectively.

- For the stream ABC, we have,

Symbol	Low	High	range	Low=Low+range*range_low(Symbol) High=Low+range*range_high(Symbol)
	0	1	1	
A	0	0.5	0.5	Low=0+1*0=0 High=0+1*0.5=0.5
B	0.25	0.45	0.2	Low=0+0.5*0.5=0.25 High=0+0.5*0.9=0.45
C	0.43	0.45	0.02	Low=0.25+0.2*0.9=0.43 High=0.25+0.2*1=0.45

- So the Range of stream BBB is [0.43, 0.45)
- The lower and higher bounds are 0.43 and 0.45, respectively.

Question 4 Given the following predictor for audio sample $\widehat{f_n}$, assume $\mathrm{f}_0 = f_1$, deduce predict error $\mathrm{e_n}$ for the samples as in the table.

$$\text{Predictor: } \begin{cases} \widehat{f_n} = [\frac{1}{2}(\mathrm{f_{n-1}} + \mathrm{f_{n-2}})] \\ e_n = f_n - \widehat{f_n} \end{cases}.$$

Samples:

f_1	f_2	f_3	f_4	f_5
66	59	70	38	50

Answer:

$\widehat{f_2} = \left[\frac{1}{2}f_1 + \frac{1}{2}f_0\right] = 66$	$\mathrm{e}_2 = f_2 - \widehat{f_2} = 59 - 66 = -7$
$\widehat{f_3} = \left[\frac{1}{2}f_2 + \frac{1}{2}f_1\right] = [62.5] = 62$	$\mathrm{e}_3 = f_3 - \widehat{f_3} = 70 - 62 = 8$
$\widehat{f_4} = \left[\frac{1}{2}f_3 + \frac{1}{2}f_2\right] = [64.5] = 64$	$\mathrm{e}_4 = f_4 - \widehat{f_4} = 38 - 64 = -26$
$\widehat{f_5} = \left[\frac{1}{2}f_4 + \frac{1}{2}f_3\right] = 54$	$\mathrm{e}_5 = f_5 - \widehat{f_5} = 50 - 54 = -4$

- The predict error is $[\mathrm{e}_2, \mathrm{e}_3, \mathrm{e}_4, \mathrm{e}_5] = [-7,8,-26,-4]$.
- Note that the initial value f_1 is transmitted without coding, so we need to transmit $[f_1, \mathrm{e}_2, \mathrm{e}_3, \mathrm{e}_4, \mathrm{e}_5] = [66,-7,8,-26,-4]$.

Question 5 Suppose we have a 4*4 image as follows, what is the bit plane 0 of the image?

1	1	22	233
1	1	22	233
22	22	233	233
233	233	233	233

Answer:

1	1	0	1
1	1	0	1
0	0	1	1
1	1	1	1

Question 6 Given the signal $\mathrm{f(i)} = [100,80,60,-40,-30,-20,0,30]$. Please calculate its DCT coefficients F(1) and F(6).

Answer:

By using

$$\mathrm{C}(\xi) = \begin{cases} \frac{\sqrt{2}}{2}, if\ \xi = 0, \\ 1, otherwise. \end{cases}$$

$$\mathrm{F(u)} = \frac{\mathrm{C}(u)}{2} \sum_{i=0}^{7} \cos \frac{(2i+1)u\pi}{16} f(i)$$

We can calculate that

$$\mathrm{F}(1) = 49.04 + 33.26 + 16.67 - 3.9 + 2.93 + 5.56 + 0 - 14.71 = 88.85$$

$$\mathrm{F}(6) = 19.13 - 36.96 + 27.72 + 7.65 + 5.74 - 9.24 + 0 + 5.74 = 19.78$$