Digital Image Processing – Homework #7

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1) Question 8.5

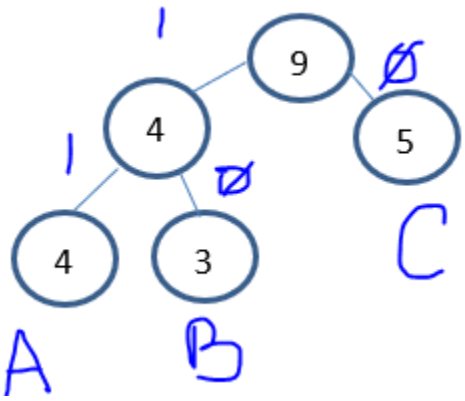
A 8-bit image with 5.3 bits / pixel entropy [computed from its histogram using Eq. (8.1-7)] is to be Huffman coded.

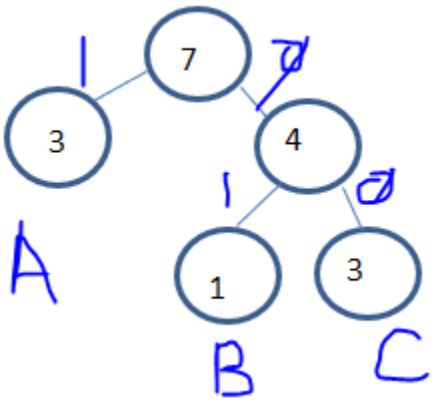
(a) What is the maximum compression that can be expected?
(b) Will it be obtained?
(c) If a greater level of lossless compression is required, what else can be done?

The maximum compression will be a ratio by the number of bits over the entropy value: $C = \frac{8}{5.3} \rightarrow 1.509$. Therefore, this will not be obtained because over 33% of the image will be lost to image redundancy. $R = 1 - \frac{1}{1.509} \rightarrow 0.337$. One way to reduce repeating values is taking different, non-redundant values in the neighborhood before applying the Hoffman code.

2) Question 8.8

(a) How many unique Huffman codes are there for a three-symbol source?
(b) Construct them.





	Left Side	Right Side
A	11	1
B	10	01
C	0	00

3) Question 8.10

Using the Huffman code in Fig. 8.8, decode the encoded string 0101000001010111110100.

Original source			Source reduction							
Symbol	Probability	Code	1		2		3		4	
a_2	0.4	1	0.4	1	0.4	1	0.4	1	0.6	0
a_6	0.3	00	0.3	00	0.3	00	0.3	00	0.4	1
a_1	0.1	011	0.1	011	0.2	010	0.3	01		
a_4	0.1	0100	0.1	0100	0.1	011				
a_3	0.06	01010	0.1	0101						
a_5	0.04	01011								

```
01010 00 00  1  0101011  1  1   1 0100
 a3   a6 a6 a2    a5    a2 a2  a2  a4
```

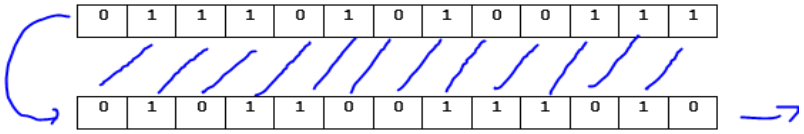
The decoded string is $a_3a_6a_6a_2a_5a_2a_2a_2a_4$.

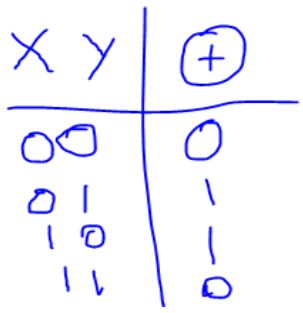
4) Question 8.22

(a) Construct the entire 4-bit Gray code.
(b) Create a general procedure for converting a Gray-coded number to its binary equivalent and use it to decode 0111010100111.

0	0000
1	0001
2	0011
3	0010
4	0110
5	0111
6	0101
7	0100
8	1100
9	1101
10	1111
11	1110
12	1010
13	1011
14	1001
15	1000

$$g_i = a_i \oplus a_{i+1} \quad 0 \le i \le m-2$$
$$g_{m-1} = a_{m-1} \qquad (8.2\text{-}9)$$





The binary equivalent of 0111010100111 will equal to 0101100111010.