

**ECE 499/599 Data Compression/Information Theory
Spring 06**

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**Homework 5
Due 05/30/06 at the beginning of the class**

Problem 1: We have the following pixel values with the corresponding frequency of occurrence. (6pts)

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|--------------|-----|----|-----|-----|------|-----|-----|-----|-----|-----|
| Pixel values | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Frequency | 100 | 20 | 300 | 120 | 1000 | 600 | 900 | 100 | 400 | 123 |

- a) Suppose you are using a codebook of size 3, and the initial codewords are $C(0) = 1$, $C(2) = 2$, and $C(3) = 3$. Show steps by steps the final codeword after running the Lloyd-Max Algorithm. What is the distortion value?
- b) Suppose you are using a codebook of size 3, and the initial codewords are $C(0) = 8$, $C(2) = 9$, and $C(3) = 10$. Repeat question (a).
- c) Do you think the final codewords will always be the same? Explain your answer.

Problem 2: Show that distortion value in the Lloyd-Max quantizer monotonically decreases with the number of iterations. (4pts)

Problem 3: In this problem, we will use MatLab to perform vector quantization on image. We will use the image Lena512.pgm (10pts).

- 1) Download the lena512.pgm from the class website
- 2) Start Matlab, and go into the directory that contains the downloaded image lena512.pgm.
- 3) At the Matlab prompt, load the image lena512.pgm using
“data = imread('lena512.pgm');”
- 4) Display image lena512 to make sure we load it in properly using
“imshow(data);” You should see the lena image.
- 5) Now the data is a 512x512 matrix contains the pixel value of the lena image.
- 6) Your job is to design a codebook consisting of 16 codewords, each codeword is a 2x2 block, using the GLA algorithm. (How many iterations do you need to run before the relative distortion error does not change much from iteration to iteration?)
- 7) Use your codebook to reconstruct the lena image.

Note: to access entry (i,j) in the matrix data, use data(i,j).
For example, if you want to add the entry (i,j) to the entry (i+1, j+1), and store the result in the entry (i,j), type “data(i,j) = data(i,j) + data(i+1,j+1);”
For tutorial on MatLab, see the link <http://www.math.ufl.edu/help/matlab-tutorial/>
Turn in your matlab source code and a hard copy of the quantized lena image.

What is the compression ratio?

Extra credits:

Implement k-d tree using the codebook in problem 3. Encode the image Barbara using the k-d tree. Email me the source code.