
This homework is due at the beginning of class on Aril 22; no late homeworks will be accepted. Typed homeworks are preferred. If you do turn-in handwritten material, it must be extremely legible. And if your material is composed of more than one pages, please use a stapler

Please note: Absolutely no copying or sharing of homework solutions between students will be allowed. If there is any indication (no need for formal evidence) that two students have shared solutions, both students will be disqualified from attending rest of the course.

This homework accounts for 20% of the total score of the course. Hence, please take time and be very careful in answering the question. Each question can be answered shortly; nevertheless, your solution must be reasonable and complete. If needed, state directly all of your assumption.

1. Multimedia: Color Concepts (6 points):

1.1 (2 points) Given three different kinds of color representations for a pixel in an image, which of them is better from the viewpoint of reducing the number of bits needed for their representation, and why?

1.2 (2 points) Supposing you are required to represent a rectangular object of red color and one eighth (1/8) the size of a TV screen (assume the TV to be HDTV resolution: i.e., it has 1000 horizontal lines). One way is to represent the red rectangle as an image of pixels. Another is to use geometric representation of the rectangle (assume the TV screen is a 2-dimensional coordinate system, and that up to 255 regular shapes such as polygons, etc., plus 1 category representing "all other shapes" are represented by the needed number of bits). How many bits do you need to represent in these two cases? Assume RGB representation for color, with each primary color represented by 1 byte. (Hint: In the pixel representation, each pixel will need its coordinate and the three colors specified.)

1.3 (1 point) Given a color represented in the RGB format by:

Red = 0.80
Green = 0.50
Blue = 0.20

Find an equivalent color in the YUV format.

1.4 (1 point) Given a color represented in the YUV format by:

Y = 0.50
U = 0.10
V = 0.20

Find an equivalent color in the RGB format.

2. Television Video Synchronization: 5 points

2.1 (1 point) Differentiate between *progressive* and *interlaced* scanning in displays.

2.2 (2 points) Assume that you are making a new TV standard called MYTVSTD. This is different from NTSC in the sense that, instead of fixing the frame rate to be 29.97 frames per second, you have fixed it to be 29.95 frames per second. Now you want to propose a "drop frame" technique in which you drop some frame numbers from each minute to achieve synchronization with displays that run at 30Hz. Describe what frame numbers you will drop from which minute, and clearly show the reason for your answer.

2.3 (2 points) Supposing instead, you propose a revolutionary new TV standard called REVTVSTD. In this standard, the frame rate is fixed to be 30.05 frames per second. How will you devise a scheme for the synchronization with 30Hz TV displays?

3. Audio Coding: 6 points

3.1 (1 point) Describe the various steps in digitization and coding of audio signals.

3.2 The following sequence of real numbers has been obtained sampling an audio signal:

2.3, 2.1, 3.2, 1.2, 1.3, 2.3, 2.5, 3.2, 3.8, 3.8, 2.5, 2.0, 1.4, 1.2, 1.2, 1.0, 0.8, 0.6,0.0, -0.3, -0.5, -0.8, -1.2, -1.5, -1.7, -1.9, -2.2, -2.5, -2.7, -2.9, -3.1, -3.9

Quantize this sequence by dividing the interval [-4, 4] into 32 uniformly distributed levels (place the level 0 at -4.0, the level 1 at -3.75, and so on. This should simplify your calculations). Assume that input values in the range [-4,-3.75) map to output -4 (which becomes level 0 for the quantizer), input values in the range [-3.75,-3.50) map to output -3.75 (which becomes level 1 for the quantizer), and so on. Here, the intervals are closed at the left and open at the right, which means -4 is included, but -3.75 is not in the first interval, and so on.

3.2.1 (2 points) Write down the quantized sequence. How many bits do you need to transmit it?

3.2.3 (3 points) Encode the quantized sequence using DPCM. What are the maximum and minimum differences between successive samples? Assuming these maximum and minimum values, find out how many bits are needed now to encode the sequence (1 points) Write a program in your favorite language to do the above computation. Give

pseudocode for purposes of this homework. What is time complexity of the program? Express it in terms of the number of samples in the input.

4. Quantization: 3 points

4.1 (1 points) Differentiate between scalar and vector quantization.

4.2 (2 points) Suppose that you rewrite the input sequence in the above question,(on audio coding) as a sequence of pairs of numbers (adjacent two numbers in the sequence constituting a pair). Draw the set of resulting vectors. How many bits do you need to encode just these vectors? Does vector quantization help in this case?