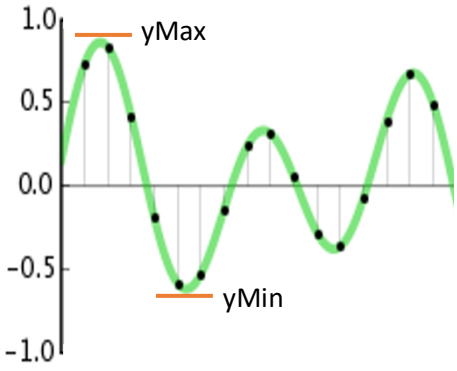
CS443/543 Homework 4

Due date: 4/8/2019

Dr. Chung is providing three sample wav files (dee.wav and lyineyes.wav) for this assignment; Find HW4_sample_audio.zip on class Canvas.



Uniform quantization is the process of mapping a large set of input values to a (uniformly divided) smaller set. The value of each sample signal is rounded off to the nearest division. For example, an analogue signal can be encoded to 3-bit digital samples. Specifically, each sample's amplitude is mapped to one of 8 possible values in (yMax – yMin)/8. Therefore, each sample can be mapped to one of the closest values (if we assume yMax = 1 and yMin = -1) among:

-0.8750, -0.6250, -0.3750, -0.1250, 0.1250, 0.3750, 0.6250, 0.8750

Tasks:

(a) You have to implement and apply uniform (linear) quantization algorithm to reduce 16-bit audio to 4-bit and 8-bit audio. You can use `[Y, FS]=audioread(FILENAME)` which returns Y (double-precision normalized samples between -1.0000 and 1.0000) and FS (Frequency).

(b) You have to plot 200 audio samples (from 1000th to 1200th points) from three different bit-depths. These three lines, which represent three bit-depths, should be superimposed with each other in different colors. For example:

```
t=1000:1200
figure; plot(t,Y,'r:'); % Y refers to the original 16bit sample points-
Red dotted line
hold on; plot(t,x),'b-'); % x refers to the 4bit sample points-blue
hold on; plot(t,z), 'g--'); % z refers to the 8bit sample points-green
grid on; legend('original','4bit uniform quantized', '8bit uniform
quantized' )
```

(c) Your code should be able to save all of your 4bit and 8bit quantized sounds in .wav files (use `audiowrite` if you use matlab).

(d) You have to calculate the distortion (the average squared error) between the original and quantized audio signal. where $\tilde{f}$ is a quantized signal values and N is the number of values.

$$\left[\sum_{n=1}^{N}(\tilde{f}_n - f_n)^2\right] / N$$

(e) Write a report: in this report, you have to include your plots and distortion values, and need to discuss how the sound quality (your subjective observation through listening to the output files) and the distortion values (the objective observation) are changed as the bit-depth is changed.

Submit: 1) your uniform quantization code, 2) output quantized wav files (4 files; 2 for each sample), and 3) a report.

Regarding grading:

- A program that runs into errors upon starting or almost immediate gets an automatic 0.
- You can use algorithms and pseudo codes from slides and lectures freely. However, if I found your code was based on existing ones from the internet, you will get an automatic 0.
- There is a 20% penalty for poor documentation & readability. Have plenty of comments.
- No partial credit will be given to programs that lack documentation.
- Make sure to place comments so that others can understand your program.

Enjoy!