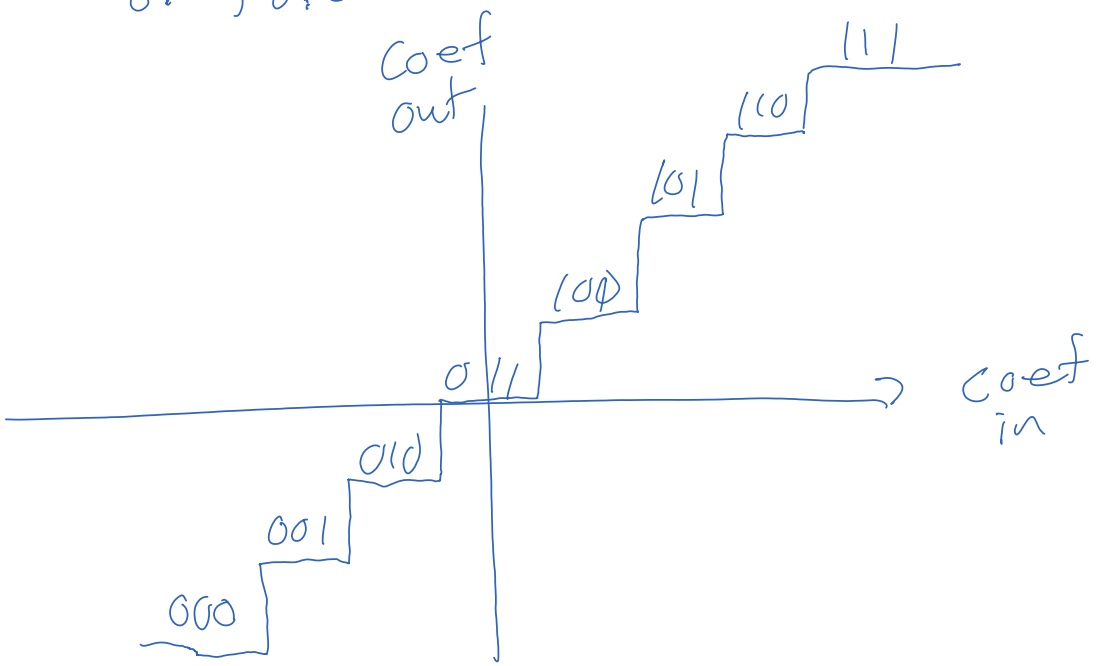
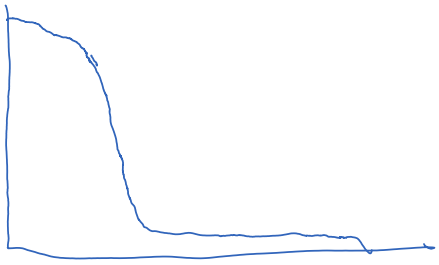
Monday, April 8, 2019 8:04 AM

HW: Find DCT + DFT of [1 2; 1 2] and [1 1.5 2; 1 2 3]. Compare energy compaction.

8.3, 8.5

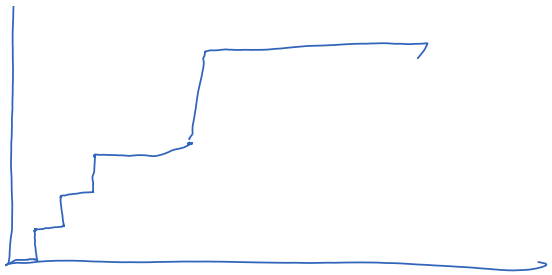


- uniform quantization
- fixed-length bits per symbol

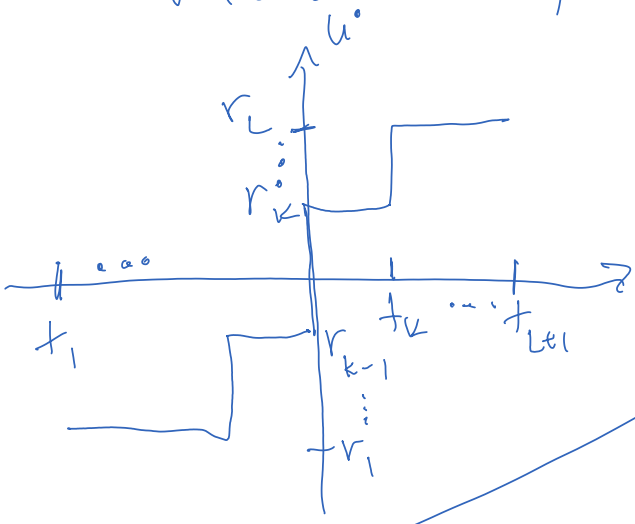


Histogram of coefficient.

What are optimal quantization levels?



nonuniform quantizer — allows for nonuniform step sizes so that finer quantization can occur where coefficient values usually are.



We want $\varepsilon = E[(u-u')^2]$

$$= \int_{t_1}^{t_{L+1}} (u-u')^2 p_u(u)\, du$$

to be small

(u' = quantized output)

$$= \sum_{i=1}^{L} \int_{t_i}^{t_{i+1}} (u-u')^2 p_u(u)\, du$$

minimize over choice of thresholds (decision levels) and reconstruction levels.

$t_K = \dfrac{r_K + r_{K+1}}{\quad}$ } solutions to these

$$r_k = \frac{\int_{t_k}^{t_{k+1}} u\, p_u(u)\, du}{\int_{t_k}^{t_{k+1}} p_u(u)\, du}$$

$$t_k = \frac{r_{k-1} + r_k}{2}$$

equations minimize E $\{t_k\}$, $\{r_k\}$

⇒ use iterative minimizer or approximation

- result is called optimal mean-square or Lloyd-Max quantizer

Properties:

1) $E[u'] = E[u]$

2) quantization error is orthogonal to quantization output. $E[(u-u')u'] = 0$

3) $\sigma_{u'}^2 = \sigma_u^2 - \sigma_m^2$

σ_m^2 ← mean-square distortion

Read 6.10

Bit allocation

distortion $D = \frac{1}{N} \sum_{k=0}^{N-1} E\left[|v(k) - v'(k)|^2\right]$

$$= \frac{1}{N} \sum_{k=0}^{N-1} \sigma_k^2 f(n_k)$$

where σ_k^2 = variance of coef $V(k)$

$f(n_k)$ = quantizer distortion as function of # of bits

$(f(0) = 1, f(\infty) = 0)$

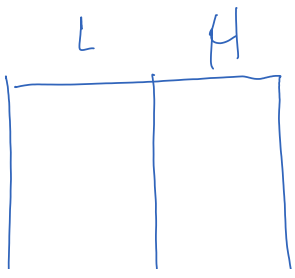
$h_0[n] = \frac{1}{2}\delta[n] + \frac{1}{2}\delta[n-1]$ $H_0(z) = \frac{1}{2} + \frac{1}{2}z$

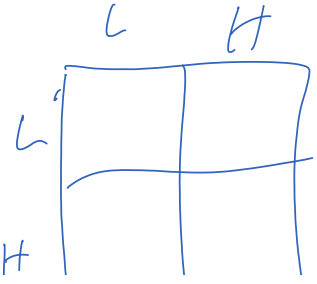
$h_1[n] = \frac{1}{2}\delta[n] - \frac{1}{2}\delta[n-1]$

$H_0^2(z) = \left(\frac{1}{2} + \frac{1}{2}z^{-1}\right)^2 = \frac{1}{4}\left(1 + 2z^{-1} + z^{-2}\right)$

$H_0^2(-z) = \left(\frac{1}{2} - \frac{1}{2}z^{-1}\right)^2 = \frac{1}{4}\left(1 - 2z^{-1} + z^{-2}\right)$

$H_0^2(z) - H_0^2(-z) = z^{-1}$





Read 6.10, 8.11

HW: 6.47

Image formats

GIF - graphics interchange format
- pronounced "jif"

- indexed image format
  - index of color values, each of which is an RGB triple
    - only 256 colors are allowed
  - array of values pointing to entries the index - each pixel location points to one color in the index

Is GIF lossless?
- only 256 colors are allowed
- images with more colors must be color-quantized first before storing as GIF

Is GIF a compressed format?

- color quantization itself leads to comp
- yes, the image array uses a lossle compression scheme

GIF uses LZW (Lempel-Ziv-Welch)

L+Z — published original method

W — published a fast version

History

- Compuserve used GIF format for its online presence + file downloading
- GIF format grew in popularity as it propagated to the web
- Unisys owned patent rights to LZW, unknown to Compuserve, + asserted their rights in 1993.
- Compuserve agreed in 1994 to pay royalties to Unisys.
- patent expired in 2003

- PNG was developed as a public-domain replacement for GIF

GIF came in two flavors:

- 1987
- 1989 - interlacing (progressive transmis + display)
  - multiple images in one file

PNG

PNG - portable network graphics
- PNG's not GIF

- allows for colormap + index image (palette)
- allows for up to 24-bit palette instead 8-bit palette of GIF
- replacement for GIF
- typically, PNG images are smaller th GIF (DEFLATE compression algorit used in zlib)

  - indexed
  - grayscale
  - grayscale w/ alpha channel

- (alpha describes level of transparency of each pixel)
- truecolor
- truecolor w/ alpha
- can do interlacing but no animation

Comparison

JPEG better for natural images (mostly sm

GIF + PNG better for artificial images - drawings, cartoons, diagrams, plots, text (few colors)

PNG is typically smaller than GIF

GIF can do animations

vector formats are ideal for drawings plots, etc. (SVG, EPS, PDF)