Lecture 4 – Digital Multimedia Formats

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Administrative

- HW3 – Due Monday, Oct. 12, 2015
  - Beginning of class
  - Relatively short for quiz
- PA1 – Due Monday, Oct. 19, 2015
- Quiz #1 – Wednesday, Oct. 14, 2015
  - Plan on 60-75 minutes

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Administrative

- Please bring computer / view device next class.

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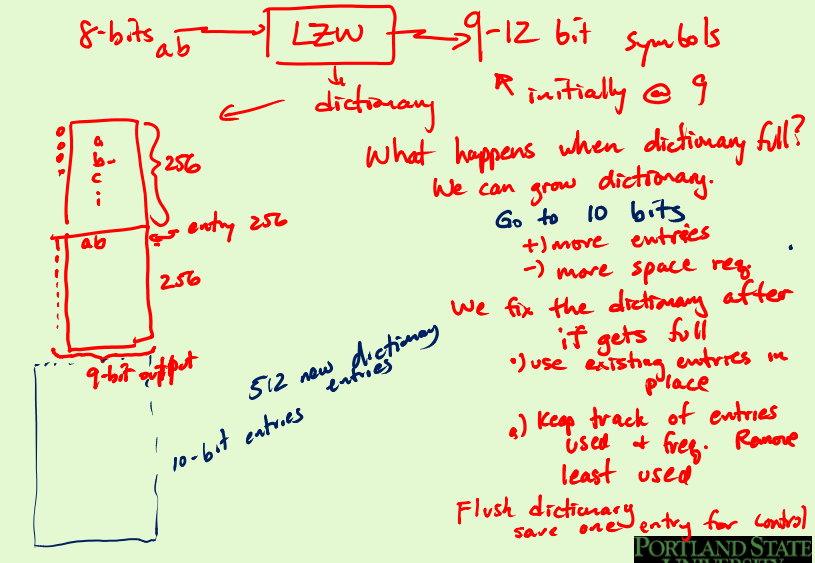
Implementing LZW

Adaptive compression



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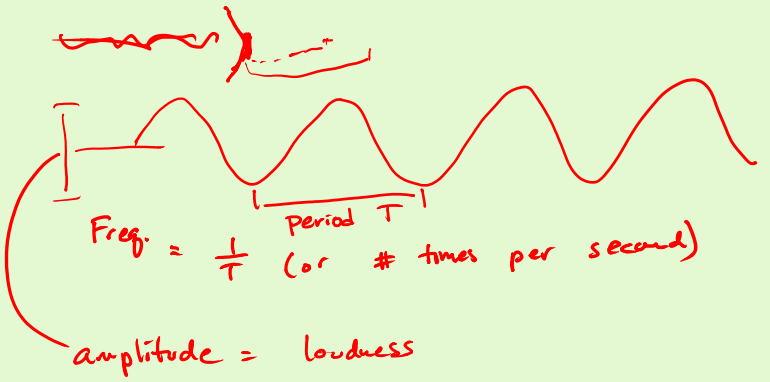
Sound

Pressure variations from vibrating matter



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Speaking / Hearing Range

Humans hearing - 15 Hz - 20 kHz
speak - 50 Hz - 15 kHz

Dogs upto 40kHz
Cats upto 60kHz

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Digital Audio

Computers are digital + use an approximation for continuous audio

Represent as a series of samples
- sampling rate in Hz
- sampling depth ⇐ 5 bits per sample

"A→D conversion" – capture signal
"D→A conversion" – converts back to analog

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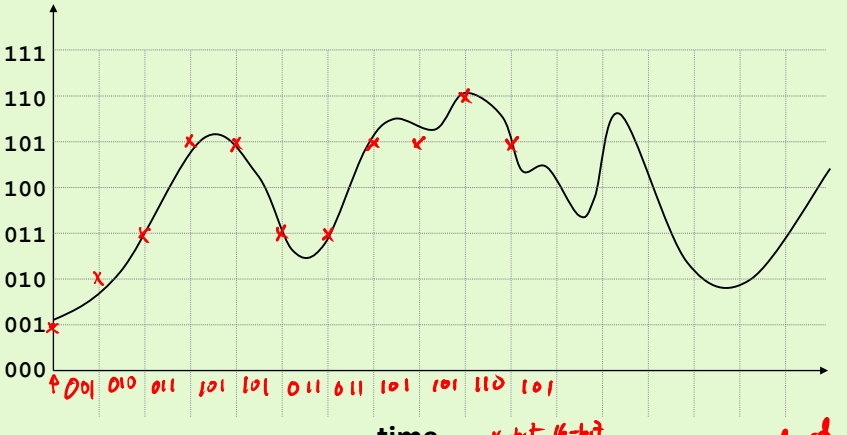
Sampling Digital Audio



CD-audio: 16-bit samples, 44,100 Hz, (L, R) stereo (16-bit, 16-bit) } Gold standard for humans

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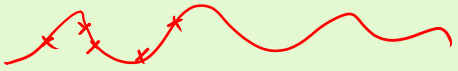
How Many Samples?

Nyquist - sample at 2 times the maximum freq. you want to capture



f_{max} → sample @ $2 \cdot f_{max}$ w/ infinite bits per sample

44100 Hz CD Audio > 2× 20 kHz

a little bit extra

2^{16}

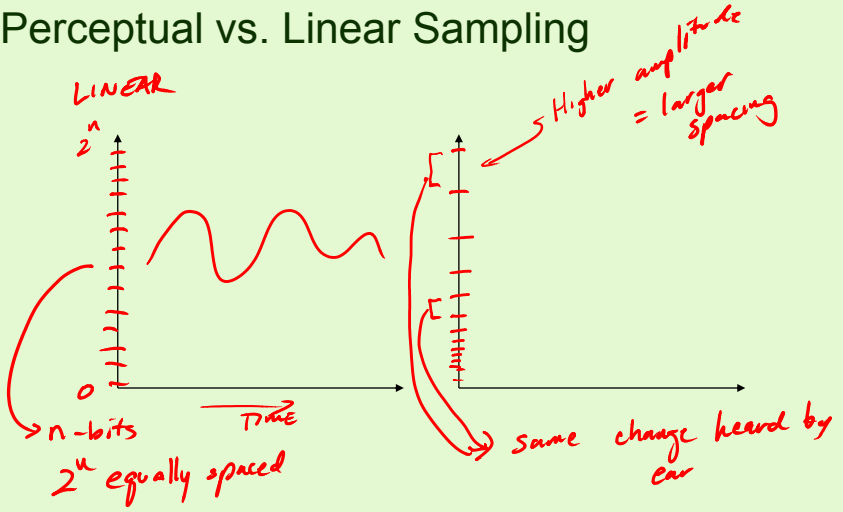
16-bits sample for CD-audio → 65536 unique levels

n levels requires $\log_2(n)$ bits

Audio Formats

- u-law – telephony networks
  - 8-bit samples @ 8000Hz
  - → perceptually uniform encoding
- CD-Audio
  - 16-bit samples
  - 44,100 Hz sample rate
  - 2 channel L/R for stereo
  - $16 \cdot 2 \cdot 44100 \simeq 1.4$ Mbps
- MPEG- Audio – variety of bit rates
  - 64 → 256 kbps
  - Intended for CD-audio data

Perceptual vs. Linear Sampling



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Digital Images

Represented as a matrix of numeric values that are quantized intensity value

Key properties

Resolution - pixels (e.g. 6000x4000 or 24 M pixels)
pixels per inch

Quantization = # of levels to represent intensity
8-bit to 16-bit per channel
8-12 for color
8-16 grayscale / medical

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Color Spaces

Color models used to assign codes to human perceivable colors

RGB - red green blue
- used in light emitting systems
- additive color space
  - R, G, B all at full intensity = white

CMY - cyan magenta yellow
- used in light absorbing systems
- subtractive color space
  - C, M, Y all at full intensity = black
  - Cyan absorb R pass GB
  - Magenta " G " RB
  - Yellow " B " RG

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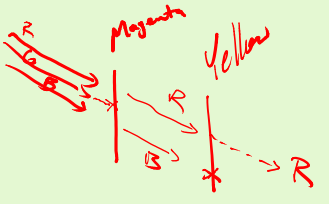
Color Spaces

If you want Red in CMY



CMYK ← K = black
- Used for printers
- All CMY should be black → muddy brown in printing
  - +) better black
  - +) save ink

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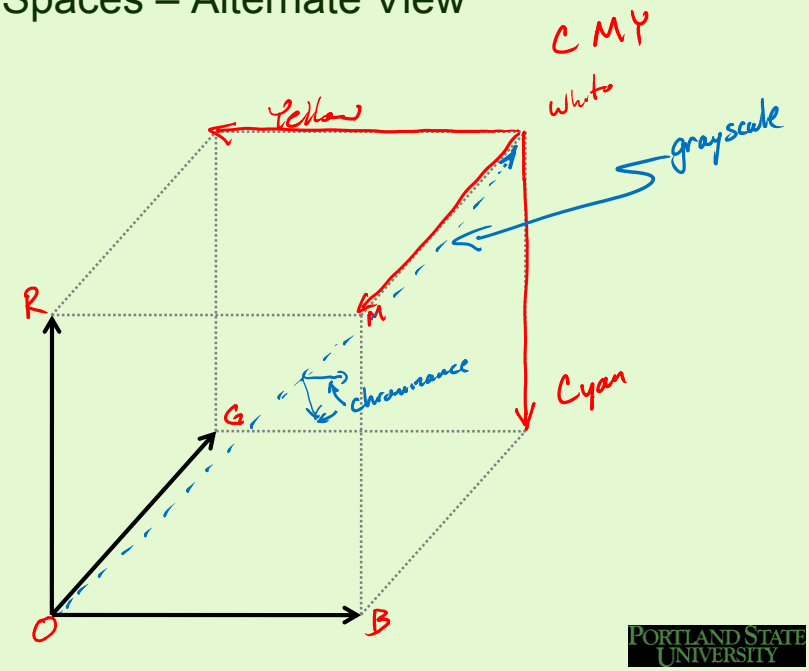
Color Spaces – Alternate View



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Color Spaces – YUV, YIQ

Primarily used for video + television

Y is brightness (luminance)

UV (or IQ) provide color (chrominance)

Humans most sensitive to changes in Y

**

$$\begin{bmatrix} y \\ i \\ q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.528 & 0.311 \end{bmatrix} \begin{bmatrix} r \\ g \\ b \end{bmatrix}$$

$$\begin{bmatrix} y \\ u \\ v \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.169 & -0.331 & 0.500 \\ 0.500 & -0.419 & -0.081 \end{bmatrix} \begin{bmatrix} r \\ g \\ b \end{bmatrix}$$

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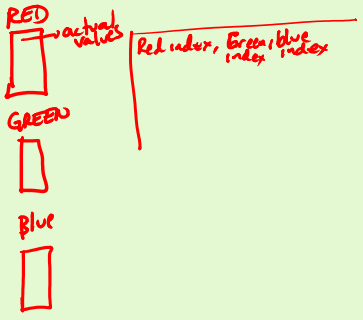
Storing Images

Store or put in memory

1) Tuples (R, G, B)

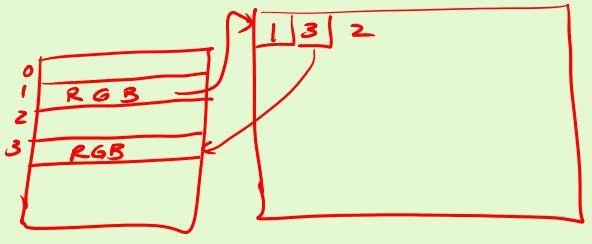
RGBRGBRGB ... -->

2) Three # that are indices into RGB intensity table



Saves space when, for example, only 8-colors of red.
↳ index for red only needs to be 3-bits

3) A single # that's an index to a table of RGB colors



GIF uses 8-bit 256 color max color table

Video history

att.com

- 1927 – First long distance “TV”
- 1936 – 200 TV sets in use world wide
  - BBC television
  - 240 lines of resolution
- 1937 – CBS begins
- 1939 – Demonstration at World’s Fair by RCA
- 1941 – FCC releases NTSC standard for black and white TV
- 1950 – FCC approves color TV standard
- 1967 – Most TVs broadcasts are in color
- 1980’s – Begin development of HDTV
- 2009 – HDTV broadcast only in USA

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An early TV

- Still have artifacts today…

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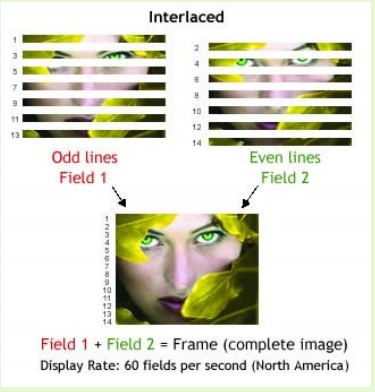
Analog video

- NTSC – National Television Standards Committee
  - Lots of decisions made by technology concerns
  - First black and white
  - 525 lines of resolution
    - 480 visible
  - 2:1 interlaced
  - 60 Hz
  - 4:3 ratio



http://reocities.com/SiliconValley/vista/7055/cable.htm
http://mintywhite.com/more/hardware-more/highdefinition-720p-1080i-1080p/

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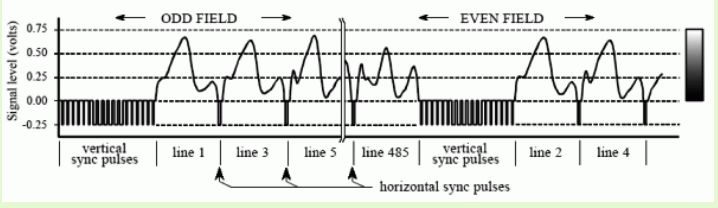
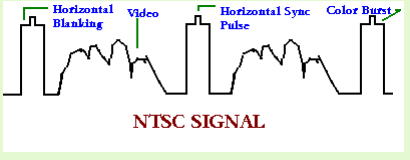
Analog video

- NTSC – National Television Standards Committee





http://oocities.com/SiliconValley/vista/7055/cable.htm
http://www.dspguide.com/ch23/3.htm

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Analog video

- PAL / SECAM
  - NTSC – hue correction errors, more susceptible to noise (small luminance bandwidth)
  - 625 lines of resolution
    - 576 visible
  - 2:1 interlaced
  - 50 Hz
  - 4:3 ratio

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