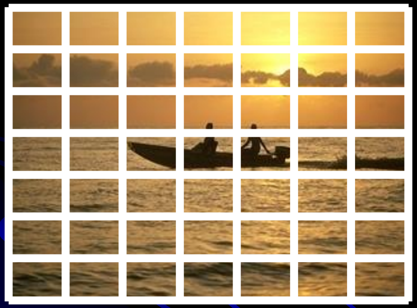
CSSE463: Image Recognition Day 2

- Roll call
- Announcements:
  - Moodle has drop box for Lab 1
  - Next class: lots more Matlab how-to (bring your laptop)
- Questions?
- Today: Color and color features
  - Do questions 1-2 about ICME sunset paper now

Q1-2

Pixels to Predicates

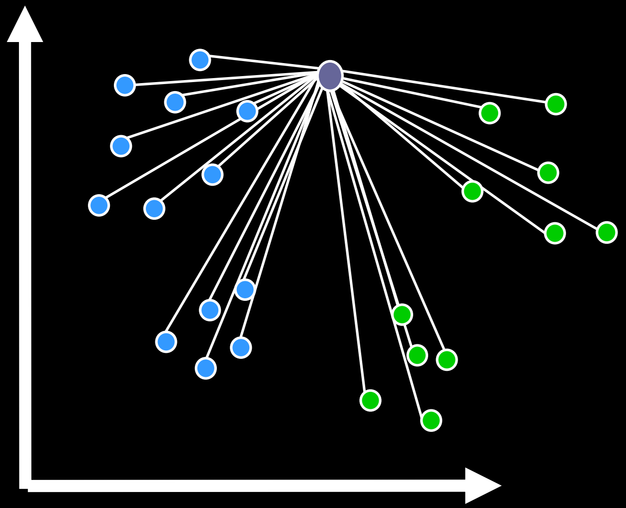
1. Extract features from images



$$x = \begin{pmatrix} 0.4561 \\ 0.1928 \\ \ldots \\ 0.2756 \end{pmatrix}$$

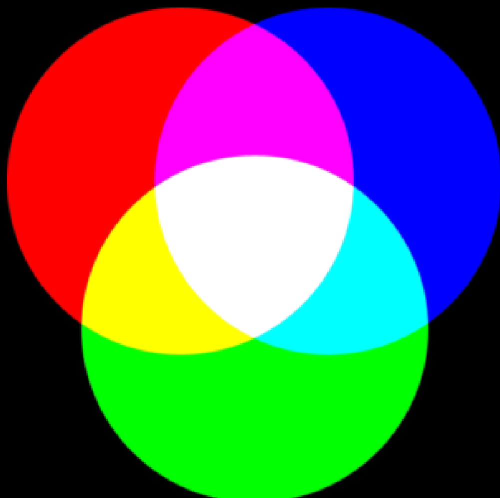
Color
Texture
Shape
Edges
Motion

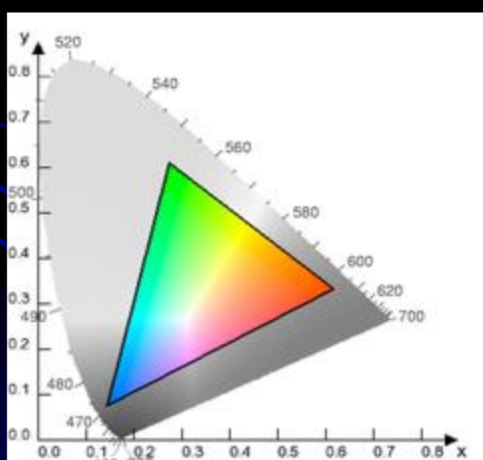
2. Use machine learning to cluster and classify



Principal components
Neural networks
Support vector machines
Gaussian models

Basics of Color Images





Source: Wikipedia

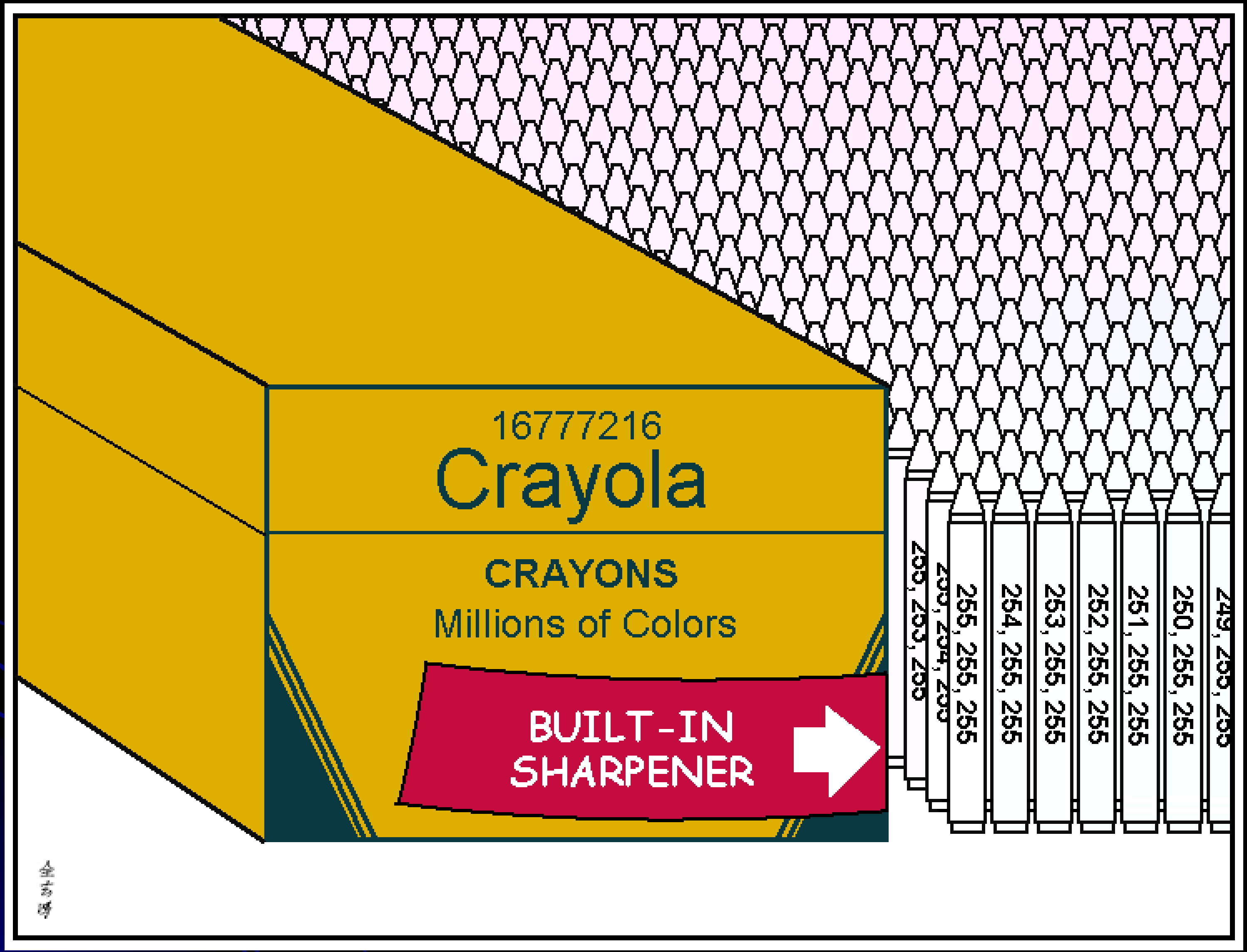
- A color image is made of red, green, and blue *bands*.
  - Additive color
    - Colors formed by adding primaries to black
  - Comments from graphics?
  - RGB mimics retinal cones in eye.
  - RGB used in sensors and displays
    - Why "16M colors"?
    - Why 32 bit?

Basics of Color Images

- Each band is a 2D matrix

- Each R, G, or B value typically stored in a byte.
  - Range of values?
- The 4th byte is typically left empty
  - Allows for quicker indexing, because of alignment
  - Reserved for transparency (in graphics)

- How much storage, in KB, is required for a 128x192 thumbnail color image (uncompressed, including unused 4th bytes)?



http://abstrusegoose.com/221

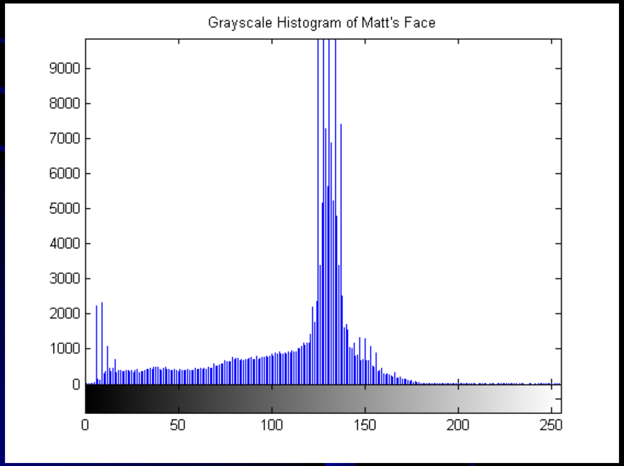
We can extract different types of color features (statistics) from images

- 1. Color histograms
- 2. Color moments
- 3. Color coherence vectors

Related considerations:

- Some color spaces “work better”
- Spatial components can help

Color histograms



- Gives distribution of colors
- Sample to left is for intensities only
- Pros
  - Quantizes data, but still keeps lots of info
- Cons
  - How to compare two images?
  - Spatial info gone
  - Histogram intersection (Swain and Ballard)

Color moments

$m_1 = 116.3$
$m_2 = 1152.9$
$m_3 = -70078$
$m_4 = 7.4$ million

$m_1 = 132.4$
$m_2 = 2008.2$
$m_3 = 4226$
$m_4 = 12.6$ million

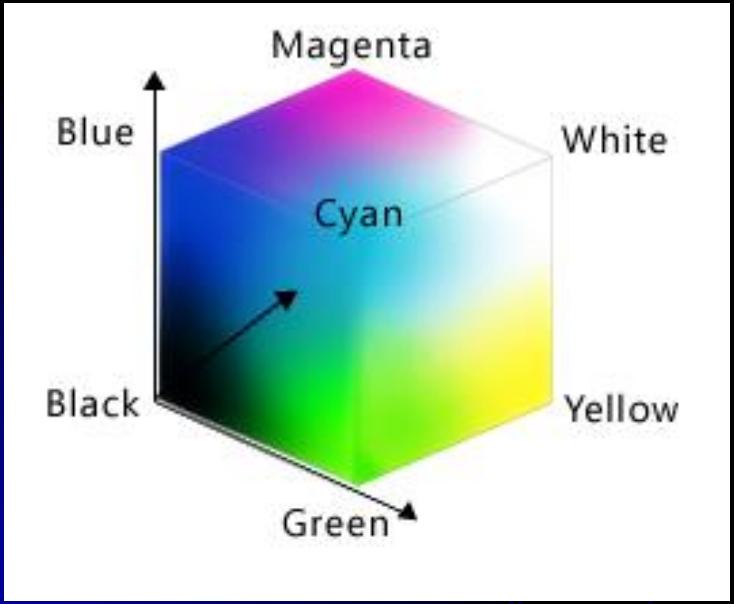
$$m_d = \frac{1}{n}\sum_{i=1}^{n}\left(x_i - \mu\right)^d$$

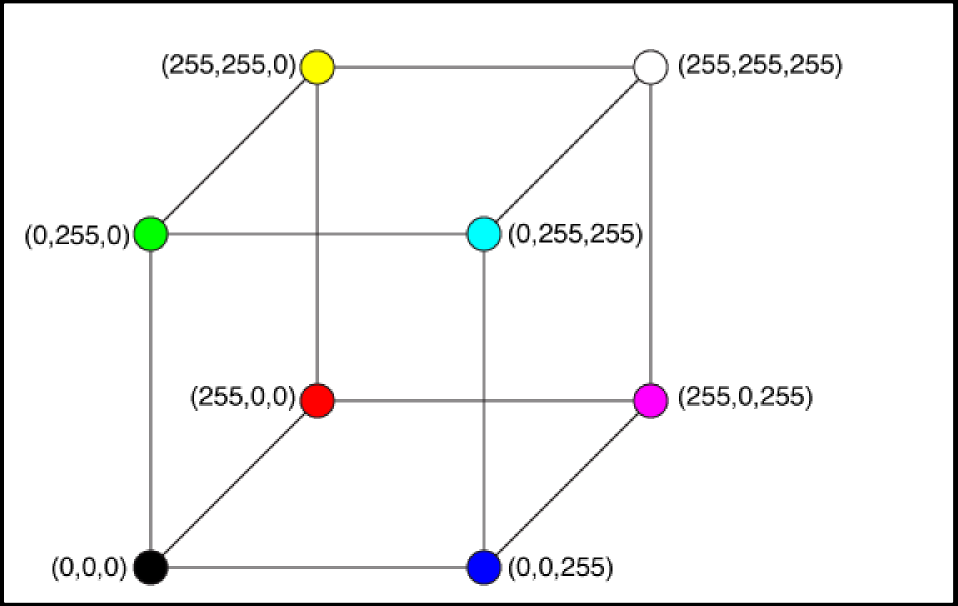
- Central moments are *statistics*
  - 1st order = mean
  - 2nd order = variance
  - 3rd order = skew
  - 4th order = kurtosis
  - Some have used even higher order moments, but less intuitive
- For color images, take moments of each band

RGB color space

- Red/green/blue
- Rectangular axes

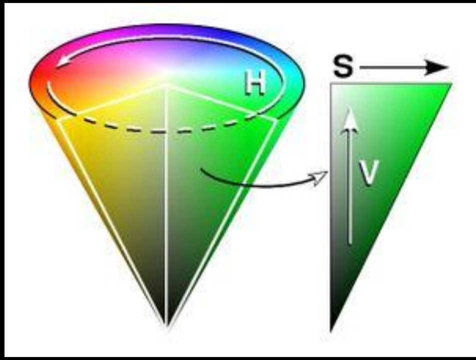
- Simple, but non-intuitive

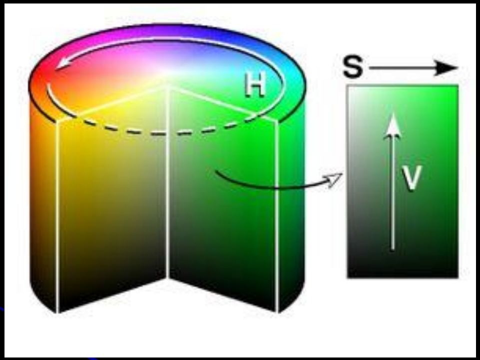


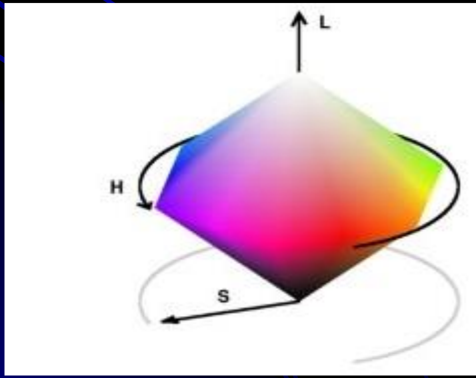


http://xstitch.zachrattner.com/Images/RGBCube.png
http://dev.bowdenweb.com/css/colors/i/rgb-color-space-visualized-as-a-cube-msdn.png

HSV color space







- Hue-saturation-value (HSV) cone
  - also called HSI (intensity)
  - Intuitive
    - H: more than "what color": it's wavelength; position on the spectrum!
    - S: how vibrant?
    - V: how light or dark
- "Distance" between colors
  - Must handle wraparound of hue angle correctly ($0 = 2\pi$)
- Matlab has method to convert from rgb to hsv, can find formula online.

Wikipedia, http://www.getreuer.info/_/rsrc/1311740880043/home/colorspace/colorspace_01.jpg?height=209px&width=462px

Interactive HSV color picker

- http://www.colorpicker.com/

Other color spaces

- LST (Ohta)[1]
  - L = luminance: L = (R + G + B)/sqrt(3)
  - S and T are *chroma* bands.
    - S: red vs. blue: S = (R – B) / sqrt(2)
    - T: green vs. magenta: T = (R – 2G + B) / sqrt(6)
  - These 3 are the *principal components* of the RGB space (PCA and eigenvectors later in course)
  - Slightly less intuitive than HSV
  - **No problem with wraparound**
- Others
  - YIQ (TV signals), QUV, Lab, LUV
  - http://www.scarse.org/docs/color_faq.html#graybw

Y. I. Ohta, T. Kanade, and T. Sakai, Color information for region segmentation, Computer Graphics and Image Processing, Vol. 13, pp. 222-241, 1980. http://www.ri.cmu.edu/pub_files/pub4/ohta_y_1980_1/ohta_y_1980_1.pdf

Spatial component of color

- Break image into parts and describe each one
  - Can describe each part with moments or histograms
- Regular grid
  - Pros?
  - Cons?
- Image regions
  - Pros?
  - Cons?

Additional reading

- Color gamuts
  - http://en.wikipedia.org/wiki/Gamut
- Color coherence vectors
  - Extension of color histograms within local neighborhoods
  - Used in:
    - A. Vailaya, H-J Zhang, and A. Jain. On image classification: City images vs. landscapes. Pattern Recognition 31:1921-1936, Dec 1998.
  - Defined in:
    - G Pass, R Zabih, and J Miller. Comparing images using color coherence vectors. 4th ACM Conf. Multimedia, pp 65-73, Boston, 1996.