Introduction to Computer Vision

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Lecture 9

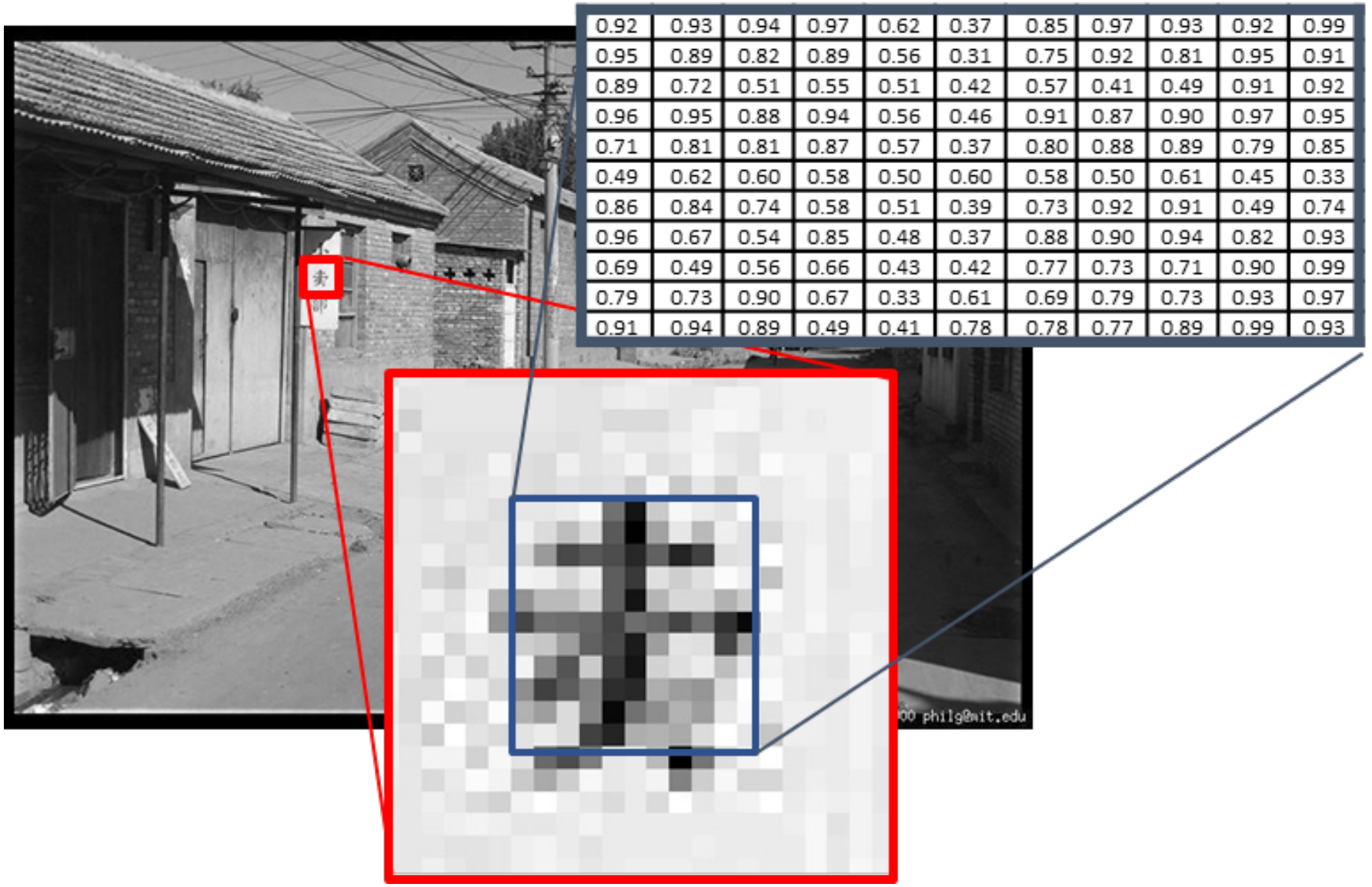
Color

Color

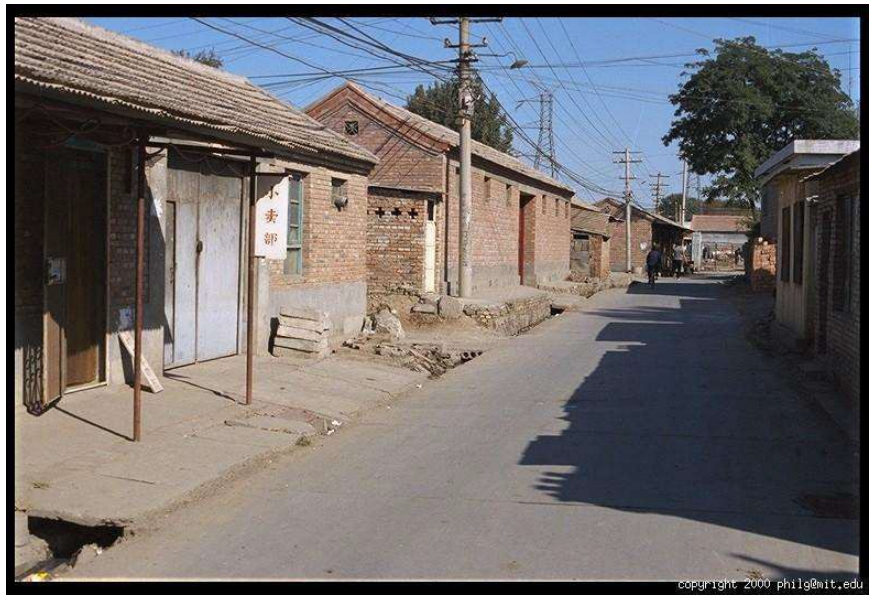
Learning outcomes:

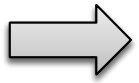
- Frequency Spectrum
- Color Cameras
- Bayer Filter
- Color Spaces

Grayscale intensity



Color





R

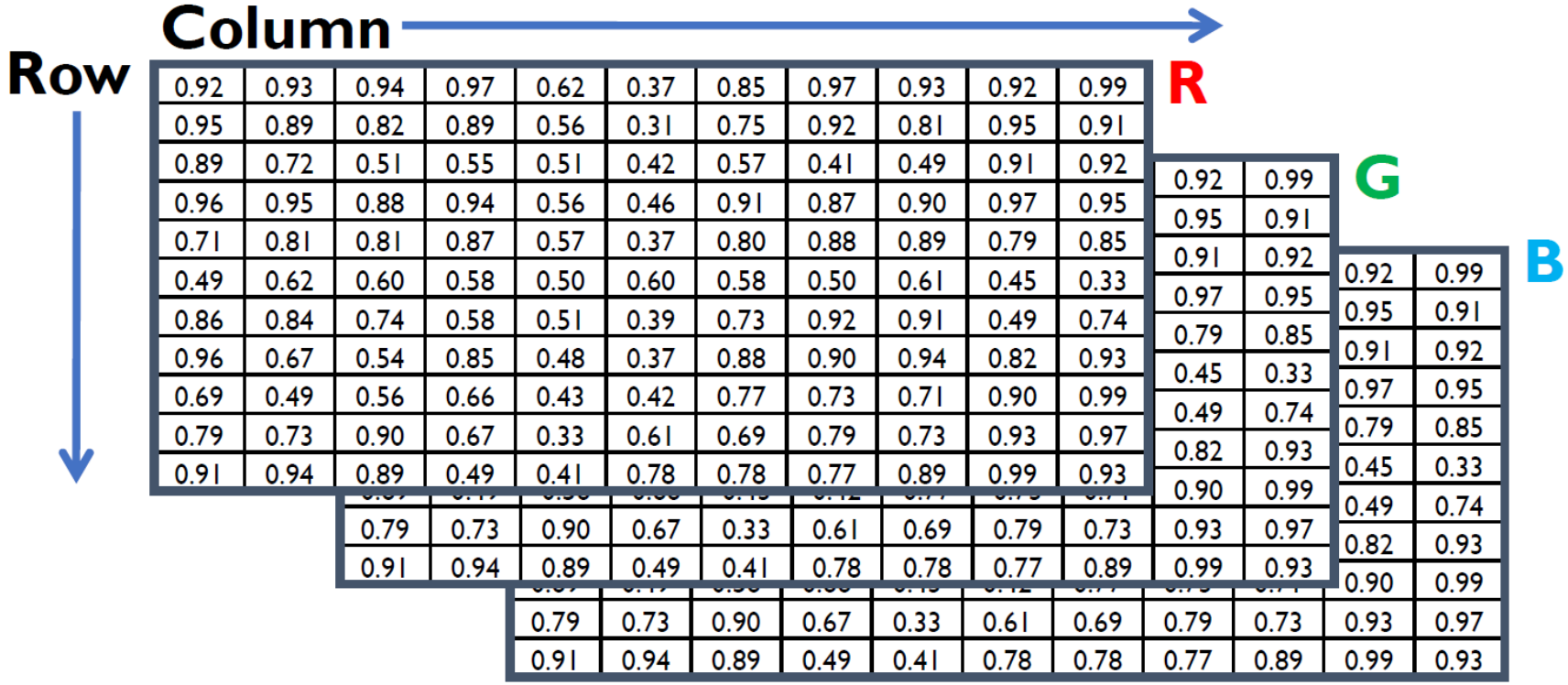
G

B

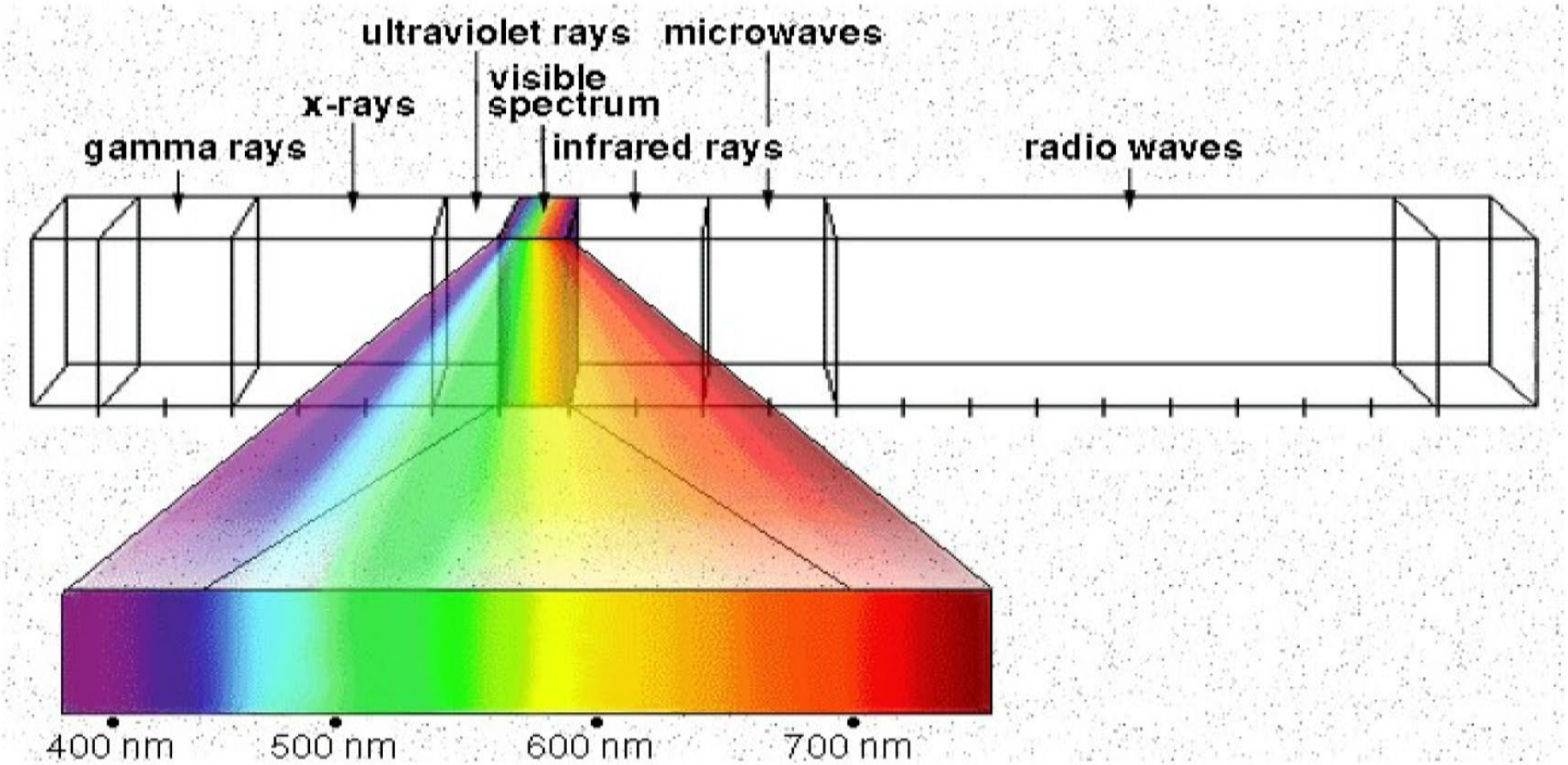
Images in Python (import numpy)

N x M grayscale image "im"

- im[0,0,0] = top-left pixel value, red channel
- im[y,x,1] = y pixels down, x pixels to right, green channel
- im[N-1,M-1,2] = bottom-right pixel, blue channel



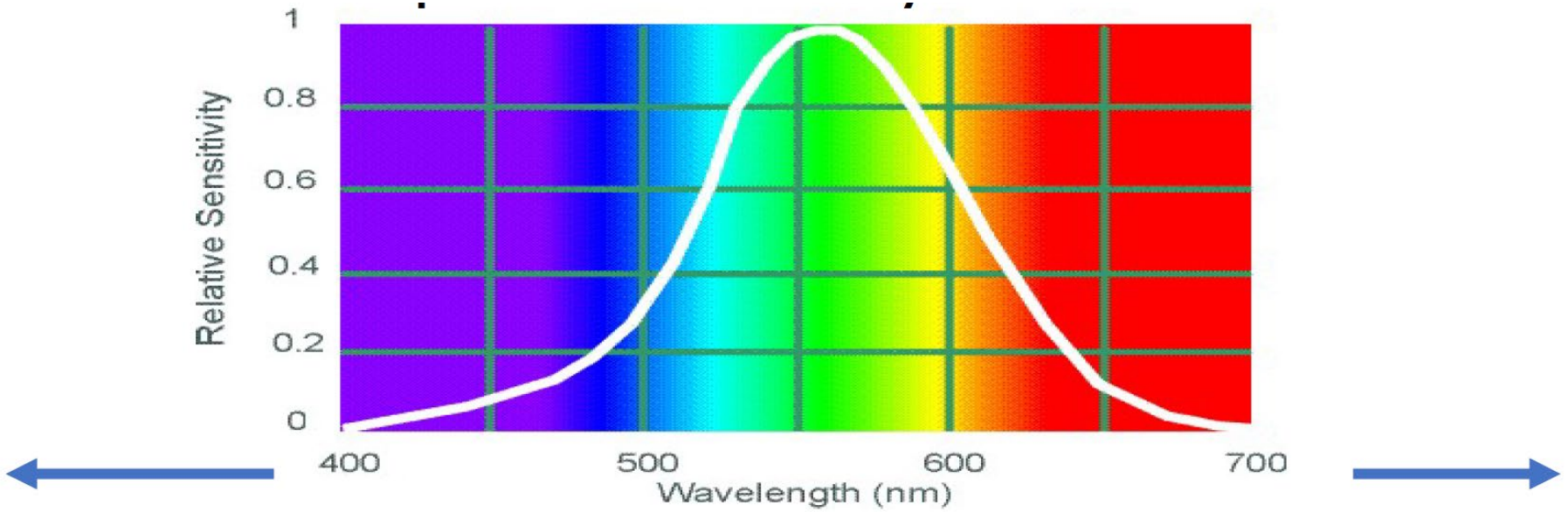
Electromagnetic Spectrum



Wavelength of light
and its perceived color

Human Spectral Sensitivity

Approximate human spectral sensitivity

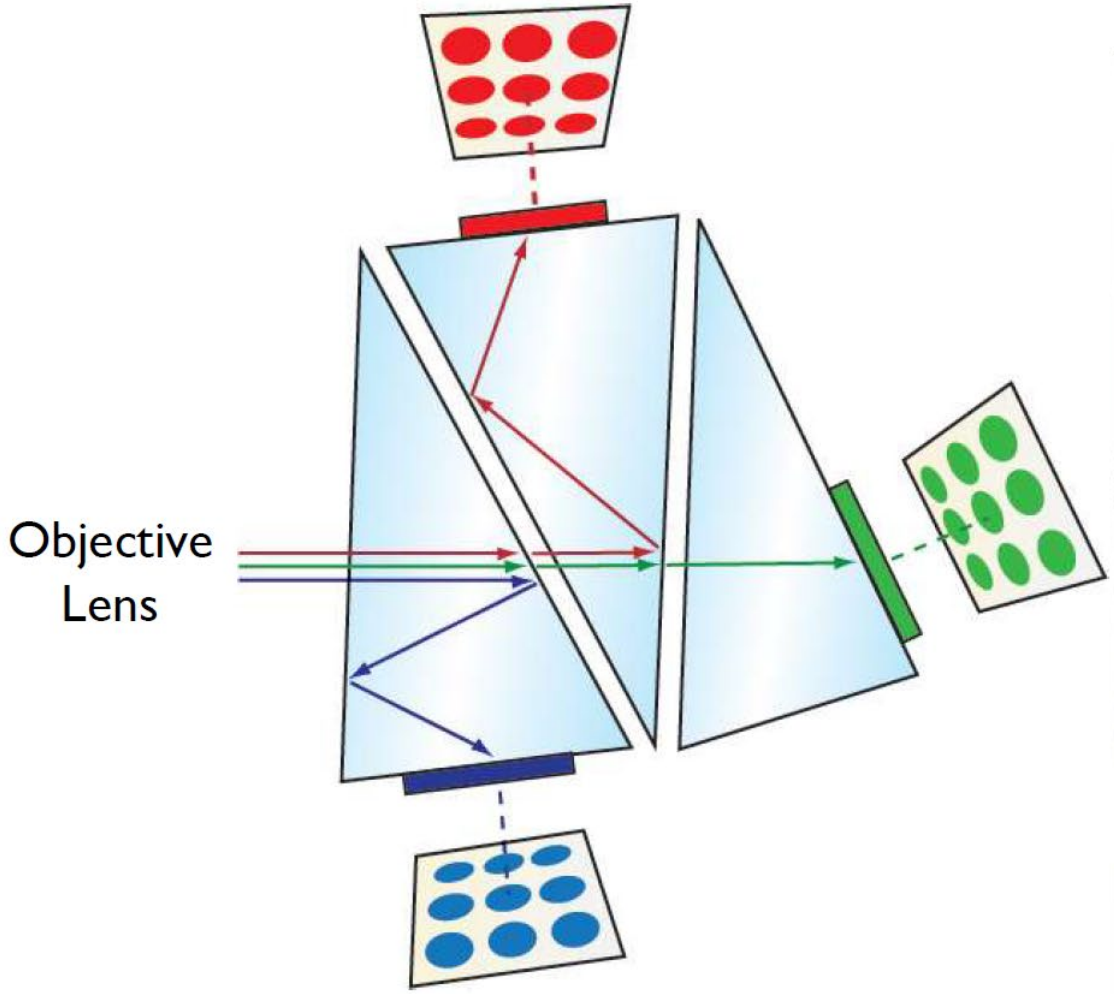


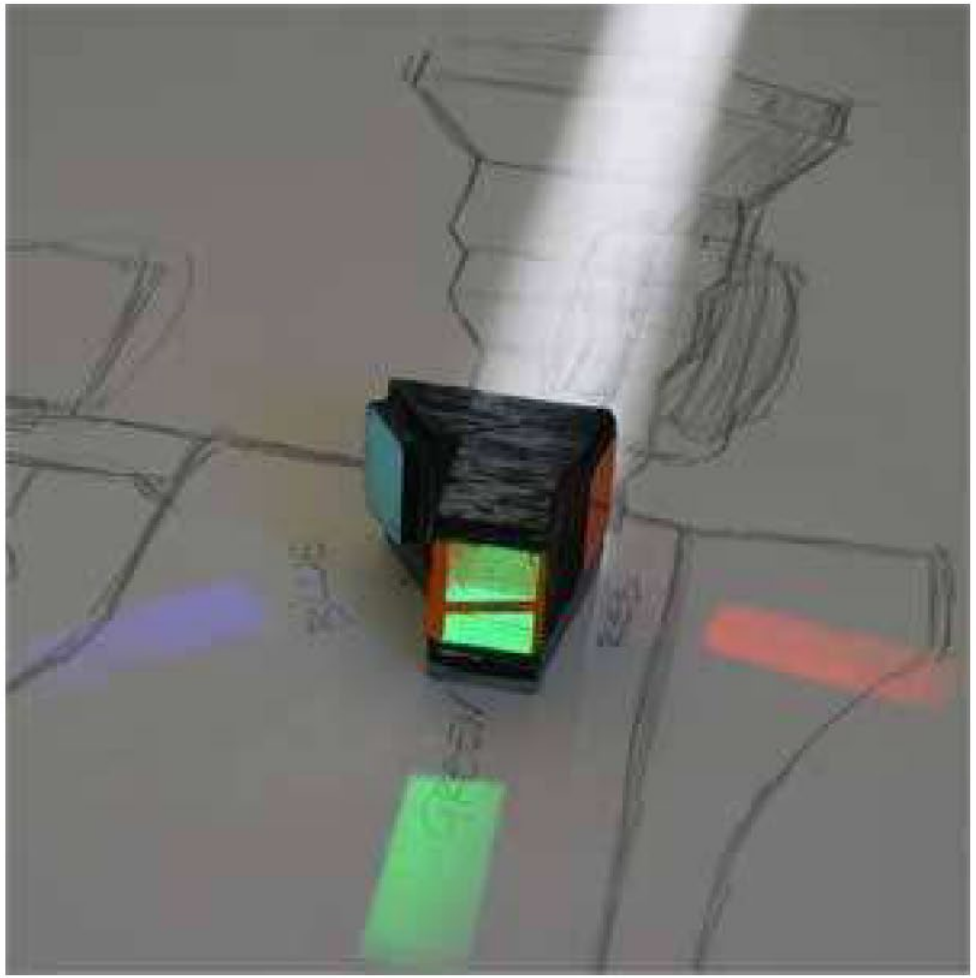
Less than ~400nm to 10nm = ultraviolet (UV)

Human visible portion of electromagnetic (EM) spectrum

Greater than ~700nm to 1mm = infrared (IR)

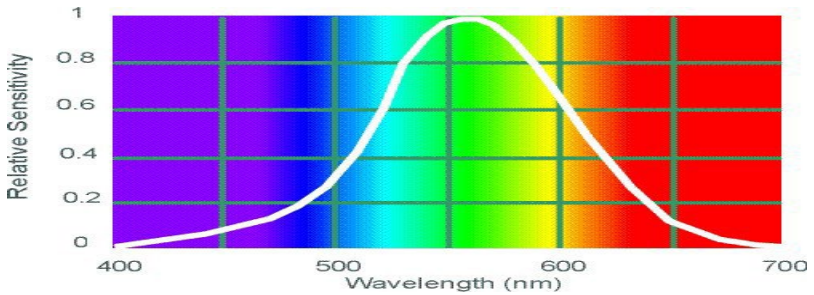
Cameras with 3 Sensors

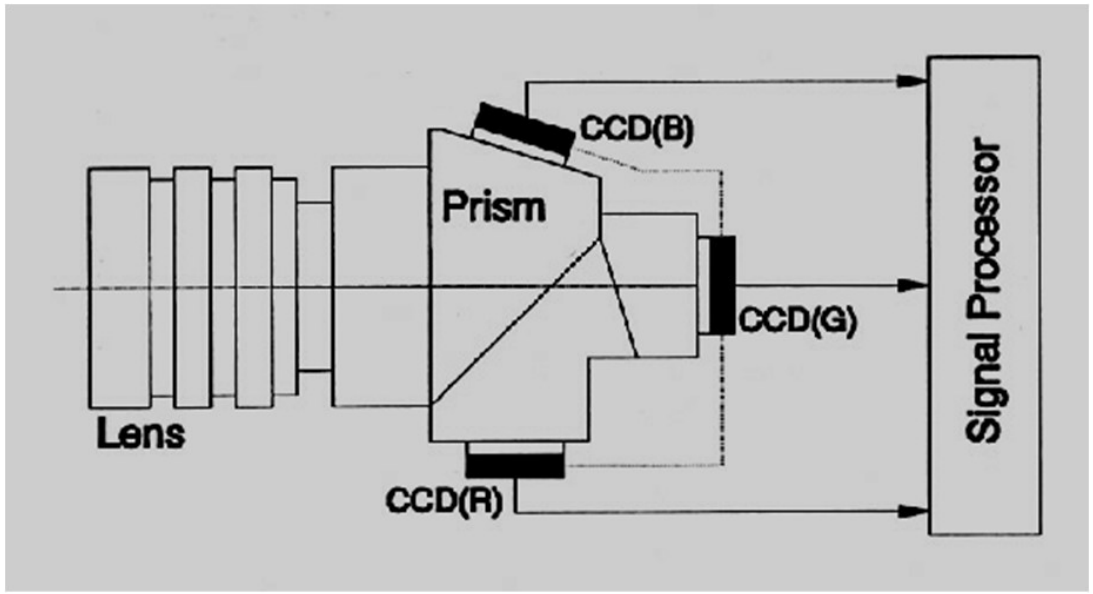


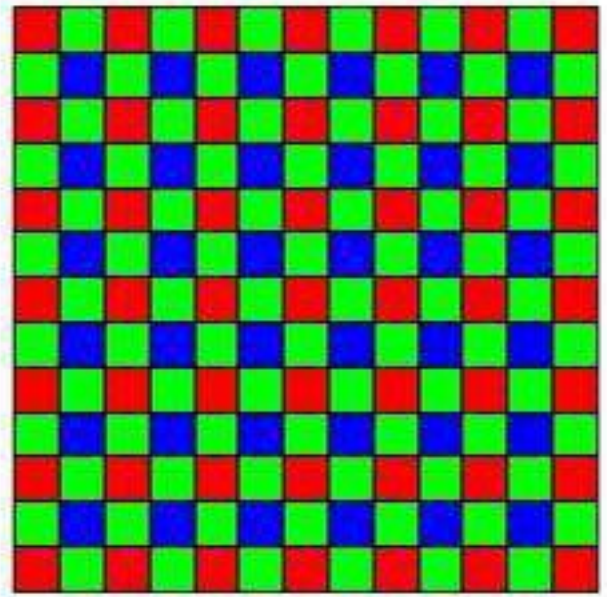


Color Sensing in Camera (RGB)

- 3-chip vs. 1-chip: quality vs. cost
- Why more green?
- Why 3 colors?



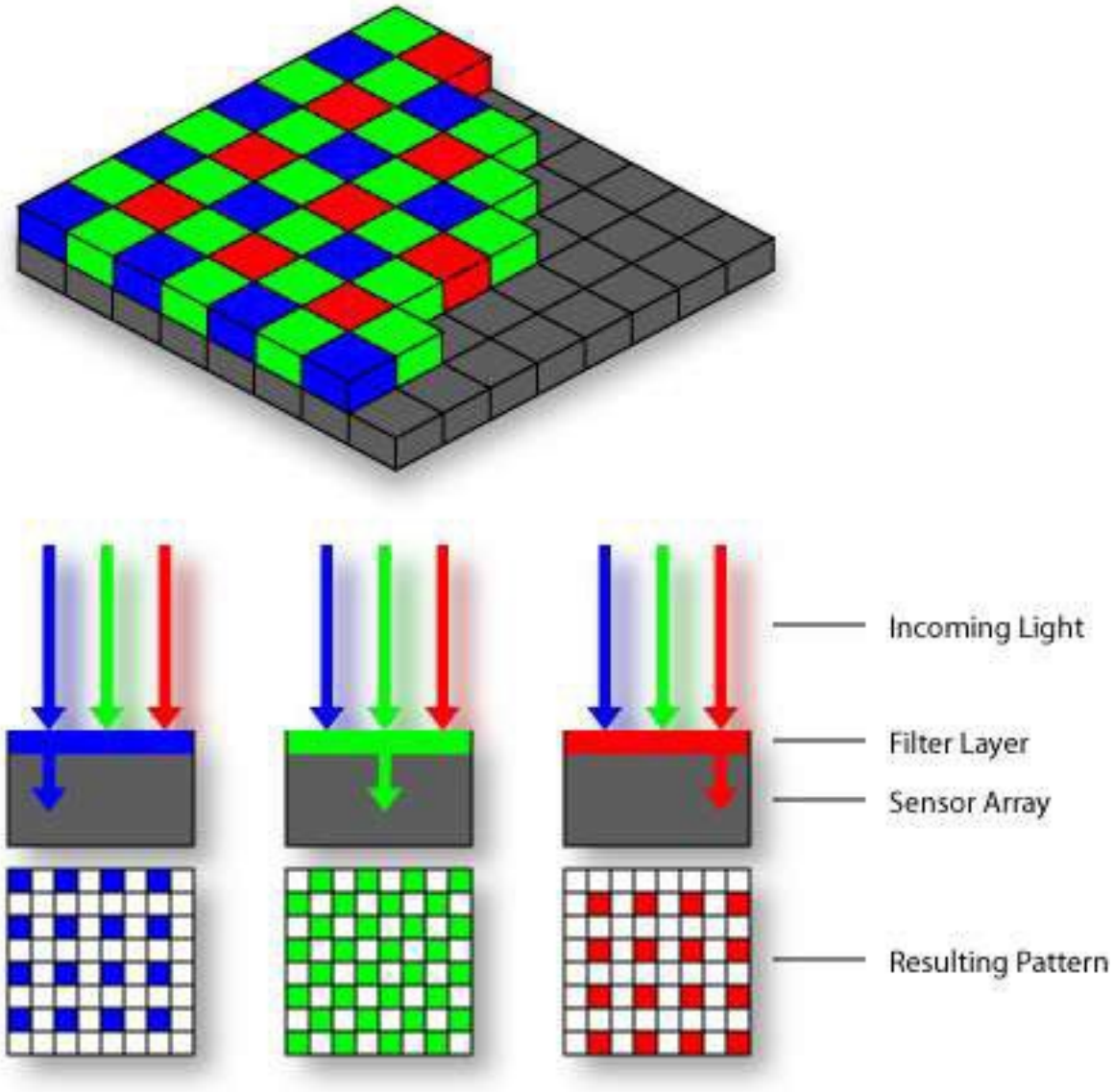


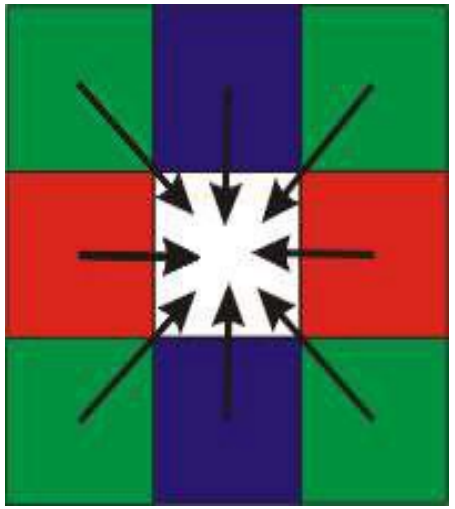


Bayer filter

http://www.cooldictionary.com/words/Bayer-filter.wikipedia

Additional Slide: Bayer Grid

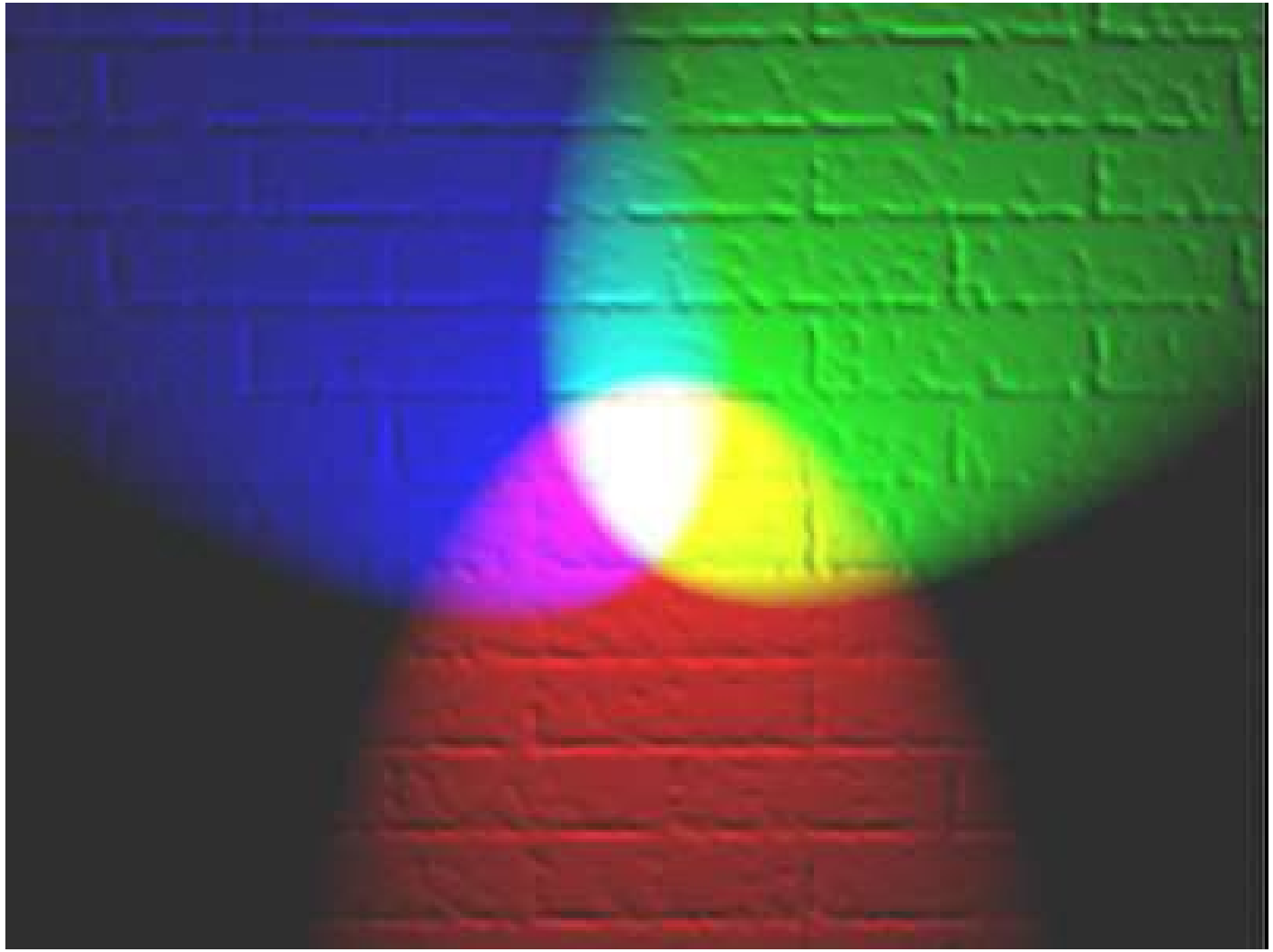




Estimate RGB
at ‘G’ cells from
neighboring values

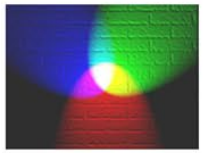
Color spaces

How can we represent color?



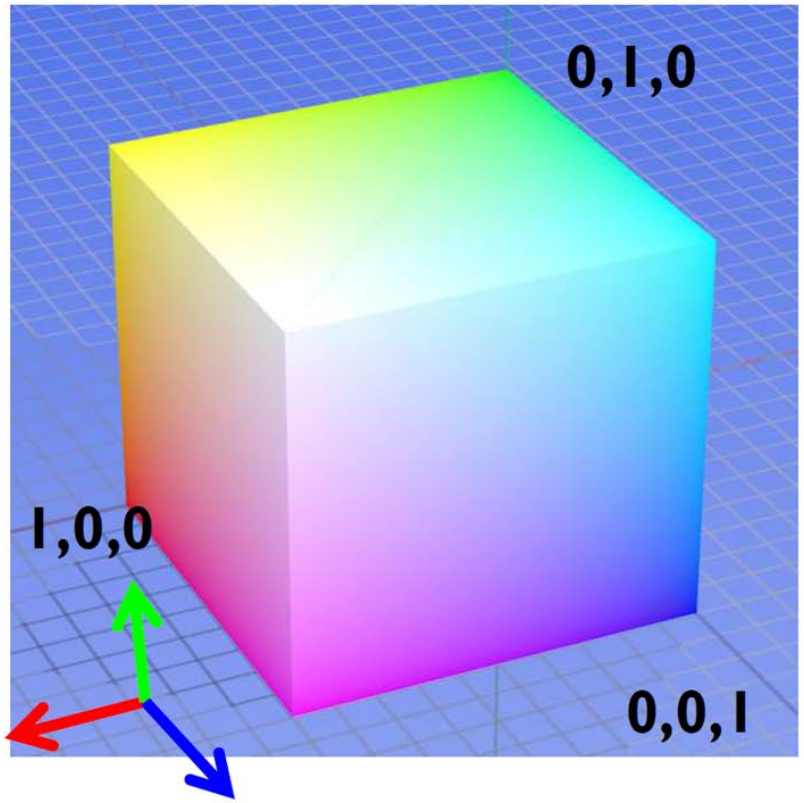
http://en.wikipedia.org/wiki/File:RGB_illumination.jpg

Color spaces: RGB



Additive color model

Default color space



Any color = r*R + g*G + b*B

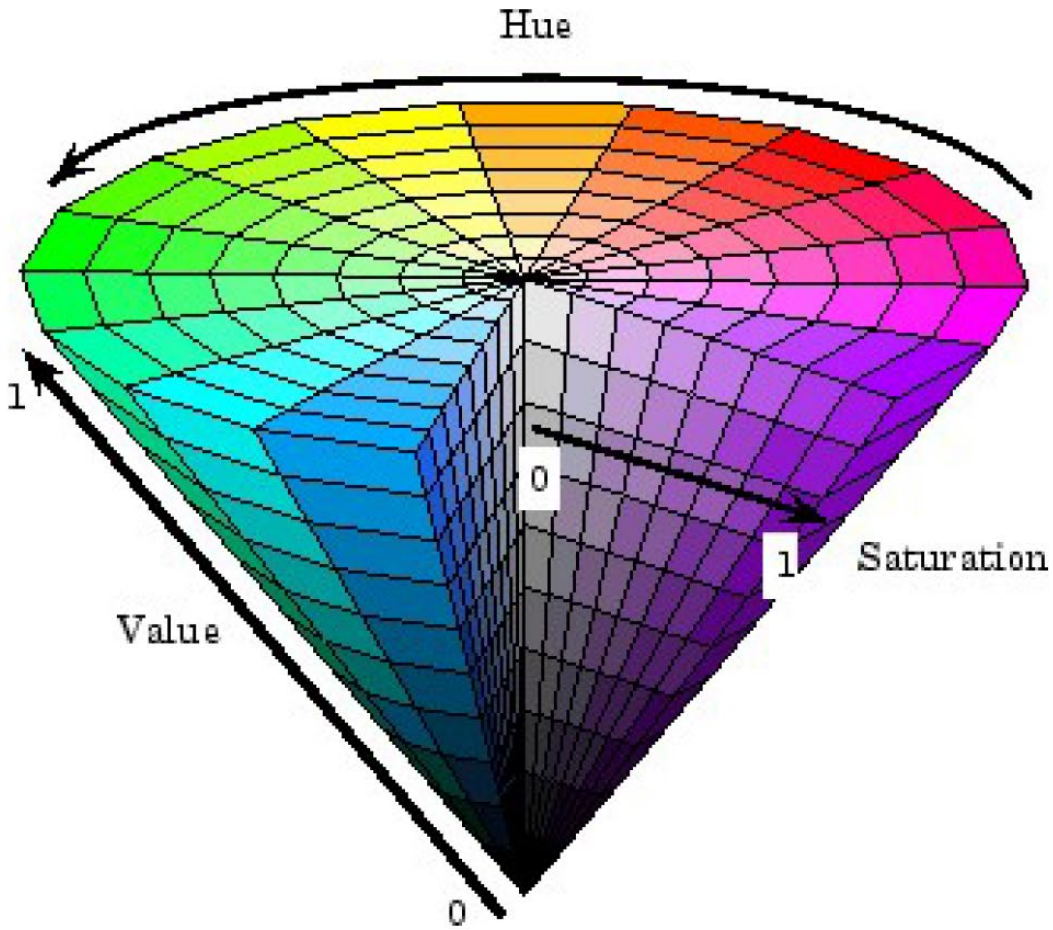
R = 1
(G=0,B=0)

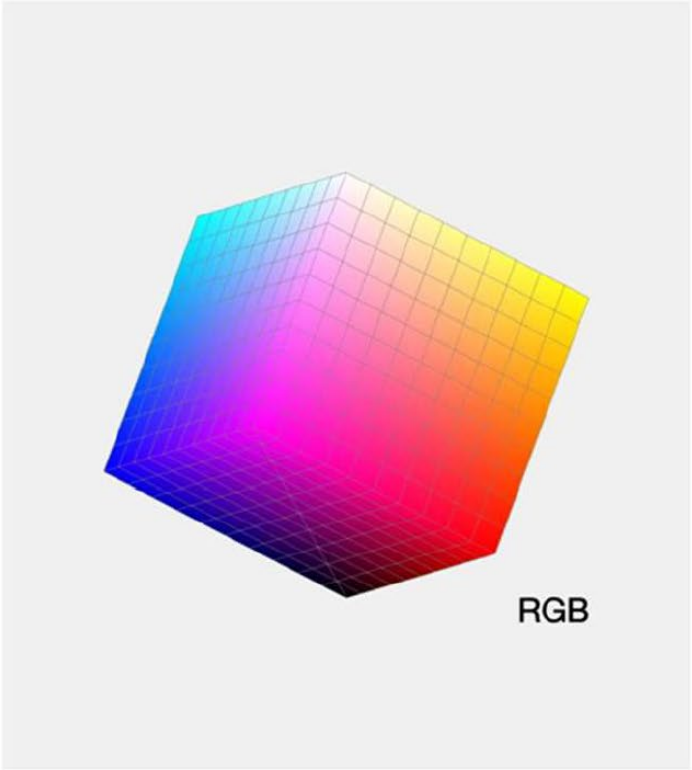
G = 1
(R=0,B=0)

B = 1
(R=0,G=0)

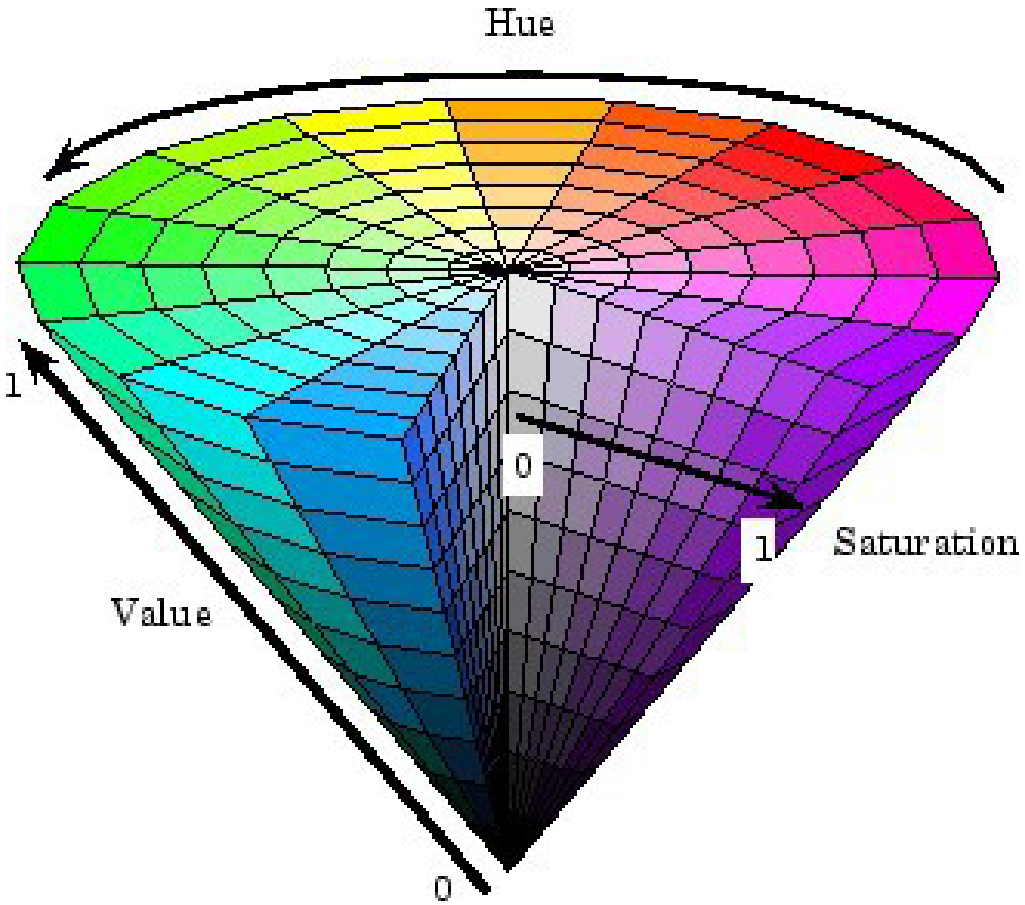
Color spaces: HSV

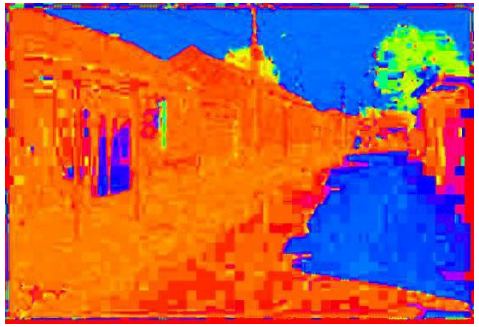
Intuitive color space





Color spaces: HSV





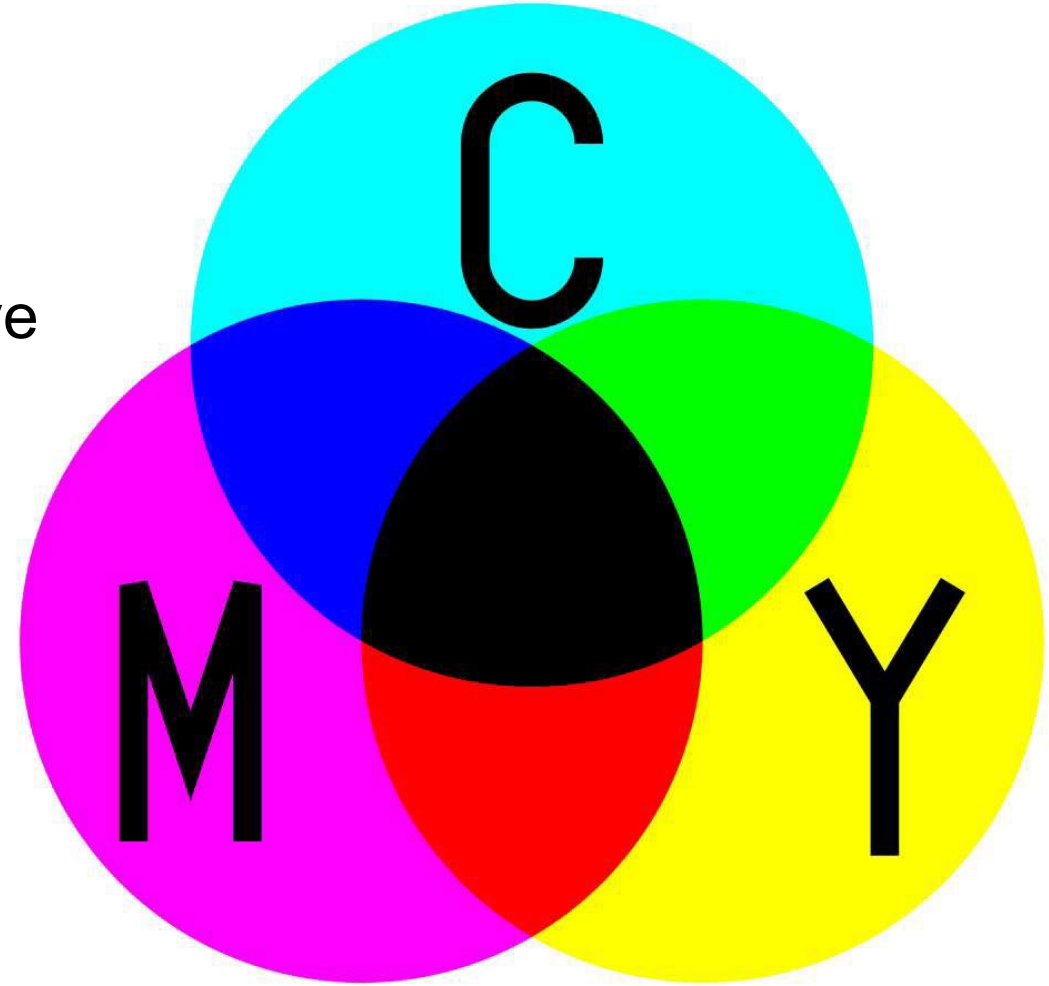
H
(S=1,V=1)

S
(H=1,V=1)

V
(H=1,S=0)

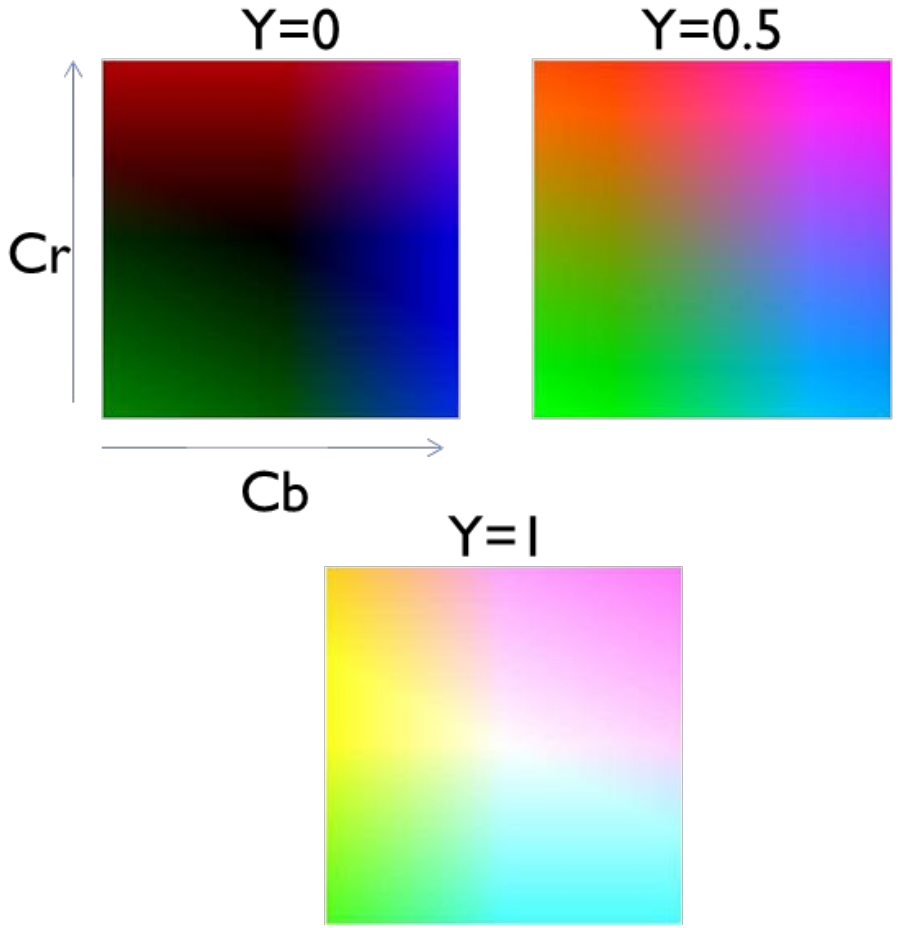
Color Spaces: CMYK

- **Subtractive** color model
- What if light passes through successive layers of absorbing media?
- Printers use this



Color spaces:YCbCr

- YCbCr separates brightness (luma) from color (chroma).
- Y represents luma, Cb and Cr represent blue and red difference
- Fast to compute, good for compression, used by TV



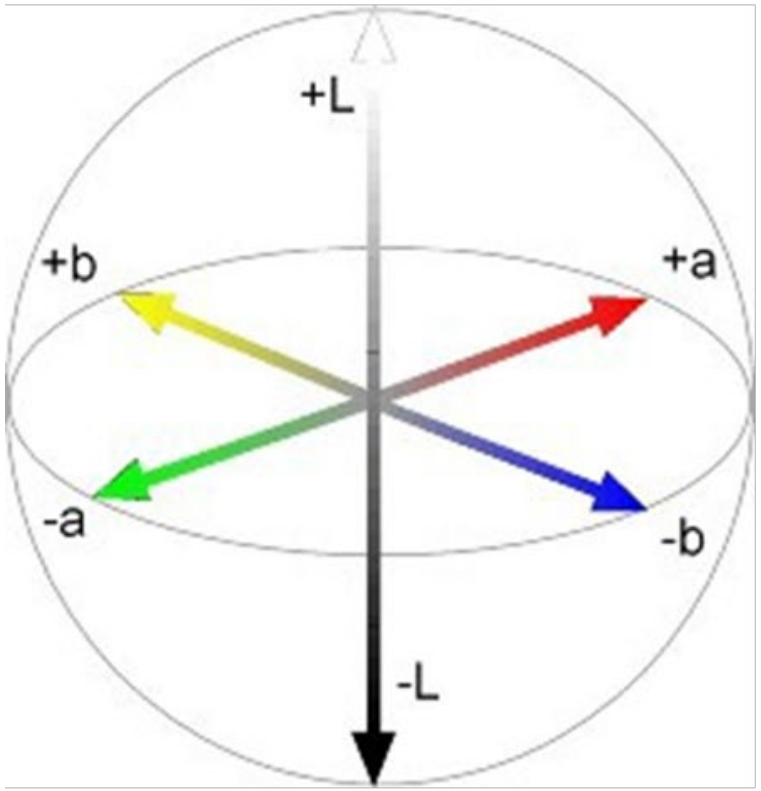
Y
(Cb=0.5,Cr=0.5)

Cb
(Y=0.5,Cr=0.5)

Cr
(Y=0.5,Cb=05)

Color spaces: L*a*b*

"Perceptually uniform" color space



L
(a=0,b=0)

a
(L=65,b=0)

b
(L=65,a=0)

Application

Colors can be used to segment out & track objects