

281 Live Session

Week 3 – 2023/1/25

Agenda

- Overview of Units 2 & 3
- Bonus material on color spaces
- Group exercise (Histogram Equalization)

Discussion Questions

1: Perspective Projection

2: Image Formation

3: Image Artifacts

4: Convolution

5: Fourier

6: Pyramids, Edges, and Features

7: Image Analysis

8: Least-Squares

9: Total and Iterative Least-Squares

10: Clustering

11: Dimensionality Reduction

12: Linear Classifiers

13: Nonlinear Classifiers

2.2 Thin Lens

2.3 Depth of Focus

2.4 Color Filter Array (CFA) (With Exercise)

2.5 Pixels

2.6 Exposure

3.2 Chromatic Aberrations and Noise

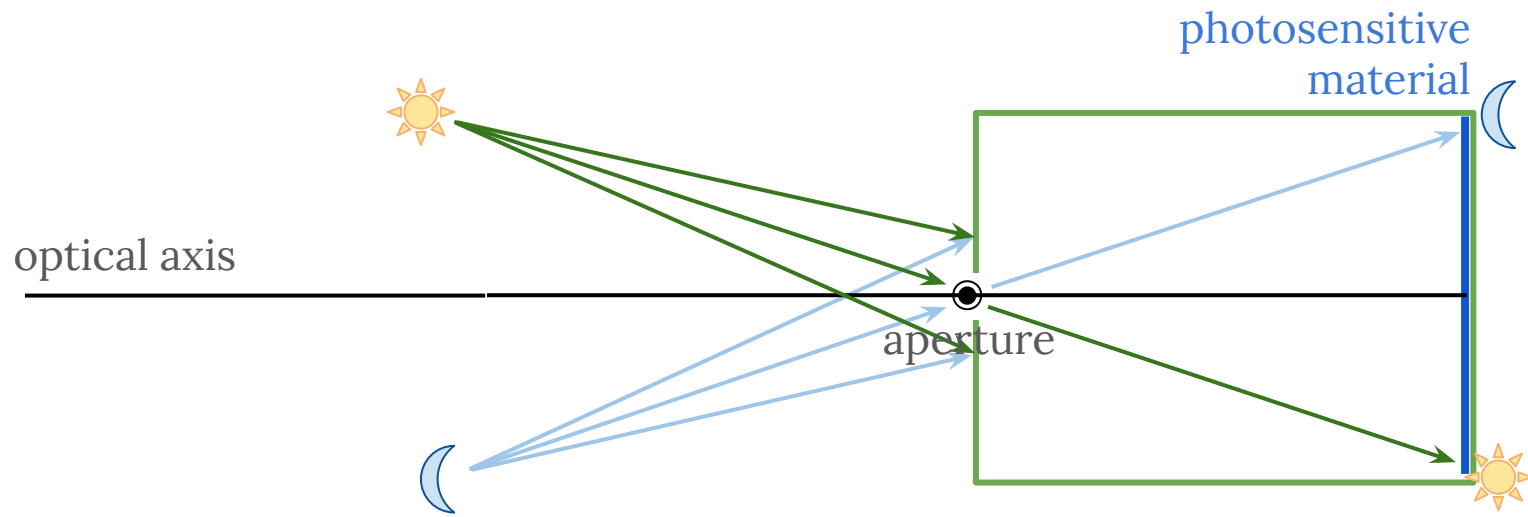
3.3 Lens Distortion (With Exercise)

3.4 JPEG Compression (With Exercise)

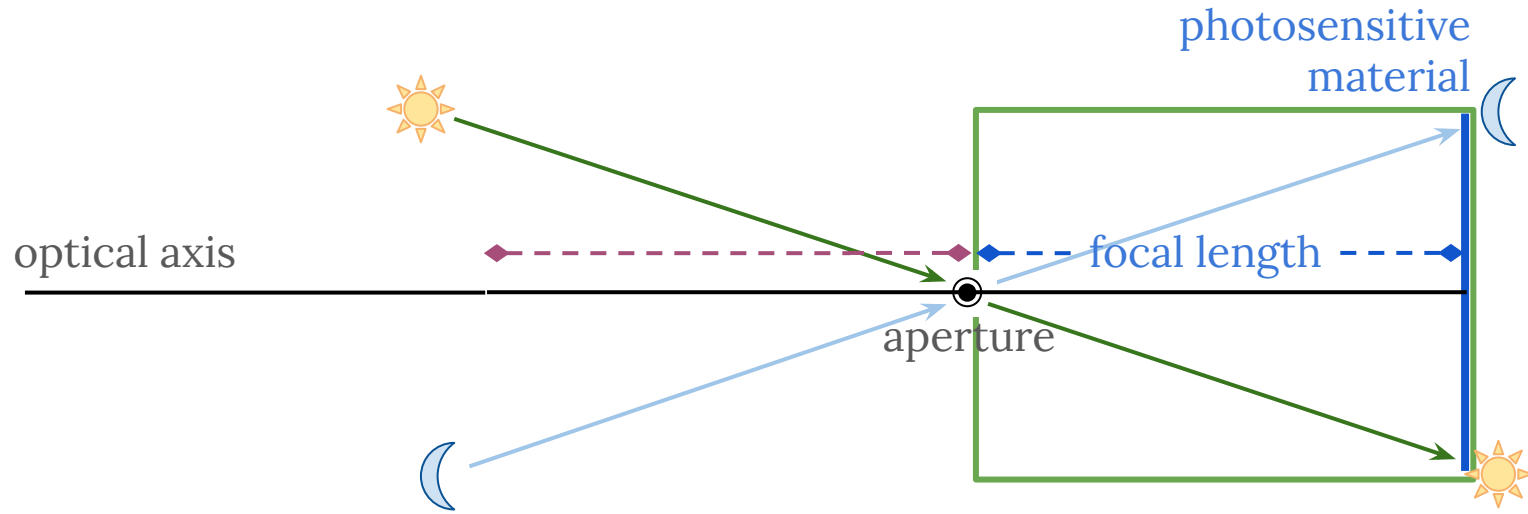
3.5 Summary

- What is the focal length of a lens?
- How does a camera sensor differentiate between colors?
- What is demosaicing?
- Why does chromatic aberration occur?
- What is the difference between pincushion and barrel distortion?

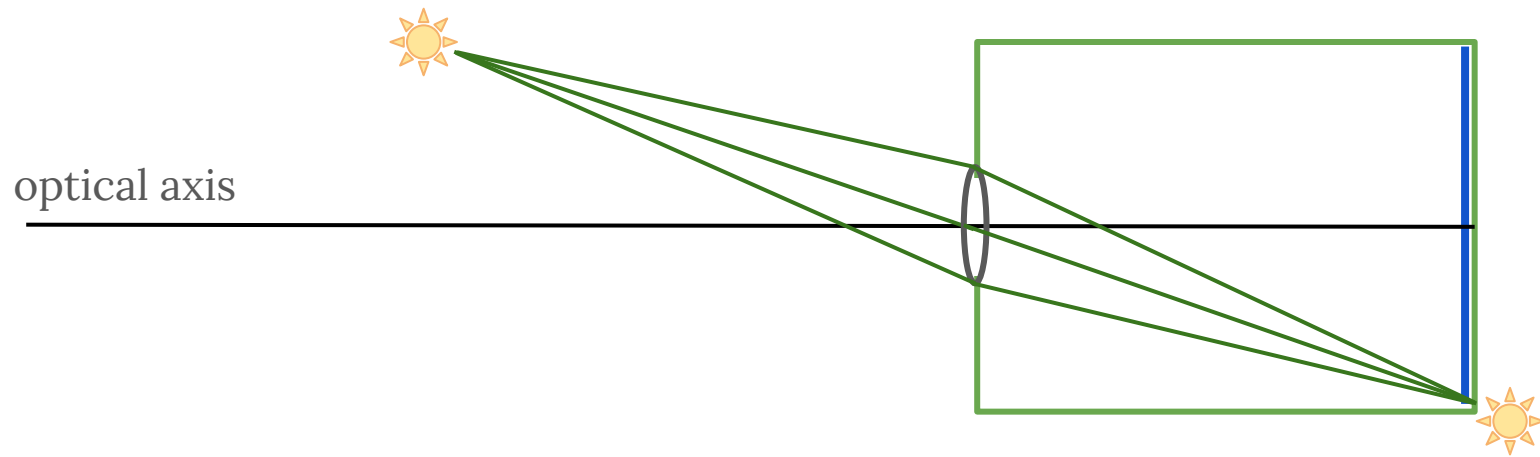
Pinhole vs Thin Lens



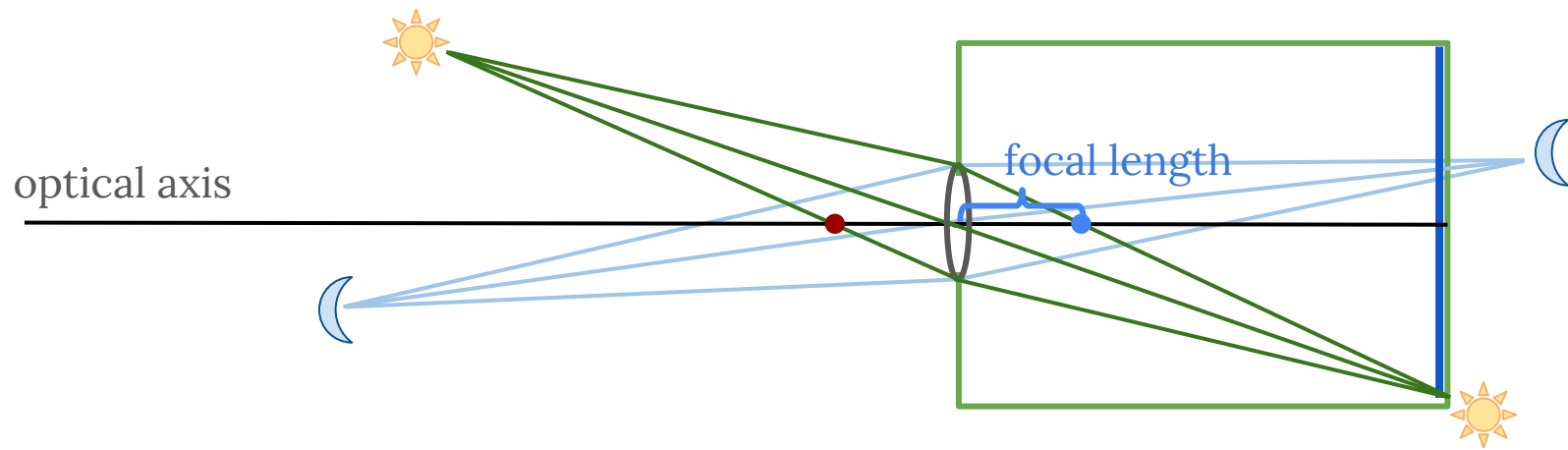
Pinhole vs Thin Lens



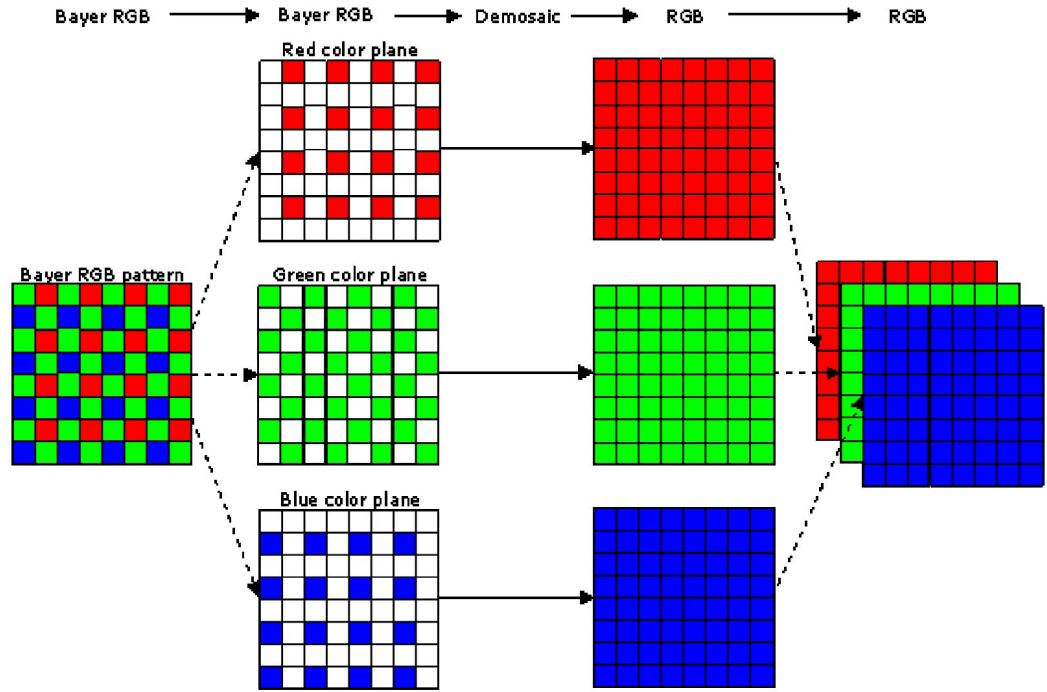
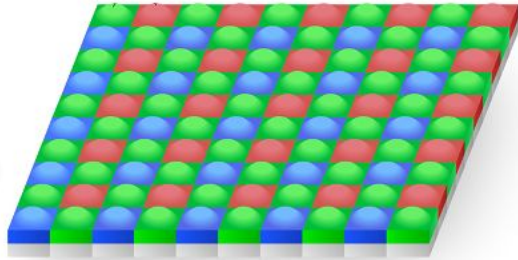
Pinhole vs Thin Lens



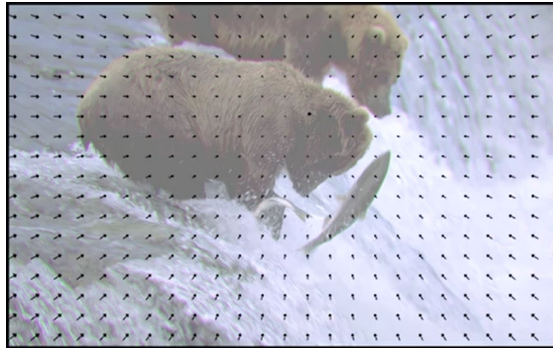
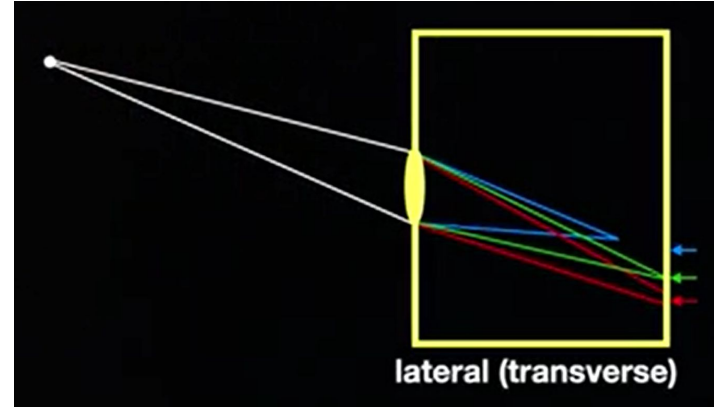
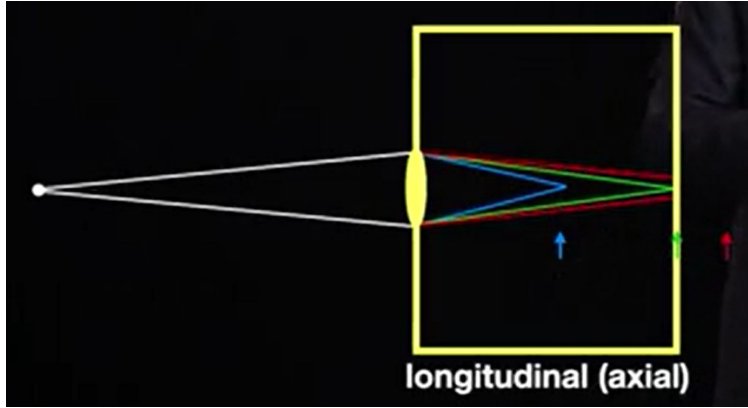
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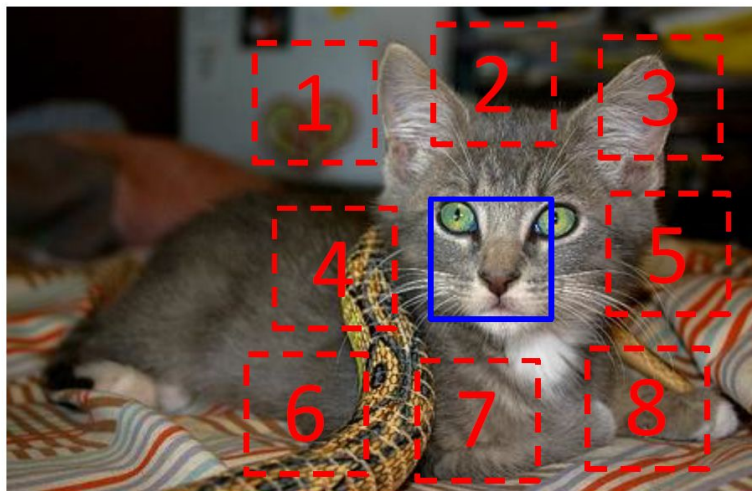
Demosaicing



Unit 3 – Chromatic Aberration



What is the network really learning?

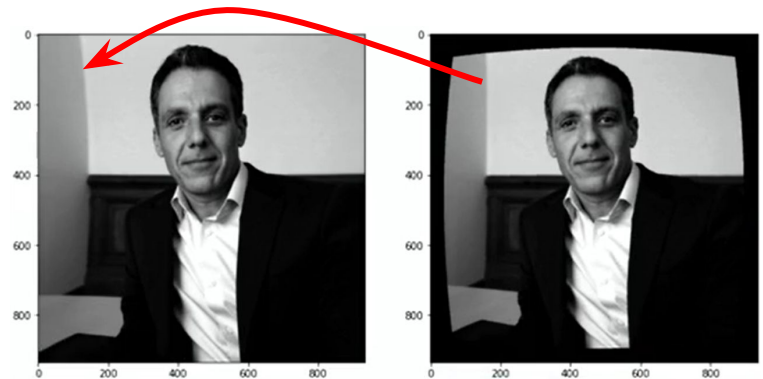
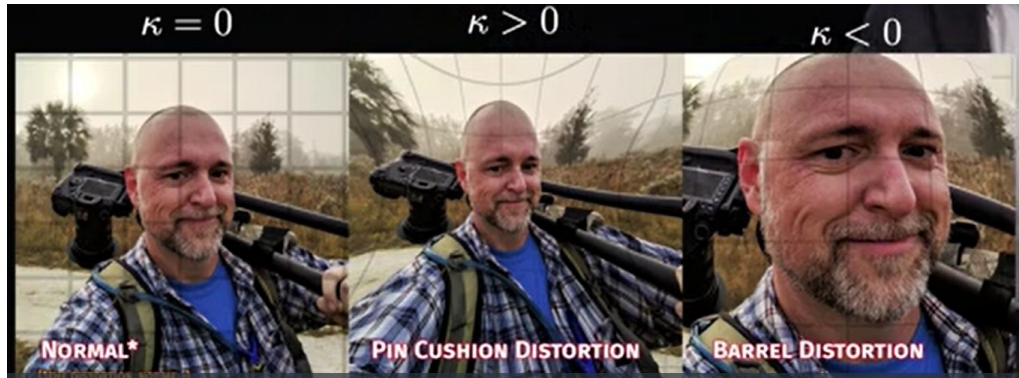


$$X = (\text{cat face crop}, \text{cat ear crop}); Y = 3$$



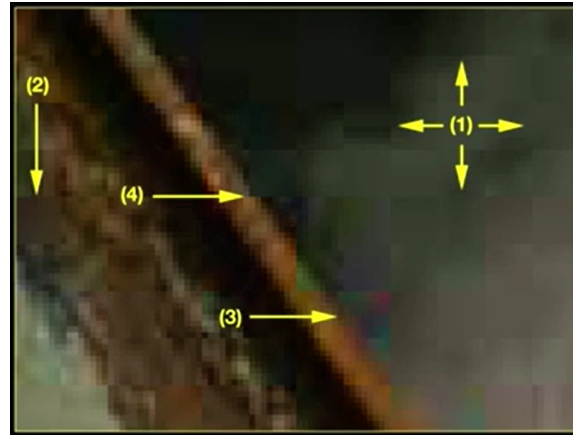
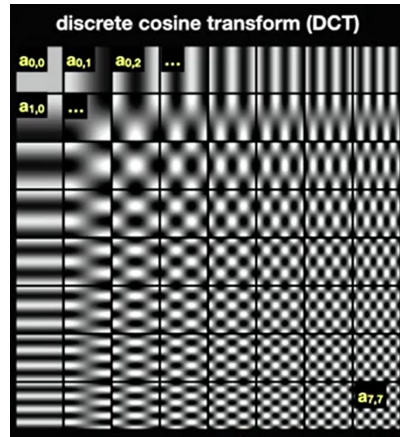
Unit 3 – Lens Distortion

- Consider carefully what “warped image” and “unwarped image” means
- Warping an image in order to generate an unwarped image is a reverse lookup operation
- For every regular grid location in the output image, warp coordinates back to a non-grid location in the input and interpolate to extract the color



Unit 3 – JPEG Compression

- We will learn more about decomposing images in Unit 5
- For now, just appreciate that images are usually compressed in a *lossy* way



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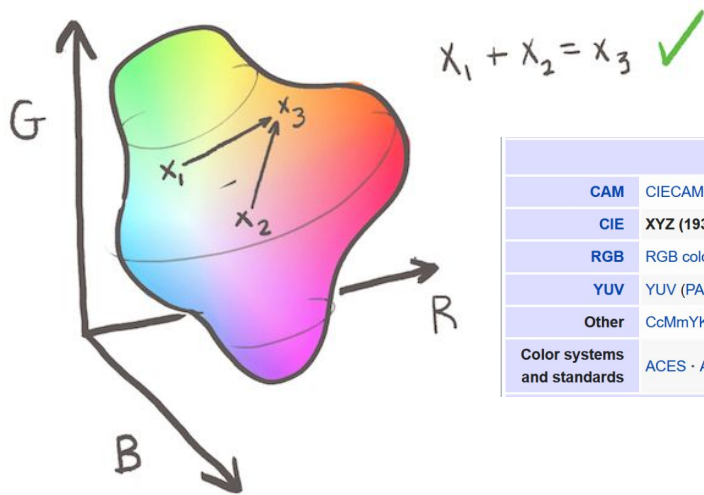
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Color space transformations

Color models: mathematical representations of relationships between colors

Many ways to parameterize colors, useful for different applications

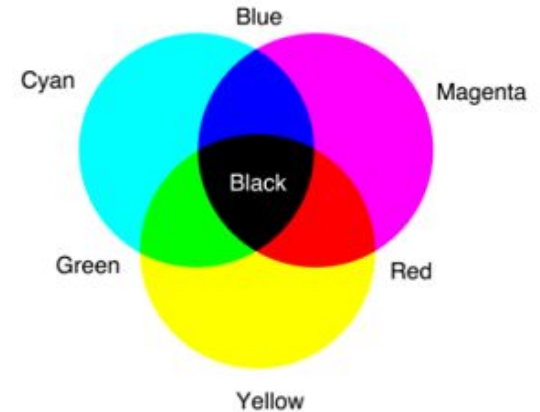
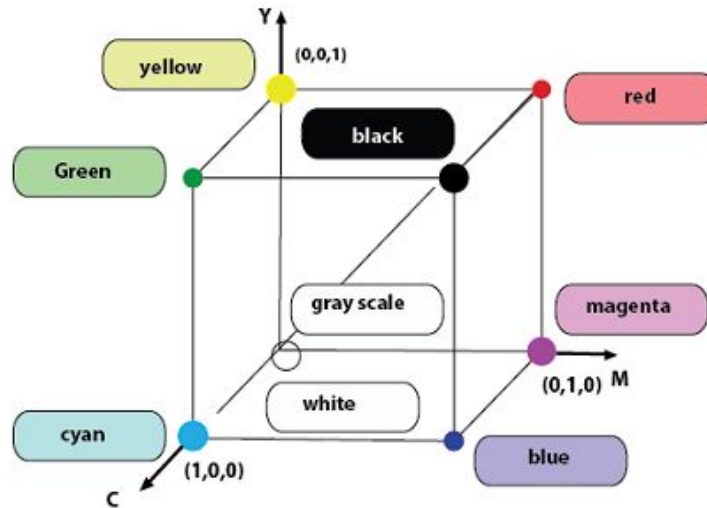


List of color spaces · Color models	
CAM	CIECAM02 · iCAM
CIE	XYZ (1931) · RGB (1931) · CAM (2002) · YUV (1960) · UVW (1964) · CIELAB (1976) · CIELUV (1976)
RGB	RGB color spaces · sRGB · rg chromaticity · Adobe · Wide-gamut · ProPhoto · scRGB · DCI-P3 · Rec. 709 · Rec. 2020 · Rec. 2100
YUV	YUV (PAL) · YDbDr (SECAM · PAL-N) · YIQ (NTSC) · YCbCr (Rec. 601 · Rec. 709 · Rec. 2020 · Rec. 2100) · ICtCp (Rec. 2100) · YPbPr · xvYCC · YCoCg
Other	CcMmYK · CMYK · Coloroid · LMS · Hexachrome · HSL, HSV · HCL · Imaginary color · OSA-UCS · PCCS · RG · RYB · HWB
Color systems and standards	ACES · ANPA · Colour Index International (CI list of dyes) · DIC · Federal Standard 595 · HKS · ICC profile · ISCC–NBS · Munsell · NCS · Ostwald · Pantone · RAL (list)

CMYK color model (subtractive)

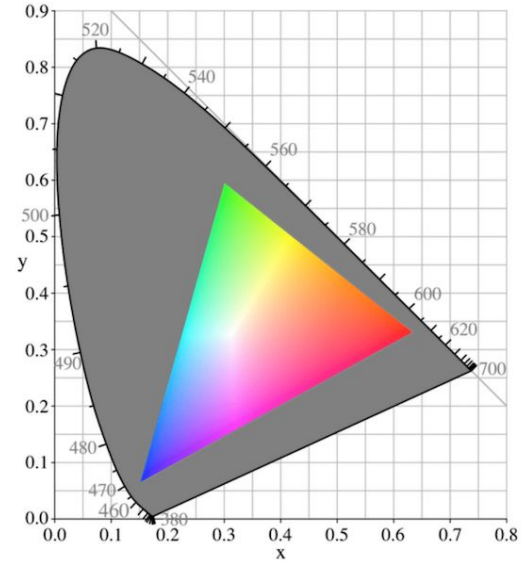
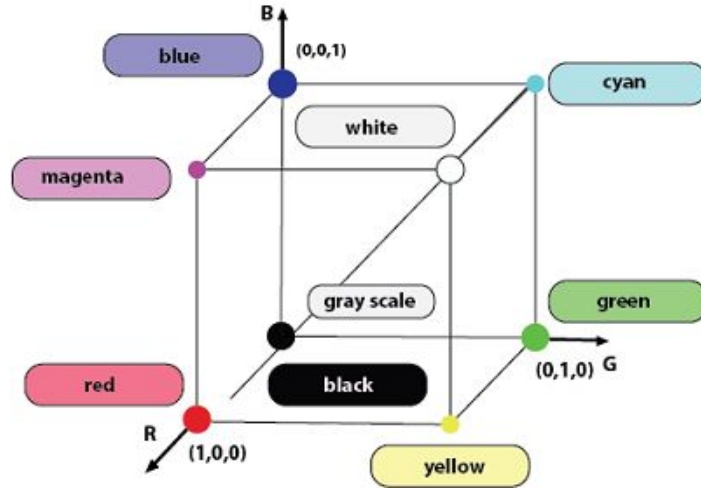
CMYK

Cyan
Magenta
Yellow
Black

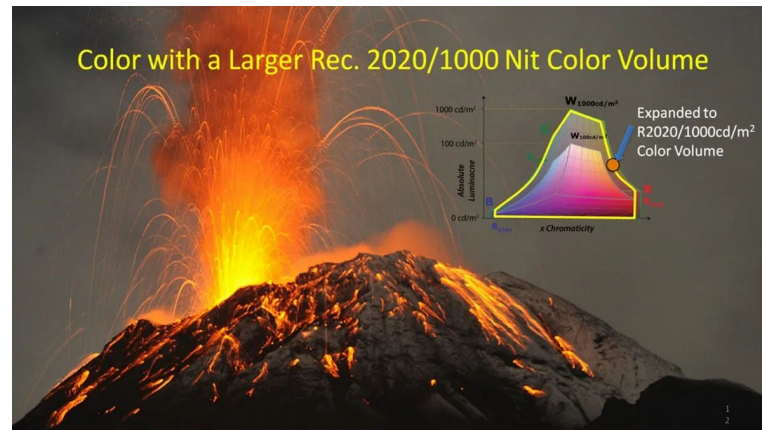
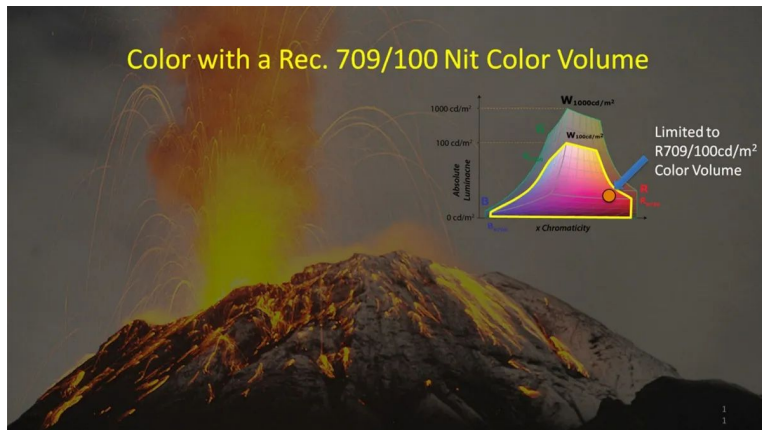
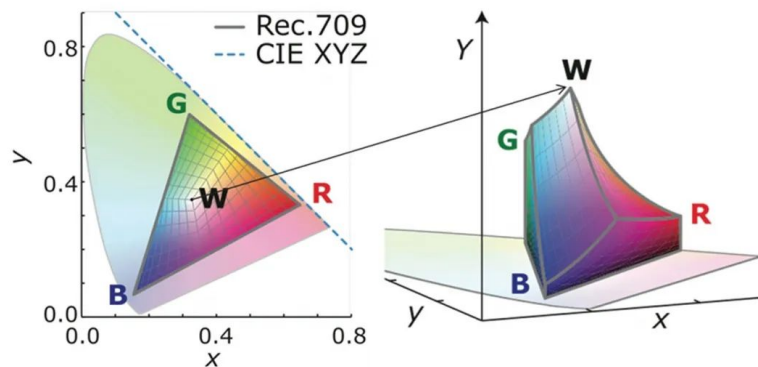


RGB color model

RGB
Red
Green
Blue

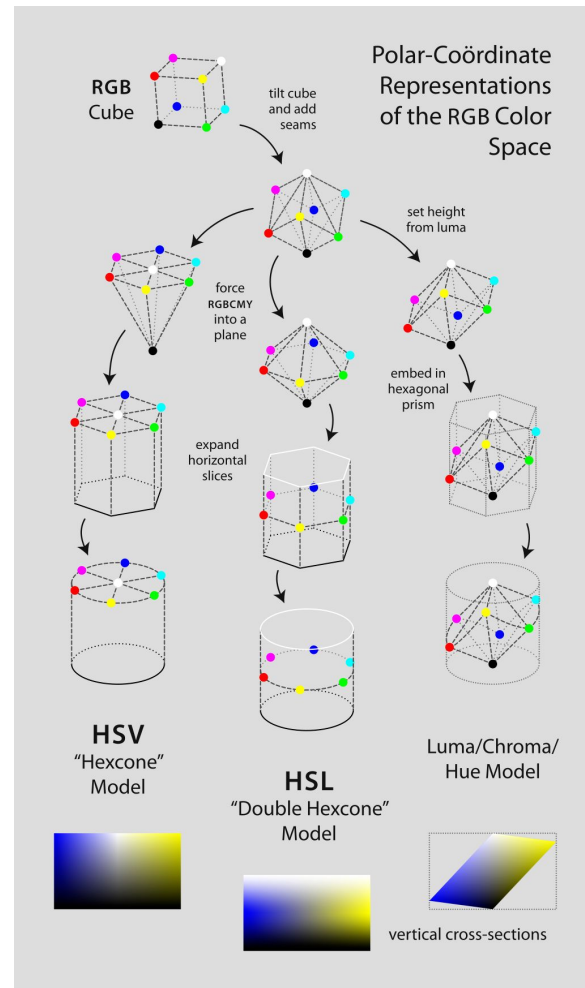
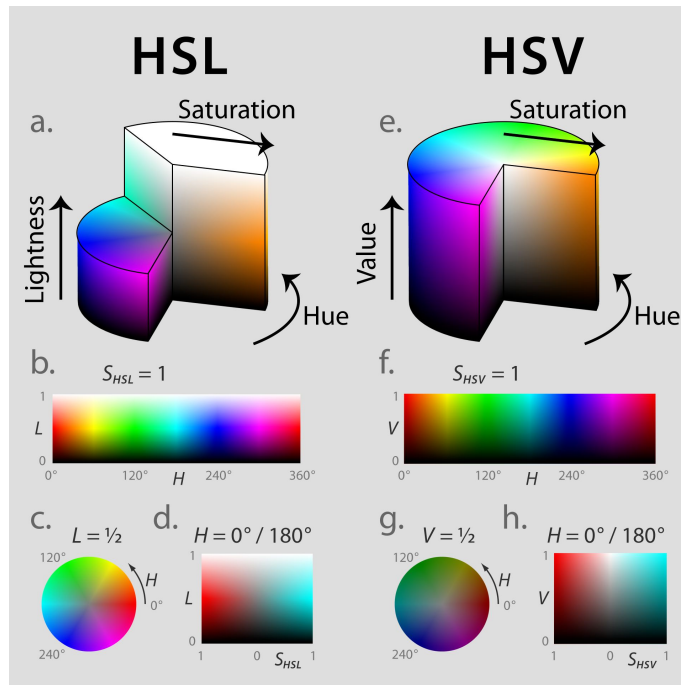


Color volumes and color gamut



HSV and HSL color models

HSV/HSL
Hue
Saturation
Value/Lightness

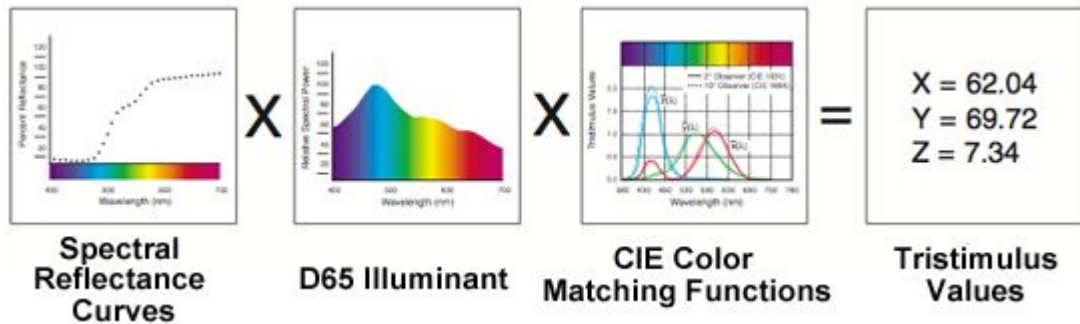
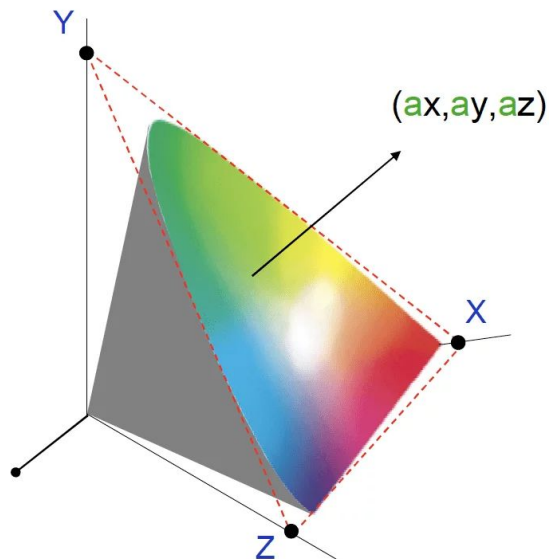


XYZ color model

XYZ

CIE 1931

Mathematically
convenient



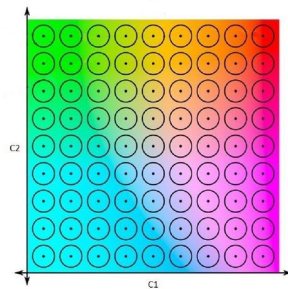
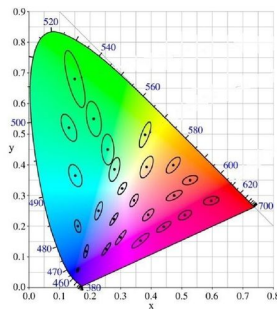
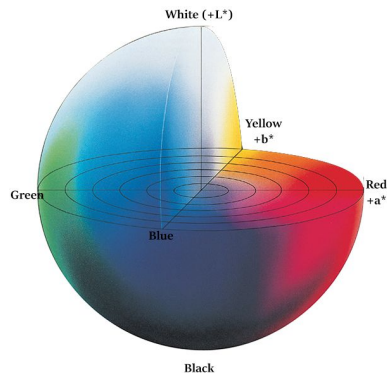
L*a*b* color model

L*a*b*

Luminance

a (red-green)

b (yellow-blue)



Perceptual Uniform Colormap



Red Orange Yellow Green Blue Indigo Purple



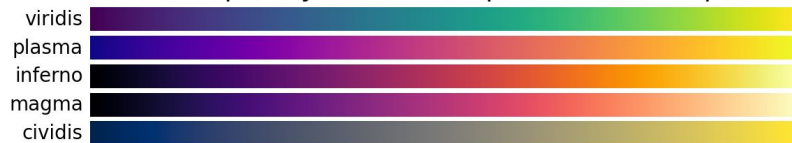
Typical Rainbow Colormap



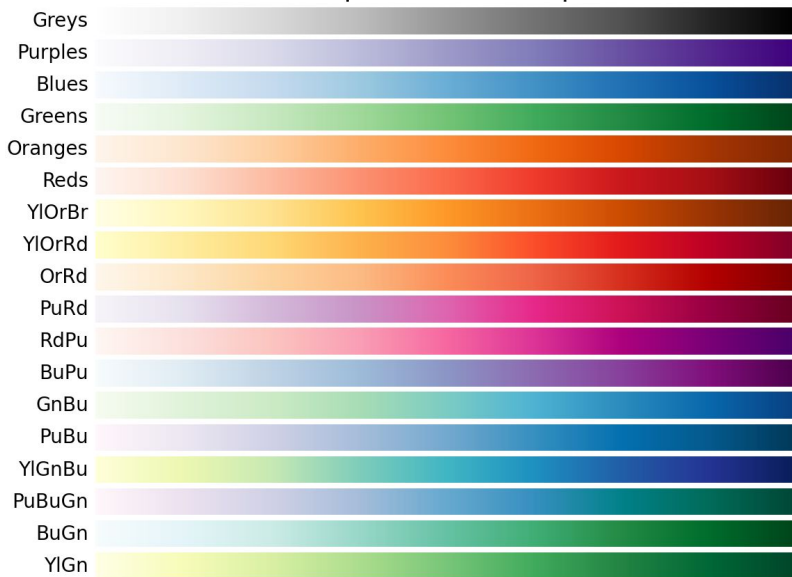
Non-Uniform Distances between Hues.

Matplotlib colormaps

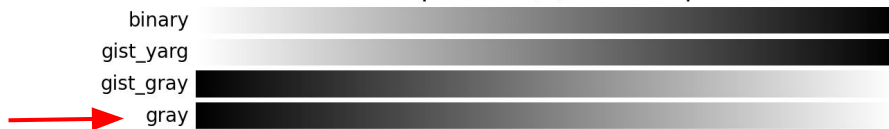
Perceptually Uniform Sequential colormaps



Sequential colormaps



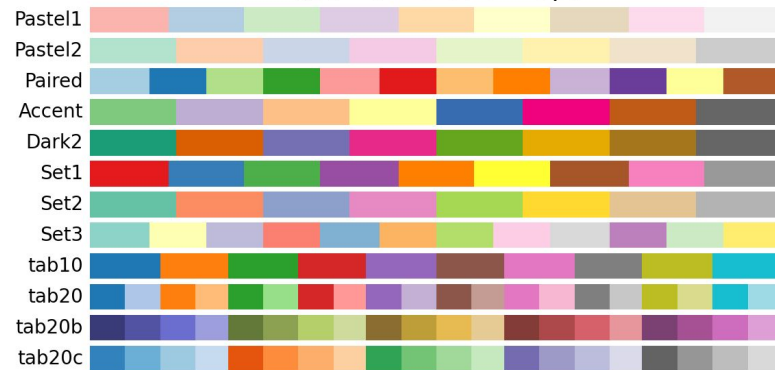
Sequential (2) colormaps



Diverging colormaps



Qualitative colormaps

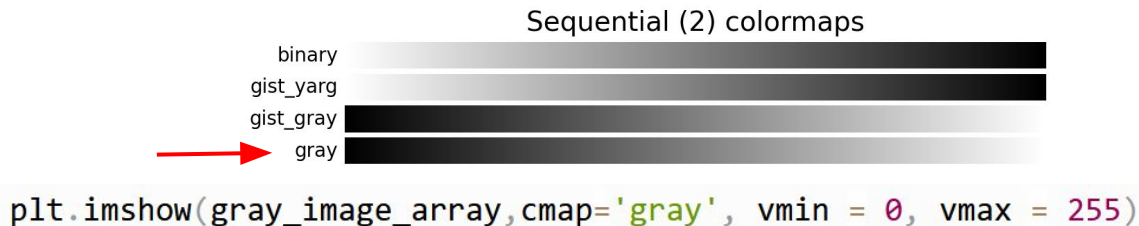


Matplotlib colormaps

Cmap 'gray' is a *linear* mapping of pixel values to gray values

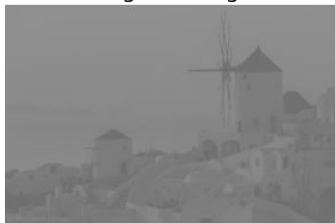
Do your remapping (e.g. gamma correction, etc) before calling imshow

Matplotlib will automatically use the full input range of the image unless you specify vmin/vmax (e.g. [0, 255] or [0, 1])

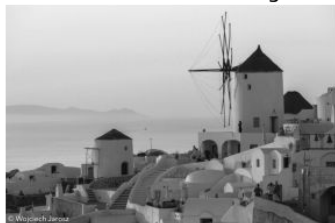


Group Exercise – Histogram Equalization

Original Image



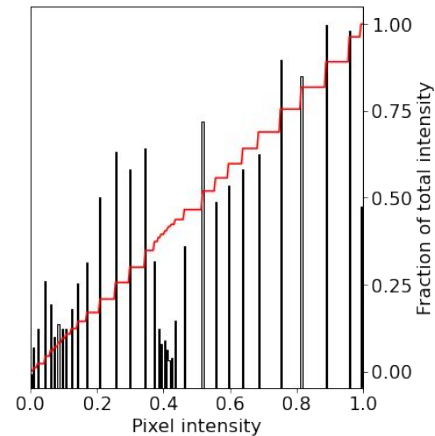
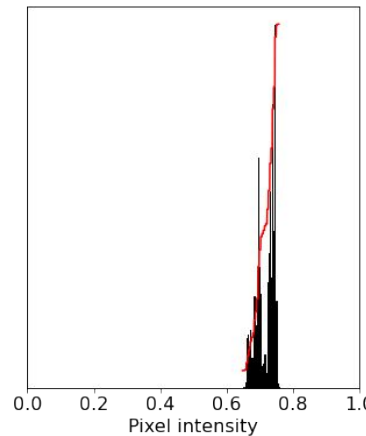
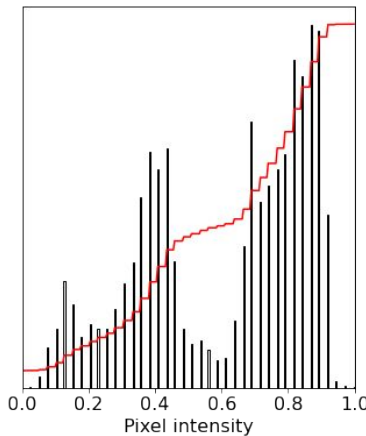
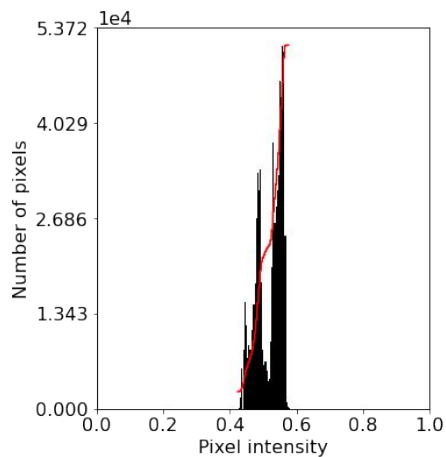
Contrast Stretching



Gamma Correction



Histogram Equalization



Group Exercise – Histogram Equalization

Original Image



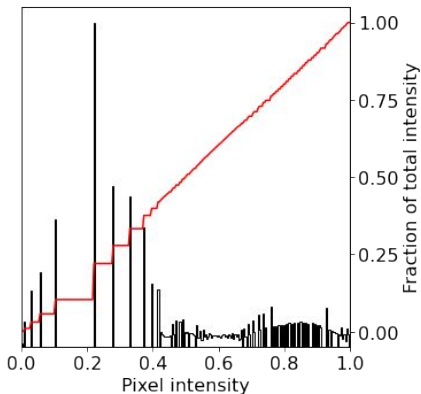
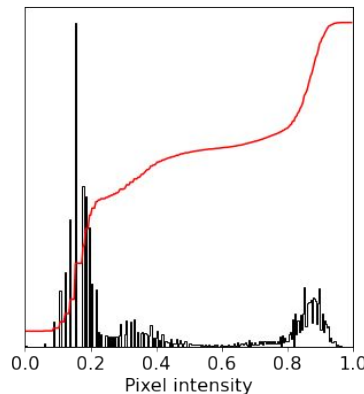
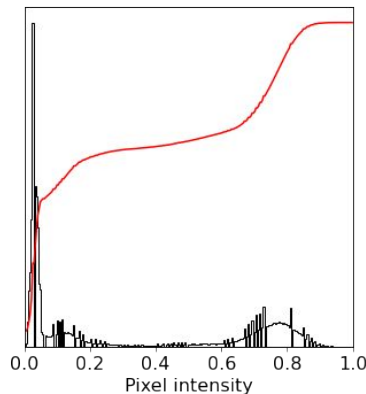
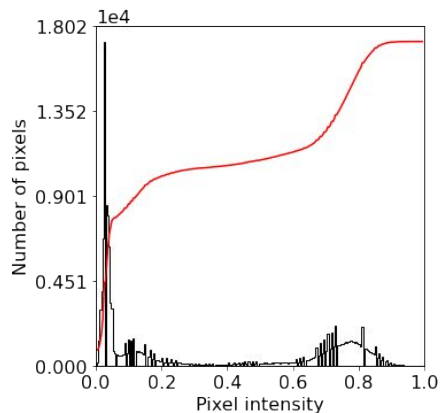
Contrast Stretching



Gamma Correction



Histogram Equalization



Upcoming ToDo's

- Watch async lectures for Unit 3
- Assignment 1 due January 30th
- Assignment 2 due February 6th
- Assignment 3 (to be released soon) due February 13th