

CSC317 Computer Graphics

... starting at 11:10 am

CSC 317/2504: Computer Graphics

Course web site (includes course information sheet):

<https://github.com/dilevin/computer-graphics-csc317>

Instructor

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TAs

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Wenzhi Guo

Zecheng Wang

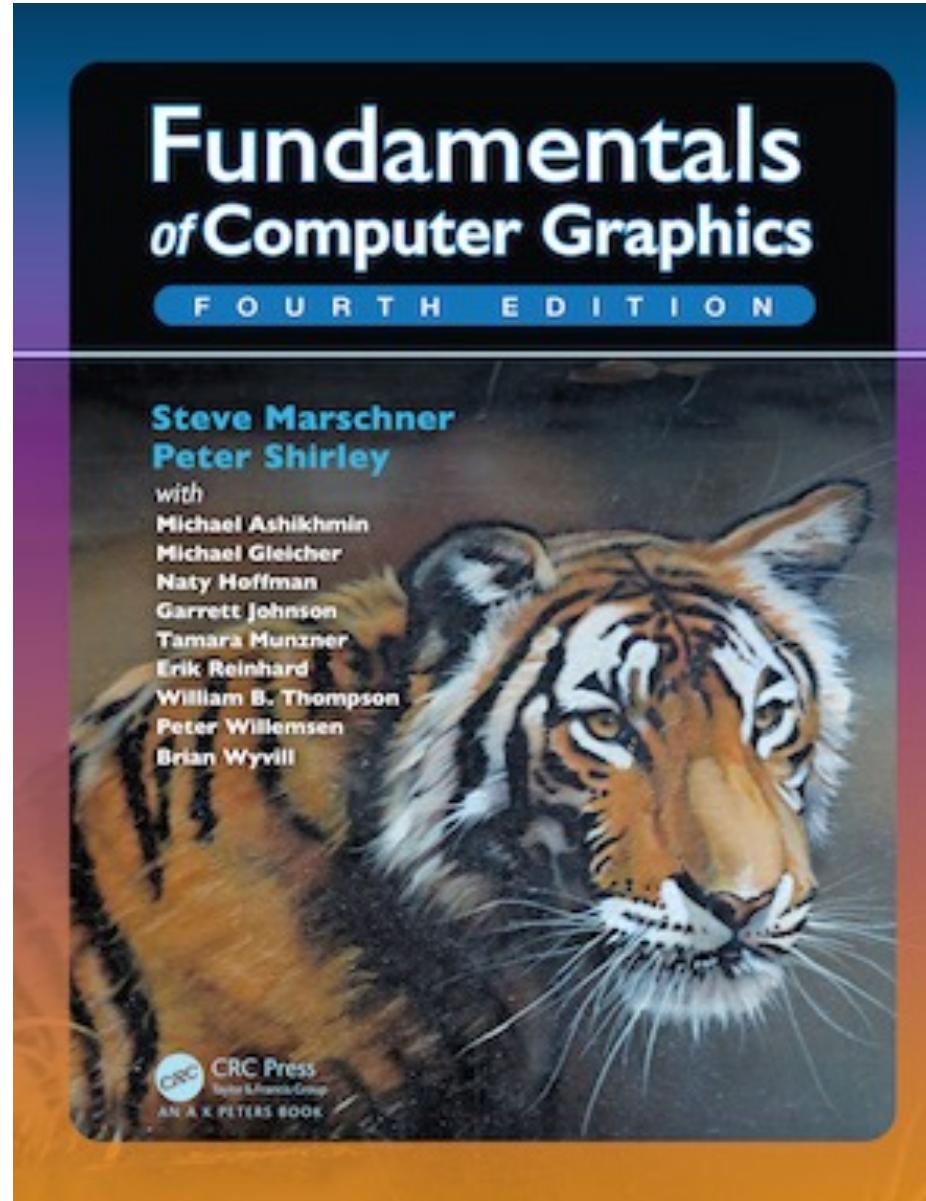
csc317tas@cs.toronto.edu

Office Hours:

Friday 1pm-2pm BA5268

Required Textbook

(Lots of figures on slides adapted from here)



Schedule (on the webpage)

Lecture Schedule

Week	Topic / Event
1	Introduction, Assignment 1 (Raster Images) due 20/09
2	Lecture 2, Assignment 2 Ray Casting due 27/09
3	Lecture 3, Assignment 3 Ray Tracing due 04/10
4	Lecture 4, Assignment 4 Boundary Volume Hierarchy due 13/10
	24 hour Take home midterm (Exact date to be determined)
5	No Lecture, Thanksgiving
6	Lecture 5, Assignment 5 Meshes due 25/10
7	Lecture 6, Assignment 6 Shader Pipeline due 01/11
8	Lecture 7, Assignment 7 Kinematics due 15/11
9	No Lecture, Reading Week !
10	Lecture 8, Assignment 8 Mass-Spring Systems due 22/11
11	Lecture 9, Assignment on Generative AI due 29/11
12	Lecture 10 New Developments in Computer Graphics

Academic Honesty Policy

It's on the webpage and is mandatory reading!

%	Item
63	Assignments
17	Midterm
20	In Tutorial Final Exam

Today

1. Introduction to Computer Graphics
2. Preview of class assignments
3. Raster Images

Introduction to Computer Graphics

What is Computer Graphics?

Computers:
accept, process, transform and present information.

Computer Graphics:
accept, process, transform and present information
in a visual form.

“Core” Areas of Computer Graphics

Modeling

Rendering

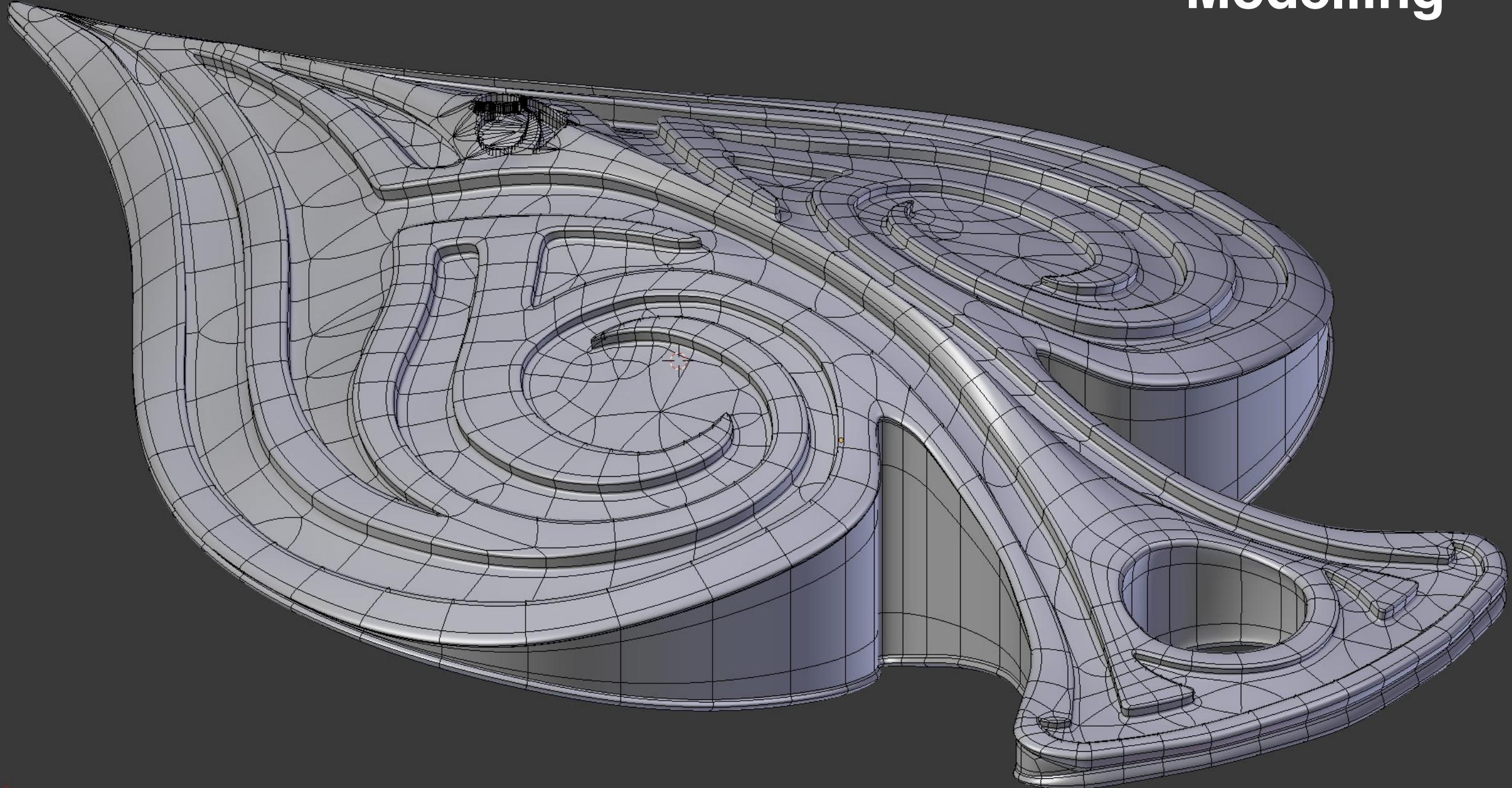
Animation

File Render Window Help Back to Previous Cycles Render

v2.77 | Verts:0/7,223 | Edges:0/14,649 | Faces:0/7,424 | Tris:14,454 | Mem:92.44M | Curve.010

User Ortho (Local)

Modelling



(1) Curve.010

View Select Add Mesh Edit Mode Global

File Render Window Help Back to Previous Cycles Render v2.77 | Verts:0/7,223 | Edges:0/14,649 | Faces:0/7,424 | Tris:14,454 | Mem:92.44M | Curve.010

<http://www.blenderunleashed.com/tutorials/essential-modeling-skills-basic-operators-part-2/>

Rendering



Animation



Other Areas of Computer Graphics

User Interaction

Virtual Reality

Visualization

Image Processing

3D Scanning

Computational Photography

Assignment Previews

Raster Images

Ray Casting

Ray Tracing

Boundary Volume Hierarchies

Meshes

Shaders

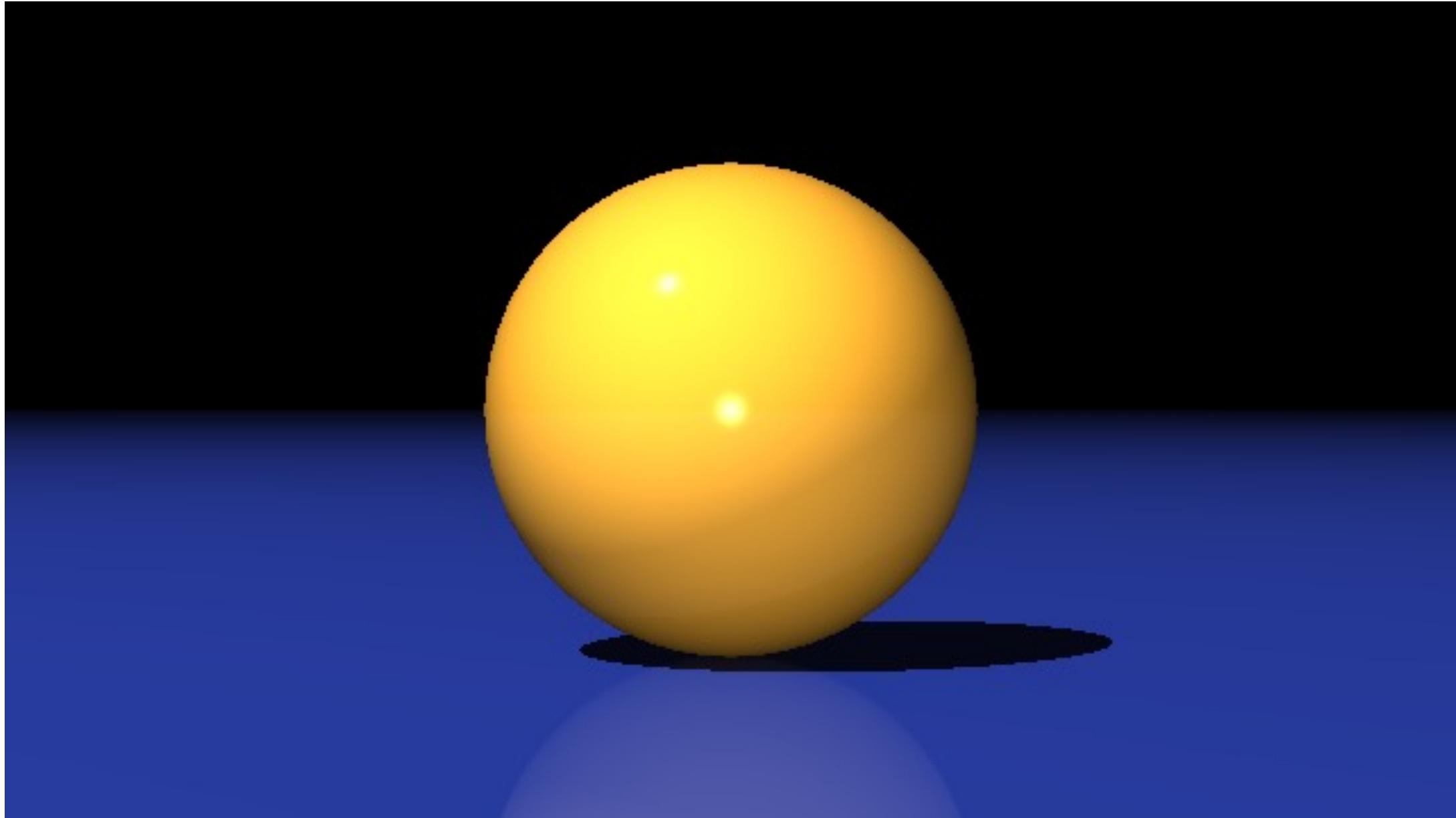
Kinematics

Mass-Springs

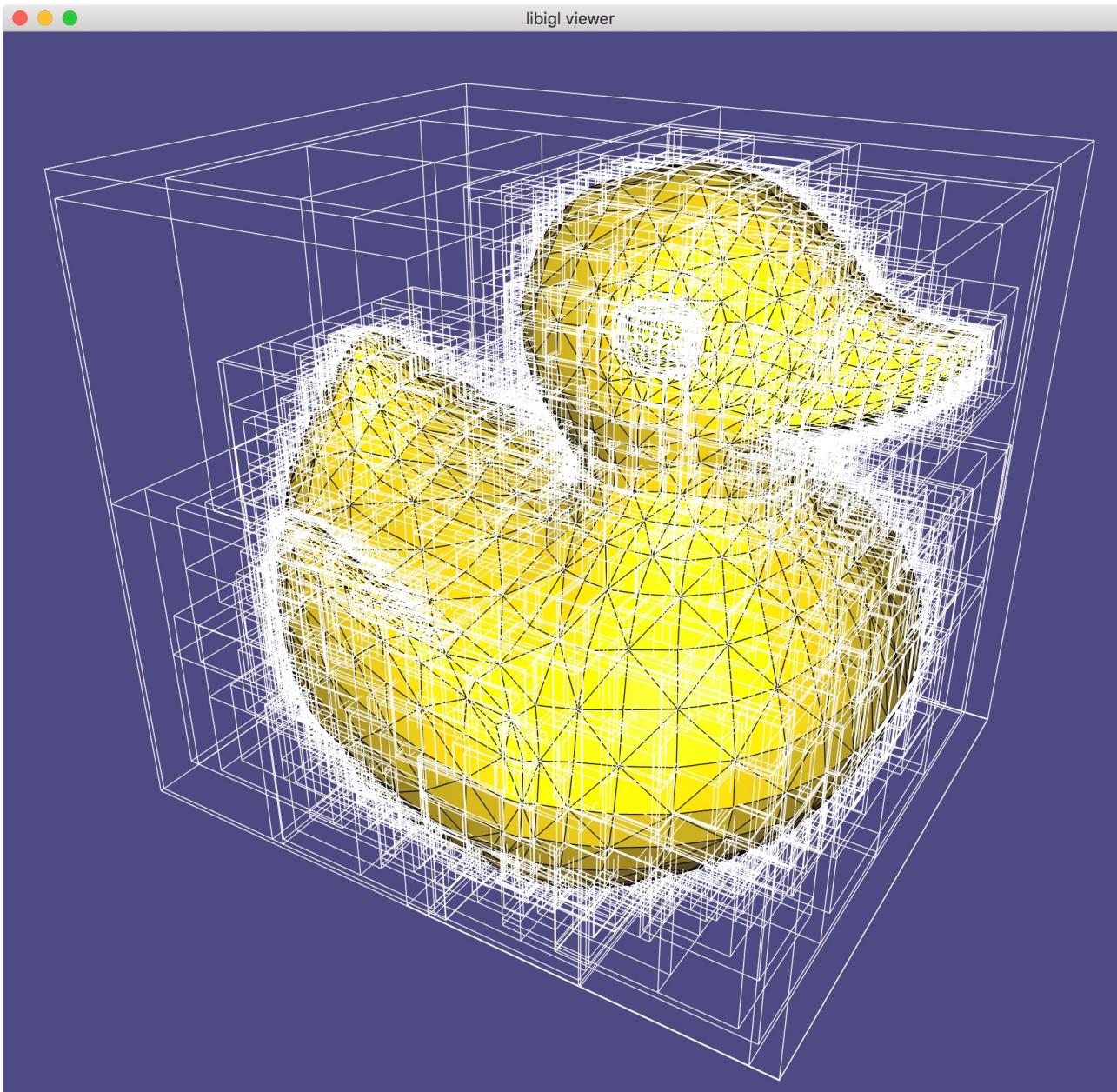
Ray Casting



Ray Tracing

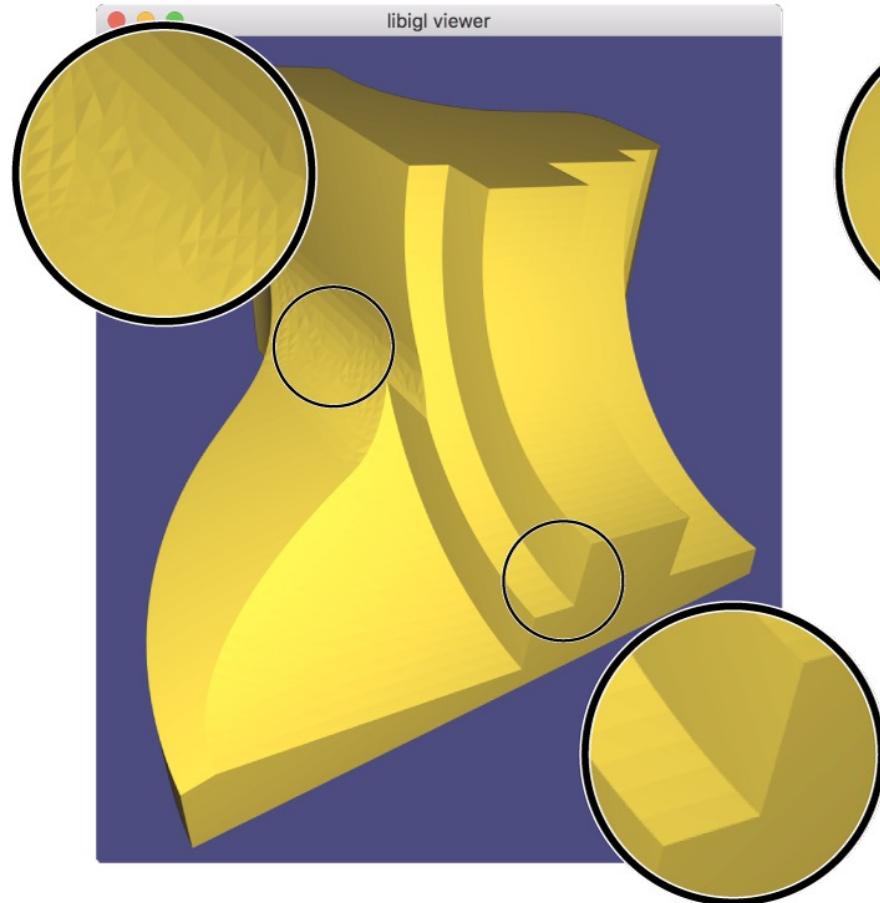


Boundary Volume Hierarchies

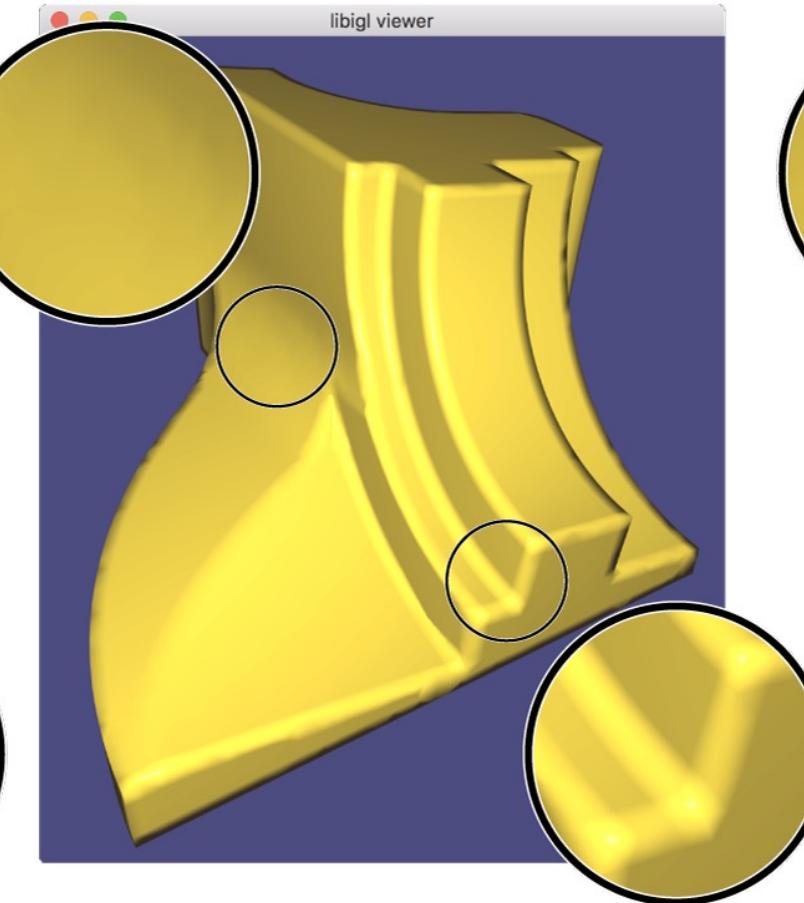


Meshes

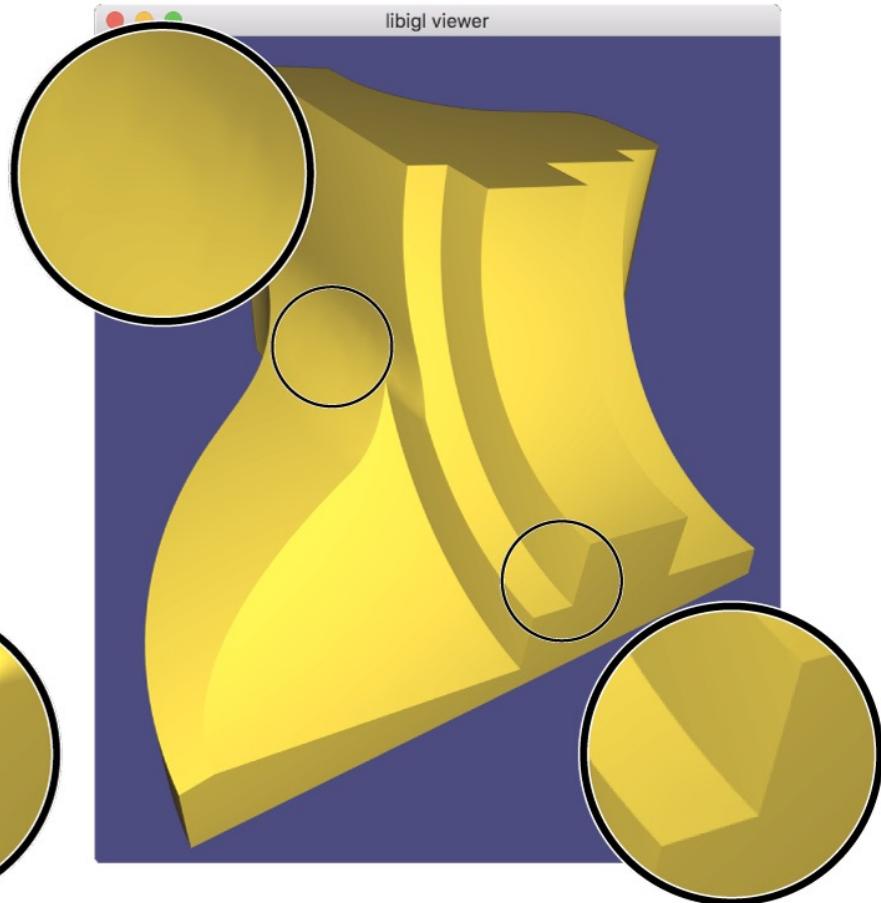
Per-face normals



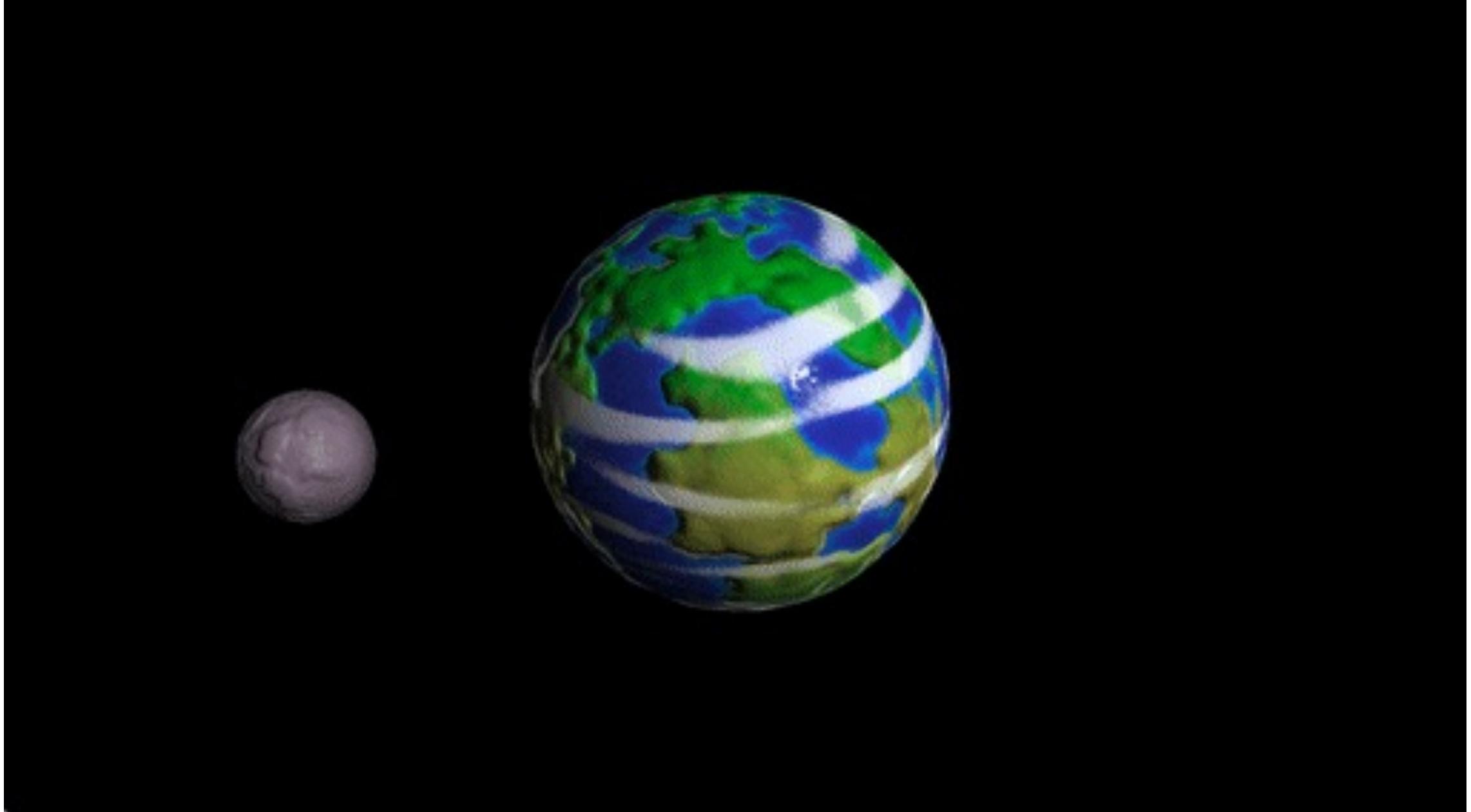
Per-vertex normals



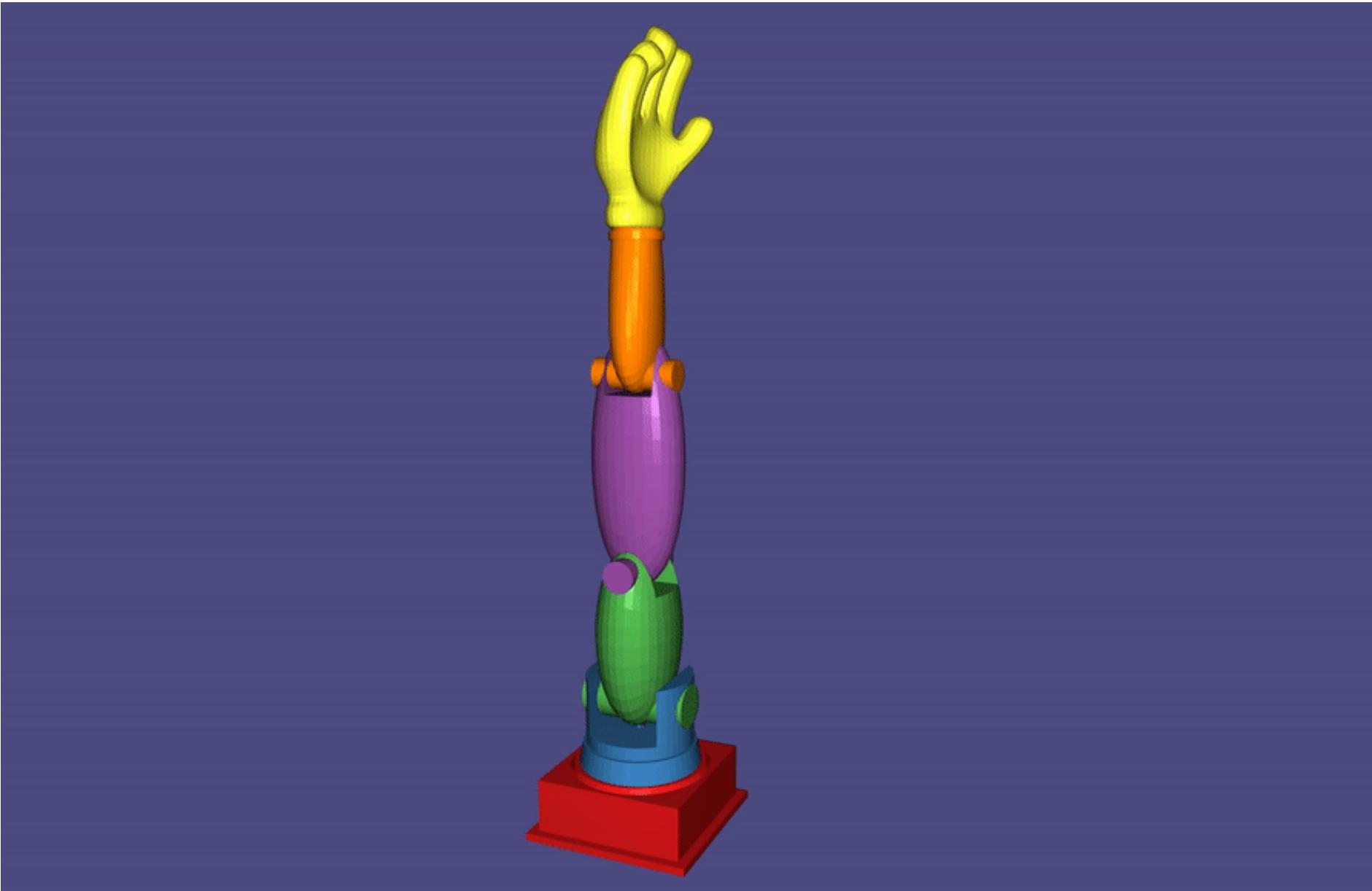
Per-corner normals



Shaders



Kinematics



Mass-Springs



Raster Images

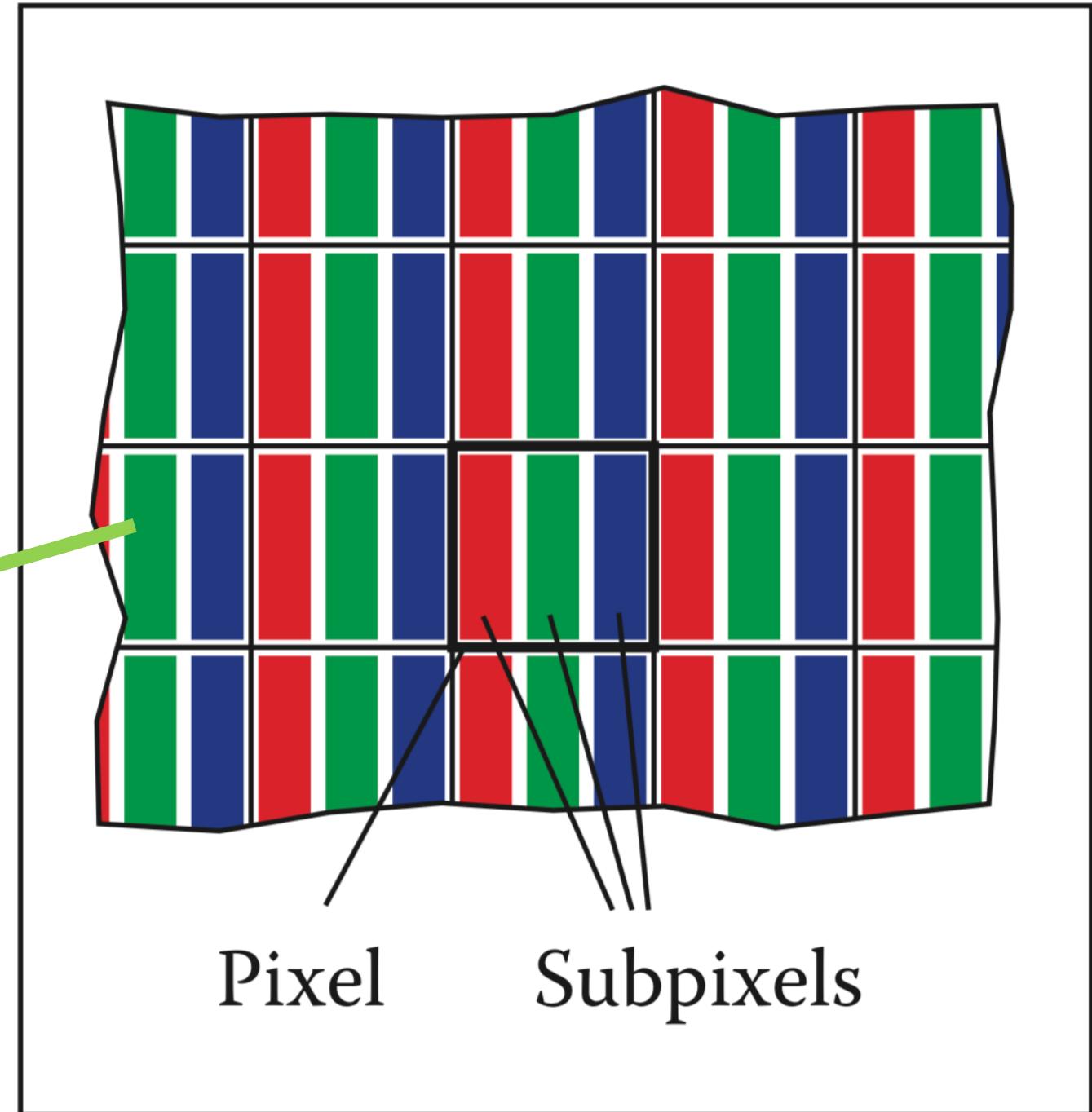
Raster Displays



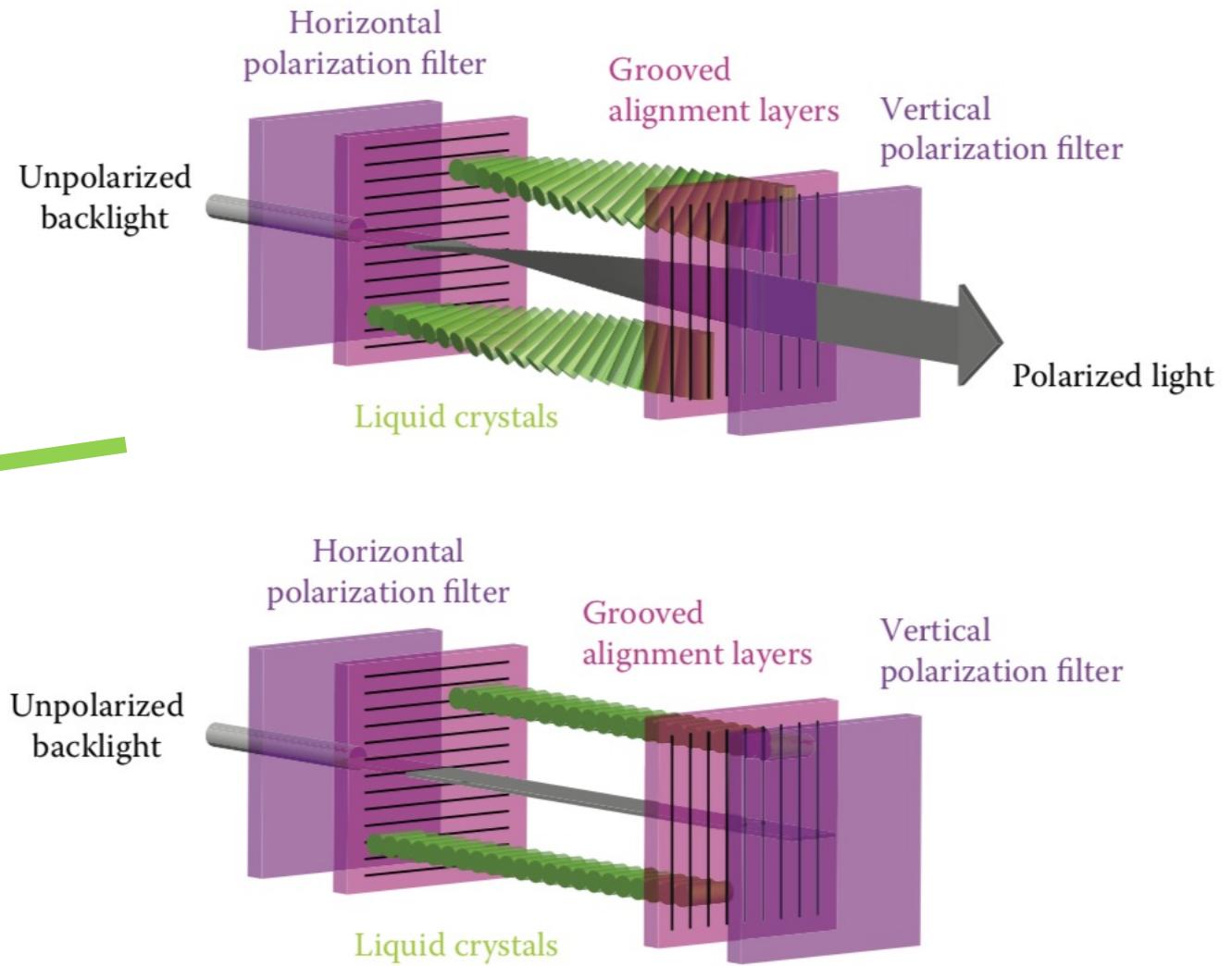
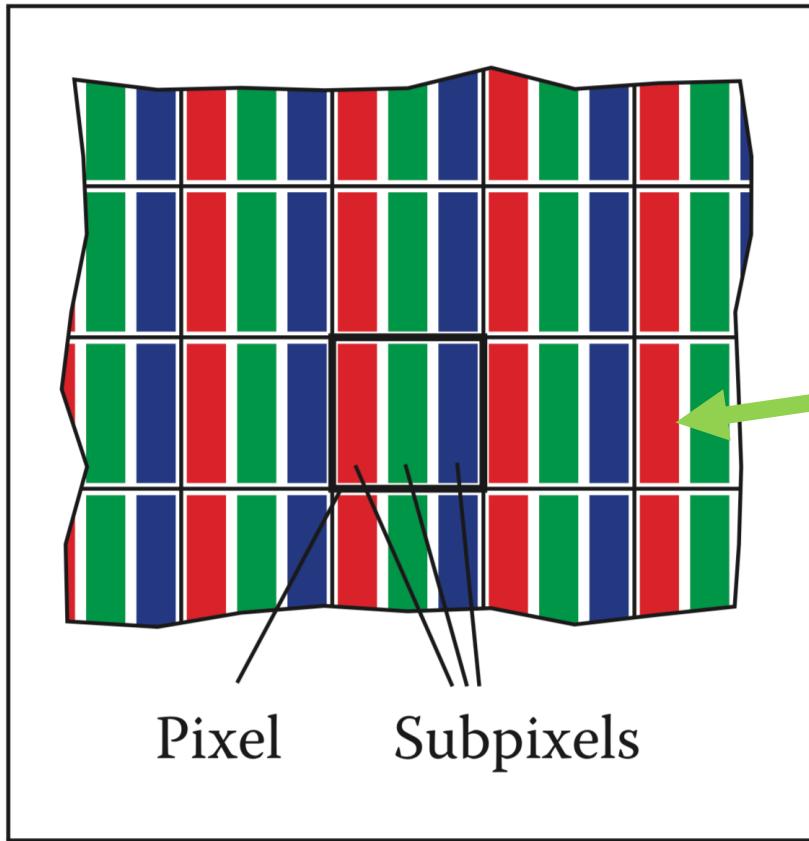
Raster Displays



Raster Displays



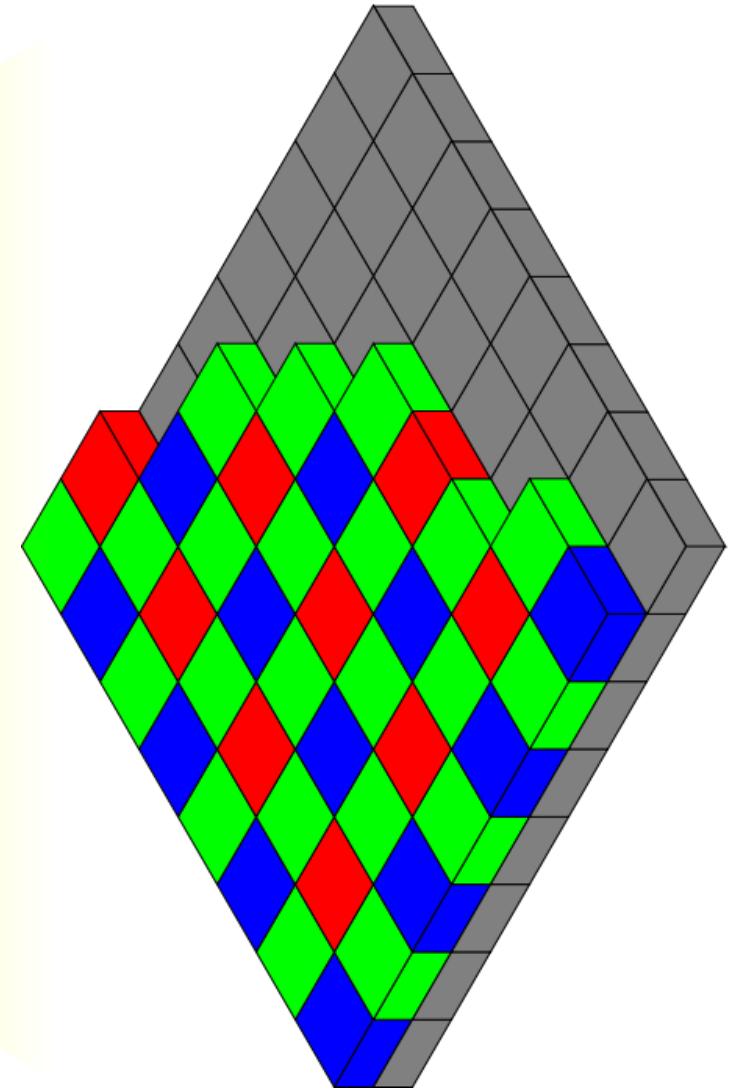
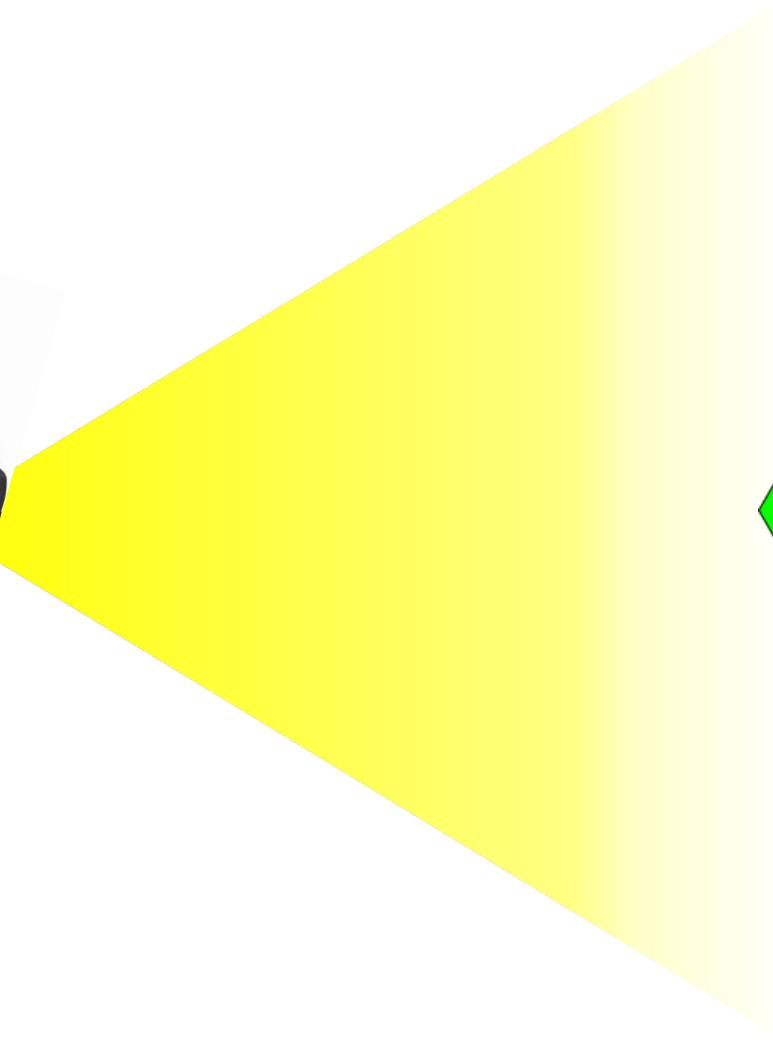
Raster Displays



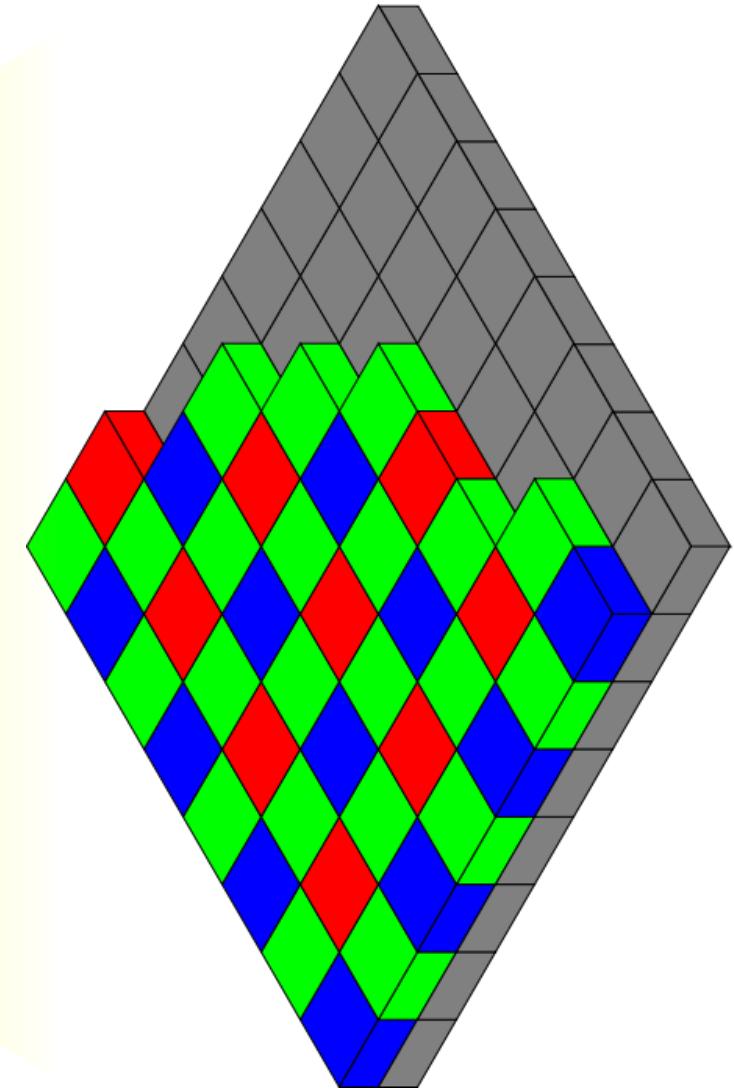
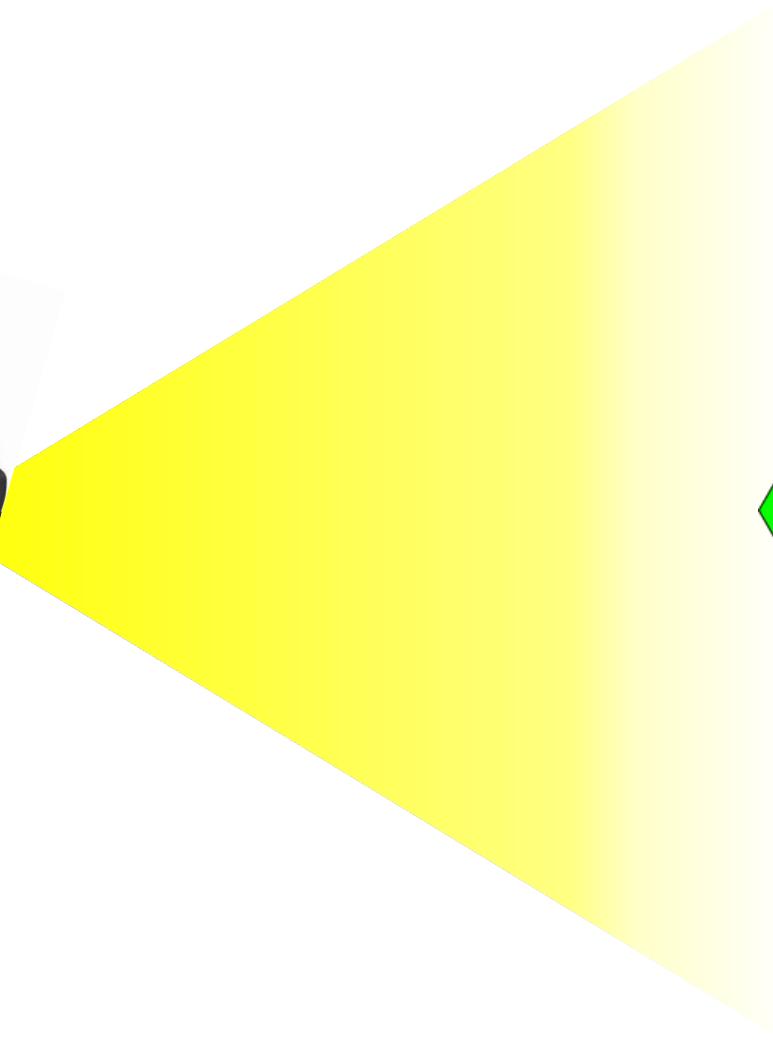
Raster Input Devices



Raster Input Devices

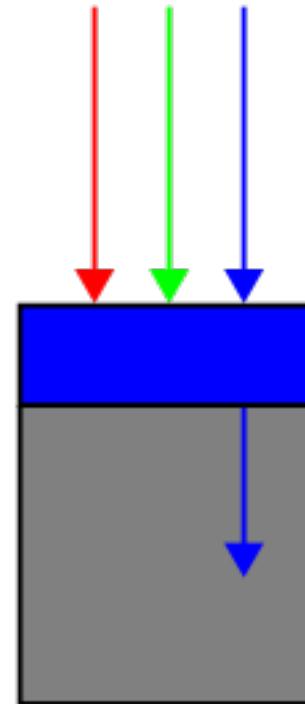
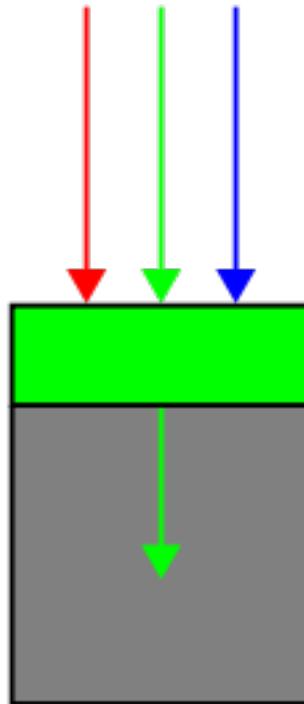
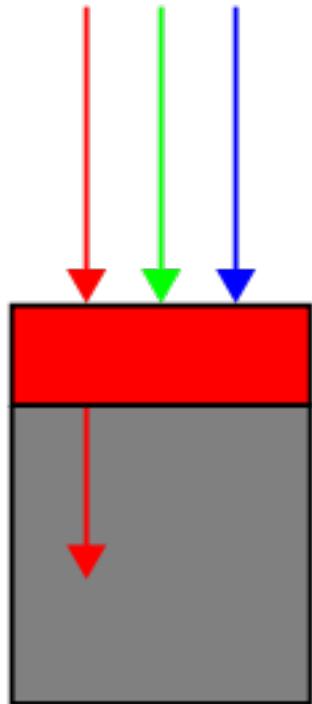


Raster Input Devices



Bayer Filter

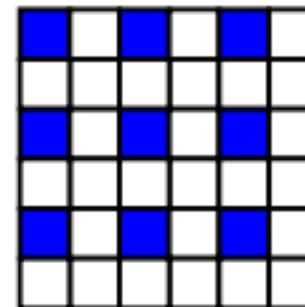
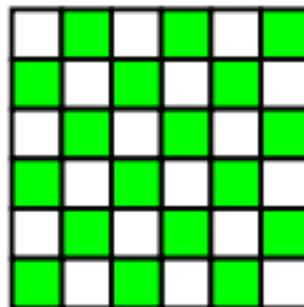
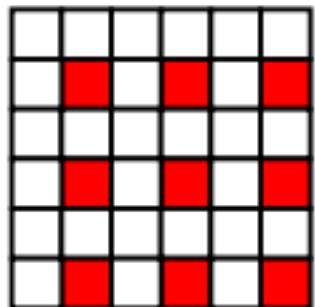
Raster Input Devices



Incoming light

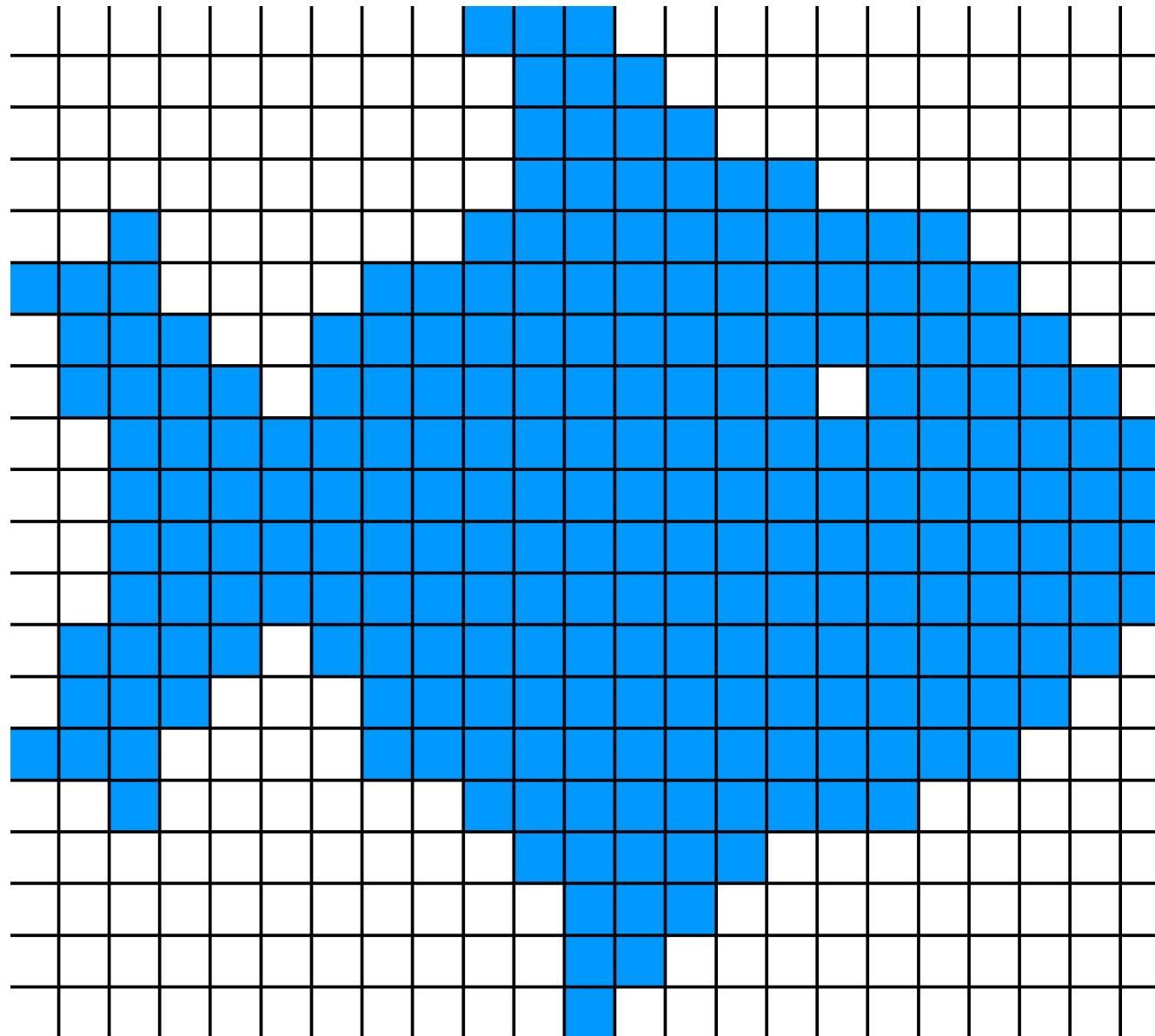
Filter layer

Sensor array



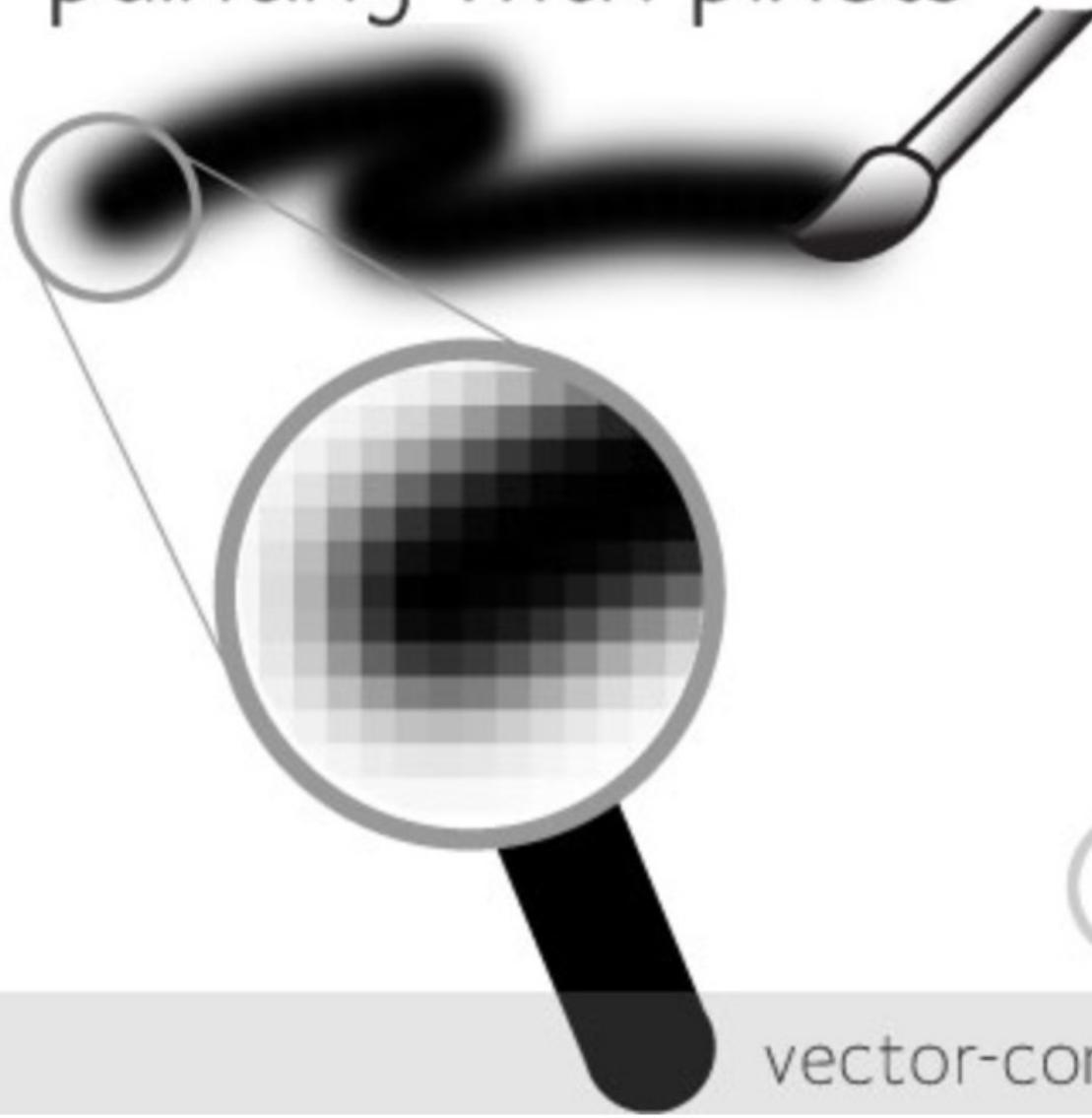
Resulting pattern

Raster Image

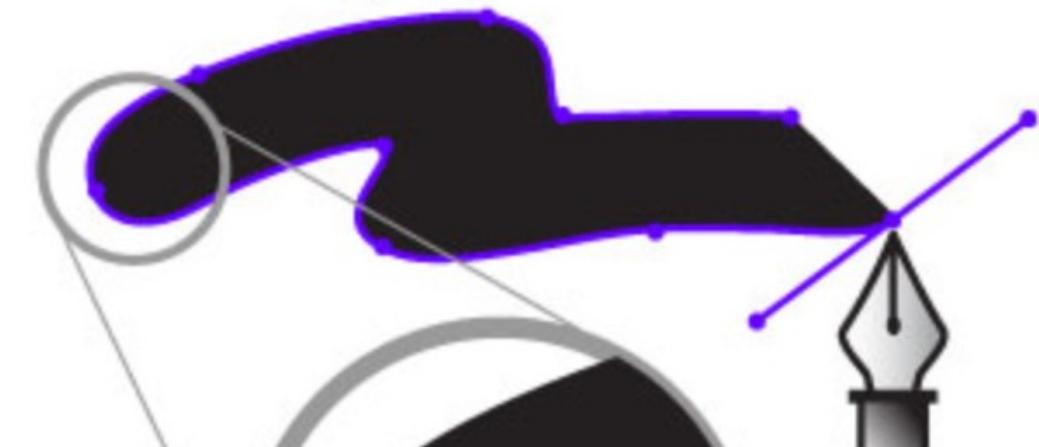


Aside: More Than Just Raster Images

painting with pixels



drawing with vectors



Images as a Function

$$I(x, y) : \mathbb{R}^2 \rightarrow \mathbb{R}^{+n}$$

Image coordinates ????



Images as a Function

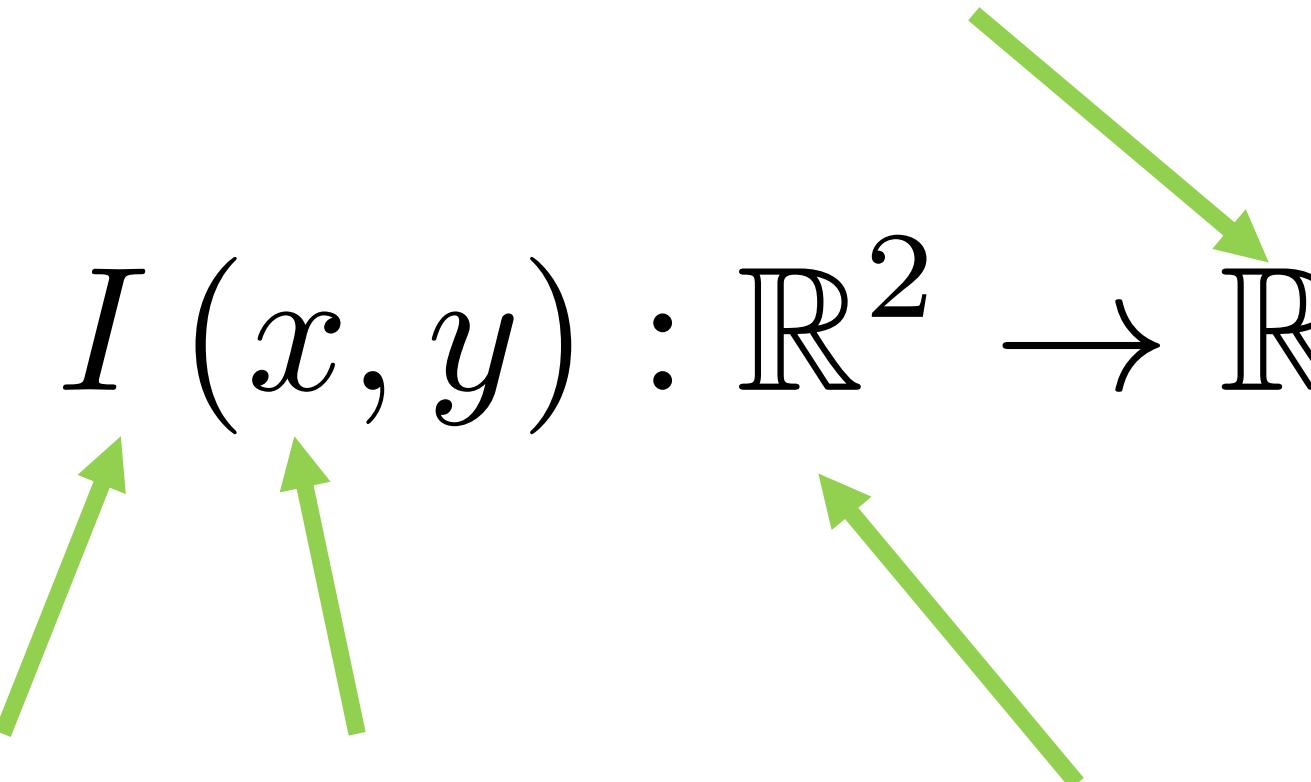
nD Real Numbers > 0

$$I(x, y) : \mathbb{R}^2 \rightarrow \mathbb{R}^{+n}$$

Image

coordinates

2D Real Numbers



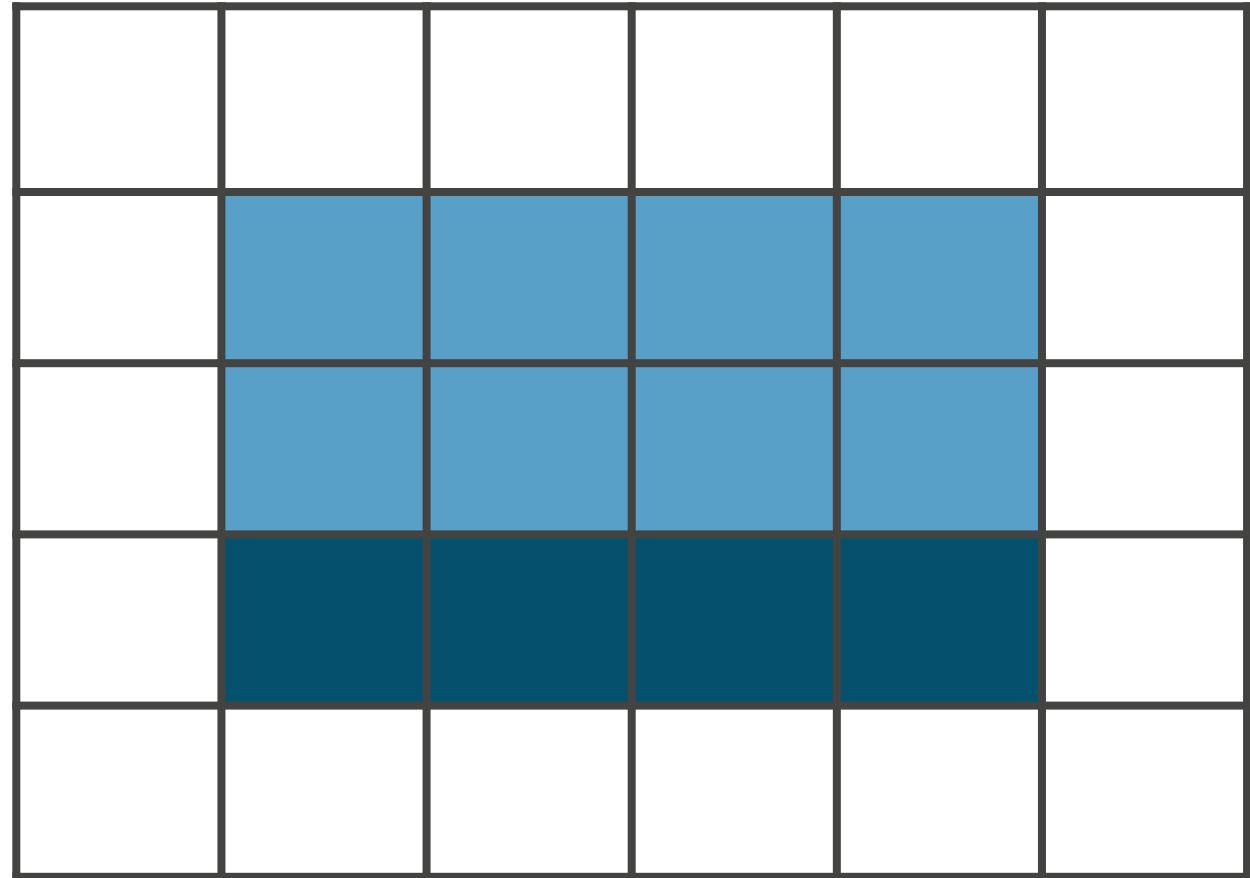
Images as a Function

$$I(x, y) : \mathbb{R}^2 \rightarrow \mathbb{R}^{+n}$$

A Pixel is not a Square



Object

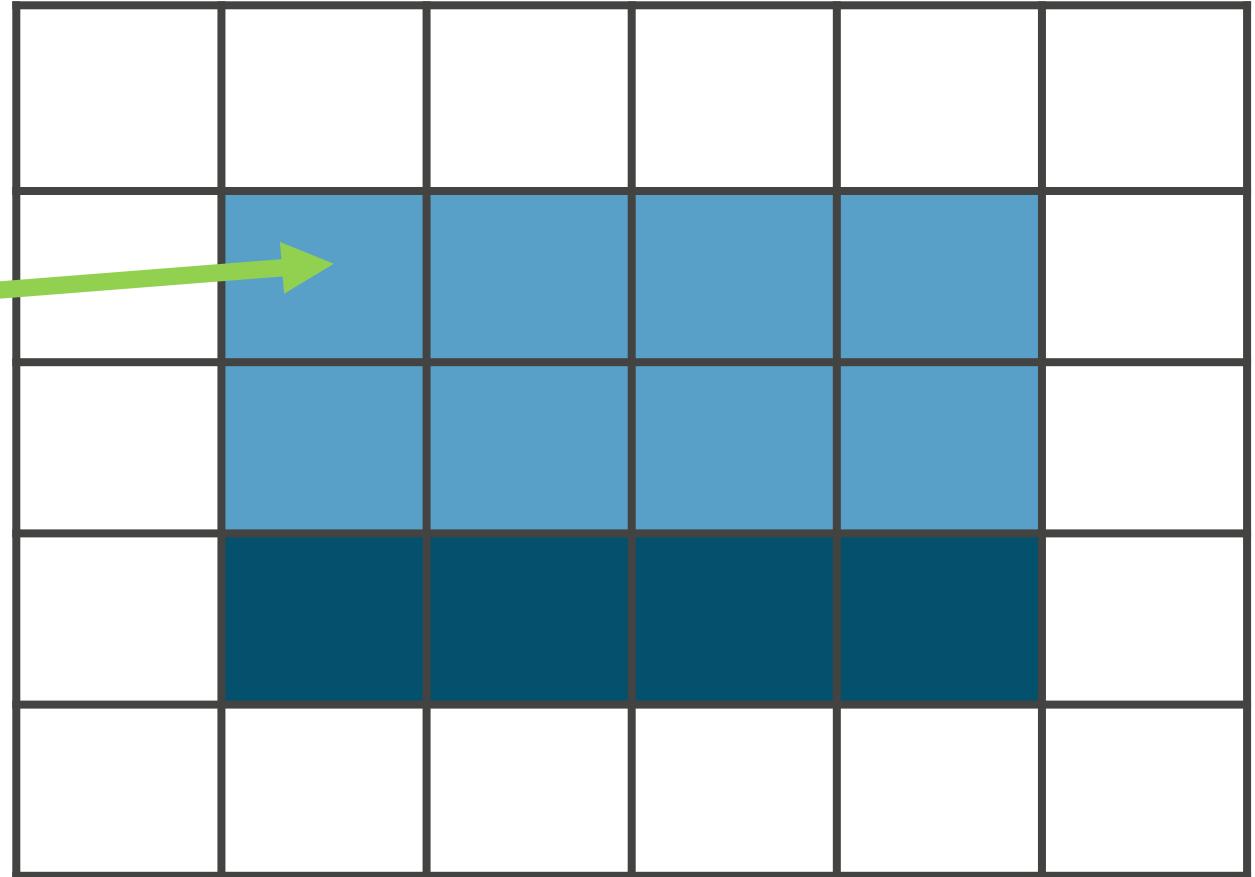


Image

A Pixel is not a Square

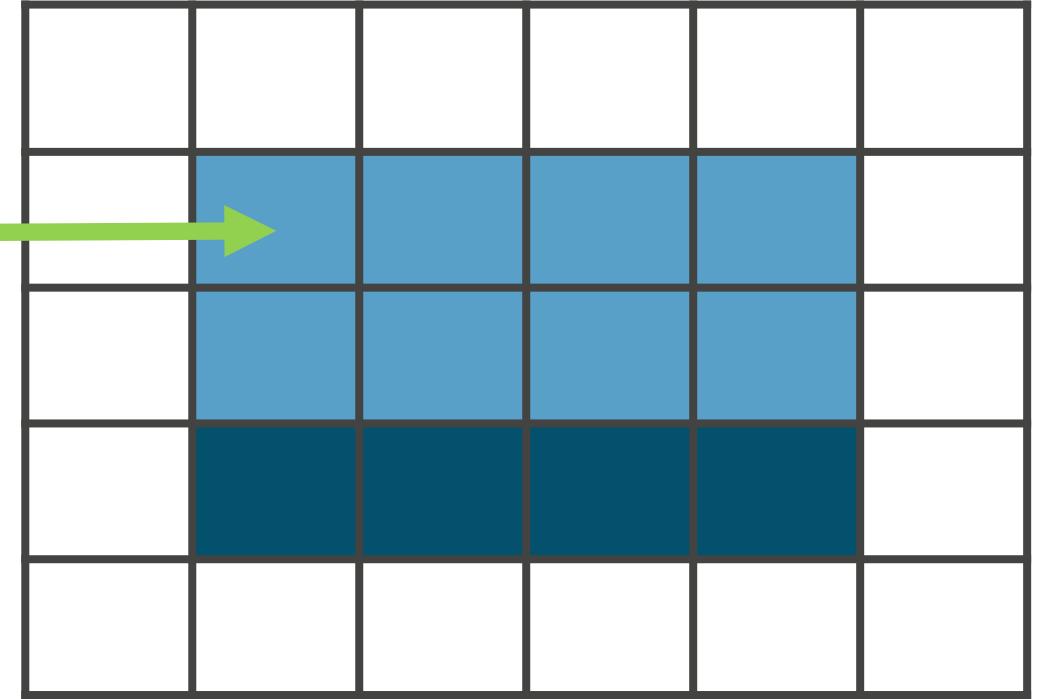


Object



Image

A Pixel is not a Square

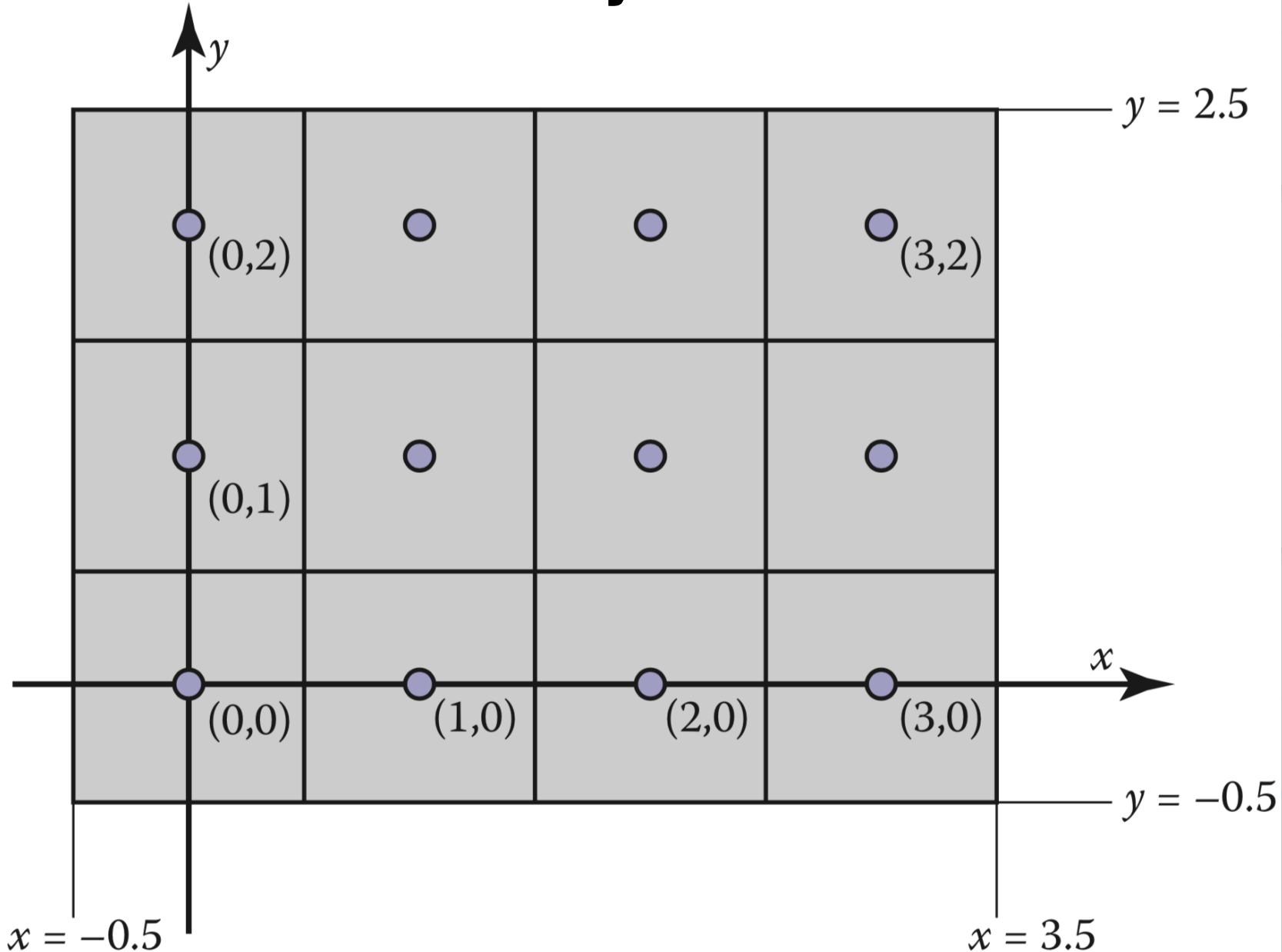


Object

$$\text{colour} = \int_{\text{Area}} \text{Light } d\text{Area}$$

Image

Standard Pixel Coordinate System



Data Types for Raster Images

Storage for 1024x1024 image (1 megapixel)

bitmap: 128KB

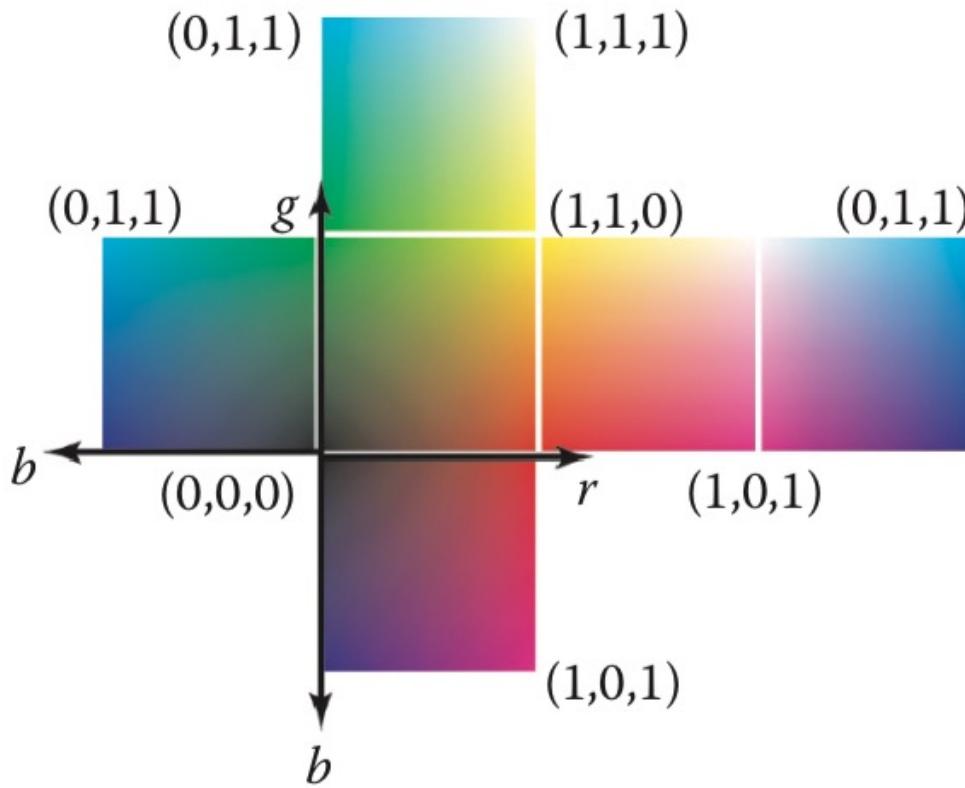
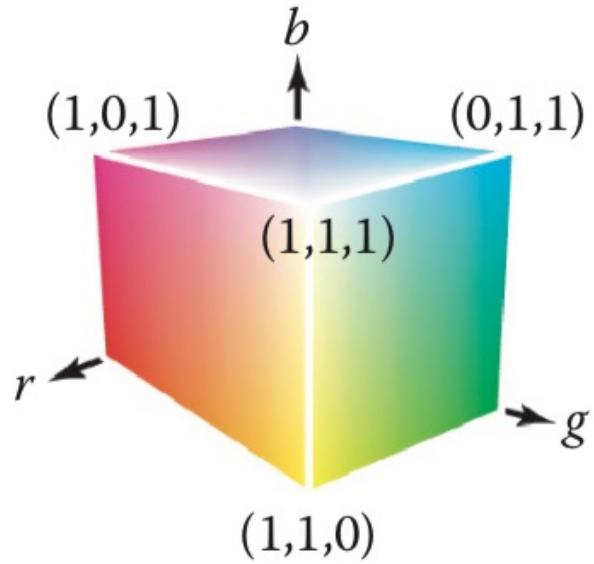
grayscale 8bpp: 1MB

grayscale 16bpp: 2MB

color 24bpp: 3MB

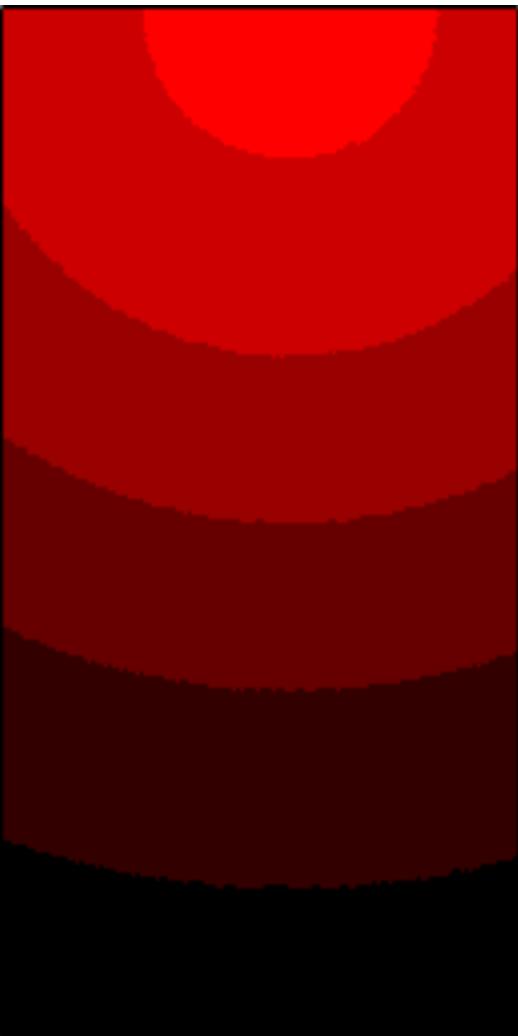
floating-point HDR color: 12MB

RGB Images

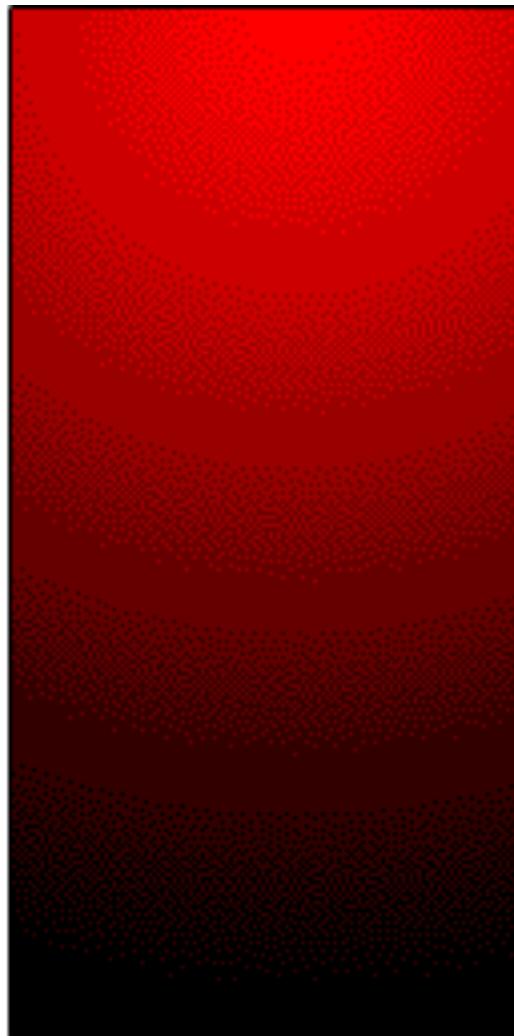


black = (0, 0, 0),
red = (1, 0, 0),
green = (0, 1, 0),
blue = (0, 0, 1),
yellow = (1, 1, 0),
magenta = (1, 0, 1),

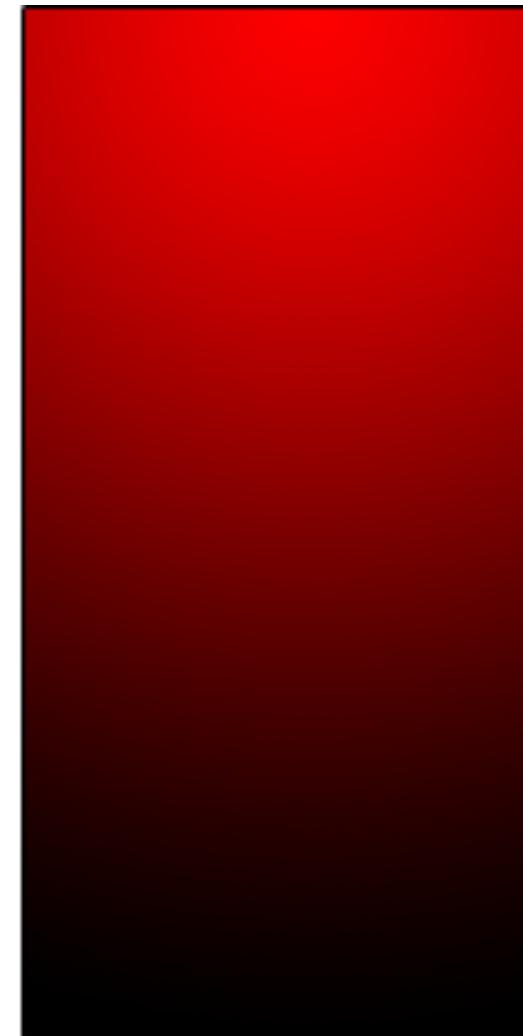
Artifacts of Raster Images: Banding



8-bit gradient



8-bit gradient,
dithered



24-bit gradient

Artifacts of Raster Images: Clipping



Original



Clipped

Gamma Correction



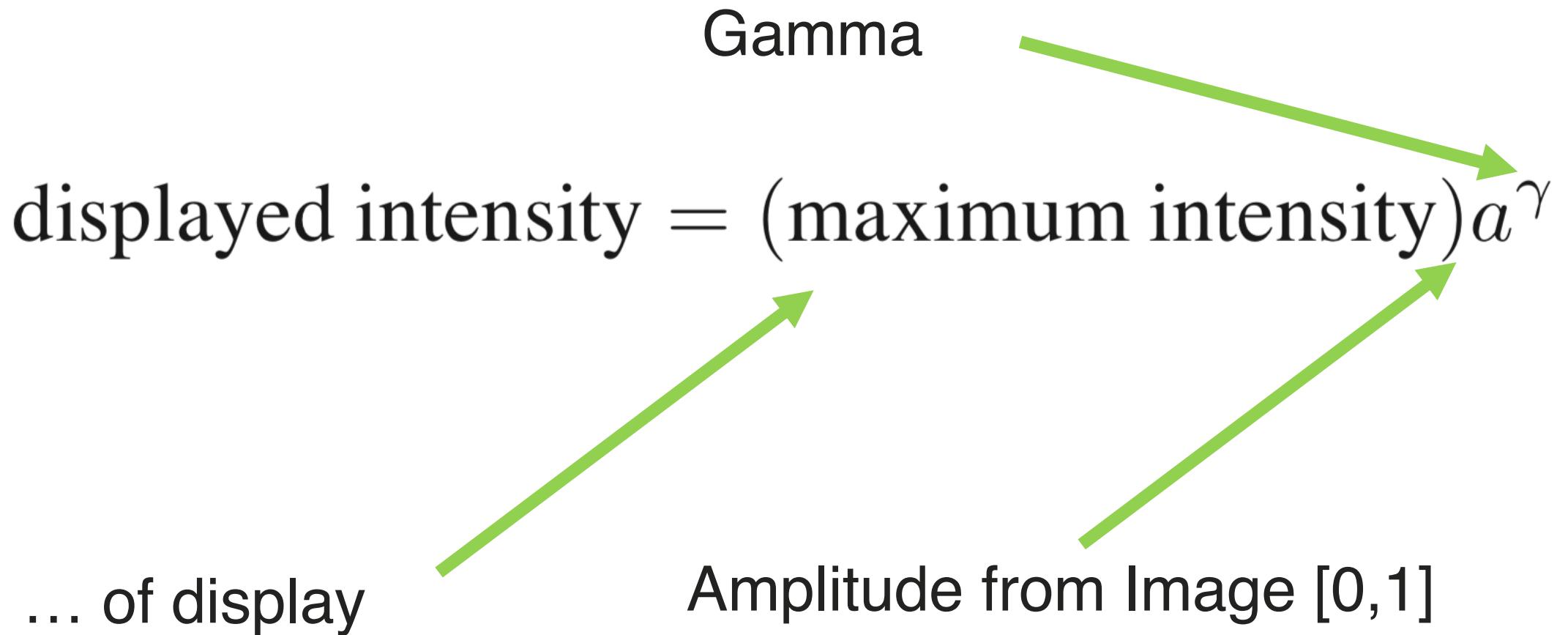
Linear encoding $V_S =$	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Linear intensity $I =$	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Display intensity is nonlinear wrt input intensity

Gamma Correction

displayed intensity = (maximum intensity) a^γ

Gamma Correction



Gamma Correction

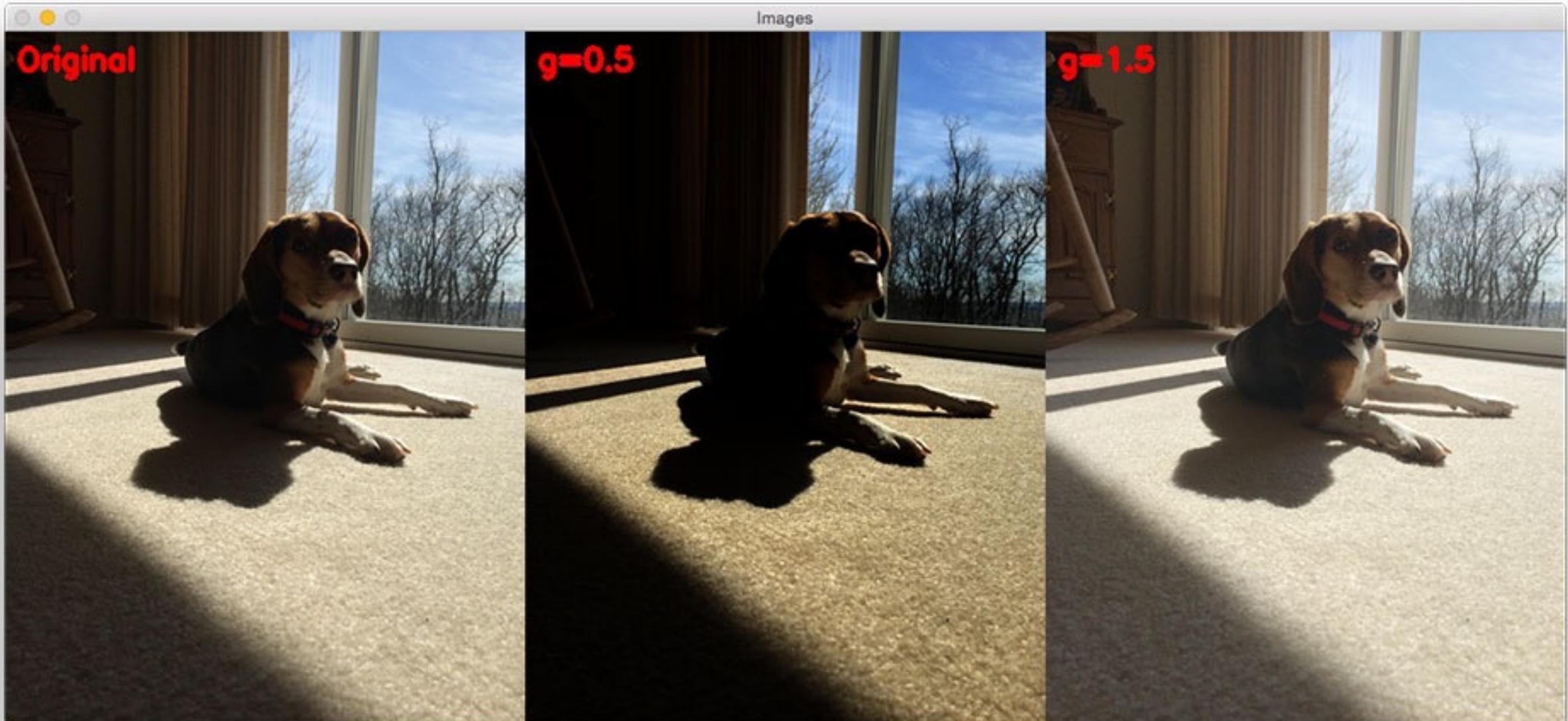
Measure: Find image amplitude that = $\frac{1}{2}$ display brightness

$$0.5 = a^\gamma$$

Fit model

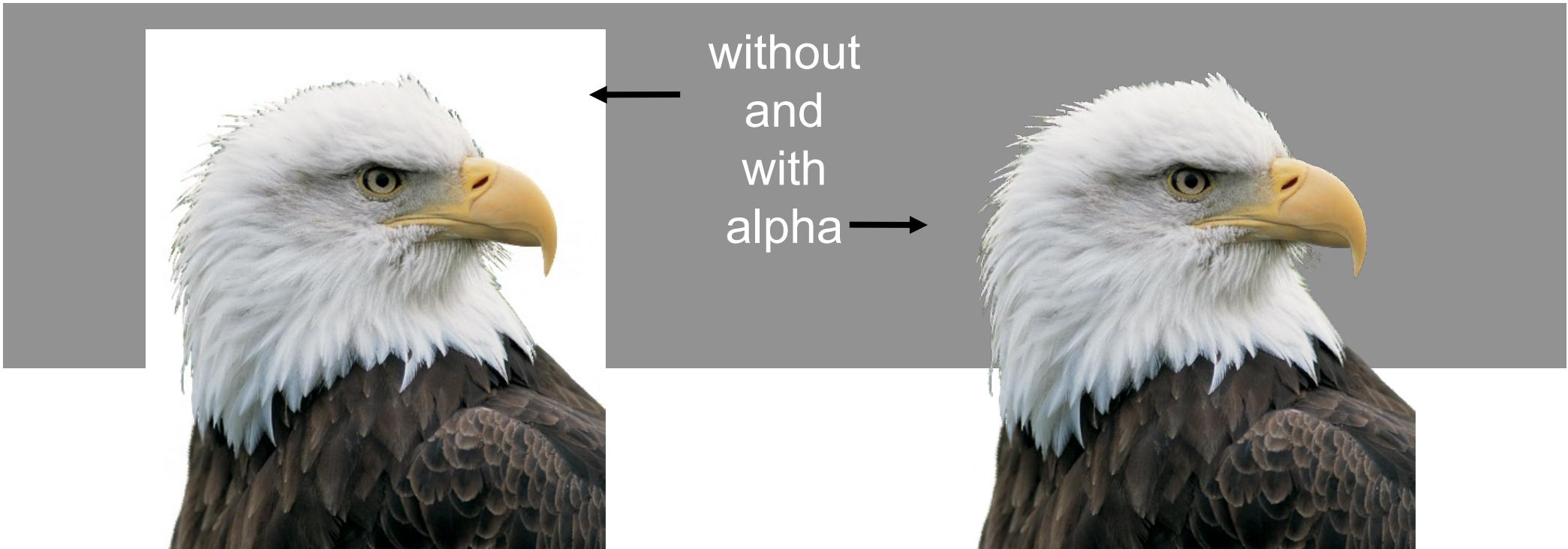
$$\gamma = \frac{\ln 0.5}{\ln a}$$

Gamma Correction



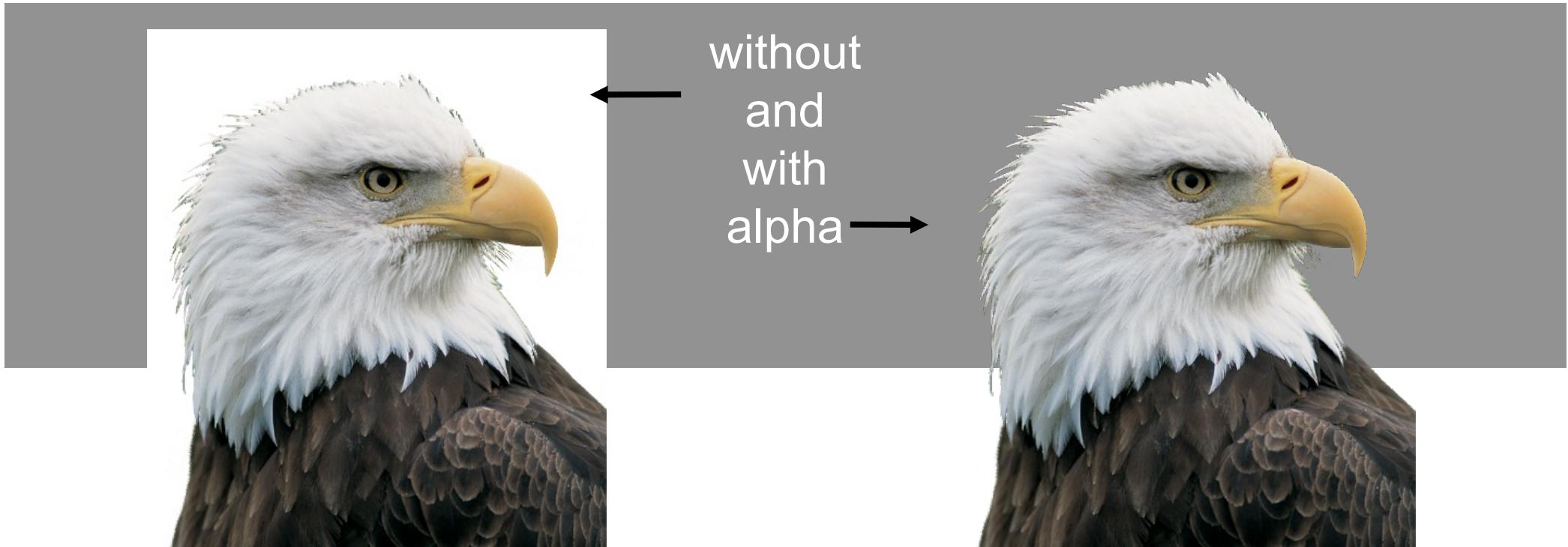
Transparency

Append (Red, Green, Blue) to be (Red, Green, Blue, Alpha)



Transparency

Append (Red, Green, Blue) to be (Red, Green, Blue, Alpha)



$$\mathbf{c} = \alpha \mathbf{c}_f + (1 - \alpha) \mathbf{c}_b.$$

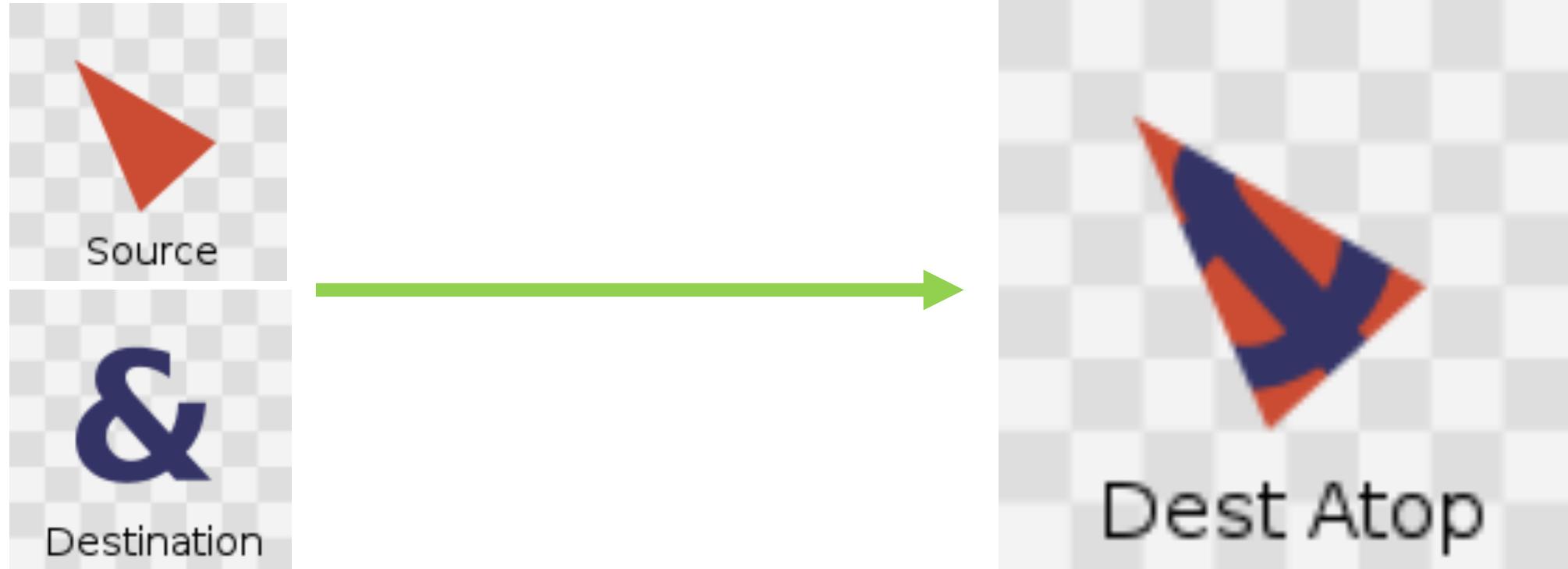
Compositing

Compositing is about layering images on top of one another



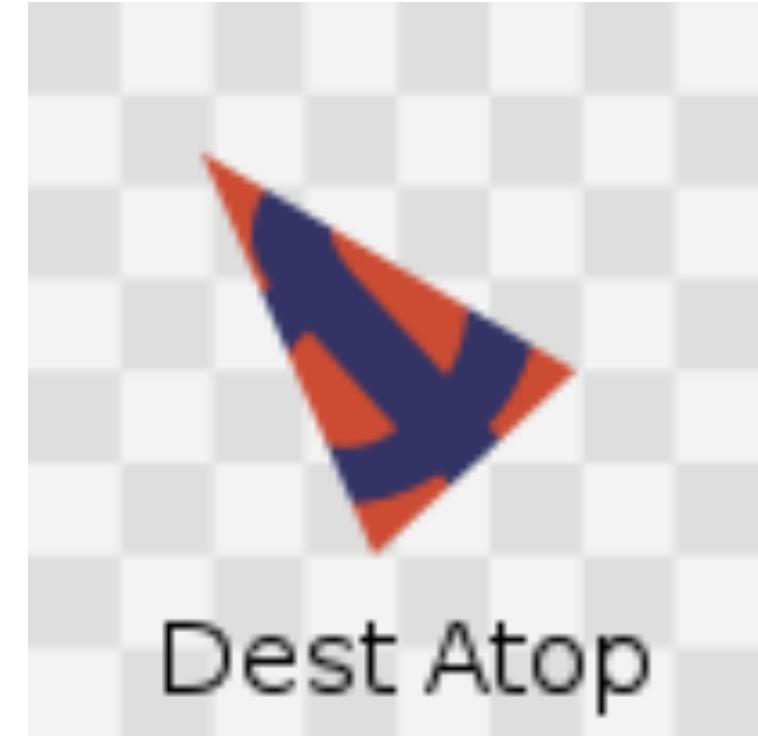
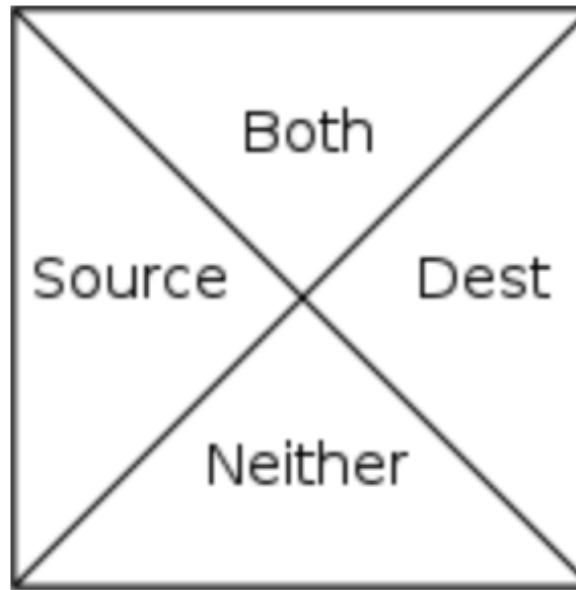
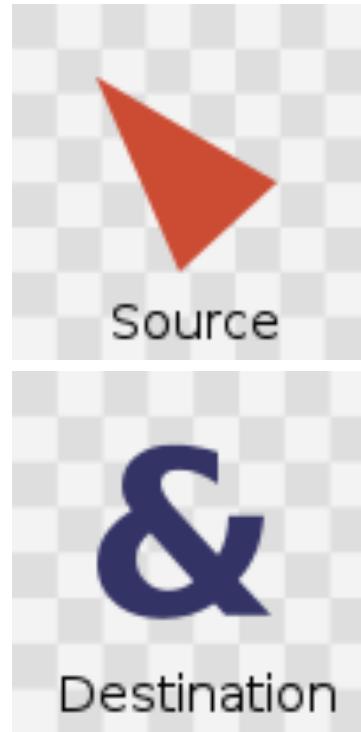
Compositing

Compositing is about layering images on top of one another



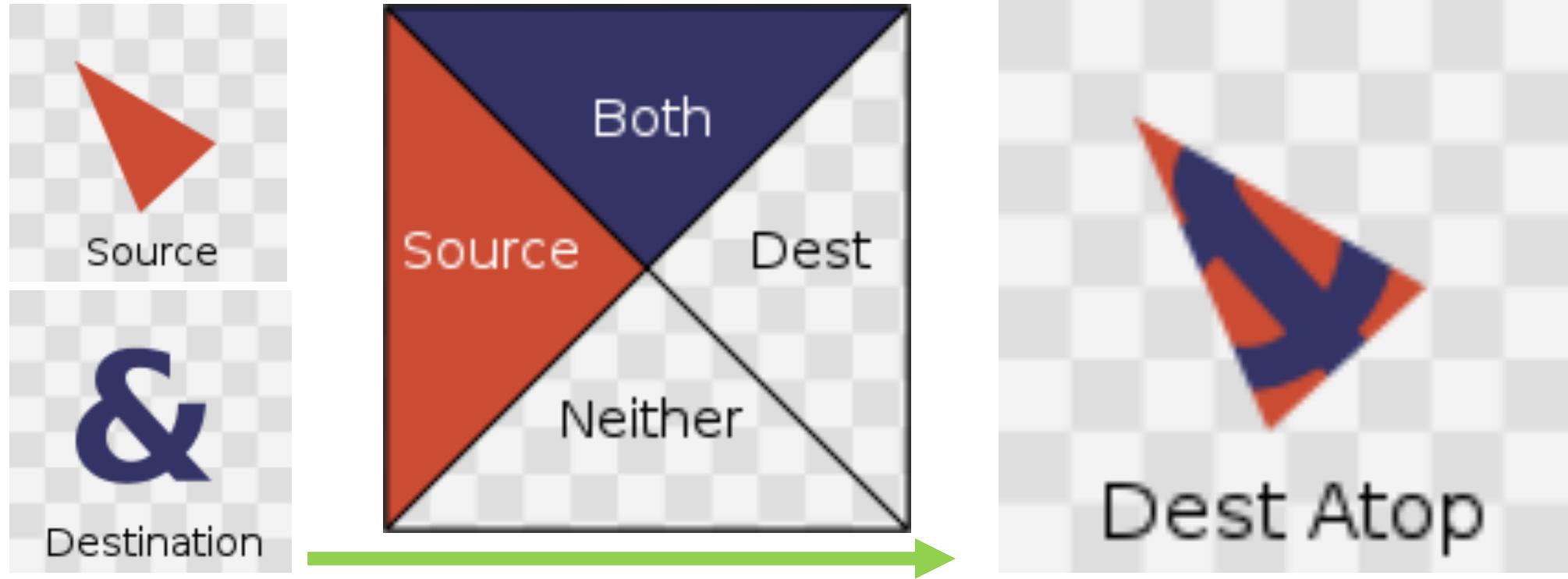
Compositing

Compositing is about layering images on top of one another



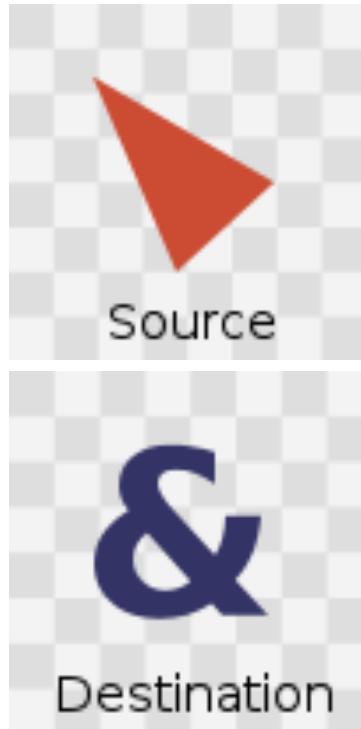
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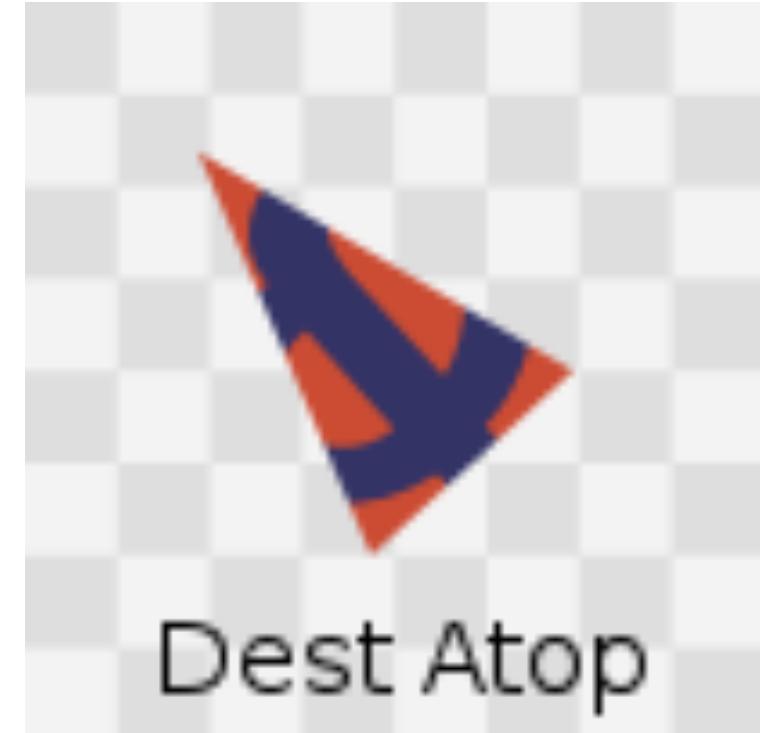


Compositing

Compositing is about layering images on top of one another

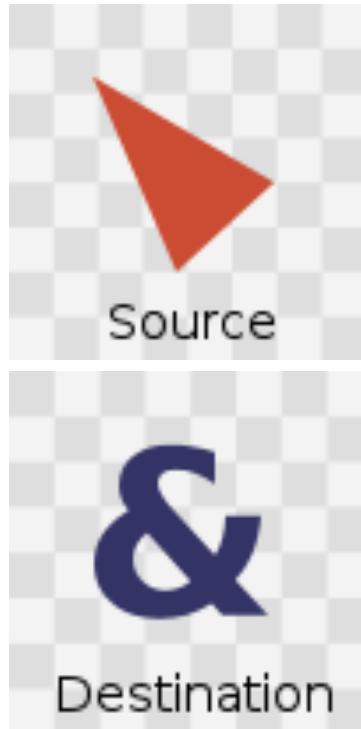


$$A_{\text{src}} \cdot [s] + A_{\text{dest}} \cdot [d] + A_{\text{both}} \cdot [b]$$



Compositing

Compositing is about layering images on top of one another



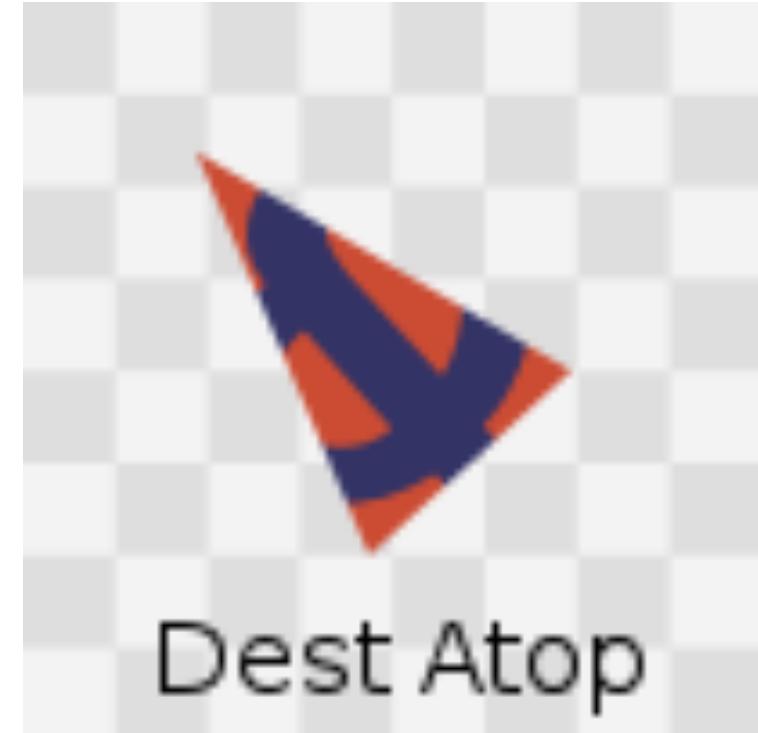
$$A_{\text{src}} \cdot [s] + A_{\text{dest}} \cdot [d] + A_{\text{both}} \cdot [b]$$



$$A_{\text{src}} = \alpha_s \cdot (1 - \alpha_d)$$

$$A_{\text{dst}} = \alpha_d \cdot (1 - \alpha_s)$$

$$A_{\text{both}} = \alpha_s \cdot \alpha_d$$



Assignment 1 TODAY

DUE IN 10 Days (START NOW!)

Next Week: Ray Casting