CSC418/2504 Computer Graphics

CSC 418/2504: Computer Graphics

Course web site (includes course information sheet):
https://github.com/dilevin/computer-graphics-csc418

Instructors:
Prof. David I.W. Levin diwlevin@cs.toronto.edu

Office Hours:

Dave – Tuesday 5-6pm, Wednesday 5-6pm

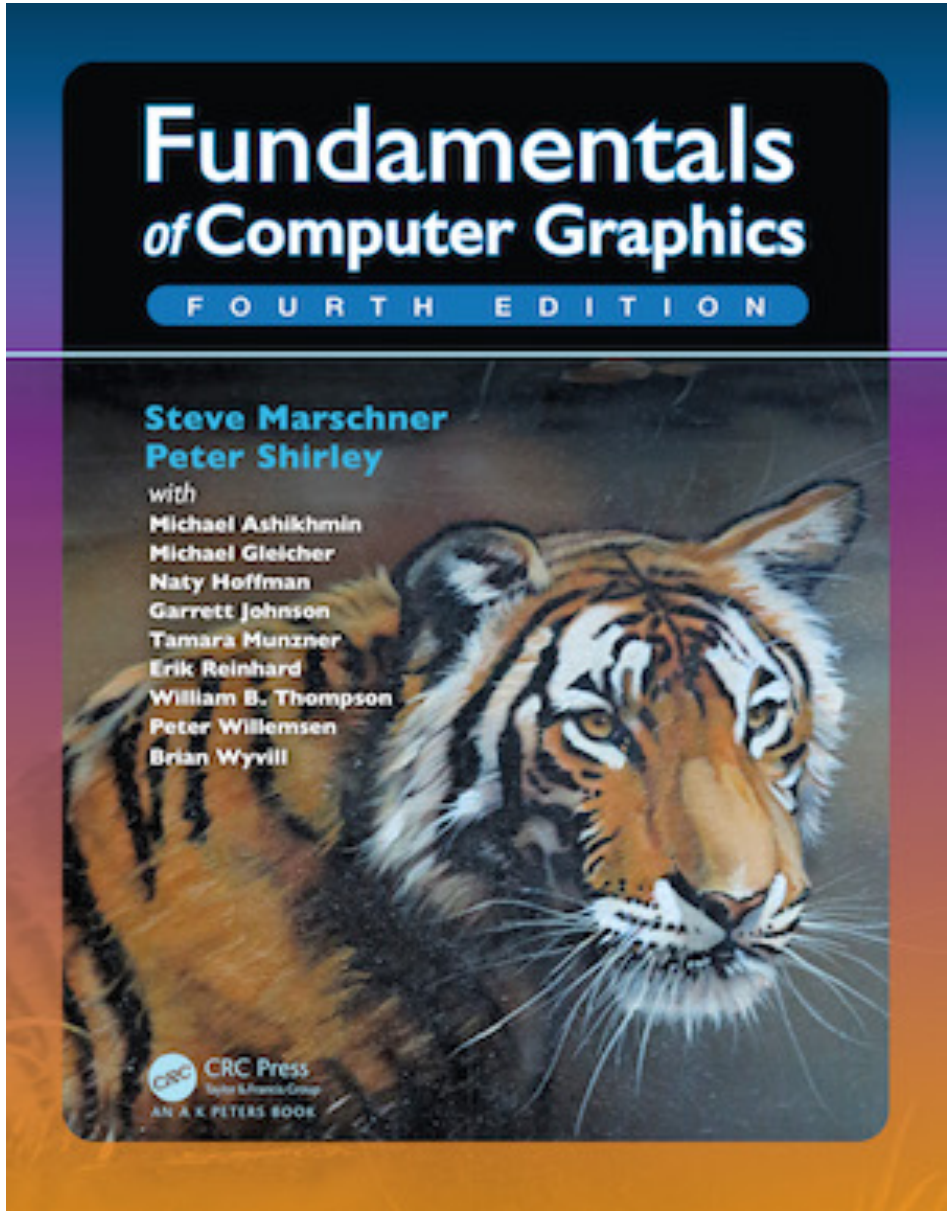
Questions on Assignments: Github issues pages

Schedule

Lectures
LEC0101 Wednesdays 15:00-17:00 in GB221
LEC2001 Wednesdays 15:00-17:00 in GB221
LEC0201 Tuesdays 15:00-17:00 in GB244
LEC2201 Tuesdays 15:00-17:00 in GB244

Tutorials
LEC0101 Monday 12:00-13:00 in GB221
LEC2001 Monday 12:00-13:00 in GB221
LEC0201 Monday 12:00-13:00 in GB244
LEC2201 Monday 12:00-13:00 in GB244

Required Textbook
(Lots of figures on slides adapted from here)



Schedule (on the webpage)

Week	Topic / Event
1	Introduction, Assignment 1 (Raster Images) due 17/01
2	Lecture 2, Assignment 2 (Ray Casting) due 24/01
3	Lecture 3, Assignment 3 (Ray Tracing) due 31/01
4	Lecture 4, Assignment 4 (Boundary Volume Hierarchy) due 7/02
5	Lecture 5, Assignment 5 (Meshes) due 28/02
6	Lecture 6, Assignment 6 (Shader Pipeline) due 28/02
Reading Week February 17-21	Study for 1st exam
Monday, February 24	In-tutorial Exam (20% of grade)
7	*Work on Assignments 5 and 6*
8	Lecture 7, Assignment 7 (Kinematics) due 13/03
Sunday, March 15	Drop date (consider if grade so far is <50%)
9	Lecture 8, Assignment 8 (Mass-Spring Systems) due 20/03
10	Lecture 9, Final Image/Animation/Game Competition due 06/04
11	*Study for exam next week and work on Final Project*.
Monday, March 30	In-tutorial Exam (10% of grade)
12	Research Trends in Computer Graphics

Academic Honesty Policy

It’s on the webpage and is mandatory reading!

Administrivia

Grading:

%	Item
64%	Assignments
15%	Monday, Feb 24, in-tutorial exam
15%	Monday, March 30, in-tutorial exam
6%	Final Image

Tutorial sessions:

- Work on assignments, TAs will be there to help you

Today

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

But First ……


POP QUIZ, HOT SHOT...

Preliminary Math Quiz

Goals:

1. Show you what kind of mathematical background is expected in this course
2. Show you what you need to brush up on. Questions about these basic math operations will not be answered by either Professors or TAs, we expect you to know this stuff.
3. Give you a sense of how ready you are to take this course.

Time: 20 minutes (should be more than enough)

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.

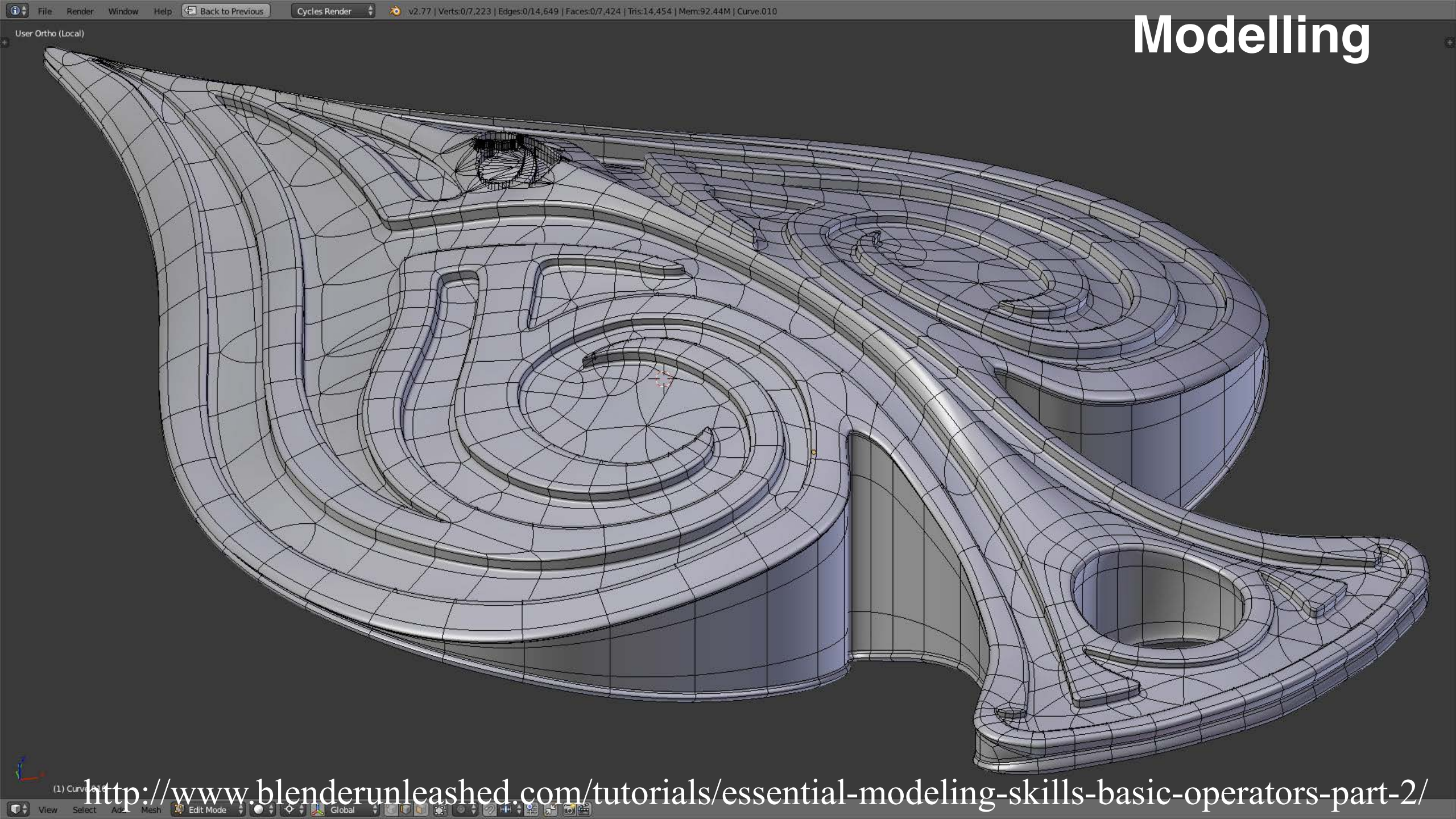
“Core” Areas of Computer Graphics

Modeling

Rendering

Animation

Modelling



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

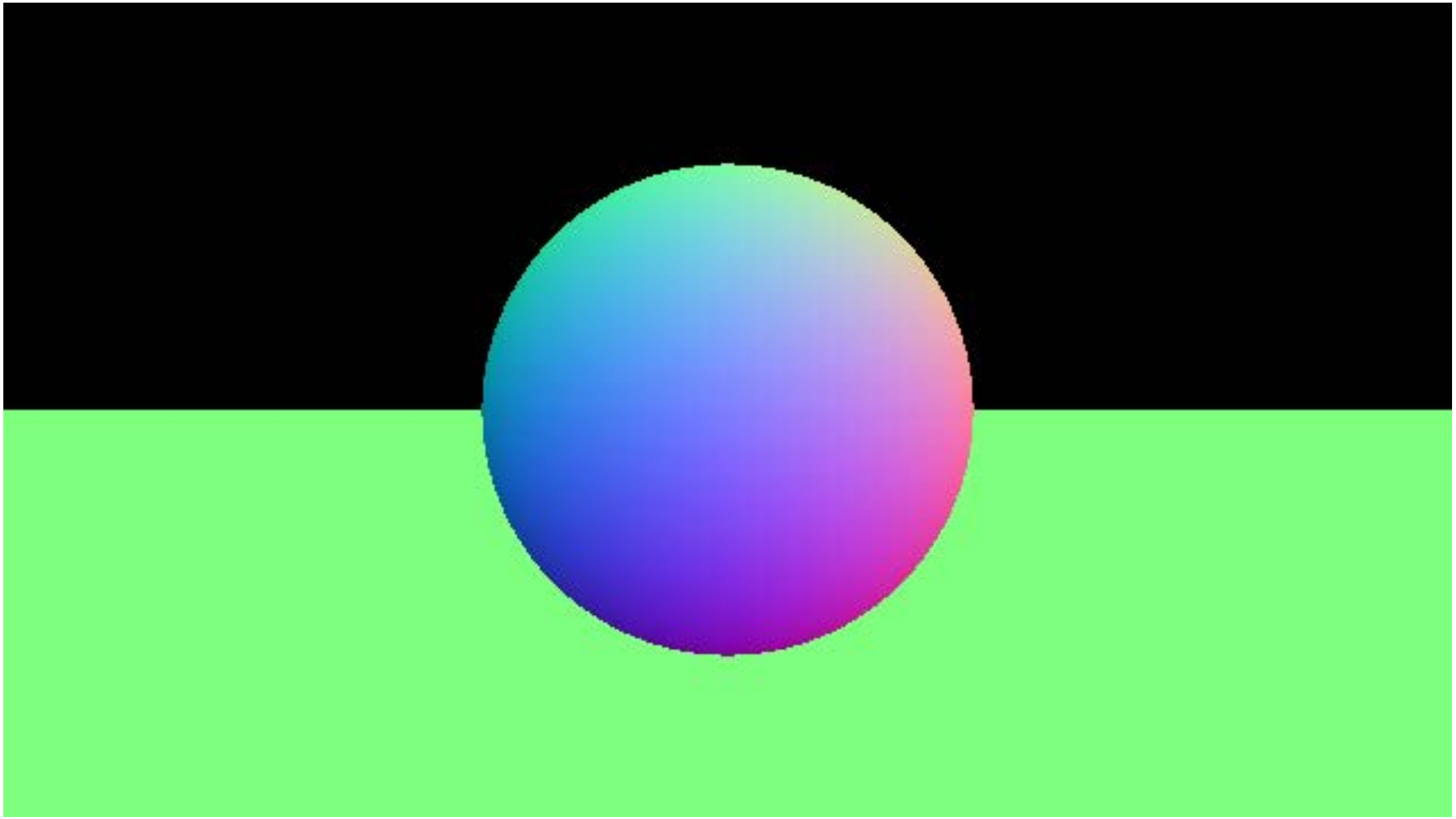
Shaders

Kinematics

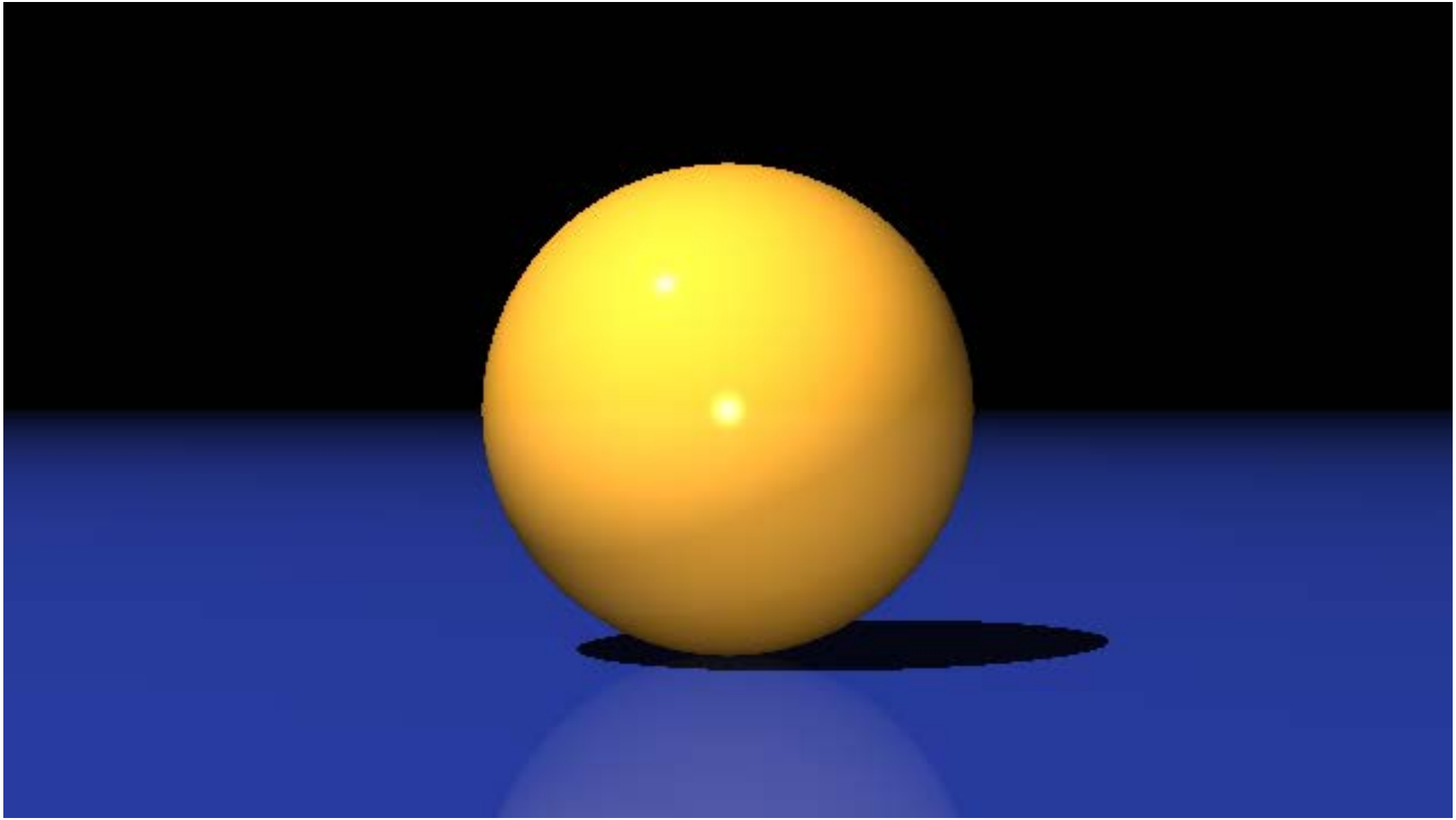
Mass-Springs

Final Project: Image Showcase !

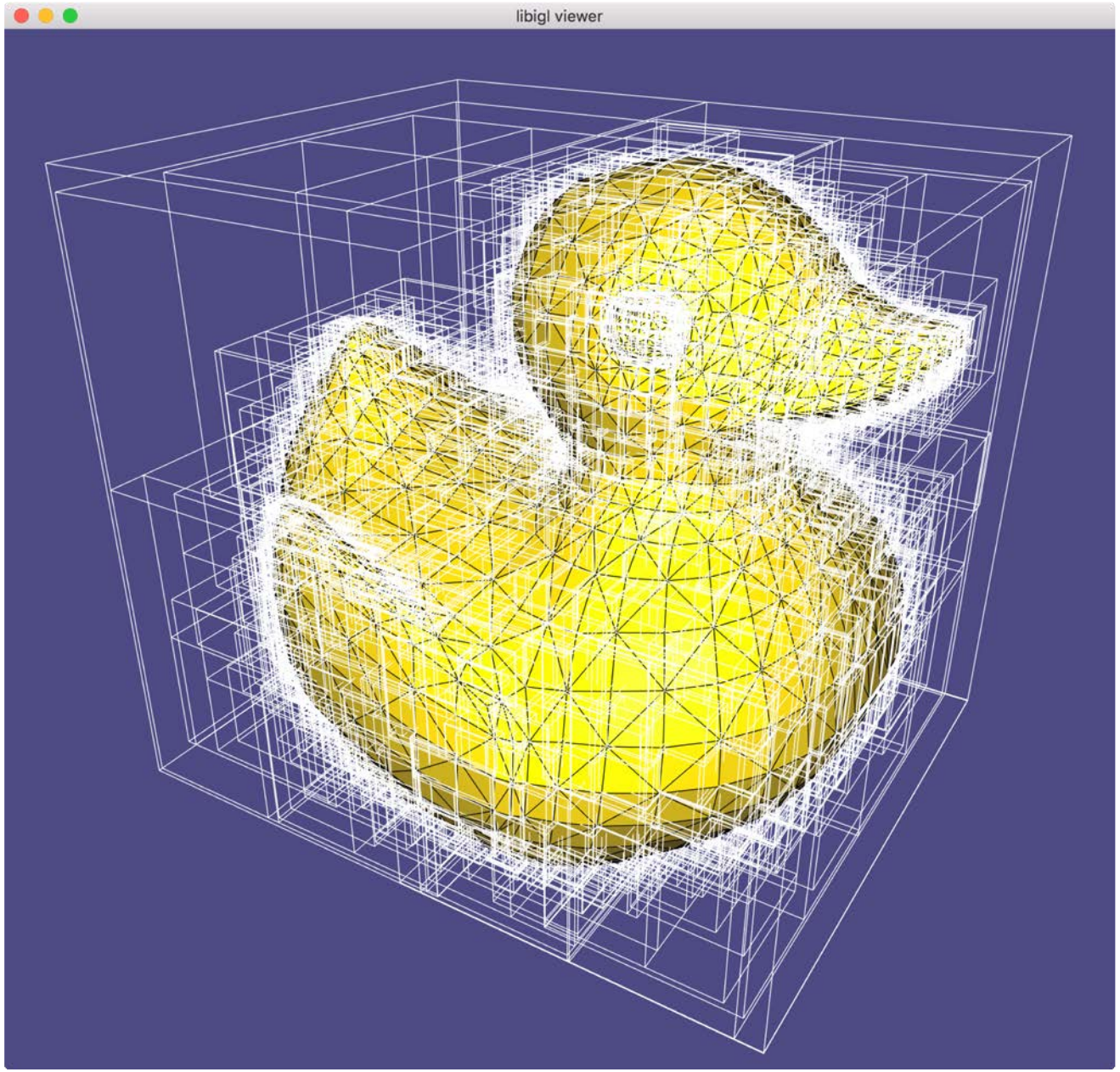
Ray Casting



Ray Tracing

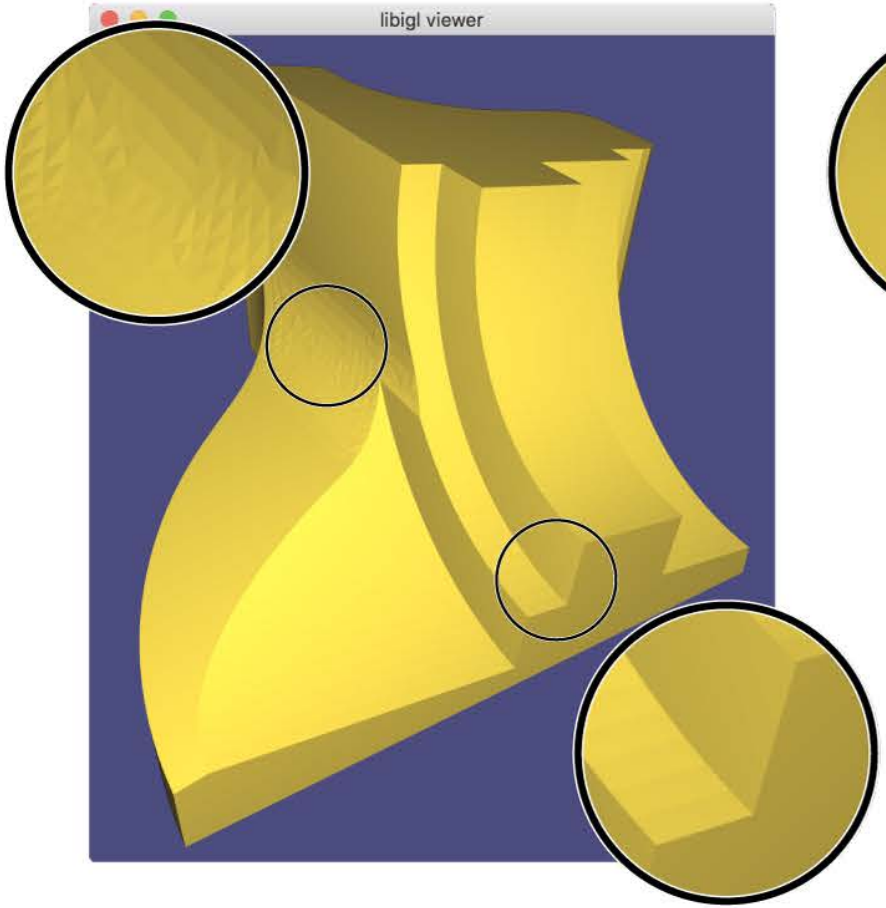


Boundary Volume Hierarchies

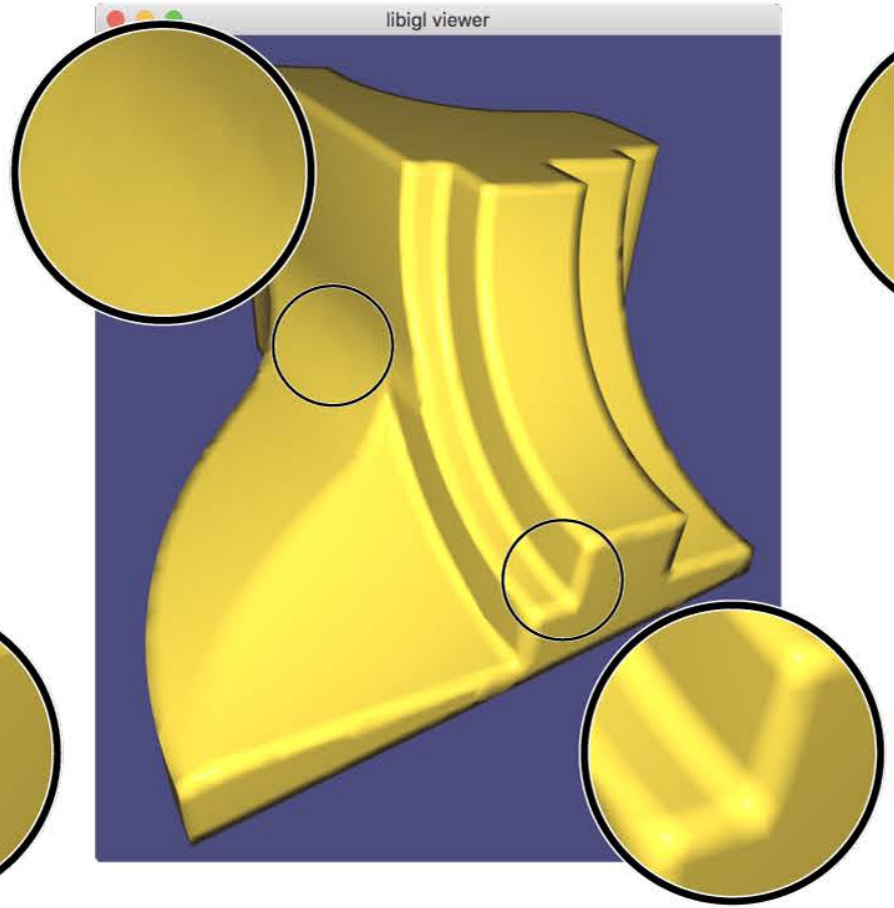


Meshes

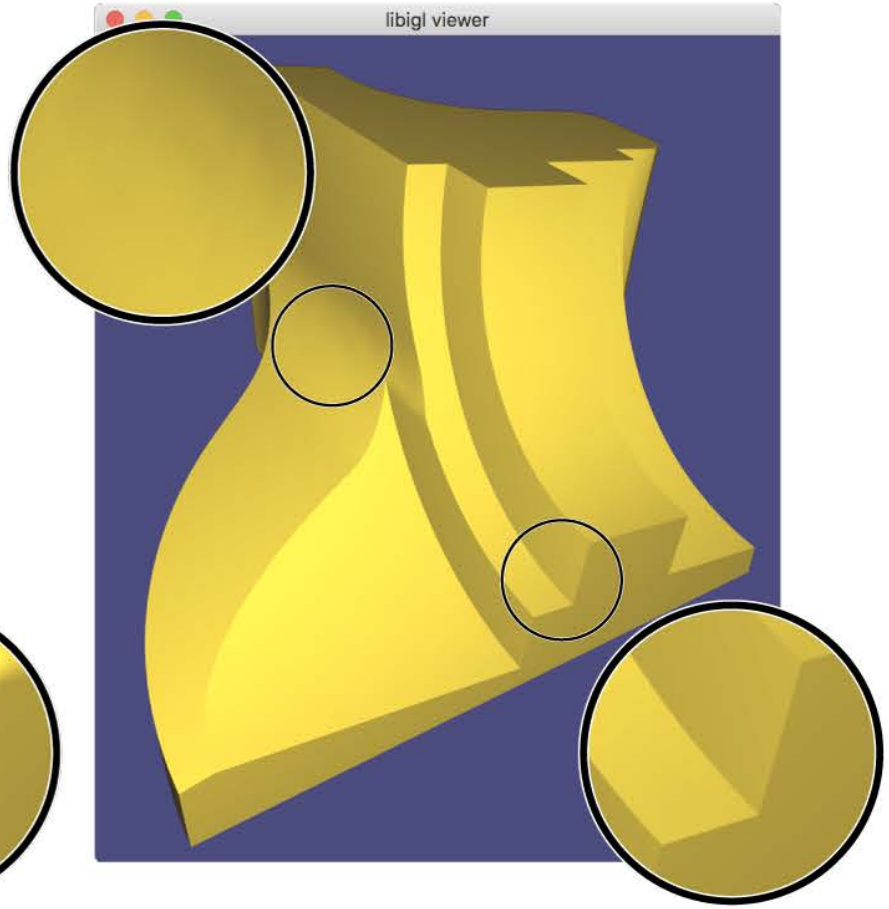
Per-face normals



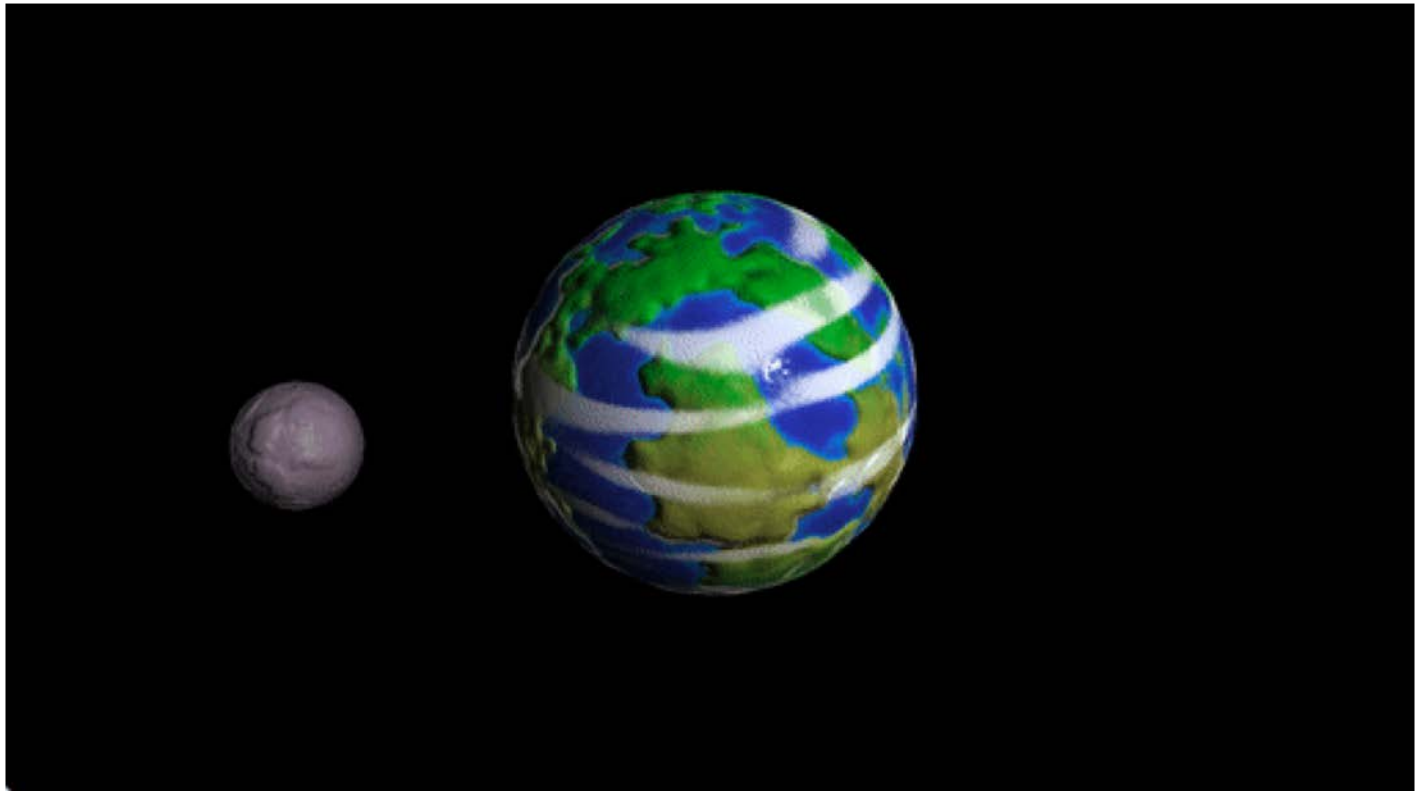
Per-vertex normals



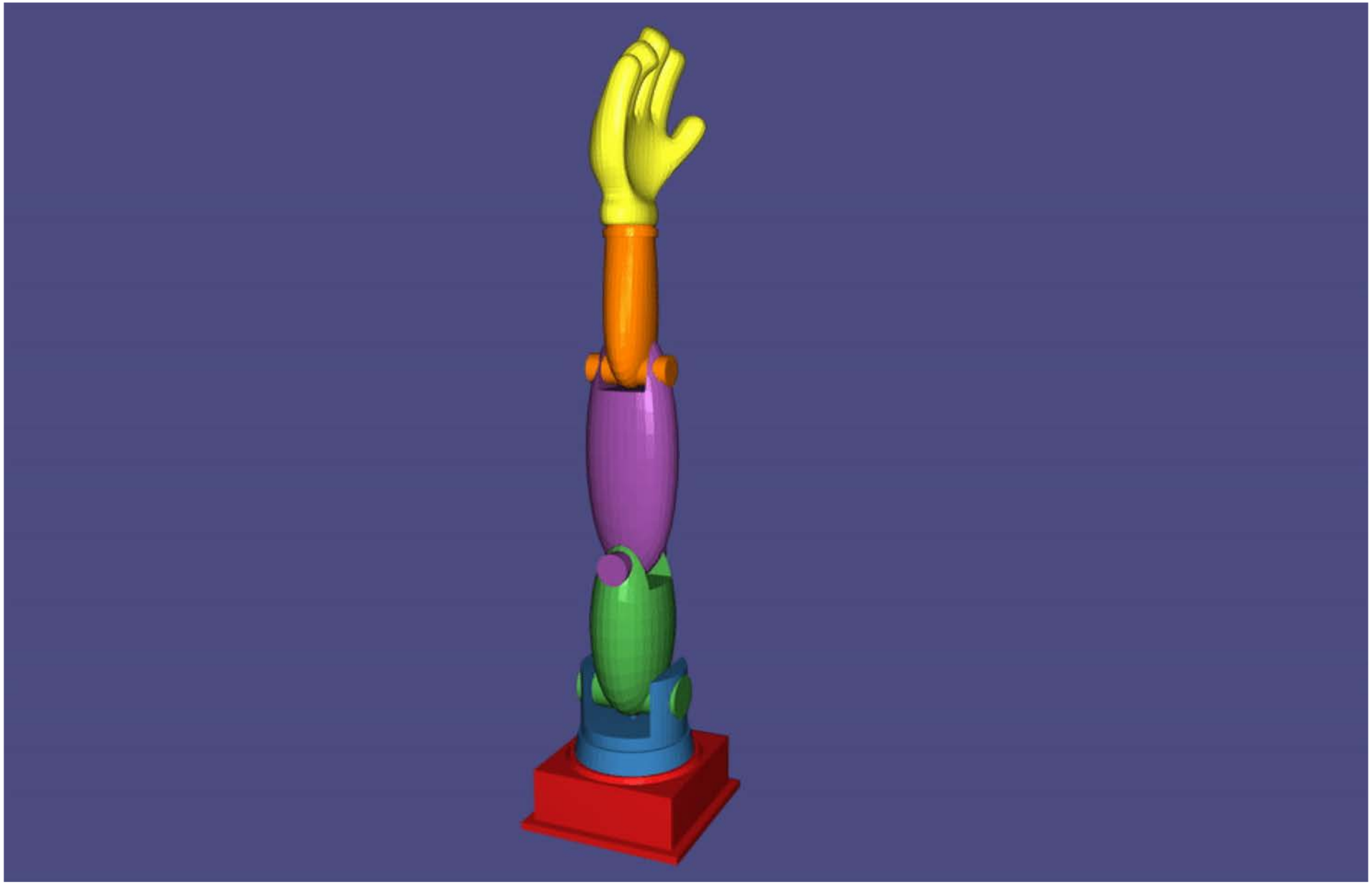
Per-corner normals



Shaders



Kinematics



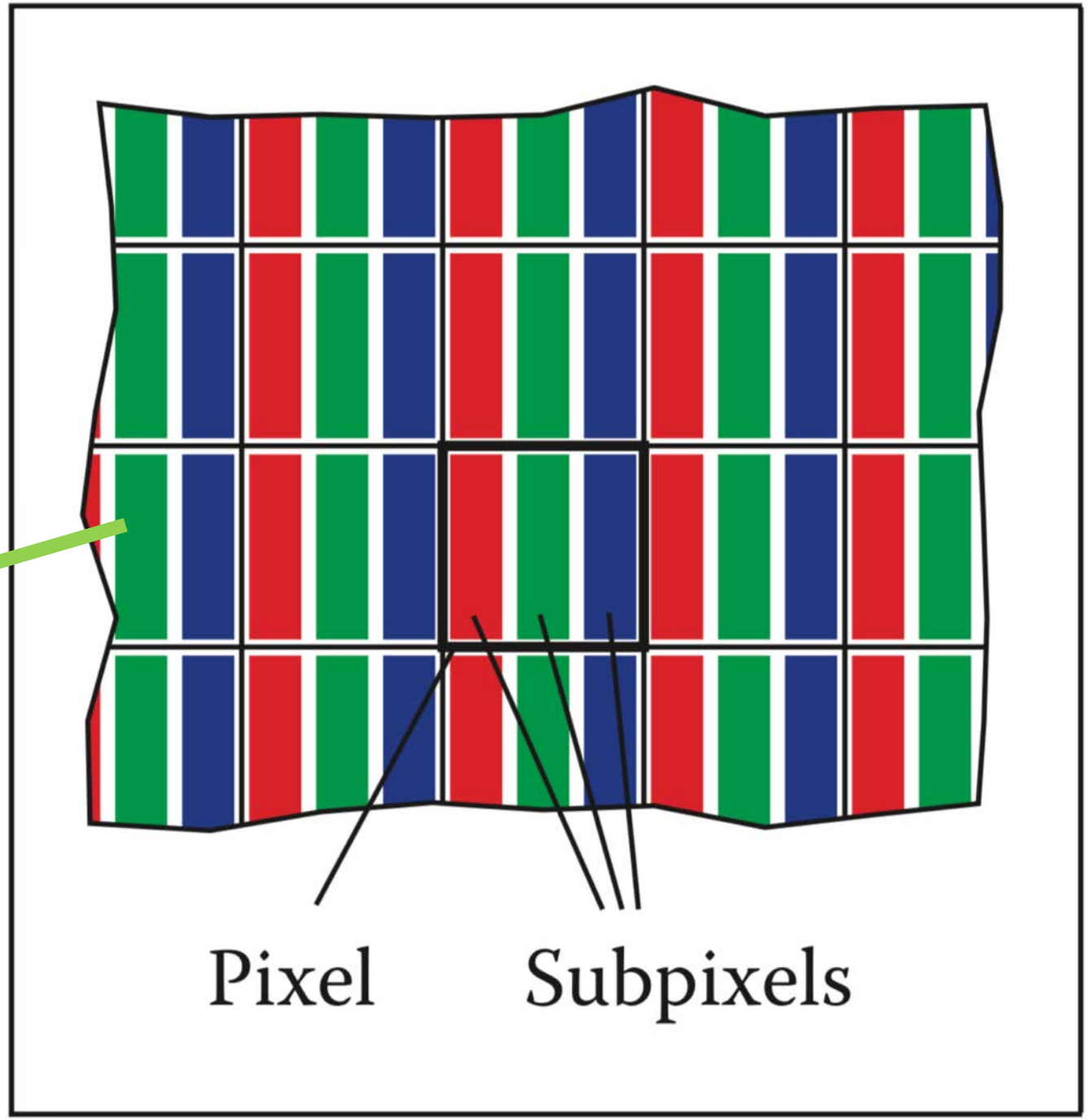
Mass-Springs


Raster Images

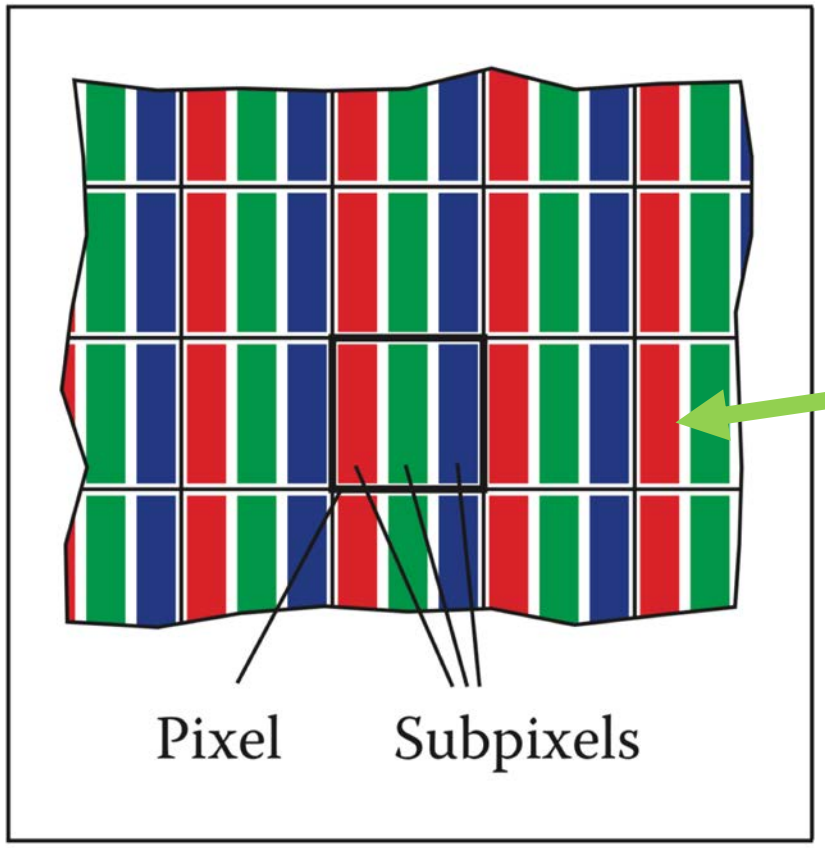
Raster Displays

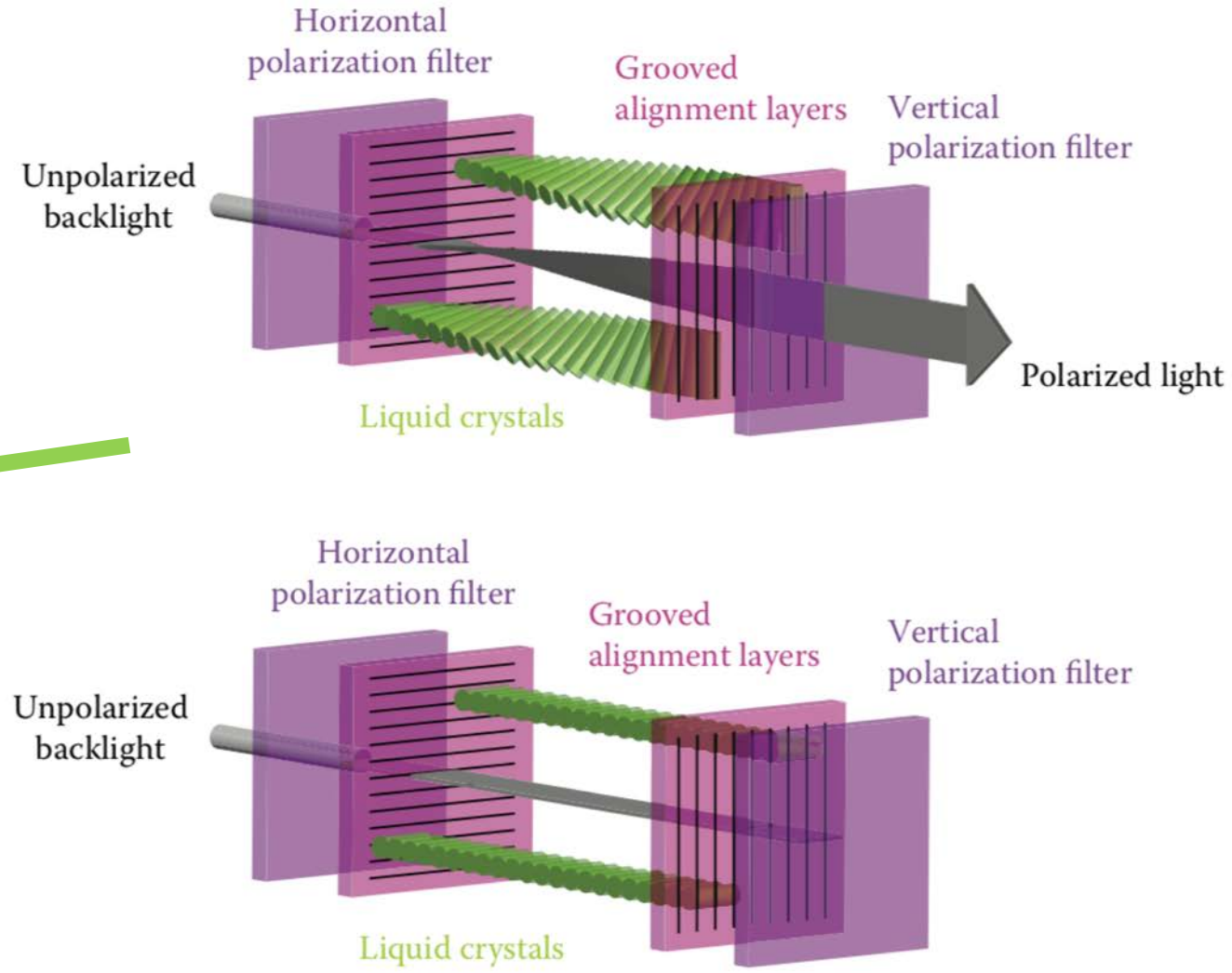
Raster Displays

Raster Displays



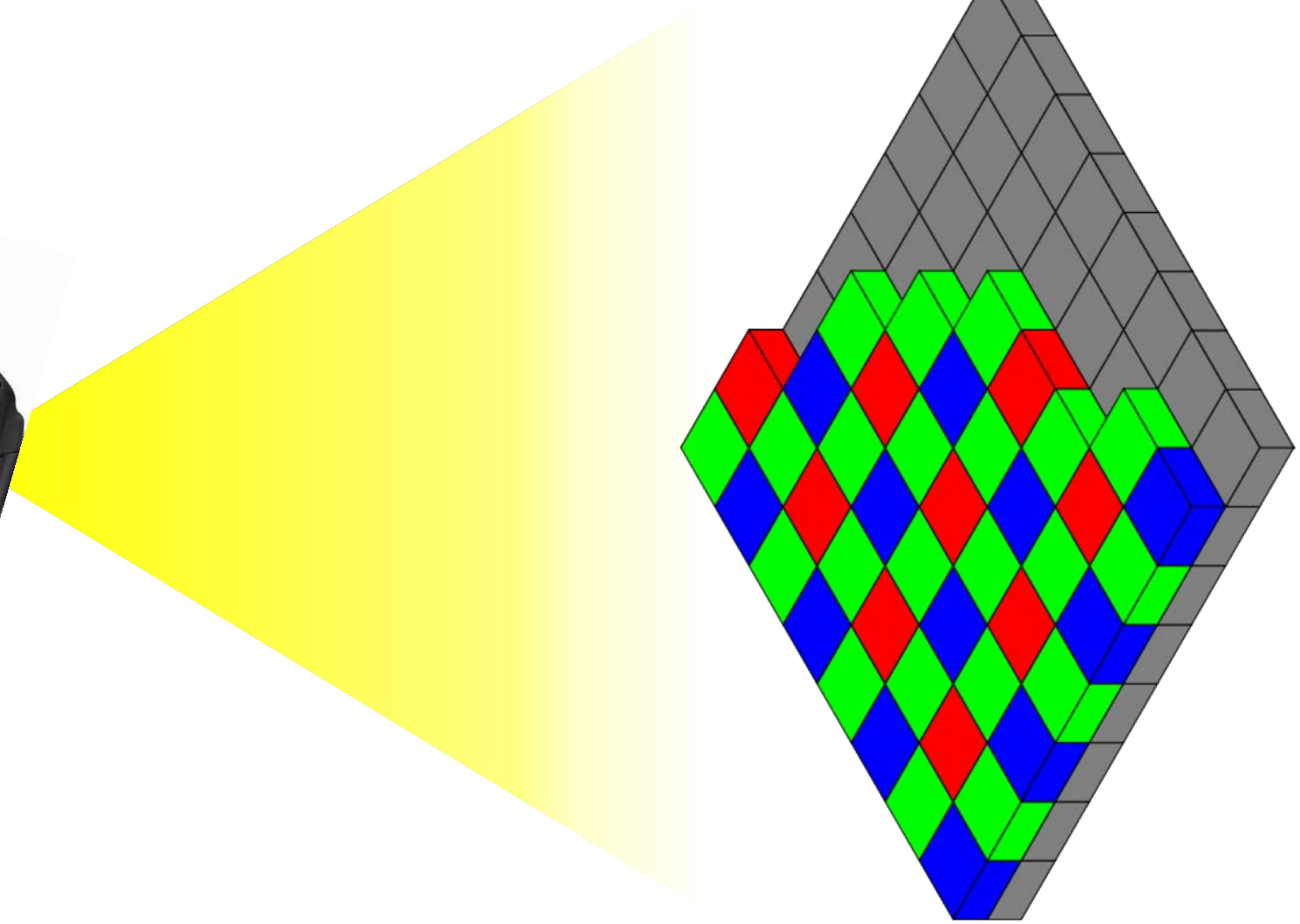
Raster Displays



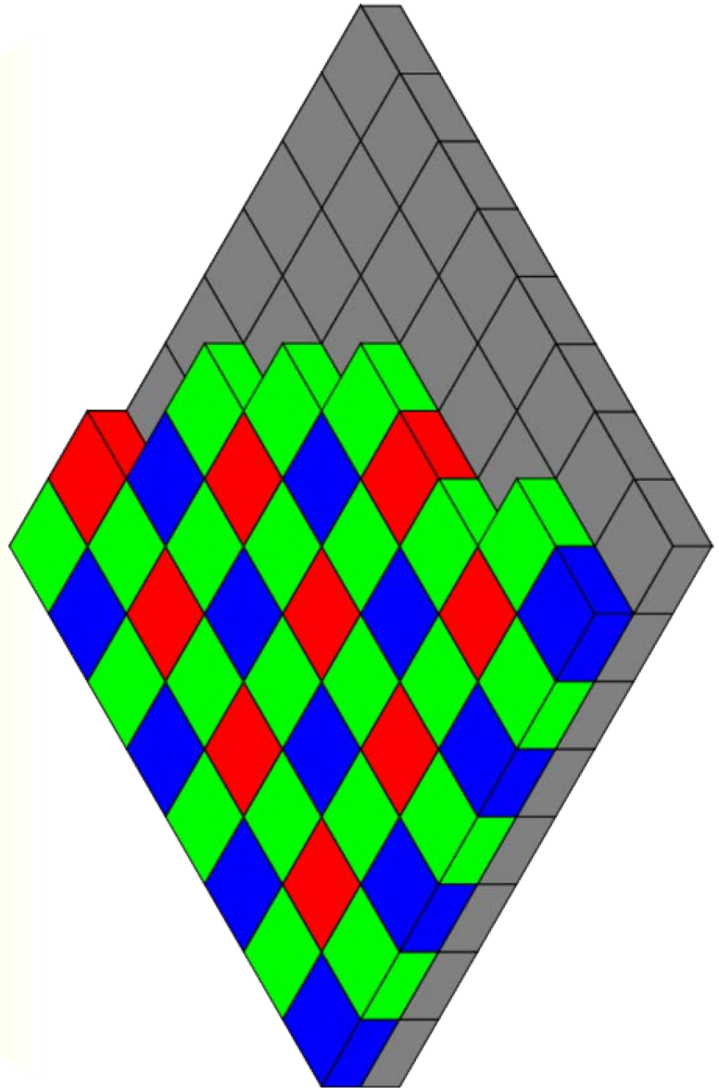


Raster Input Devices

Raster Input Devices

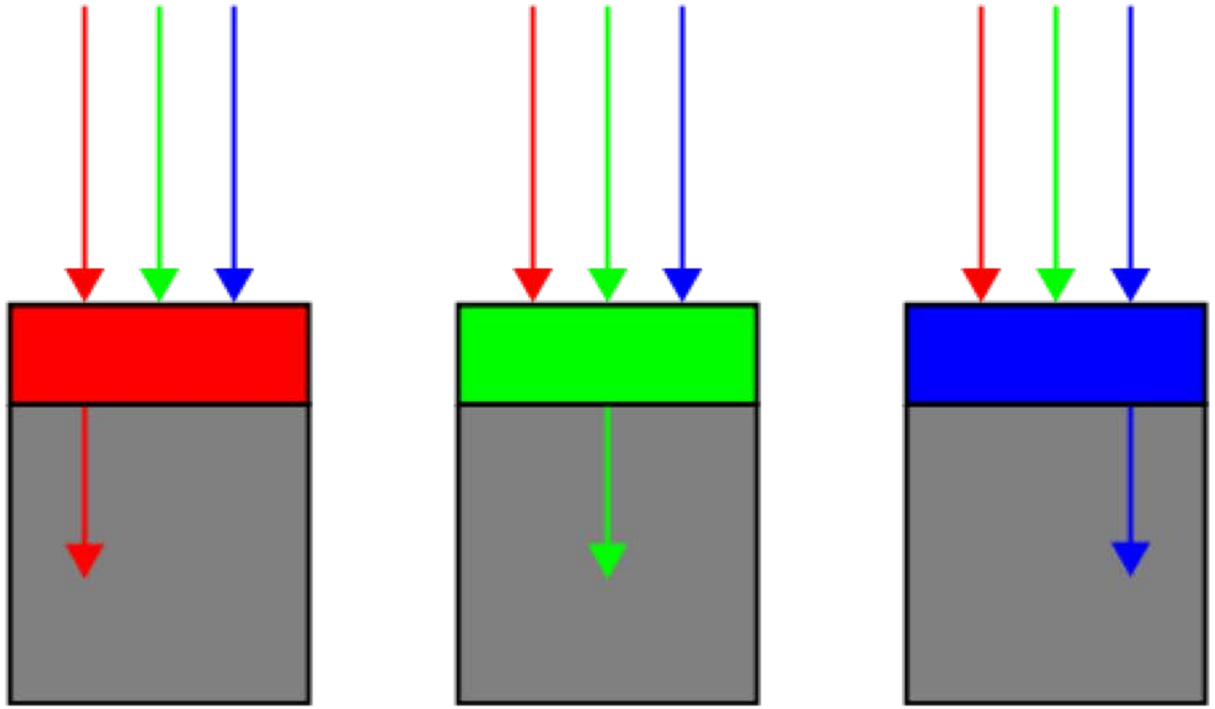


Raster Input Devices



Bayer Filter

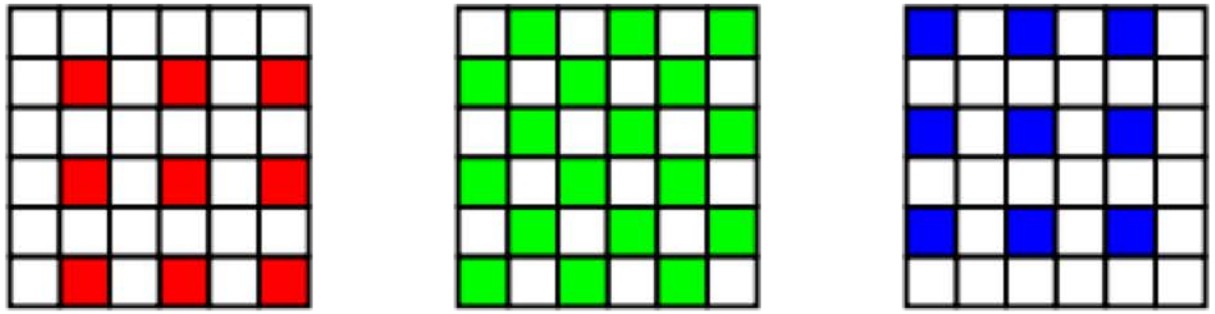
Raster Input Devices



Incoming light

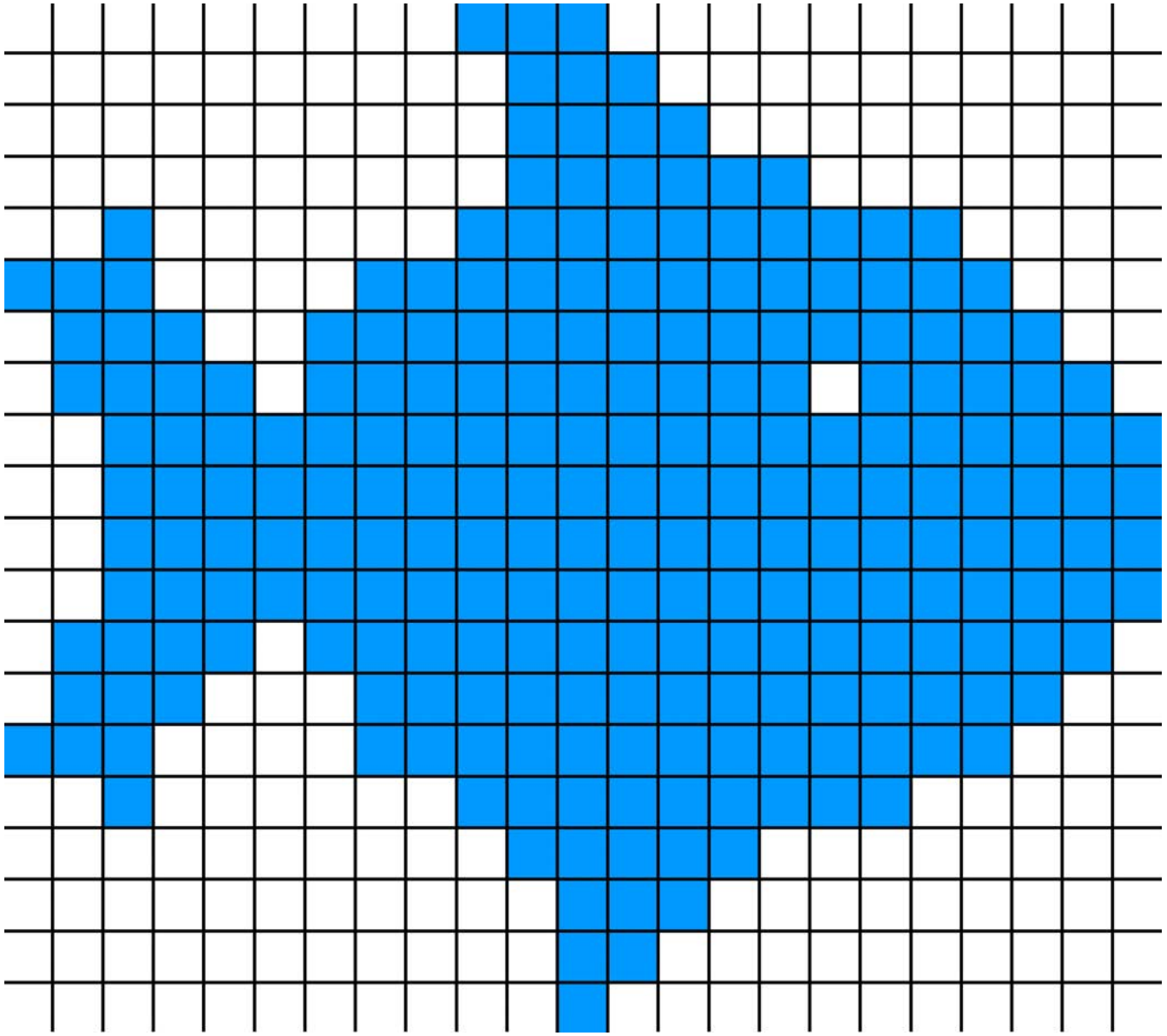
Filter layer

Sensor array

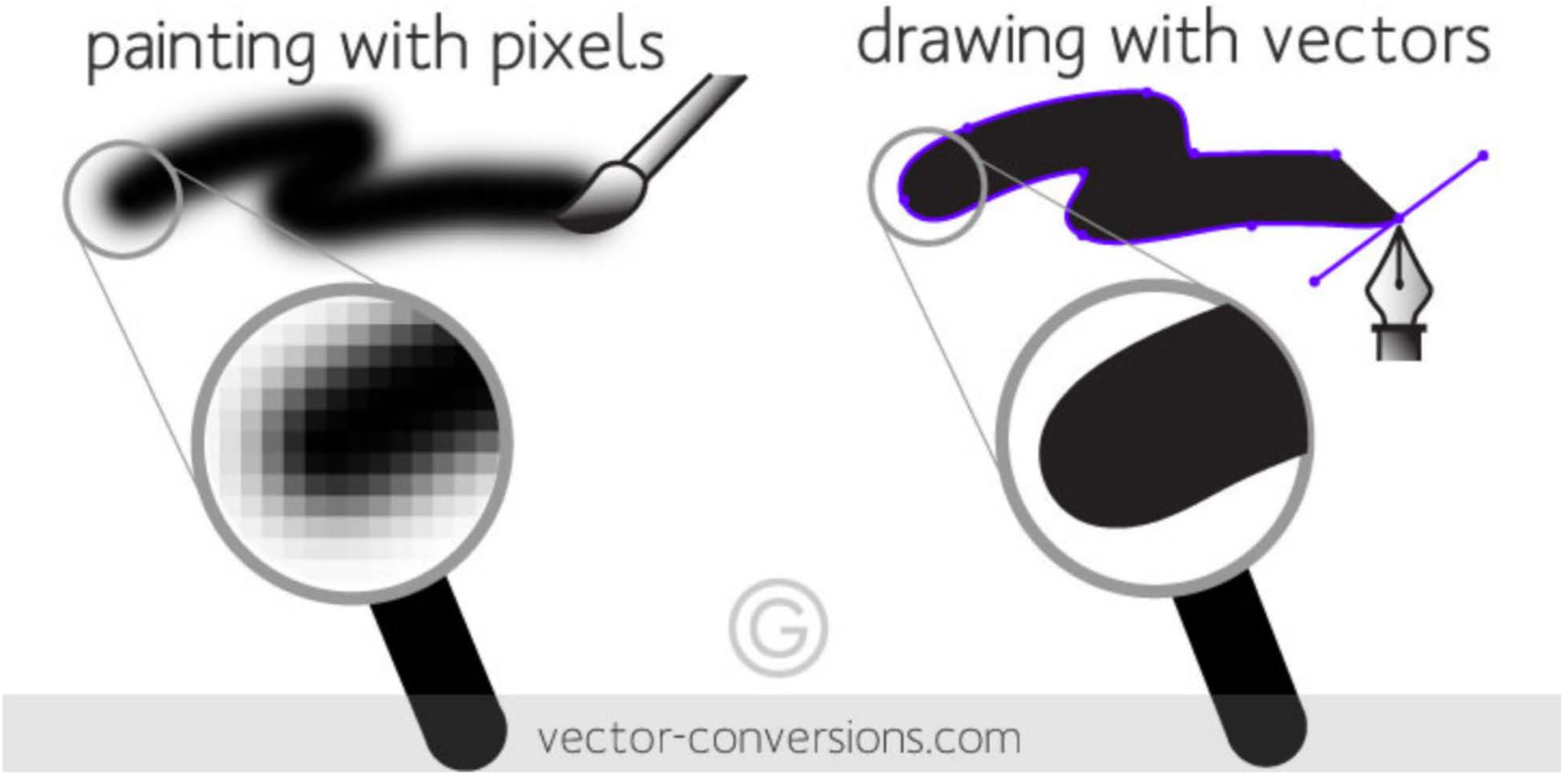


Resulting pattern

Raster Image



Aside: More Than Just Raster Images

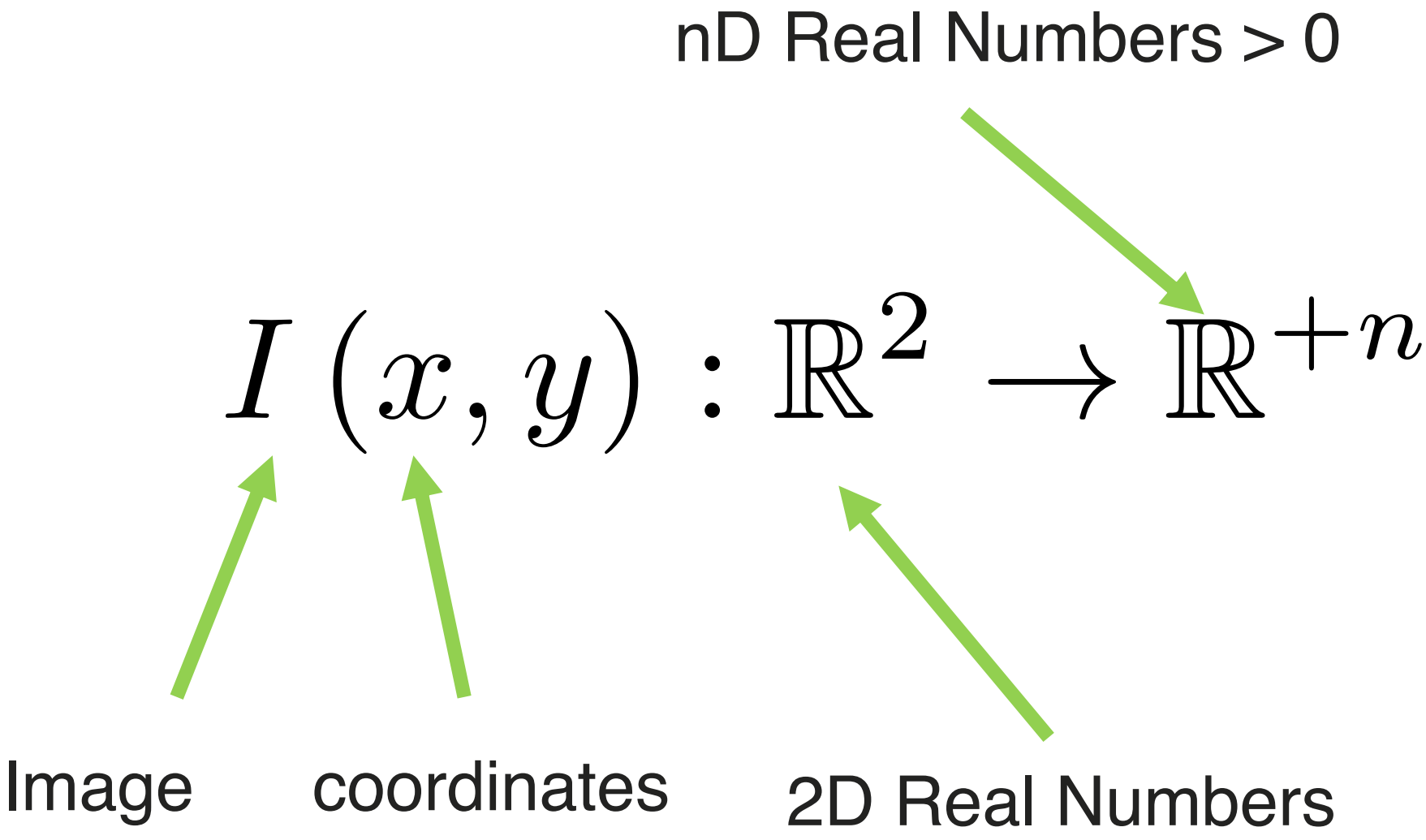


Images as a Function

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

Image coordinates ????

Images as a Function

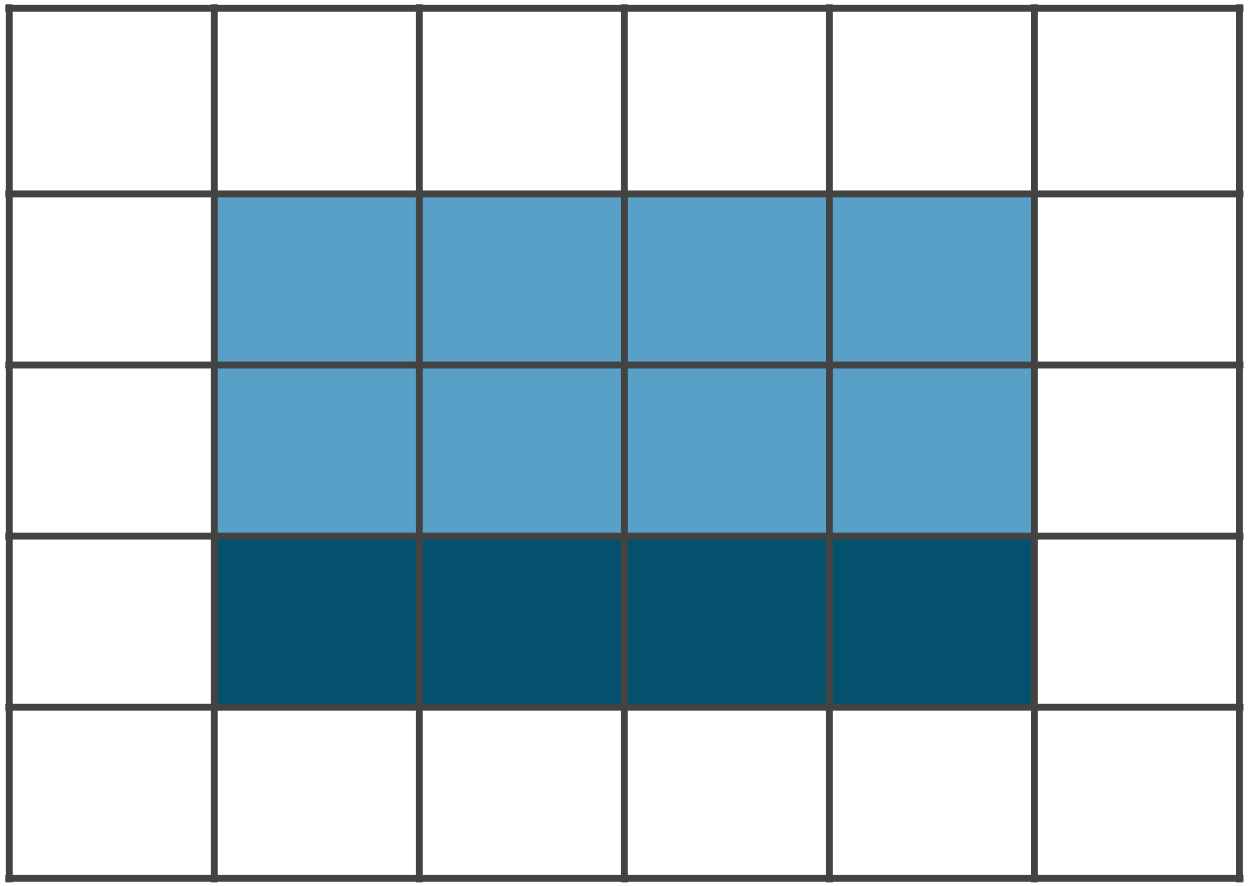


Images as a Function

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

A Pixel is not a Square

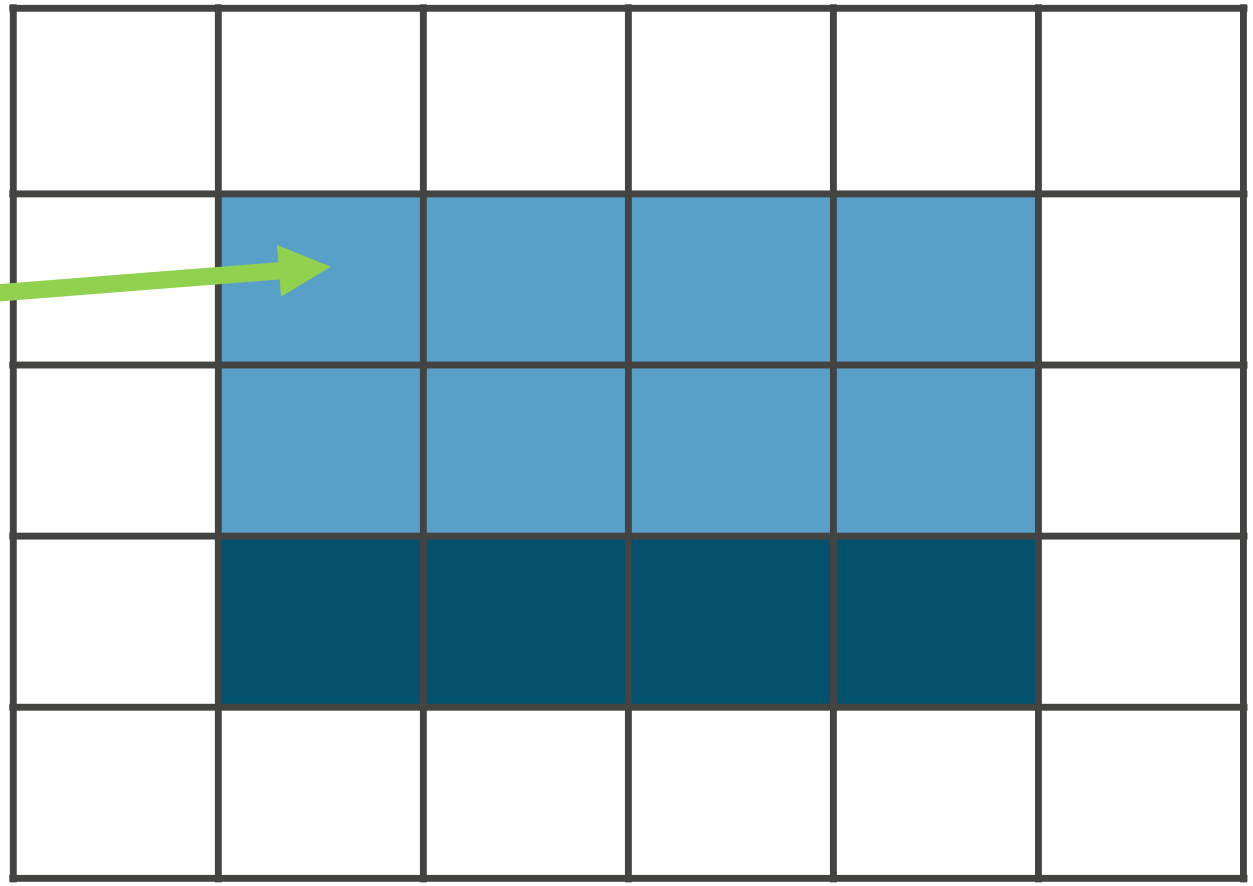
Object



Image

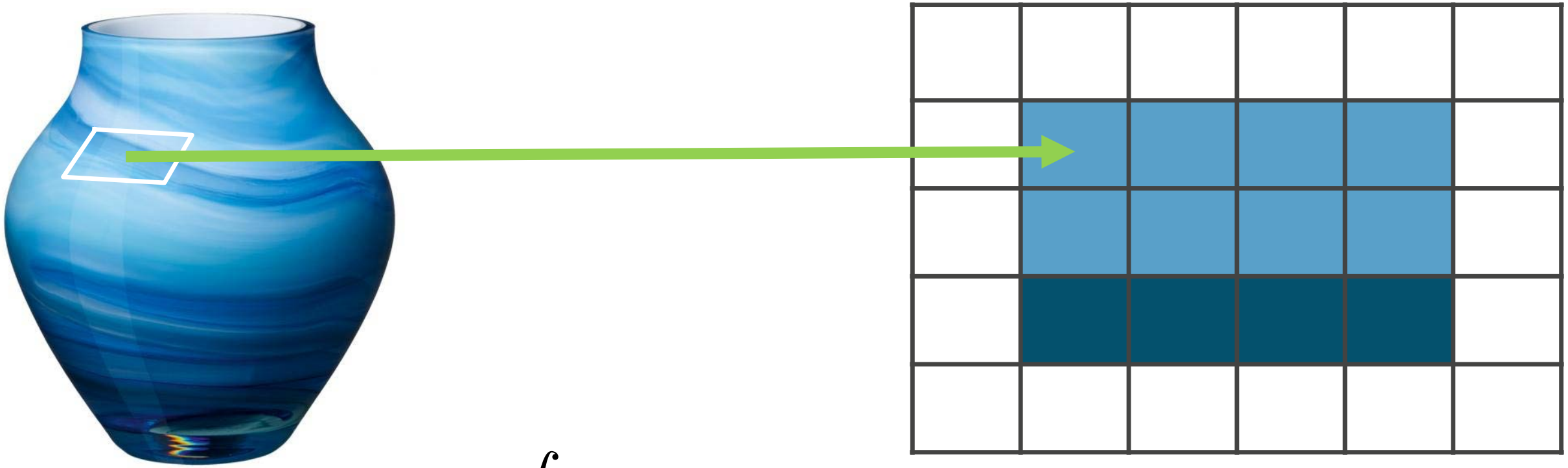
A Pixel is not a Square

Object



Image

A Pixel is not a Square

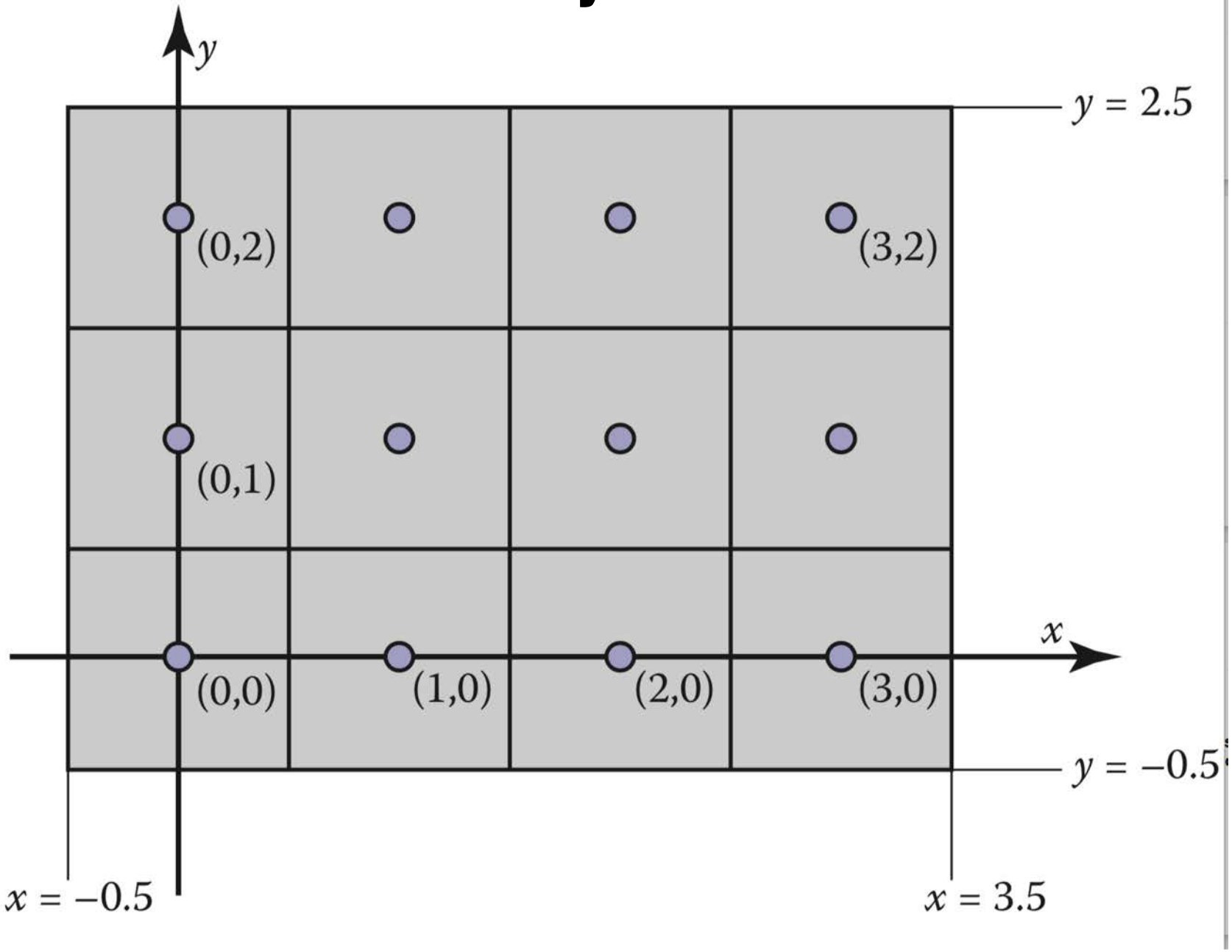


$$\text{colour} = \int_{\text{Area}} \text{Light } \text{dArea}$$

Object

Image

Standard Pixel Coordinate System

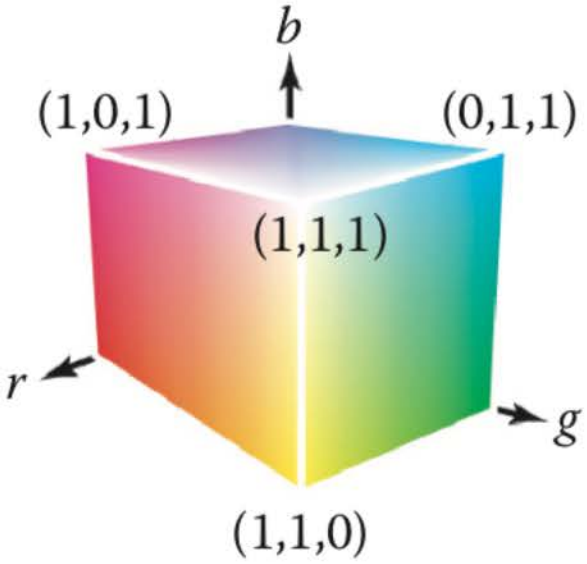


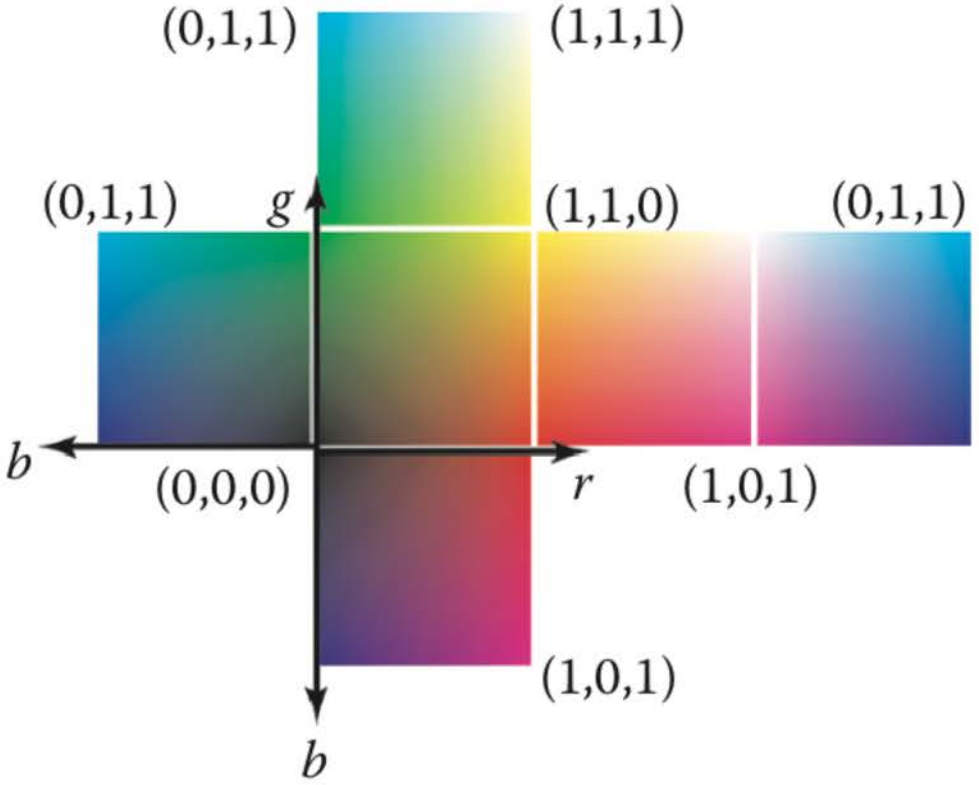
Data Types for Raster Images

Storage for 1024x1024 image (1 megapixel)

- bitmap: 128KB
- grayscale 8bpp: 1MB
- grayscale 16bpp: 2MB
- color 24bpp: 3MB
- floating-point HDR color: 12MB

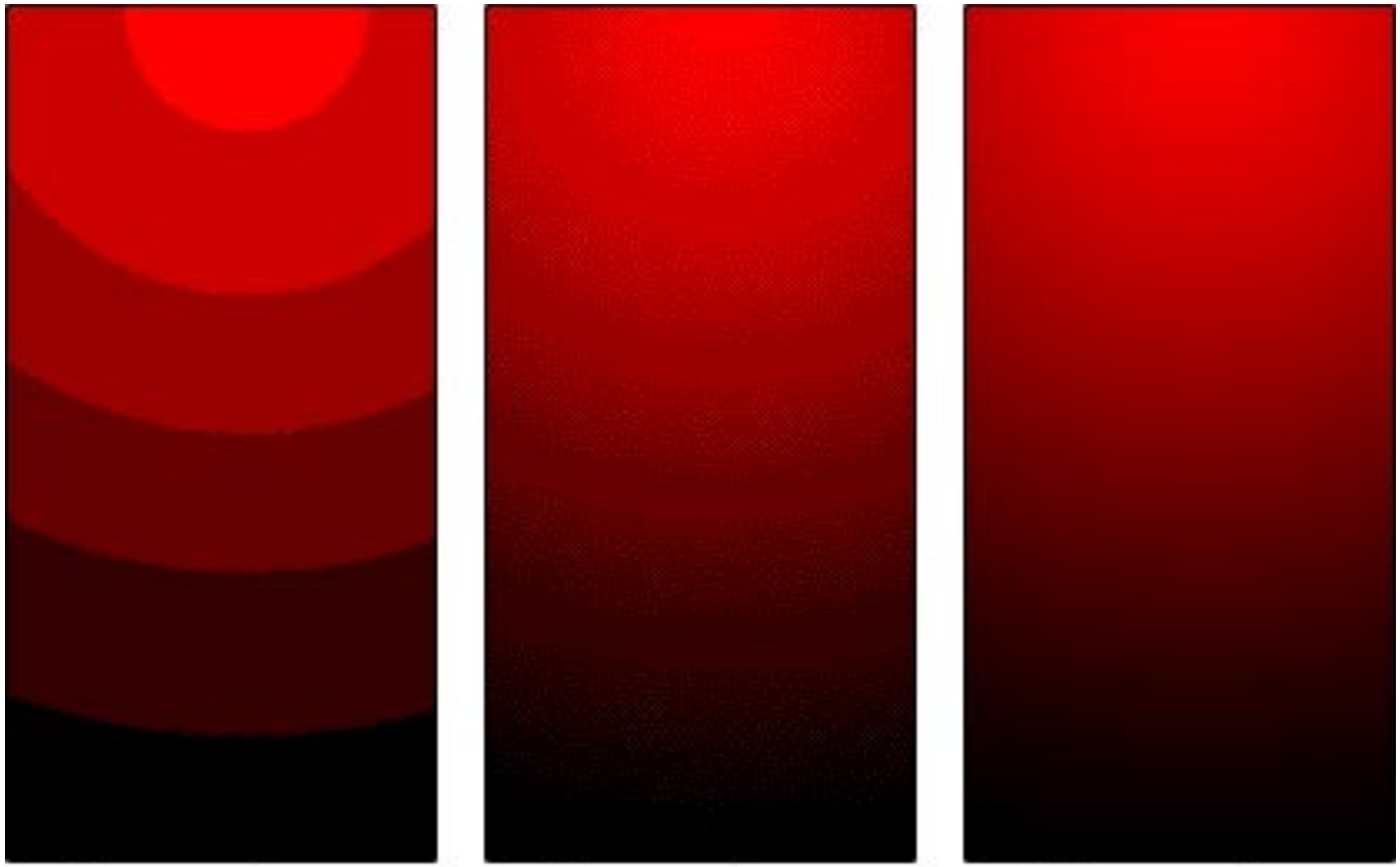
RGB Images





$$\begin{aligned}
\text{black} &= (0, 0, 0), \\
\text{red} &= (1, 0, 0), \\
\text{green} &= (0, 1, 0), \\
\text{blue} &= (0, 0, 1), \\
\text{yellow} &= (1, 1, 0), \\
\text{magenta} &= (1, 0, 1),
\end{aligned}$$

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

$$\text{displayed intensity} = (\text{maximum intensity})a^{\gamma}$$

Gamma Correction

Gamma

$$\text{displayed intensity} = (\text{maximum intensity})a^{\gamma}$$

… of display

Amplitude from Image [0,1]

Gamma Correction

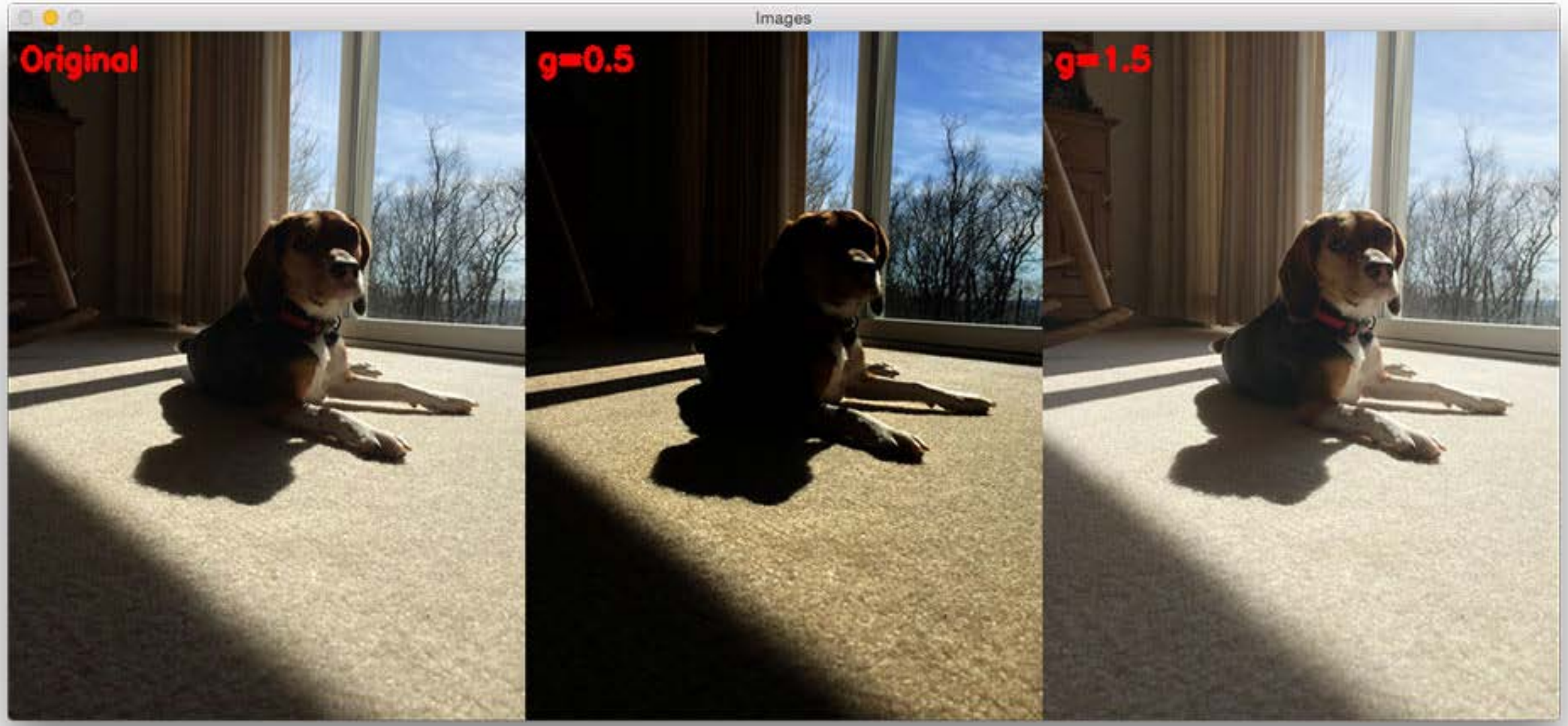
Measure: Find image amplitude that = ½ display brightness

$$0.5 = a^{\gamma}$$

Fit model

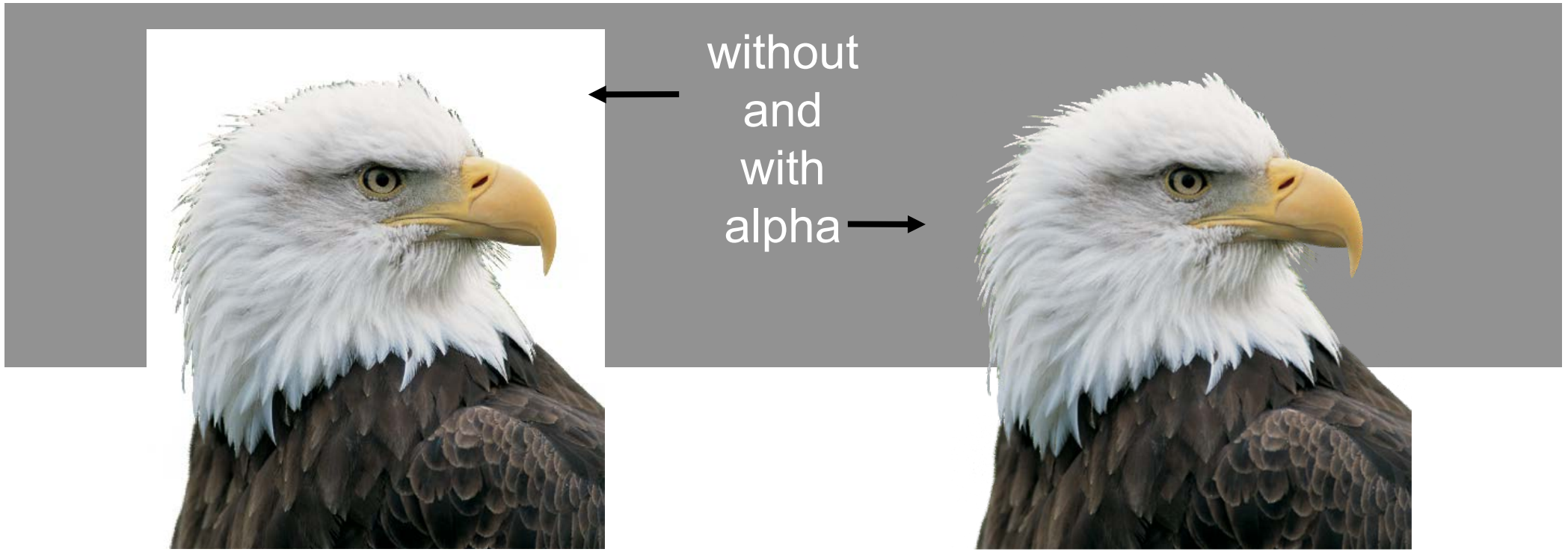
$$\gamma = \frac{\ln 0.5}{\ln a}$$

Gamma Correction



Transparency

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



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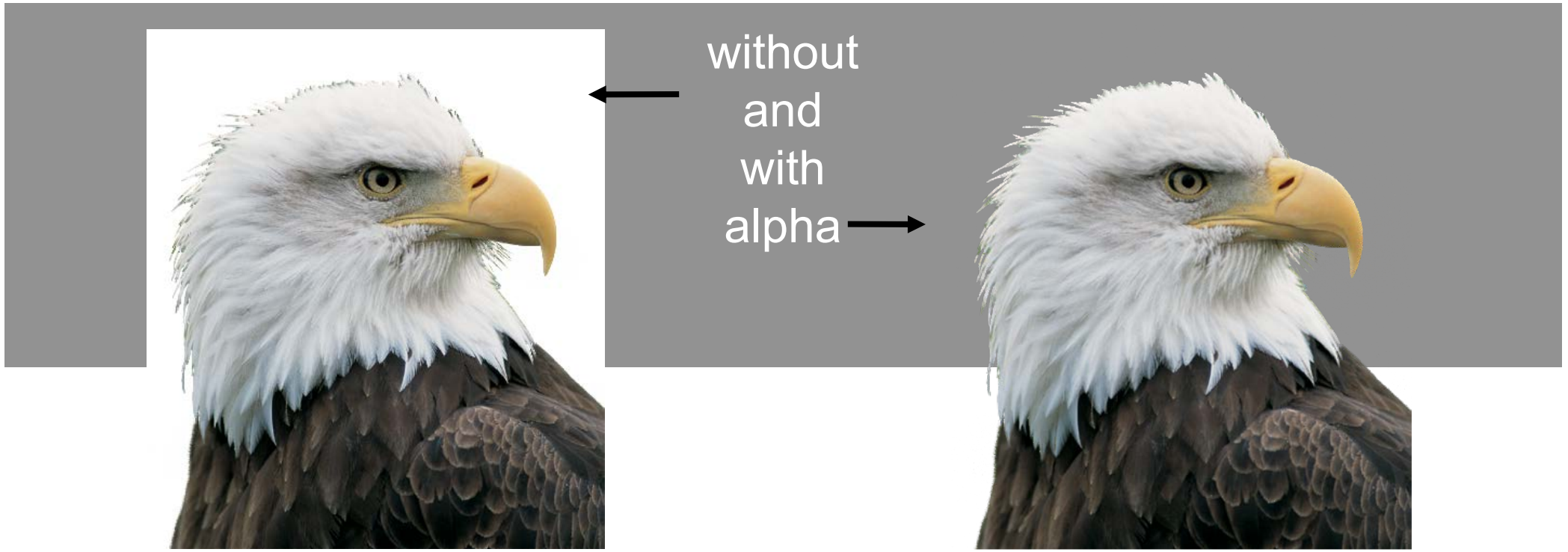

$$\mathbf{c} = \alpha \mathbf{c}_f + (1 - \alpha)\mathbf{c}_b.$$

Compositing

Compositing is about layering images on top of one another

http://ssp.impulsetrain.com/porterduff.html

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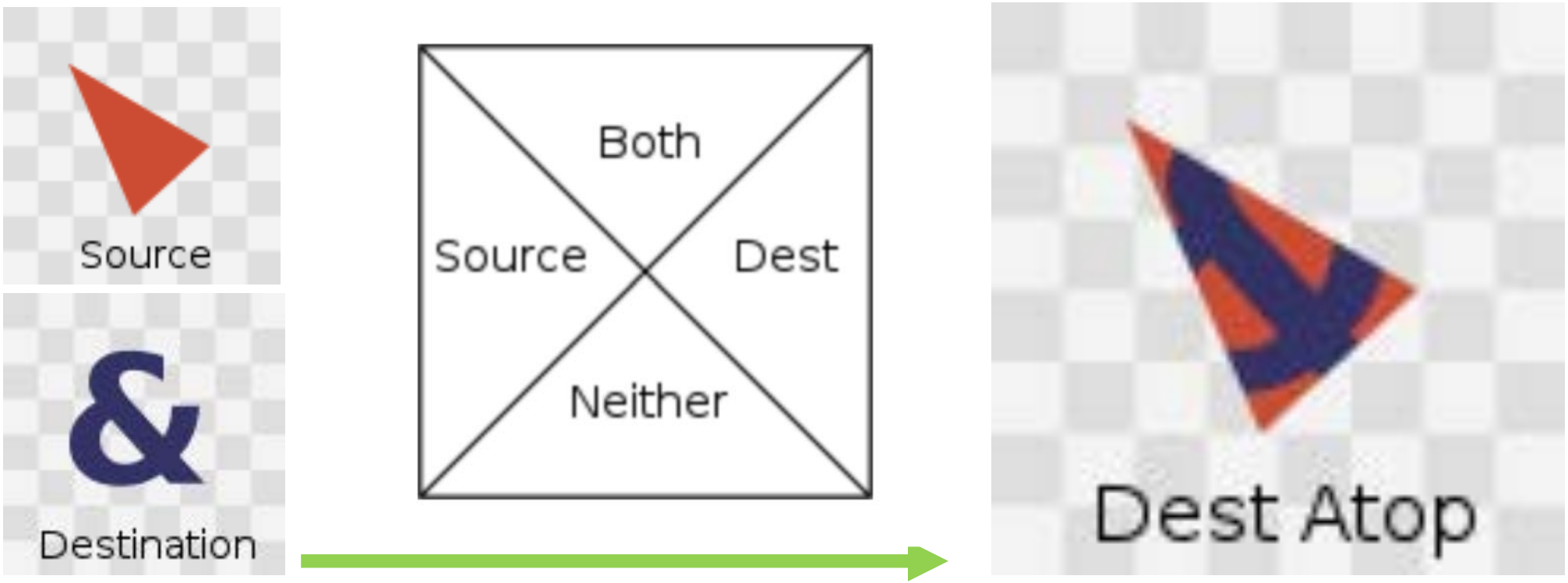

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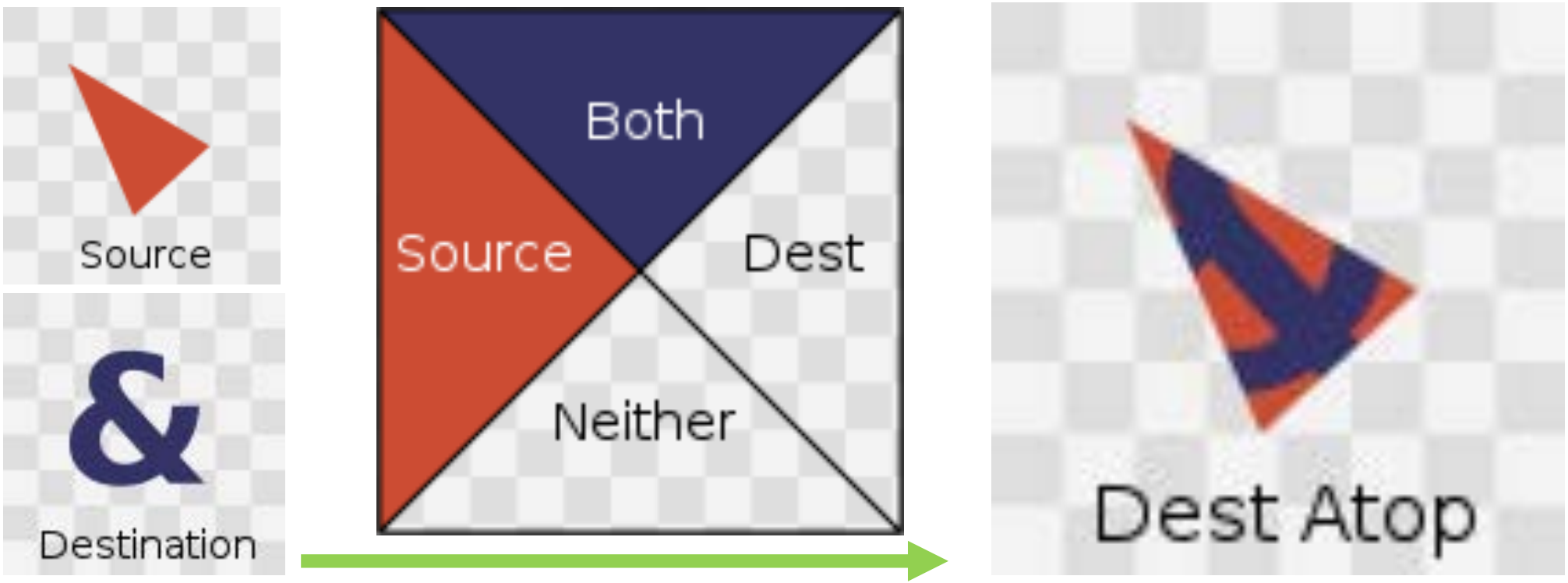

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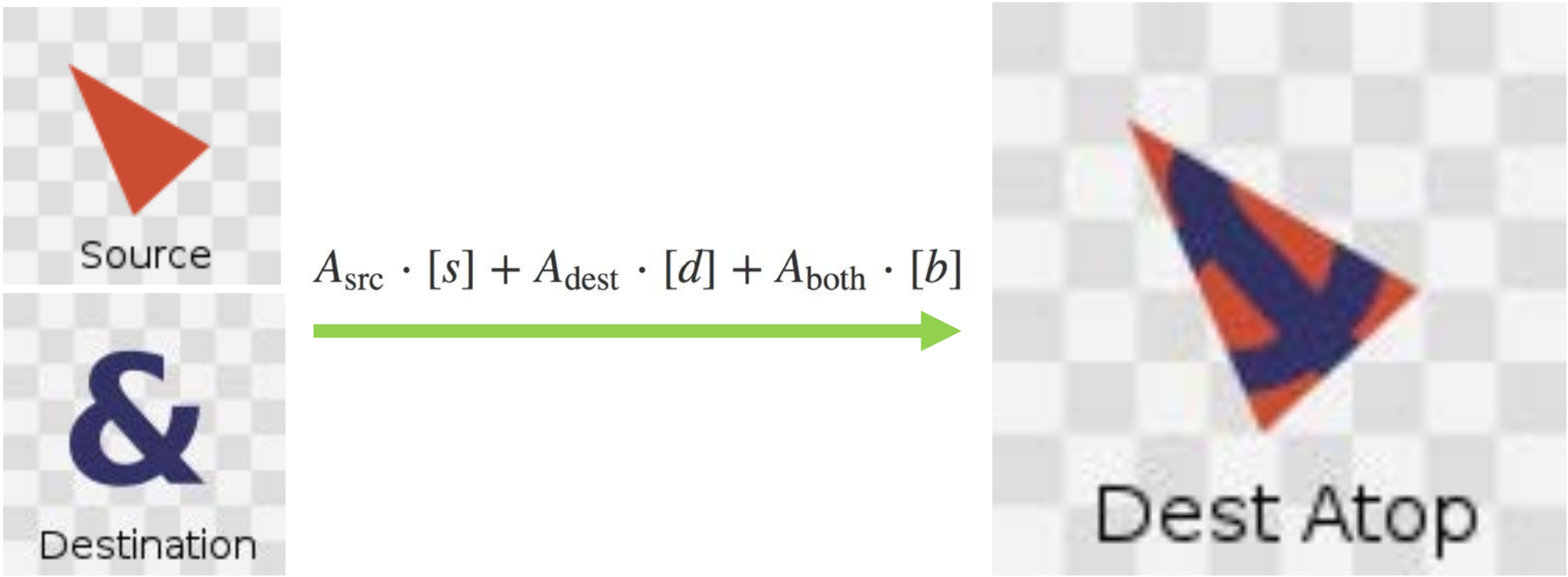

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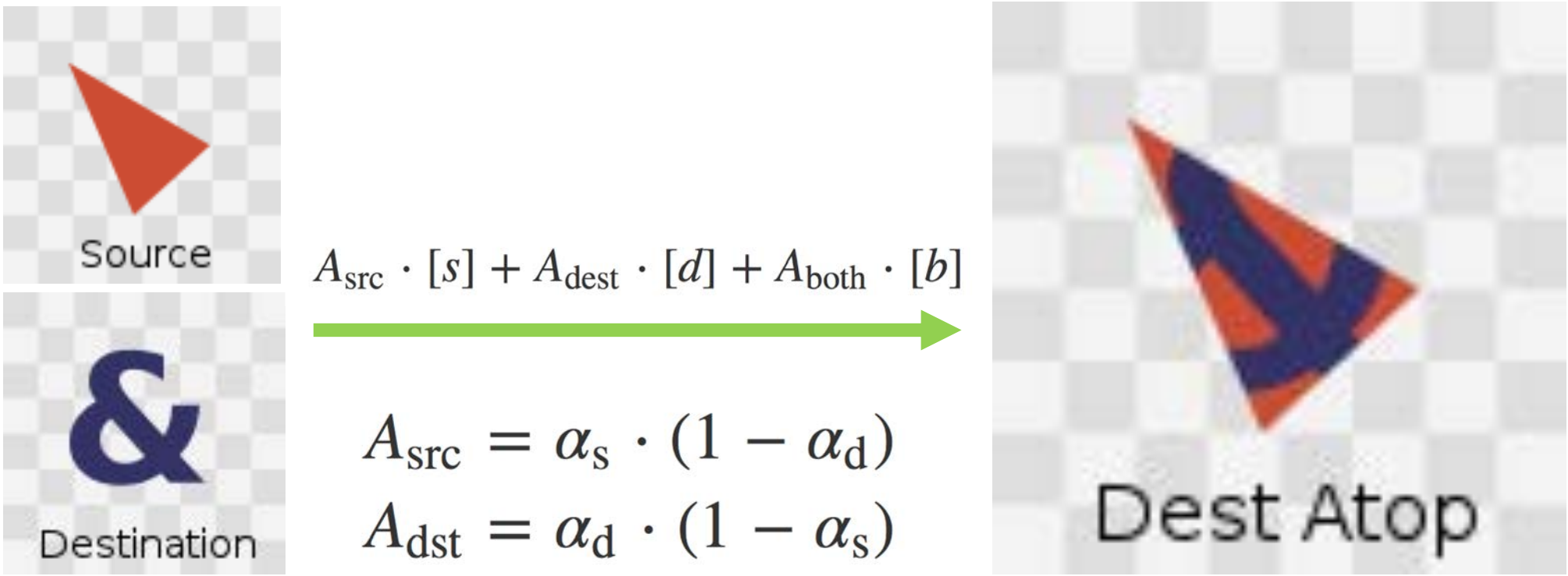

http://ssp.impulsetrain.com/porterduff.html

Assignment 1 Available Right Now

DUE IN 10 Days (START NOW!)

Next Week: Ray Casting