Raster Images

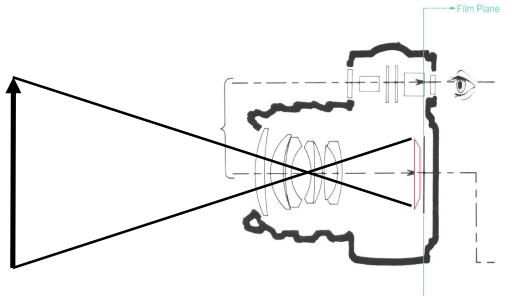
What is an Image?

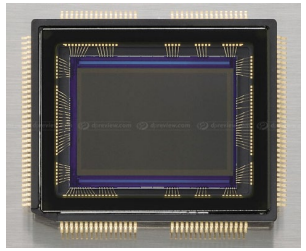
Image = distribution of light energy on 2D “film”
Digital images represented as rectangular arrays of pixels

Raster Devices

- Input (scanners, cameras)

  2D array sensor: digital camera

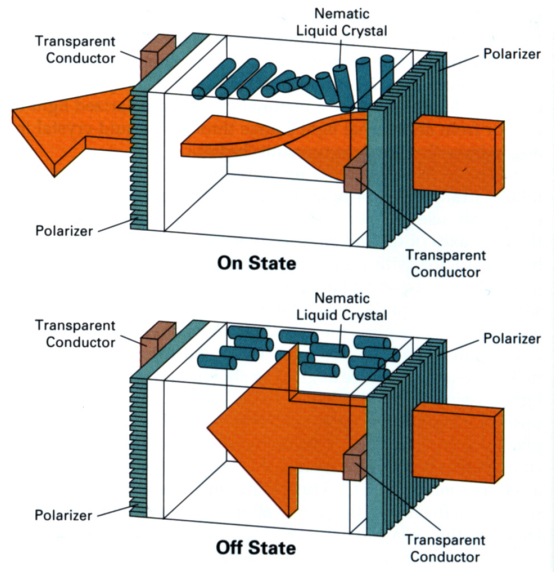




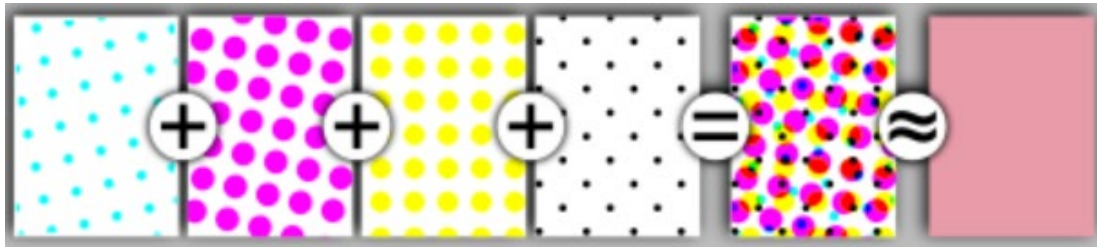
- Output (printers, displays)

  Emissive: light-emitting diode (LED)

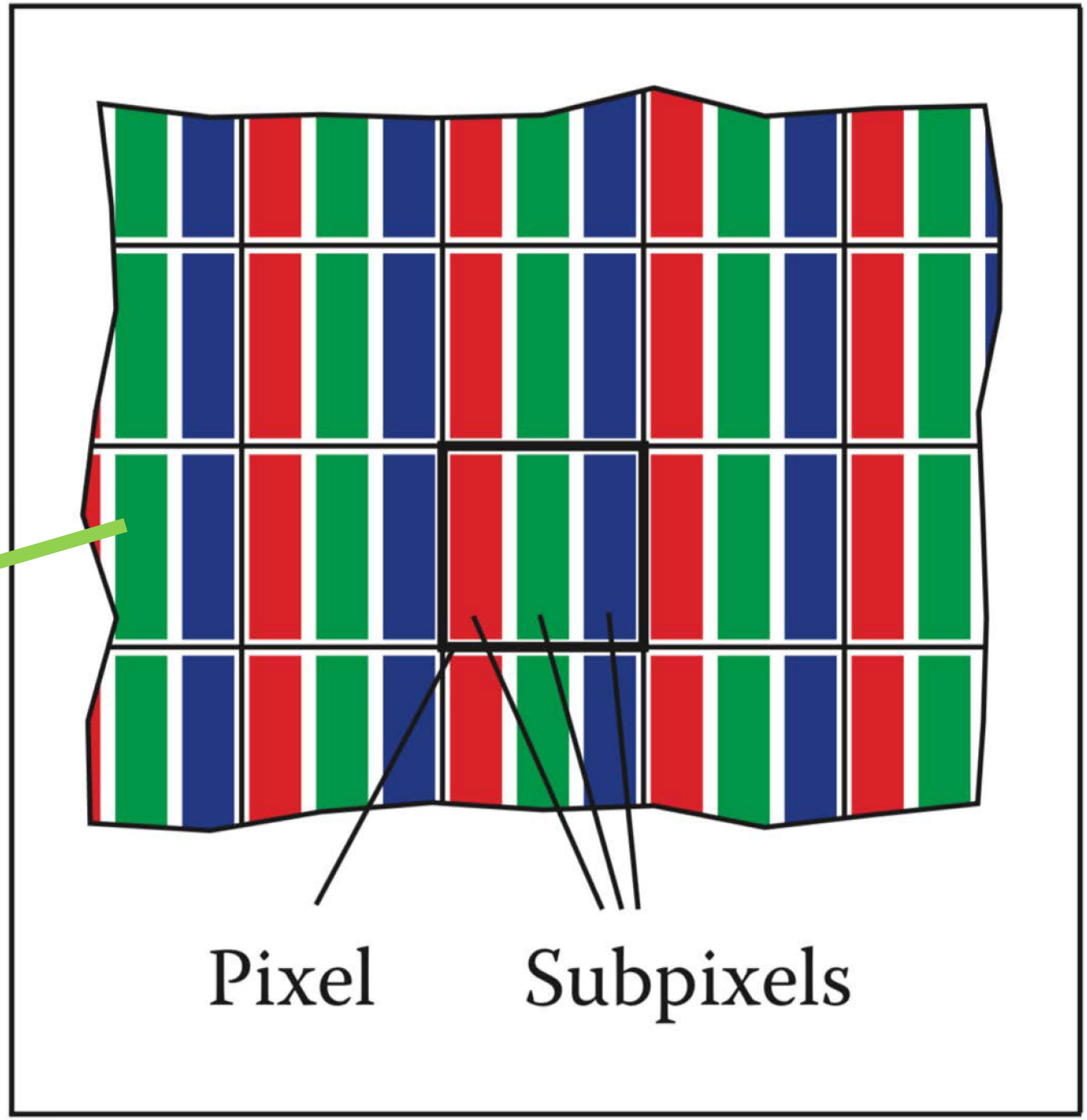
  Transmissive: liquid crystal display (LCD)



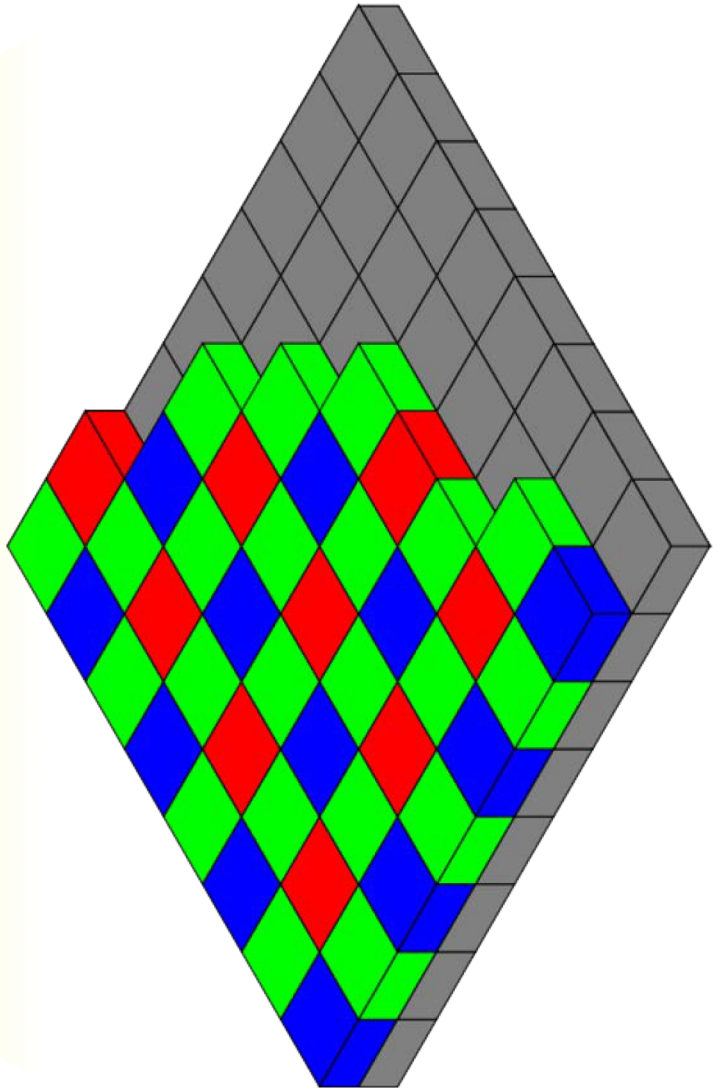
  Ink-jet printer



Raster Displays

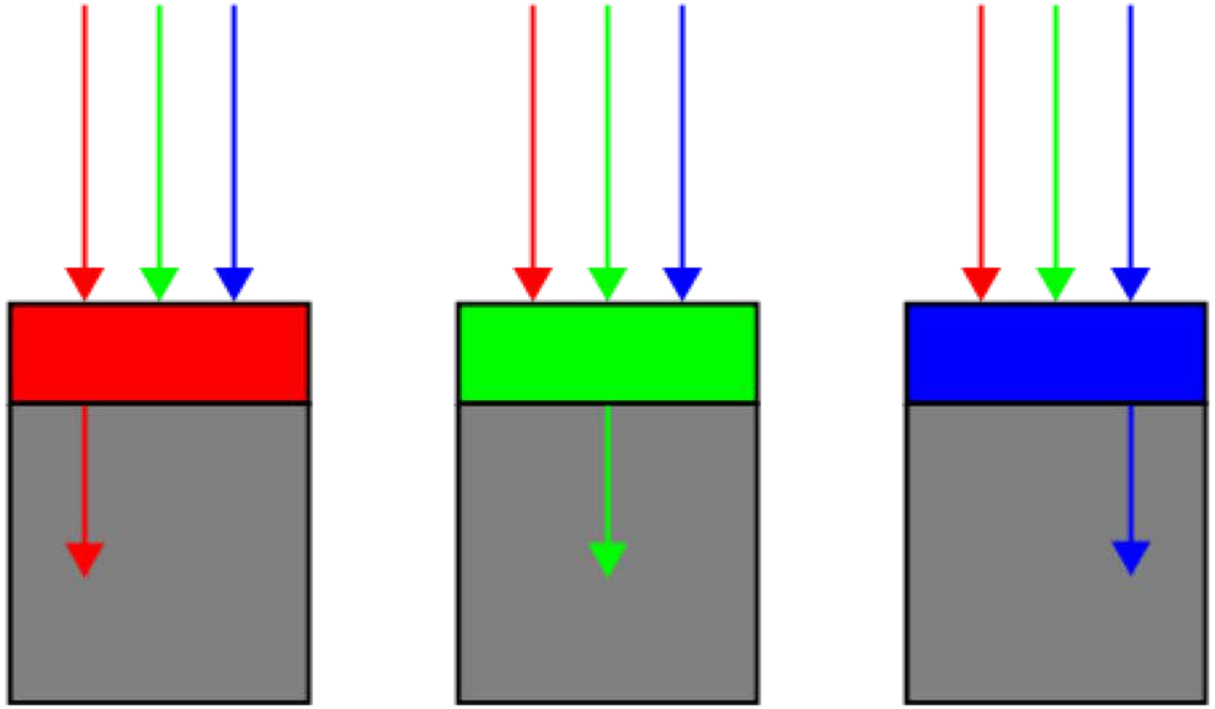


Raster Input Devices



Bayer Filter

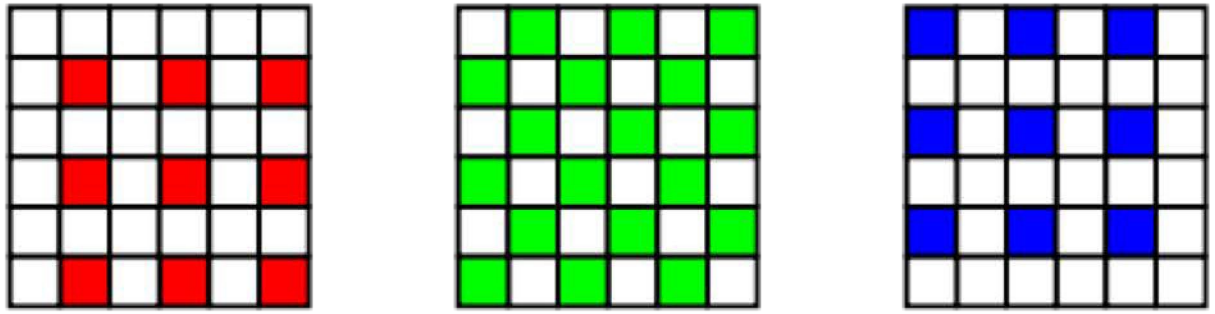
Raster Input Devices



Incoming light

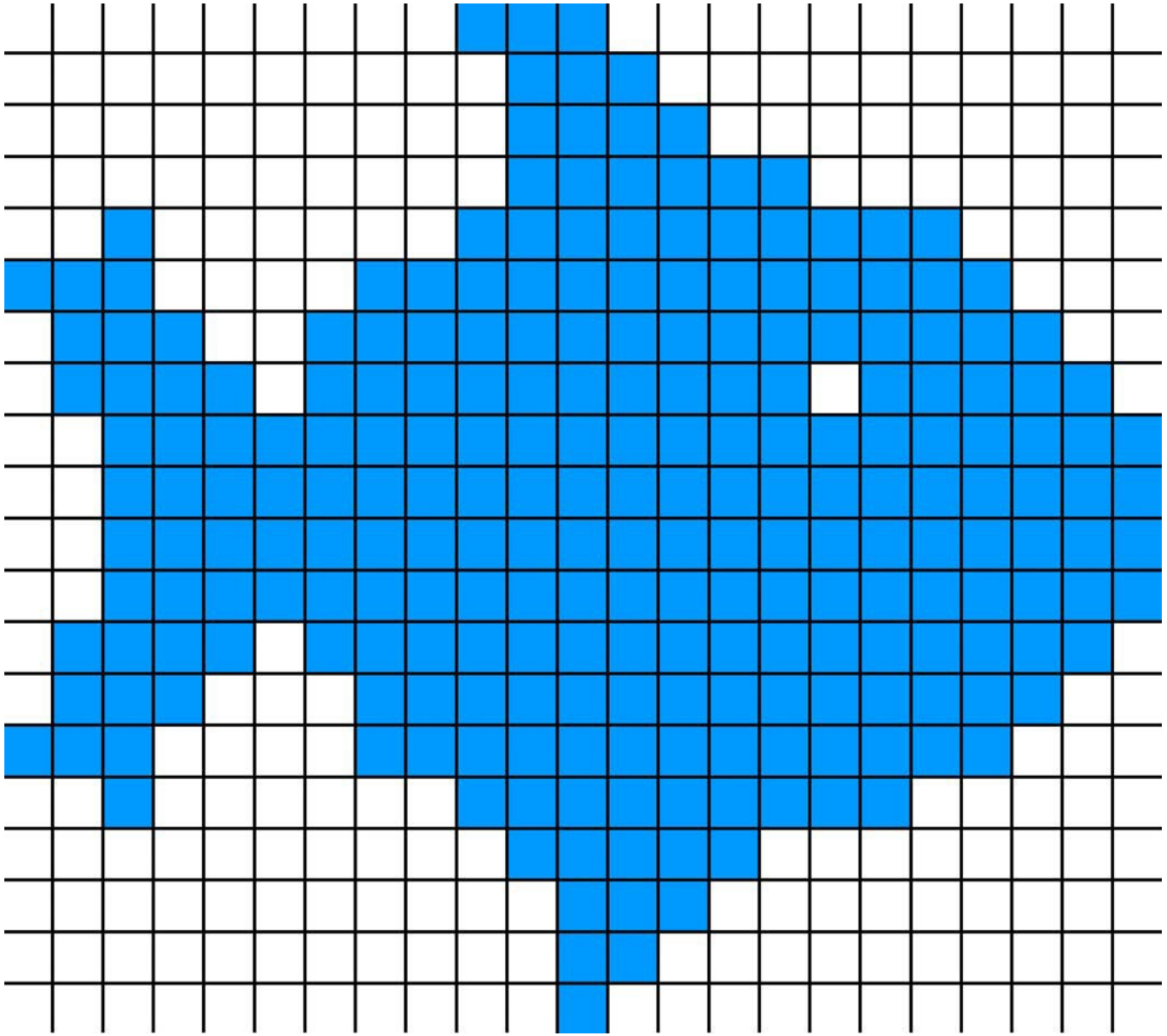
Filter layer

Sensor array

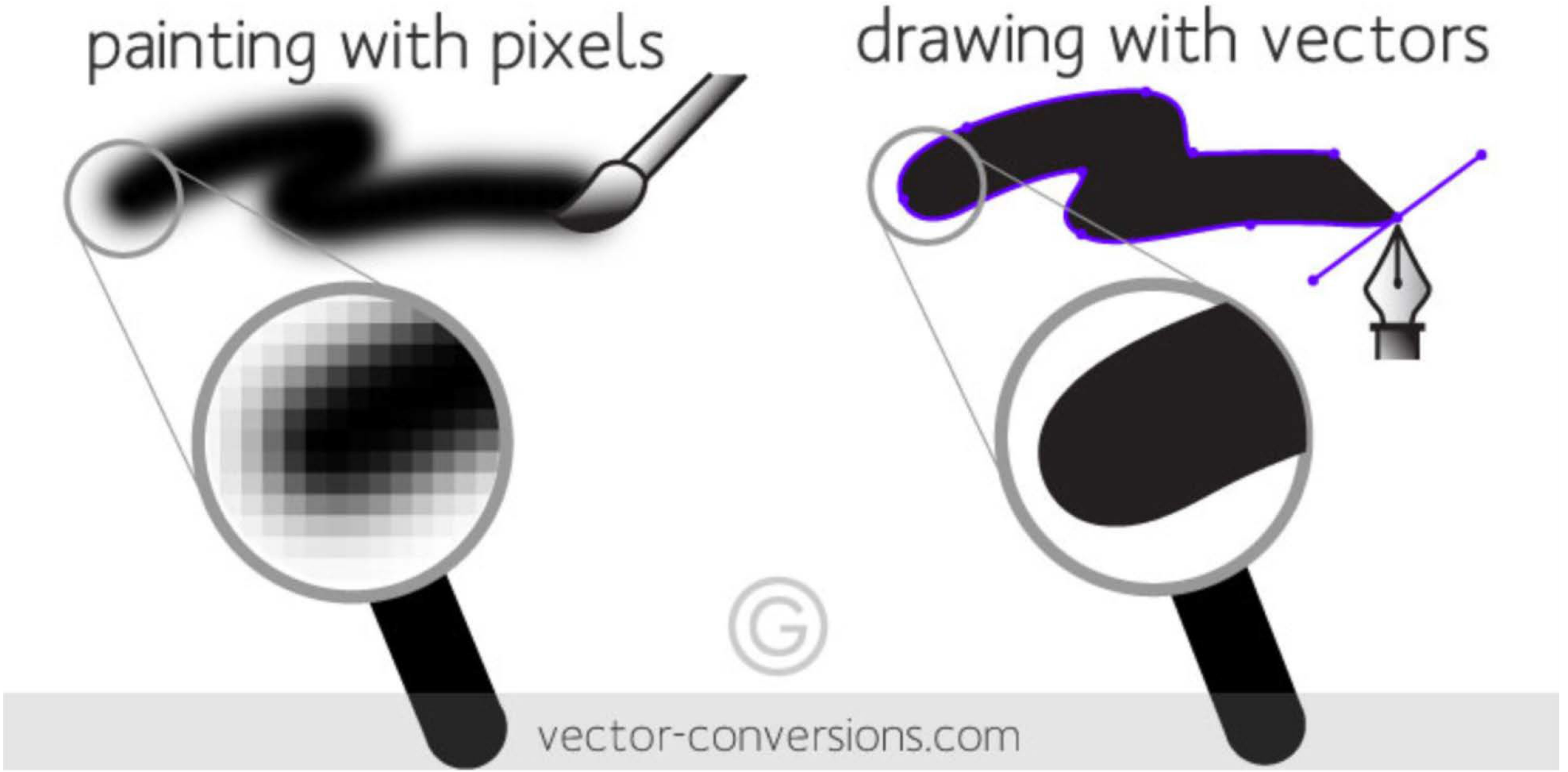


Resulting pattern

Raster Image



Aside: More Than Just Raster Images

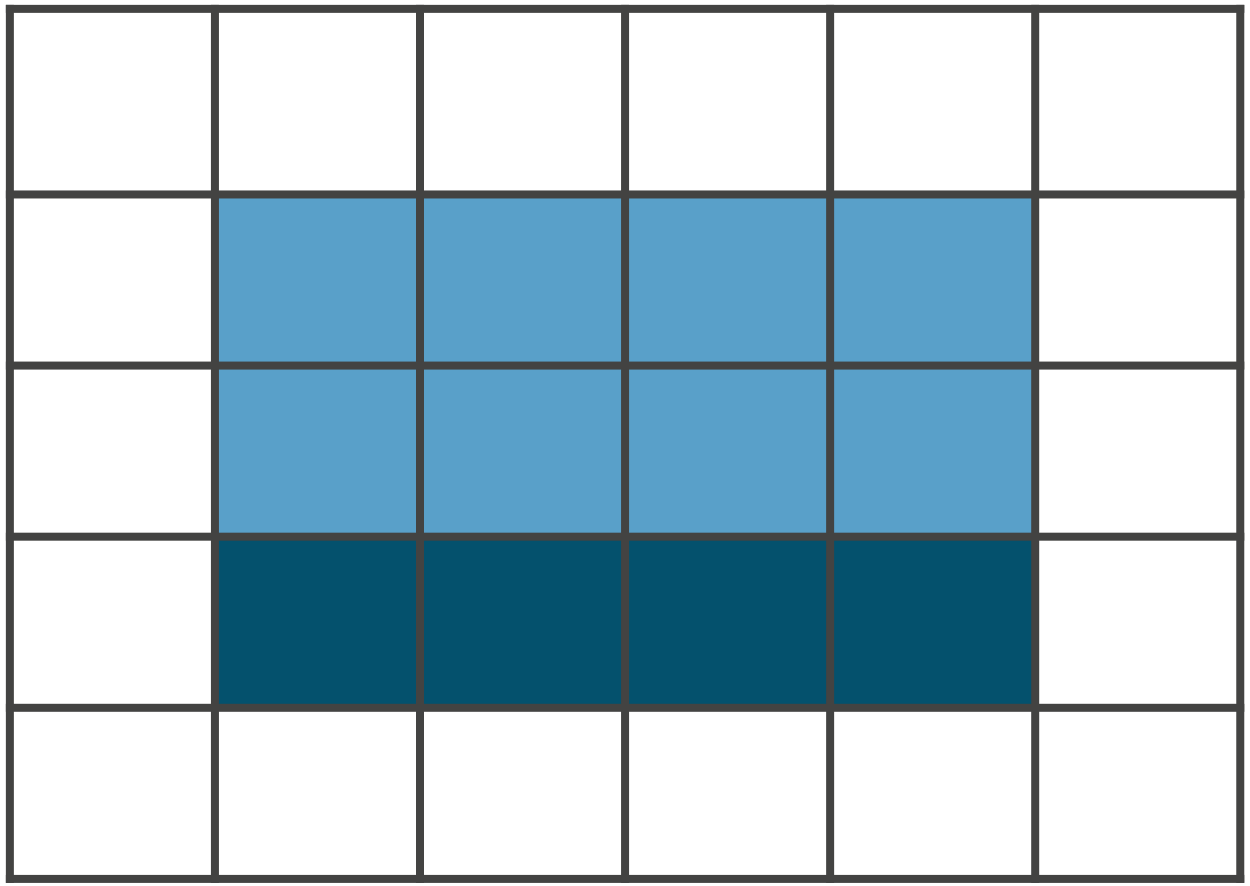


Images as a Function

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

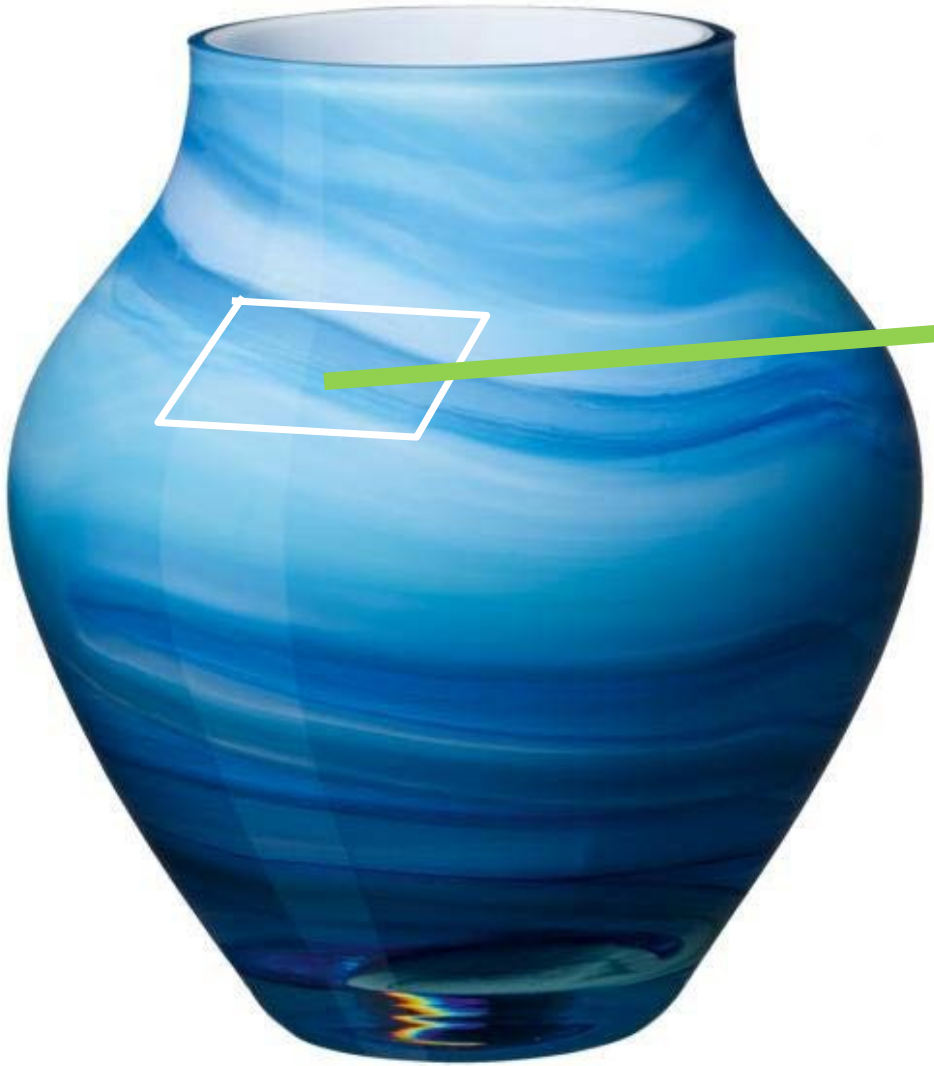
A Pixel is not a Square

Object

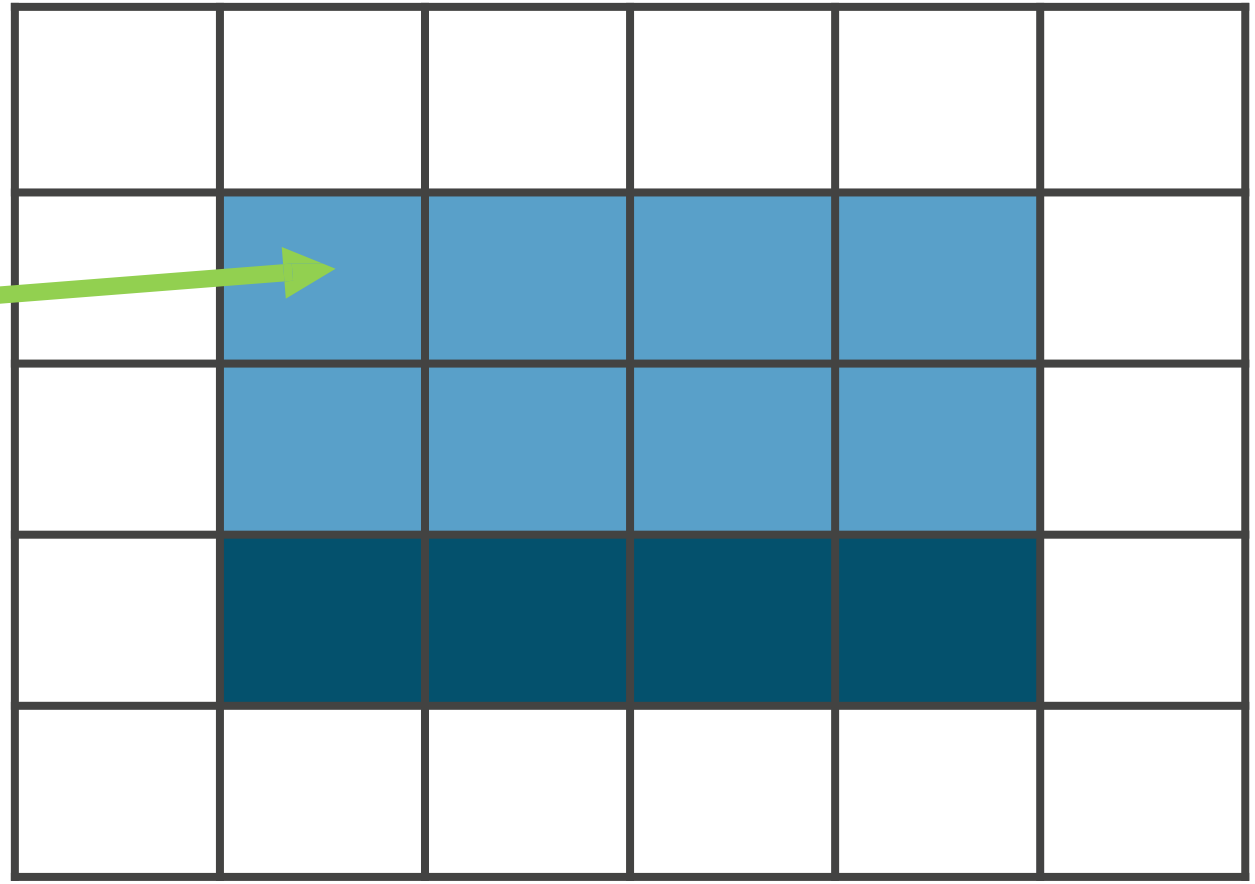


Image

A Pixel is not a Square

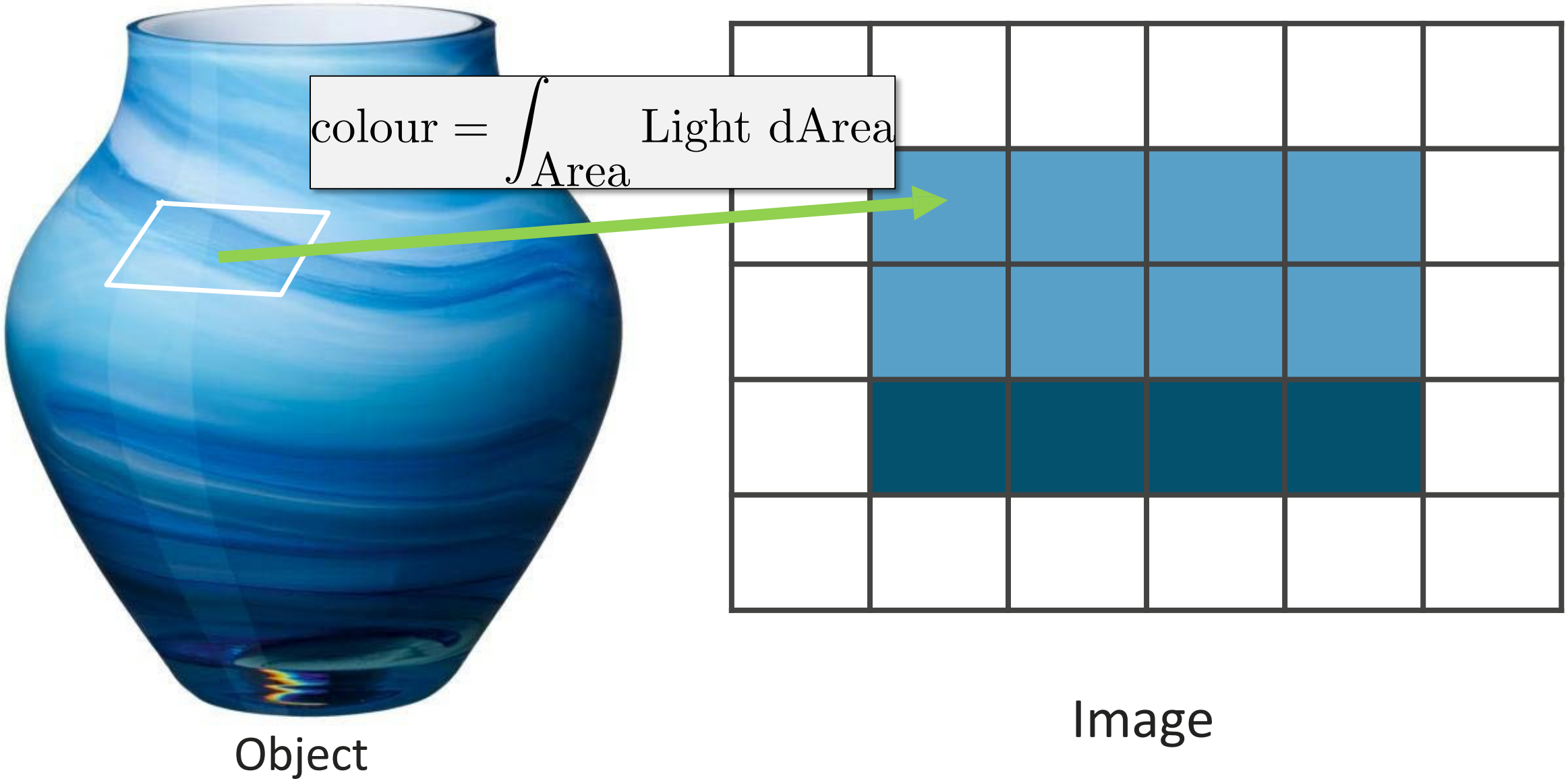


Object

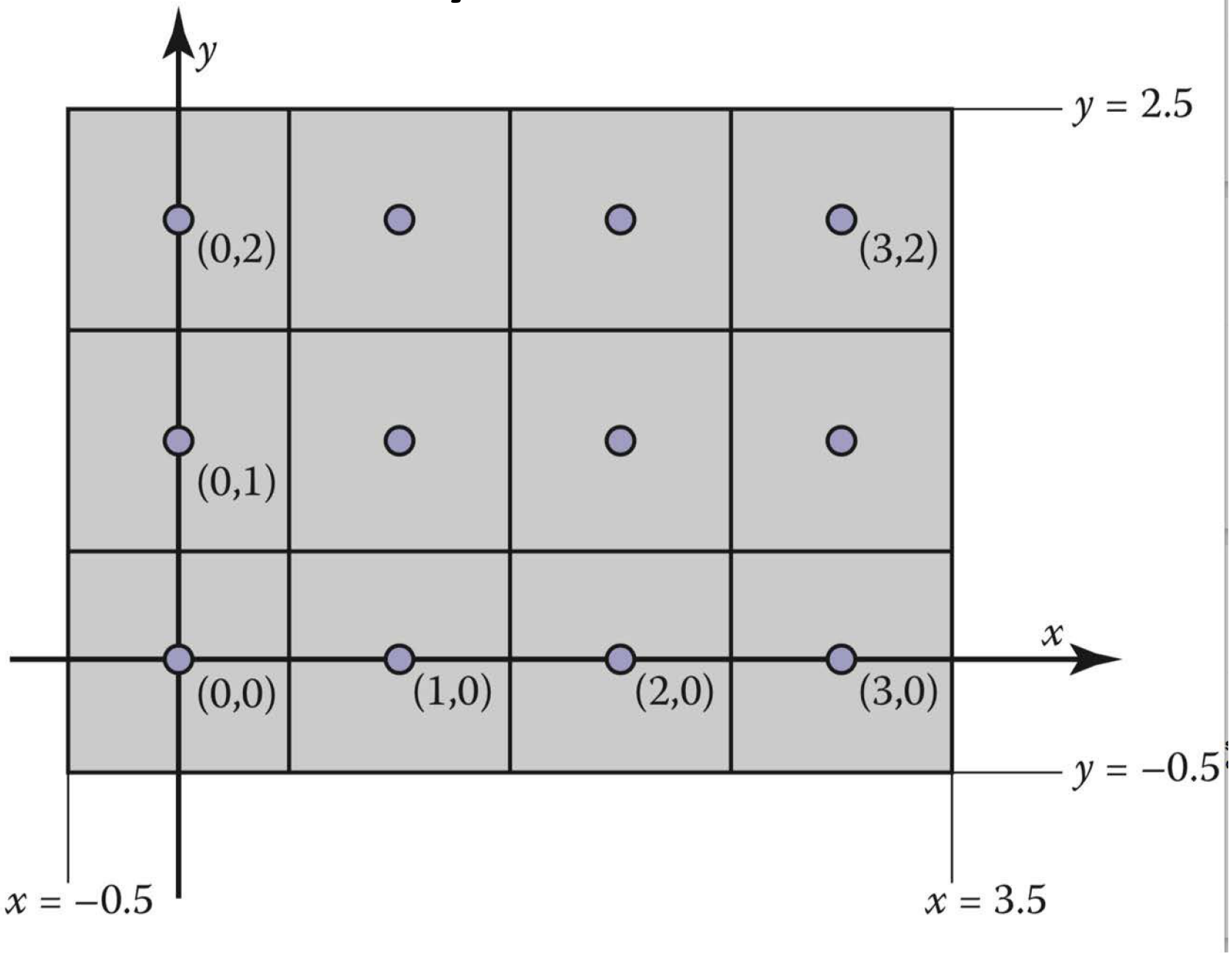


Image

A Pixel is not a Square



Standard Pixel Coordinate System

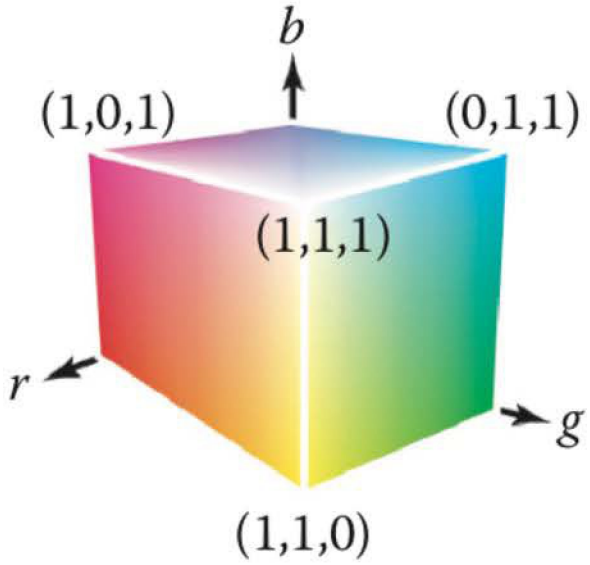


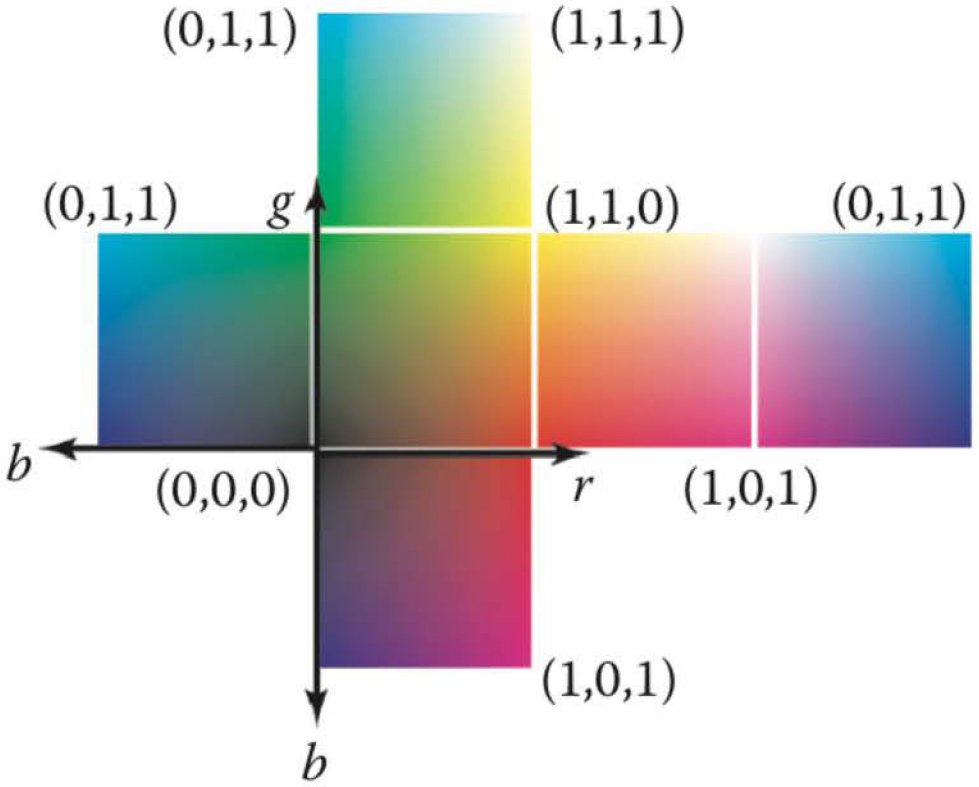
Data Types for Raster Images

Storage for 1024x1024 image (1 megapixel)

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

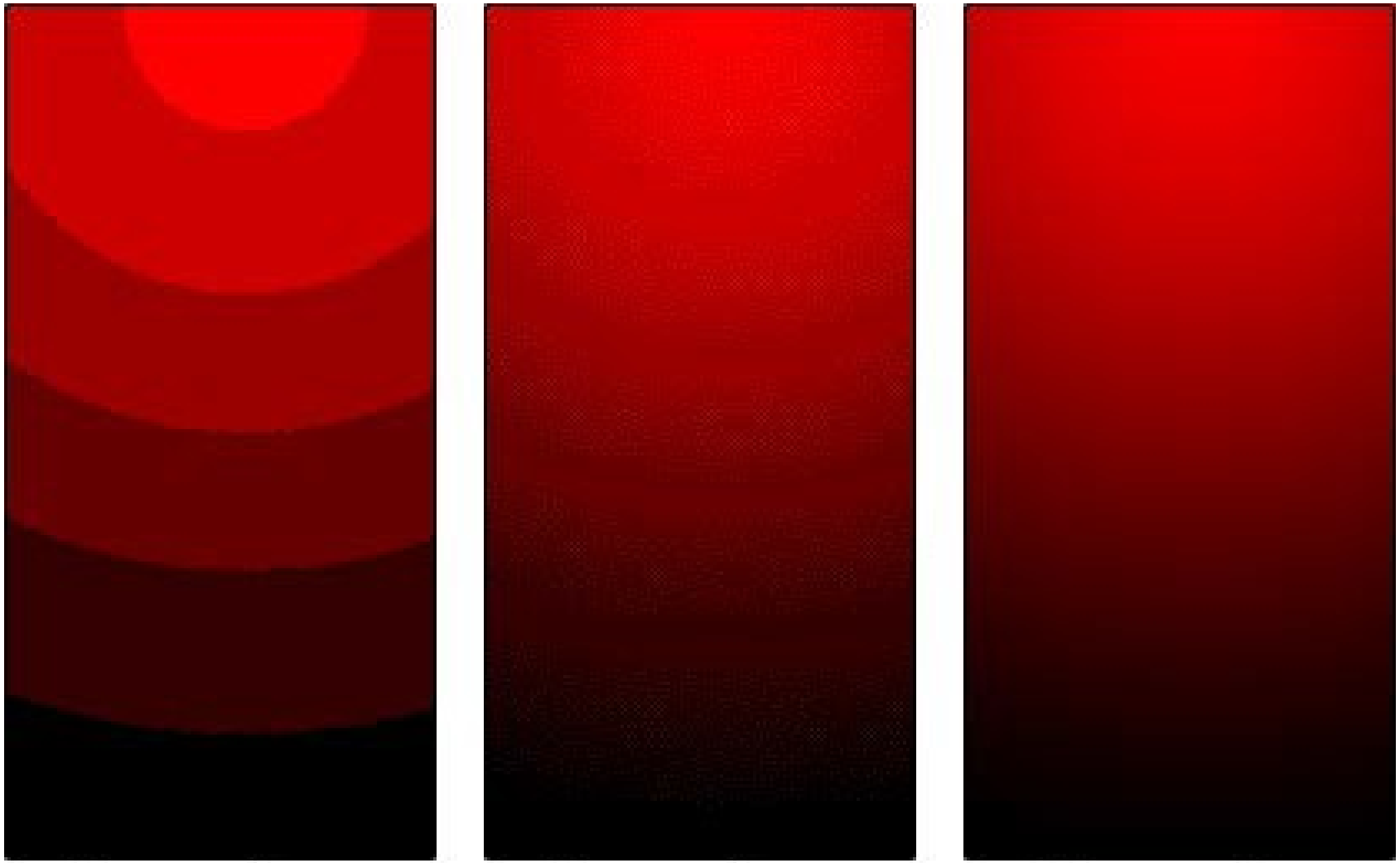
RGB Images





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

Artifacts of Raster Images: Banding

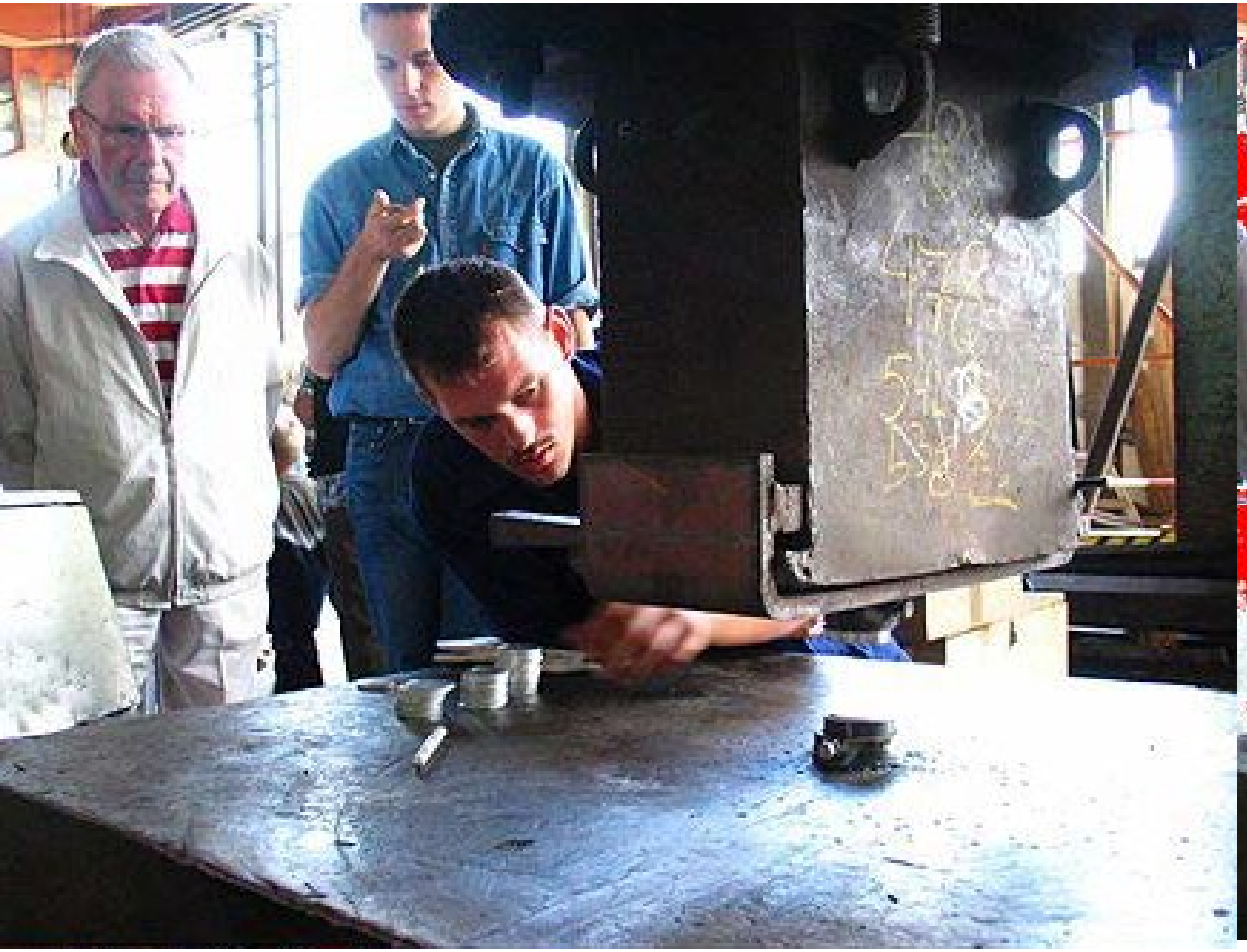


8-bit gradient

8-bit gradient, dithered

24-bit gradient

Artifacts of Raster Images: Clipping



Original

Clipped

Gamma Correction

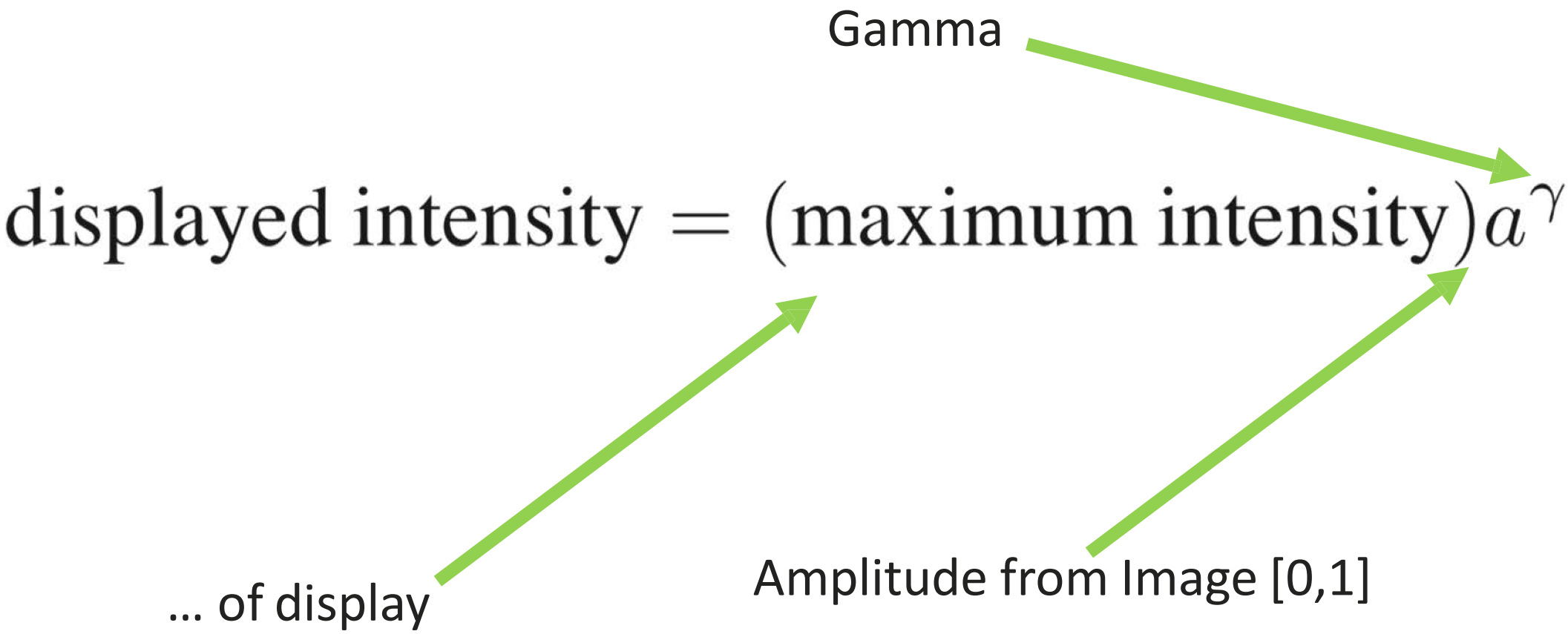
Linear encoding V_S =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Linear intensity I =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Display intensity is nonlinear wrt input intensity

Gamma Correction

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

Gamma Correction



Gamma Correction

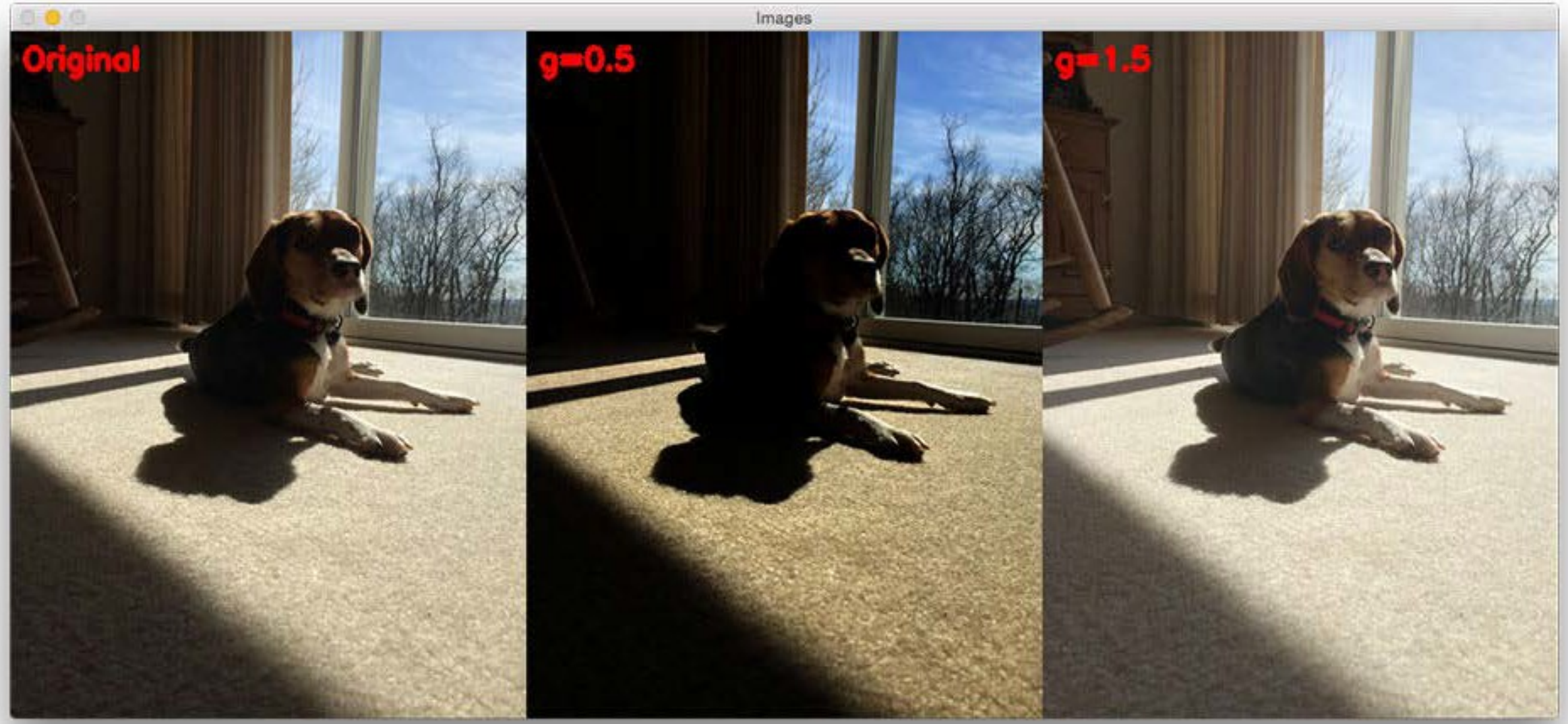
Measure: Find image amplitude that = ½ display brightness

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

Fit model

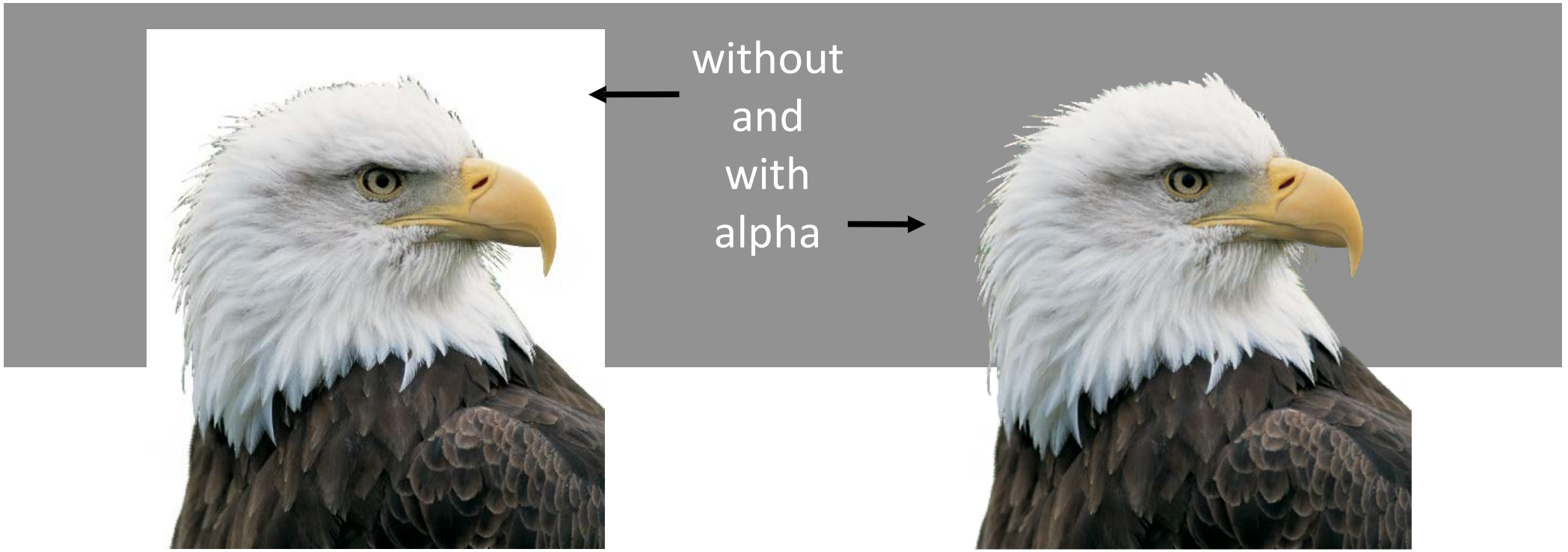
$$\gamma = \frac{\ln 0.5}{\ln a}$$

Gamma Correction



Transparency

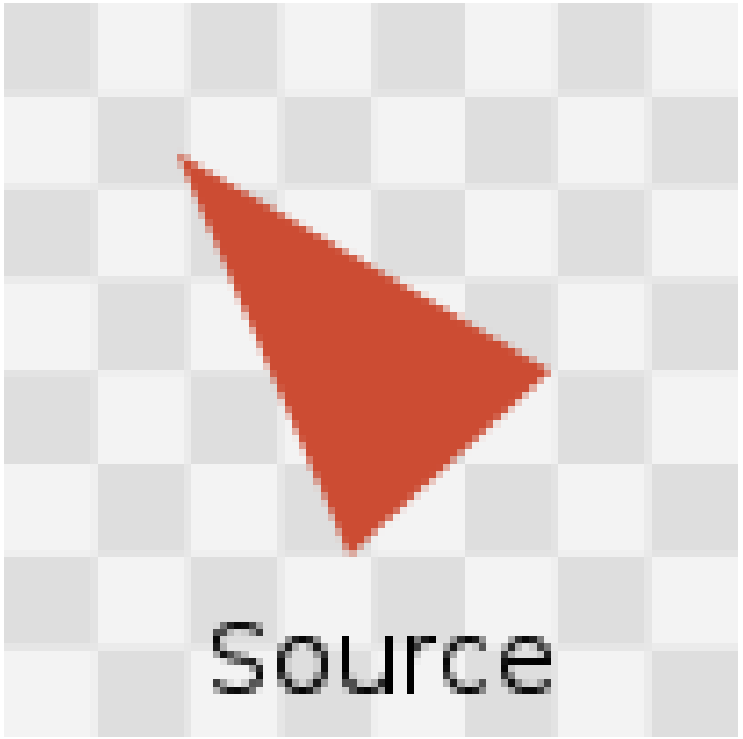
Append (Red, Green, Blue) to be (Red, Green, Blue, Alpha)



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

Compositing

Compositing is about layering images on top of one another



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

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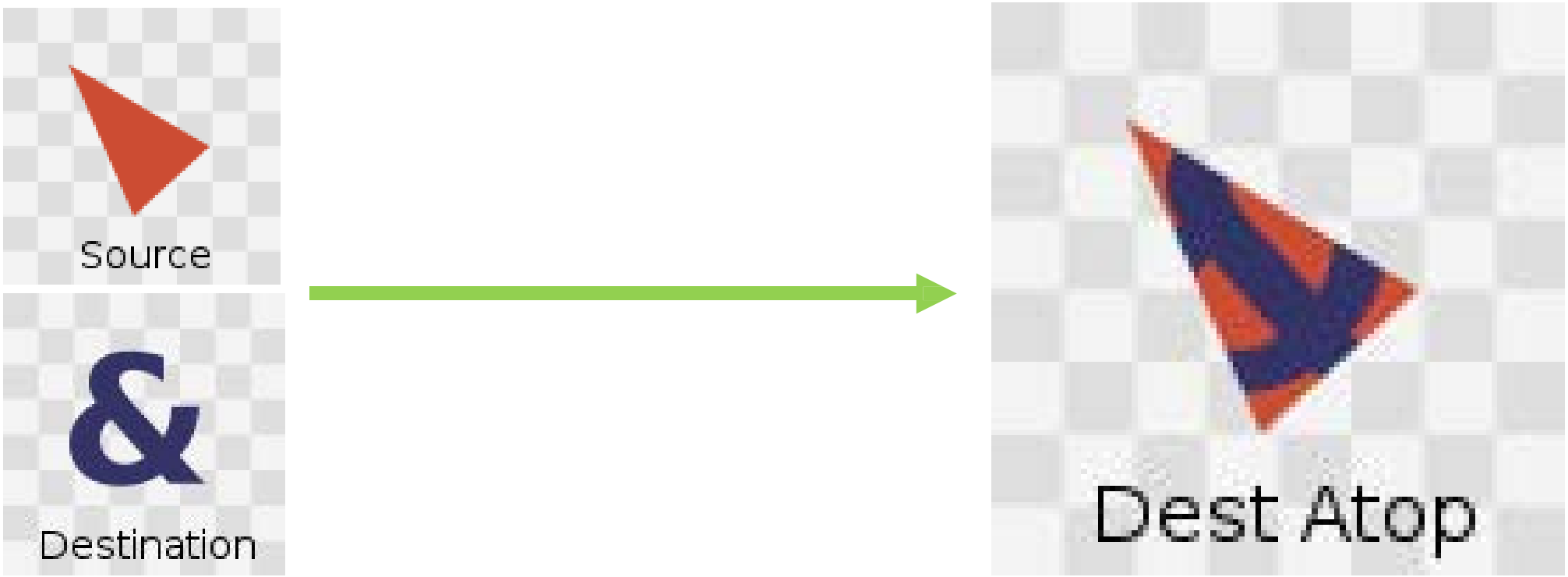

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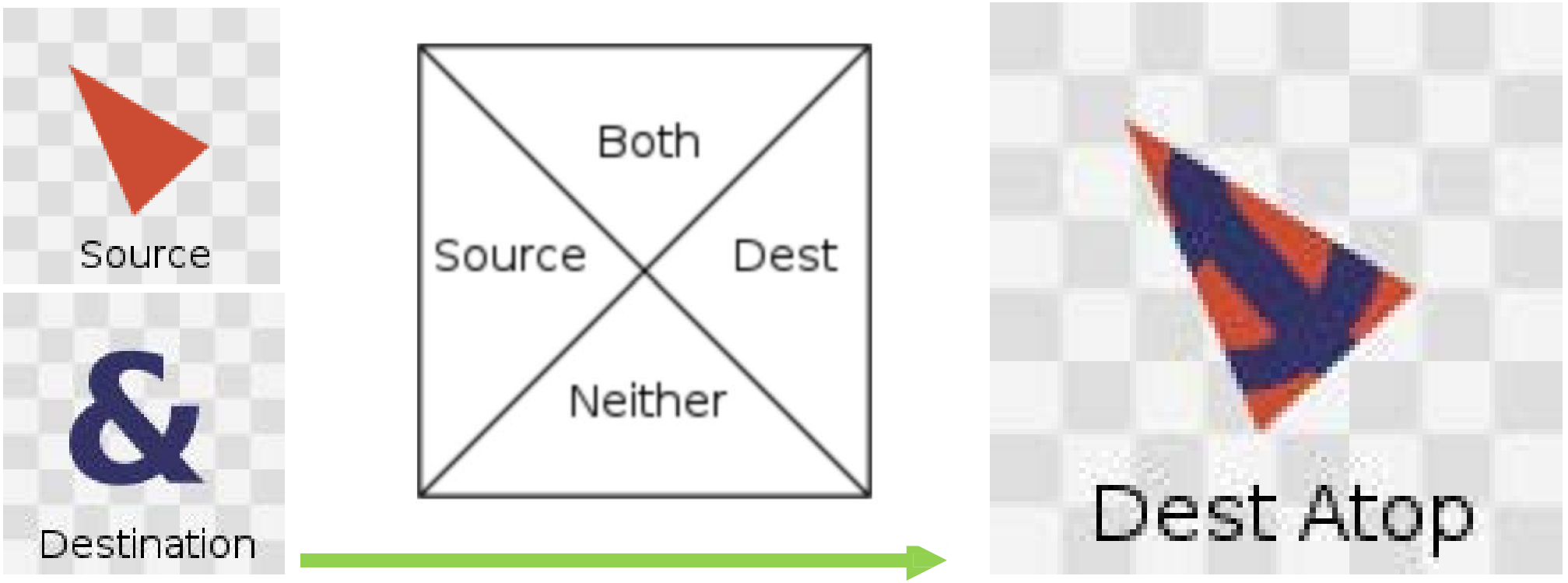

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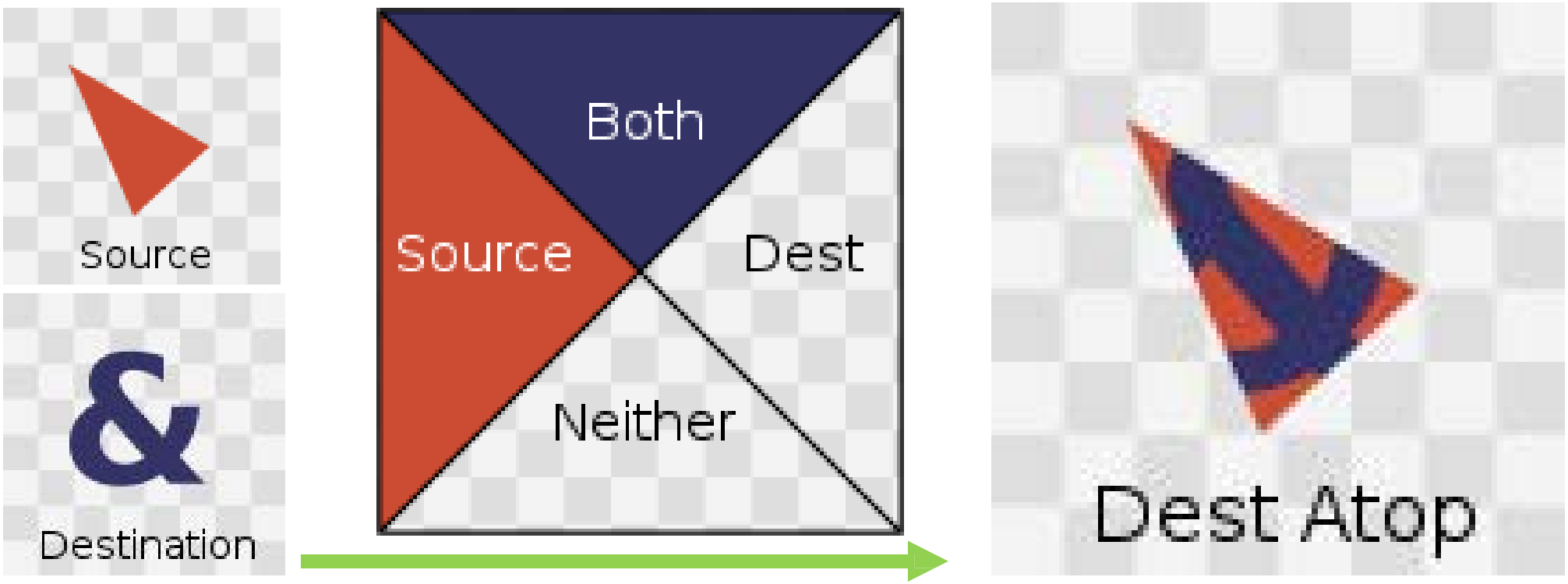

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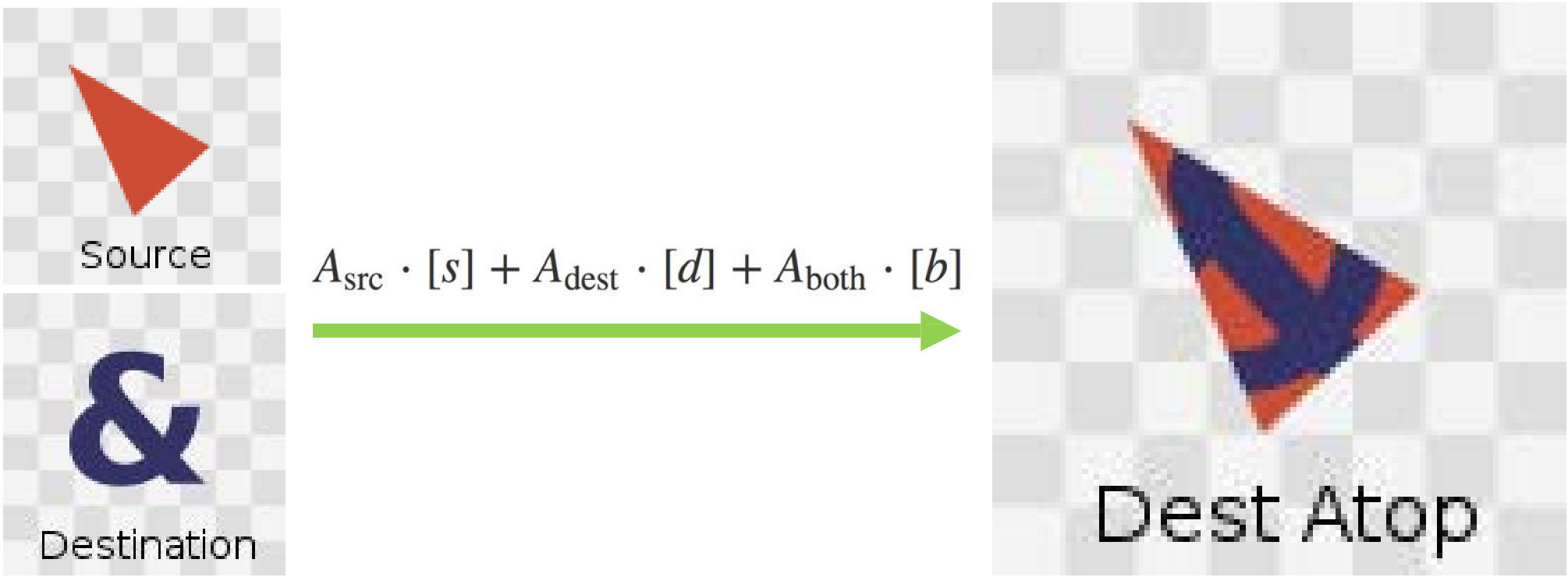

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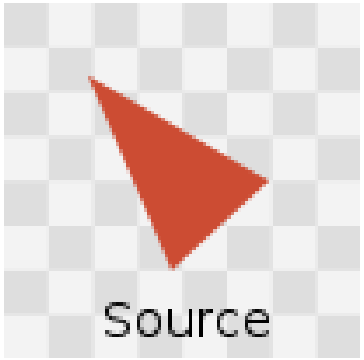

$$A_{\text{src}} \cdot [s] + A_{\text{dest}} \cdot [d] + A_{\text{both}} \cdot [b]$$

$B(s, d)$ for color blending

$$A_{\text{src}} = \alpha_{\text{s}} \cdot (1 - \alpha_{\text{d}})$$
$$A_{\text{dst}} = \alpha_{\text{d}} \cdot (1 - \alpha_{\text{s}})$$
$$A_{\text{both}} = \alpha_{\text{s}} \cdot \alpha_{\text{d}}$$

	[s]	[d]	[b]
Src	*s*	0	s
Atop	0	*d*	s
Over	*s*	*d*	s
In	0	0	s
Out	*s*	0	0
Dest	0	*d*	d
DestAtop	*s*	0	d
DestOver	*s*	*d*	d
DestIn	0	0	d
DestOut	0	*d*	0
Clear	0	0	0
Xor	*s*	*d*	0

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

Assignment 1

Available Right Now

Next Week: Ray Casting