



Graphics Overview

Multimedia Techniques & Applications

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Outline

- Overview
- Graphical modeling approaches: bitmapped / vector
- Comparisons of graphical modeling approaches

Graphics

- The software and hardware technologies used in computer system to create, modify, and display **still images** in a digital form
- Important because
 - Images are usually more expressive than pure texts
 - Images are the fundamentals of video, animation, and fonts

Digital Images

- Data can come from a number of ways



digitalization



captured in digital form

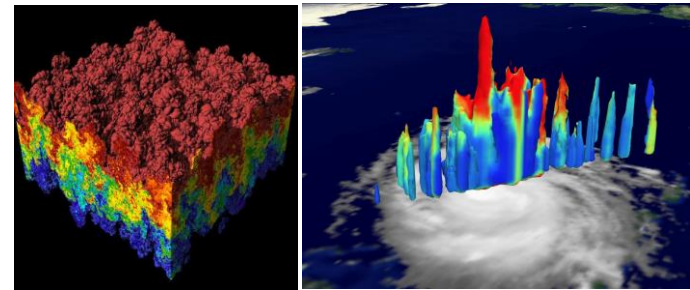


created by artists

generated by
programs



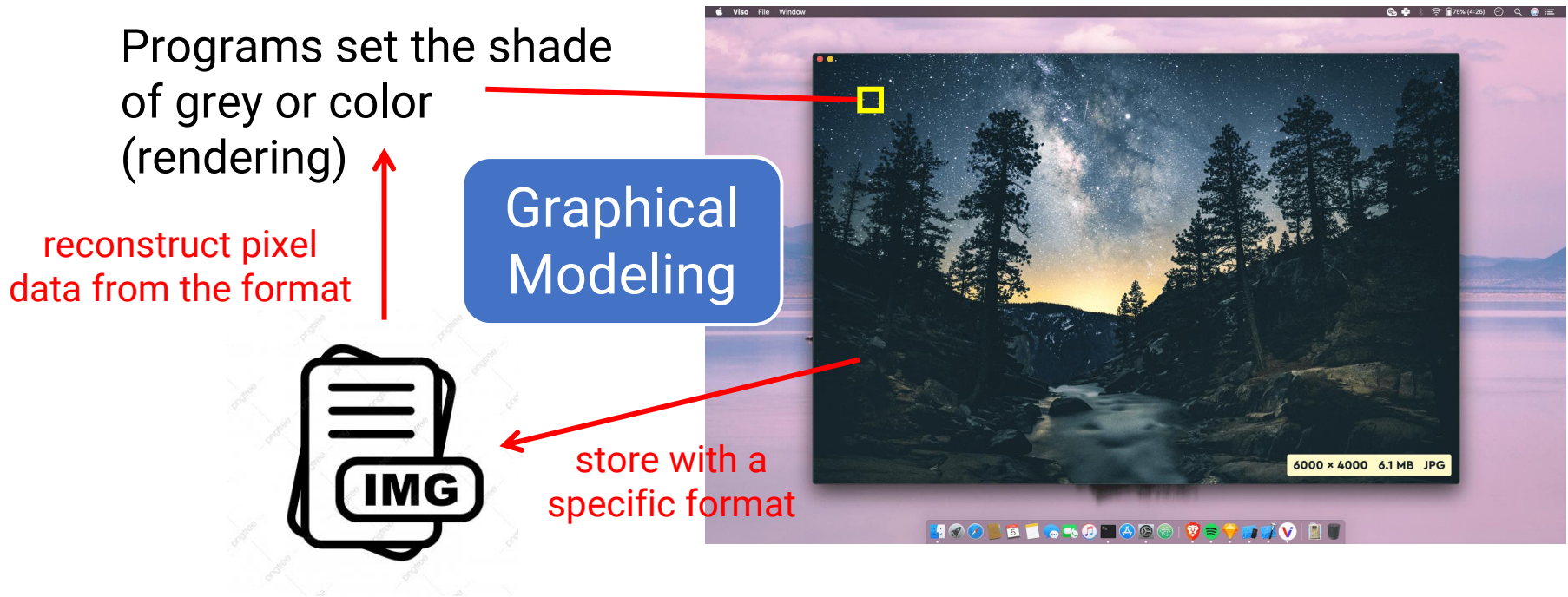
3D graphics



visualization

Image Display

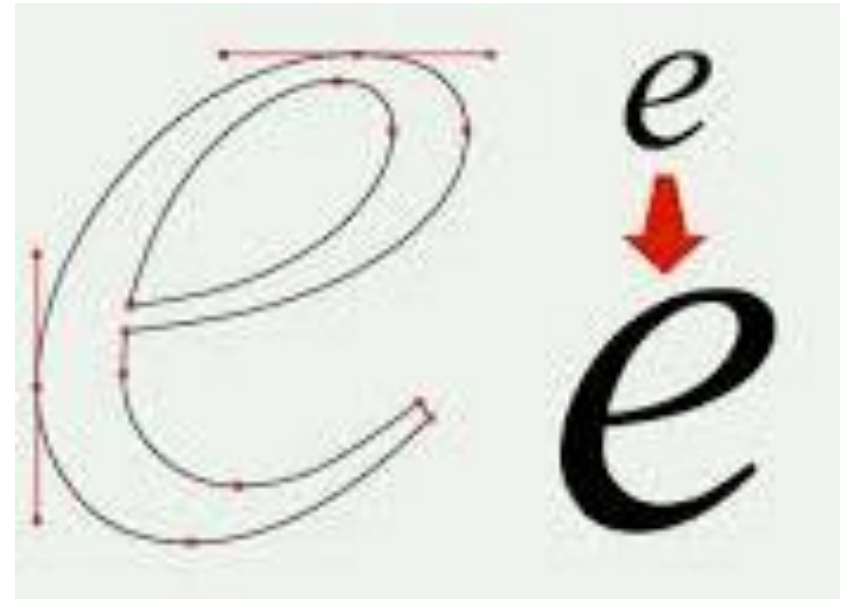
- Monitor display pictures as a **rectangular array of pixels** (small, usually square, dots of color)
 - Merge optically when viewed at a suitable distance to produce the impression of continuous tones



Two Approaches for Graphical Modeling



bitmapped graphics



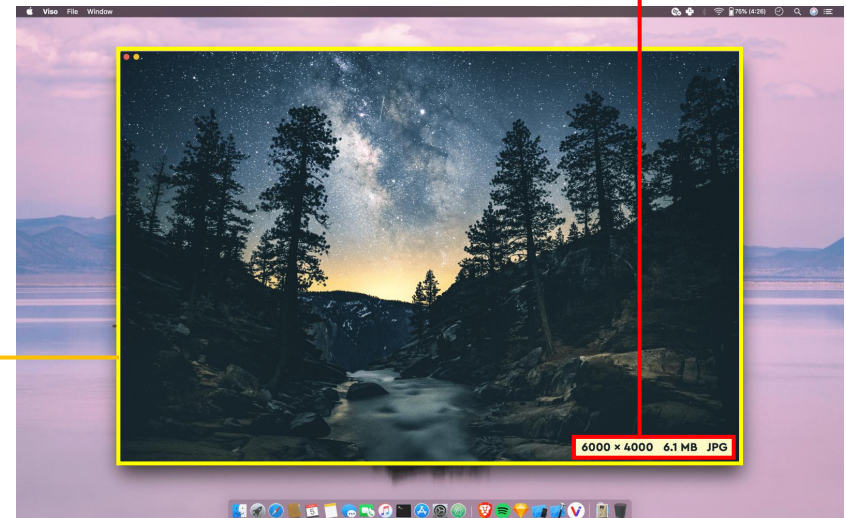
vector graphics

Bitmapped Graphics

- An image is modelled by an array of pixel values
- Distinction between
 - **Logical pixels**
 - Stored value in an image file
 - **Physical pixels**
 - Physical dots on a display screen
- Operations for displaying
 - Scaling
 - Clipping

physical pixels
1200 x 800

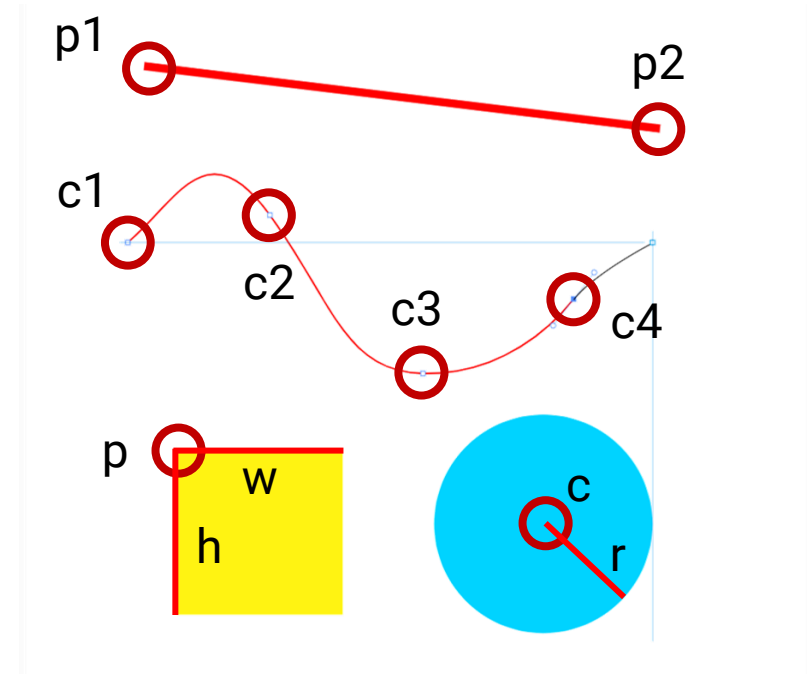
Image resolution
(logical pixels)



Vector Graphics

- An image is modelled by the mathematical description of a collection of individual objects making up the image
 - **Lines**
 - End points
 - **Curves**
 - Control points
 - **Shapes**
 - Shape-dependent parameters

object-oriented graphics !



Vector Graphics (cont.)

- Displaying a vector image requires some computation to be performed **in order** to interpret the model and generate an array of pixels to be displayed
- Example: line

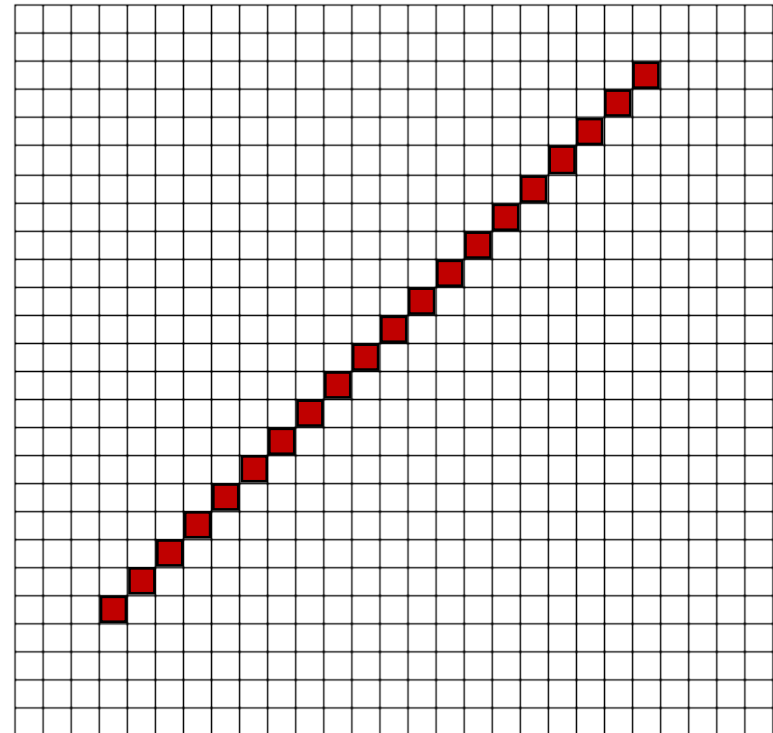
Given $p1(x_1, y_1)$ and $p2(x_2, y_2)$
located on a line $y = mx + b$

→ Compute m

Assume $0 < m \leq 1$, we can
draw the line by filling

$$y_{k+1} = y_k + m$$

$$x_{k+1} = x_k + 1$$



Comparisons: Image Size

Image Size

- **Bitmapped images**

128 x 128 = 16384 pixels

each pixel has 3 channels (rgb)

each channel requires 8 bits

49152 bytes

- **Vector image**

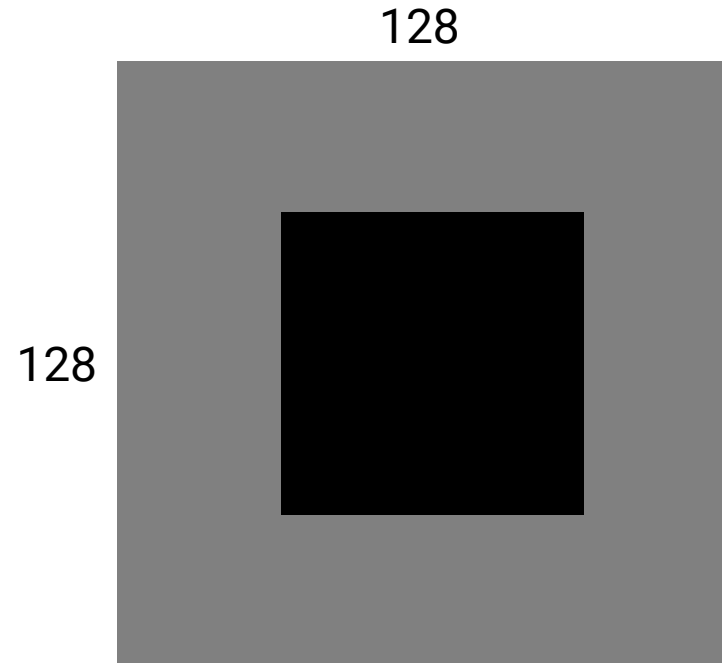
```
0.5 1.5 0.5 setrgbcolor
```

```
0 0 128 128 rectfill
```

```
0 0 0 setrgbcolor
```

```
32 32 64 64 rectfill (in order)
```

78 bytes (independent of any resolutions)

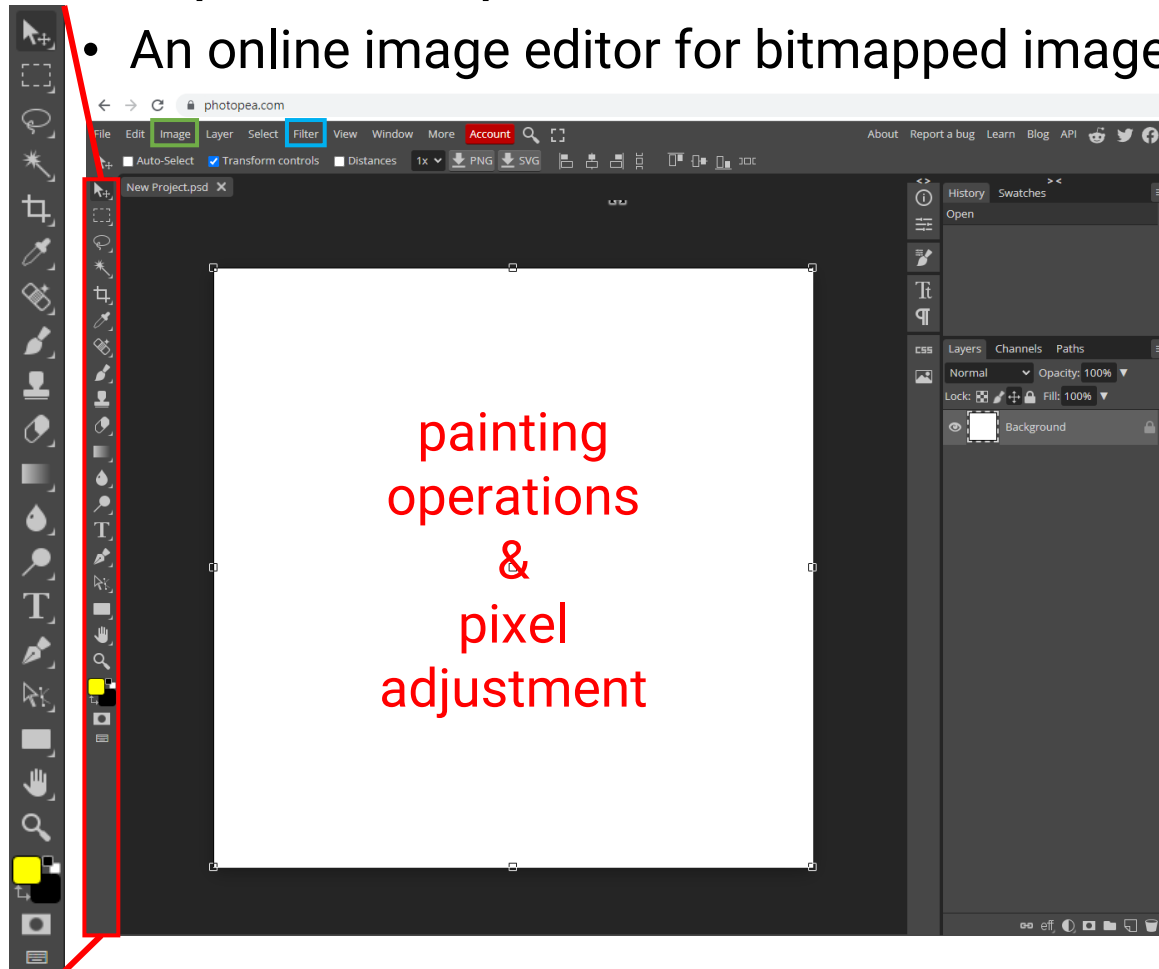


Comparisons: Image Editing

Editor for Bitmapped Images

- Example: Photopea

- An online image editor for bitmapped image



pixel point processing

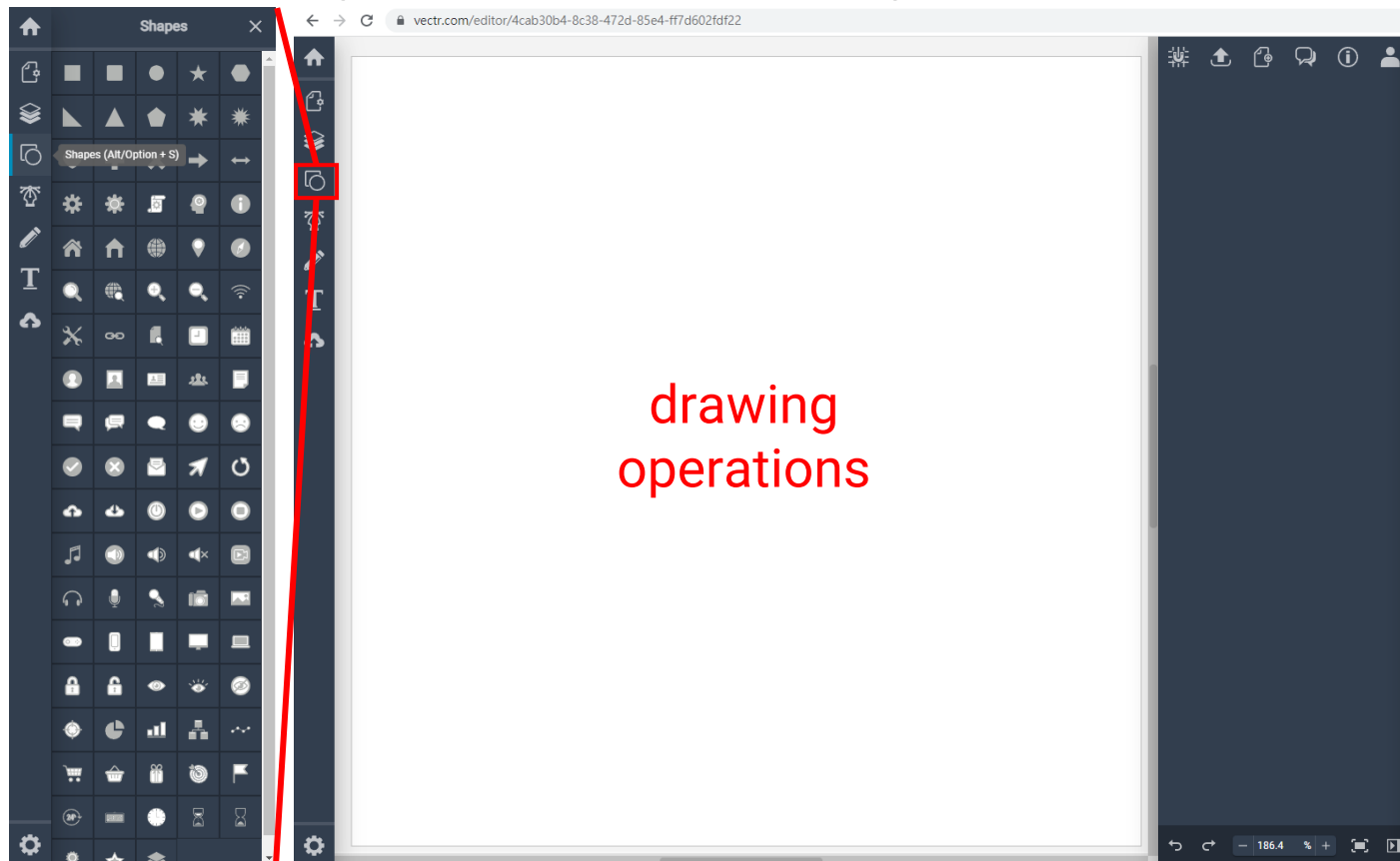
Brightness/Contrast...	
Levels...	Ctrl + L
Curves...	Ctrl + M
Exposure...	
Vibrance...	
Hue/Saturation...	Ctrl + U
Color Balance...	Ctrl + B
Black & White...	
Photo Filter...	
Channel Mixer...	
Color Lookup...	
Invert	Ctrl + I
Posterize...	
Threshold...	
Gradient Map...	
Selective Color...	
Shadows/Highlights...	
Desaturate	Ctrl+Shift + U
Match Color...	
Replace Color...	

Average
Blur
Blur More
Box Blur...
Gaussian Blur...
Lens Blur...
Motion Blur...
Radial Blur...
Surface Blur...

pixel group processing

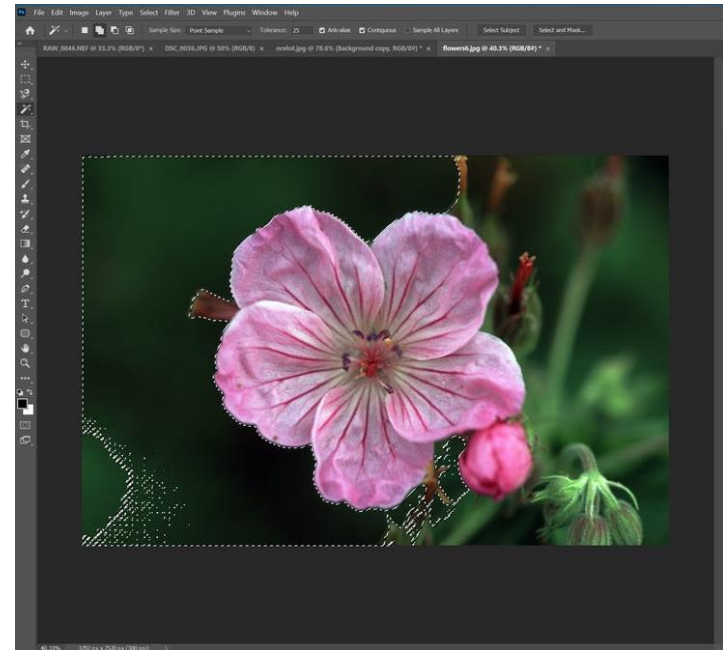
Editor for Vector Graphics

- Example: Vectr
 - An online image editor for vector image



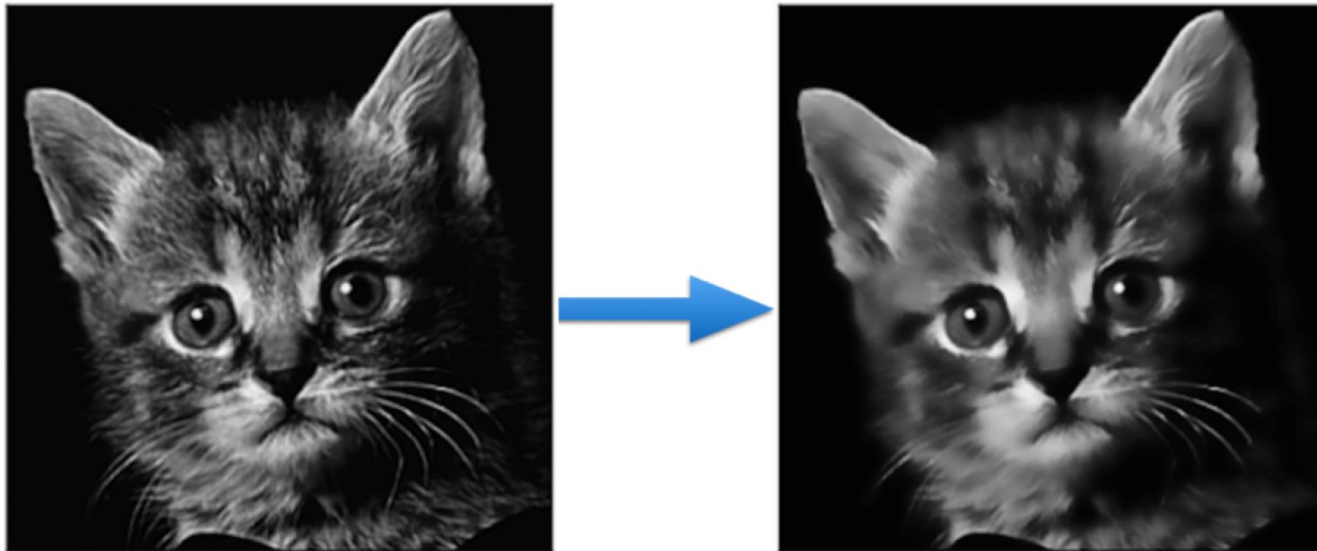
Object Selection

- Intuitive for vector representation
- Painstaking for bitmapped image
 - Need to cutout the object boundary (e.g., magic wand)



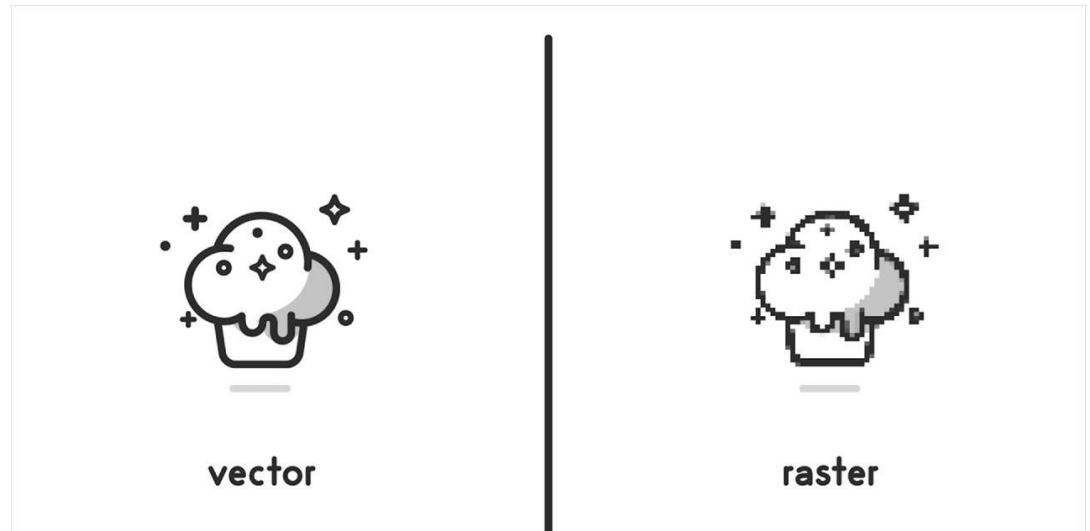
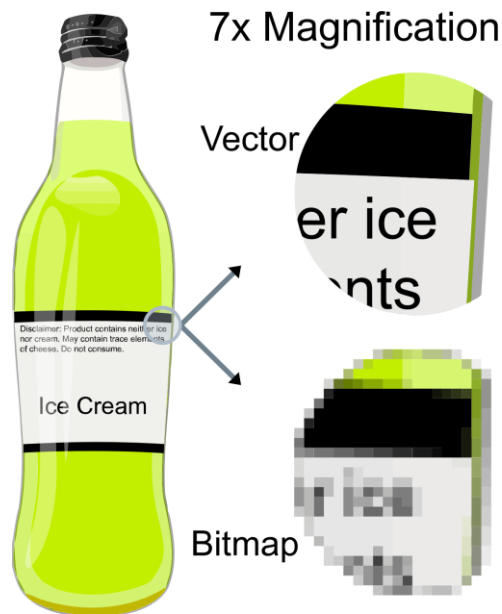
Pixel Point/Group Processing

- Example: blurring
 - Simple for bitmapped image
 - Additional work for vector graphics
 - Need to be first transformed into a bitmapped format
 - Difficult to transfer back to vector graphics for further editing



Resizing

- Bitmapped images need **down-sampling** or **up-sampling**, usually result in perceptual loss of quality
- Vector graphics is independent of the display resolution (on-line rendering based on math)



Resizing (cont.)

- Live Demo

Which Model Should Be Used?

- Depends on
 - **Type of content (target of the image)**
 - Bitmapped images provide better control of pixel values, thus being more suitable for natural images
 - Vector graphics are resolution independent, thus being more suitable for texts and icons



- **Memory requirement**
- **Display efficiency**

Graphic Model Conversion

Vector Graphics to Bitmapped Images

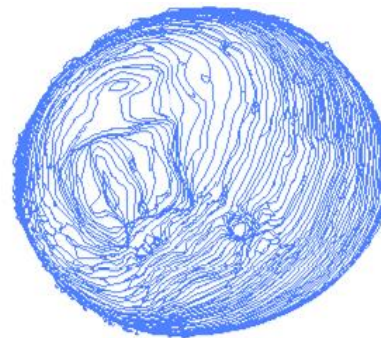
- Easy
- Used the same algorithm that are used to display the image on a monitor
 - **However, will lose all its vector properties after the conversion**

Bitmapped Images to Vector Graphics

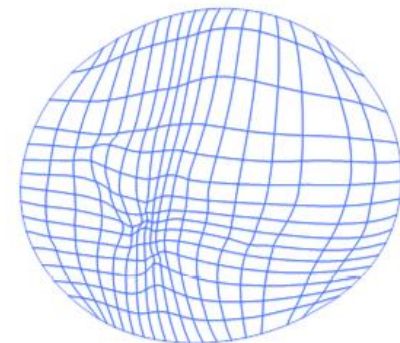
- Very difficult to do well
- Require tools to identify the boundaries of the shapes and shades within the images
- Also require a method to approximate the boundary using the available sorts of curves, lines, and shapes
- Finally, difficult to produce the color textures



input bitmapped image



Adobe Live Trace



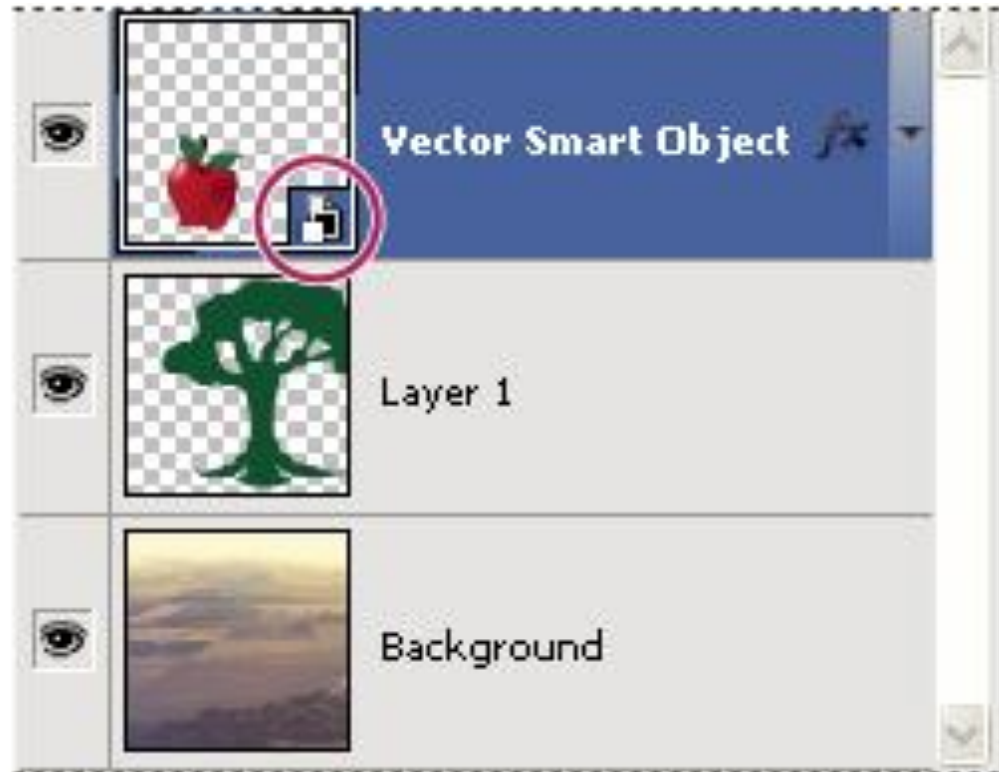
Sun et al., SIGGRAPH 07

Layers

Layers

- First introduced in Photoshop 3
- Work like an overhead projector transparency
 - Allow to draw on parts of the layer, leaving some of it transparent
 - An image can be constructed by stacking layers on top of each other
- One of the most significant ways in which digital technology has affected how artists work
- Supported in both bitmapped and vector graphics editors

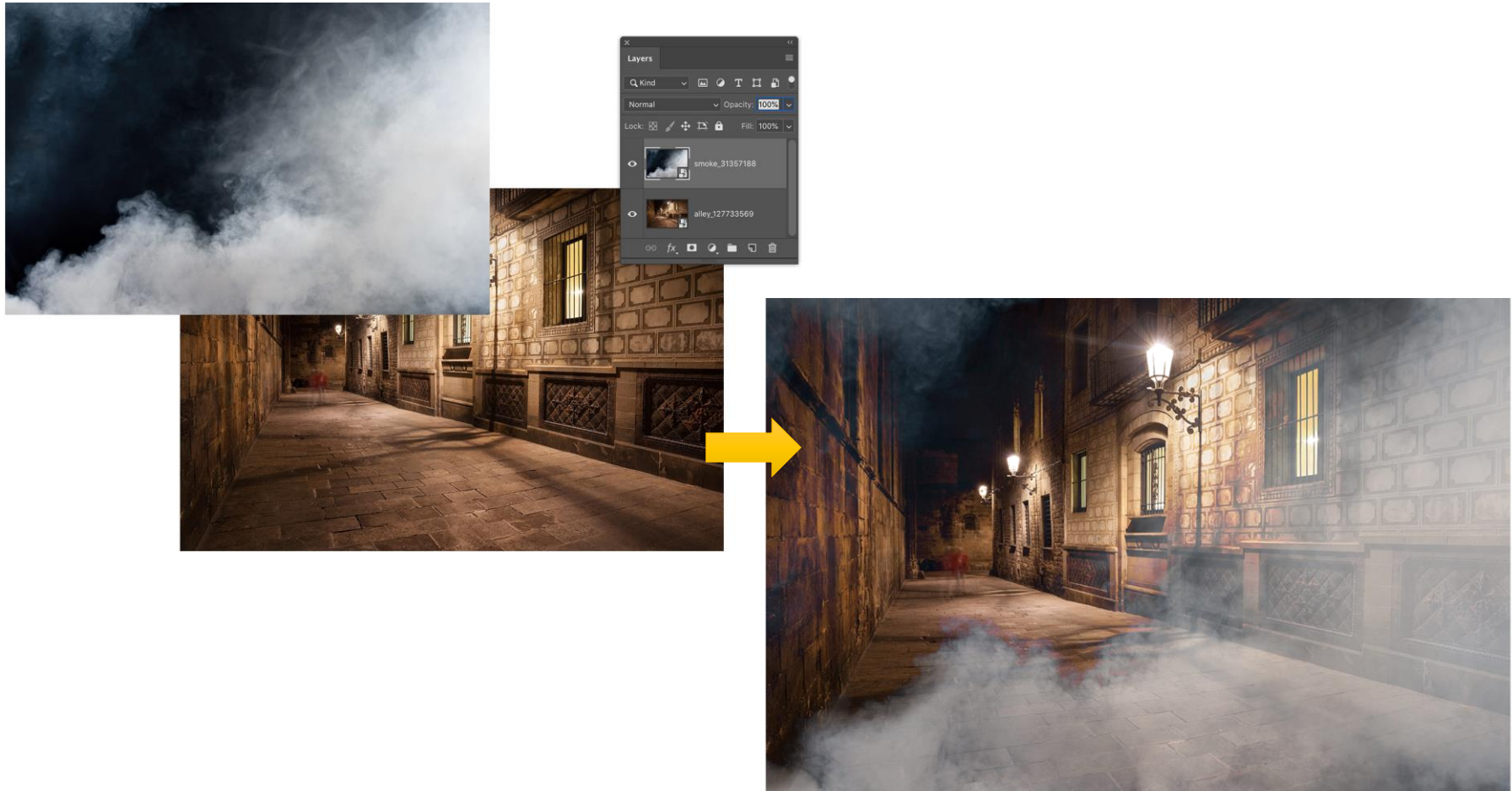
Application: Object Distinguish



Application: Digital Tracing Paper



Application: Image Composition



Application: Image Composition (cont.)

- Perez et al., Poisson Image Editing, SIGGRAPH 2003



sources/destinations



cloning



seamless cloning

<https://blog.csun.net/0014485485>

File Formats

File Formats of Bitmapped Images

- Related to the way of compressing data
 - **Lossless compression**
 - GIF (Graphics Interchange Format)
 - TODO: Is GIF still only restricted to 256 colors?
 - PNG (Portable Network Graphics)
 - BMP (Windows Bitmap)
 - TIFF (Tagged Image File Format)
 - TGA (Truevision TGA, TARGA)
 - **Lossy compression**
 - JPEG (Joint Photographic Experts Group)
 - TIFF (Tagged Image File Format)

File Formats of Vector Graphics

- Related to different applications
 - PostScript
 - EPS (encapsulated PostScript)
 - SVG (Scaleable Vector Graphics)
 - SWF (Small Web Format)
 - PDF (Portable Document Format)
 - AI (Adobe Illustrator Artwork)