CSC 240 Computer Graphics
Video 1A: Images & Pixels

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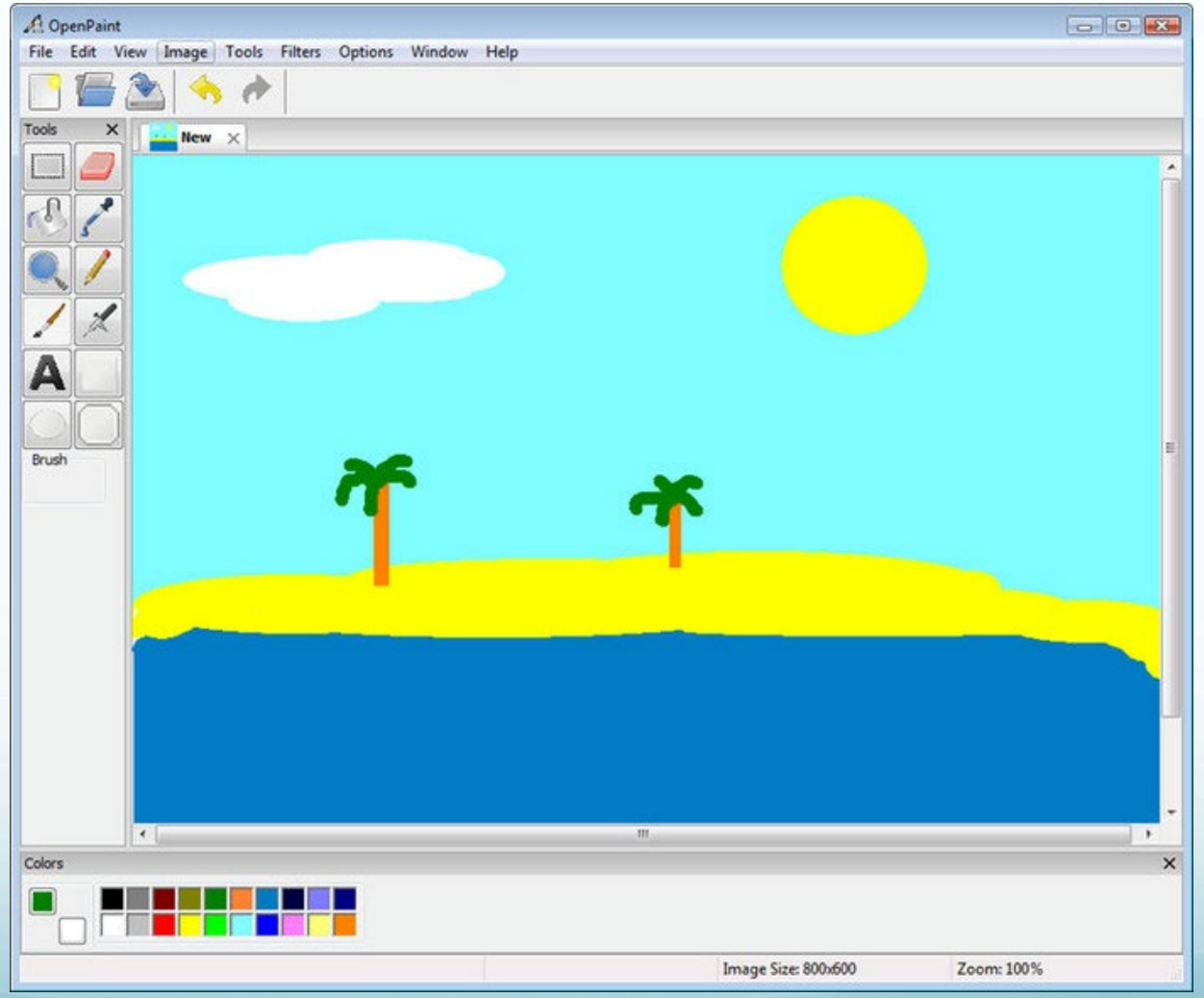
Partially based on slides & content courtesy Sara Mathieson

What is Computer Graphics?

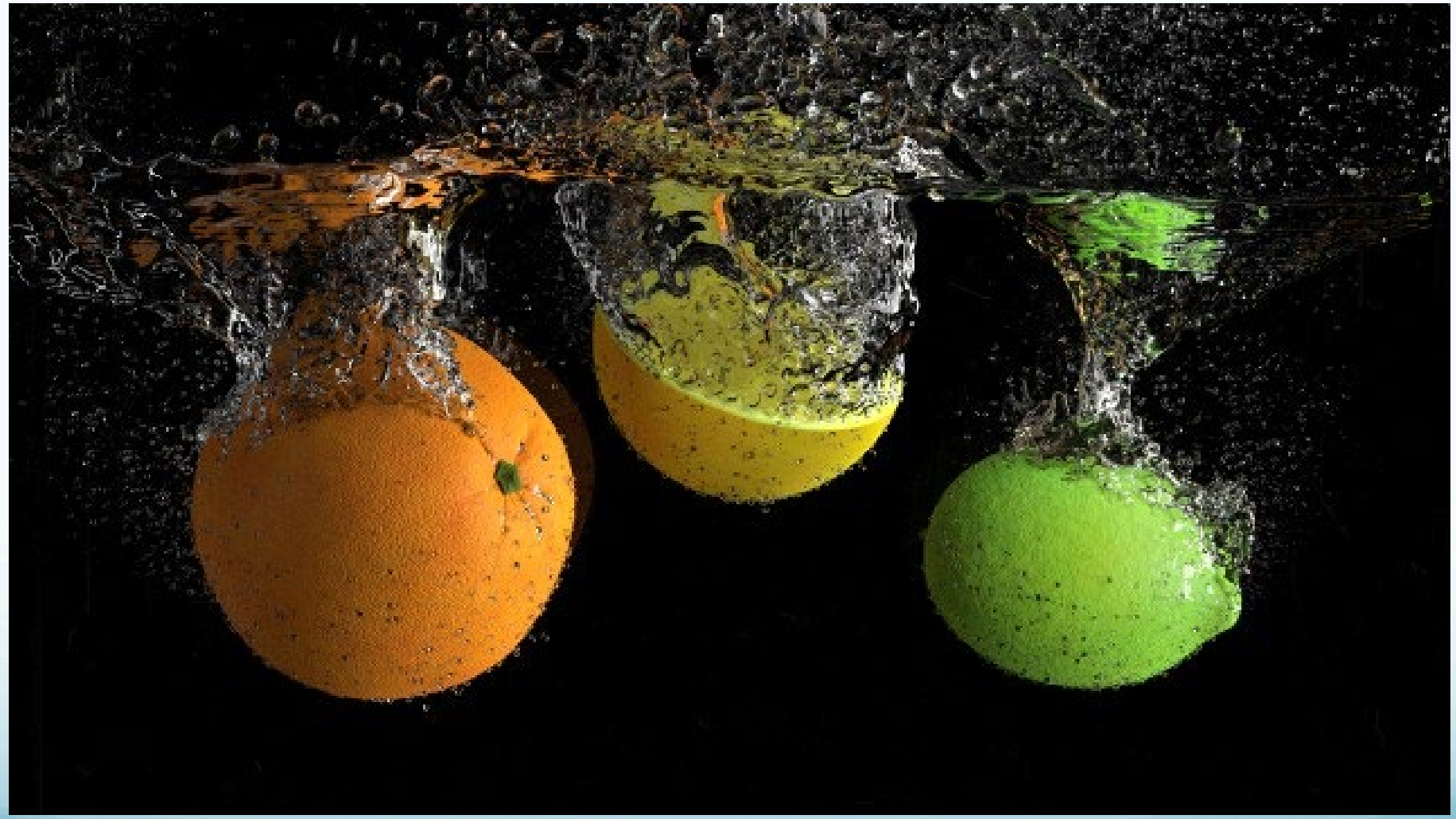
- Creating images using a computer
- Manipulating images
- Modeling and simulation
- Animation and game design
- User-interface design

Creating images



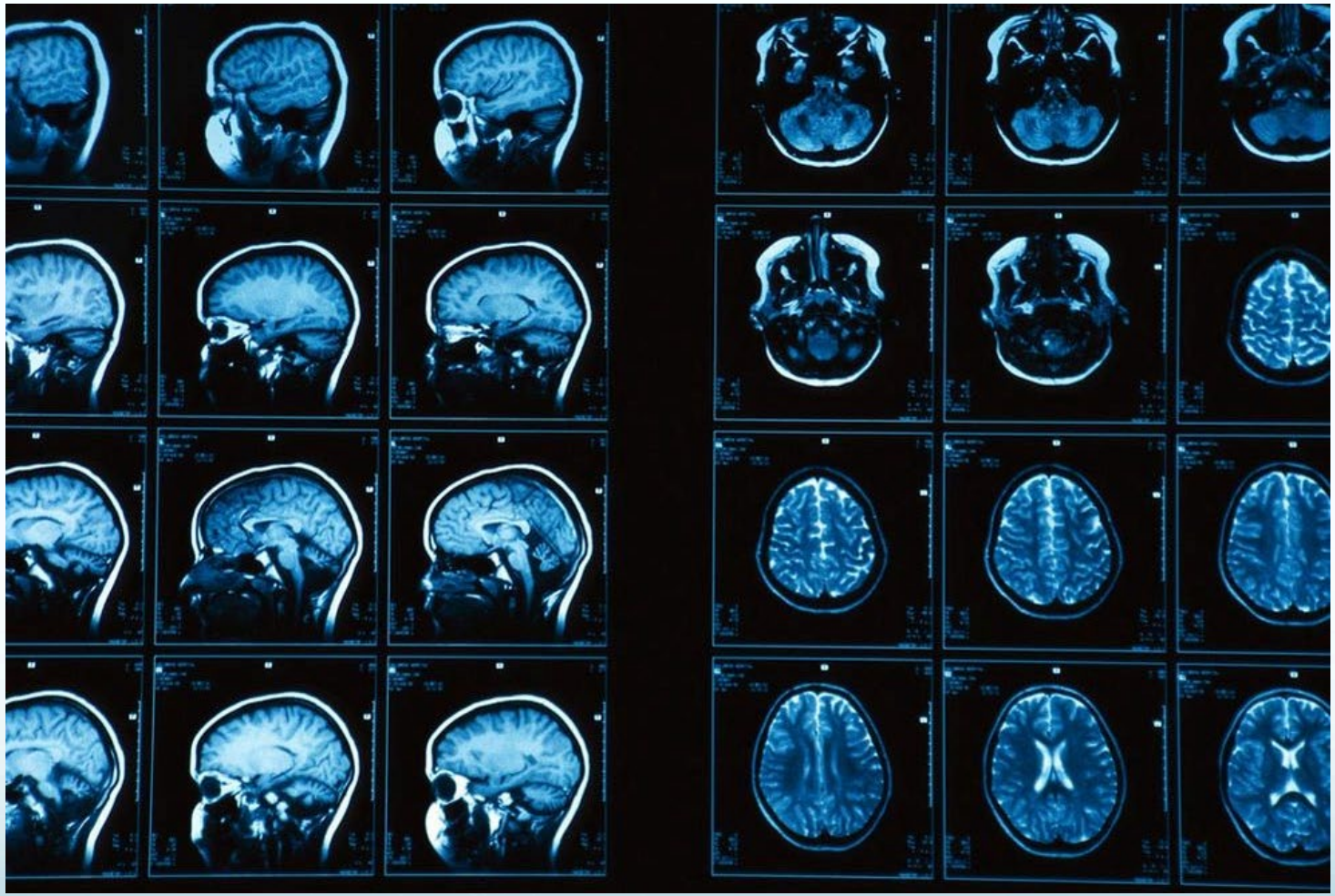
openpaint.en.softonic.com

Creating images



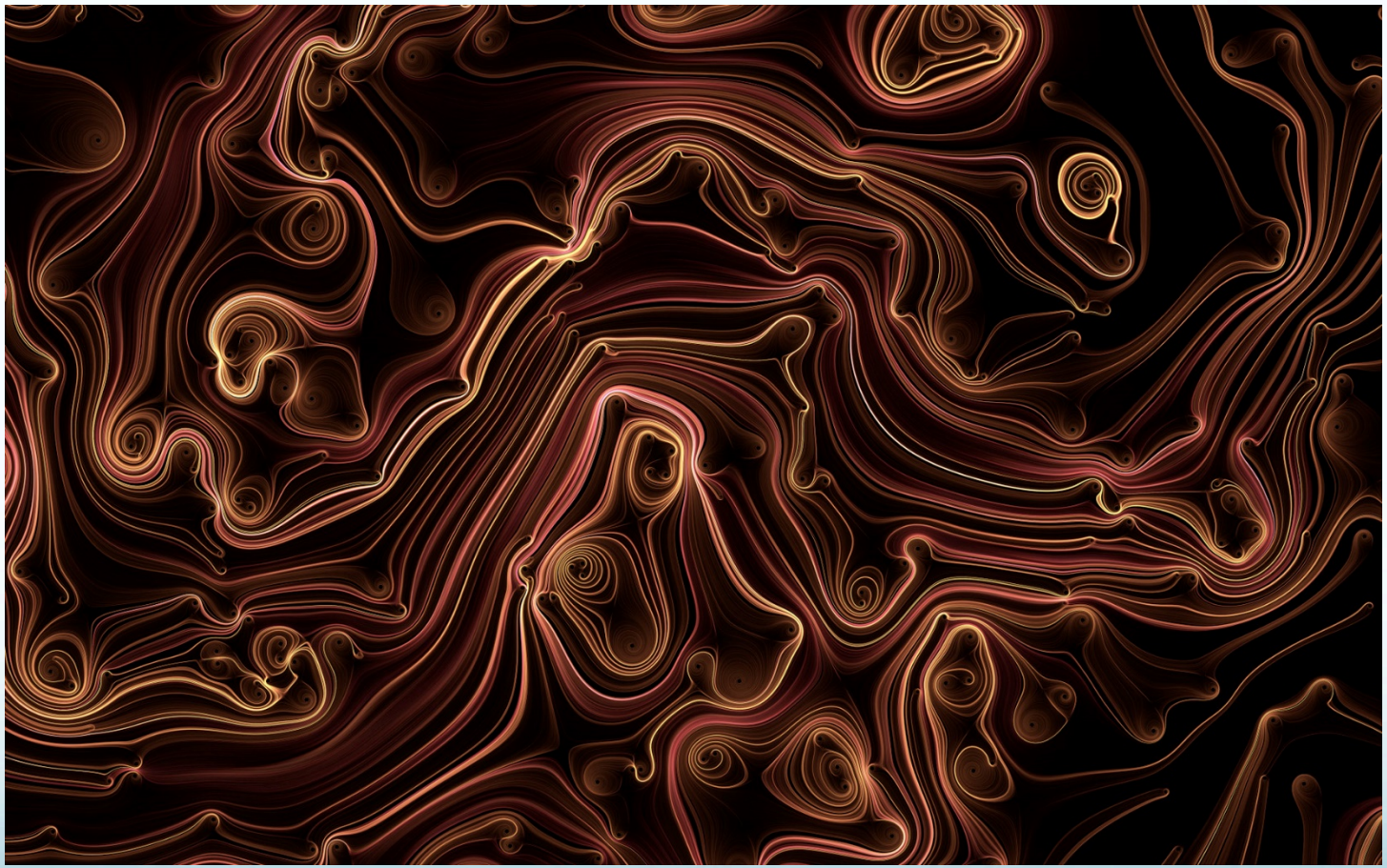
blender.org

Creating images



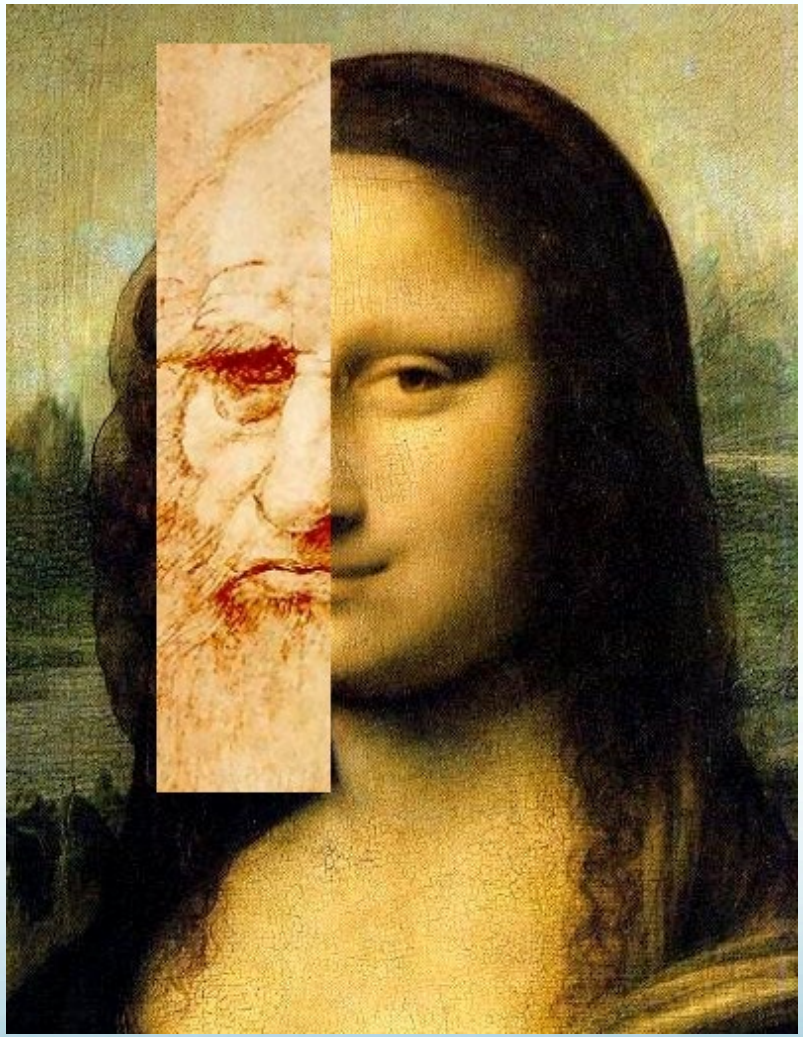
Brain MRI scan, by Ken Glaser/Corbis, National Geographic

Creating images



Addition/Subtraction, by Robert Hodgin

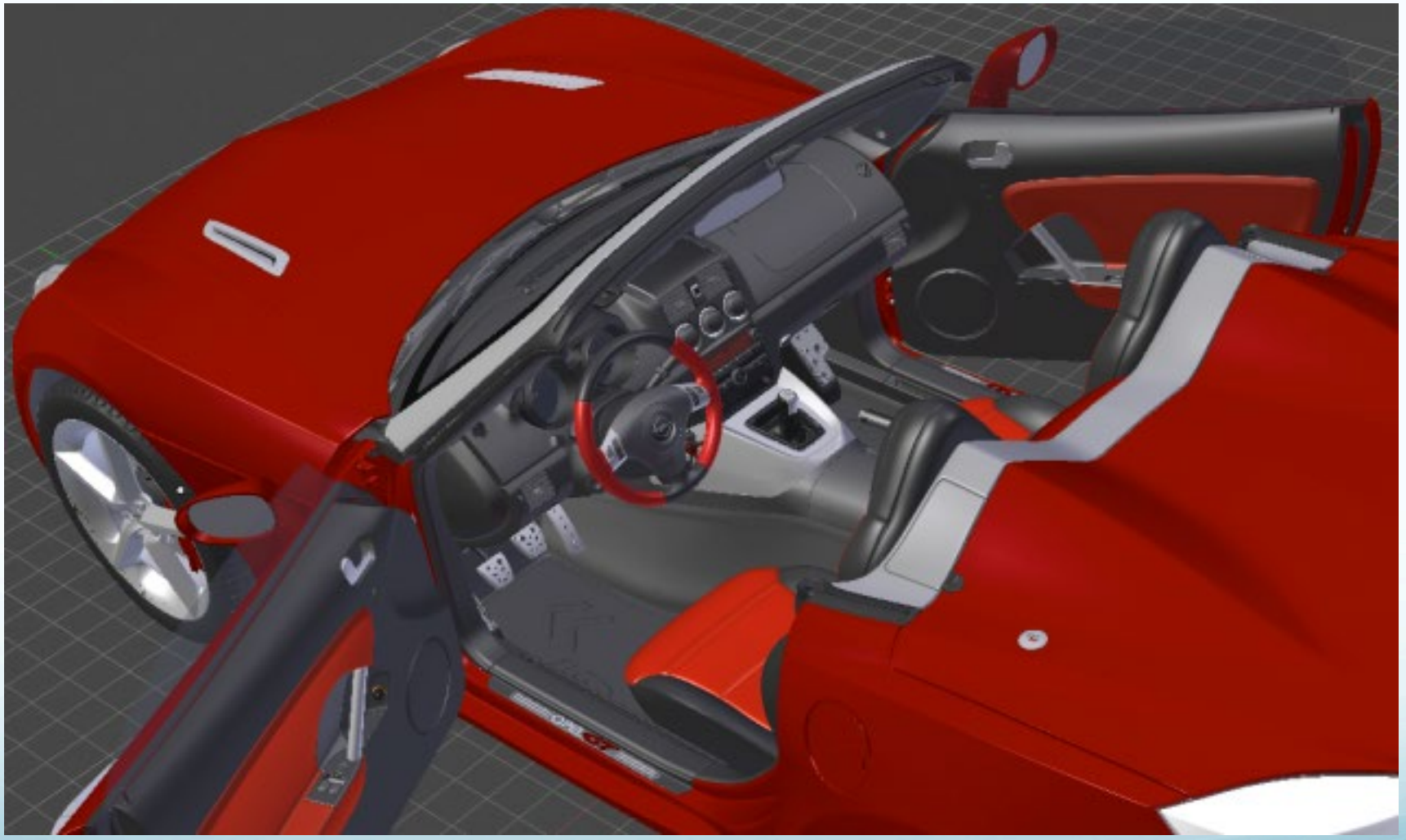
Manipulating images



"DaVinci MonaLisa1b" by David R. Tribble

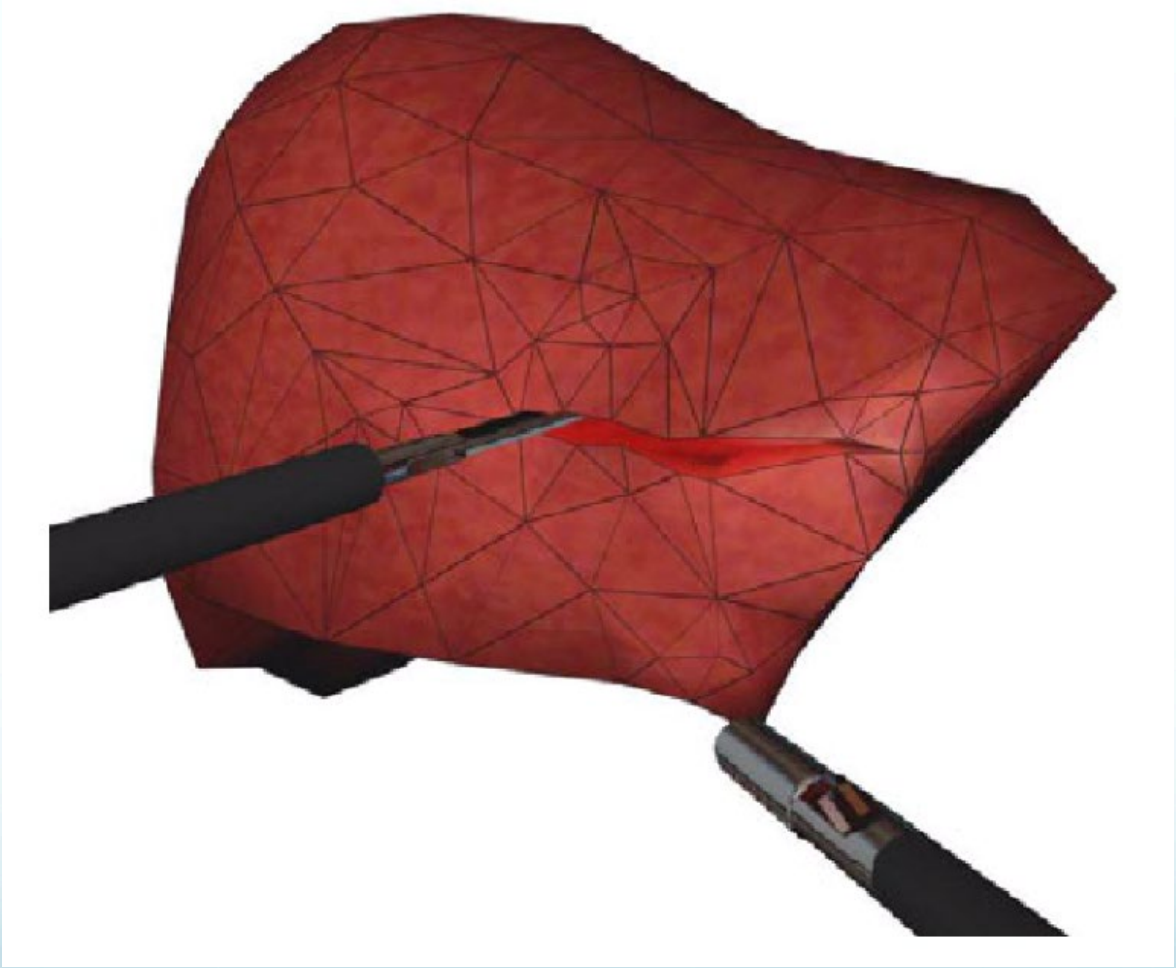
Manipulating images

Modeling and simulation



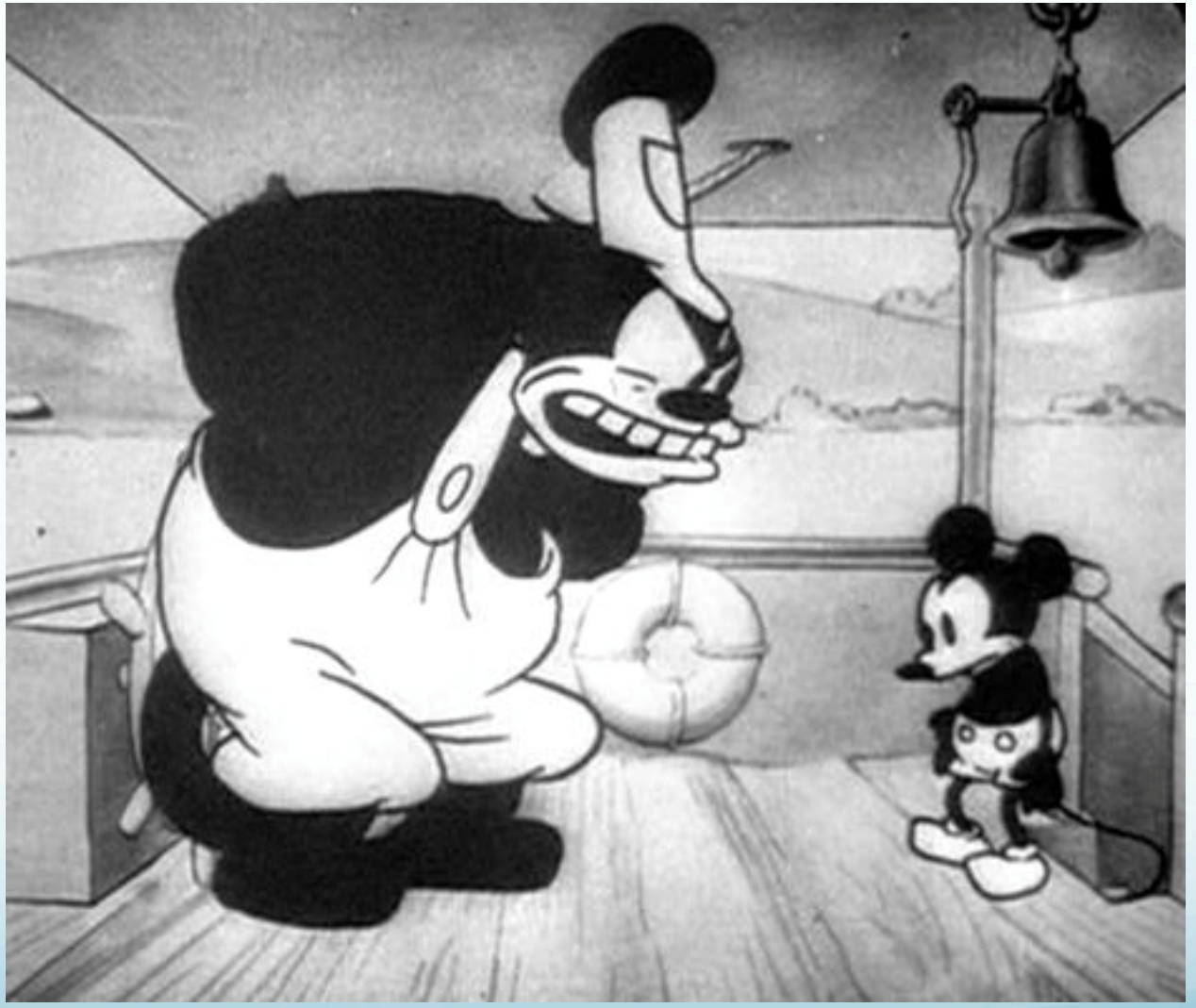
blender.org

Modeling and simulation



Adaptive tissue modeling, Vidal *et al*, 2006

Animation



“Steamboat Willie”, Disney and Ub Iwerks, 1928

Animation

“Monsters Inc”, Disney/Pixar, 2001

Animation

Elsa: 400,000 strands of hair

“Frozen”, Disney, 2013

Animation

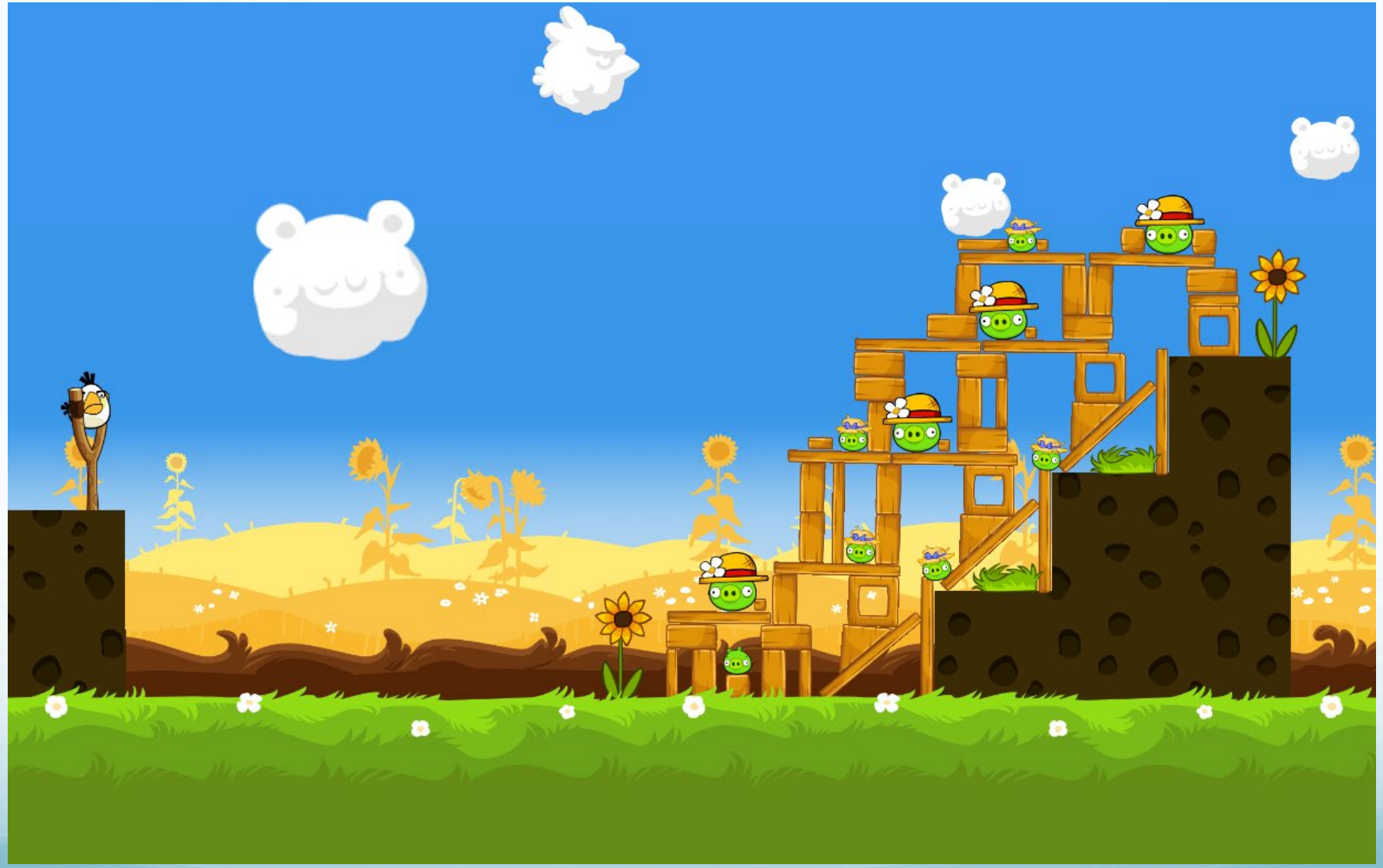
Giraffe: 9 million strands of hair

“Zootopia”, Disney, 2016

Game design

blender.org

Game design

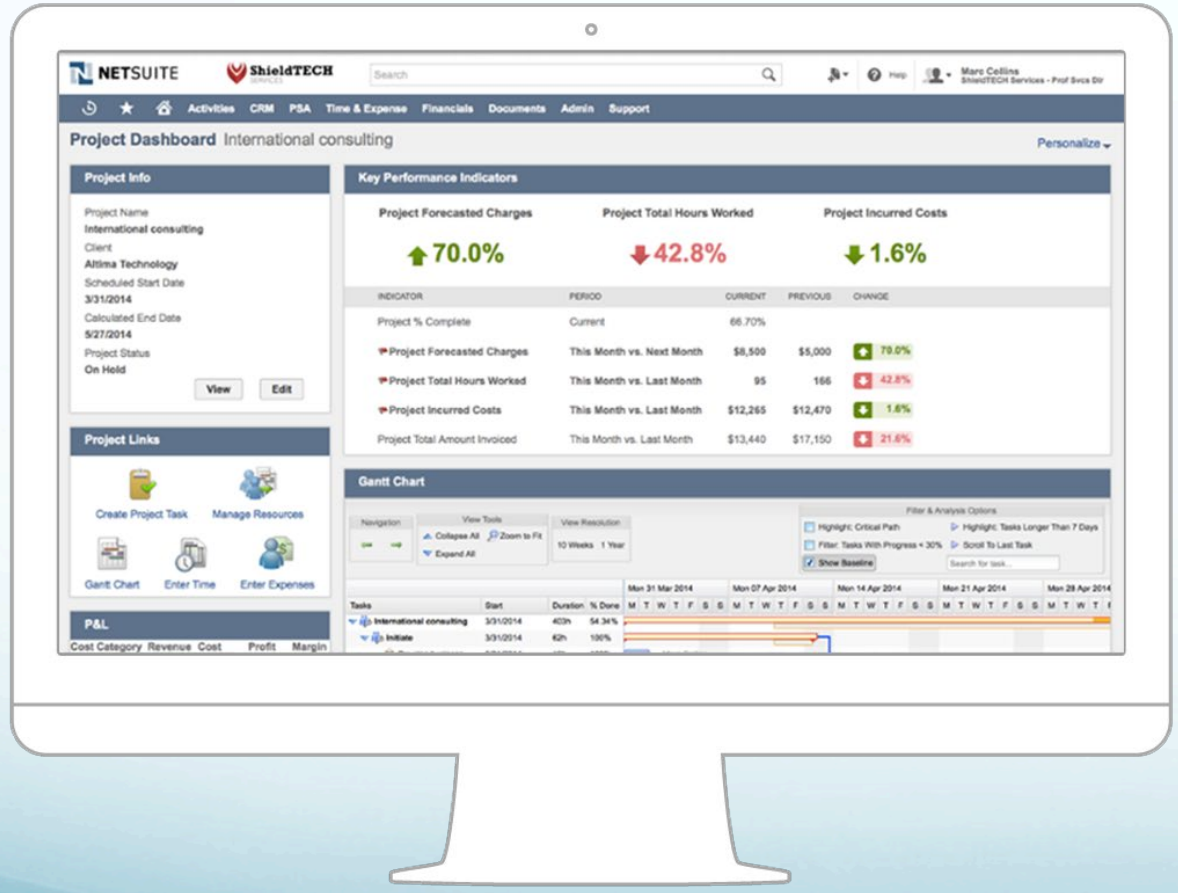


Angry Birds, Gaming To Learn

Game design

Pokémon Go, Niantic, 2016

User-interface design



What is a digital image?

What is a digital image?

Representation of an image in symbolic form:

- Allows reconstruction of the image from the representation
- Handles any possible image

(In practice, we achieve only an approximation of these goals)

Image Representation

Two main strategies:

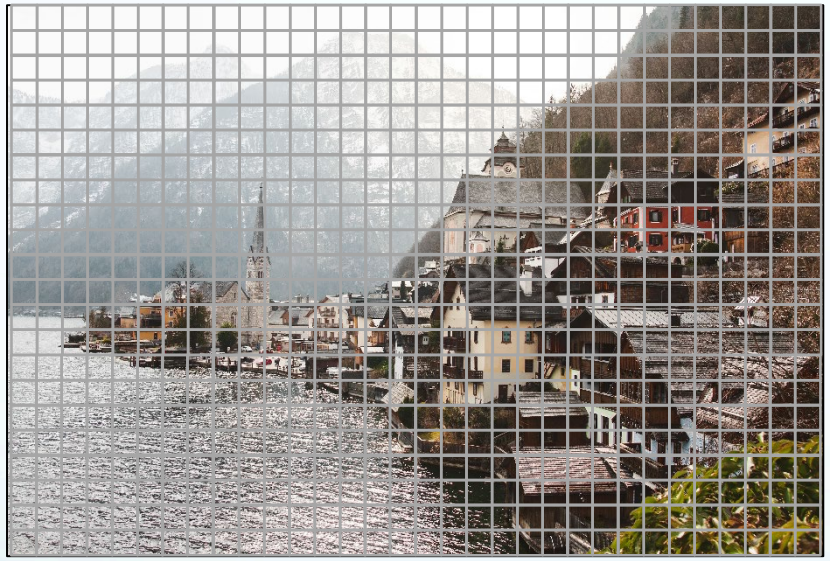
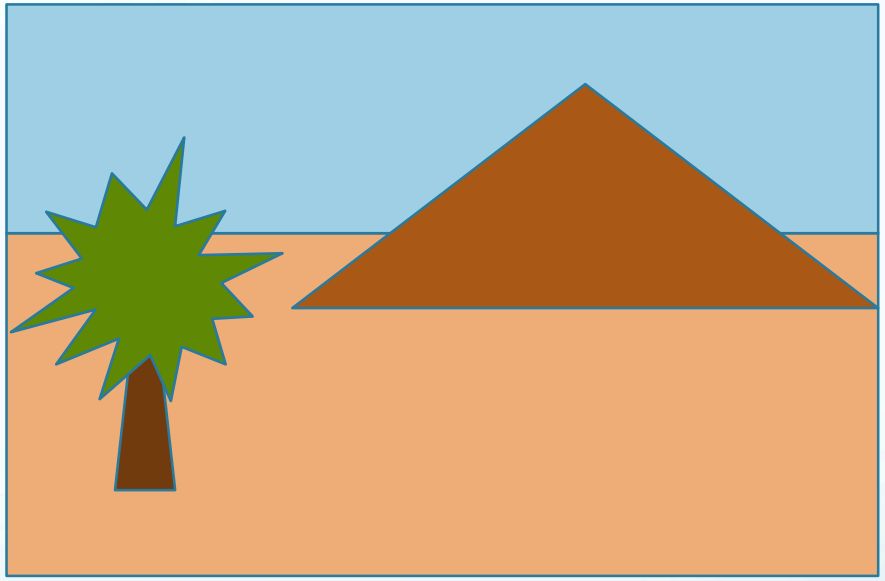


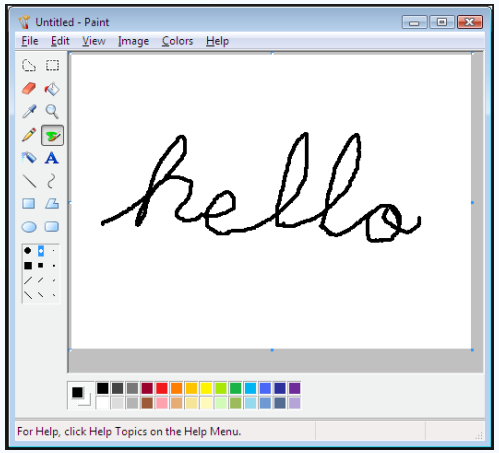
Photo by **Daniel Frank** from **Pexels**

Many small, identical but flexible components
"picture elements" = **pixels**
Resolution = size of smallest visible detail (i.e., one pixel)



Fewer large, diverse components
Each requires description

Raster Graphics vs. Vector Graphics



- **Raster graphics**: pixel by pixel
  - Used in **painting** programs
  - Microsoft paint, Adobe photoshop

- **Vector graphics**: defined by shapes
  - Used in **drawing** programs
  - Line from A to B, Circle at C with radius r, etc
  - Inkscape, Adobe illustrator

INKSCAPE
Draw Freely.

Raster Graphics vs. Vector Graphics

- **Example**: tree in front of a house

- **Question**: if you erase the tree, is the entire house still there?

- **Answer**:
  - vector graphics: yes!
  - raster graphics: no ☹

Images: Draw Doo and drawingmanual.com

Raster Graphics vs. Vector Graphics

Pros and Cons?

- **Raster graphics**: can't rescale (image gets "pixilated"), more fine control, portable format
- **Vector graphics**: scale arbitrarily, less space to store, easier to interpret, limited vocabulary

Raster Graphics vs. Vector Graphics

File Formats

- Raster-based

- **GIF** (Graphics Interchange Format)
  Limited colors, but supports animation.
  Lossless compression.

- **PNG** (Portable Network Graphics)
  Replacement for GIF, also lossless compression.

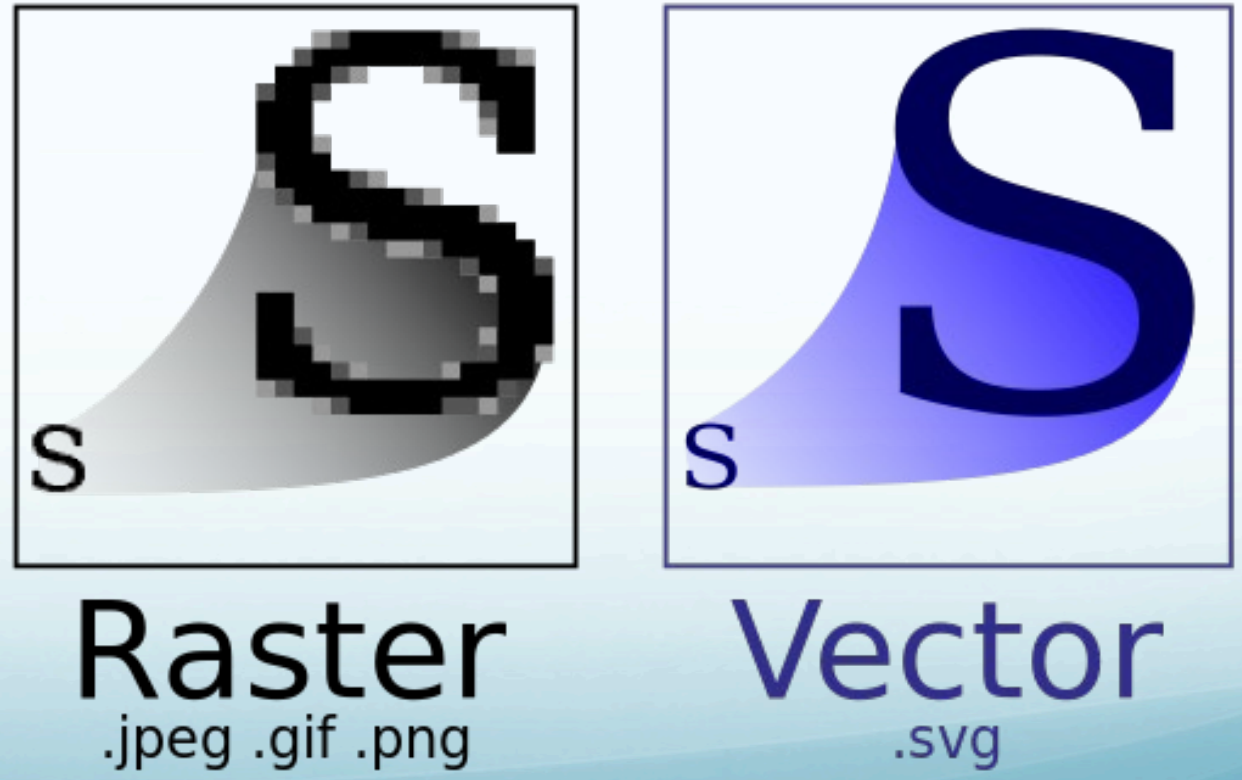
- **JPEG** (Joint Photographic Experts Group)
  Designed with space/quality tradeoff in mind.
  Best for photos.

Images: Wikipedia

Raster Graphics vs. Vector Graphics

File Formats

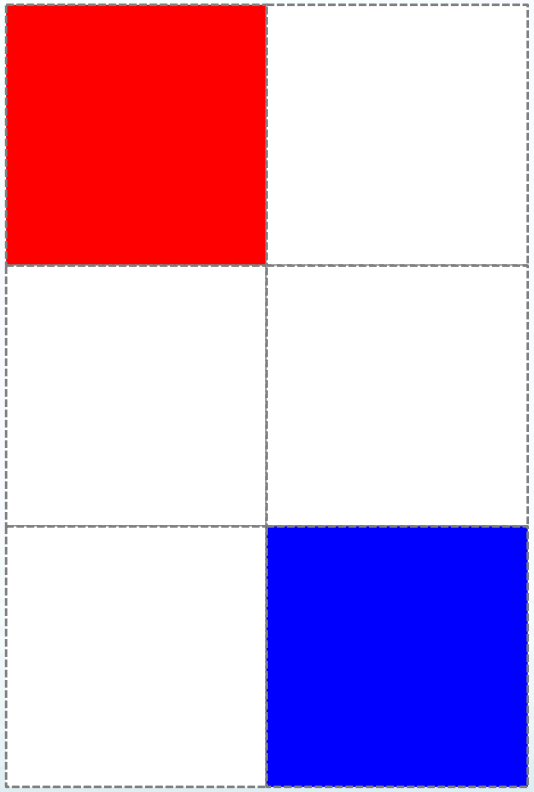
- Vector-based
  - SVG (Scalable Vector Graphics)



Images: Wikipedia

Simple image format

PPM: Portable Pixel Map



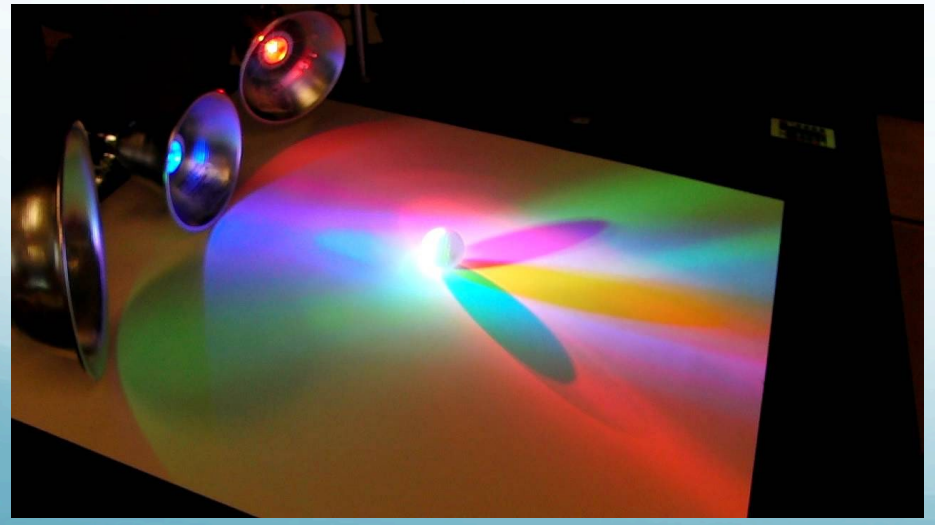
Based on: slides from Eitan Mendelowitz

Pixel coloring

Specify amount of each color in mixture

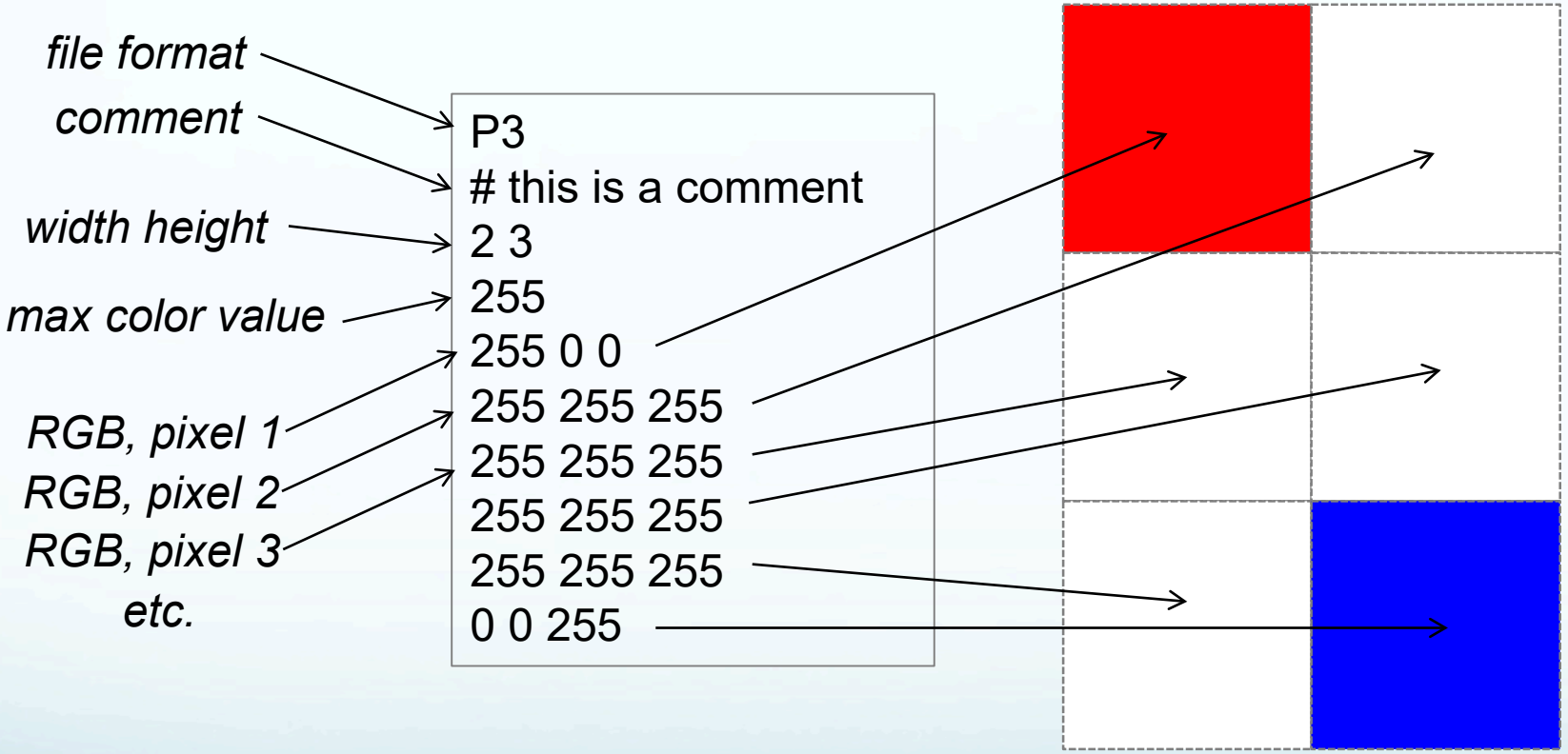
- Red
- Green
- Blue

➢ “RGB” → three numbers 0-255



www.colorcodehex.com

Simple image format



This pixel order is called **row major**.
Some formats use **column major** instead.
Some group by color (all red values, all green, all blue).

Quick Quiz

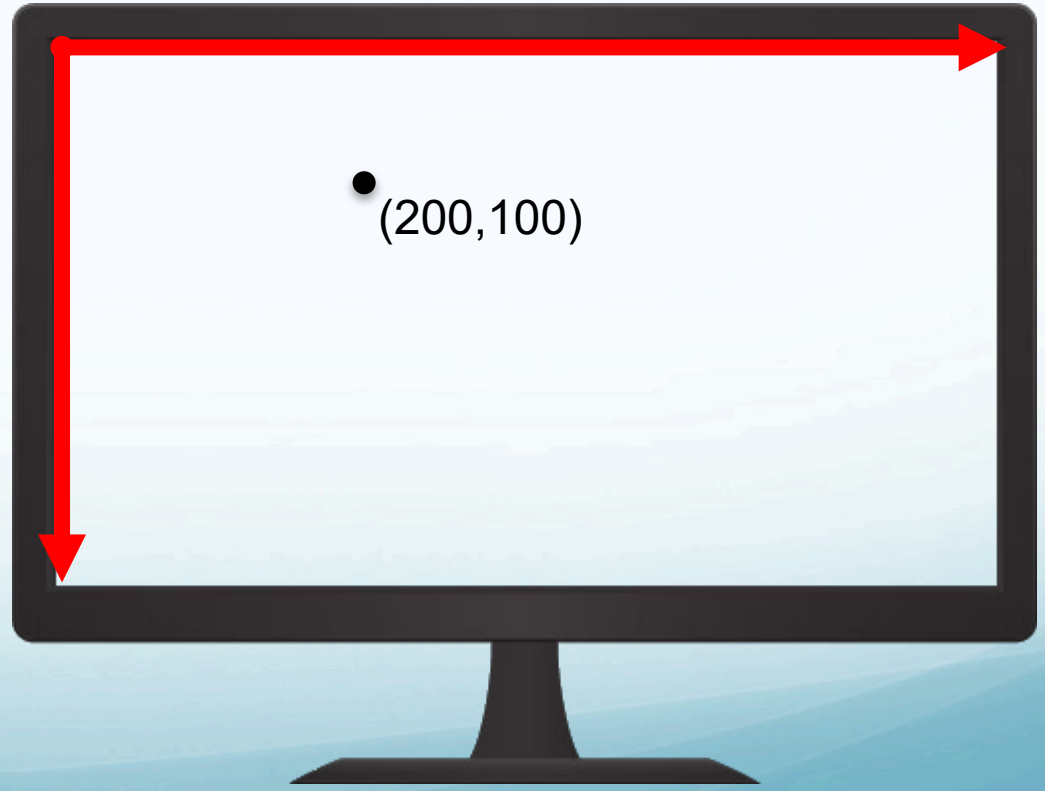
Pause the video and respond at https://forms.gle/VViU5wYsiBf36nAV9

- What color is represented by the RGB values (0,0,0)?
  Black
- What RGB triplet corresponds to pure blue?
  (0,0,255)
- What color is represented by (255,255,0)?
  Yellow
- Do digital cameras record in vector image format or raster?
  Raster

Screen Coordinates

Display on a computer screen is a raster image!

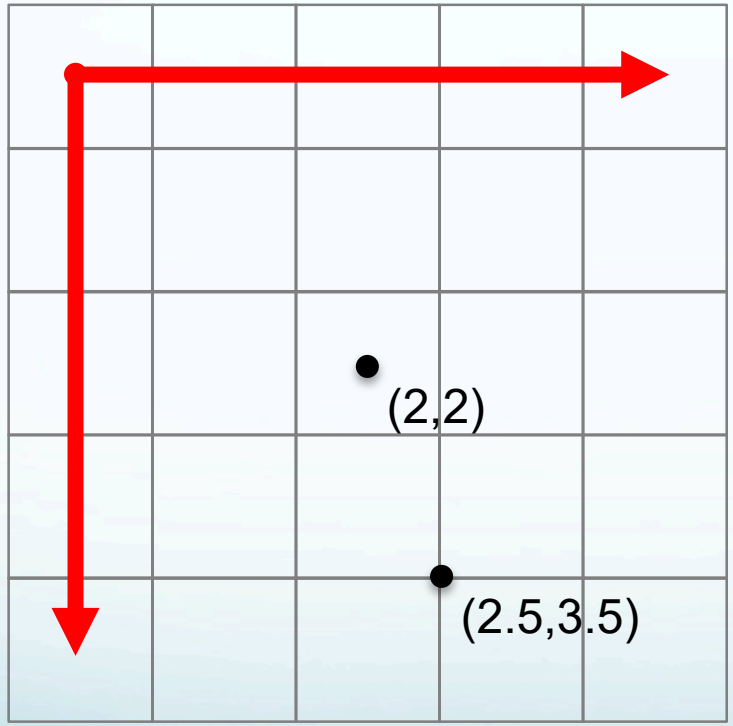
- 2D coordinate system specifies position
- Each pixel is one unit by one unit
- Origin is at top left
- X axis points **right**
- Y axis points **down**



Coordinate Alignment with Pixels

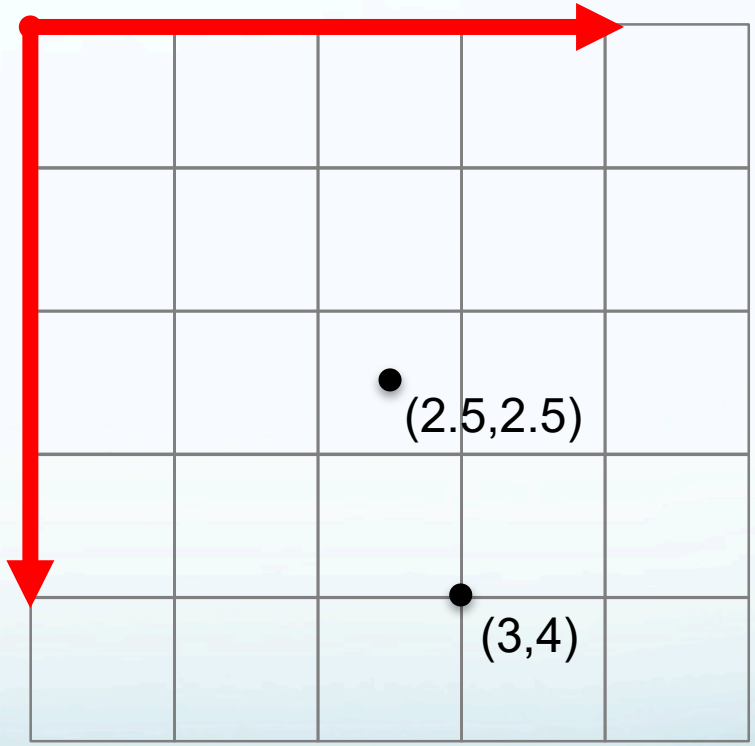
Two conventions exist for how coordinate values align with pixels.

Whole numbers at pixel centers, fractions at boundaries



Pixel centered origin:
the origin point corresponds to the centre of the top-left pixel.

WebGL uses corner origin!



Corner origin:
the origin point corresponds to the top-left corner of the top-left pixel.

Whole numbers at pixel boundaries, fractions at centers

All coordinates are higher by 0.5 than PCO

Quick Quiz

Pause the video and respond at https://forms.gle/VViU5wYsiBf36nAV9

- A graphics window is 800 pixels high and 600 wide. What are the coordinates of the image center, assuming corner origin?

  (300,400)

- A graphics window is 800 pixels high and 600 wide. What are the coordinates of the image center, assuming pixel center origin?

  (299.5,399.5)

- The coordinates of a particular pixel center are (3.5,7.5). Which origin convention is being used?

  Corner origin

Review

After this video, you should be able to:

- Identify applications of computer graphics
- Distinguish between raster and vector image formats
- Define terms: **pixel** and image **resolution**
- Use RGB triplets to represent different colors
- Describe the axis configuration for standard screen coordinates
- Work with points in both pixel center origin and corner origin conventions

Music by bensound.com