Images

Displaying, Storing, and Encoding

Digital Displays

- When we look at digital displays, we see something like this.

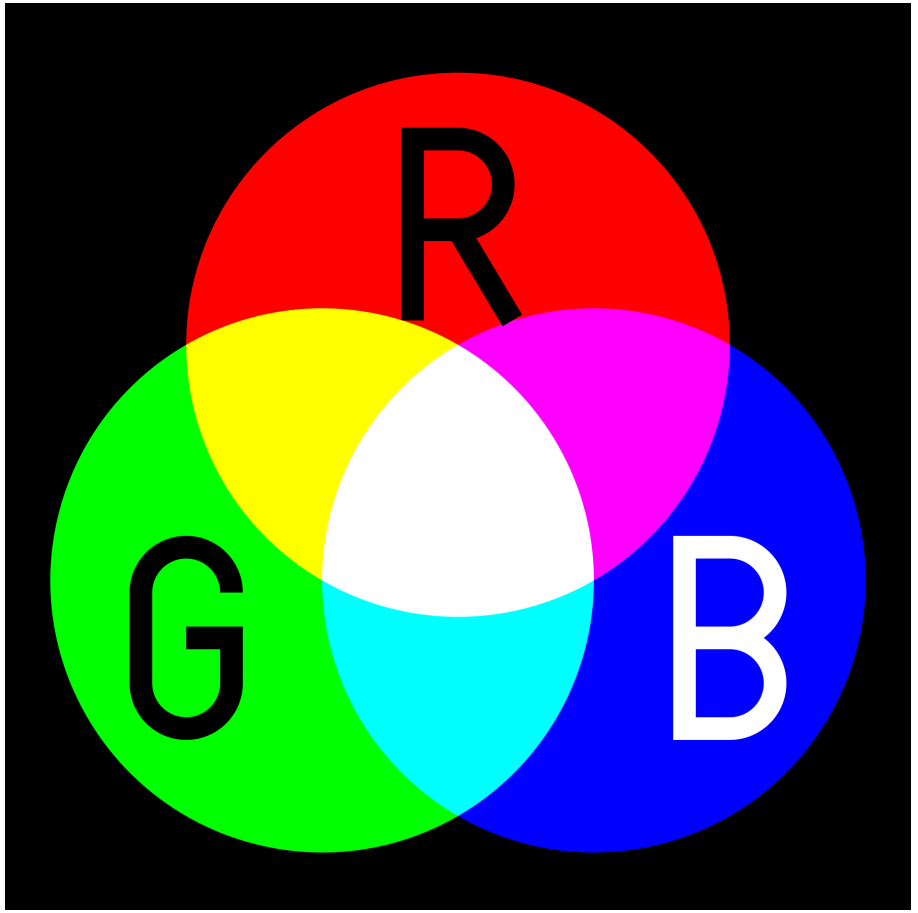
- However, if we were to look very closely, we could see the pixels that make up the display

What's a Pixel?

- Short for Picture Element
- Tiny dots that make up your computer screens
  - 1080P = 1920 x 1080 = 2,073,600 pixels!
- Basically imperceptible
- All the dots together make up the images you see!

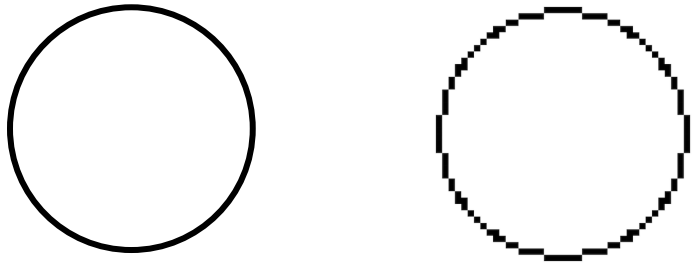
How?

- The RGB Color Model
- Pixels are made up of combinations of red, green, and blue light
- Each color is represented by a number to determine that color's intensity



Rasterization

- Displaying content on computer screens relies on showing approximations of things from the real world
- Is this a circle?



Sort of….

- It looks like a circle, because the pixels are so small and densely packed that we see a perfectly round image
- Our eyes and visual perception system aren’t perfect and can be ”tricked” into seeing things
- Web Demonstration

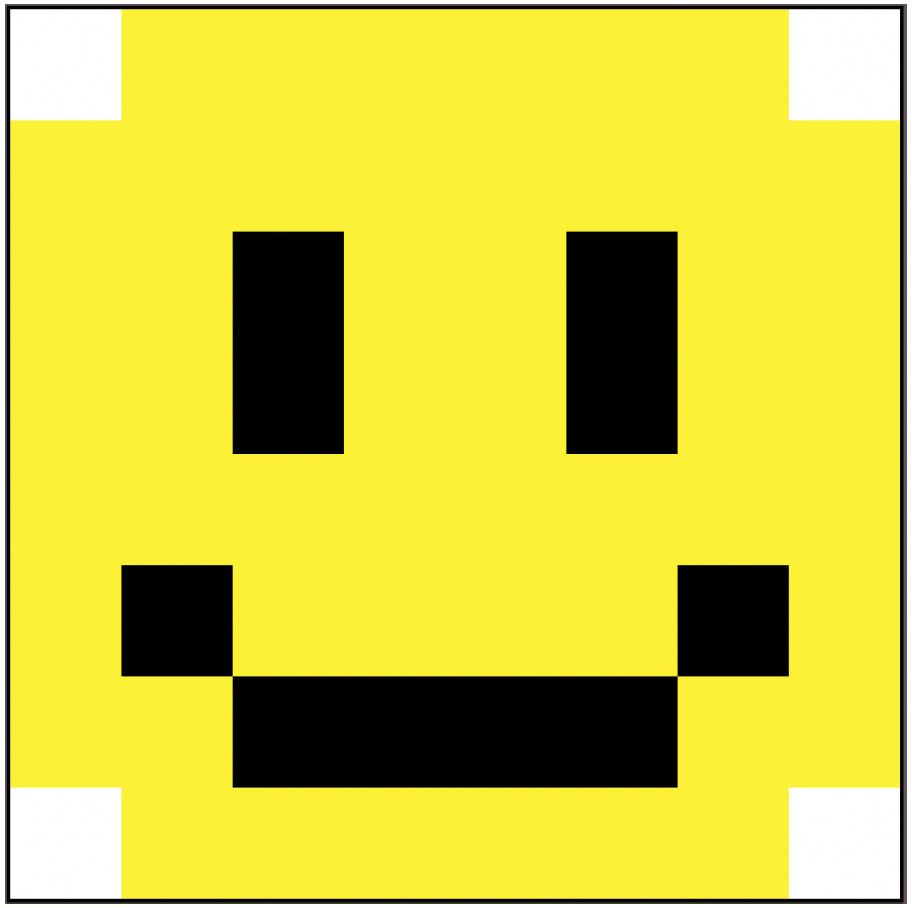
Raster (Pixel based) Image Types

- BMP (Bitmap)
  - Lossless
  - Uncompressed
  - Can support up to 64-bits with 24-bit being common
- Gif (Graphic Interchange Format)
  - Lossless
  - Color palette limited to 256 colors per pixel (8-bits)
  - Supports Transparency and Animation Frames
- JPEG (Joint Photographic Experts Group)
  - Lossy Compression
  - Data is lost in compression (original can't be recovered)
  - Color palette can show over 16 million colors per pixel (24-bits)
- PNG (Portable Network Graphics)
  - Lossless Compression
  - Data is not lost in compression (original can be recovered)
  - Can support 48-bits per pixel
  - Supports Transparency

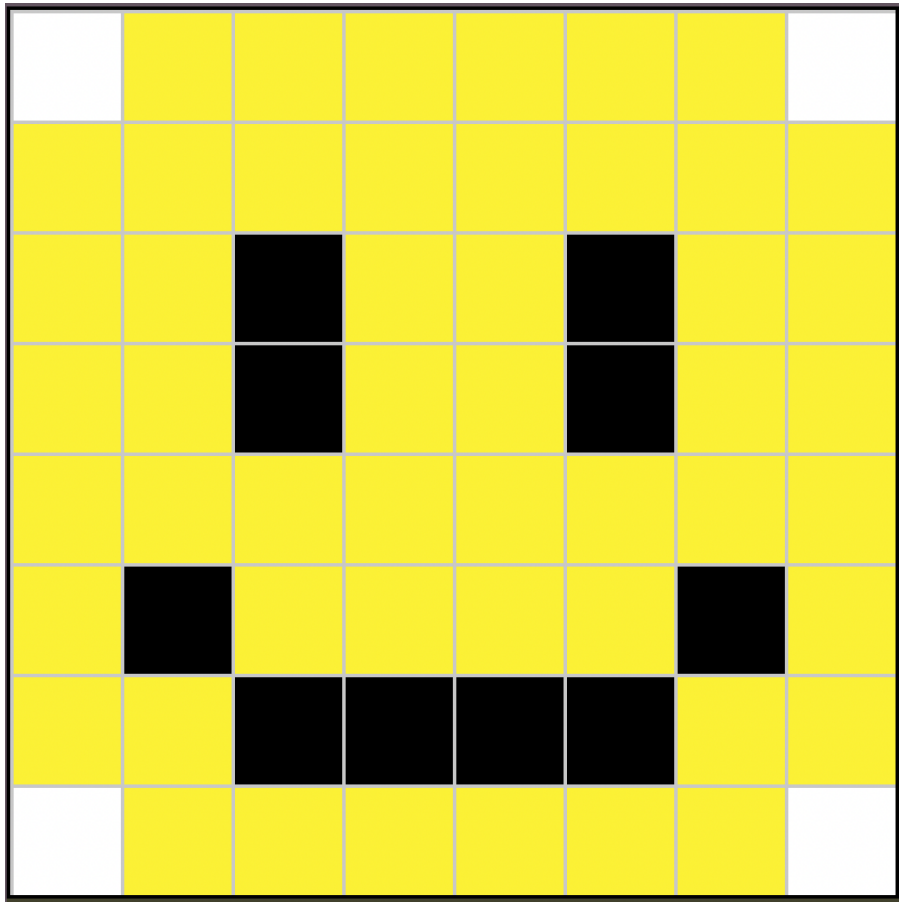
Vector Graphics

- Vector graphics scale to any size without quality loss
- Defined by rendering instructions and mathematical representation rather than pixel data
  - SVG Files (Scalable Vector Graphics)
  - Representation format is usually XML (eXtensible Markup Language)
- Written using a vector graphics image editing program like Inkscape or coded/defined manually (example)
- Need to be translated or “rasterized” to pixel data to be shown on your screen

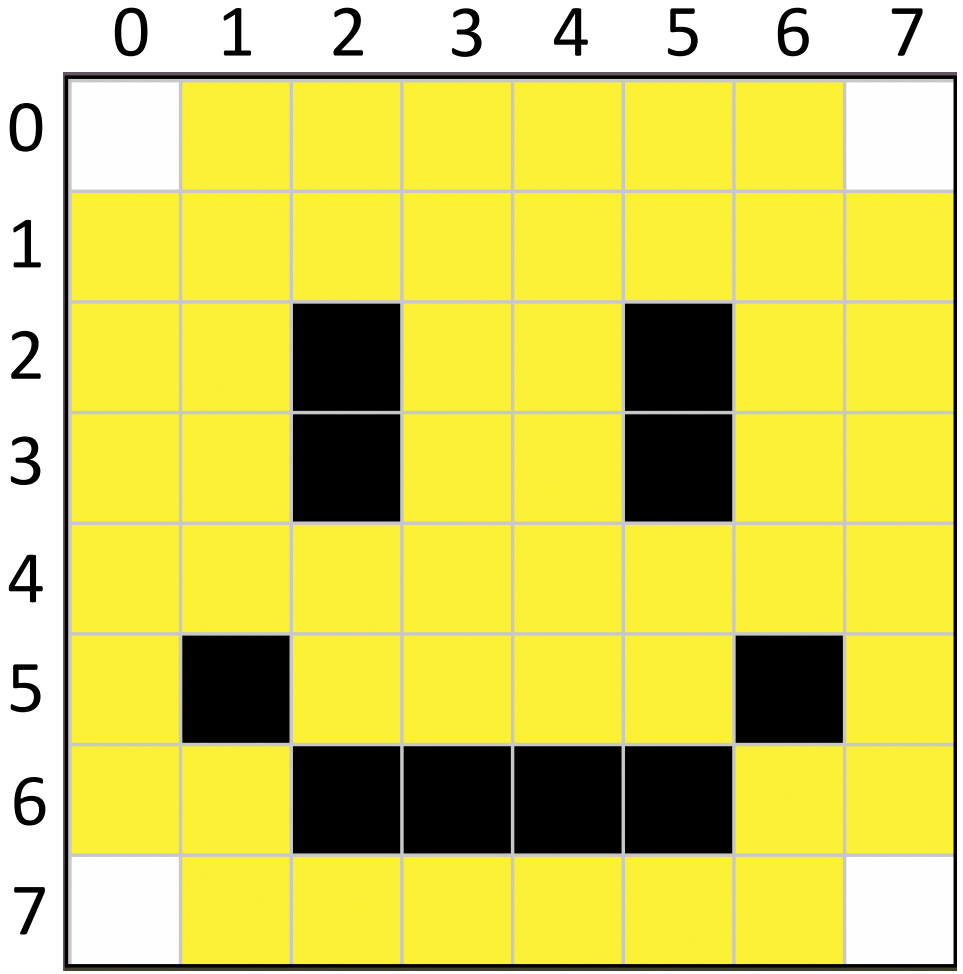
Storing Raster Images



Storing Raster Images



Storing Raster Images



Storing Raster Images

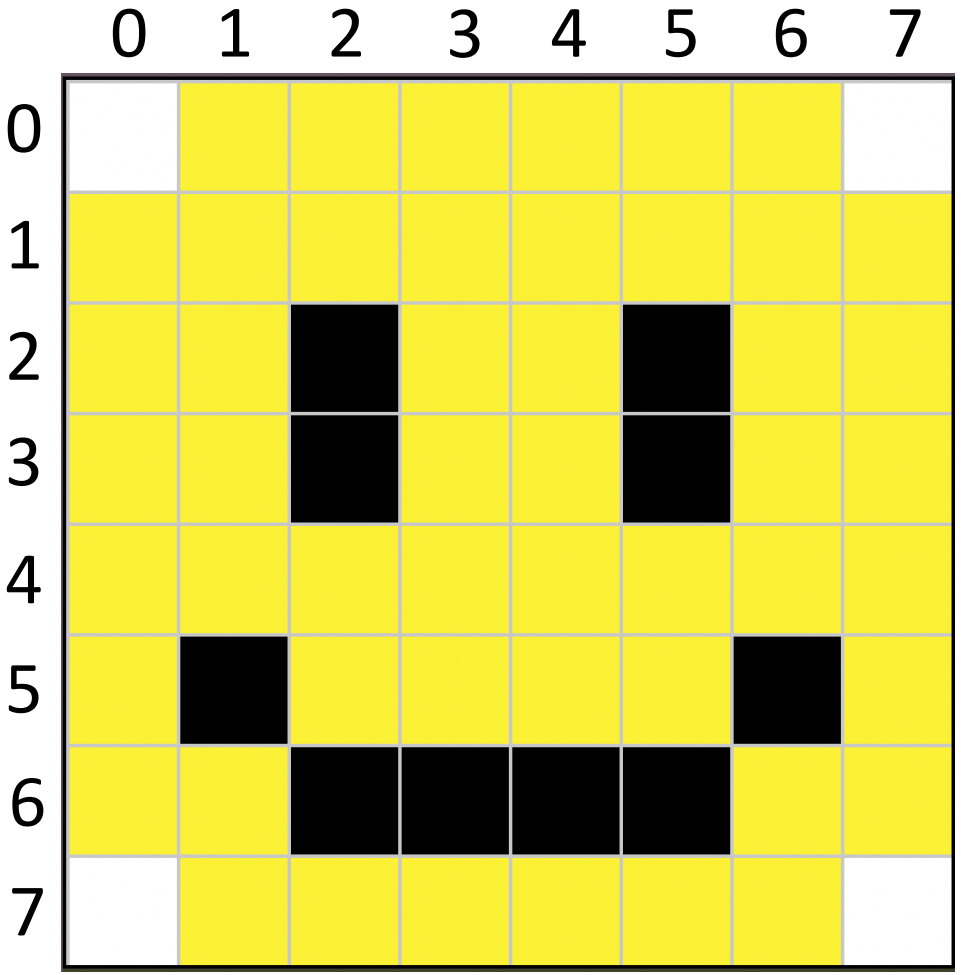
Can access via:

- (x, y)
- (column, row)

(0, 0)

(3, 2)

(5, 2)



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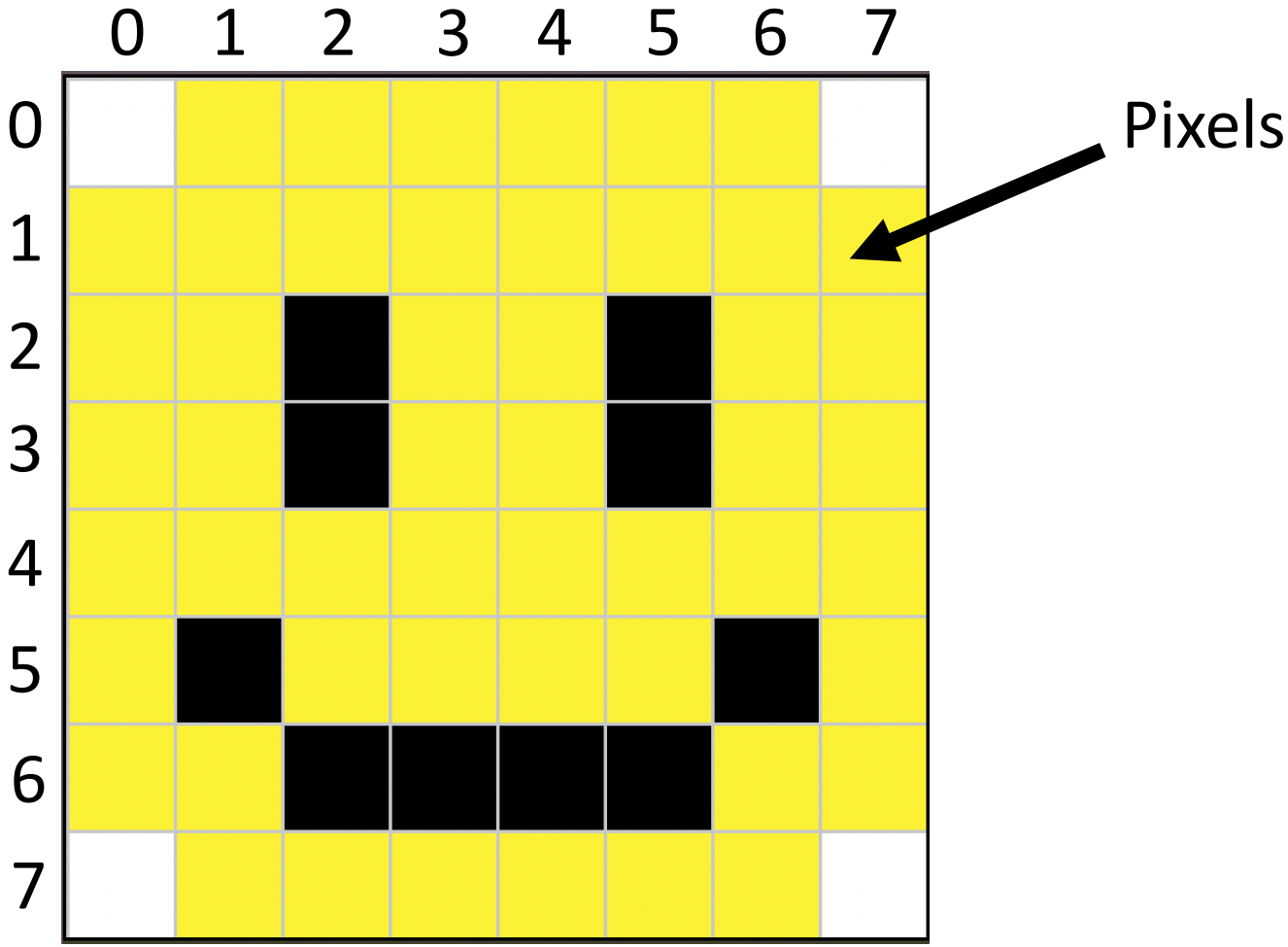
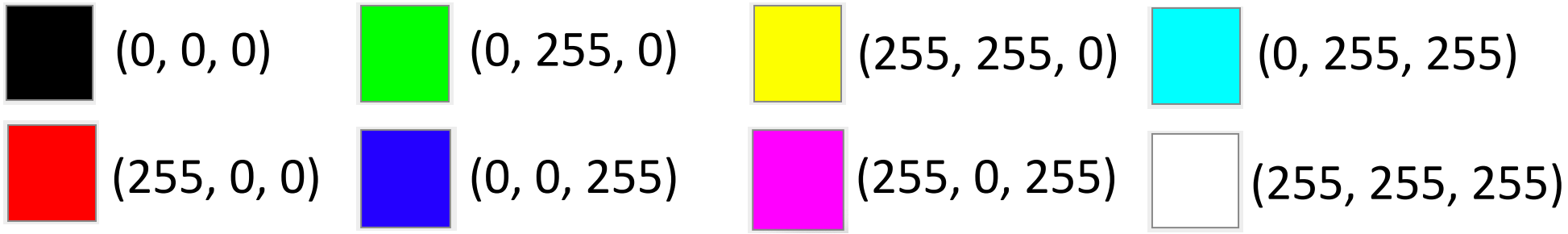


Determining Color

- Each color value or **channel** is stored as a number in triplet
  - (R, G, B)

- Assuming each possible value ranges from 0 – 255
  - Each color value is made up of 8 bits (0000 0000 – 1111 1111)
  - 24-bits total
  - Can increase this to 32-bits to encode an **alpha channel** (transparency)



The Binary Encoding

- Color Values

(113, 220, 185) → Binary: (0111 0001, 1101 1100, 1011 1001)
Hexadecimal: #71DCB9

- Image Sizes
  - An image that is 800 x 600
    - 480,000 pixels * 24-bits per pixel
    - 1,440,000 bytes (1.44 megabytes)
  - A 4K image is 24,883,200 bytes (24.88 megabytes)

Kilobyte = 1,000 bytes
Megabyte = 1,000,000 bytes