IMAGE FORMATS

Prof. Wright | COMD 3662

COMPRESSION

- **compression** - the process that encodes files to use less disk space

- online media (images, audio, video) is virtually always compressed

- most images online are compressed via the JPEG, GIF, and PNG formats
  - WEBP is new(ish) and still relatively rare online, but you're likely to see a *lot* more of it over the next few years

COMPRESSION PROS/CONS

- **benefits of compressing files:**
  - smaller file size = faster downloads
 - uses less memory and storage
- **drawbacks:**
  - *technically* the computer needs to work harder to decode highly compressed files
    - this only matters for *very* simple computers (like the $5 Pi Zero)
  - new compression formats have inconsistent support
    - for example, WEBP is the currently most versatile and efficient image format, but Safari only recently started supporting it
    - some browser versions remain popular for years after they become obsolete, which makes new formats more complicated to use

BITMAP ≠ BMP

- **bitmap** images are rectangular grids of pixels
  - also known as raster graphics (from *rastrum*, Latin for "a rake")
  - came from process used with early CRT monitors, which "rake" images into horizontal lines rather than individual pixels
  - all raster image formats (JPG, GIF, etc.) are bitmap images…
  - …but the term "bitmap" is often used to refer to uncompressed raster images, usually in BMP format
- **BMP** is an uncompressed* bitmap format
  - assigns full RGB values for each pixel in the image
  - perfect image reproduction but very high file sizes
  - despite file size, BMP was well-suited to the limited processing power of early PCs because no graphics adapter was necessary
    - all the information needed to display the image is contained within the image file
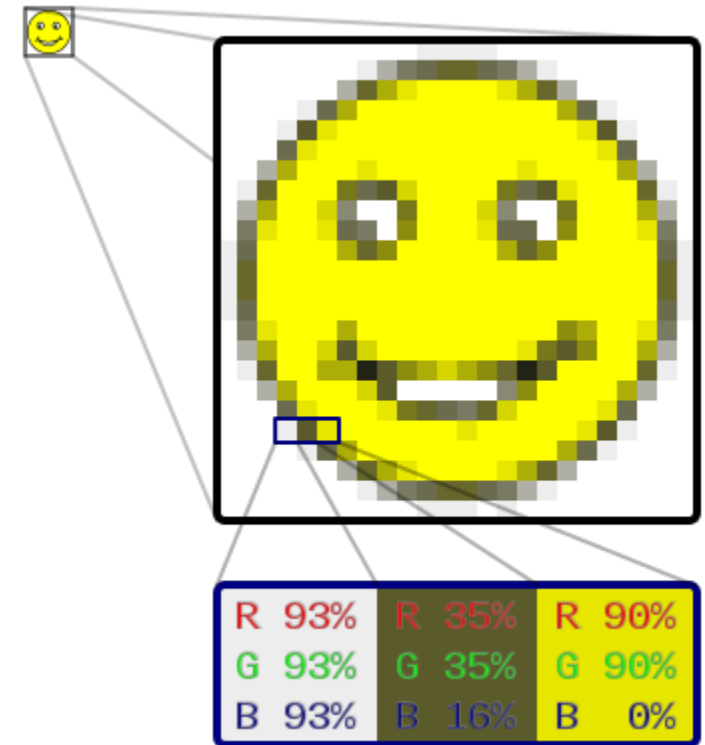
***technically* BMPs can be compressed by limiting their color range, but this is rarely an issue in web design

ENCODED BMP


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0xff, 0xff, 0xff, 0xff, 0xff, 0xf9, 0xff, 0xff, 0xff, 0xff, 0xf0, 0xff, 0xff, 0xff, 0xff, 0xff,
0xfe, 0xff, 0xff, 0xff, 0xff, 0xf0, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0x7f, 0xff, 0xff, 0xff,
0xf0, 0xff, 0xff, 0xff, 0xff, 0xe1, 0xff, 0x3f, 0xff, 0xff, 0xff, 0xf0, 0xff, 0xff, 0xff, 0xfc,
0x00, 0x3f, 0xbf, 0xff, 0xff, 0xff, 0xf0, 0xff, 0xff, 0xff, 0xfe, 0x00, 0x1f, 0xbf, 0xff, 0xff,
0xff, 0xf0, 0xff, 0xff, 0xff, 0xfc, 0x00, 0x0f, 0xbf, 0xff, 0xff, 0xff, 0xf0, 0xff, 0xff, 0xff,
0xfc, 0x00, 0x0f, 0xff, 0xff, 0xff, 0xff, 0xf0, 0xff, 0xff, 0xff, 0xfc, 0x00, 0x09, 0xff, 0xff,
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0xf0, 0xff, 0xff, 0xff, 0xff, 0x80, 0x0f, 0xff, 0xfc, 0xf8, 0x1f, 0xf0, 0xff, 0xff, 0xff, 0xff,
0x80, 0x1f, 0xf9, 0xfc, 0xf1, 0x1f, 0xf0, 0xff, 0xff, 0xff, 0xff, 0x80, 0x1f, 0xf9, 0xf9, 0xf3,
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0xf0, 0xff, 0xff, 0xff, 0xf8, 0x0f, 0xff, 0xff, 0xcf, 0x9f, 0x1f, 0xf0, 0xff, 0xff, 0xff, 0xf8,
0x1f, 0xff, 0xff, 0x8f, 0x3f, 0x3f, 0xf0, 0xff, 0xff, 0xff, 0xfc, 0x00, 0xff, 0xff, 0x9e, 0x3e,
0x3f, 0xf0, 0xff, 0xff, 0xfe, 0x3c, 0x00, 0x7f, 0xff, 0x1e, 0x7c, 0x7f, 0xf0, 0xff, 0xff, 0xfc,
0x00, 0x0c, 0x7f, 0xff, 0x1e, 0x78, 0xff, 0xf0, 0xff, 0xff, 0xff, 0x00, 0x0e, 0x7f, 0xff, 0x1c,
0x78, 0xff, 0xf0, 0xff, 0xfe, 0xff, 0xf0, 0x07, 0x7f, 0xff, 0x3c, 0x71, 0xff, 0xf0, 0xff, 0xf7,
0x7f, 0xff, 0x81, 0xff, 0xff, 0xf8, 0xe3, 0xff, 0xf0, 0xff, 0xf9, 0xff, 0xff, 0xc1, 0xff, 0xff,
0xfd, 0xc3, 0xff, 0xf0, 0xff, 0xfe, 0xff, 0xff, 0xe0, 0xff, 0xff, 0xff, 0xc7, 0xff, 0xf0, 0xff,
0xc7, 0x3f, 0xff, 0xf0, 0xff, 0xff, 0xff, 0x8f, 0xff, 0xf0, 0xfe, 0x01, 0x89, 0xff, 0xf4, 0x7f,
0xff, 0xf0, 0x8f, 0xff, 0xf0, 0xff, 0x80, 0xc6, 0x7f, 0x7c, 0xff, 0xff, 0xf0, 0x1f, 0xff, 0xf0
```

INDEXED COLOR
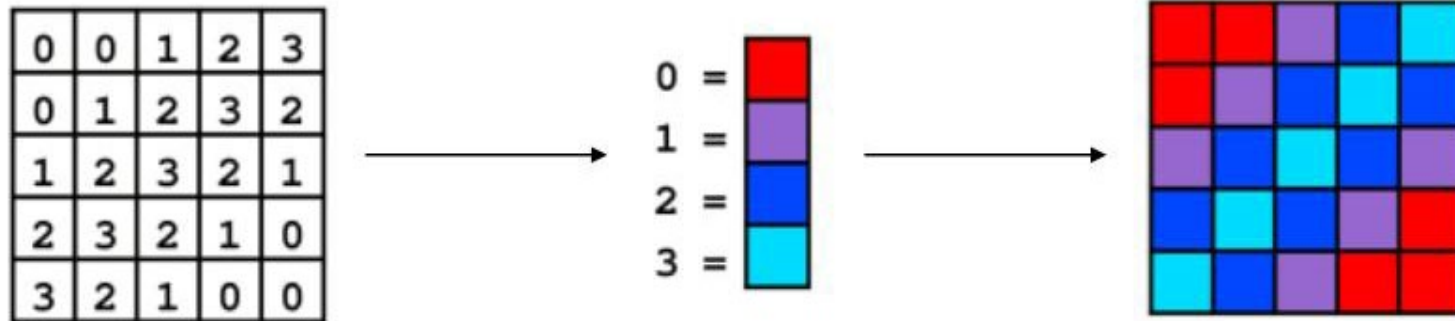
- **indexed color** - assigns numerical values to a limited number of colors (*color table*), and assigns each pixel with one of those values
  - think of it as paint-by-numbers for pixels
  - fewer colors used = smaller file size
  - great for images with limited color range, esp. graphics
 - standard (8-bit) color tables have a two-color minimum and a 256-color maximum

TRUE COLOR

- **true color** - each pixel encoded with red/green/blue (RGB) channels for monitor display
  - individual RGB values range from 0 to 255
  - hexadecimal codes combine these three values into one number:

    #FF0000 = FF 00 00 = R(255) G(0) B(0)
- also called 24-bit color, since each value for R, G, and B takes 8 bits of data to encode

GIF TRANSPARENCY

- **GIFs can display transparency in addition to color**
    - encodes an "empty" color on its color table
    - pixels assigned this color display as clear/transparent when the image is rendered in a browser
- **GIF transparency is *binary***
    - pixels are either a solid color or totally transparent, nothing in between
    - can result in a jagged edge between solid and transparent pixels (see right):

1024 x 529 px; 41KB in JPEG format
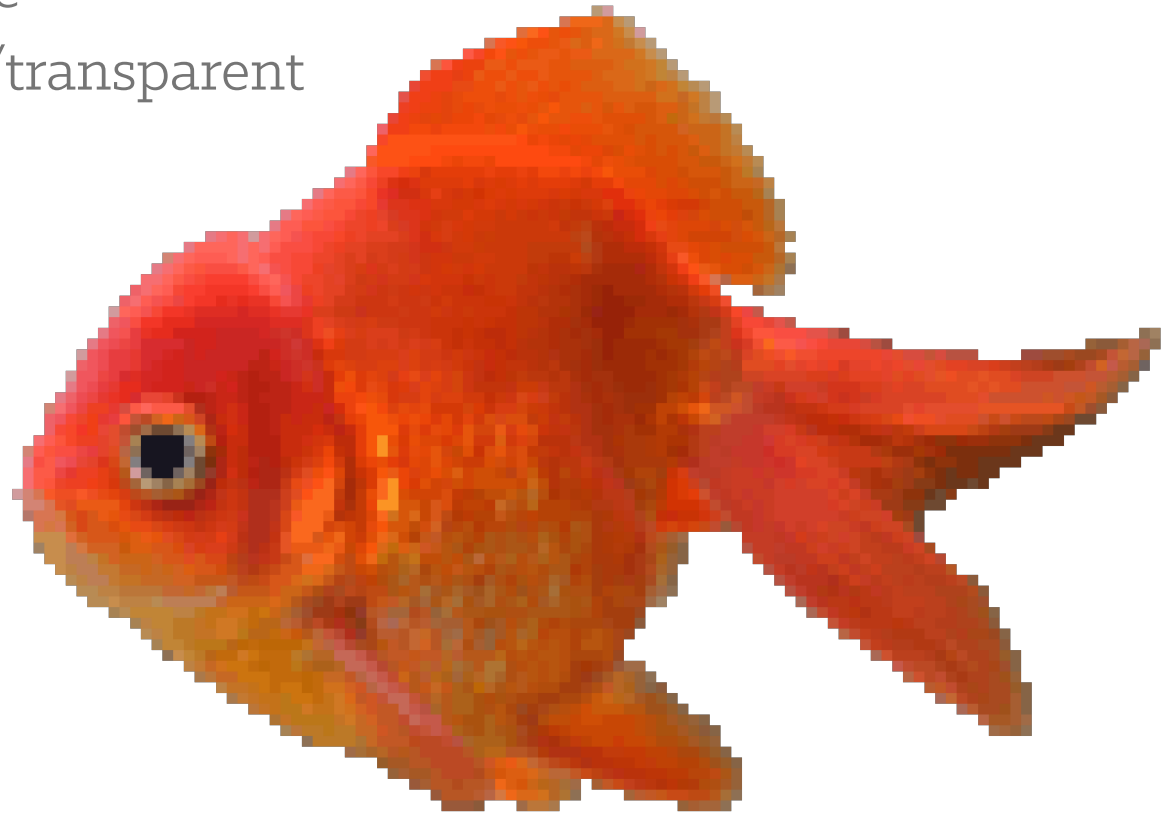
Azul Brazilian Airlines logo, 2011

256-COLOR GIF

35 KB

20% smaller file than original JPEG

64-COLOR GIF

25.9 KB

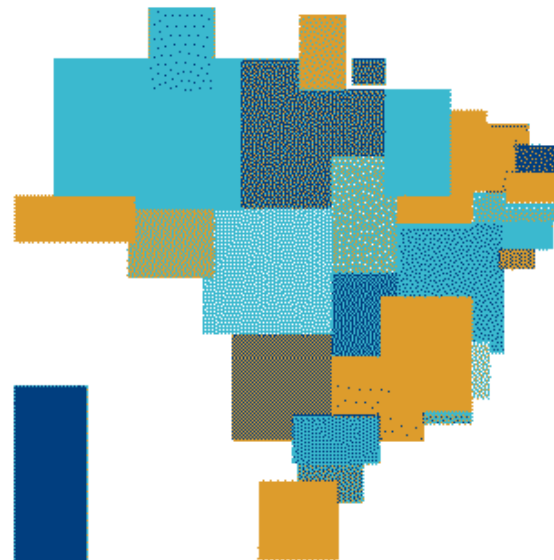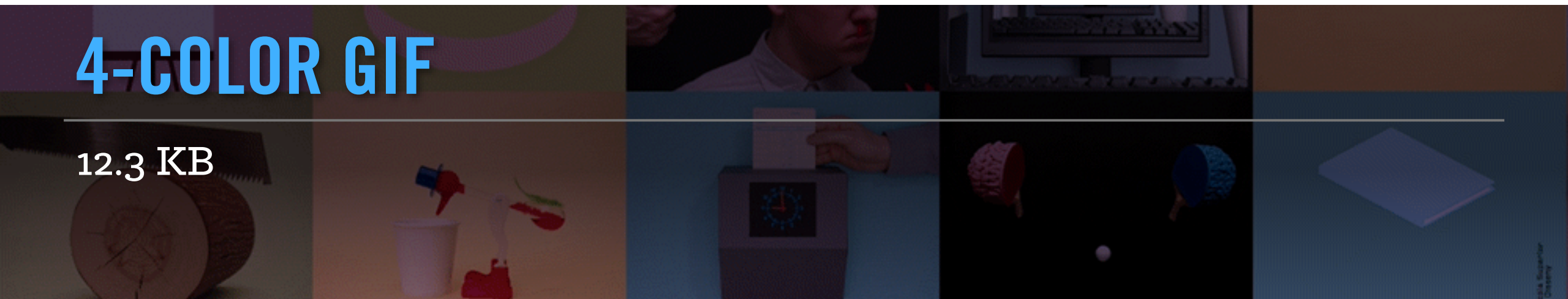**32-COLOR GIF**

21 KB

4-COLOR GIF

12.3 KB

JPEG | FORMAT BASICS

- Joint Photographics Experts Group
  - no difference between JPG and JPEG
- ideal for photographs and illustrations/complex graphics
- file compression settings control *downsampling* of the image
  - high compression trades image quality for smaller files
- JPEG is a **lossy** format
 - image data is lost every time a file is re-saved

JPEG COMPRESSION

- JPEG takes advantage of how the human eye perceives color
  - we see differences in *luminosity* (light and dark) better than differences in color
- JPEG compression uses the G (green) channel to reference luminosity, and changes its data as little as possible
- the R (red) and B (blue) channels are combined* and broken into blocks, which average out differences between individual shades
  - *this is a simplification but essentially what happens in the process
- **artifacts** are blocks or streaks of color caused by compression
  - ideally JPEG compression is invisible to the naked eye...
  - ...but artifacts are common in images that have been highly compressed or opened and resaved (which repeats the lossy compression process)
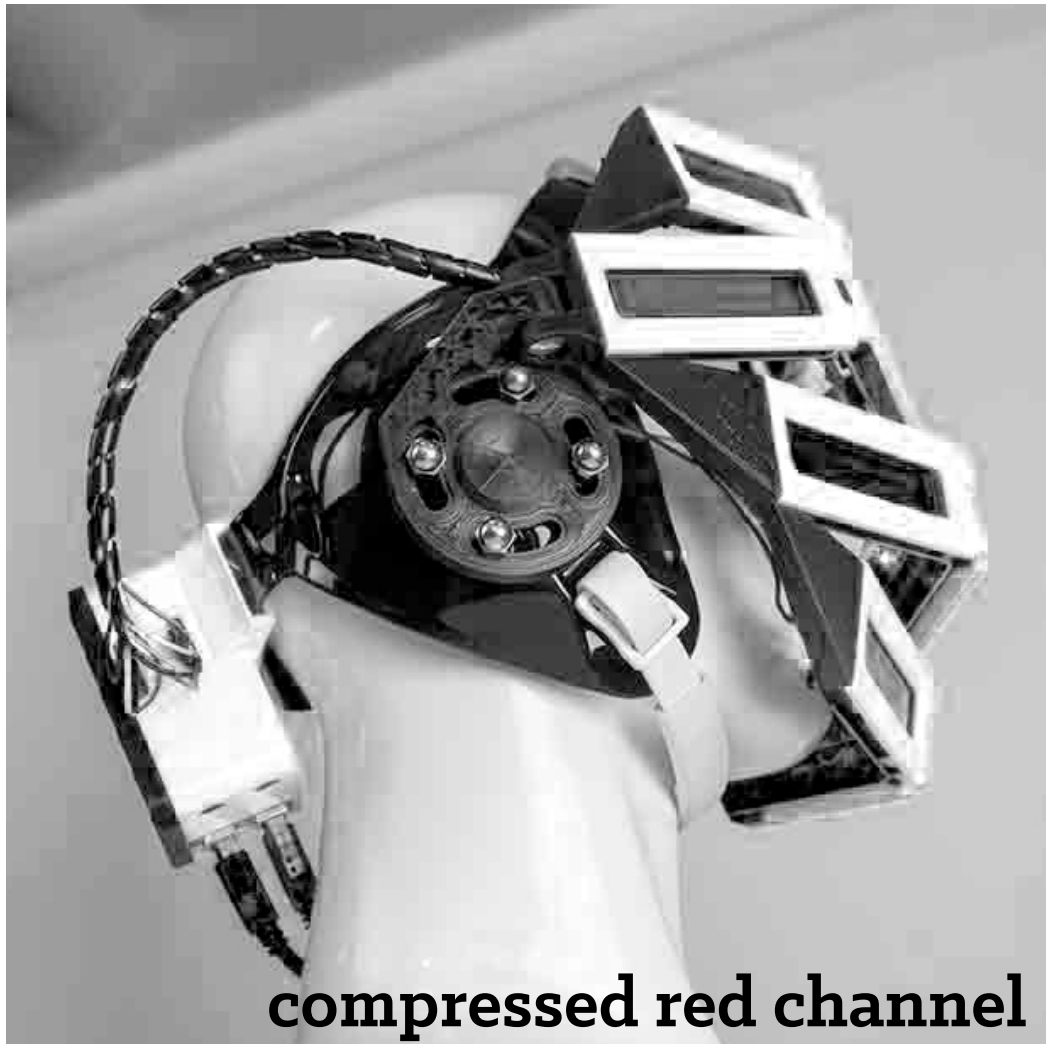
JPEG COMPRESSION DEMO
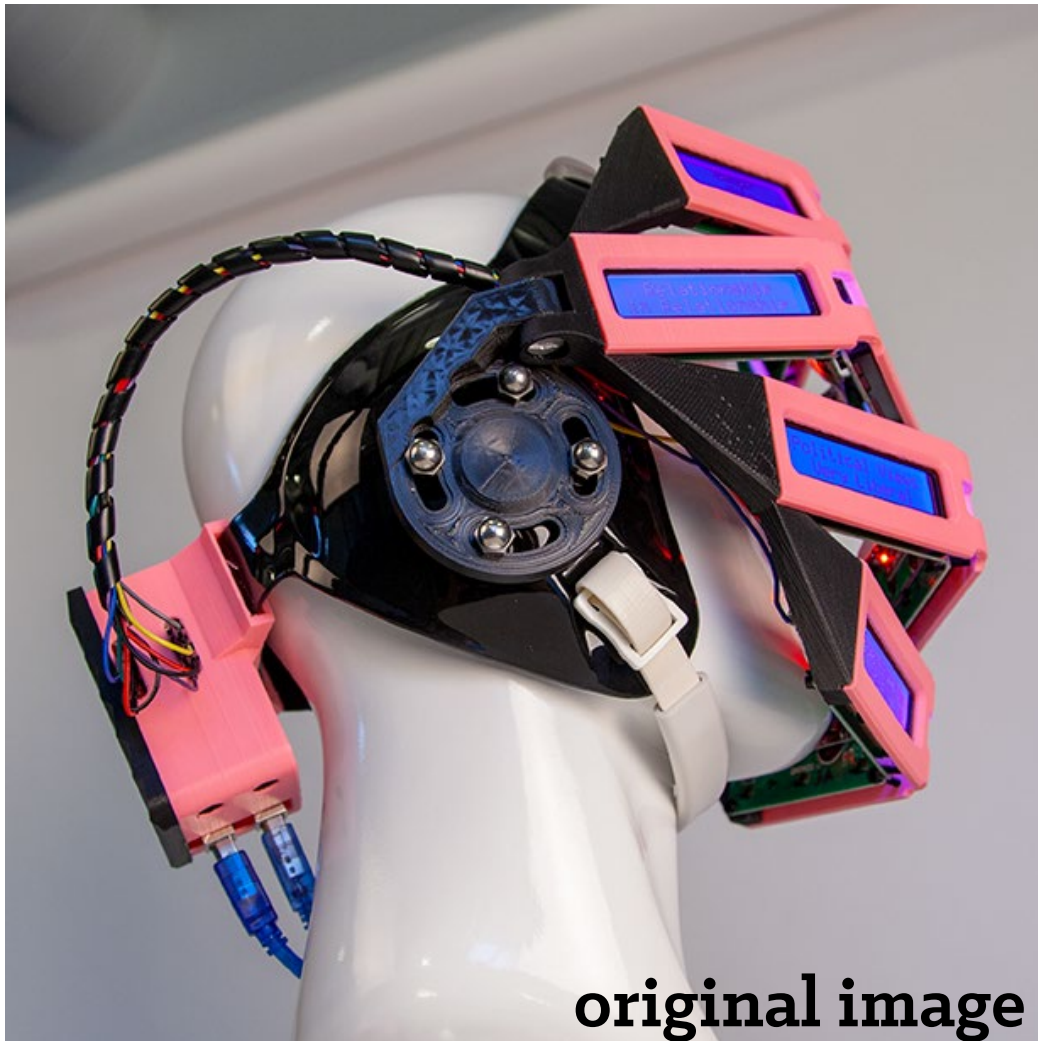
original image
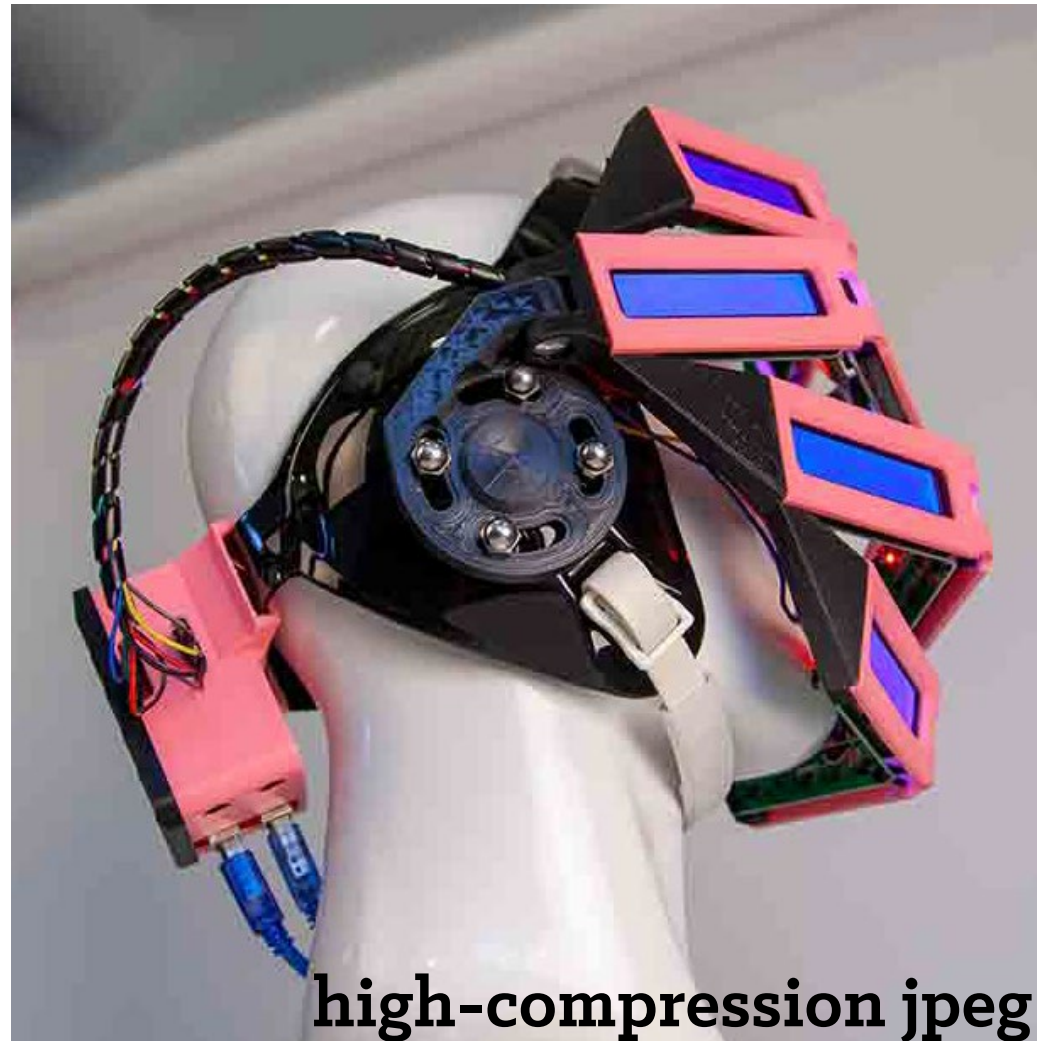
high-compression jpeg

original red channel

compressed red channel

GREEN CHANNEL

original green channel
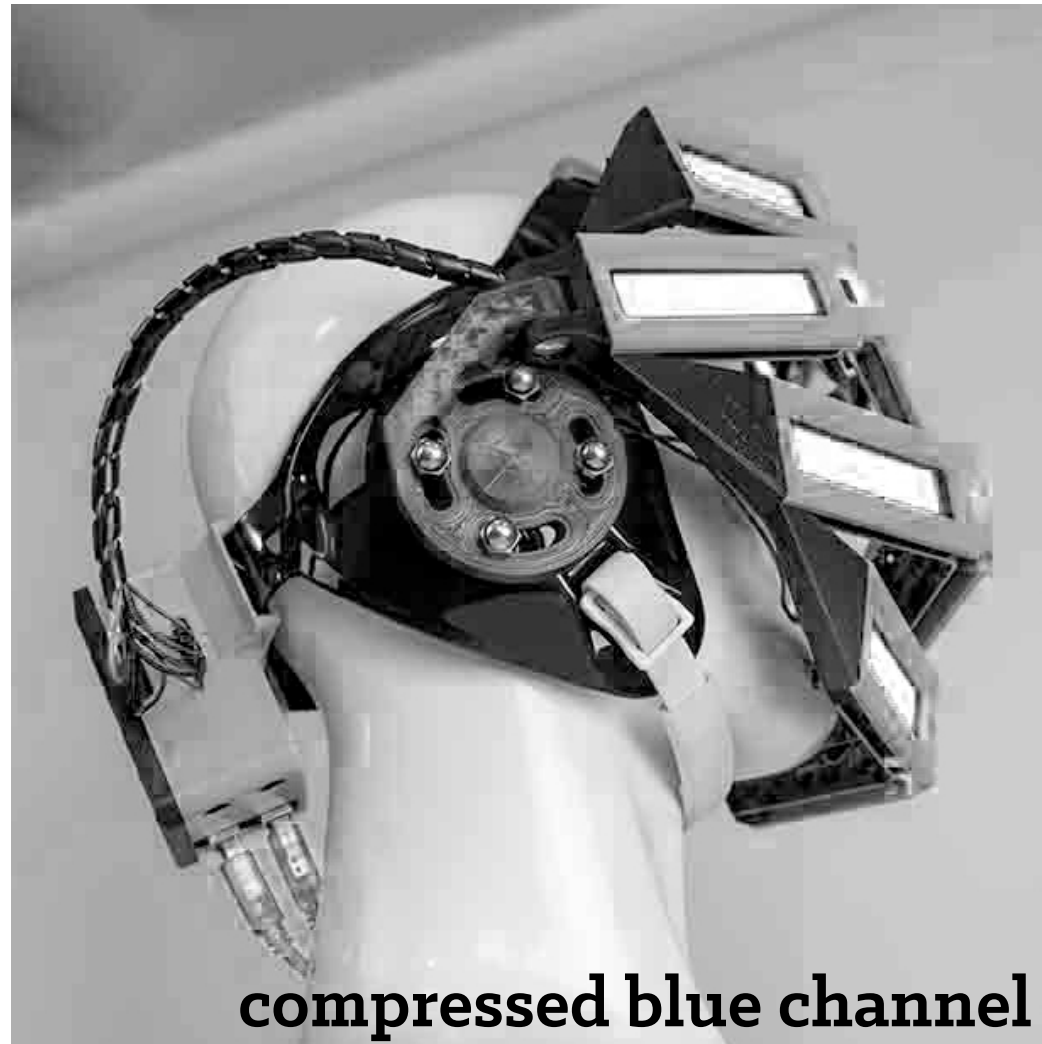
compressed green channel

BLUE CHANNEL

original blue channel

compressed blue channel

PNG | FORMAT BASICS

- Portable Network Graphics
- can use indexed color OR true color
  - PNG-8 is 8-bit indexed color (like GIF)
    - uses a color table with 256 max slots
  - PNG-24 is 24-bit true color (like JPEG)
    - encodes RGB values
- all PNG compression is lossless
  - no data is lost opening and re-saving PNGs(!)
- PNG-24 encodes **alpha** in addition to RGB values
  - the **alpha channel** encodes transparency
  - this color mode is also called RGBA
  - adding an alpha channel technically makes the file 32-bit, but it's still a PNG-24
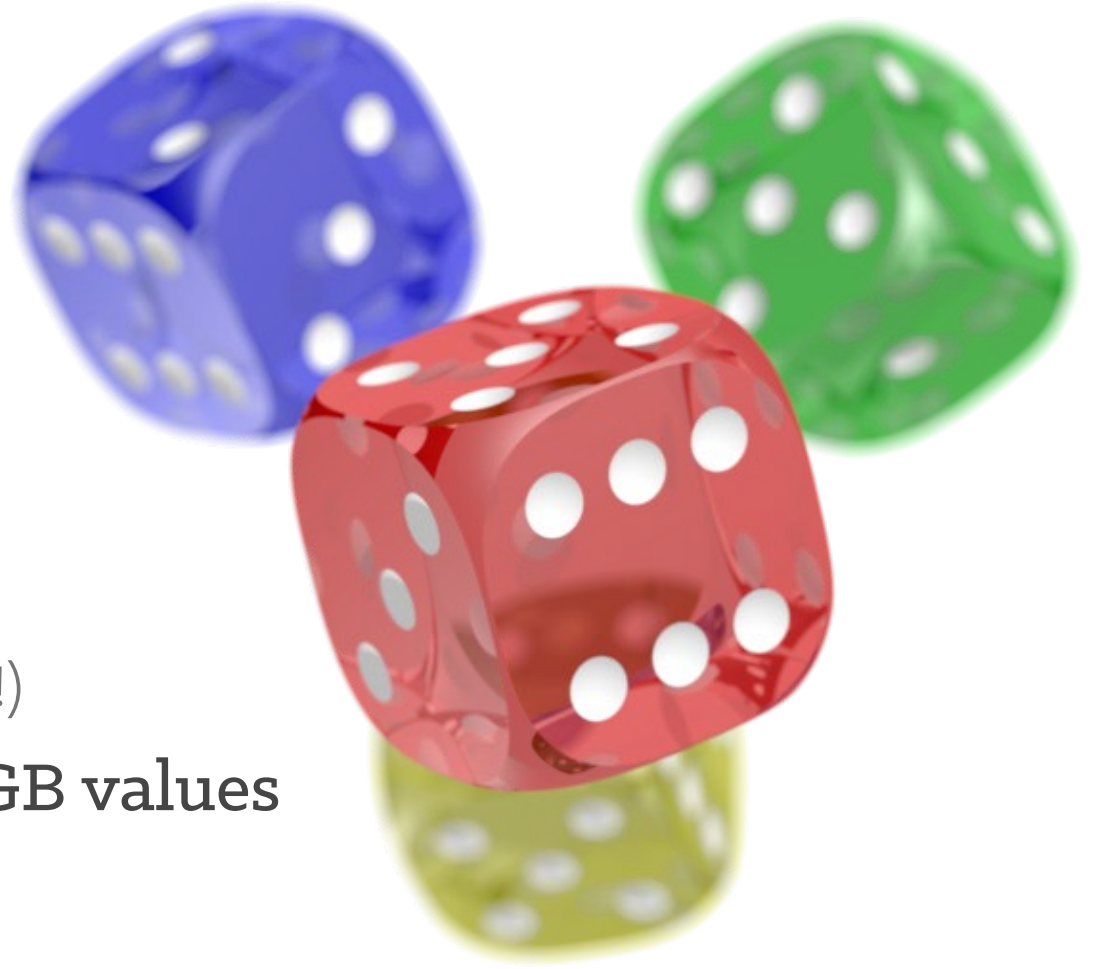
TRANSPARENCY: GIF vs PNG

GIF, 256 colors, 48.9 KB

PNG-24, true color, 241.3 KB

- **GIF has jagged, pixelated edges**
  - due to GIF's *binary transparency* - each pixel is either "on" or "off"

- **PNG blends more smoothly, but file is much larger**
  - PNG-8 uses indexed color (like GIF), can't do variable transparency

GIF vs PNG-8

*GIF, 256 colors, 17.9 KB*

PNG-8, 256 colors, 12.6 KB

- PNG-8 files are usually smaller than equivalent GIFs
- no perceptible difference in quality or image fidelity

WEBP | FORMAT BASICS

- pronounced "weppy"

- developed by Google, originally as more efficient replacement for JPEG

- supports animation, lossy and lossless compression, and transparency
  - like JPEG, GIF and PNG combined

- based on a video compression technique called *block prediction*
  - it guesses the content of a pixel based on its neighbors
  - big savings from static (non-moving) sections of animations...
  - ...and areas with similar colors in still images (walls, skies, etc.)

WEBP COMPATIBILITY
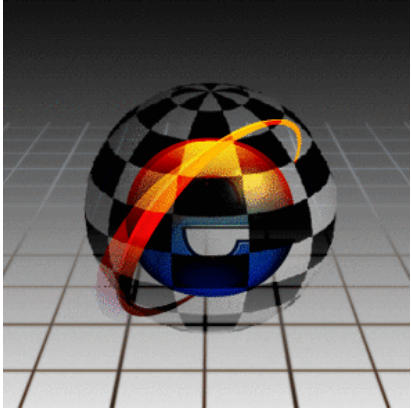
- if WEBPs are so much better than other image formats, why aren't they everywhere?

- for a media to widely adopted, it needs *universal native support* - it needs to work automatically, in all browsers, without any extra files or plugins

  - most browsers supported WEBP starting in 2015, but Safari did not until Fall 2020
  - before then, any site using WEBP images would not load properly on iPhone/iPad

- WEBP can be enabled for "legacy" browsers with a JS plugin

  - it's not always possible to add JS plugins to commercial sites, since most are built with *content-management systems* (CMS) that limit changes to core site architecture

SVG | SCALABLE VECTOR GRAPHICS

- SVG is a versatile format for using vector graphics online
  - has basic advantages of vector files: infinitely scalable, small file size, load quickly
  - also supports animation and interactivity

- based on XML (extended markup language)
  - like HTML, XML is designed to be easily understood by both humans and machines
  - this also means SVG files are usually very small

- SVGs contain text data instead of image data
  - they can be created and edited with most text-editing programs
    - rather than graphics software like Illustrator
  - they also have their own element <svg> for encoding them directly in your HTML

WHAT'S A VECTOR, ANYWAY?

- vector graphics are defined in terms of points on a cartesian plane
  - **cartesian plane** - two-dimensional space defined by x and y coordinates
- points are connected by mathematically expressed lines and curves; every vector shape is essentially a bunch of complex equations graphed out like algebra
- since vector images are defined mathematically (rather than by pixel), they can be infinitely scaled up or down with no loss in quality
- first used by US Military in 1958 as part of the SAGE air defense system
  - *vector* also means the flight path of an aircraft

7x Magnification

Vector

Disclaimer: Product contains neither ice nor cream. May contain trace elements of cheese. Do not consume.

Ice Cream

er ice
nts

Bitmap