# Ch 3: Images

## Overview

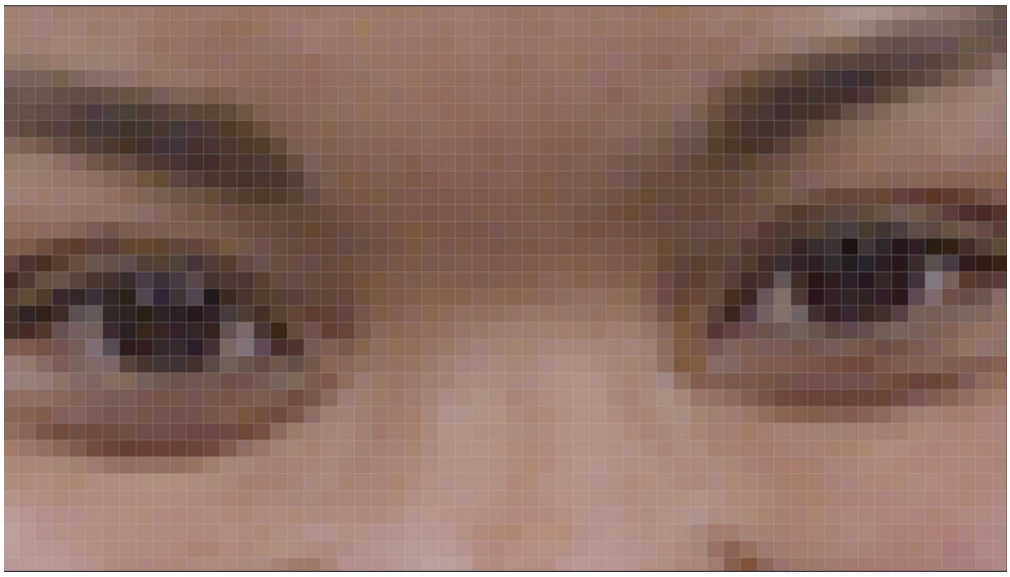
Images are stored as a number of file types, including but not limited to bitmaps (.bmp), JPGs (.jpg), PNGs (.png), and GIFs (.gif). Each type of file has its advantages and disadvantages, limitations, and more. In this module, we will explore different types of images, and learn about how Hollywood lies to them.

## Demonstration Ideas

- Get class to name off different types of image files
- Show picture in PS and blow up really big

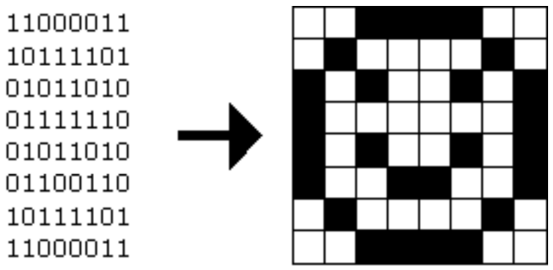
## Notes

- Now, if we try to zoom in on an image, we'll eventually see the pixels that it's made of. But since images are represented as a finite number of bytes, we can't possibly see details that aren't already captured. We see something like this:



  - Each grid is a pixel, since an image has a finite size and thus finite information in it.

- A black and white smiley face might be represented in binary like this:




  - With the bit `1` to represent black and `0` for white, we can create a "bitmap" image.

- The bitmap format is like the JPEG format for images, except that JPEGs use compression, which makes images smaller by using fewer bits, and throwing away some of the information. And JPEG files all start with the same three bytes, `255`, `216`, `255` as a standard, to indicate its filetype.
- We translate those decimal numbers into hexadecimal, we get `0xff`, `0xd8`, and `0xff`
- Knowing this, we can recover JPEGs (if files were deleted but not overwritten) from raw binary data, in a similar way to detecting strings (with a starting value and an ending value).
- Bitmap files, with the extension BMP, are older and less efficient since they don't have compression. But they are easier to work with since each pixel has some number of bytes.
- The file header, or what should go at the beginning of the file, of BMPs look like this:

| offset | type | name | |
|---|---|---|---|
| 0 | WORD | bfType | BITMAPFILEHEADER |
| 2 | DWORD | bfSize | |
| 6 | WORD | bfReserved1 | |
| 8 | WORD | bfReserved2 | |
| 10 | DWORD | bfOffBits | |
| 14 | DWORD | biSize | BITMAPINFOHEADER |
| 18 | LONG | biWidth | |
| 22 | LONG | biHeight | |
| 26 | WORD | biPlanes | |
| 28 | WORD | biBitCount | |
| 30 | DWORD | biCompression | |
| 34 | DWORD | biSizeImage | |
| 38 | LONG | biXPelsPerMeter | |
| 42 | LONG | biYPelsPerMeter | |
| 46 | DWORD | biClrUsed | |
| 50 | DWORD | biClrImportant | |
| 54 | BYTE | rgbtBlue | RGBTRIPLE |
| 55 | BYTE | rgbtGreen | |
| 56 | BYTE | rgbtRed | |
| 57 | BYTE | rgbtBlue | RGBTRIPLE |
| 58 | BYTE | rgbtGreen | |
| 59 | BYTE | rgbtRed | |
| ... | | | |
| 243 | BYTE | rgbtBlue | RGBTRIPLE |
| 244 | BYTE | rgbtGreen | |
| 245 | BYTE | rgbtRed | |

  - Files are just a sequence of bits, and if we think of each byte as having some offset from the beginning, we can specify exactly what should be in a file for it to be valid.
  - We see a few fields we might be able to guess the values for, like `biWidth` and `biHeight`.
  - But the most interesting part is the repeating sequence at the end, an `RGBTRIPLE` comprised of three bytes that each represent the colors blue, green, and red. With those three colors in various amounts, we can display millions of different colors.

- Difference between png and jpg
    - Portable Network Graphics (**PNG**) is a raster graphics **file format** that supports lossless data compression. **PNG** was created as an improved, non-patented replacement for **Graphics Interchange Format** (GIF) and is the most widely used lossless image compression **format** on the Internet.
    - **JPG** is a file extension for a lossy graphics file. ... JPEG stands for Joint Photographic Experts Group who created the standard. **JPG** files have 2 sub-formats, **JPG**/Exif (often **used** in digital cameras and photographic equipment), and **JPG**/JFIF (often **used** on the World Wide Web).
    - This makes it useful for storing photographs at a smaller size than a BMP. **JPG** is a common choice for use on the Web because it is compressed. For storing line drawings, text, and iconic graphics at a smaller file size, GIF or **PNG** are **better** choices because they are lossless.

## Thought Questions

1. Why do bitmaps have headers?
2. Why should we ever use something that is not a .png?
3. Why are JPGs not always the best file type?