Back to Bits
Announcements

• Lab 4 due tomorrow at midnight
  - Ninja session tonight
Today

• How do we convert graphics and videos to digital storage format?

• Colors and animation in Zelle graphics library
Bits and Bytes

• Recall that a **bit** is the smallest unit of digital storage, always in one of two states: 0 or 1.

• A **byte** is 8 bits, so one byte can have $2^8 = 256$ possible states.

  - 00110100, 00110101, 00110110, …
How much storage?

• A boolean: one bit

• Ints and floats: it depends, but with only 4 bytes we can represent all the ints from -2,147,483,647 to 2,147,483,648

• Strings: using ASCII encoding there are 128 possible characters, so a string needs 7 bits per character.
Graphics

- A digital image is a grid of **pixels**. Each pixel is a tiny square filled in with a particular color.

- Digital colors are defined by how red, green, and blue they are, each on a scale from 0 to 255.

- So one pixel needs 3 bytes. And a 6 megapixel photo (a 2000 x 3000 grid of pixels) needs 18 MBs, or roughly 18 million bytes.
Digital video is a rapidly changing series of images, something like 60 frames (or images) per second.

For 1080p HD video, it’s 60 2.1-megapixel images per second. One second of video thus requires:

- \( 60 \times 2.1\text{M} \times 3\text{B} = 378 \text{ MB} \).

A minute of footage would be \( 60 \times 378 \text{ MB} = 22 \text{ GB} \)! But that’s more than the memory on many smartphones.

In fact compression takes advantage of redundancy brings this number way down. *The Martian* in HD is less than 6GB (including audio).
Colors in Zelle graphics

• In the GraphWin constructor, we specify the width and height of our grid of pixels.

• Use the color_rgb(red, green, blue) function to generate any color you want.

• Or use one of the pre-defined colors. To explore these colors, use the colorPicker as described on reference page.
Animation

• Use the `sleep(seconds)` function from the `time` library to do animation in Python.

• The `sleep` function will pause your program for the specified number of seconds (usually a fraction of a second). After that short pause you can move graphics objects by some small distance.

• If the interval and distance are small enough, these discrete steps create the illusion of smooth motion.
Examples