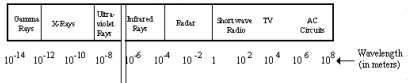
Images

- The Science of Images
  - What is an Image on the computer?
- The Psychology of Images
  - What do we use images for?
  - What effect color has on our mood and perception?
- The Technology of Images
  - How do you use and manipulate images?
  - Images in Director

The Science of Images:
B&W Image Representation

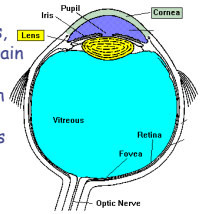
- An image is represented as a 2D array of pixels
  - Its dimensions: **w** pixels wide by **h** pixels high
- Each **pixel** is a small square on the screen
- **Resolution**: How many pixels a screen can represent
- Each pixel has a **color** associated with it
- If the color can be either **black or white**, then one needs only 1 bit per pixel
  - 1 = black; 0 = white
- **Size** of a B&W image: w * h * 1 bits = (w * h)/8 B
  - A 640 x 480 BW image takes 38,400 B = 37.5 KB (1KB = 1024 B)

The Science of Images:
How do we see what we see?

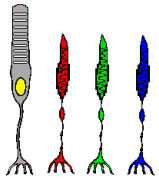


"Light" is a small portion of wavelengths of electromagnetic waves.
As these waves enter the eye, they excite the cones and rods in the retina,
and through the nerve, they inform our brain

Light is continuous, but our brain can distinguish about 10M colors



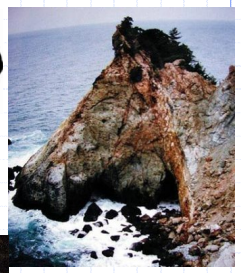
Cones are color-sensitive
Rods are intensity-sensitive

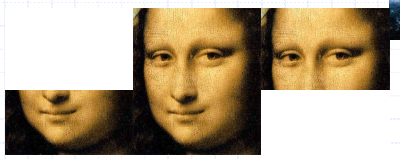


Our visual system...

- ...is not very

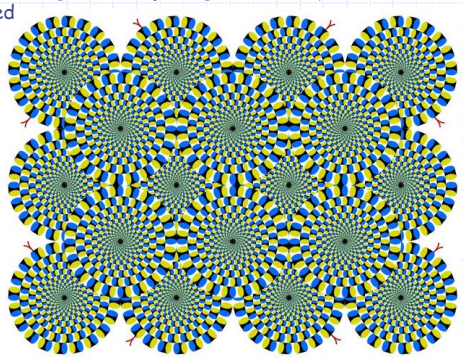
at distinguishing details



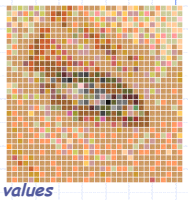


Our brain...

... is correcting and readjusting what the eye sees but it may get confused



The Science of Images:
Color Image Representation



- We can produce every visible color (and then some) by its Red-Green-Blue **RGB** percentage composition
  - (R, G, B) = (100%, 0%, 0%) is a fully saturated **red**
  - (R, G, B) = (0%, 50%, 0%) is a half-saturated **green**
  - (R, G, B) = (50%, 50%, 50%) is a medium gray
  - (R, G, B) = (100%, 100%, 100%) is
  - (R, G, B) = (0%, 0%, 0%) is black
- Then, we can represent every visible color by 3 RGB ***values***
- The value **scale** has 256 different values, 0 ... 255
  - (R, G, B) = (255, 0, 0) is a fully saturated **red**
  - (R, G, B) = (0, 128, 0) is a half-saturated **green**
  - (R, G, B) = (128, 128, 128) is a medium gray
  - (R, G, B) = (255, 255, 255) is
  - (R, G, B) = (0, 0, 0) is black
- But why 256 R, 256 G, 256 B values? Why not, say, 128 of each?

Bit depth

- Since each color value is a number between 0 and 255 and we use 8 bits to represent such a number, we use 8+8+8=24 bits to fully represent **all** RGB colors
- How many different colors do we represent? 2^{24} = _____
- Are they enough?
- **Size** of a "true-color" image: w * h * 24 bits = (w * h*24)/8 B
  - A 640 x 480 color image takes 921,600 B = **900** KB!
- The number of bits used in an image is called the **bit-depth**
- For true-color, bit-depth is 24
- But we can represent images using fewer colors (e.g., with smaller bit depth)

So, red = 111111110000000000000000
How about tangerine?

- Can U remember tangerine=111111111001100100000000
- Humans find it difficult to remember 24 bits in a row ;-)
  - (Computers have no such problems)
- Humans can more easily remember 6 characters
  - (e.g., phone numbers)
- We can group 4 bits at a time to a new symbol
- With 4 bits we have 16 different symbols (which ones?)
- Hexadecimal! The ultimate geek talk
- So, what is **tangerine** in Hex?

Decimal	0	1	...	9	10	11	12	13	14	15	16	17	18	...
Hexadecimal	0	1	...	9	A	B	C	D	E	F	10	11	12	...

What the hex?

- To read a hex color number, break it into 3 groups of 2-digit hex
  - FF0000 = (255, 0, 0) is a fully saturated **red**
  - 008000 = (0, 128, 0) is a half-saturated **green**
  - 808080 = (128, 128, 128) is a medium gray
  - FFFFFF = (255, 255, 255) is
  - 000000 = (0, 0, 0) is black
- By the way, your browser may not be able to show every color

The Technology of Images:
Compression Formats

- **24 bits** (bit-depth) are enough to represent up to **16 million** different colors
- A particular photograph, even though it may be very colorful, it may not need all 24 bits to be represented because it will likely not use all of them
- **JPG** is a **compression** format that allows the image to be stored using far fewer than 24 bits/pixel
- When we save an image "as jpg" we actually compress it.
- As a result, the **quality** of the image will **degrade** so that the compression image may lose some of its quality
- There are several **levels** of jpg compression and most people may not be able to tell the difference (see http://www.wellesley.edu/Chemistry/Flick/jpgquality.html)

The Technology of Images:
Limited Palette Image Representation

- If we use fireworks or director to create a drawing, we likely are going to use far fewer than 16 million colors
- **GIF** is a image format that uses only 256 colors (it determines the best 256 colors for the image)
- A **gif** image uses only 1 Byte/pixel, plus the table to remember which particular 256 colors it uses (its "**palette**")
- When **importing** a gif image in Director, we are also importing its palette - which goes into the palette channel
- See http://cs.wellesley.edu/~cs215/Lectures/L07-ImagesColorTheory/cfan2_digicolor.html

Experiment in Director

- Download and import images with few and many colors
- Transform bitmaps from the imported 32 bits to 16 bits, to 8 bits (options: remap colors or dither)
- Save and Compress to observe differences in file sizes

* you are here