CMPT 165
Graphics – Part 1

June 12th, 2015

Today's Agenda

- File formats
  - Pro's and Con's
- Terminologies:
  - Image resolution
  - Color-depth
  - Color dithering
  - Compression
- Notes on coursework
  - Caution on academic dishonesty
  - Assignment 1 - marking scheme

Image Graphics – Part 1

File formats for storing graphics

Today we'll focus on these:

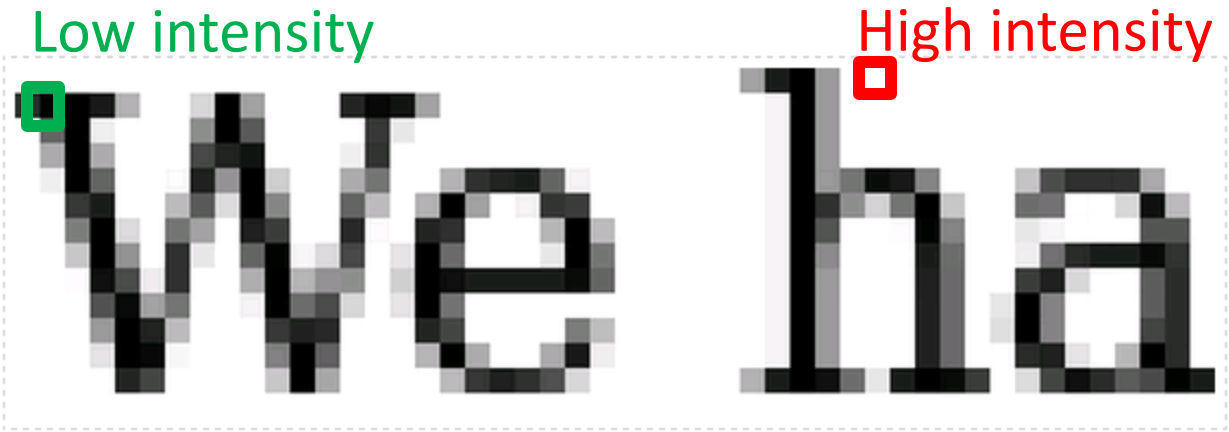
- GIF
- JPEG
- PNG
- …

Each use different strategies to store image data

…But what is image data?

Pixels

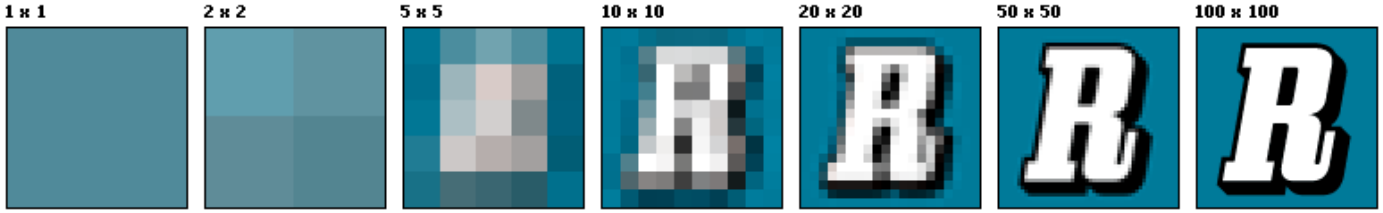
- Picture elements = Pixel (px)
- E.g.
  - Take screenshot of “We ha” (PrtScn button on keyboard)
  - A grid of pixels is stored:



- Each emits an amount of **intensity** (in physics, defined as amount of power transmitted through a surface)
  - High vs. low (strong vs. weak)

Image resolution

- **Image resolution**: refers to total number of pixels an image has
  - Represented as # of pixel columns by # of rows (width X height)
  - Historically:
    - High resolution: 1024 X 765 pixels
    - Lower resolution: any thing less
  - e.g.



https://upload.wikimedia.org/wikipedia/commons/f/f2/Resolution_illustration.png

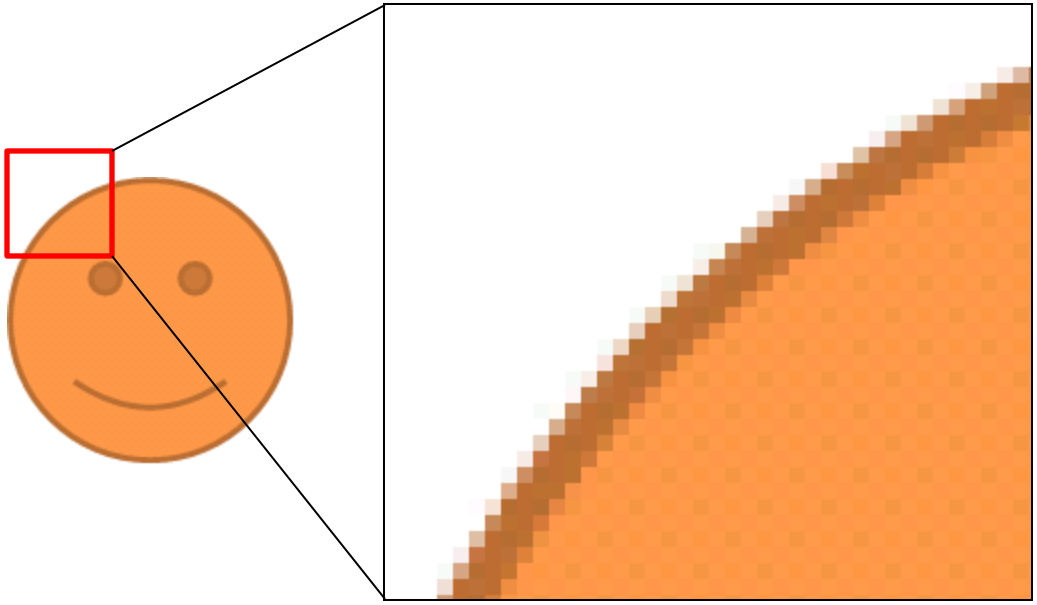
- Higher resolution → larger file size
- Unit of file size: bytes (kilo-, mega-, giga-)
  - E.g. 8MP camera

(MP: mega-byte pixel → 1 Mega = 10^{6})

  - Photo size: 3,264 X 2,448 pixels
    - (3,264 X 2,448) pixels X 1 bytes/pixel = 7,990,272 bytes → ~8 MB
    - Quite large!

Image resolution

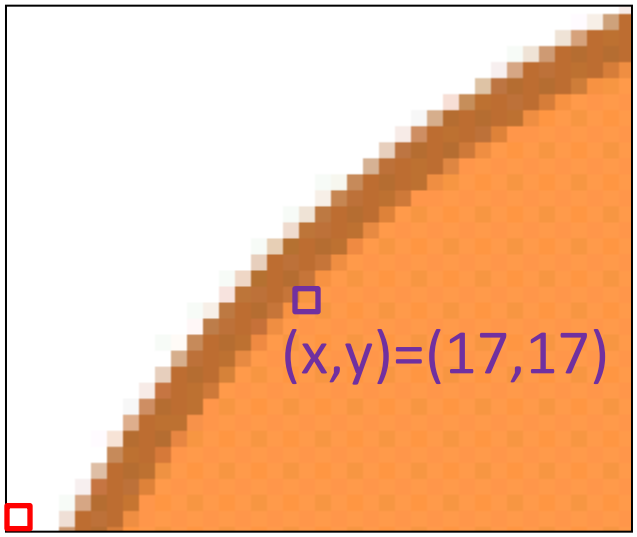
- **Pixelation:** artifacts you seen when you "zoom in"

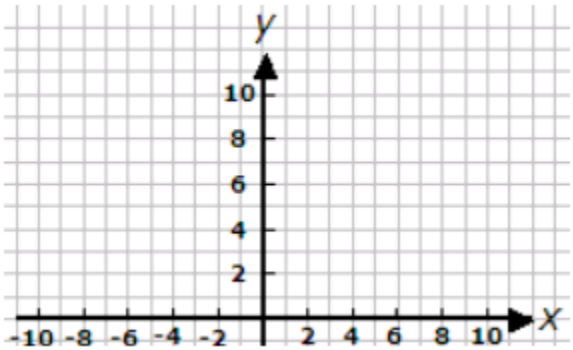


- There are countless **computer algorithms** to address this problem
  - Learn about them in, e.g., these courses:
    - Image processing (CMPT 419)
    - Computer graphics (CMPT 361)

Pixels

- Each pixel is indexed by **x-, y- coordinates**



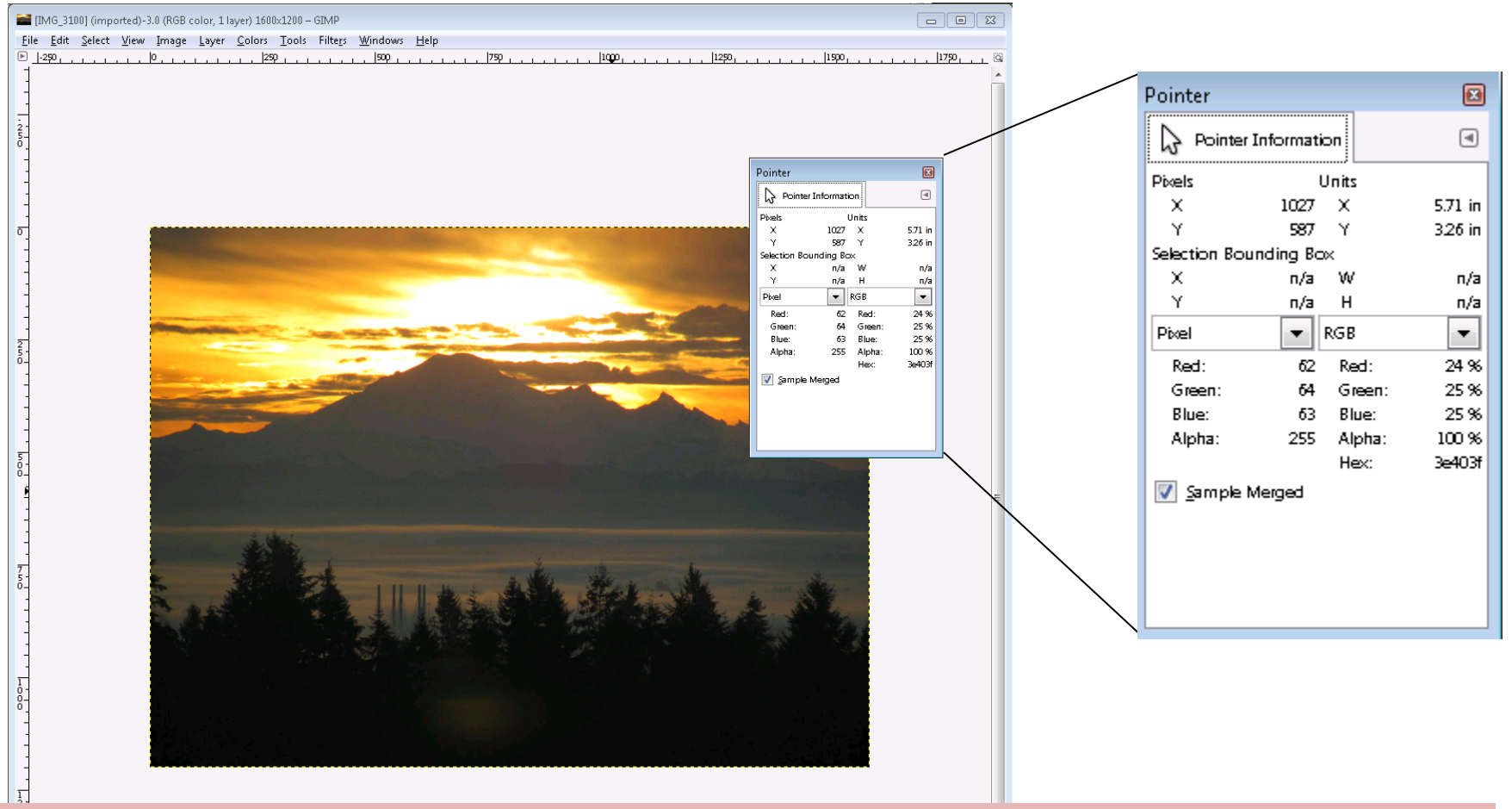


- Function notation: image *f*
  - *f*(x,y) gives a color intensity
  - E.g.

    f(0,0) = #000 (white)

    f(17,17) = #FA0 (orange)

Examining pixels in image editor



$f(x,y) = \#000$

Each pixel refers to color info, i.e. not coordinates!

Storing images

- Pixel: intensity value of a light source
- Each pixel has (x,y) coordinates
- Image: grid of pixels

- Using fewer bits to store each pixel is desirable…
  - Why? Smaller file size!

- How to store these info?
  - Depends on file format
    - Choice of color model & color-depth
    - Compression scheme (to reduce file size)
    - …

RGB Model & Color Depth

- Additive model: 3 channels of Red, Blue, Green
- **Color depth**: number of bits to represent a pixel

- In CSS, we can specify with a 24-bit color code:

  e.g. #**RRGGBB**

  Q: why 24?

  A: 24-bit=8 bits X 8 bits X 8 bits

- In actual files, depends on format used:
  - Some formats use 5 bits to encode each channel: $2^{(5x3)} = 2^{15}$
  - Some formats only use 8-bit for all 3 channels: $2^{(8)} = 256$

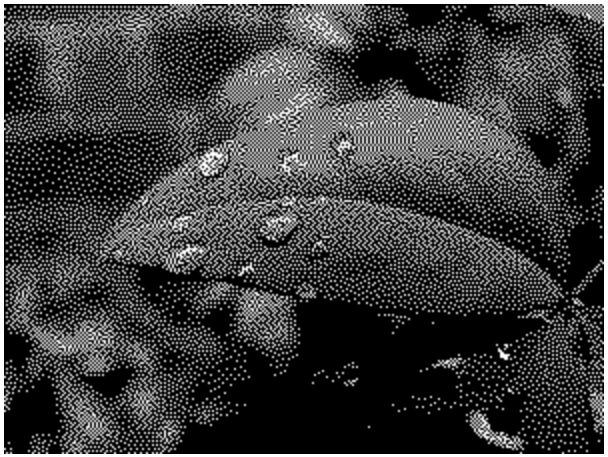
Storing colors

24-bit (256 X 256 X 256 colors)

known as monochrome (mono=1, chrome=color)

…Can be any color

1-bit?



4-bit color (2^4=16 shades)

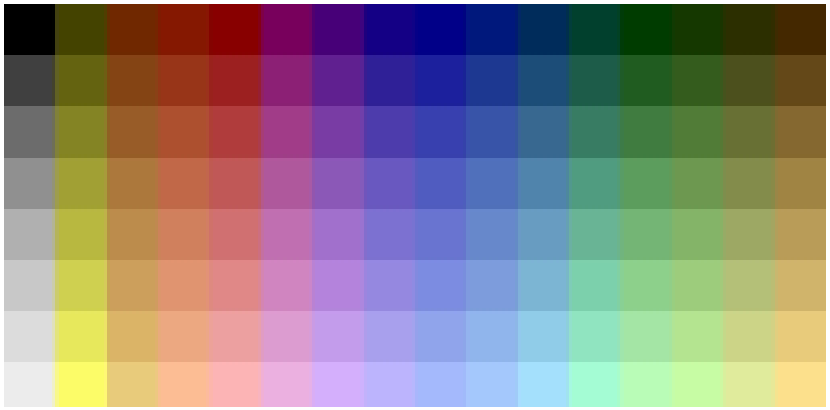
Examples from https://en.wikipedia.org/wiki/Dither

Examples

Color-depth of 7-bit → **colormap** of 128 choices:

16 shades →

8 shades ↓

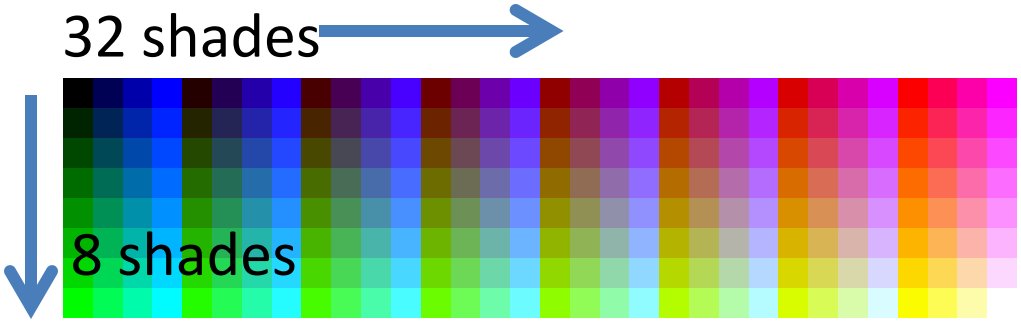


https://upload.wikimedia.org/wikipedia/commons/d/d1/Atari2600_NTSC_palette.png

Images from https://upload.wikimedia.org/wikipedia/commons/d/d1/Atari2600_NTSC_palette.png

Examples

Color-depth of 7-bit → **colormap** of 128 choices:



https://upload.wikimedia.org/wikipedia/commons/9/93/256colour.png

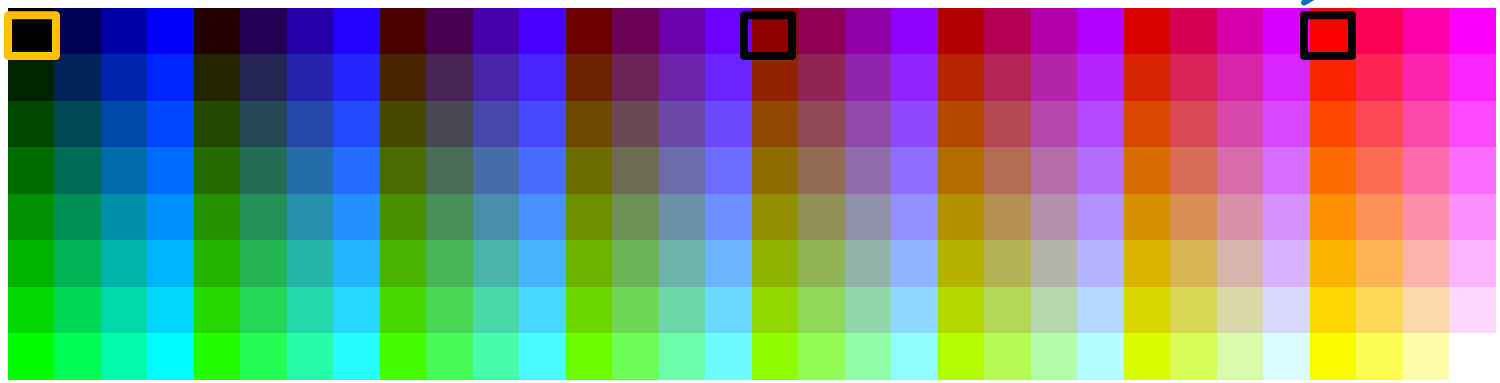
Images from https://upload.wikimedia.org/wikipedia/commons/d/d1/Atari2600_NTSC_palette.png

Indexed color

1st index

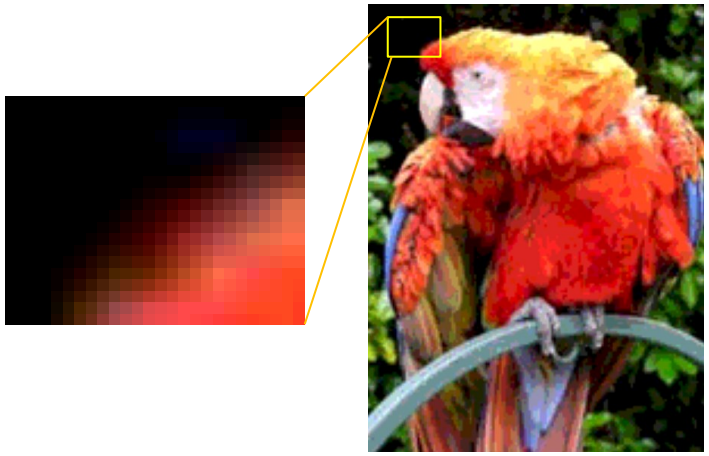
17th index

29th index



https://upload.wikimedia.org/wikipedia/commons/9/93/256colour.png

1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	17	17	17
1	1	1	1	1	1	1	17	29	29



Size/quality trade-off

- Fewer bits to store each pixel
  - ☺ → smaller file size
  - ☹ → quality suffers

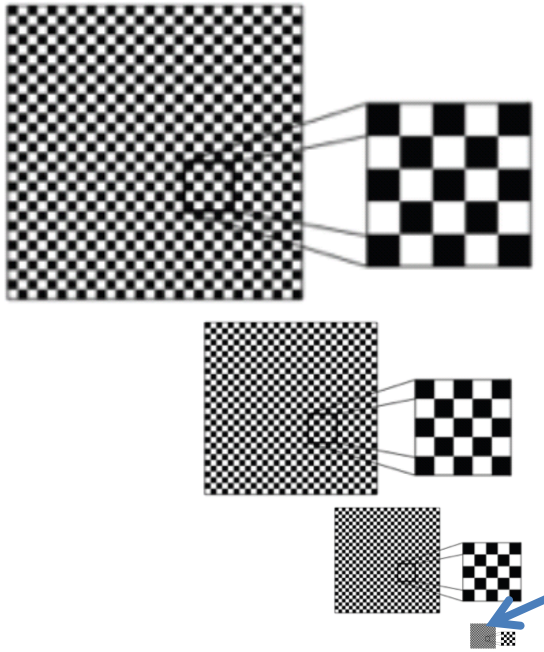
	GIF	JPEG	PNG
Color depth	8-bit	24-bit or 8-bit	24-bit

- Methods to deal with this trade-off:
  - Color-dithering
  - Compression

Color dithering

- **Dithering**: use of special patterns that involves interlacing a number of colors to allow perception of more color
- Allows viewer to **perceive** more colors
- E.g. 2 colors:

Fig. 5.2 of Study Guide

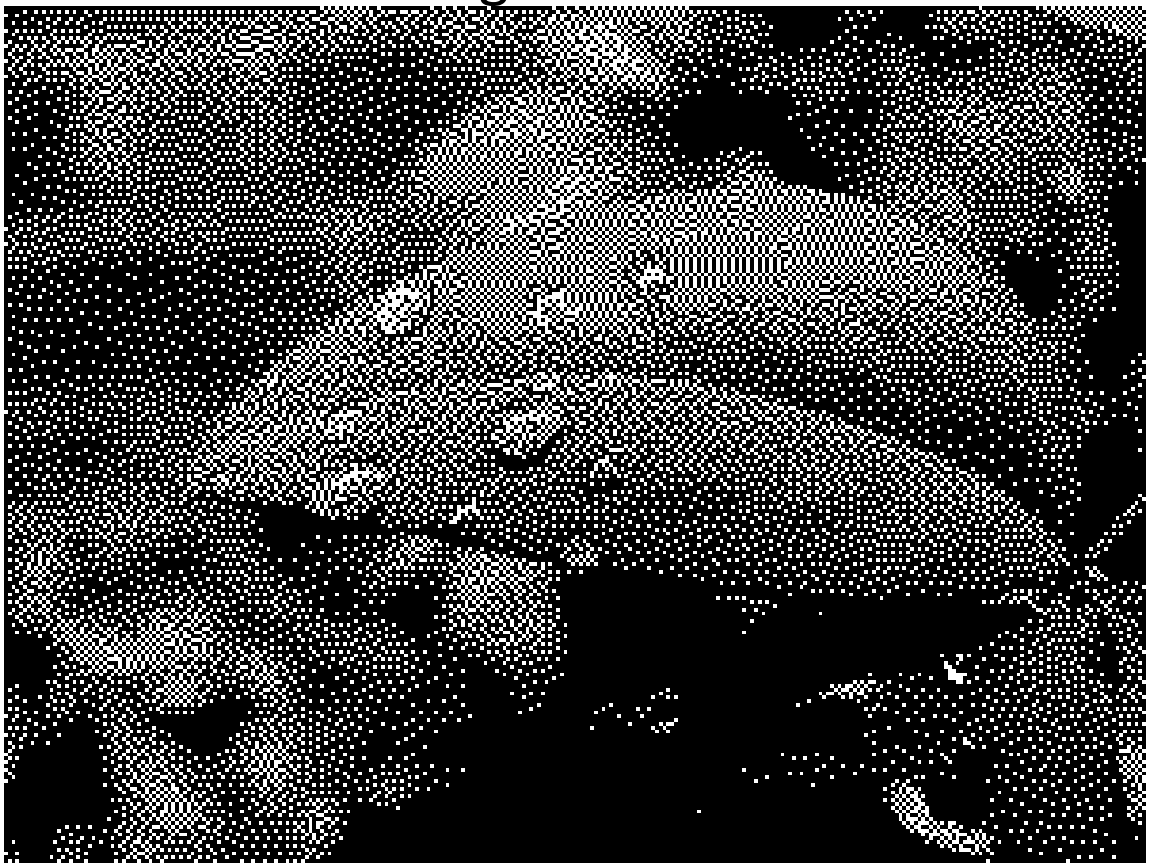


We can perceive gray by interlacing 2 colors (black + white)

Color dithering

24-bit (256 X 256 X 256 colors)

1-bit with dithering:

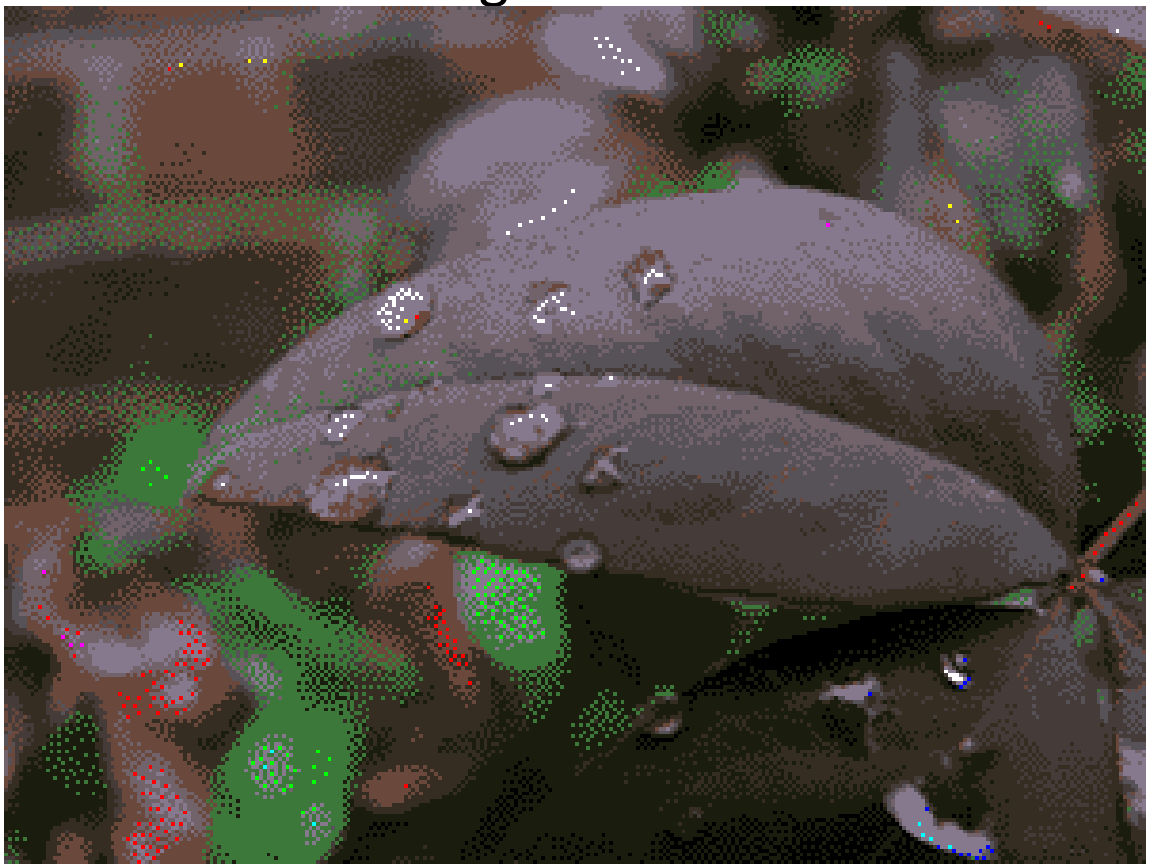


Examples from https://en.wikipedia.org/wiki/Dither

Color dithering

24-bit (256 X 256 X 256 colors)

4-bit with dithering:



Examples from https://en.wikipedia.org/wiki/Dither

Size/quality trade-off

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  - ☺ → smaller file size
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- Methods to deal with this trade-off:
  - Color-dithering
  - Compression

Compression

- Compression: a method to reduce file size
  - Many compression algorithms (computer programs) exist
  - Algorithms work by exploiting some properties of the image
    - E.g. leverage redundancies in pixels

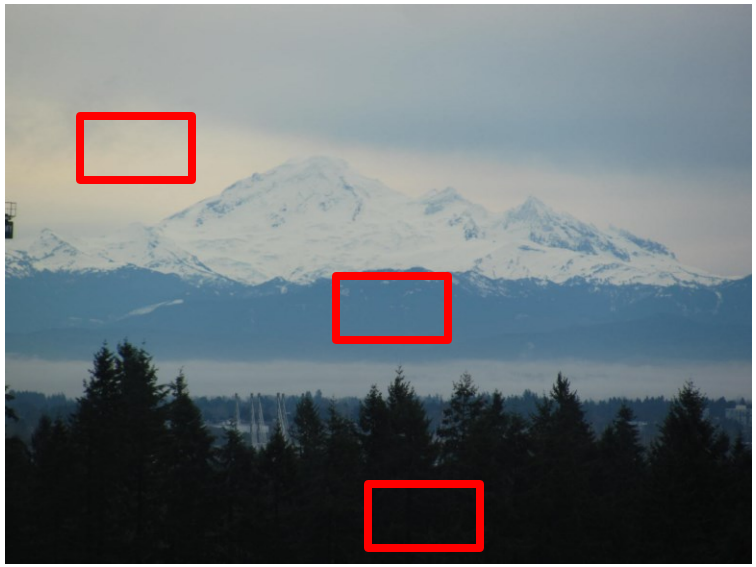

Photo by L. Tang

Compression

- **Compression ratio**:

  FILESIZE_BEFORE : FILESIZE_AFTER

  – Higher generally preferred… more compact

- 2 categories:
  1. Lossless: no loss of data
  2. Lossy: involves loss of data…
     - Achieves **higher** compression ratio ☺…
     - At expense of **lower** image quality ☹

	GIF	JPEG	PNG
Compression	Lossless compression	Lossy compression	Lossless compression

You may choose compression ratio (% of original file size)

Transparency

Opacity?

- Amount of light absorbed by a medium
- High opacity → Low transparency

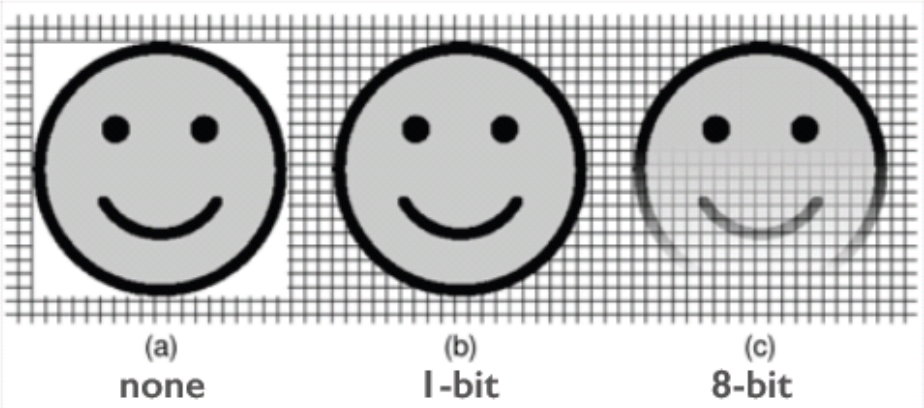

Figure 5.4: Various types of transparency in images

Three ways to handle transparency info:

1. Don't store
2. 1-bit for each pixel (on or off)
3. As an additional channel (8-bit for each pixel) → known as **alpha channel**
   - Various levels of opacity

	GIF	JPEG	PNG
Transparency	1-bit	None	8-bit

Animation

"Motion picture"

- Motion is achieved by playing a series of **static** images (frames)
- Storing animation in graphics → store all frames in single file

	GIF	JPEG	PNG
Supports animation?	Yes	No	Yes

Creating animated graphics file:

- Online GIF-creators:
  - https://imgflip.com/images-to-gif
  - http://gifmaker.me/
  - …
- PNG animation: use PhotoShop

Summary

3 file formats discussed so far:

	GIF	JPEG	PNG
Color depth	8-bit	24-bit or 8-bit	24-bit
Compression	Lossless compression	Lossy compression	Lossless compression
Support for transparency	1-bit	N/A	8-bit
Support for Animation?	Yes	N/A	Yes

Today's Summary

Key Terminologies:

Image resolution

Pixel, bits, unit of bytes

Intensity vs. coordinates

Color-depth

Monochrome, 8-, 16-, 24-bit, etc.

Opacity, transparency, alpha channel

Color dithering

Compression

Lossy vs lossless

Image editing software

- Popular editing:
  - MS Paint (Windows)
  - Adobe Photoshop (Mac and Windows)
  - Pixelmator (Mac)
  - GIMP (Mac, Windows, and Linux)

Finding images

- Paid picture services: no need to cite, pay $1-2
  - E.g. Stock Xchange, Fotolia, Shutterstock, Dreamstime
- Google Image
  - “Free to use or share”
  - “Free to use or share, even commercially”
- Websites where you don’t need any permissions for using images in blog posts:
  - Flickr, freeimages, morgueFile, FreeFoto, FreeDigitalPhotos, Creative Commons, Pixabay
- Who owns it? http://www.tineye.com/
- Don’t forget to caption your figures!

Example of citing an image

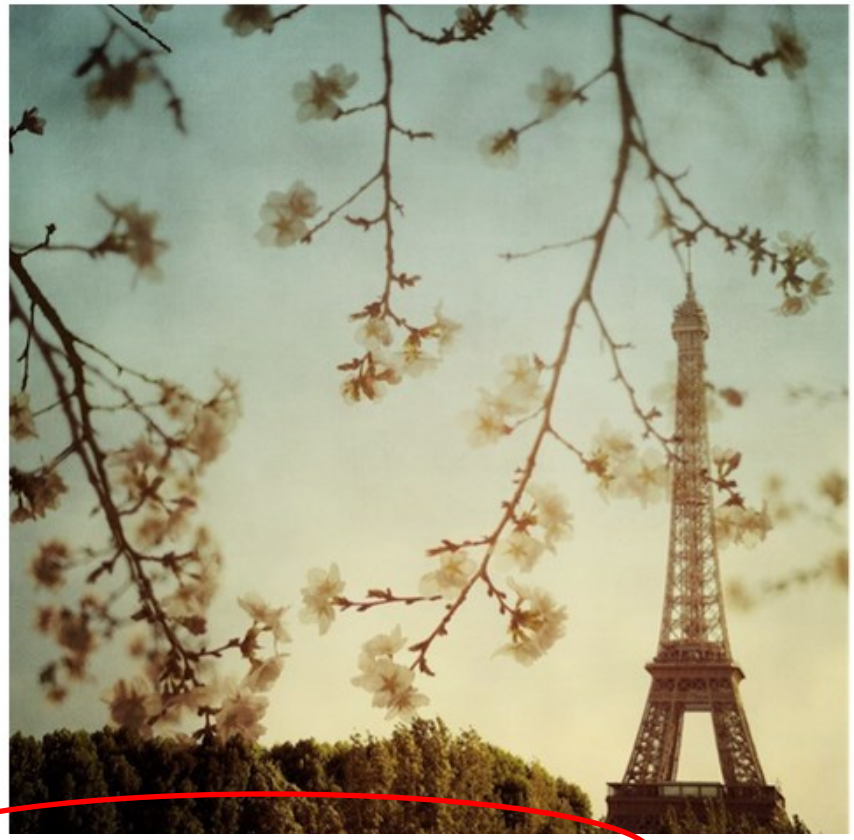

Image by Irene Suchocki via Etsy Shop

Questions?

Notes on coursework

- Exercises: use exact phrases when asked
  - E.g. Lab 4 asked for 99 cents, not 75 cents!?

- Lateness
  - Submitting URL and modifying files after deadline is considered late. We will check them!
  - Penalty for lateness: 10% each day late; not accepted after more than 2 days late

Testing your assignments

(optional but highly encouraged)

1) Try on various browsers. Any critical problems?

2) Show to your friends, gather their feedback

3) Look for comments with common concern, e.g.

   "I didn't know how to get back to page X"

   "I find this hard to read"

4) Modify your webpages accordingly

Questions?