Images, Strings

CSE 120 Winter 2019

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There's a simple reason your new smart TV was so affordable: It's collecting and selling your data

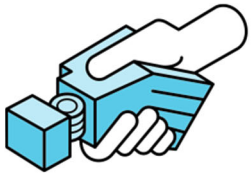
"If you want a 65-inch 4K smart TV with HDR capability, one can be purchased for below $500. But that low price comes with a caveat most people probably don't realize: Some manufacturers collect data about users and sell that data to third parties.

"Smart TVs can be sold at or near cost to consumers because Vizio is able to monetize those TVs through data collection, advertising, and selling direct-to-consumer entertainment (movies, etc.)."

- https://www.businessinsider.com/smart-tv-data-collection-advertising-2019-1

Administrivia

- Assignments:
  - Arrays and Elli [checkoff] due tomorrow (2/14)
  - Reading Check 5 due @ 3:30 pm tomorrow (2/14)
  - Color Filters [checkoff] due on Tuesday (2/19)
  - Controlling Elli [submit] due on Tuesday (2/19)
  - Living Computers Museum Report due in 2 weeks (2/26)
- Guest lecture on Friday: Artificial Intelligence



living computers Report

museum + labs

- Field trip out to the Living Computers: Museum + Labs in SoDo
  - Admission is paid for you!
  - Transportation: Link + walk, bus, drive
  - Go when you can: open Wed-Sun each week

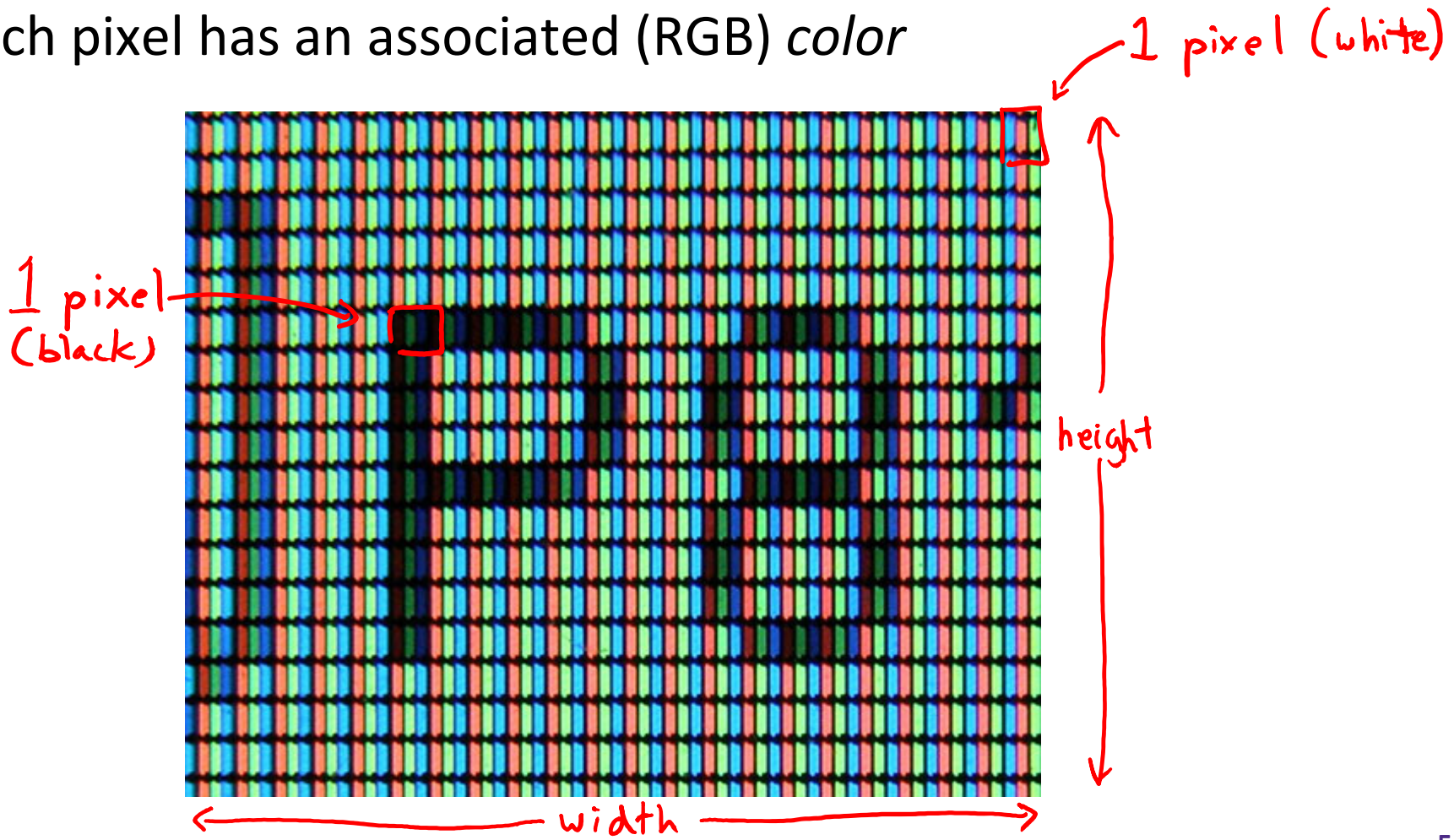
- **Report:** PDF including photos and responses due 2/26
  - Part 1: Favorite Exhibit
  - Part 2: Computer History
  - Part 3: Modern Tech Exhibit Reflection

Outline

- **Images**
- Compression
- Strings

Images

- An image is just a 2-dimensional set of pixels
  - The image has a *width* and a *height*
  - Each pixel has an associated (RGB) *color*



Images

- An image is just a 2-dimensional set of pixels
  - The image has a *width* and a *height*
  - Each pixel has an associated (RGB) *color*

- In Processing, an image is represented as an array of `color` data
  - Can explicitly use `color[] myImage`
  - Processing also provides special datatype `PImage`

Using Images in Processing

1) Load an image from a file into a Processing variable
   - Use the `loadImage("photo.jpg")` function
     - The image name is a String representing the *path* to the file, similar to your website
   - Store the return value from `loadImage()` into a `PImage` variable
     - *e.g.* `PImage myImg = loadImage("img/justin.jpg");`

2) Draw the image on your canvas using the `image()` function
   - `image(<PImage var>, <x_pos>, <y_pos>)`
   - *e.g.* `image(myImg, 0, 0);`

The Canvas as an Image

- The drawing canvas is also treated as an image!
  - Retrieve the current canvas image data (*i.e.* array of `color` data) using the `loadPixels()` function
    - `loadPixels()` has no parameters or return value
    - The canvas image data will be automatically stored into the system variable `pixels[]`
  - You can manually manipulate the data in `pixels[]`
    - *e.g.* `pixels[0] = color(0);  // set to black`
  - Update the drawing canvas with the current/new data in `pixels[]` using the `updatePixels()` function
    - `updatePixels()` also has no parameters or return value

Linearizing an Image

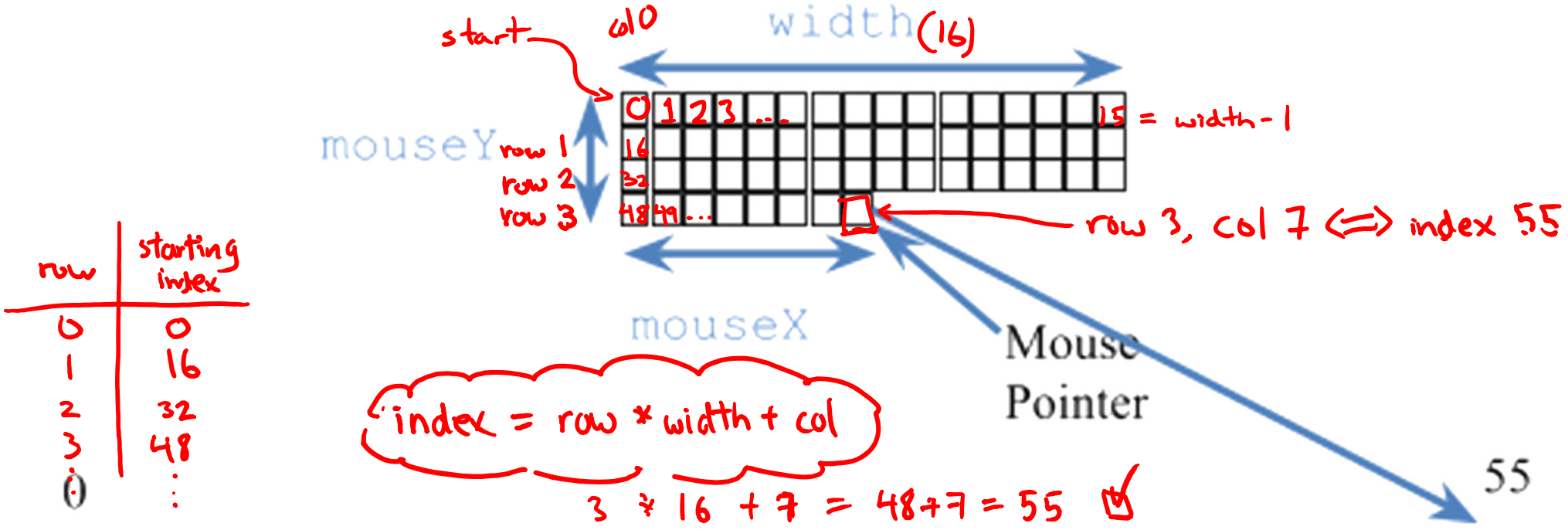
small example:

0	1
2	3
4	5

- Despite being 2-D in nature (*i.e.* x- and y-coordinates), we deal with image data in a 1-D array (*i.e.* `pixels[]`)

length n uses indices 0 to n-1

  - As we increment our array index, we move left-to-right horizontally and then top-to-bottom vertically

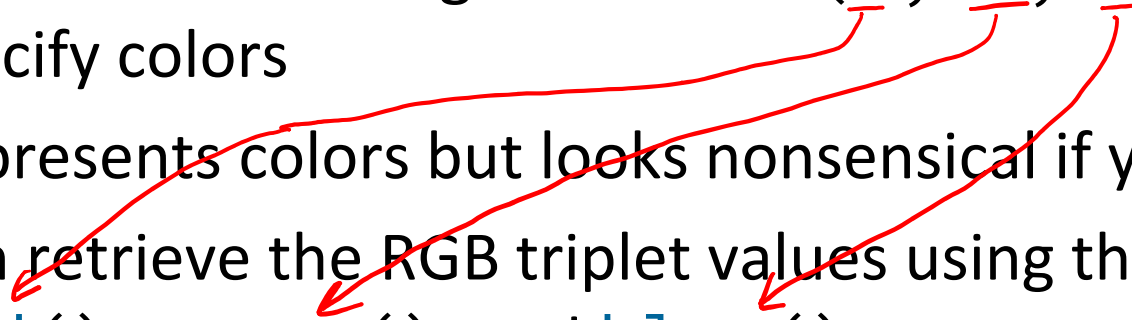


row	starting index
0	0
1	16
2	32
3	48
⋮	⋮

Color as Data in Processing

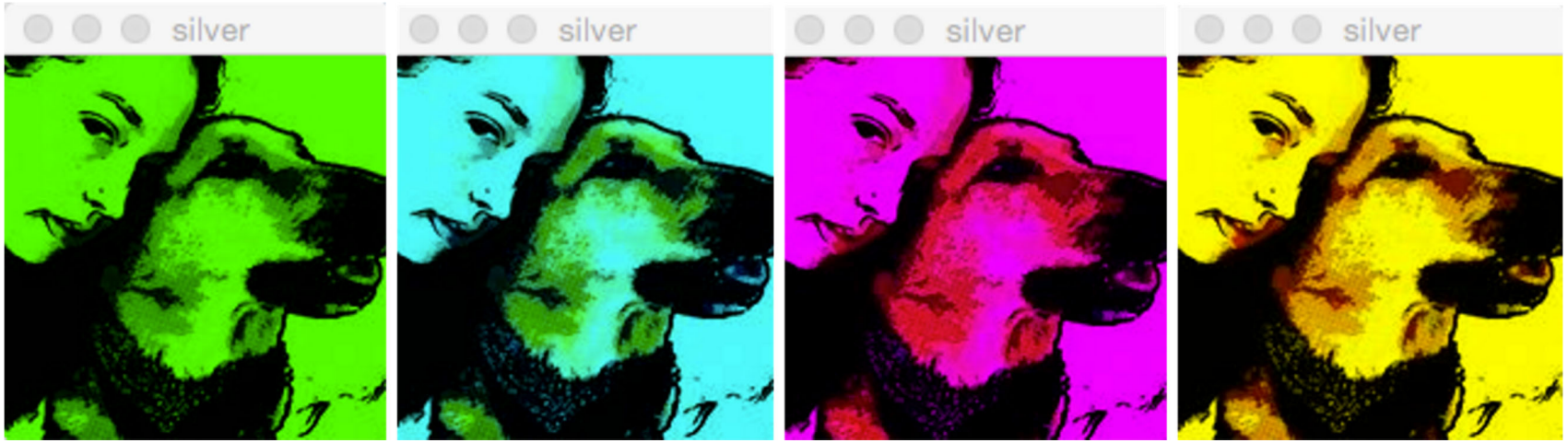
- **Recall:** all data on a computer is stored using *binary encoding*
  - Including colors, though we won't cover exactly how

- Processing has a special `color` datatype
  - We're used to using the `color(R, G, B)` function to specify colors
  - Represents colors but looks nonsensical if you try to print it
  - Can retrieve the RGB triplet values using the functions `red()`, `green()`, and `blue()`



Color Filters

- Learn the basics of using and manipulating images in Processing
  - You choose a photo to display
  - Display the RGB of the pixel your mouse is hovering over
  - Key presses will filter the colors of your image appropriately



Outline

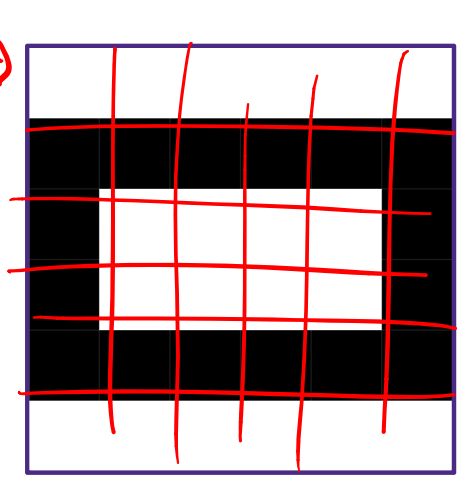
- Images
- **Compression**
- Strings

Compression

- Compression is the process of encoding information/data using fewer bits than the original representation
  - Lossless: original bits can be *exactly* recovered from transformed bits
  - Lossy: original bits *cannot* be exactly recovered from transformed bits (*i.e.* some data is lost)

Lossless Compression

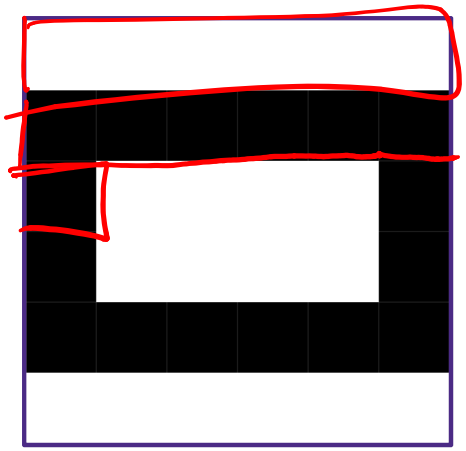
- Eliminates bits that can be recovered again
- Consider this 6 x 6 black-and-white image:



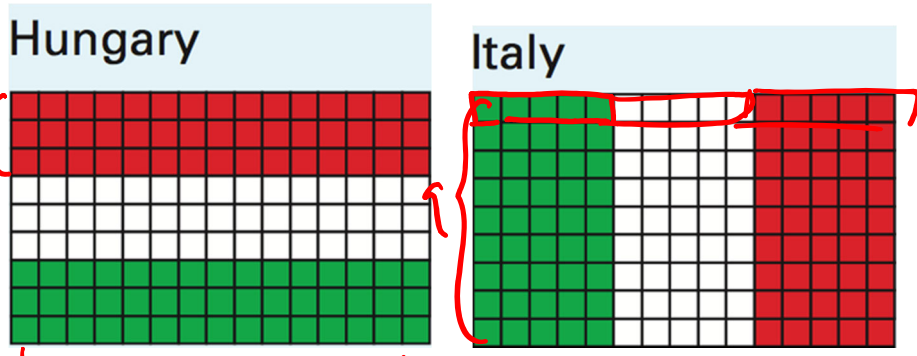
- Uncompressed:
  - WWWWWW BBBBBB BWWWWB BWWWWB BBBBBB WWWWWW

Lossless Image Format: RLE

- Run Length Encoding
  - Not used commonly, but found in formats (TIFF and Bitmap)
  - For repeated data/color, encode # of repeats
  - Many variations on actual encoding exist
- Black-and-white example:
  - `6W 7B 4W 2B 4W 7B 6W`

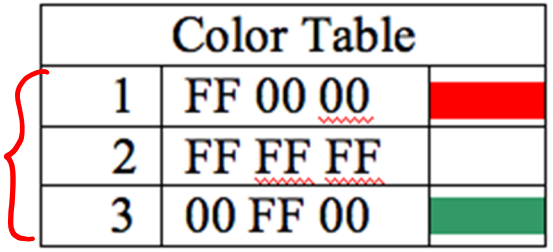


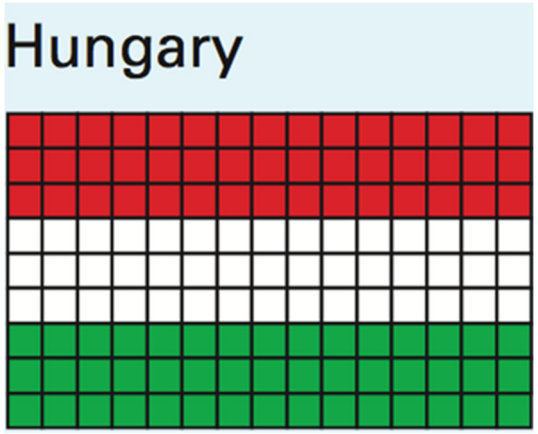
- Flag example:
  - `HU = 45:R,45:W,45:G`
  - `IT = 5:G,5:W,5:R,5:G,5:W,5:R`
    `5:G,5:W,5:R,5:G,5:W,5:R`
    `5:G,5:W,5:R,5:G,5:W,5:R`
    `5:G,5:W,5:R,5:G,5:W,5:R5:G,5:W,5:R`

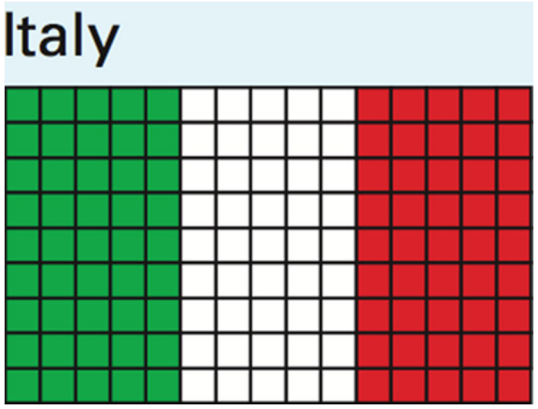


Lossless Image Format: GIF, PNG

- Graphics Interchange Format
  - Uses a 256-color palette (not RGB) encoded in a Color Table
    - Why GIFs may not seem like "true color"
  - Uses **LZW Encoding** (Lempel-Ziv-Welch)
    - Create encodings based on strings of colors in image
    - Supplanted RLE for lossless compression



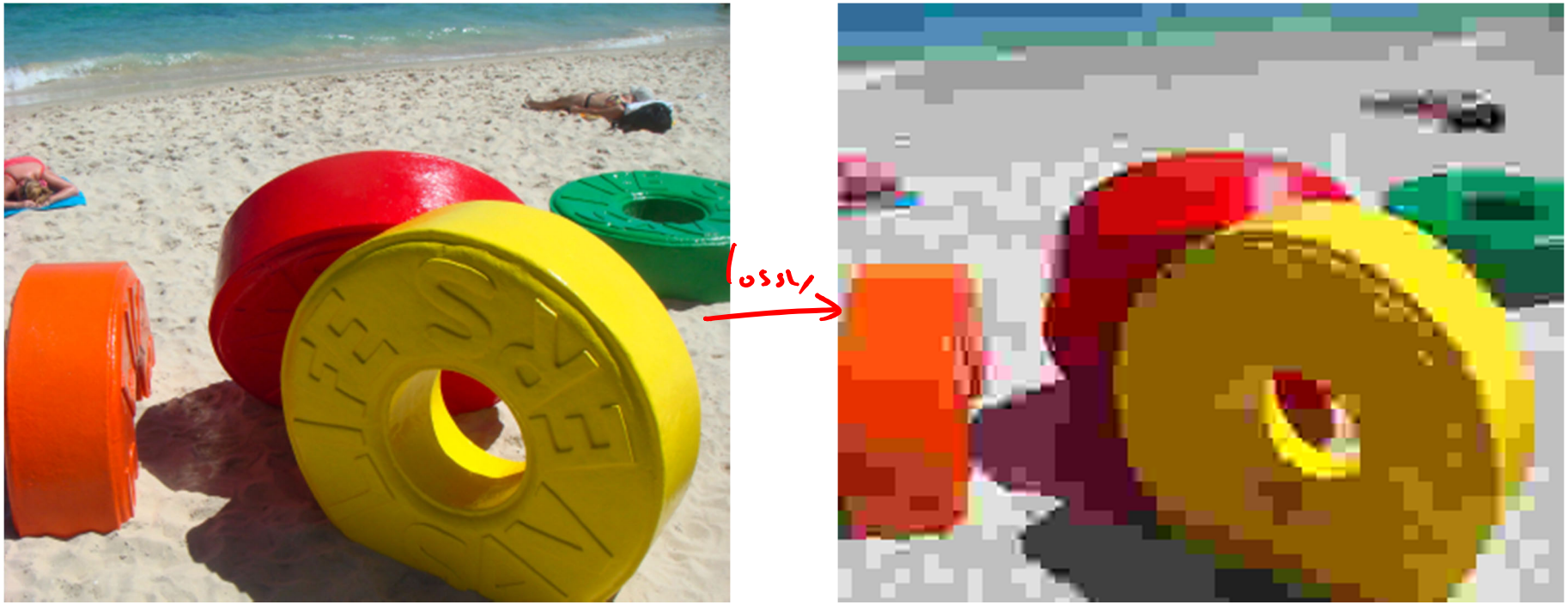




- Portable Network Graphics
  - Improved, non-patented replacement for GIF
  - Doesn't support animations

Lossy Image Format: JPEG/JPG

- Joint Photographic Experts Group
  - Tradeoff between amount of compression and image quality
  - Areas of similar color are represented by a single shade
    - Based on quantization of discrete cosine transform (DCT) operation

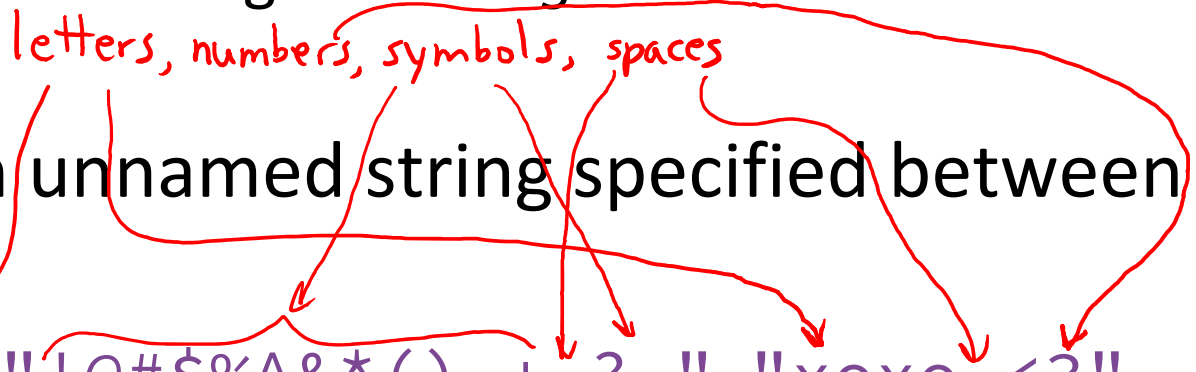


Outline

- Images
- Compression
- **Strings**

Strings

- A string is a string of characters (0 or more)
  - Strings cannot be modified, but string variables can be reassigned
  - Individual characters can be accessed (not modified), numbered from left-to-right *starting at 0*



- String literal: an unnamed string specified between double-quotes
  - *e.g.* `"hello"`, `"!@#$%^&*()_+ ?~"`, `"xoxo <3"`
  - `""` is known as the empty string (0 characters in it)

Using Strings

- Declaration: `String str;`
- Assignment: `str = "hello";`

string variable

string

position 0 1 2 3 4

- Get character using `str.charAt(i)` str.charAt(1) → 'e'
- Get length using `str.length()` 5

dot notation

- Concatenation: join strings using '+' operator
  - *e.g.* `"hi "` + `"there"` gives you `"hi there"`

plus when used with numbers, concatenate when used with strings

- Conversion to string usually occurs *implicitly*
  - Can also explicitly use `str()`

int x = 120;
"CSE" + x is really "CSE" + str(x)

Strings vs. Arrays

- Strings are *sort of* like arrays of characters:

	Array	String
Declare	`char[] chArray;`	`String str;`
Initialize	`chArray = {'h','i','!'};`	`str = "hi!";`
Get element	`chArray[1]`	`str.charAt(1)`
Get length	`chArray.length`	`str.length()`

Example: Recording User Input

- `keyPressed()` lets you read user input 1 character at a time

- Use a `String` variable to "store"
  - Add/append new characters using concatenation

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```
String input = "";   // start with empty string

void draw() {
}

void keyPressed() {
  input = input + str(key);
  println("input = " + input);
}
```

convert char to String

string literal

concatenation

Word Guessing

- Learn to use text input & output
  - Player 1 enters a secret phrase
  - Player 2 tries to guess the secret phrase
  - Game tells you how many letters correct & # of attempts