Images

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Global Variables: Bad Style

```
# Constant – visible to all functions
NUM_DAYS_IN_WEEK = 7

# Global variable – visible to all functions
balance = 0


def main():
    balance = int(input("Initial balance: "))
    while True:
        amount = int(input("Deposit (0 to quit): "))
        if amount == 0:
            break
        deposit(amount)


def deposit(amount):
    balance += amount
```

Different variables with the same name!
Super confusing!

- **Also, really BAD style**
  - So bad, that Python won't even let you do it unless you basically add a command that says "I want to have bad style"
  - I'm not going to show you that command in Python
    - But, if you know it already, DON'T use it!
    - We're in polite company

Using Parameters: Good Style

Don't want using your toaster to impact your refrigerator!

```
def main():
    balance = int(input("Initial balance: "))
    while True:
        amount = int(input("Deposit (0 to quit): "))
        if amount == 0:
            break
        balance = deposit(balance, amount)


def deposit(balance, amount):
    balance += amount
    return balance
```

<u>Encapsulation Principle</u>: Data used by a function should be a parameter or encapsulated in function

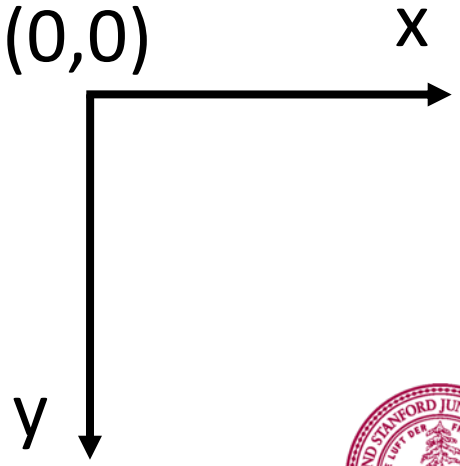
Learning Goals

1. Understanding how images are represented
2. Learning about the SimpleImage library
3. Writing code that can manipulate images

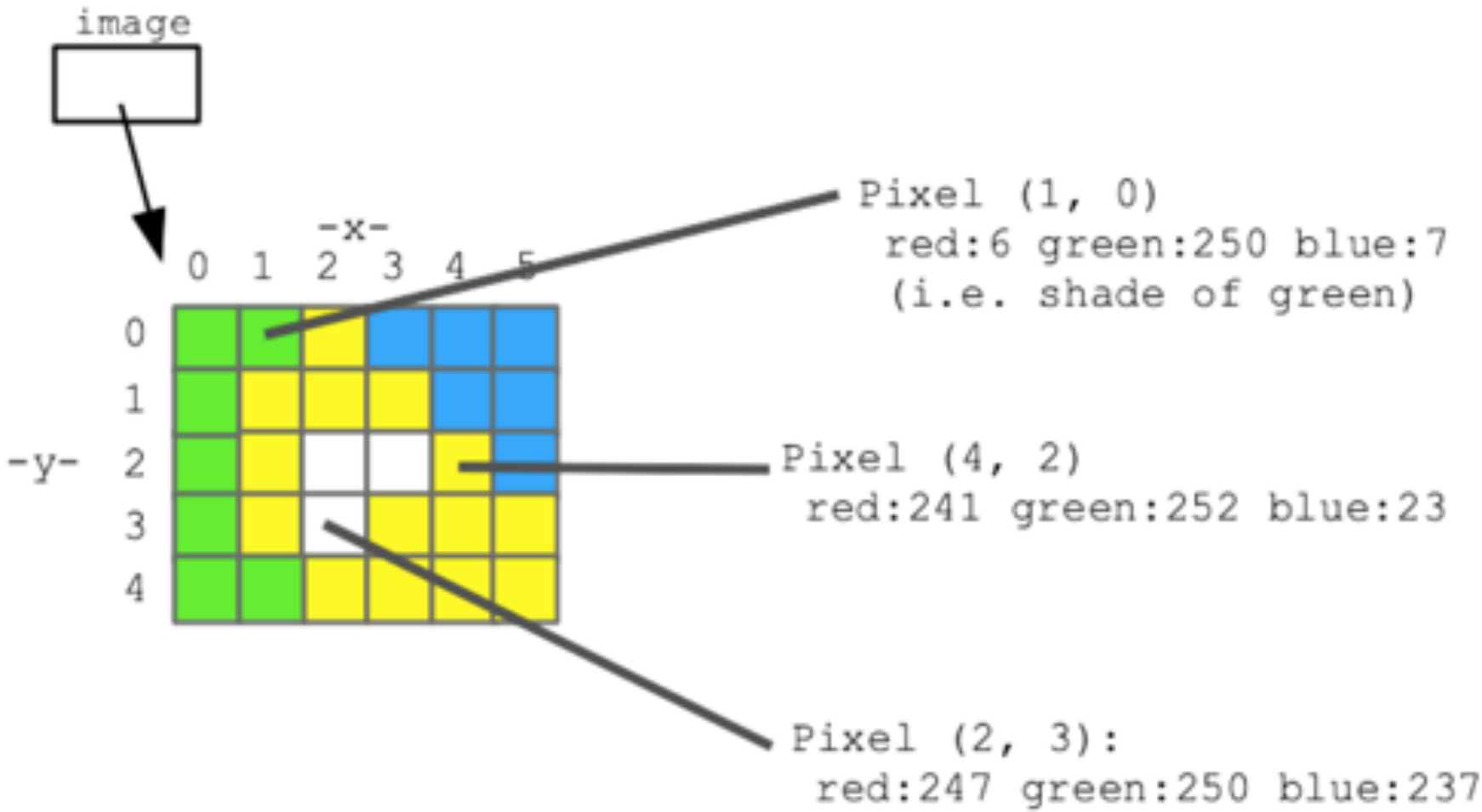
Images

What is an Image?

- Image made of square pixels
  - Example: flower.png
- Each pixel has x and y coordinates in the image
  - The origin (0, 0) is at the upper-left corner
  - y **<u>increases</u>** going down, x increases going right
- Each pixel has single color encoded as 3 **RGB** values
  - R = red; G = green; B = blue
  - Each value represents brightness for that color (red, green, or blue)
  - Can set RGB values to make any color!



Pixels in an Image Close-Up



Working with Images: Pillow and the SimpleImage library

Installing Pillow

- Pillow is a version of the Python Imaging Library (PIL)
  - Nick Parlante built SimpleImage library using Pillow
  - You'll be using SimpleImage in this class
  - So, you need to install Pillow first
- To install Pillow, open PyCharm Terminal tab and type (note the capital **`P`** in **`Pillow`**):
  - On a PC: **`py -m pip install Pillow`**
  - On a Mac: **`python3 -m pip install Pillow`**
  - Will see something like:

    ...bunch of stuff...

    `Successfully installed Pillow-7.1.1`
- Handout #8: Image Reference Guide contains more information

Using SimpleImage Library

- In folders for assignment or lecture on images, there is a file **`simpleimage.py`**
  - This is the SimpleImage library
- To use the SimpleImage library in your code, include at the top of your program file:

```
from simpleimage import SimpleImage
```

- This is importing the SimpleImage module, so that it is accessible in the code you write
  - Similar to when you used **`import random`** to use random number generator library

Functions in SimpleImage Library

- Create a SimpleImage object by reading an image from file (jpg, png, gif, etc.) and store it in a variable.
  - Note: each SimpleImage object is made up of Pixel objects

```
my_image = SimpleImage(filename)
```

- Show the image on your computer.

```
my_image.show()
```

- We can manipulate an image by changing its pixels
- We can also create new images and set its pixels

Accessing Pixels in an Image

- We can use a new kind of loop called a "for-each" loop
- Recall basic **`for`** loop (using **`range`**):

```
for i in range(num):
    # i will go from 0 to num - 1
    do_something()
```

- For-each loop:

```
for item in collection:
    # Do something with item
```

- For-each loop with image:

```
image = SimpleImage("flower.jpg")
for pixel in image:
    # Do something with pixel
```

For-Each Loop Over Pixels

```
image = SimpleImage("flower.jpg")
for pixel in image:
    # Body of loop
    # Do something with pixel
```

This code gets repeated once for <u>each</u> pixel in image

- Like variable **`i`** in **`for`** loop using **`range()`**, **`pixel`** is a variable that gets updated with each loop iteration.
- **`pixel`** gets assigned to each pixel object in the image in turn.

Properties of Images and Pixels

- Each SimpleImage image has properties you can access:
  - Can get the width and height of image (values are in pixels)

    `image.width`, `image.height`

- Each pixel in an image also has properties:
  - Can get x, y coordinates of a pixel in an image

    `pixel.x` , `pixel.y`

  - Can get RGB values of a pixel

    `pixel.red`, `pixel.green`, `pixel.blue`

    - These are just integers between 0 and 255
    - Higher R, G, or B values means more of that color in pixel
  - Can also **set** pixel RGB values in an image to change it!

Example: A Darker Image

```
def darker(filename):
    """
    Reads image from file specified by filename.
    Makes image darker by halving red, green, blue values.
    Returns the darker version of image.
    """
    # Demonstrate looping over all the pixels of an image,
    # changing each pixel to be half its original intensity.
    image = SimpleImage(filename)
    for pixel in image:
        pixel.red = pixel.red // 2
        pixel.green = pixel.green // 2
        pixel.blue = pixel.blue // 2
    return image
```

Example: Get Red Channel

```
def red_channel(filename):
    """
    Reads image from file specified by filename.
    Changes the image as follows:
    For every pixel, set green and blue values to 0
    yielding the red channel.
    Return the changed image.
    """
    image = SimpleImage(filename)
    for pixel in image:
        pixel.green = 0
        pixel.blue = 0
    return image
```

Let's take it out for a spin!
imageexamples.py

Greenscreening

What is Greenscreening?

- Like the movies (and Zoom backgrounds)
  - Have original image with areas that are "sufficiently green."
  - Replace "green" pixels with pixels from corresponding x, y locations in another image

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```
INTENSITY_THRESHOLD = 1.6

def greenscreen(main_filename, back_filename):
    image = SimpleImage(main_filename)
    back = SimpleImage(back_filename)
```

What is Greenscreening?

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  - Have original image with areas that are "sufficiently green."
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```
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def greenscreen(main_filename, back_filename):
    image = SimpleImage(main_filename)
    back = SimpleImage(back_filename)
    for pixel in image:
```

What is Greenscreening?

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  - Replace "green" pixels with pixels from corresponding x, y locations in another image

```
INTENSITY_THRESHOLD = 1.6

def greenscreen(main_filename, back_filename):
    image = SimpleImage(main_filename)
    back = SimpleImage(back_filename)
    for pixel in image:
        average = (pixel.red + pixel.green + pixel.blue) // 3
        # See if this pixel is "sufficiently" green
        if pixel.green >= average * INTENSITY_THRESHOLD:
```

What is Greenscreening?

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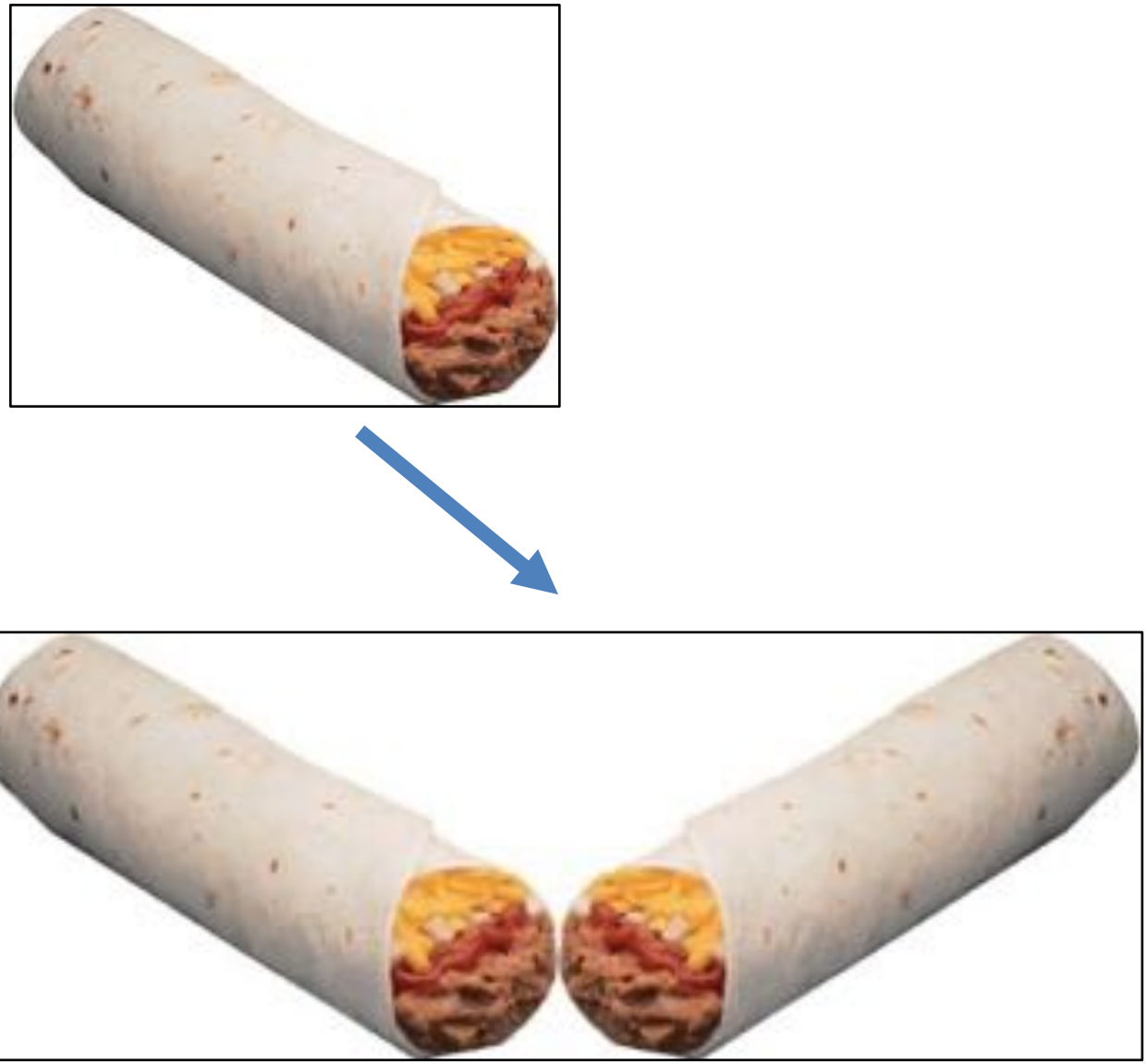
INTENSITY_THRESHOLD = 1.6

def greenscreen(main_filename, back_filename):
    image = SimpleImage(main_filename)
    back = SimpleImage(back_filename)
    for pixel in image:
        average = (pixel.red + pixel.green + pixel.blue) // 3
        # See if this pixel is "sufficiently" green
        if pixel.green >= average * INTENSITY_THRESHOLD:
            # If so, overwrite pixel in original image with
            # corresponding pixel from the back image.
            x = pixel.x
            y = pixel.y
            image.set_pixel(x, y, back.get_pixel(x, y))
    return image
```

Let's try it!
(But using red instead of green)

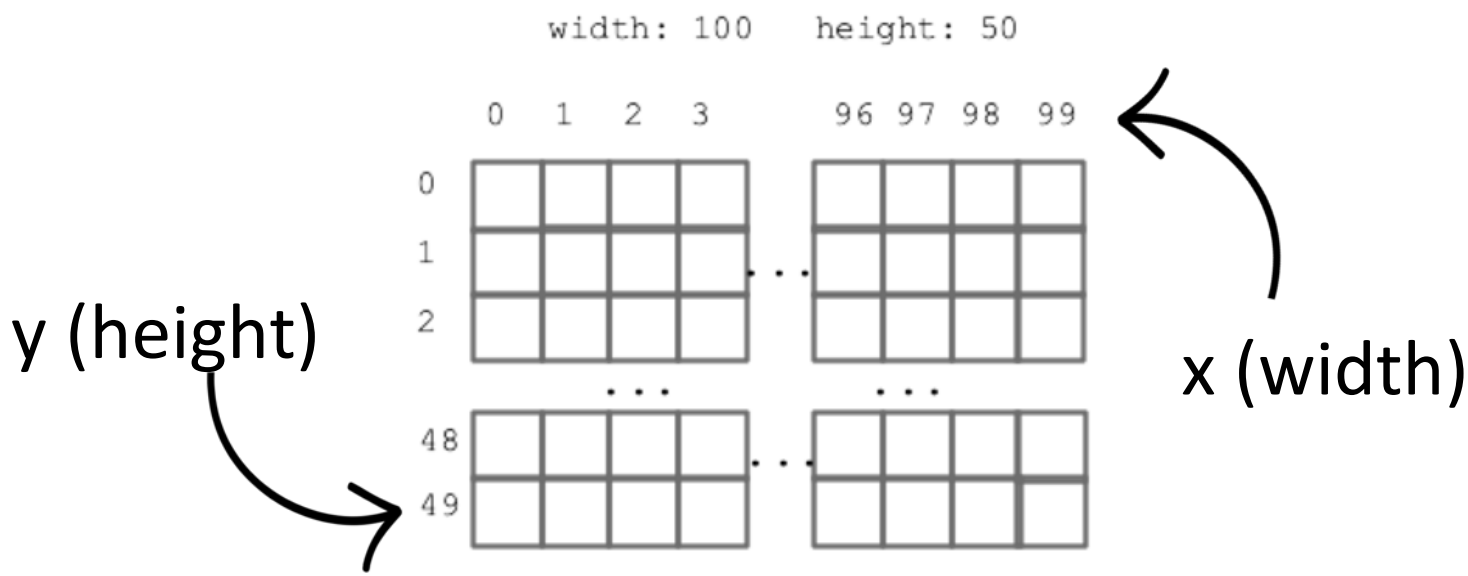
Mirroring an image



Nested Loops

```
image = SimpleImage(filename)
width = image.width
height = image.height

for y in range(height):
    for x in range(width):
        pixel = image.get_pixel(x, y)
        # do something with pixel
```



Mirroring an Image

```
def mirror_image(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height

    # Create new image to contain mirror reflection
    mirror = SimpleImage.blank(width * 2, height)

    for y in range(height):
        for x in range(width):
            pixel = image.get_pixel(x, y)
            mirror.set_pixel(x, y, pixel)
            mirror.set_pixel((width * 2) - (x + 1), y, pixel)
    return mirror
```

I wanna see it!

What's The Difference?

```
def darker(filename):
    img = SimpleImage(filename)
    for px in img:
        px.red = px.red // 2
        px.green = px.green // 2
        px.blue = px.blue // 2
    return img
```

```
def darker(filename):
    img = SimpleImage(filename)
    for y in range(img.height):
        for x in range(img.width):
            px = img.get_pixel(x, y)
            px.red = px.red // 2
            px.green = px.green // 2
            px.blue = px.blue //  2
    return img
```

Nothing!

We only want to use nested for loops if we care about **x** and **y**.
(Needed that for mirroring image.)

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