Images

Let’s make em
Housekeeping

- We are going very fast!
- Our first review session is Wednesday Jul 5 in SkillAud - please attend!
- Happy day off!
Today

- Variables recap
  - Also a first look at numbers in Python

- Introducing: Images
  - Images as a variable
  - for loop and range() function
  - Editing images
A note

- We are going very fast!

- It is okay if you don’t understand everything, that’s why we have section, review sessions, office hours and LAIR.

- Don’t struggle through lecture/homework questions alone! Come to LAIR and OH - we love explaining things!

- We go this fast through week 4, then you know enough Python syntax that everything calms down quite a Bit.
Recap: Variables

- Variables are something that hold a value, and you can update that value as much as you want
- Here is the syntax for making a variable:

  ```python
  var_name = #something
  ```

```python
def variable_example(filename):
    bit = Bit(filename)
    color = bit.get_color()
```

On this map, `color` has value 'blue'
Recap: Variables

- We can change the value of variables

```python
def variable_example(filename):
    bit = Bit(filename)
    color = bit.get_color()
    bit.move()
    color = 'red'
    bit.paint(color)
```

`color` still has value 'blue'
Recap: Variables

- We can change the value of variables

```python
def variable_example(filename):
    bit = Bit(filename)
    color = bit.get_color()
    bit.move()
    color = 'red'
    bit.paint(color)
```

**color** now has value **'red'**
Recap: Variables

- We can change the value of variables

```python
def variable_example(filename):
    bit = Bit(filename)
    color = bit.get_color()
    bit.move()
    color = 'red'
    bit.paint(color)
```

`color` now has value `'red'`
So bit paints red!
Variables as numbers

- We haven’t used numbers much yet, but Python is very good with numbers

```python
def variable_num_example(filename):
    lecture_days = 3
    weeks_in_q = 8
    if go_to_wednesday_review():
        lecture_days = 4
    total_lectures = lecture_days * weeks_in_q
    # 24 if you don’t go to wednesday review
    # 32 if you do go to wednesday review
```
Aside: Math is as expected in Python

```python
def variable_num_example(filename):
    x = 3
    y = 8
    sum = x + y  # sum is 11
    prod = x * y  # prod is 24
    diff = x - y  # diff is -5
```

Aside: Math is as expected in Python

```python
def variable_num_example(filename):
    x = 3
    y = 8
    sum = x + y  # sum is 11
    prod = x * y  # prod is 24
    diff = x - y  # diff is -5
```
def variable_num_example(filename):
    x = 3
    y = 8
    sum = x + y  # sum is 11
    prod = x * y  # prod is 24
    diff = x - y  # diff is -5

    # regular division
    quotient = y / x  # quotient is 2.6666

    # int division
    int_quotient = y // x
    # int_quotient is 2, // truncates decimal
Today

- Variables recap
  - Also a first look at numbers in Python

- Introducing: Images
  - Images as a variable
  - for loop and range() function
  - Editing images
Introducing Images

- On computers, images are represented as grids of “pixels”

- More pixels = higher resolution

- A “pixel” is usually represented as a tuple of 3 numbers: the red, green and blue values (RGB), which make up the color of that pixel. RGB values are 0-255
Pixel details

- We can locate pixels by their (x, y) coordinates
- An RGB value of (0, 0, 0) is black, (255, 255, 255) is white
- Every other color is in between. Lower = darker
Pixel details
- We can locate pixels by their \((x, y)\) coordinates
- An RGB value of \((0, 0, 0)\) is black, \((255, 255, 255)\) is white
- Higher value = more of that color mixed in, lighter

Pixel \((1, 1)\) has value:
\((200, 0, 0)\)
Intense red, no blue or green

Pixel \((2, 3)\) has value:
\((115, 55, 18)\)
Reddish, darker mix!

Pixel \((5, 0)\) has value:
\((0, 160, 250)\)
No red, mix green and lots of blue for light blue!
def my_first_image_func():
    image = SimpleImage('apple_tree.jpg')
    # image stores a bunch of pixel tuples!
    some_pixel = image.get_pixel(2, 3)
    # some pixel = (115, 55, 18)
    red_val = some_pixel.red # red_val is 115

    some_pixel at (2, 3) has value: (115, 55, 18)
    Reddish, darker mix!
Looping through pixels

Let’s write a function `sun()` that turns every pixel in the first row of `apple_tree.jpg` to be a nice sunny orange, or RGB value (255, 165, 0)
Looping through pixels

def sun():
    # load image file into variable ✓
    image = SimpleImage('apple_tree.jpg')
    # change pixels one at a time?
    pixel = image.get_pixel(0, 0)
    pixel.red = 255
    pixel.green = 165
    pixel.blue = 0

    pixel = image.get_pixel(1, 0)
    ...
    pixel = image.get_pixel(2, 0)  .  .  .  .
Introducing the for loop!

- It seems like we need a loop here, but we don’t exactly have a condition like bit.front_clear() to test
- Instead, we have a number of pixels we want to loop through
- This is where the for loop comes in!

```python
for var_name in range(start_num, end_num):
    # body of loop
    # var_name will be equal to start_num, then start_num + 1 on the next loop and so on
    # until we hit end_num (don’t run end_num)
```
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

![Image with pixel values](image.png)
We now have a variable named \texttt{x} and its value is 0
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

We now have a variable named `pixel` its position is (0, 0) and its RGB value is (0, 160, 250)
**Introducing the for loop!**

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

- **x** is now 1
- **pixel** is still at (0, 0) with RGB (0, 160, 250)
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

- `x` is still 1
- `pixel` is now at (1, 0) with RGB (0, 200, 0)
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)

x is now 2
pixel is still at (2, 0) with RGB (0, 160, 250)
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

`x` is still 2

`pixel` is now at (2, 0) with RGB (0, 200, 0)
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

---

$x$ is now 3

$\text{pixel}$ is still at $(2, 0)$ with RGB $(0, 160, 250)$
Introducing the for loop!

```python
def sun():
    # load image file into variable ✓
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)

x is still 3
pixel is now at (3, 0) with RGB (0, 200, 0)
```
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

**x** is now 4

**pixel** is still at (3, 0) with RGB (0, 200, 0)
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

$x$ is still 4

`pixel` is now at $(4, 0)$ with RGB $(0, 160, 250)$
Introducing the for loop!

```python
def sun():
    # load image file into variable ✅
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

$x$ is now 5

pixel is still at $(4, 0)$ with RGB $(0, 160, 250)$
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
```

- `x` is still 5
- `pixel` is now at (5, 0) with RGB (0, 160, 250)
Introducing the for loop!

```python
def sun():
    # load image file into variable ✅
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)

    x was 5, and our end number is 6, so we stop here (x does not become 6)
```
Introducing the for loop!

```python
def sun():
    # load image file into variable
    image = SimpleImage('apple_tree.jpg')
    # try just grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)

    # post loop code
```

x was 5, and our end number is 6, so we stop here (x does not become 6)
def sun():
    # load image file into variable ✓
    image = SimpleImage('apple_tree.jpg')
    # grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
        # now change pixel to be (255, 165, 0)
def sun():
    # load image file into variable 
    image = SimpleImage('apple_tree.jpg')
    # grabbing each pixel
    for x in range(0, 6):
        pixel = image.get_pixel(x, 0)
        # now change pixel to be (255, 165, 0)
        pixel.red = 255
        pixel.green = 165
        pixel.blue = 0
Two tweaks

def sun():
    image = SimpleImage('apple_tree.jpg')
    width = image.width  # 6 for our picture
    # now, this loop works for any size picture!
    for x in range(0, width):
        pixel = image.get_pixel(x, 0)
        # now change pixel to be (255, 165, 0)
        pixel.red = 255
        pixel.green = 165
        pixel.blue = 0
Two tweaks

def sun():
    image = SimpleImage('apple_tree.jpg')
    width = image.width # 6 for our picture
    # now, this loop works for any size picture!
    for x in range(0, width):
        pixel = image.get_pixel(x, 0)
        # now change pixel to be (255, 165, 0)
        pixel.red = 255
        pixel.green = 165
        pixel.blue = 0
    return image # return changed image to caller
    # without this, our work is lost!
Let’s now write a function `all_sun(filename)` that turns every pixel in the first row of any image to be a nice sunny orange, or RGB value (255, 165, 0)

Looping through ALL pixels
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    # change first row
    for x in range(0, width):
        pixel = image.get_pixel(x, 0)
        pixel.red = 255
        pixel.green = 165
        pixel.blue = 0
    ...  
    return image
```python
def all_sun(filename):
    # works for any image!
    image = SimpleImage(filename)
    width = image.width
    # change first row
    for x in range(0, width):
        pixel = image.get_pixel(x, 0)
        pixel.red = 255
        pixel.green = 165
        pixel.blue = 0
    ...
    return image
```
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    # change first row
    for x in range(0, width):
        pixel = image.get_pixel(x, 0)
        pixel.red = 255
        pixel.green = 165
        pixel.blue = 0
    # change second row?
    for x in range(0, width):
        pixel = image.get_pixel(x, 1)
        pixel.red = 255
        pixel.green = 165
        pixel.blue = 0
Our loop needs to loop!

```python
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    # can we repeat this loop for every row?
    for x in range(0, width):
        # the 0 coordinate is the row, need to get rows
        # 1, 2, 3 .
        pixel = image.get_pixel(x, 0)
        pixel.red = 255
        pixel.green = 165
        pixel.blue = 0
```
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    # how many times do we need to run the inner loop?
    for y in range(0, ??):
        for x in range(0, width):
            # y is now another variable that
            # changes with each loop
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            #x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Run all_sun('apple_bush.jpg')
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:

width = 3
height = 2
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
```
0 1 2
0 Light blue  Green  Red
1 Green  Brown  Green
```
```
width = 3
height = 2
y = 0
```
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3
height = 2
x = 0
y = 0
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3  x = 0
height = 2  y = 0
pixel = RGB(0, 160, 250) at (0, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3          x = 0
height = 2         y = 0
pixel = RGB(255, 160, 250) at (0, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:

width = 3  x = 0
height = 2  y = 0
pixel = RGB(255, 165, 250) at (0, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3          x = 0
height = 2         y = 0
pixel = RGB(255, 165, 0) at (0, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3  x = 1
height = 2  y = 0
pixel = RGB(255, 165, 0) at (0, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3          x = 1
height = 2         y = 0
pixel = RGB(0, 200, 0) at (1, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3  
x = 1
height = 2  
y = 0
pixel = RGB(0, 200, 0) at (1, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3           x = 2
height = 2           y = 0
pixel = RGB(255, 165, 0) at (0, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:

width = 3          x = 2
height = 2          y = 0
pixel = RGB(200, 200, 0) at (2, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3             x = 2
height = 2            y = 0
pixel = RGB(200, 0, 0) at (2, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3
height = 2
pixel = RGB(200, 0, 0) at (2, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3        x = 2
height = 2       y = 1
pixel = RGB(200, 0, 0) at (2, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3  x = 0 (new x-loop)
height = 2  y = 1
pixel = RGB(200, 0, 0) at (2, 0)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3                     x = 0
height = 2                    y = 1
pixel = RGB(0, 200, 0) at (0, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
- width = 3  x = 0
- height = 2  y = 1
- pixel = RGB(255, 165, 0) at (0, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3
height = 2
pixel = RGB(255, 165, 0) at (0, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3  x = 1
height = 2  y = 1
pixel = RGB(115, 55, 18) at (1, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3           x = 1
height = 2           y = 1
pixel = RGB(255,165,0) at (1, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3
height = 2
pixel = RGB(255, 165, 0) at (1, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3  x = 2
height = 2  y = 1
pixel = RGB(0, 200, 0) at (2, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3           x = 2
height = 2           y = 1
pixel = RGB(255, 165, 0) at (2, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height  # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0
    return image

Variables:
width = 3                    x = 2 (end x-loop)
height = 2                   y = 1
pixel = RGB(255, 165, 0) at (2, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3               x = 2 (end x-loop)
height = 2             y = 1 (end y-loop)
pixel = RGB(255, 165, 0) at (2, 1)
def all_sun(filename):
    image = SimpleImage(filename)
    width = image.width
    height = image.height # this is the number of rows!

    for y in range(0, height):
        for x in range(0, width):
            # y is the row index
            # x is the column index
            pixel = image.get_pixel(x, y)
            pixel.red = 255
            pixel.green = 165
            pixel.blue = 0

    return image

Variables:
width = 3 x = 2 (end x-loop)
height = 2 y = 1 (end y-loop)
pixel = RGB(255, 165, 0) at (2, 1)
Recap: Double for-loops

- To loop through every pixel in an image:
  ```python
  for y in range(0, image.height):
      for x in range(0, image.width):
  ```

  - This will run the “x-loop” `image.height` times, traversing row-by-row

- To traverse col-by-col:
  ```python
  for x in range(0, image.width):
      for y in range(0, image.height):
  ```
If time: darker
Recap

- Images can be stored in variables
- Images are made up of RGB pixels
- We can change the pixels
- We can loop through every pixel in an image with a double for loop over width and height