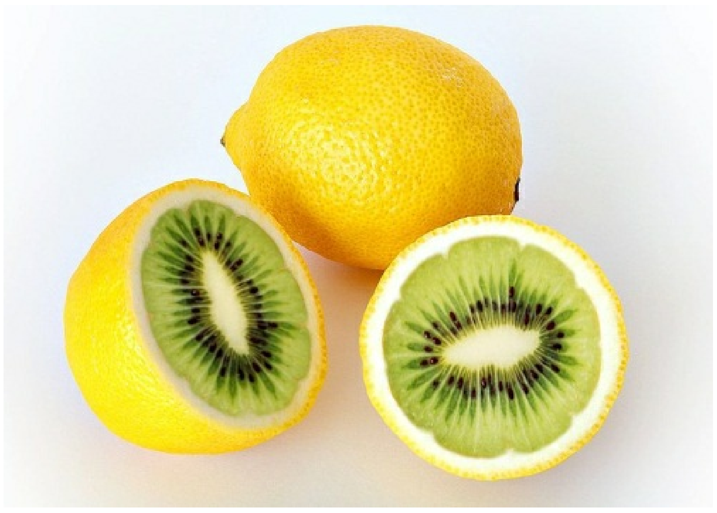
PLTW COMPUTER SCIENCE

Activity 1.4.3

Arrays and Images

Introduction

Have you ever played with special photo effects on a computer? Now that you know that images are really just zeros and ones, you might wonder: how are those special effects created?



Even very routine computer work involves constant manipulation of images. Every time you move a window on the screen, click on a menu, or even just move the mouse, the pixels on the screen change. What algorithms are used to determine the zeros and ones for the graphics card to send to the monitor?

Ready, set, JPG!

Materials

- Computer with Enthought Canopy distribution of *Python*® programming language
- Webcam or other way to obtain a digital picture

Resources

1.4.3 sourceFiles.zip

Reference Card for Pyplot and PIL

Procedure

Part I: Using Arrays of Pixels

1. Form pairs as directed by your teacher. Meet or greet each other to practice professional skills. Set team norms.
2. Launch Canopy. Open an editor window.

3. In the previous activity, you created an `ndarray` called `ax`. It was an array of SubplotAxes objects. You accessed one SubplotAxes by using an index in square brackets: `ax[0]`. You probably recognize that this is the same syntax used to access an element of a list. However, the `ndarray` is different than a list; it is an array. All the elements of an array are of the same type, and as a result the computer can access the elements more quickly. Lists and tuples are slower than arrays, but they can mix different data types, like strings and integers.
   How are arrays and lists similar? How are they different?

4. Execute the following code and consider line 14.

```
'''
JDoe_JSmith_1_4_3: Change pixels in an image.
'''
import matplotlib.pyplot as plt
import os.path
import numpy as np  # "as" lets us use standard abbreviations
'''Read the image data'''
# Get the directory of this python script
directory = os.path.dirname(os.path.abspath(__file__))
# Build an absolute filename from directory + filename
filename = os.path.join(directory, 'woman.jpg')
# Read the image data into an array
img = plt.imread(filename)
'''Show the image data'''
# Create figure with 1 subplot
fig, ax = plt.subplots(1, 1)
# Show the image data in a subplot
ax.imshow(img, interpolation='none')
# Show the figure on the screen
fig.show()
```

   The `imread()` function is not a method being called on an object here; `plt` was the nickname we assigned to the `matplotlib.pyplot` library when we imported it. The `imread()` function takes a string that is the name of the image file. It returns an array object that is an `ndarray`, an object with properties and methods defined in the `numpy` library. Try: `In []: type(img)`
   The authors of the `ndarray` package called it ndarray because it supports n-dimensional (i.e., any dimensional) arrays. Image arrays can be 2-dimensional:
   [row] [column]
   if each pixel is represented by only one number, as in a black and white image. In an RGB color image, each pixel is a list of three color intensities. Some color images have a fourth number for each pixel called the **alpha channel** that identifies how **opaque** the pixel is. Opaque is the opposite of transparent; you cannot see through an opaque object. Whether the array for each pixel has three or four elements, a color image is a 3-dimensional array:
   [row] [column] [color channel]

   Examine the output:

```
In []: img
```

Each pixel is an array of three numbers–red, green, and blue intensities–each between 0 and 255, inclusive. An array of these pixel arrays forms a row of pixels. An array of the row arrays forms the image. Since `img` is an array of rows,

```
In []: len(img)
```

tells how many rows there are. Since `img[0]` is an array of the first pixel row,

```
In []: len(img[0])
```

tells how many pixels wide the image is. Since `img[5]` is the 6th row of pixels (don't forget the first one is indexed with zero!), `img[5][9]` is the 10th pixel in the 6th row. Since the three elements of that pixel's array are RGB intensities, `img[5][9][1]` is the green intensity at (5, 9).

Referring to lines 10-12 of your code, use the IPython session to open the image `woman.gif`. Determine the values of

- the height = the number of rows of pixels =__________________
- the width = the number of columns = __________________
- the green intensity at (5,9) = `img[5][9][1]`
- the red intensity at (4,10) = __________________
- the red intensity of the 25th pixel in the 50th row = __________________