Plan for October 22

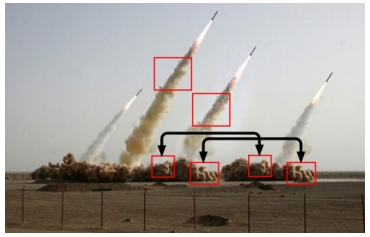
- Images, tuples, RGB color model
  - Image processing by understanding API
  - Image processing with tuples and generators
  - Image processing with pixels and filters
- Review problem-solving with sets, list comprehensions, and thinking
  - Toward reveling in APT quests and adventures

Near-term Administrivia and Due Dates

- Midterm regrade:
  - Review rubric, ask Prof in your section
- Mastery APTs for mid-term catchup
  - October 23 and October 30
- Programming Assignments: Four left
  - 10/29, 11/5, 11/19, 12/3
- APTs and APT Quizzes
  - Quizzes: 11/2, 11/16, 11/30 (moved by one week)
- Midterm exam and final
  - November 12, December 9 and 13

Image Processing

- What's real, what's Photoshopped
  - http://bit.ly/1Kj0Kn6 from 2008
  - Learn more at http://bit.ly/1Psi0hG, we'll do very basic stuff in class and lab, next assignment too!



Example: convert color to gray scale

Process each pixel
Convert to gray

Let's look at GrayScale.py

- Key features we see
  - Import Image library, use API by example
  - Image.open creates an image object
- Image functions for Image object im
  - `im.show()`, displays image on screen
  - `im.save("xy")`, saves with filename
  - `im.copy()`, returns image that's a copy
  - `im.load()`,[x,y] indexable pixel collection
  - `im.getdata()`,iterable pixel generator
- Let's look at two ways to process pixels!

Image Library: open, modify, save

- `Image.open` can open most image files
  - .png, .jpg, .gif, and more
  - Returns an image object, so store in variable of type Image instance
  - Get pixels with `im.getdata()` or `im.load()`
- `Image.new` can create a new image, specify color model "RGB" and size of image
  - Add pixels with `im.putdata()`
- These belong to Image package

`im.getdata()`, accessing pixels

- Returns something *like* a list
  - Use: `for pix in im.getdata():`
  - Generates pixels on-the-fly, can't slice or index unless you use `list(im.getdata())`
  - Structure is called a Python generator!
  - Saves on storing all pixels in memory if only accessed one-at-a-time
- See usage in GrayScale.py, note how used in list comprehension, like a list!

Generator: Tuples and Pixels

- The `im.getdata()` function returns list-like iterable
  - Can use in list comprehension, see code
  - Use `.putdata()` to store again in image

```
pixels = [makeGray(pix) for pix in im.getdata()]
```

```
def makeGray(pixel):
    r,g,b = pixel
    gray = (r+g+b)/3
    return (gray,gray,gray)
```

Making Tuples and Generators

- Overuse and abuse of parentheses
  - To create a tuple, use parentheses

```
for pix in im.getdata():
    (r,g,b)  = pix
    npx  = (255-r,255-g,255-b)
```

  - To create a generator use parentheses as though creating a list comprehension!

```
[2*n for n in range(10000)]
(2*n for n in range(10000))
```

- See this in PyDev console

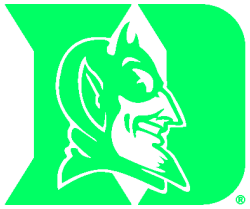
Questions about Image Code

http://bit.ly/101fall15-oct20-2

Example: convert blue to green

Process each pixel
Convert blue ones to green

Is this like red-eye removal?



Making blue things green

- How do we identify blue pixels?
  - In the blue devil image it's easy, not white
  - (R,G,B) triple for white? (255,255,255). So not white?
- Not sure about B value, but perhaps R value is low, at least lower than 255
  - Let's try changing based on R < 200
  - See Colorme.py
  - http://www.rapidtables.com/web/color/RGB_Color.htm
- Tuples are immutable, so examine tuple
  - Return a new tuple, function makeGreen

Code in GrayScale.py and Colorme.py

- Very similar! Loop over pixels, change each
  - Capture the similarity by parameterizing what changes, common way to solve-problems
  - Pass in the function makeGray or makeGreen
  - This is what happens in lab this week! See ColorAnyway.py
- What's a green-screen technique?



`im.load()`, accessing pixels

- Returns something that can be indexed [x,y]
  - Only useful for accessing pixels by x,y coords
- Object returned by `im.load()` is ...
  - Use pix[x,y] to read and write pixel values
- Note: this is NOT a generator

```
pix = im.load()
tup = pix[0,0]
pix[1,1] = (255,255,0)
```


Set, List, Join, and APT Review

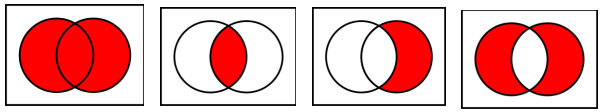
- Sets don't contain duplicates
  - Simple to create from a list, .add for more
  - Not accessible by index, can iterate over elts
  - Very, very fast: `x in SET`, compare list
- Look at WordCompositionGame APT
  - How to think about solving this?
  - http://www.cs.duke.edu/csed/pythonapt/wordcomposition.html

Can you solve this with paper/pencil?

- Conceptually, in words, how to find words worth 3 points for listA player?
  - Describe how you determine this (English, not Python)
  - What about three points for player listB, listC?
- How do you find words that score 2?
  - Can you express in terms of set operations? Like the previous example?

APT WordCompositionGame

- Using sets and set operations can help
  - Set intersection and set union
  - Other set operations
- A | B, set union, A & B, set intersection
- B – A, set difference, B ^ A, symmetric diff



Answer Questions

http://bit.ly/101fall15-oct22-1

Code smells you start understanding

- If you wrote code to score for player listA
  - How to use code for player listB and listC?
  - Would the code fragments be similar?
- Capture differences via parameters when there's lots of duplication in code
  - See the example in GrayScale and Colorme

APT AnagramFree

- How do you know "spear" and "pears" are anagrams?
  - Sort the words and see if sorted form the same
  - What is returned by `sorted("spear")`?
  - What type is `''.join(sorted("spear"))`
  - Can we use `''` or `' '` or `':'` or `'|'`
- How do you know whether there are many words that are anagrams? Can sets help?