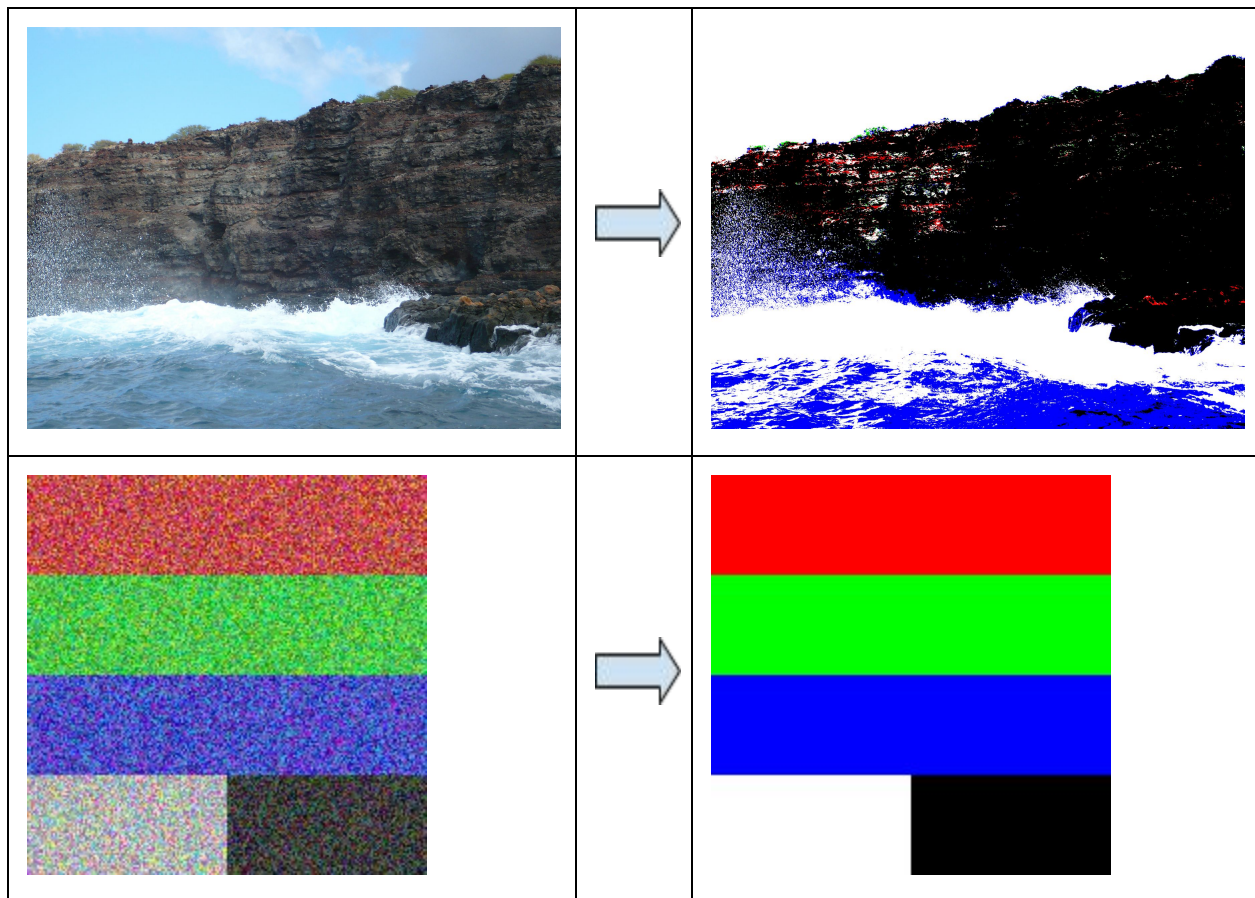


CS 101  
Fall 2015  
Program Assignment # 6  
Algorithm Due : Sunday, 11/8/2015  
Program Due : Sunday, 11/15/2015

## Color Reduction

Many years ago computers couldn't display 1000's of colors. Images would have their color reduced. Now color reduction can be used to create image effects to give it a cartoonish look. Reduction is also used for some visual systems in robotics and other applications to help recognize objects. For this assignment we will read an image in the PPM format, and adjust the colors to be the closest of a choice of colors.



The image on the left has the possibility of 16,777,216 colors, while the picture on the right uses 5 possible colors

## PPM Files

Portable PixMap format or PPM is a simple image file format. There are a few variants of the PPM format, but we will be concentrating on one particular specification of the text file versions. Since it's just a normal text file, we can open, read and write the image files just like they were any normal text document. This makes it very convenient since we can use all the Python file handling techniques we've learned this semester. We have included ***ppmReader.html*** to view the ppm files that have been supplied. You may also want to use an image editor like gimp to view the images ( <http://www.gimp.org> ). You will also want to examine the files in a text editor.

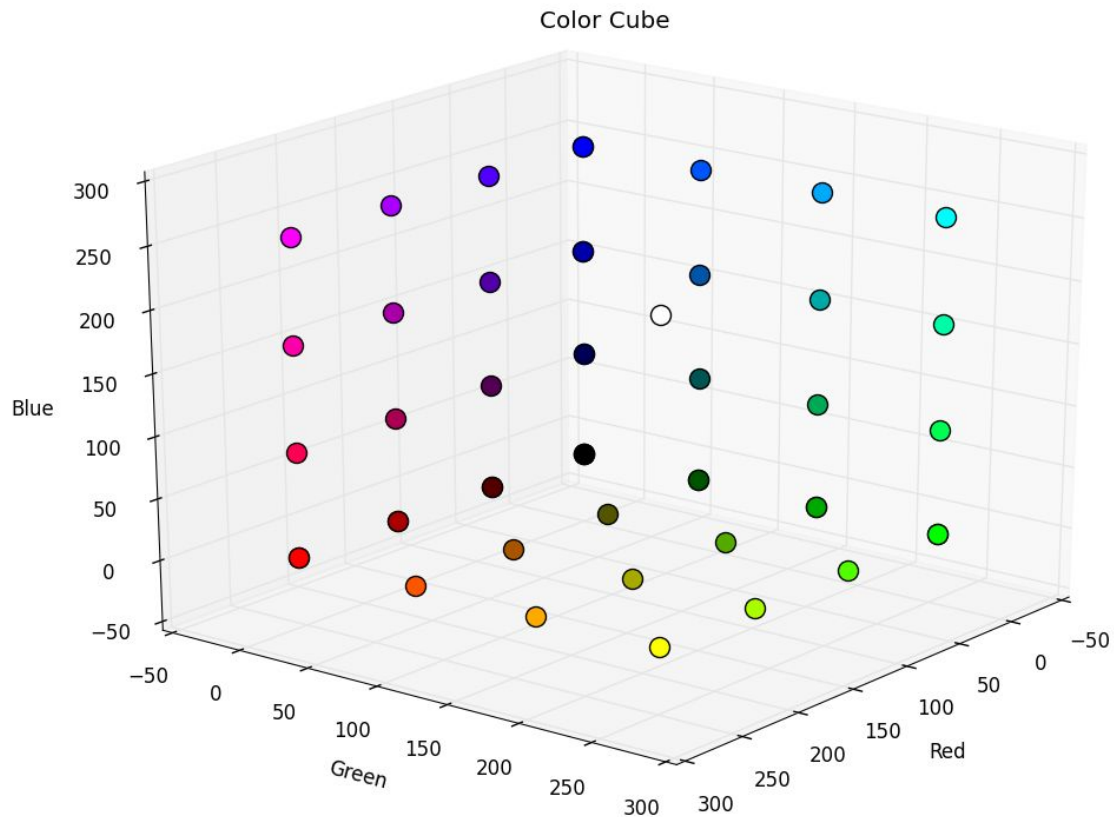
PPM Format ( Ocean.ppm )

Line #	Example Data	Description
1	P3	PPM Header information. P followed by a number. We'll be using the P3 format.
2	3072 2304	Size of the image in pixels. This 3072 wide and 2304 pixels tall.
3	255	Color Depth of the Image. Each Red, Green, Blue component will be 0-255 in value. This is always 255 in our examples.
4	143	Red Component of the first pixel.
5	211	Green component of the first pixel
6	255	Blue Component of the first pixel
7	144	Red component of the second pixel
...	...	...
21233665	80	Red component of last pixel
21233666	112	Green component of last pixel
21233667	135	Blue Component for the last pixel.

The PPM format is very flexible. In our incarnation each color component is on a separate line. We also will not have any comments in the header. If you save an ASCII ppm file from gimp you will have to edit the resulting text file and remove the comment from the header.

## Color Reduction

We will be reducing an image down to 5 colors; Red, Green, Blue, White, and Black. Each pixel is made up of a red, green and blue component. In the files we will be working with each has 256 values from 0 - 255. You can imagine each pixel color being a point in a 3 dimensional model.



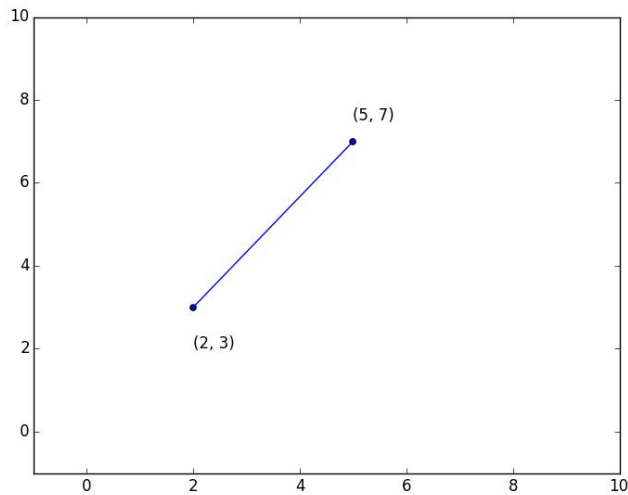
You'll notice that the color at the back of 0, 0, 0 is black. If you follow out the red direction you'll notice the color getting redder. Same with green and blue. The white point shown is directly opposite the black point in the cube and is located at 255, 255, 255.

We will convert our image into the following color points

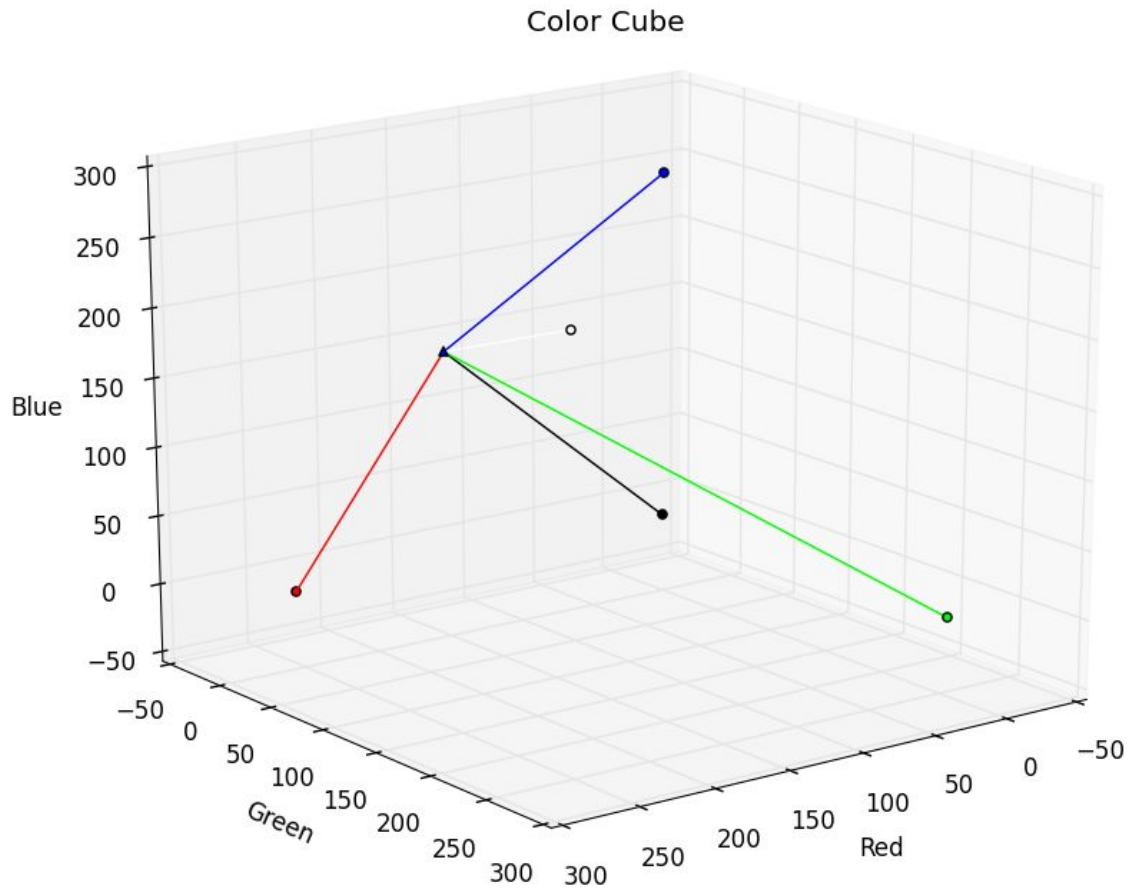
Color	Red	Green	Blue
Red	255	0	0
Green	0	255	0
Blue	0	0	255

Black	0	0	0
White	255	255	255

The first pixel in Ocean.ppm is 255, 143, 211. We want to convert that color to one of our 5 choices of colors. We can use the Euclidean distance to find which color point is closest to our color. You may know how to get the Euclidean distance of 2 points in a 2d plane.



This diagram shows a 2d plane with points at (2, 3) and (5, 7). The distance between them is calculated by  $distance = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$ . The distance here is 5. To find the distances in a 3d plane we can extend this formula with x, y's and z's. We can replace those with r for red, g, for green and b for blue. To find the distance from one color to another we would use  $distance = \sqrt{(r_1 - r_2)^2 + (g_1 - g_2)^2 + (b_1 - b_2)^2}$ . The color we want to choose for our color reduced image will be the color that is the shortest distance from the original color.



The triangle is the original color, pixel 1 from Ocean.ppm. In our final output image it will be replaced with one of the 5 colors that it is closest to.

## Requirements

- Display a menu for the user. On an invalid entry warn the user and ask for input. 1. Reduce Color PPM, Q. to Quit
- Ask the user for a valid file. If the file does not exist the user should be warned and prompted again.
- The PPM files that are loaded should be validated to make sure the first line is P3, signifying that is a PPM file, and the color depth is 255..
- Ask for an output image to save our changes to. If the file cannot be created the user should be warned and prompted again..

## Notes

There is a test\_pattern.ppm file that can be used to help validate your program. The image size is 200 x 200. The first 50 lines are variations of red, 50 lines of greens, 50 lines of blue. The last 50 lines is half white and half black. ( See the example image above. ). Your resulting

output image should look like the example given earlier.

## Definitions

**Pixel** - any one of the very small dots that together form the picture on a television screen, computer monitor, etc. <sup>1</sup>

## Example

```
>>> ===== RESTART =====
>>>
```

Color Reduction

1. Convert PPM Image  
Q. Quit

```
==> 1
Enter a valid filename to convert. ==> nofile.m
The file you specified does not exist. Please enter a valid filename
Enter a valid filename to convert. ==> BadHeader1.ppm
The files first line should be P3
Enter a valid filename to convert. ==> BadHeader2.ppm
The color depth must be 255
Enter a valid filename to convert. ==> umkc.ppm
What is the name of the file you want to save to? ==> umkc_out.ppm
```

Your file has been saved.

Color Reduction

1. Convert PPM Image  
Q. Quit

```
==> q
>>>
```

## Extra Credit ( 5 Points )

The image directories also contain .jpg files. The PPM files supplied were text image files and

can be opened and worked with as a text file. Jpeg files are binary files. The PIL library allows you to open other image types like JPegs, as well as create new images.

- Add a new menu item to convert a jpg.
- Load the image with the pil module and create a new jpg with the colors reduced.
- The PIL library is loaded in the Computer Science lab. If you want the PIL library on your own computer you will have to install the PIL module for your version of Python.

## References

1. "Pixel." *Merriam-Webster*. Merriam-Webster, n.d. Web. 15 July 2014.  
<<http://www.merriam-webster.com/dictionary/pixel>>.
2. Pillow documentation <https://pillow.readthedocs.org/en/latest/>
3. Euclidean Distances <http://mathworld.wolfram.com/Distance.html>