CS 6476 – Problem Set 0 – Images as Functions

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```
In [1]: # Importing the opencv library for Python
        import cv2
```

```
In [2]: # Importing numpy for matrices/images handling
        import numpy as np
```

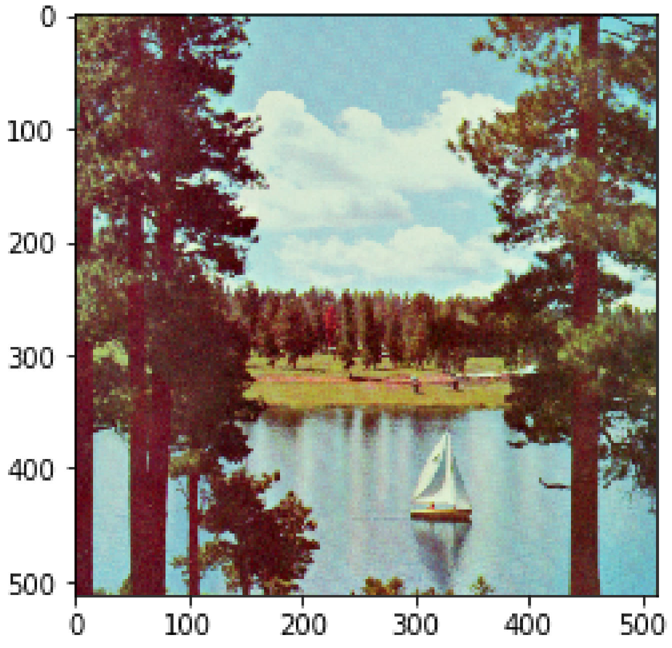
```
In [3]: # Importing matplotlib.pyplot to embed images within this notebook
        import matplotlib.pyplot as plt
```

1. Input images

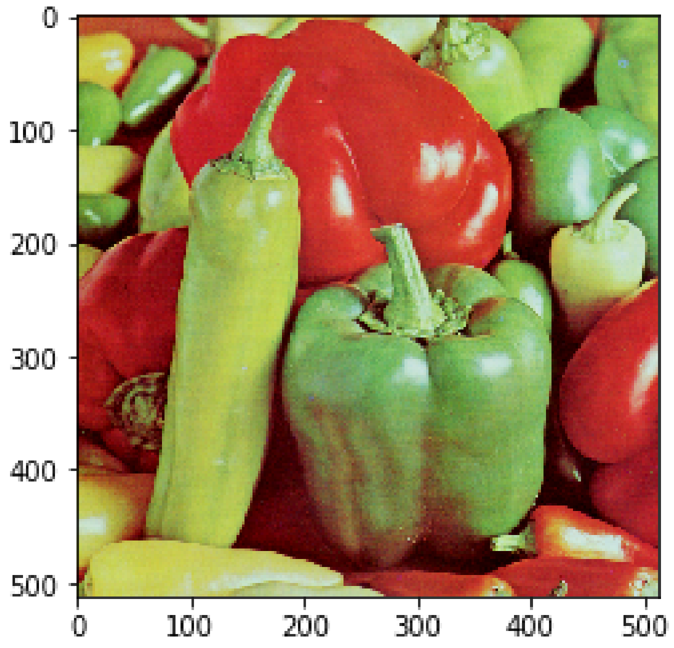
```
In [4]: # Loading the 2 images downloaded
        # from http://sipi.usc.edu/database/database.php?volume=misc
        img1 = cv2.imread('./images/4.2.06.tiff', cv2.IMREAD_COLOR)
        img2 = cv2.imread('./images/4.2.07.tiff', cv2.IMREAD_COLOR)
```

```
In [5]: #Checking that both images have been loaded correctly
        plt.imshow(cv2.cvtColor(img1, cv2.COLOR_BGR2RGB)) #openCV-matplotlib format fix
```

```
Out[5]: <matplotlib.image.AxesImage at 0x1749e278>
```



```
In [6]: plt.imshow(cv2.cvtColor(img2, cv2.COLOR_BGR2RGB))

Out[6]: <matplotlib.image.AxesImage at 0x178e5d68>
```

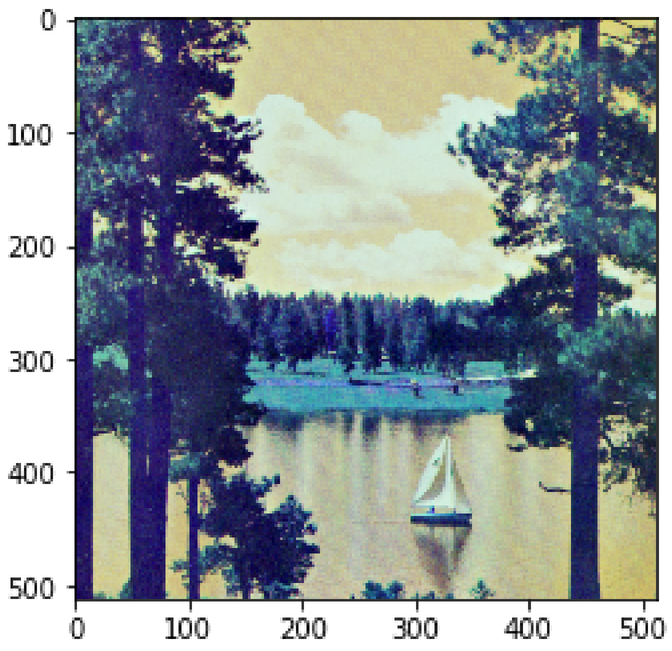


```
In [7]: np.shape(img1) #images are 3-dimensional arrays

Out[7]: (512L, 512L, 3L)

In [8]: #Saving them
        cv2.imwrite('./out/ps0-1-a-1.tiff', img1)
        cv2.imwrite('./out/ps0-1-a-2.tiff', img2)

Out[8]: True
```

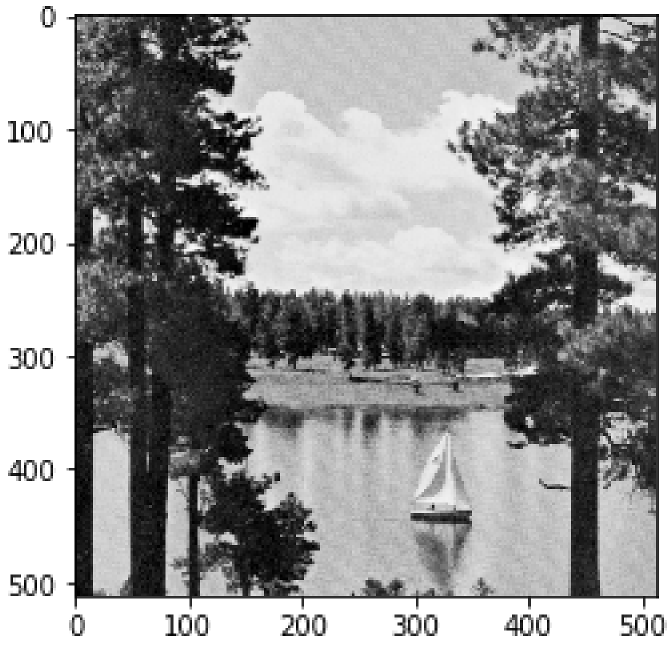
2. Color planes

```
In [9]: #Swap the red and blue pixels of image 1
        img1brswap = img1.copy()

        red_ch = img1brswap[:,:,2].copy() #BGR, red is the 3rd channel
        blue_ch = img1brswap[:,:,0].copy() #BGR, blue is the 1st channel

        img1brswap[:,:,2] = blue_ch
        img1brswap[:,:,0] = red_ch
        cv2.imwrite('./out/ps0-2-a.tiff', img1brswap)
        plt.imshow(cv2.cvtColor(img1brswap, cv2.COLOR_BGR2RGB))
```

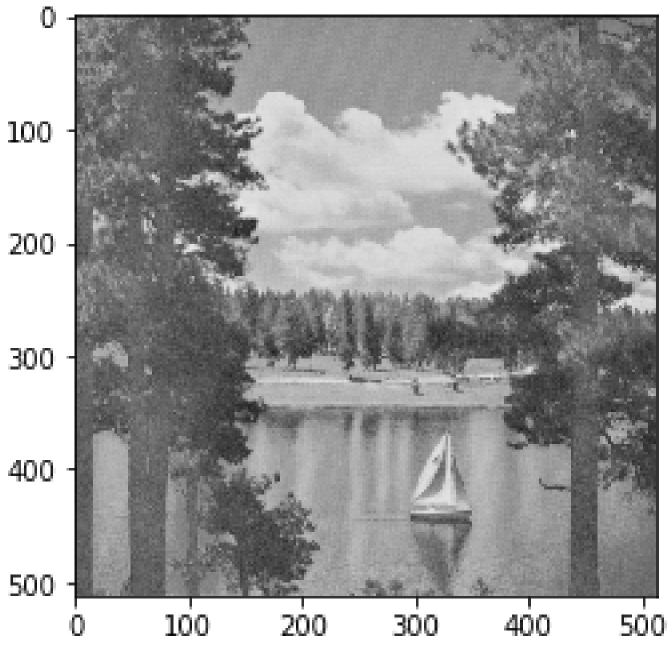
```
Out[9]: <matplotlib.image.AxesImage at 0x17824828>
```



```
In [10]: #Monochrome image from image 1, using only the green channel
         img1Mg = img1[:,:,1].copy() #BGR, green is the 2nd channel

         cv2.imwrite('./out/ps0-2-b.tiff', img1Mg)
         plt.imshow(img1Mg, cmap='gray', vmin = 0, vmax = 255) # prevent plt rescale

Out[10]: <matplotlib.image.AxesImage at 0x1b1269e8>
```



```
In [11]: #Monochrome image from image 1, using only the red channel
         img1Mr = img1[:,:,2].copy() #BGR, red is the 3rd channel

         cv2.imwrite('./out/ps0-2-c.tiff', img1Mr)
         plt.imshow(img1Mr, cmap='gray', vmin = 0, vmax = 255)

Out[11]: <matplotlib.image.AxesImage at 0x1b325320>
```

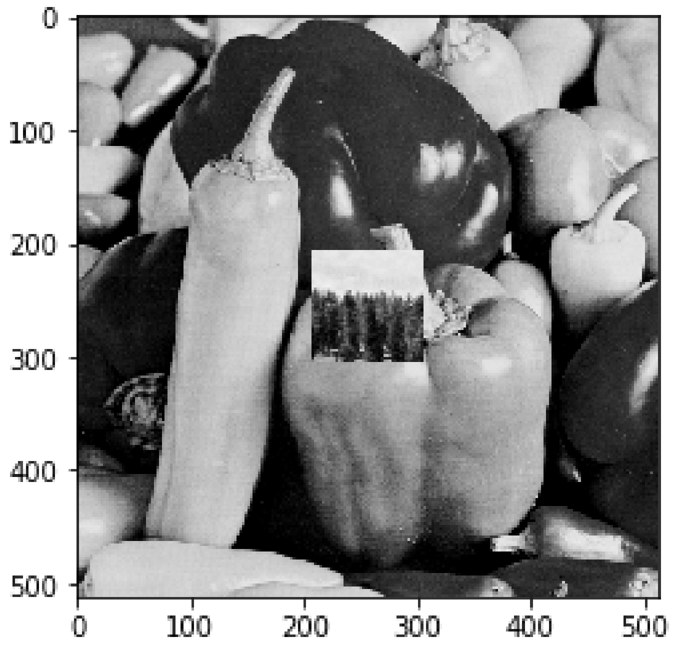


d. The image obtained from extracting the green channels seems to be closer to what I would expect a monochrome image to look like. The contrast and distinction between black and white parts are more accentuated, comparatively to the other image (using the red channel). In the second case, it seems like everything is closer to an in-between value, moderately grey. While it depends on what kind of algorithms we are looking to use and what goal we are pursuing, I think the green-channel one would be more useful when contrasts (or intensity differences) are important (e.g. identifying different zones of an image).

3. Replacement of pixels

```
In [12]: #Replacing inner 100 pixels square from one image by another
         img2Mg = img2[:,:,1].copy()

         margin = (np.shape(img1Mg)[0] - 100) / 2 #both images are the same size
         img1MgInner = img1Mg[margin:-margin, margin:-margin].copy()

         img2MgRep = img2Mg.copy()
         img2MgRep[margin:-margin, margin:-margin] = img1MgInner

         cv2.imwrite('./out/ps0-3-a.tiff', img2MgRep)
         plt.imshow(img2MgRep, cmap='gray', vmin = 0, vmax = 255)
```

```
Out[12]: <matplotlib.image.AxesImage at 0x1b59b6d8>
```



4. Arithmetic and Geometric operation

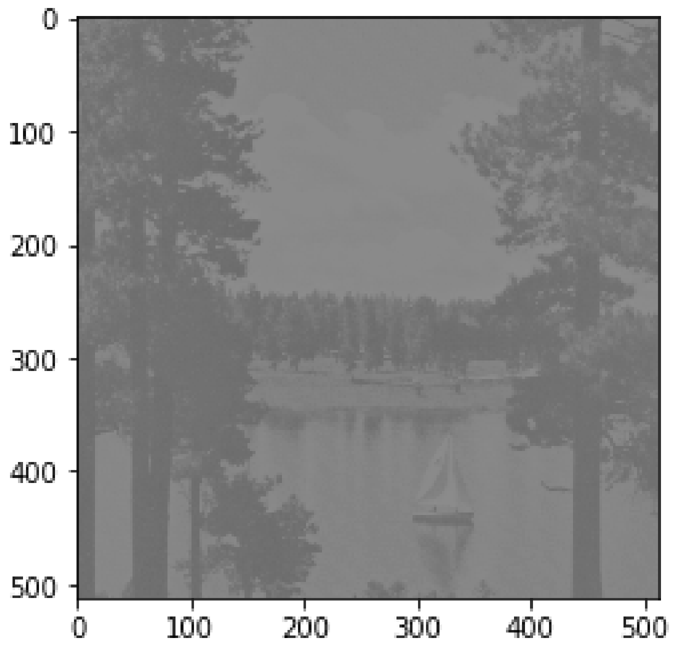
```
In [13]: print np.min(img1Mg), np.max(img2Mg), np.mean(img1Mg), np.std(img1Mg)
```

```
0 237 124.3044548034668 77.63570734791477
```

The minimum and maximum pixel intensity values for the monochrome version of Image 1 are 0 and 237. The average is about 124 and the standard deviation, about 78. These values were obtained using Numpy's built-in vectorized methods.

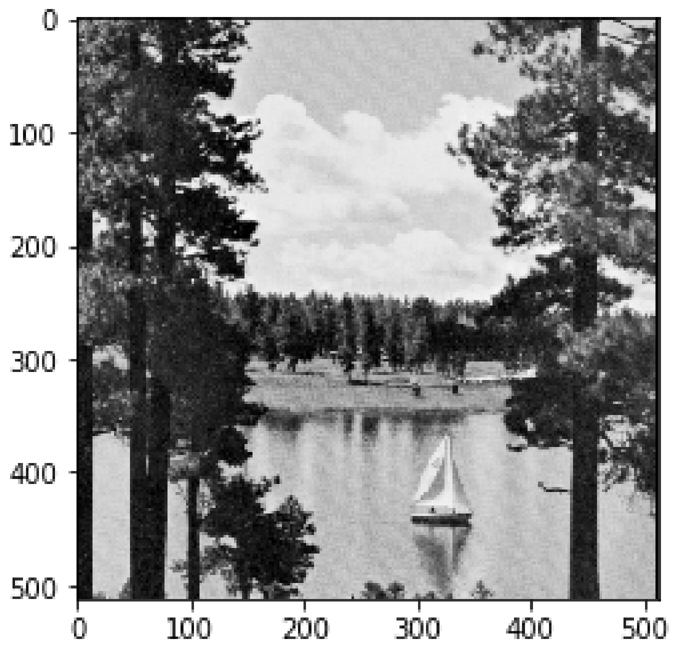
```
In [14]: #Operations on the monochrome image with mean and std.
         img1MgMeanStd = (img1Mg - np.mean(img1Mg))/np.std(img1Mg) * 10 + np.mean(img1Mg)
         cv2.imwrite('./out/ps0-4-b.tiff', img1MgMeanStd)
         plt.imshow(img1MgMeanStd, cmap='gray', vmin = 0, vmax = 255)
```

```
Out[14]: <matplotlib.image.AxesImage at 0x1b7017b8>
```

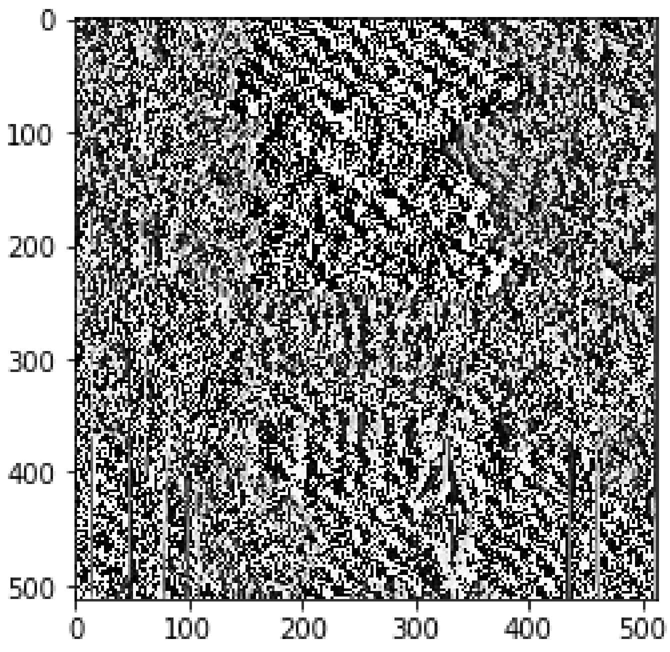


```
In [15]: #Shifting the image by 2 pixels
         img1MgShift = np.roll(img1Mg, shift = -2, axis = 1)
         cv2.imwrite('./out/ps0-4-c.tiff', img1MgShift)
         plt.imshow(img1MgShift, cmap='gray', vmin = 0, vmax = 255)
```

```
Out[15]: <matplotlib.image.AxesImage at 0x1b9c7eb8>
```

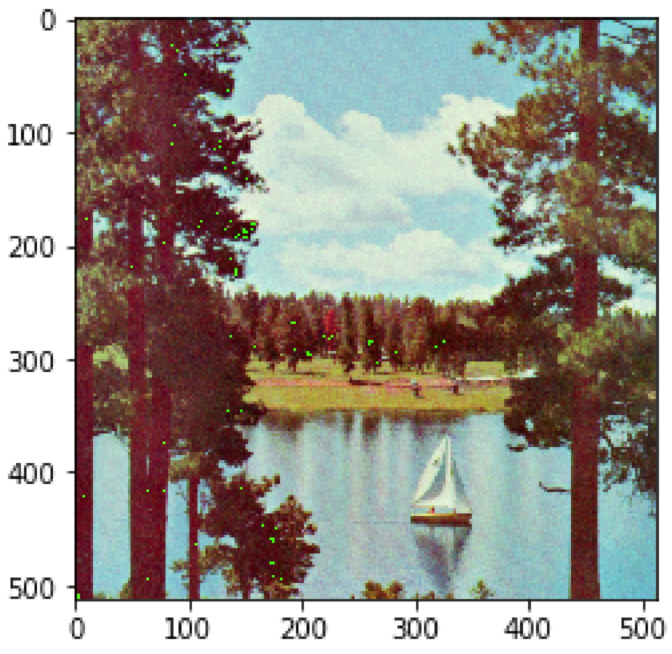


```
In [16]: #Substracting the shifted image to the original
         img1MgDiff = img1Mg - img1MgShift

         img1MgDiff[img1MgDiff < 0] = 0
         cv2.imwrite('./out/ps0-4-d.tiff', img1MgDiff)
         plt.imshow(img1MgDiff, cmap='gray', vmin = 0, vmax = 255)

Out[16]: <matplotlib.image.AxesImage at 0x1ba3da58>
```



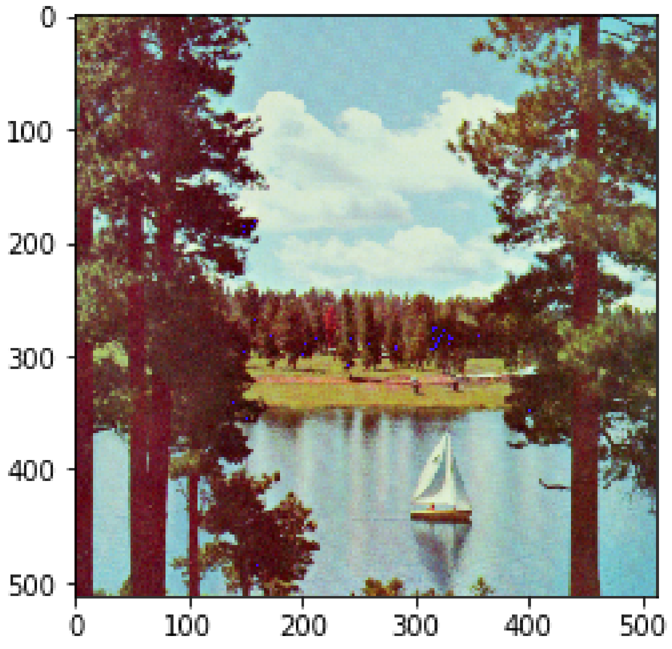
5. Noise

```
In [33]: #Adding gaussian noise
         sigma = 5

         noise = np.zeros_like(img1)
         noise[:,:,1] = np.random.standard_normal(np.shape(img1)[0:2]) * sigma
         img1Noisy = img1 + noise
         img1Noisy[img1Noisy < 0] = 0
         img1Noisy[img1Noisy > 255] = 255

         img1Noisy = img1Noisy
         cv2.imwrite('./out/ps0-5-a.tiff', img1Noisy)
         plt.imshow(cv2.cvtColor(img1Noisy, cv2.COLOR_BGR2RGB))

Out[33]: <matplotlib.image.AxesImage at 0x1e2abcc0>
```



The noise was visible starting from sigma = 1, but I've increased it a bit (5) to have noise present in different areas.

```
In [18]: #Adding gaussian noise
         sigma = 5

         noise_blue = np.zeros_like(img1)
         noise_blue[:,:,0] = np.random.standard_normal(np.shape(img1)[0:2]) * sigma
         img1NoisyBlue = img1 + noise_blue
         img1NoisyBlue[img1NoisyBlue < 0] = 0
         img1NoisyBlue[img1NoisyBlue > 255] = 255

         img1Noisy = img1Noisy
         cv2.imwrite('./out/ps0-5-b.tiff', img1NoisyBlue)
         plt.imshow(cv2.cvtColor(img1NoisyBlue, cv2.COLOR_BGR2RGB))

Out[18]: <matplotlib.image.AxesImage at 0x1cf7e4a8>
```



c. In this case, for this image and this amount of noise, the blue noise doesn't affect the image as the green noise. As the noise on the green channel happens to be very visible (green becomes prevalent over other channels) in dark areas (where the contrast is important), it is more difficult to perceive a difference with noise on the blue channel. Hence, the second image looks better.