COSC 190, AI, Computer Vision, and Cognition
HW#1
Instructor: Dr. Fred Park

Part I

1. Work through the matlab handout.
2. Plot your favorite function using matlab.
3. Write a function handle f for a quadratic polynomial. Plot the polynomial. What's the difference between a function and a function handle?
4. What is the difference between a row vector and a column vector? Can you change one to the other and vice versa? How so?
5. Write down an example of a matrix. How is the sizing of the matrix determined? Write down a 2×3 matrix A.
6. If I want to square all the elements in the matrix A you just created above, how would I do so?
7. What's the difference between the $.*$ and $*$ operator when multiplying two vectors? Are they the same? i.e. does $x.*y = x*y$ for any two vectors? Why or why not?

Part II

1. Write a "for" loop that outputs each number from 1 to 10.
2. Write a "for" loop that sums the numbers from 1 to N, where N is input chosen by the user.
3. Write a "for" loop that takes a product of the numbers from 1 to N, where N is input chosen by the user.
4. Repeat 1, 2, and 3 using a "while" loop.
5. Sum all of the numbers from 1 to 100 in two different ways. Using your code. And then by adding two appropriately chosen vectors and then summing the entries.
6. Type "help randi" at the matlab prompt. Can you think of a way to create the coin flip probability experiment with 2 coins using this function? How's about the 4 coin flip experiment? Write out pseudo-code for this experiment.
7. Write a script that uses the randi function and calculate the probabilities for the coin flip problem with 2 coins, 4 coins, and N coins. Here, N is input by the user.

Part III

1. **Matrices:** A matrix is a rectangular array of numbers as defined in class.
   Given the matrix defined in matlab: `>> A = [1 2 3; 4 5 6]`,

   (a) What is the size of the matrix A? How many rows and columns? How can you use Matlab to determine the size?

   (b) Using matlab code, in one command, extract the first row of the matrix A and output it. Do the same for the third column.

   (c) In one command, square every entry in the matrix A and output it.

   (d) In one single Matlab command, add a third row to the matrix A with entries 7, 8, and 9.

2. **Color Image Viewing and Manipulation:** Load in the 'marbles.jpg' image into the Matlab workspace. You can find the image on my website: `www.fredpark.com/teaching`
   (hint: use the command `>> f = imread('marbles.jpg');`)

   (a) Use the command: `>> figure(1); image(f);` to view the image and add the title "Color Image" to it.

   (b) Using specific matlab notation, extract the red, green, and blue channels from the color image respectively.
   (hint: you can try using `>> R = f(:,:,1);` to extract the red channel. What does the ':' notation represent?)

   (c) Use the matlab subplot environment to plot both the image and the R, G, and B channels in the same figure. Use a Matlab script to do so. Make sure to title each of the channels in the subplots.

   (d) Now, manipulate the color image f by blacking out the red and green marbles so that only the blue marble is viewable. You can set the side of the image containing the red and green marbles to a pixel intensity of 50. Now view the image and you should only be able to see the blue marble.

   (e) Take a picture with your mobile device of an object that contains red, green, and blue colors. Load that image into the Matlab console and repeat the same decomposition as in (c). Does the decomposition into channels agree with the color image model?

3. **Explain in Your Words:** Explain in words what the key issue is with color constancy in images. i.e. what is the issue with the computers color sensing under differing illumination conditions? Is the human system better or worse?

4. **Retinex Revisited:** Using the transformation from the first day of class to linearly re-map the min and max values of f to 0 and 255 respectively.

   (a) (optional) For you advanced students, you can create a coefficient matrix A and write the problem of finding α and β from $y = \alpha x + \beta$ as a 2×2 system $A\vec{x} = \vec{b}$ where $\vec{x}$ contains α and β and you can figure out what $\vec{b}$ contains. You can solve for $\vec{x}$ by using the simple matlab command for Gaussian Elimination: `A\b`

   (b) Histogram viewing. Use the "hist" definition from class to view the histogram distribution of the image intensities for both the original image and the one you adjusted the contrast on. What do you notice?

   (c) Are the high intensity values sparsely distributed?

   (d) Adjust the contrast of the 'landscape.jpg' image to an acceptable level using the linear mapping technique discussed in class where the min and max values of the image are mapped to [0, 255].

   (e) Can you think of a way to increase the contrast of the shirt in the 'pout.tif' image? It seems a bit dark still in the contrast adjusted image? Hint, find a way to neglect certain high intensity values so you can boost the next set of intensities.

   (f) Adjust the contrast of the 'people.png' image to an acceptable level where the faces of the people are discernible. Note: you may need to adjust the values you are mapping. For example, the max and min value mapping to [0 , 255] may not be sufficient. You may want to consider thresholding a certain percentage of the values above a range and below a range. Then applying the linear mapping method discussed in class.

   (g) **Adjust Your Own Photo**: Take a photo under a low light situation using your smartphone device. Load the image into Matlab and apply the linear mapping technique to adjust the illumination of the image. Note: depending on your image, you may need to use the method discussed in 4(d)–4(e). The best results will be presented in class.