# Homework 1

ECE 253
Digital Image Processing

October 7, 2019

**Make sure you follow these instructions carefully during submission :**

- Homework 1 is due by 11:59 PM, October 18, 2019.
- All problems are to be solved using MATLAB/Python.
- You should avoid using loops in your MATLAB/Python code unless you are explicitly permitted to do so.
- Submit your homework electronically by following the two steps listed below:

  1. Upload a pdf file with your write-up on Gradescope. This should include your answers to each question and **relevant code snippet**. Make sure the report mentions your full name and PID. Finally, carefully read and include the following sentences at the top of your report:

     *Academic Integrity Policy: Integrity of scholarship is essential for an academic community. The University expects that both faculty and students will honor this principle and in so doing protect the validity of University intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind.*

     *By including this in my report, I agree to abide by the Academic Integrity Policy mentioned above.*

  2. Upload a zip file with all your scripts and files on Gradescope. Name this file: **ECE_253_hw1_lastname_studentid.zip**. This should include all files necessary to run your code out of the box.

**Problem 1. Basics (3 points)**

$$\text{Input } A = \begin{bmatrix} 3 & 9 & 5 & 1 \\ 4 & 25 & 4 & 3 \\ 63 & 13 & 23 & 9 \\ 6 & 32 & 77 & 0 \\ 12 & 8 & 6 & 1 \end{bmatrix} \text{ and } B = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix}.$$

(i) Point-wise multiply A with B and set it to C.

(ii) Calculate the inner product of the 2nd and 4th row of C.

(iii) Find the minimum and maximum values and their corresponding row and column indices in matrix C. If there are multiple min/max values, you must list all their indices.

In your report include all the outputs generated by your code.

**Problem 2. Simple image manipulation (5 points)**

(i) Download any color image from the Internet or use one of the given images. Read this image and call it **A**.

(ii) Transform the color image to gray-scale. Verify the values are between 0 and 255. If not, please normalize your image from 0 to 255. Call this image **B**.

(iii) Add 15 to each value of image B. Set all pixel values greater than 255 to 255. Call this image **C**.

(iv) Flip image B along both the horizontal and vertical axis. Call this image **D**.

(v) Calculate the median of all values in image B. Next, threshold image B by the median value you just calculated i.e. set all values greater than median to 0 and set all values less than or equal to the median to 1. Name this binary image **E**.

Include all images A-E in your report. Try to fit at least 4 images in a page.

**Problem 3. Histograms (6 points)**

Histograms[1] are a great statistical tool to analyze the distribution of intensity values in an image. In this problem, you have to write a MATLAB/Python function with the following specifications -

- Write a function named *compute_norm_rgb_histogram* that computes the RGB color histogram.
- Use 32 bins for each color channel (i.e. Red, Green and Blue), spaced equally between 0 and 255. This should result in a 32-length vector for each channel.

[1]You can read more about Histograms here.

- One input (RGB/color image) and one output (1 x 96 vector).
- Concatenate the three histograms together (in the order R, G, B) to make a combined histogram of length 3 x 32 = 96. Once you have computed the combined histogram, normalize it so that it sums to 1.
- Do not use MATLAB/Python inbuilt histogram function. You may use loops if necessary.
- Call the function and plot the final combined, normalized histogram for the image *geisel.jpg*. Make sure the plot is labeled correctly. Show your plot in the report.

**Problem 4. Chroma Keying (6 points)**

Chroma keying is used for extracting the foreground from images, with the background typically being a green screen. In this problem, you have been provided 2 images: *travolta.jpg* and *dog.jpg*. Write a matlab script to extract the foreground from either image and overlay the foreground on a different background of your choice. In your report you should include for each of the images:

(i) A binary image showing the foreground mask, i.e., all foreground pixels set to 1 and all background pixels set to 0.

(ii) An image with the background pixels set to 0 and the foreground pixels set to their original values.

(iii) An image with the foreground overlayed on a background of your choice.

**Problem 5. Upsampling and downsampling (10 points)**

Sampling is a technique that enables you to resize the image to desired resolution. Different interpolation techniques can be used for sampling. In this question, you will perform experiments on different interpolation methods for upsampling and downsampling (Hint: you can use resize function for both upsampling and downsampling).

(i) What are the interpolation methods you can find? (Please list 3)

(ii) How does each of the method work? (Please describe the method in 1-3 sentences)

(iii) Please select 3 color images and downsample using different methods. What are the differences you can observe visually? Which interpolation method do you think to work better?

- Dowsampling ratio: 0.3, 0.5, 0.7
- Please include the images in the report. Crop small regions to compare if necessary.

(iv) Please select 3 color images and upsample using different methods. What are the differences you can observe visually? Which interpolation method do you think to work better?

- Upsampling ratio: 1.5, 1.7, 2
- Please include the images in the report. Crop small regions to compare if necessary.

(v) Please select 3 color images. Downsample the images with scale 0.1 and upsample to original size. Which interpolation combination do you think to work the best?