**Due: $22^{nd}$ Jan 2018 11:55 PM**

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# Part 0

## Tutorial Script

Run the file called `matlab_image_tutorial.m` (will need file 'fruits.jpg') in MATLAB. Follow the content displayed on the MATLAB command window and understand the functions being used. Use the return key to un-pause the execution and go through all the steps.

# Part I

## Exercise 1

**2 points**

Download a color image of your favorite Marvel superhero from the Internet and write a Matlab script to perform the following operations on that image:

- Crop the head of the superhero from the image.
- Save the cropped sub-image as a PNG file.
- Display the green component of the cropped image.
- Change the order of the color components to [Green,Red,Blue] for the original image and display the image. {Don't use loops}

## Exercise 2

**2 points**

Write a Matlab script to perform the following operations on "barbara.jpg":

- Convert the image to gray scale.
- Plot a histogram of the gray scale image with bin-size of 5 in intensity.
- Blur the gray scale image by using Gaussian filters of size $15 \times 15$ with standard deviations 2 and 8.
- Plot histograms for the blurred images. How do they differ from each other and the original histogram?
- Subtract the blurred image obtained using the filter with standard deviation of 2 from the original gray scale image.

- Threshold the resultant image at 5% of its maximum pixel value.
- Display the final image.

What does the final image look like?

# Part II

## Filtering

**2 points**

- Filter the following matrices $I_1$ and $I_2$ without using built-in MATLAB functions.

$$I_1 = \begin{bmatrix} 120 & 110 & 90 & 115 & 40 \\ 145 & 135 & 135 & 65 & 35 \\ 125 & 115 & 55 & 35 & 25 \\ 80 & 45 & 45 & 20 & 15 \\ 40 & 35 & 25 & 10 & 10 \end{bmatrix} \quad I_2 = \begin{bmatrix} 125 & 130 & 135 & 110 & 125 \\ 145 & 135 & 135 & 155 & 125 \\ 65 & 60 & 55 & 45 & 40 \\ 40 & 35 & 40 & 25 & 15 \\ 15 & 15 & 20 & 15 & 10 \end{bmatrix}$$

  Using:

  1. $\frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \end{bmatrix}$
  2. $\frac{1}{3}\begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$
  3. $\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

- Apply following filters on the gray scale image of barbara from Part I.
  1. Central difference Gradient filter
  2. Sobel filter
  3. Mean filter
  4. Median filter

  **Note**: You can use `fspecial`, `imfilter` functions in Matlab to accomplish the above and below tasks. Do not use `imgradient`.

## Smoothing

**4 points**

Read the image 'camera_man_noisy.png' and filter using following filters:

1. Averaging filters of sizes $2 \times 2, 4 \times 4, 8 \times 8, 16 \times 16$.
2. Gaussian filter of standard deviations 2, 4, 8, 16 (A good choice of gaussian filter size is 4 times its standard deviation, in order to include most of the variability within the box).

Which filter works best?
What happens when you vary the box filter size?
What happens when you vary the standard deviation of gaussian filter?

## *Grad credits:* Edge preserving smoothing

**5 points**

A bilateral filter is an edge-preserving smoothing filter. The intensity value at each pixel in an image is replaced by a weighted average of intensity values from nearby pixels. The weights are obtained by a product of two Gaussian functions: 1) a Gaussian function of the spatial distance and 2) a Gaussian function of the intensity differences. It is this second Gaussian function that preserves the intensity edges.

Download the bilateral filter code from:
http://www.mathworks.com/matlabcentral/fileexchange/12191-bilateral-filtering.
Run the file runDemo.m to see a demo on denoising via bilateral filtering.

Denoise 'camera_man_noisy.png' using bilateral filter. The bilateral filter has three variables: 1) spatial standard deviation 2) intensity standard deviation and 3) size. Find the best parameters that work for you and report them along with the denoised image. Compare the denoised image from bilateral filter with the one from the best Gaussian filter.

The"optimal" choice of intensity standard deviation ($\sigma_I$) of the bilateral filter is related to the noise standard deviation. What will happen if we choose $\sigma_I$ to be very large? What will happen if we choose $\sigma_I$ to be very small, say almost zero? For a particular noise standard deviation, what value (or range of values) of $\sigma_I$ would you prescribe?

# Submission Instructions

Every student must submit following 2 files:

- An organized report submitted as a PDF document. The report should describe the implementation, issues (problems encountered, surprises), and an analysis of the test results (interpretation of effects of varying parameters, different image results). Intermediate and final results must be provided.
- A ZIP file containing the necessary codes.

The heading of the PDF file should contain the assignment number and topic. Also, attach a photo of yourself at top-left of the PDF along with your name and department.

# Late Submission Policy

Assignments are expected to be submitted on the due date. Each student gets a total of 3 late days that can be used however you wish. For examples, all 3 days can be used towards 1 assignment or 1 day late for 3 assignments or other combinations. Late submissions beyond that will be penalized as below:

- One day late will be penalized 25% of the credit.
- Two Days late will be penalized 50%.
- Submissions more than 2 days late will not be considered for credit.

I will be ruthless in enforcing this policy. There will be no exceptions

# Collaboration Policy

I encourage collaboration both inside and outside class. You may talk to other students for general ideas and concepts but the programming must be done independently. For mid-term and final examination there will be no collaboration permitted.

# Plagiarism

Plagiarism of any form will not be tolerated. You are expected to credit all sources explicitly. If you have any doubts regarding what is and is not plagiarism, talk to me.