HW01

March 6, 2020

1 Computer Vision - HW01

Mohammad Doosti Lakhani - 98722278

This notebooks consists of:

1. Importing Libraries
2. Loading a Grayscale Image
3. Functions
4. Gaussian vs. Average
    1. Applying 5x5 Average Filter
    2. Applying 5x5 Gaussian Filter
    3. Compare Using RMSE
5. Gaussian vs. 2X Gaussian
    1. Applying 5x5 Gaussian Filter With `sigma1=1` *Twice*
    2. Applying a Gaussian Filter with Proper Size *Once*
    3. Compare Using RMSE

1.1 1 Importing Libraries

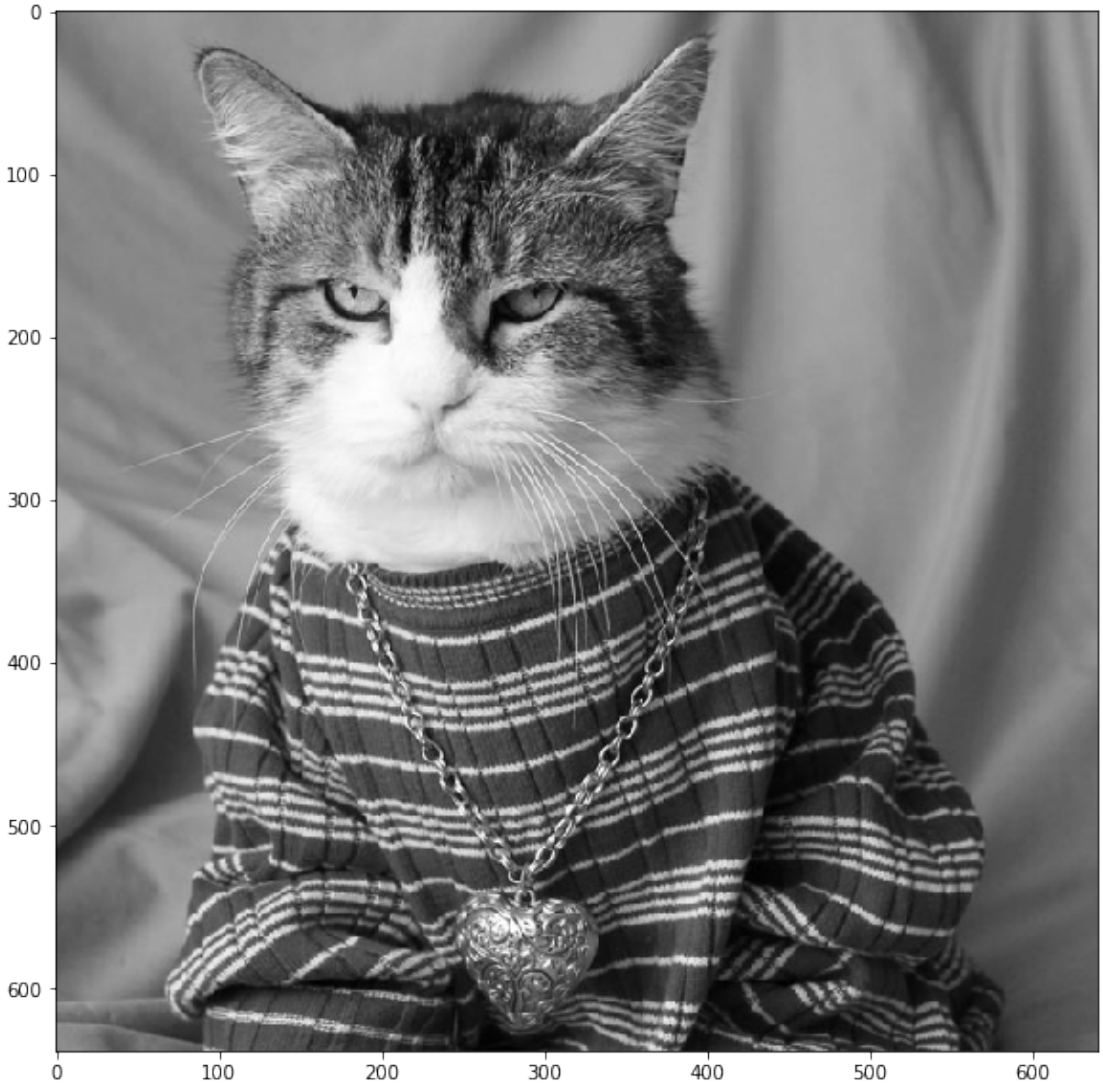
```
In [15]: import cv2
         import numpy as np
         import matplotlib.pyplot as plt
         from scipy import ndimage

         %matplotlib inline
```

1.2 2 Loading a Grayscale Image

```
In [23]: image = cv2.imread('images/cat.jpg', 0)
         plt.figure(figsize=(15,10))
         plt.imshow(image, cmap='gray')

Out[23]: <matplotlib.image.AxesImage at 0x1609dde8588>
```



1.3 3 Functions

Just a wrapper around built-in CV2 functions.

```
In [60]: def gaussian(image, size, std):
             """
             Applies gaussian filter to smooth image

             :param image: Open cv or numpy ndarray image
             :param size: The size of gaussian filter
             :param std: if 0, it will be calculated automatically, otherwise for x and y soul
             :return: An open cv image
             """
             return cv2.GaussianBlur(src=image, ksize=(size, size), sigmaX=std, sigmaY=std)
```

```
In [64]: def average(image, size):
             """
             Applies average filter to smooth image

             :param image: Open cv or numpy ndarray image
             :param size: The size of average filter
             :return: An open cv image
             """

             kernel = np.ones((size, size), dtype=np.float32) / (size ** 2)
             return cv2.filter2D(src=image, ddepth=-1, kernel=kernel)
```

1.4 4. Gaussian vs. Average

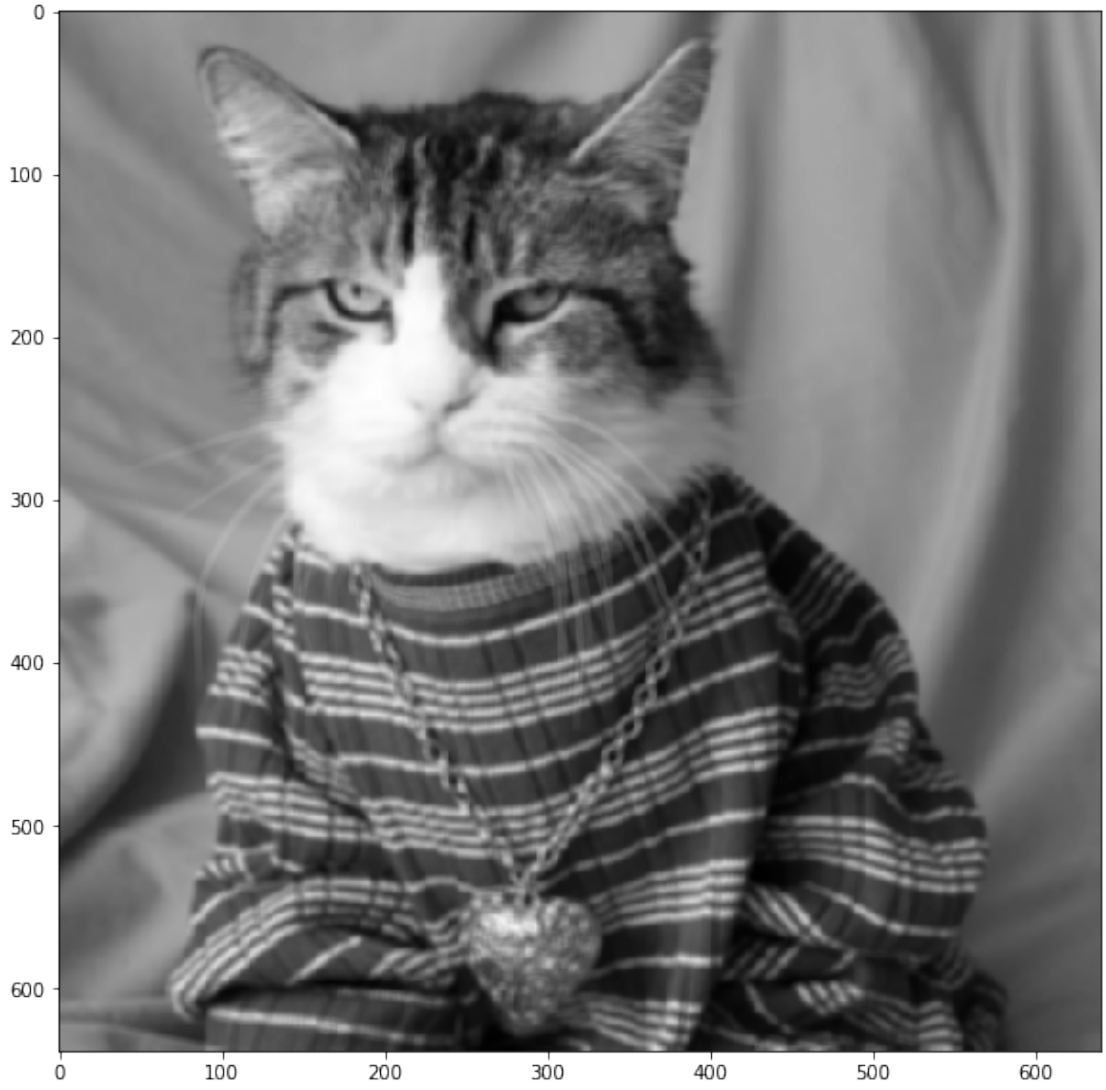
1. Applying 5x5 Average Filter
2. Applying 5x5 Gaussian Filter
3. Compare Using RMSE

1.4.1 4.A Applying 5x5 Average Filter

```
In [65]: size = 5
         average_blur = average(image, size)

         plt.figure(figsize=(15,10))
         plt.imshow(average_blur, cmap='gray')

Out[65]: <matplotlib.image.AxesImage at 0x1609e8f96d8>
```



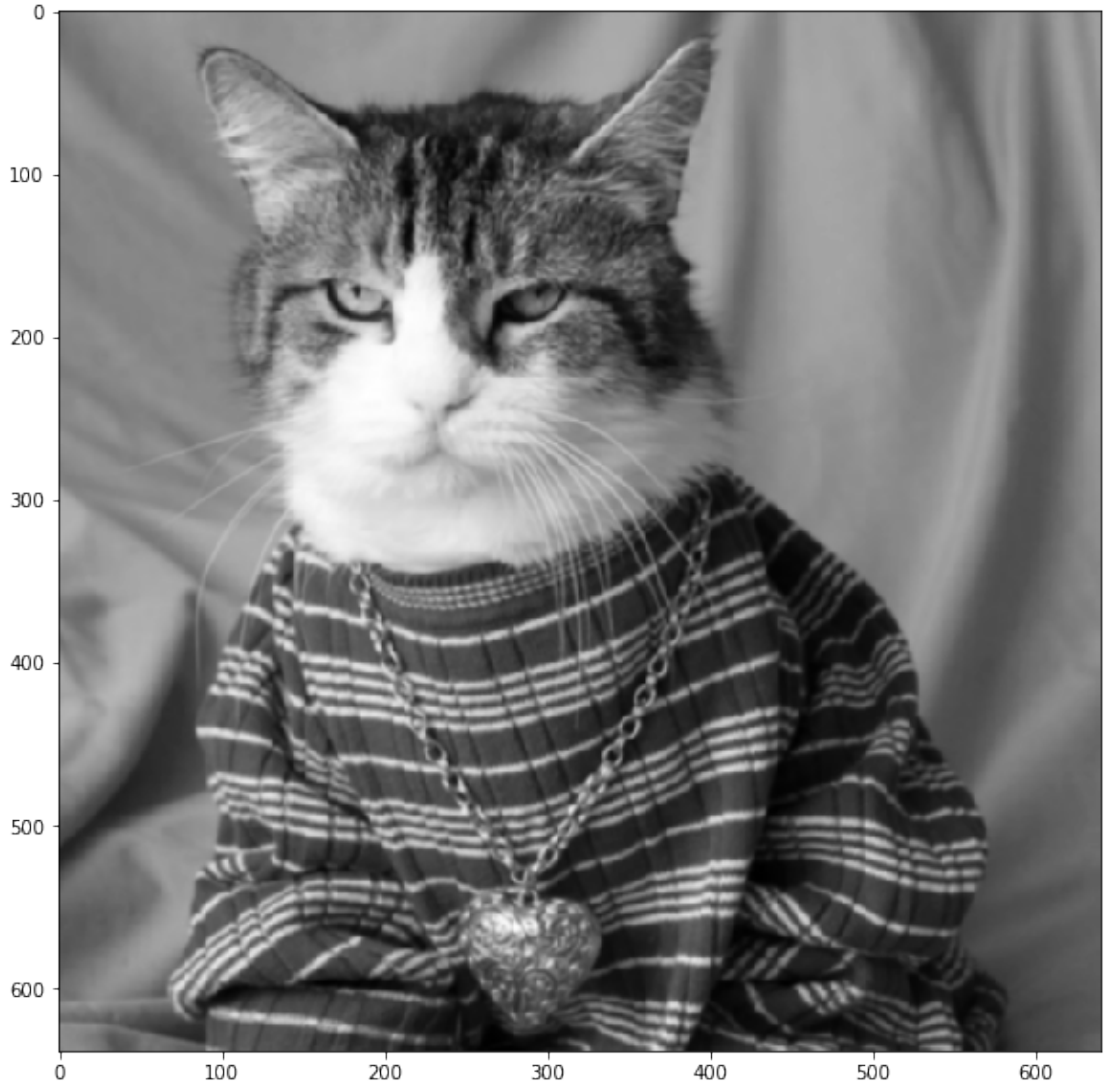
1.4.2 4.B Applying 5x5 Gaussian Filter

In this step we just need to use the defined gaussian filter then using convolve2d function for doing this.

```
In [66]: size = 5
         std = 1
         gaussian_blur = gaussian(image, size, std)

         plt.figure(figsize=(15,10))
         plt.imshow(gaussian_blur, cmap='gray')

Out[66]: <matplotlib.image.AxesImage at 0x1609e94c630>
```



1.4.3 4.C Compare Using RMSE

As images are same in term of size and content, RMSE can project the difference adequately.

```
In [67]: def RMSE(x, y):
             """
             Calculates Root Mean Squared Error of two ndim matrices

             :param x: An ndim matrix
             :param y: An ndim matrix
             :return: A float number
             """

             return np.sqrt(np.sum((x - y) ** 2) / (x.shape[0] * x.shape[1]))
```

```
In [68]: print('RMSE between an image smoothed using a 5x5 average filter and original image: '
         print('RMSE between an image smoothed using a 5x5 gaussian filter with std=1 and orig
         print('RMSE between an image smoothed using a 5x5 gaussian filter with std=1 and a a 5
```

```
RMSE between an image smoothed using a 5x5 average filter and original image:
 6.05276825272
RMSE between an image smoothed using a 5x5 gaussian filter with std=1 and original image:
 5.25244116618
RMSE between an image smoothed using a 5x5 gaussian filter with std=1 and a a 5x5 average filte
 4.46572404171
```

1.5 5 Gaussian vs. 2X Gaussian

1. Applying 5x5 Gaussian Filter With `sigma1=1` *Twice*
2. Applying a Gaussian Filter with Proper Size and `sigma2=sqrt(2)` *Once*
3. Compare Using RMSE

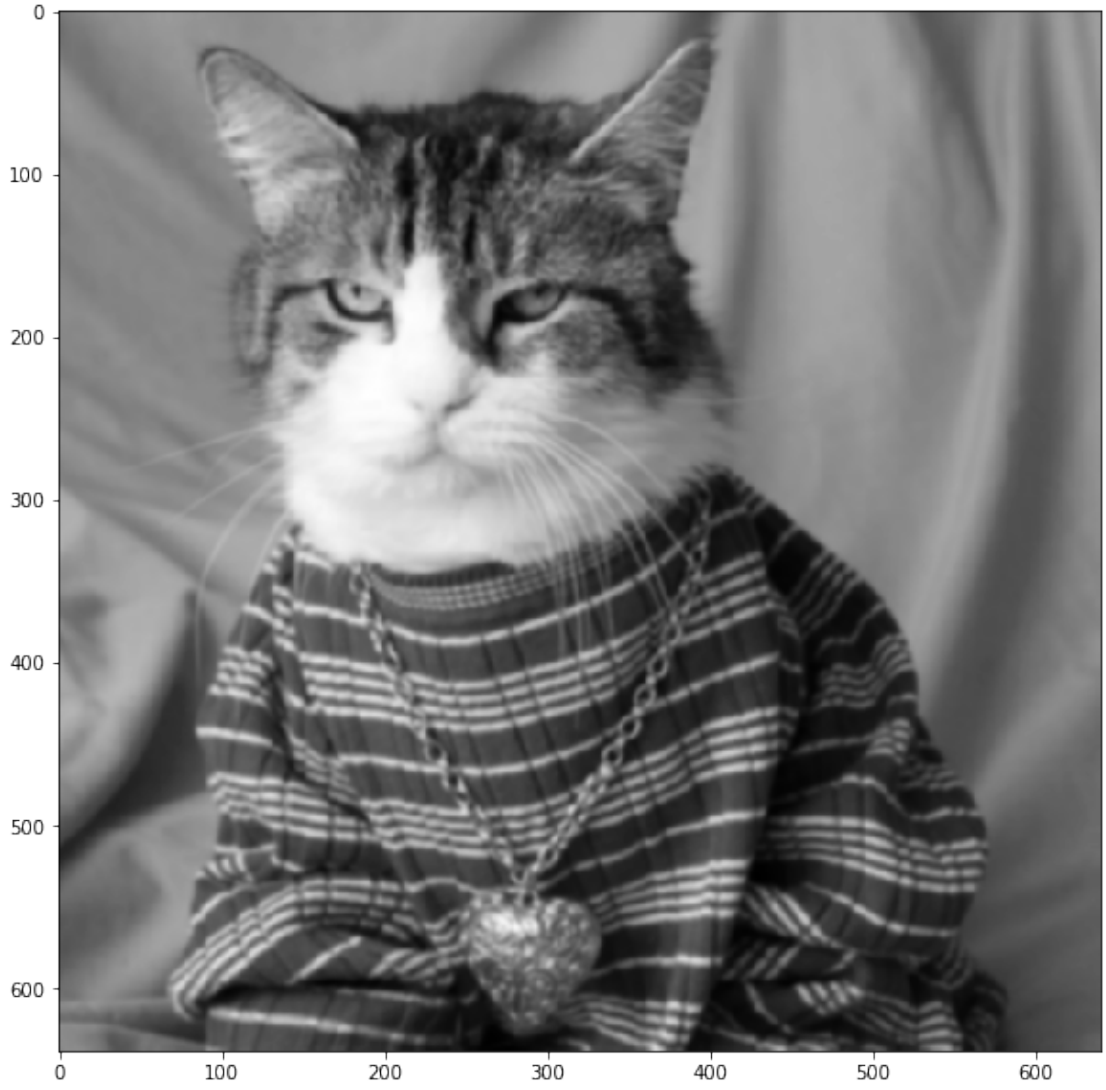
1.5.1 5.A Applying 5x5 Gaussian Filter With `sigma1=1` Twice

This is same as previous step, the only difference is that we apply gaussian twice subsequently.

```
In [69]: size = 5
         std = 1
         gaussian_blur_twice = gaussian(image, size, std)
         gaussian_blur_twice = gaussian(gaussian_blur_twice, size, std)

         plt.figure(figsize=(15,10))
         plt.imshow(gaussian_blur_twice, cmap='gray')
```

```
Out[69]: <matplotlib.image.AxesImage at 0x1609eb2f278>
```



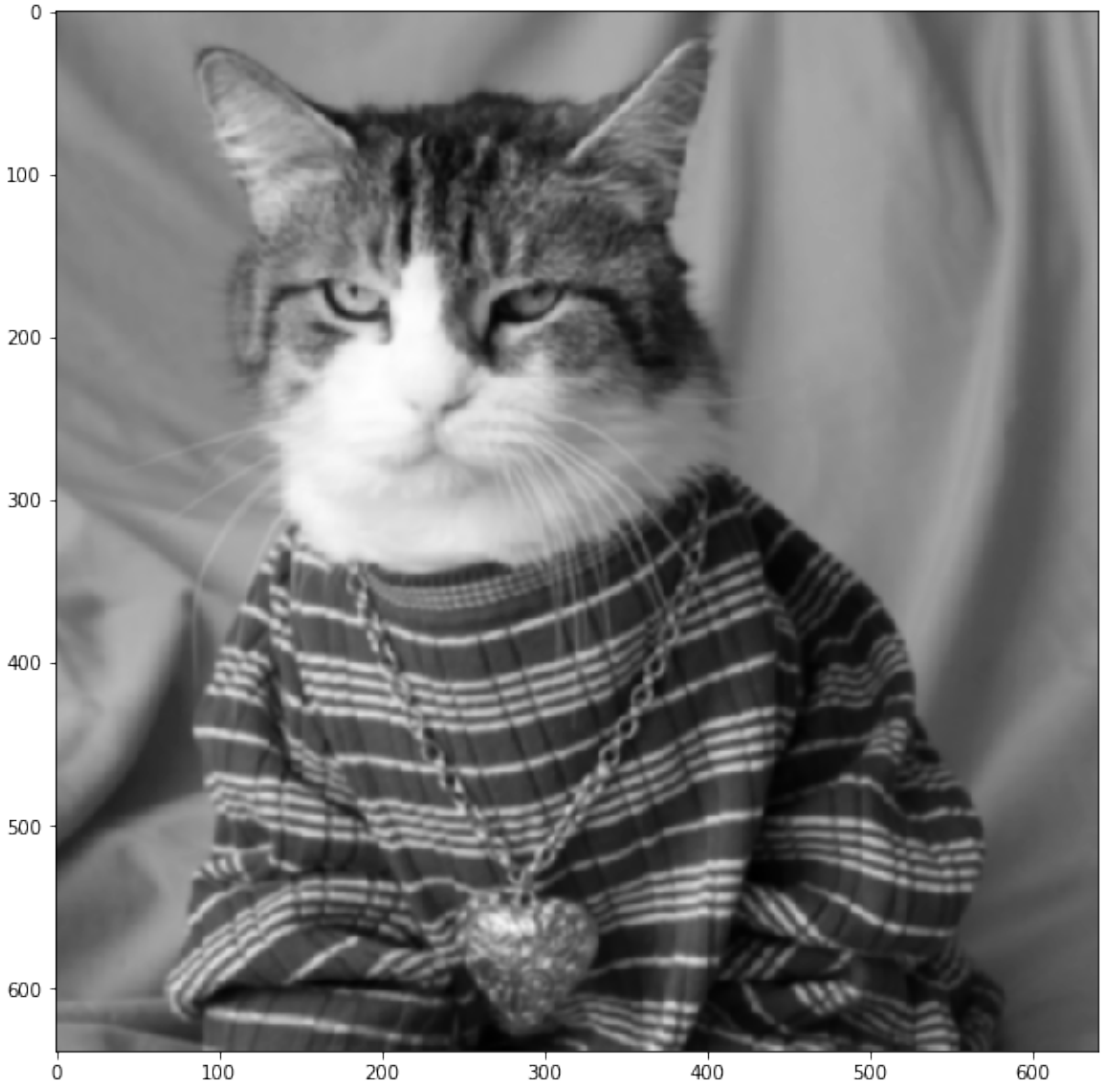
1.5.2 5.B Applying a Gaussian Filter with Proper Size and `sigma2=sqrt(2)` *Once*

To get the proper size, there is rule of thump that says the filter size should be biggest odd number which is less than 6 times of sigma. In our case as sigma is sqrt(2), 6xSigma = 8 and the biggest odd number less than 8 is 7. So kernel size will be 7.

```
In [70]: size = 7
         std = np.sqrt(2)
         gaussian_blur = gaussian(image, size, std)

         plt.figure(figsize=(15,10))
         plt.imshow(gaussian_blur, cmap='gray')

Out[70]: <matplotlib.image.AxesImage at 0x1609eb85b70>
```



1.5.3 5.C Compare Using RMSE

As images are same in term of size and content, RMSE can project the difference adequately.

```
In [71]: print('RMSE between an image smoothed TWICE using a 5x5 gaussian filter with std=1 and
               RMSE(gaussian_blur_twice, image))
         print('RMSE between an image smoothed ONCE using a 7x7 gaussian filter with std=sqrt(2
               RMSE(gaussian_blur, image))
         print('RMSE between an image smoothed TWICE using a 5x5 gaussian filter with std=1 and
               RMSE(gaussian_blur, gaussian_blur_twice))
```

```
RMSE between an image smoothed TWICE using a 5x5 gaussian filter with std=1 and original image
 5.84284289425
RMSE between an image smoothed ONCE using a 7x7 gaussian filter with std=sqrt(2) and original i
```

```
 5.8536208248
RMSE between an image smoothed TWICE using a 5x5 gaussian filter with std=1 and ONCE using a 7x
 0.297867518681
```

As we can see the last number which demonstrates the discrepancy between blured image using 7x7 gaussian once and 5x5 gaussian twice is very small which is a depiction for high similarity between the outputs. So the idea of using multiple gaussians filter subsequently can be achieved using a higher (bigger size) gaussian is approximately true.