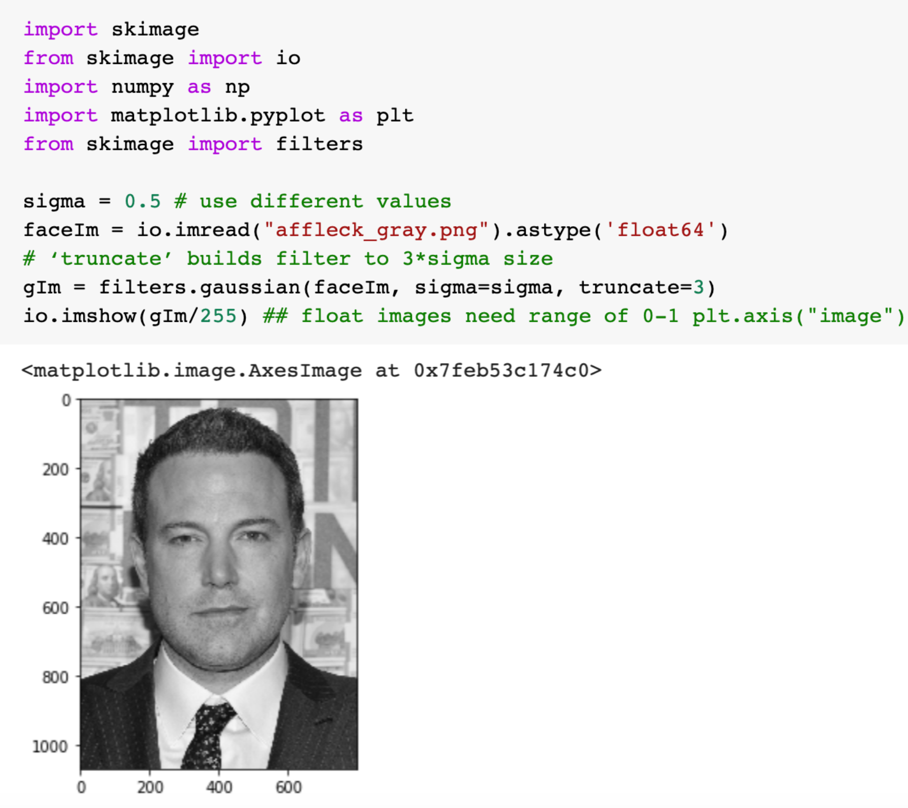
1.

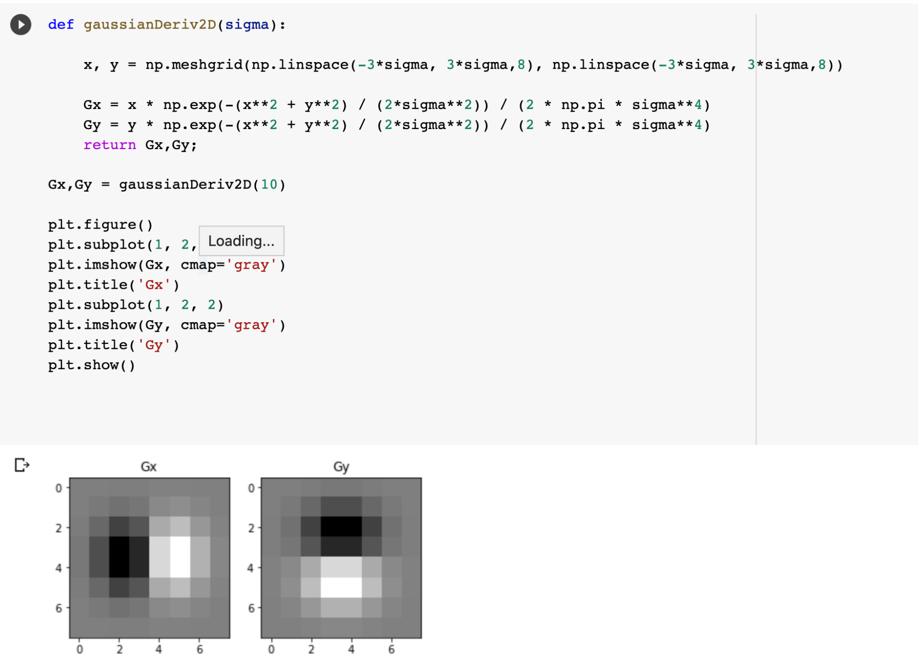


```
import skimage
from skimage import io
import numpy as np
import matplotlib.pyplot as plt
from skimage import filters

sigma = 0.5 # use different values
faceIm = io.imread("affleck_gray.png").astype('float64')
# ‘truncate’ builds filter to 3*sigma size
gIm = filters.gaussian(faceIm, sigma=sigma, truncate=3)
io.imshow(gIm/255) ## float images need range of 0-1 plt.axis("image")
```

```
<matplotlib.image.AxesImage at 0x7feb53c174c0>
```

Here is what I did for Question 1. I also changed the sigma from 20 to 0.5 and found that the picture became clearer when the sigma became smaller and smaller.

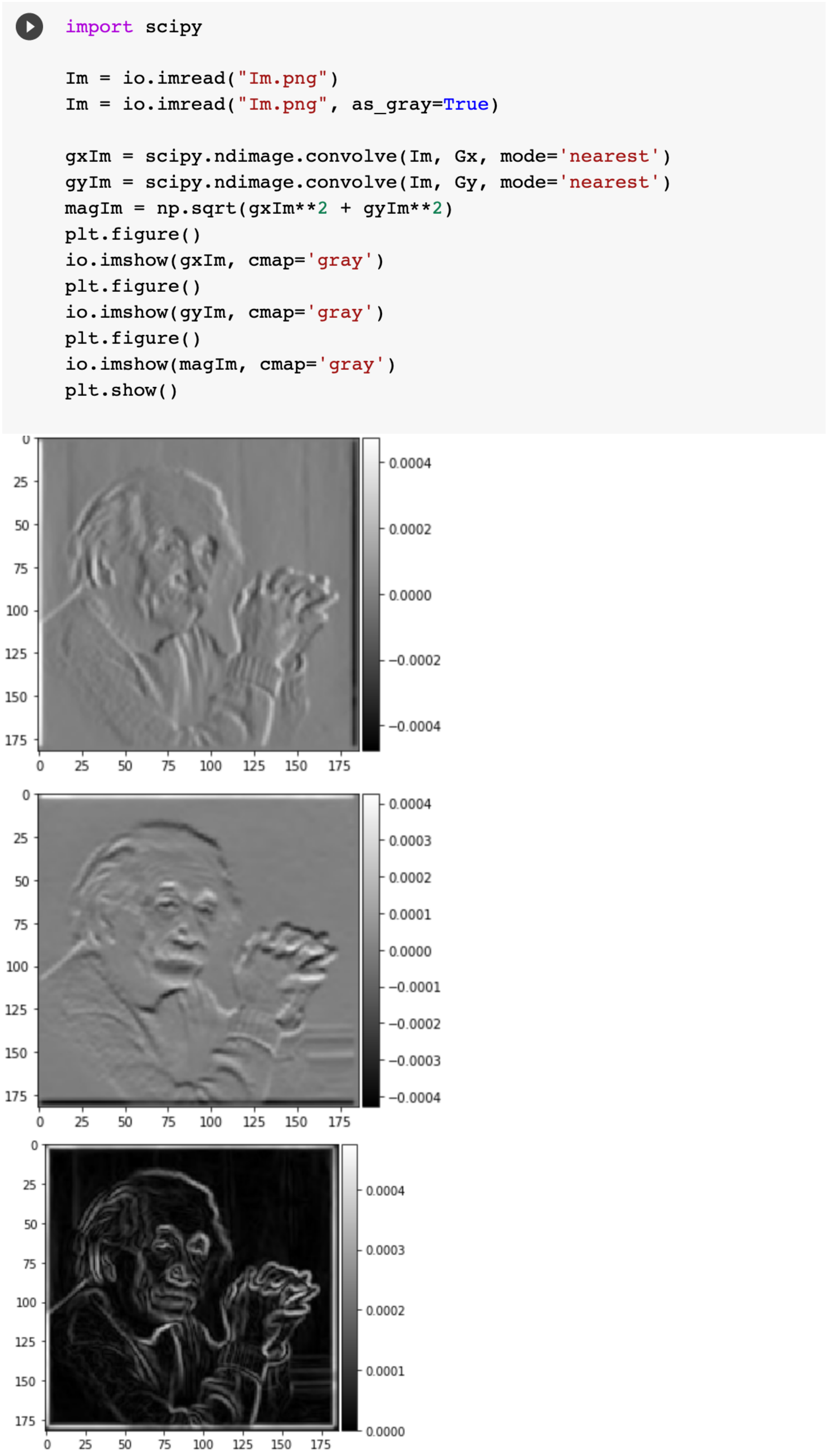
2.



```
def gaussianDeriv2D(sigma):

    x, y = np.meshgrid(np.linspace(-3*sigma, 3*sigma,8), np.linspace(-3*sigma, 3*sigma,8))

    Gx = x * np.exp(-(x**2 + y**2) / (2*sigma**2)) / (2 * np.pi * sigma**4)
    Gy = y * np.exp(-(x**2 + y**2) / (2*sigma**2)) / (2 * np.pi * sigma**4)
    return Gx,Gy;

Gx,Gy = gaussianDeriv2D(10)

plt.figure()
plt.subplot(1, 2, Loading...
plt.imshow(Gx, cmap='gray')
plt.title('Gx')
plt.subplot(1, 2, 2)
plt.imshow(Gy, cmap='gray')
plt.title('Gy')
plt.show()
```

Here is what I did for Question 2. I set the Xo and Yo to 0 and computed the Gx and Gy according to the formula in the slides.

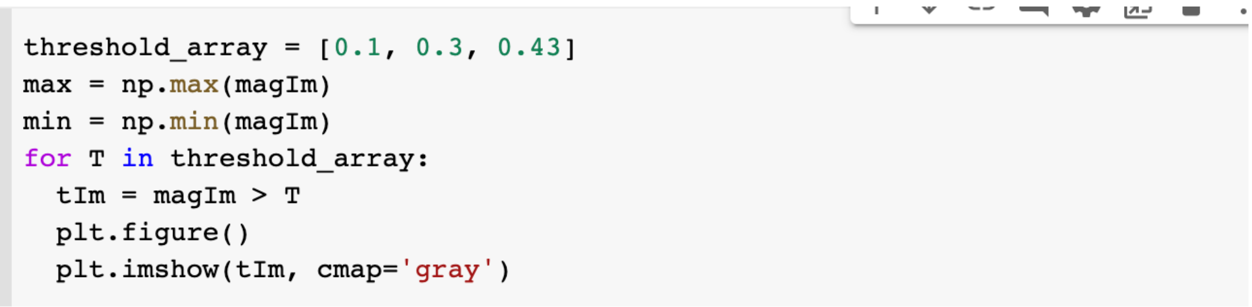
3.



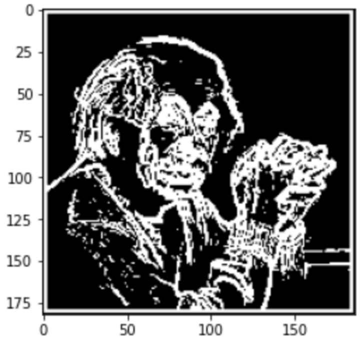
```
import scipy

Im = io.imread("Im.png")
Im = io.imread("Im.png", as_gray=True)

gxIm = scipy.ndimage.convolve(Im, Gx, mode='nearest')
gyIm = scipy.ndimage.convolve(Im, Gy, mode='nearest')
magIm = np.sqrt(gxIm**2 + gyIm**2)
plt.figure()
io.imshow(gxIm, cmap='gray')
plt.figure()
io.imshow(gyIm, cmap='gray')
plt.figure()
io.imshow(magIm, cmap='gray')
plt.show()
```

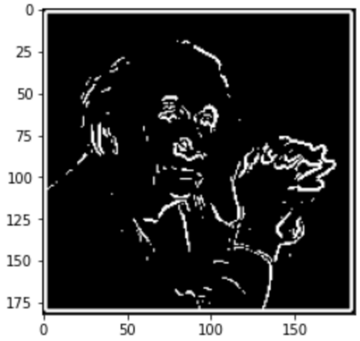
Here is what I did for question 4. For this question, I converted my input image to a 2D grayscale image in order to run it without error.

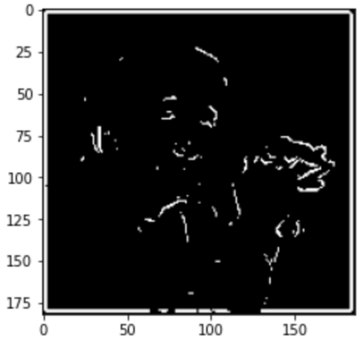
4.



```
threshold_array = [0.1, 0.3, 0.43]
max = np.max(magIm)
min = np.min(magIm)
for T in threshold_array:
  tIm = magIm > T
  plt.figure()
  plt.imshow(tIm, cmap='gray')
```

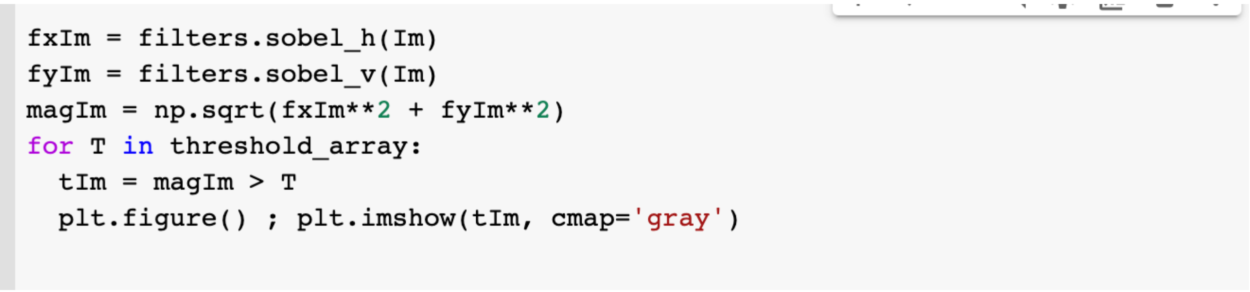




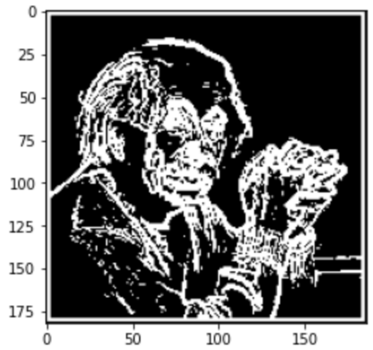


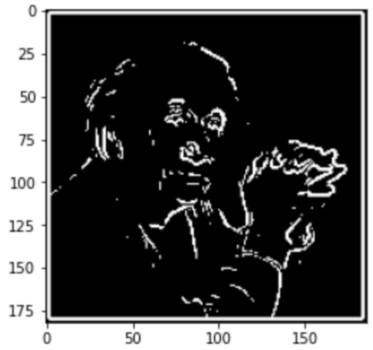
Here is what I did for question 4. I first calculate the max and min pixels of the input magnitude image. Then, I set the threshold array between the max and min to generate the output image.

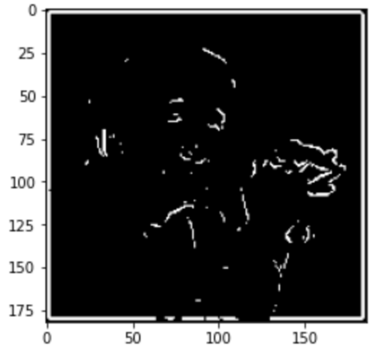
5.



```
fxIm = filters.sobel_h(Im)
fyIm = filters.sobel_v(Im)
magIm = np.sqrt(fxIm**2 + fyIm**2)
for T in threshold_array:
  tIm = magIm > T
  plt.figure() ; plt.imshow(tIm, cmap='gray')
```

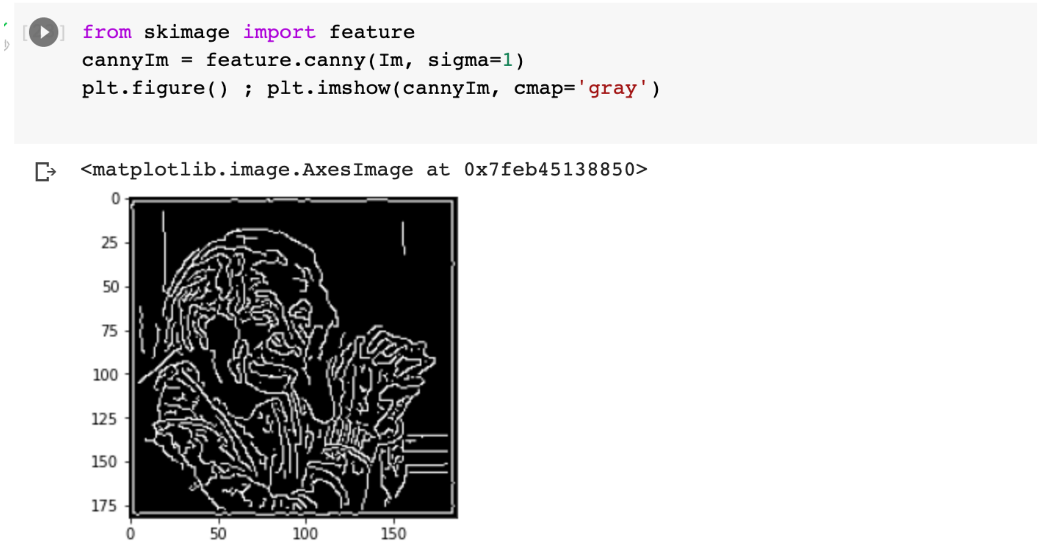






Here is what I did for question 5. I think the above result is really similar to the Sobel masks.

6.



```
from skimage import feature
cannyIm = feature.canny(Im, sigma=1)
plt.figure() ; plt.imshow(cannyIm, cmap='gray')
```

```
<matplotlib.image.AxesImage at 0x7feb45138850>
```

Here is what I did for question 6. Compared to the previous results, this is quite different.