```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly
remount, call drive.mount("/content/drive", force_remount=True).
```

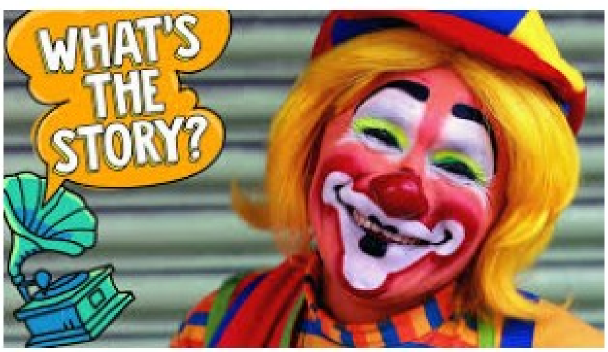
```
import numpy as np
import matplotlib.pyplot as plt
import cv2
import sys
# np.set_printoptions(threshold=sys.maxsize)
```

1. Displaying Input Image

```
img = plt.imread('/content/drive/MyDrive/Colab
Notebooks/EE5178_PA2/clown.jpeg')
print("Image Dimensions: ", img.shape)
plt.figure(figsize=(4,4))
plt.imshow(img)
plt.axis('off')
```

```
Image Dimensions:  (168, 300, 3)
```

```
(-0.5, 299.5, 167.5, -0.5)
```



2.Conver it to Grayscale

```
def RGB2GRAY(input_img):
  r = input_img[:,:,0]
  g = input_img[:,:,1]
  b = input_img[:,:,2]

  gray_scale_img = 0.2989 * r + 0.5870 * g + 0.1140 * b

  return gray_scale_img

#Convert Color Image to Gray scale Image
gray_scale_img = RGB2GRAY(img)
```

```python
print("Gray scale Image Dimensions: ", gray_scale_img.shape)
plt.figure(figsize=(4,4))
plt.imshow(gray_scale_img, cmap = 'gray')
plt.axis('off')
```

```
Gray scale Image Dimensions:  (168, 300)
```

```
(-0.5, 299.5, 167.5, -0.5)
```

3. Supressing Noise using Gaussian Filter

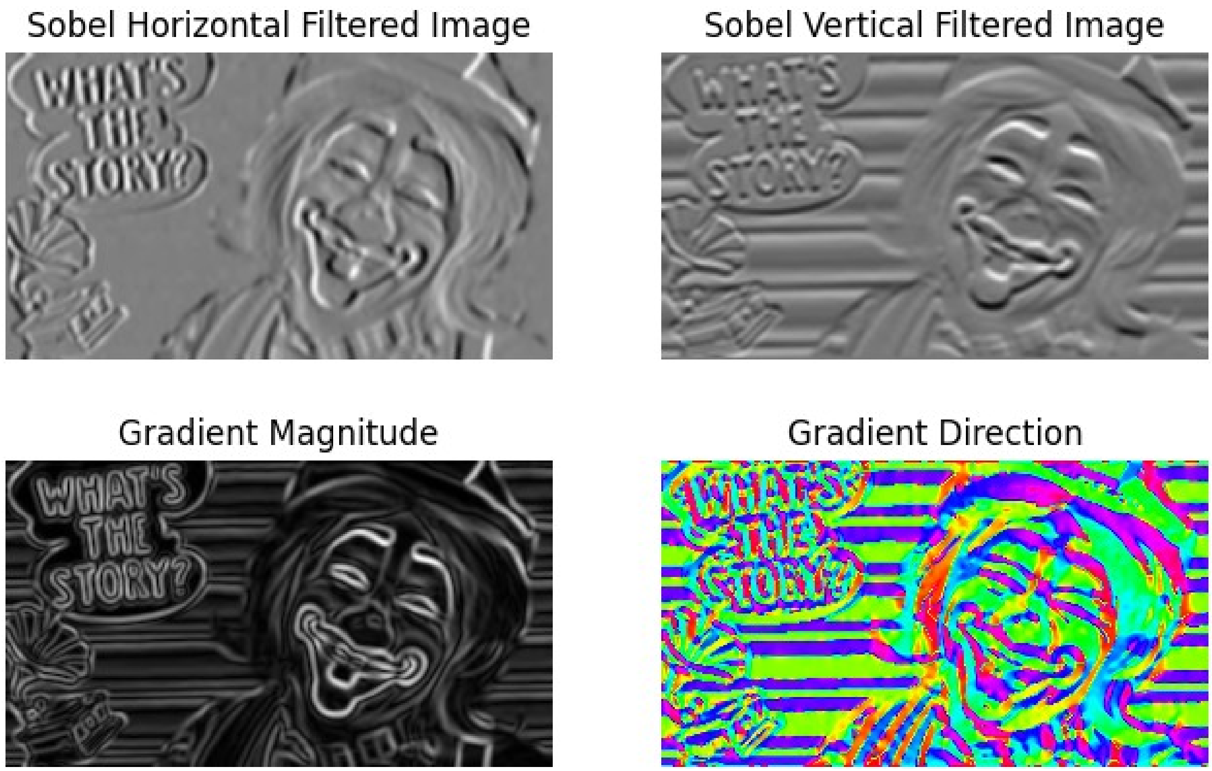
```python
# Apply Gaussian filter to remove noise
gaussian_filtered_image = cv2.GaussianBlur(gray_scale_img, (5, 5),
1.5)

print("Filtered Image Dimensions: ", gaussian_filtered_image.shape)
plt.figure(figsize=(5,5))
plt.imshow(gaussian_filtered_image, cmap = 'gray')
plt.axis('off')
```

```
Filtered Image Dimensions:  (168, 300)
```

```
(-0.5, 299.5, 167.5, -0.5)
```

4. Edge detection using Sobel

```
def DoSobel(image):
  sobelX = cv2.Sobel(image, cv2.CV_64F, 1, 0, ksize=3) # Vertical 
Edges

  sobelY = cv2.Sobel(image, cv2.CV_64F, 0, 1, ksize=3) # Horizontal 
Edges

  # Magnitude and direction of the gradient
  magnitude = np.sqrt(np.multiply(sobelX, sobelX) + 
np.multiply(sobelY, sobelY)) # Gradient Magnitude
  direction = np.arctan2(sobelY, sobelX) # Gradient Phase

  # Display the images
  plt.figure(figsize=(8, 5))

  plt.subplot(2, 2, 1)
  plt.imshow(sobelX, cmap='gray')
  plt.title('Sobel Horizontal Filtered Image')
  plt.axis('off')

  plt.subplot(2, 2, 2)
  plt.imshow(sobelY, cmap='gray')
  plt.title('Sobel Vertical Filtered Image')
  plt.axis('off')

  plt.subplot(2, 2, 3)
  plt.imshow(magnitude, cmap='gray')
  plt.title('Gradient Magnitude')
  plt.axis('off')

  plt.subplot(2, 2, 4)
  plt.imshow(direction, cmap='hsv')
  plt.title('Gradient Direction')
  plt.axis('off')

  plt.show()

  return magnitude, direction

magnitude, direction_rad = DoSobel(gaussian_filtered_image)
```

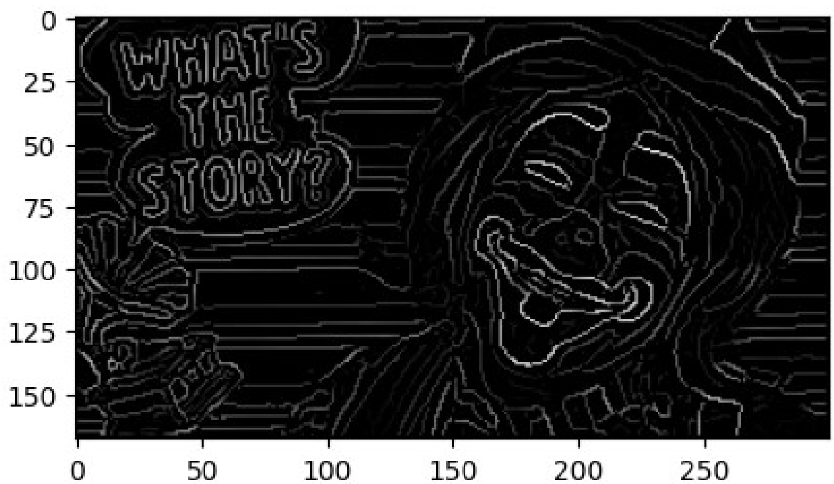


5. Non Maxima Suppression

```
def NMS_IMAGE_GEN(magnitude, direction_rad ):
  direction_deg = direction_rad*(180/np.pi)

  nms_image = np.zeros((magnitude.shape[0],magnitude.shape[1]))

  # Iterators
  itr_mag = np.nditer(magnitude, flags=['multi_index'])
  itr_phase = np.nditer(direction_deg, flags=['multi_index'])
  itr_nms = np.nditer(nms_image, flags=['multi_index'])

  '''
  magnitude :  Gradient image
  direction_deg :  phase image in degrees
  mag : magnitude value
  ph : phase value
  nms: NMS image
  '''

  # Iterate through the image and perform the Non maxima suppression
based on the Magnitude and Phase
  for count,( mag, ph, nms) in enumerate(zip(itr_mag, itr_phase,
itr_nms)):
    mag_i, mag_j = itr_mag.multi_index[0], itr_mag.multi_index[1]
    ph_i, ph_j = itr_phase.multi_index[0], itr_phase.multi_index[1]
```

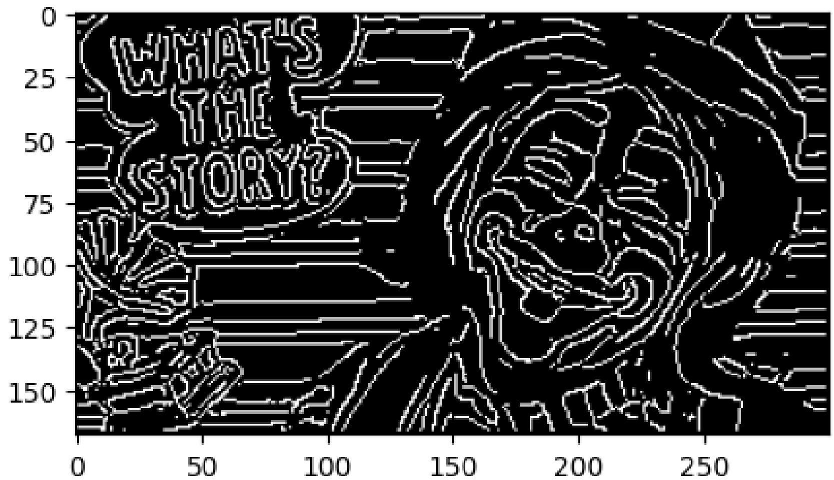
```
    nms_i, nms_j = itr_nms.multi_index[0], itr_nms.multi_index[1]

    if ((0 < mag_i < magnitude.shape[0]-1) and ( 0 < mag_j < magnitude.shape[1]-1)): # stay wihtin the bounds of image
      if (ph >= 0 and ph < 45):
        if ((magnitude[mag_i, mag_j+1] < mag) and (magnitude[mag_i, mag_j-1] < mag)):
          #retain
          nms_image[nms_i, nms_j] = magnitude[mag_i, mag_j]

      elif (ph >= 45 and ph < 90):
        if ((magnitude[mag_i+1, mag_j+1] < mag) and (magnitude[mag_i-1, mag_j-1] < mag)):
          #retain
          nms_image[nms_i, nms_j] = magnitude[mag_i, mag_j]

      elif (ph >= 90 and ph < 135):
        if ((magnitude[mag_i+1, mag_j] < mag) and (magnitude[mag_i-1, mag_j] < mag)):
          #retain
          nms_image[nms_i, nms_j] = magnitude[mag_i, mag_j]

      elif (ph >= 135 and ph < 180):
        if ((magnitude[mag_i+1, mag_j-1] < mag) and (magnitude[mag_i-1, mag_j+1] < mag)):
          #retain
          nms_image[nms_i, nms_j] = magnitude[mag_i, mag_j]

      elif (ph <=0 and ph > -45):
        if ((magnitude[mag_i, mag_j+1] < mag) and (magnitude[mag_i, mag_j-1] < mag)):
          #retain
          nms_image[nms_i, nms_j] = magnitude[mag_i, mag_j]

      elif (ph <=-45 and ph > -90):
        if ((magnitude[mag_i+1, mag_j-1] < mag) and (magnitude[mag_i-1, mag_j+1] < mag)):
          #retain
          nms_image[nms_i, nms_j] = magnitude[mag_i, mag_j]

      elif (ph <=-90 and ph > -135):
        if ((magnitude[mag_i-1, mag_j] < mag) and (magnitude[mag_i+1, mag_j] < mag)):
          #retain
          nms_image[nms_i, nms_j] = magnitude[mag_i, mag_j]

      elif (ph <=-135 and ph > -180):
        if ((magnitude[mag_i+1, mag_j+1] < mag) and (magnitude[mag_i-1, mag_j-1] < mag)):
          #retain
```

```
          nms_image[nms_i, nms_j] = magnitude[mag_i, mag_j]

  return nms_image

nms_image = NMS_IMAGE_GEN(magnitude, direction_rad)
plt.figure(figsize=(5, 5))
plt.imshow(nms_image, cmap = 'gray')

<matplotlib.image.AxesImage at 0x7d010d6207f0>
```



6.Median Value Thresholding and Final Canny Edge Image

```
# Perform Thresholding based on the Median Value present in the
Magnitude Response

def THRESHOLD(magnitude):
  median_threshold = np.median(magnitude)
  canny_img = np.zeros(magnitude.shape)
  # print(magnitude.shape)
  for i in range(magnitude.shape[0]):
    for j in range(magnitude.shape[1]):
      if (nms_image[i][j] > median_threshold):
        canny_img[i][j] = 1

  return canny_img

canny_img = THRESHOLD(magnitude)
plt.figure(figsize=(5, 5))
plt.imshow(canny_img, cmap = 'gray')

<matplotlib.image.AxesImage at 0x7d01077e5540>
```



Filtering

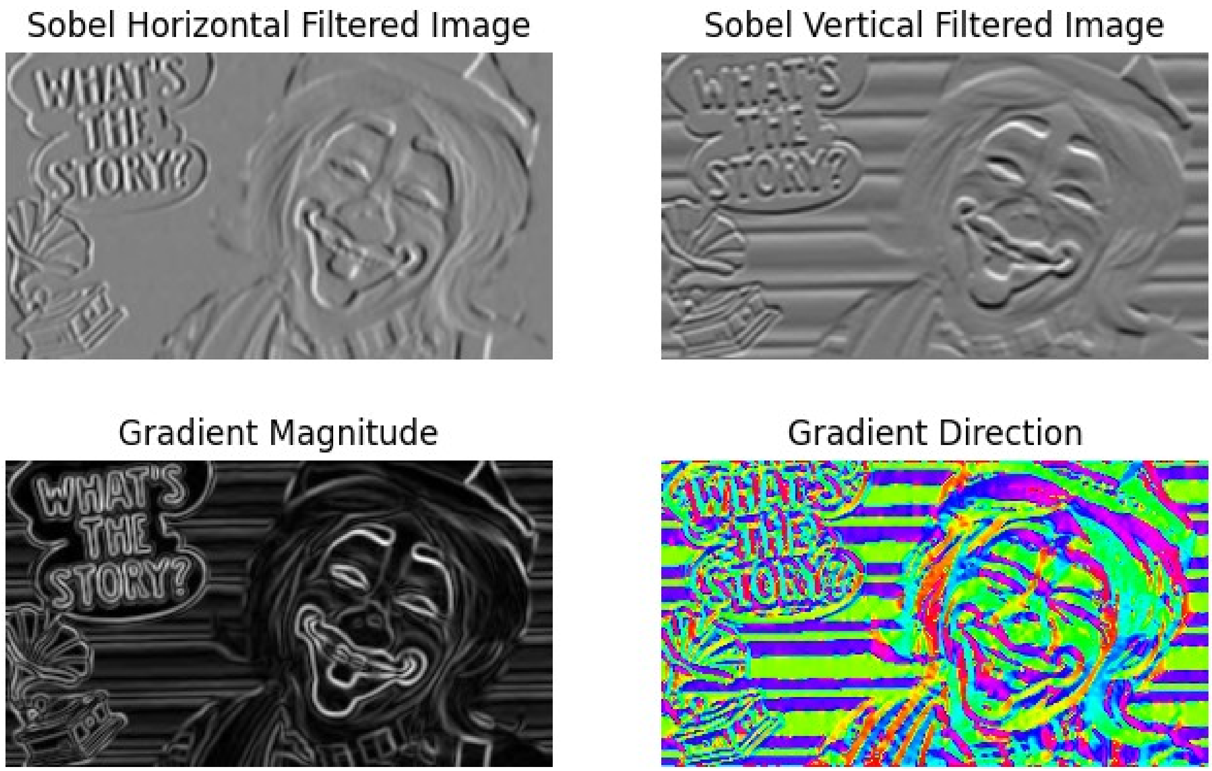
```
# Apply Gaussian filter to remove noise
gaussian_filtered_image_2 = cv2.GaussianBlur(gray_scale_img, (3, 3),
3)

print("Filtered Image Dimensions: ", gaussian_filtered_image.shape)
plt.figure(figsize=(5,5))
plt.imshow(gaussian_filtered_image, cmap = 'gray')
plt.axis('off')
```

```
Filtered Image Dimensions:  (168, 300)
```

```
(-0.5, 299.5, 167.5, -0.5)
```

Edge Response

```
magnitude_1, direction_rad_1 = DoSobel(gaussian_filtered_image_2)
```



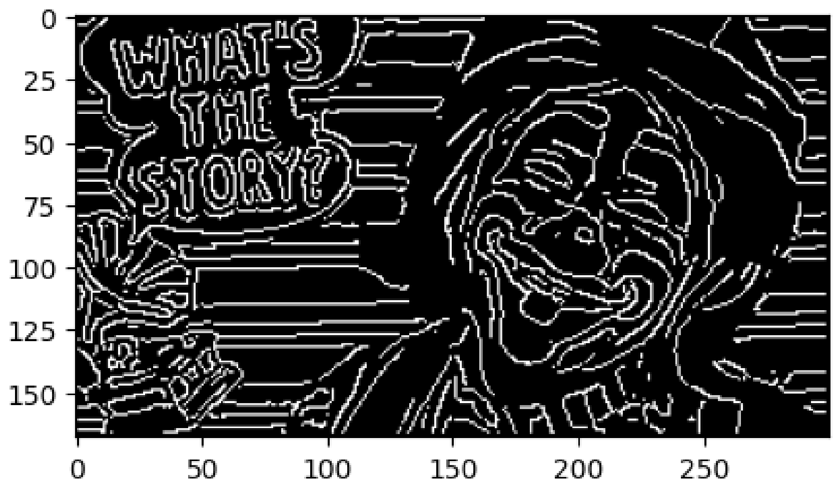
NMS Image

```
nms_image_1 = NMS_IMAGE_GEN(magnitude_1, direction_rad_1)
plt.figure(figsize=(5, 5))
plt.imshow(nms_image_1, cmap = 'gray')
```

```
<matplotlib.image.AxesImage at 0x7d010d5b2050>
```

Final Canny Image

```
canny_img = THRESHOLD(magnitude_1)
plt.figure(figsize=(5, 5))
plt.imshow(canny_img, cmap = 'gray')

<matplotlib.image.AxesImage at 0x7d010d75a500>
```



Observation:

a. Performing Gaussian Blur with increased standard deviation increases the Smooting effect on the image, thus reducing the high frequeny components.

b. Only the Edges that are strong/High intensity will present in the final image after increasing the Standard Deviation.

c. The same effect can be seen the Joker right side hair, which donot have strong edges and hence disappeared in the High Standard Deviaion Thresholded Image