Question1_Arun (1)

August 29, 2021

1 Question 1 of final assignment

1.1 packages needed:

[4]:
```
!pip install opencv-python
```

```
Collecting opencv-python
  Downloading opencv_python-4.5.3.56-cp38-cp38-win_amd64.whl (34.9 MB)
Requirement already satisfied: numpy>=1.17.3 in
c:\users\chand\nex\anaconda3\lib\site-packages (from opencv-python) (1.20.1)
Installing collected packages: opencv-python
Successfully installed opencv-python-4.5.3.56
```

[2]:
```
import pandas as pd
import numpy as np
import cv2 as cv2
from PIL import Image
import scipy
import matplotlib.pyplot as plt
from scipy import interpolate
```

[10]:
```
image = Image.open("cap.png") #Here I'm reading the image of the flower from␣
↪question
image
```

[10]:

2 Now let us vary the contrast and view how the image transforms

[7]:
```
def change_contrast(img, level):
    factor = (259 * (level + 255)) / (255 * (259 - level))
    def contrast(c):
        return 128 + factor * (c - 128)
    return img.point(contrast)

change_contrast(Image.open('cap.png'), 100)
```

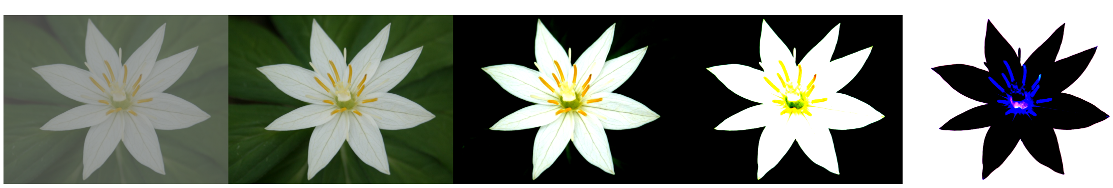
[7]:

3 It can be clearly noted that the background becomes darker

4 Let us visualize this for different steps:

[6]:
```python
def change_contrast_multi(img, steps):
    width, height = img.size
    canvas = Image.new('RGB', (width * len(steps), height))
    for n, level in enumerate(steps):
        img_filtered = change_contrast(img, level)
        canvas.paste(img_filtered, (width * n, 0))
    return canvas

change_contrast_multi(Image.open('cap.png'), [-100, 0, 100, 200, 300])
```

[6]:



5 We can choose one of those contrast scales where the edges are more pronounced

6 Then scan the array at every continuous 3x3 grid to detect the edges, or we could make use of in-built edge detection here as the edges are clear

[15]:
```
img_filtered = change_contrast(Image.open('cap.png'), 200)
img_filtered.save("cap1.png","PNG")
```

[20]:
```
img = cv2.imread('cap1.png',flags=0)
img_blur = cv2.GaussianBlur(img,(3,3),0,0)
sobelxy = cv2.Sobel(src=img, ddepth=cv2.CV_64F, dx=1, dy=1, ksize=5)
cv2.imshow('Sobel X Y using Sobel() function', sobelxy)
```

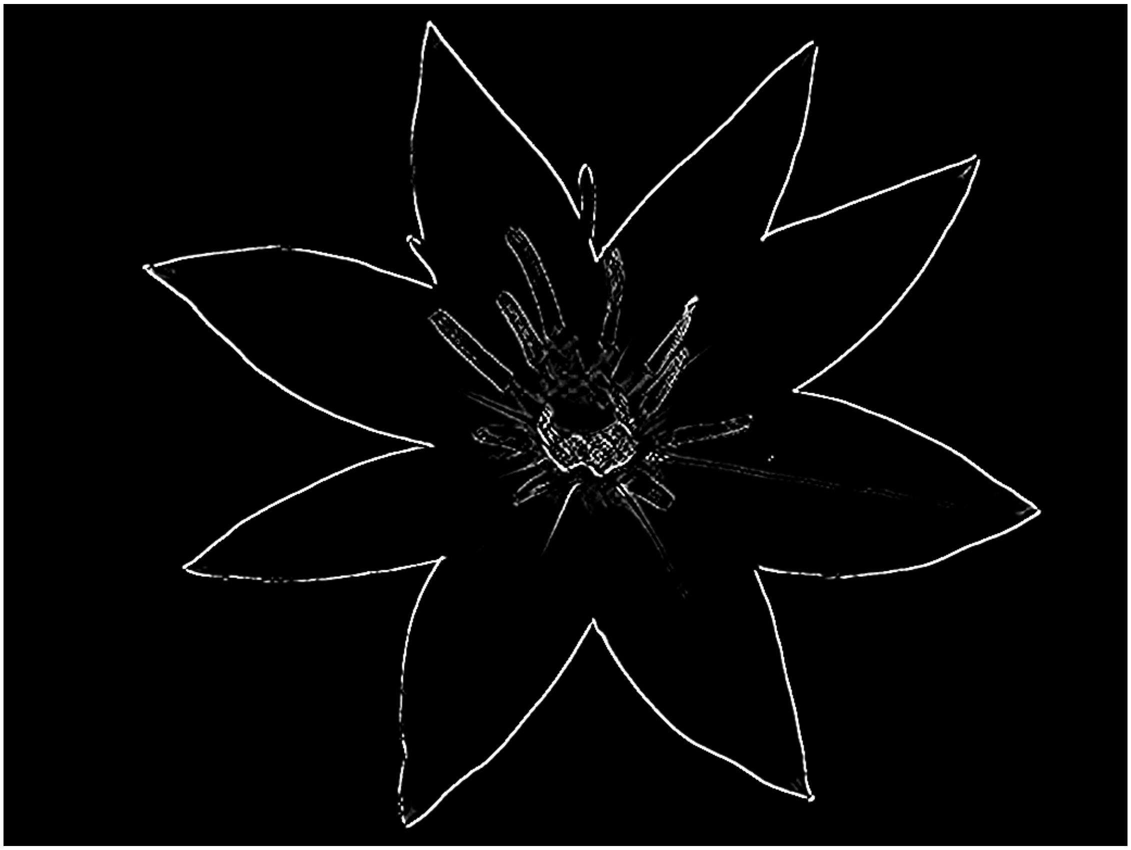
[27]:
```
%matplotlib inline
```

[32]:
```
cv2.imwrite("cap2.png",sobelxy)
```

[32]: True

[33]:
```
image = Image.open("cap2.png") #Here I'm reading the image of the flower from␣
 ↪question
image
```

[33]:



7 We can see the inner portion being mixed in hence let's choose a threshold, binarize then apply canny

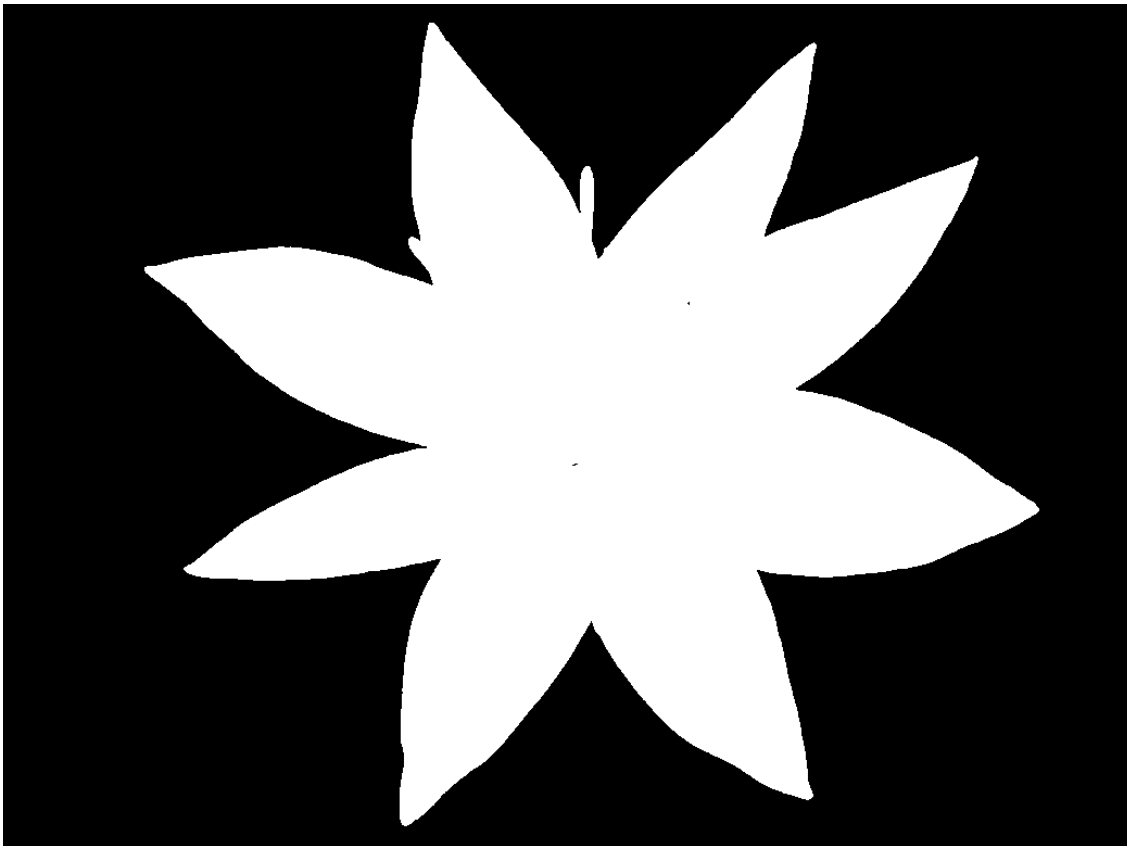
8 To make it look like pencil sketch

[37]:
```
img.shape
```

[37]: (775, 1035)

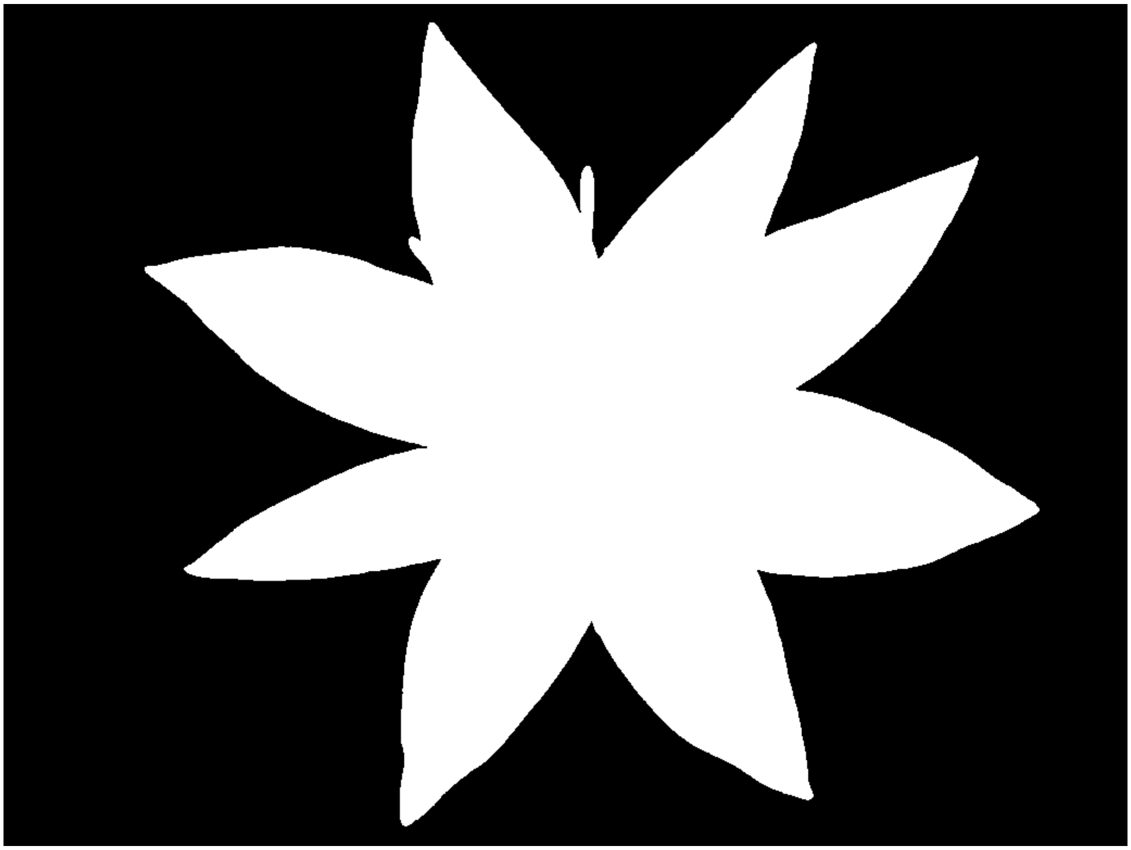
[53]:
```
img = cv2.imread('cap1.png',flags=0)
re, th = cv2.threshold(img, 1, 255, cv2.THRESH_BINARY)
Image.fromarray(th)
```

[53]:



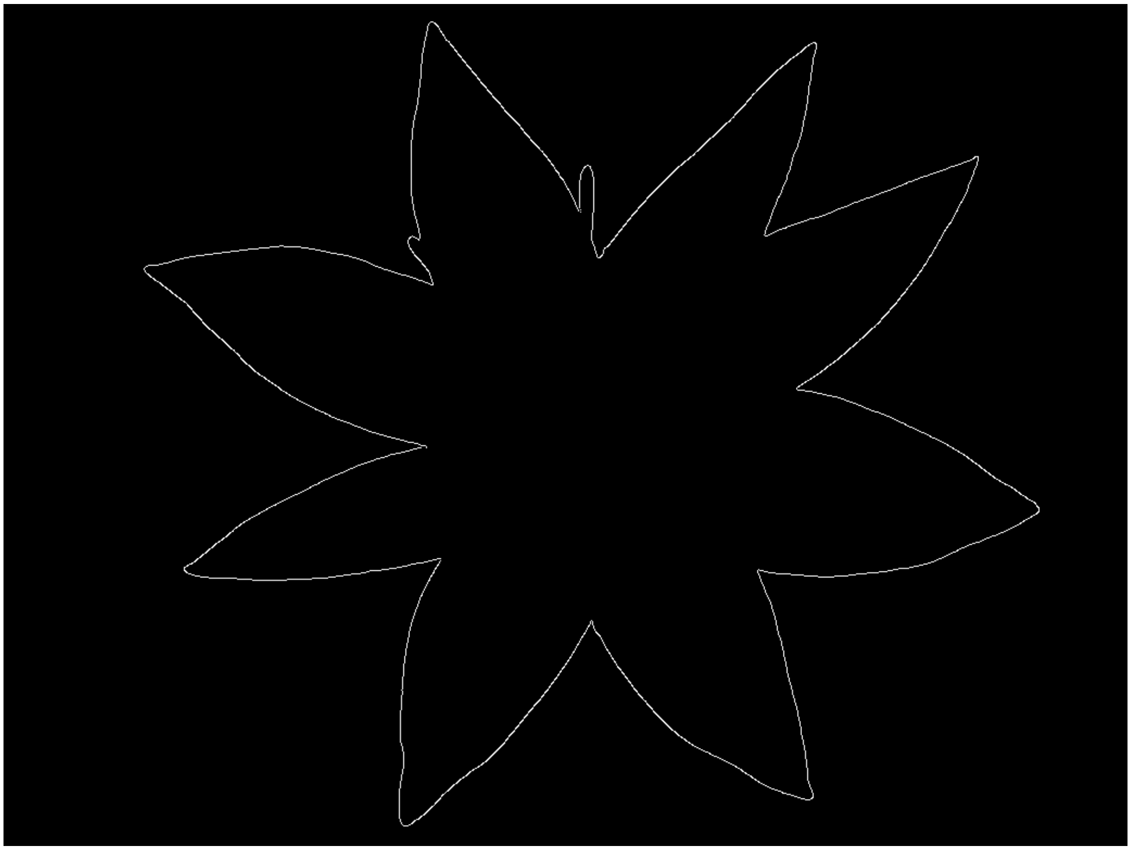
[61]:
```
cop = th.copy()
cv2.floodFill(cop,None,(0,0),255)[1]
Image.fromarray(cv2.bitwise_not(cop))
Image.fromarray(th)
OR=th | cv2.bitwise_not(cop)
Image.fromarray(OR)
```

[61]:



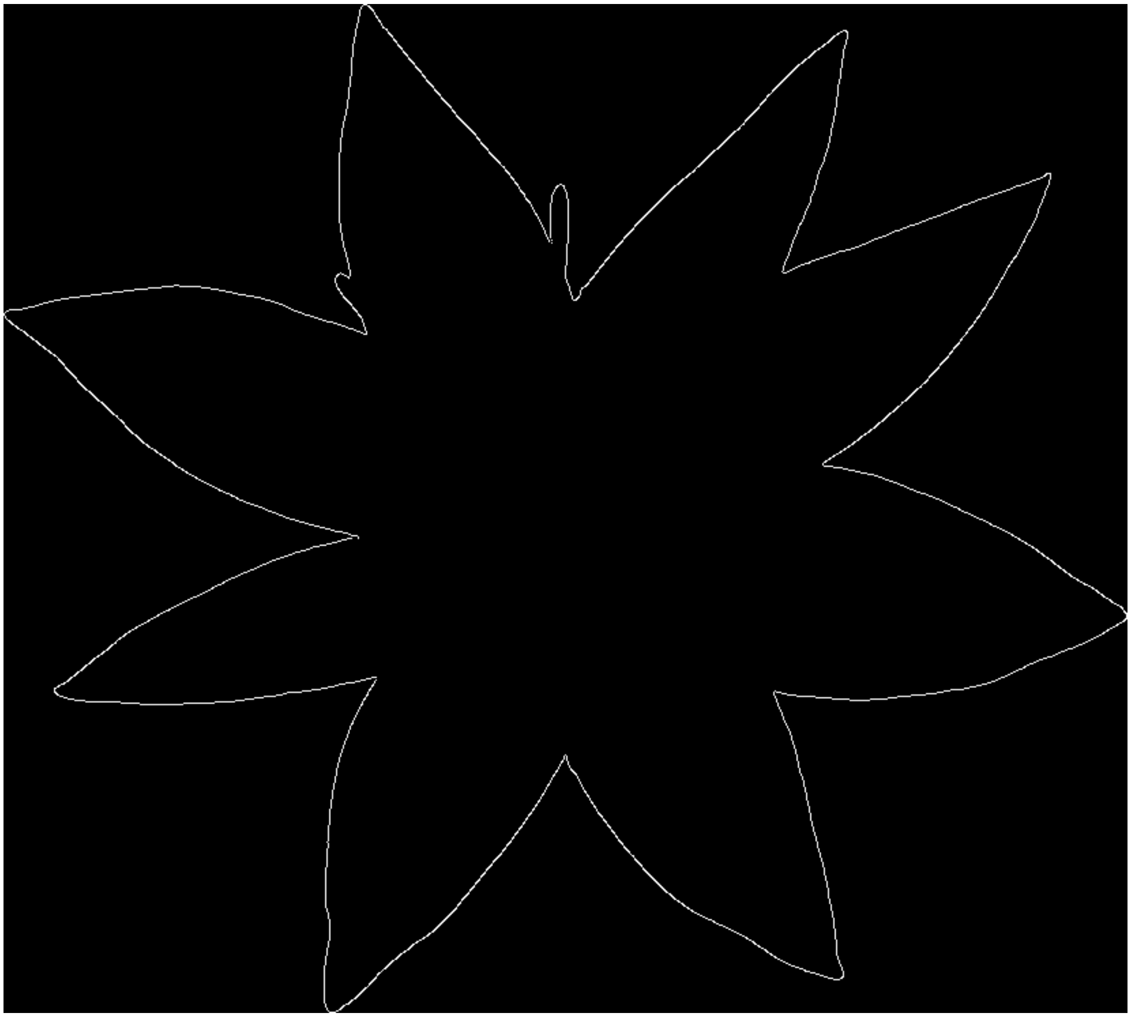
[63]:
```
Edges=cv2.Canny(OR,10,255)
Image.fromarray(Edges)
```

[63]:



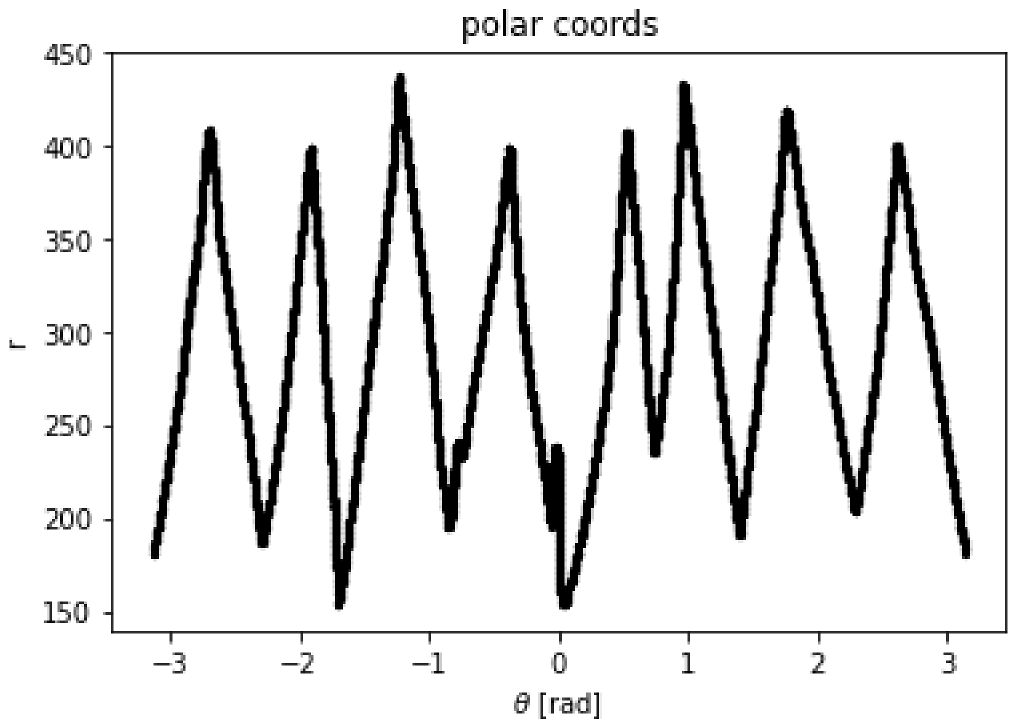
[68]:
```
m,n=[i[0] for i in np.transpose(np.nonzero(Edges))],[i[1] for i in np.
↪transpose(np.nonzero(Edges))]
a,b,c,d=min(m),min(n),max(m),max(n)
Final=[]
for j in Edges[a:c+1]:Final.append(j[b:d+1]);
Final=np.array(Final)
Image.fromarray(Final)
```

[68]:



9 Polar Form:

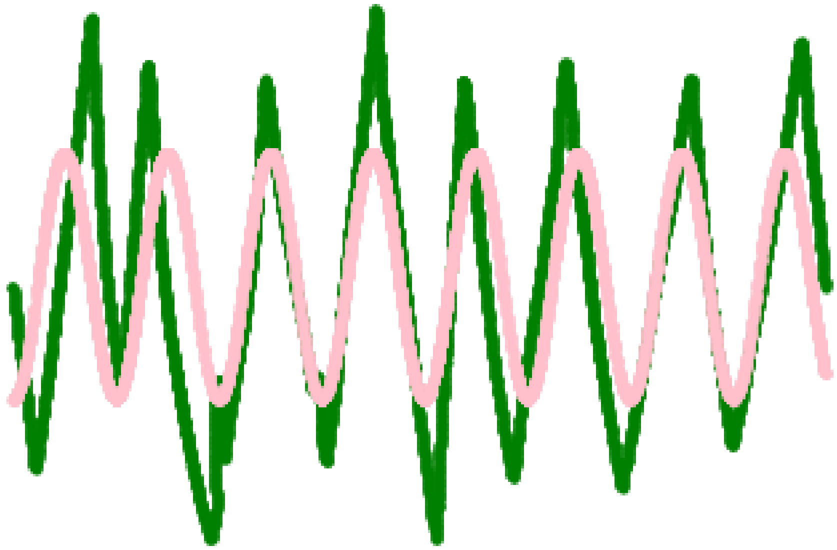
[150]:
```
m=np.array([i[0] for i in np.transpose(np.nonzero(Final))])
n=np.array([i[1] for i in np.transpose(np.nonzero(Final))])
m=m*(-1)
n=n-(Final.shape[1]/2)
m=m+(Final.shape[0]/2)
r = np.sqrt(n*n + m*m)
theta = np.arctan2(n, m)
plt.scatter(theta, r,s=5,color="black",label="Original data")
plt.title('polar coords')
plt.xlabel('$\\theta$ [rad]')
plt.ylabel('r')
plt.show()
```



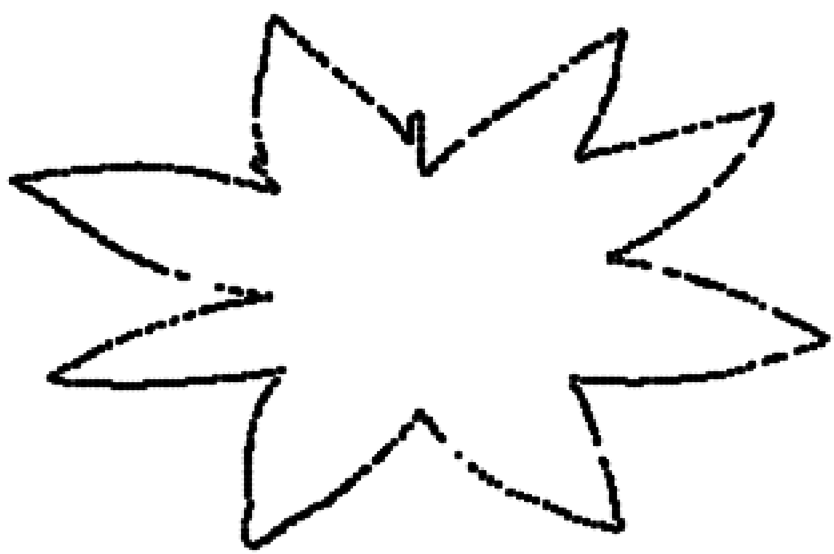
[123]:
```
from scipy import optimize

def test_func(x, a, b, c):
    return a * np.cos(b * x*np.pi/180) + c

params, params_covariance = optimize.curve_fit(test_func,  theta,r,
                                               p0=[300, 8, 300])


print(params)
```

```
[-65.8252445    7.90001705 294.31414048]
```

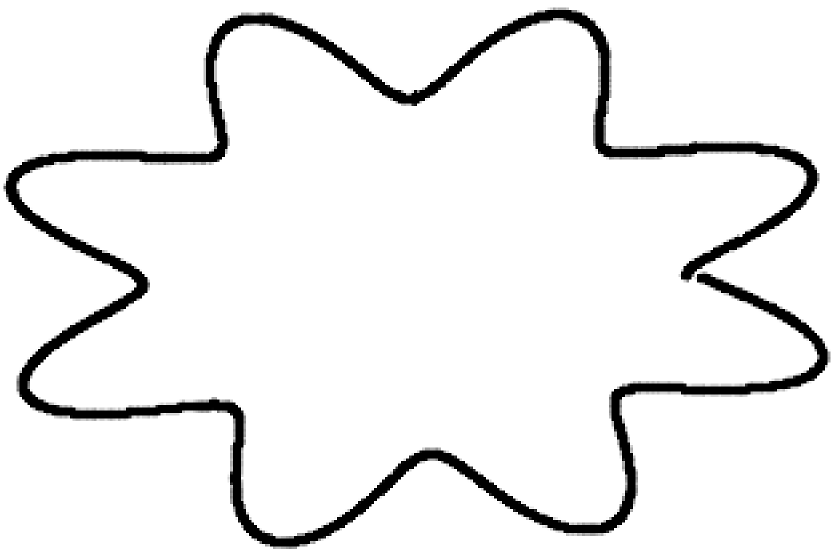
[126]:
```
plt.figure(figsize=(6, 4))
plt.scatter(theta, r, label='Original',color="Green",s=10)
plt.scatter(theta, test_func(theta, params[0], params[1], params[2]),
         label='CoS curve',color='Pink',s=10)
plt.axis("off")
plt.show()
```



[127]:
```
#Original plot
plt.scatter(n[0::5], m[0::5],s=5, color='Black')
plt.axis("off")
plt.show()
```



[143]:
```
#Reverting the interpolation from Polar coords to X-Y coords
x_out = test_func(theta,params[0], params[1], params[2]) * np.cos(np.
↪radians(theta))
y_out = test_func(theta,params[0], params[1], params[2]) * np.sin(np.
↪radians(theta))

#Original set of points
plt.scatter(x_out, y_out,s=5,color='Black')
plt.axis("off")
plt.show()
```



[146]:
```
print("Final parameters:",params)
```

```
Final parameters: [-65.8252445    7.90001705 294.31414048]
```

[147]:
```
#To store this as compression we only require the size to store 3 float values␣
↪as float size is 4 bytes
Original_file=1287082 #in bytes
Storage=4*3
Compression=Original_file/Storage
print("Compression ratio:",Compression)
```

```
Compression ratio: 107256.83333333333
```

[149]:
```
#Tho the curve isn't exact as the flower, it well resembles it and from this␣
↪curve it is easy to tell the fold of symmetry:
#It is approximately the value of B in A(cos(Bx))+C which is the curve we fitted
```

```
Fold_of_symmetry= round(params[1])
print("Fold of symmetry is close to:",Fold_of_symmetry)
```

```
Fold of symmetry is close to: 8
```

10 Testing on a different flower:

[159]:
```
image = Image.open("img3.jpg") #Here I'm reading the image of the flower from
 ↪question
image
```

[159]:

[160]:
```
def change_contrast(img, level):
    factor = (259 * (level + 255)) / (255 * (259 - level))
    def contrast(c):
        return 128 + factor * (c - 128)
    return img.point(contrast)

change_contrast(Image.open('img3.jpg'), 100)
```

[160]:

[158]:
```
def change_contrast_multi(img, steps):
    width, height = img.size
    canvas = Image.new('RGB', (width * len(steps), height))
    for n, level in enumerate(steps):
        img_filtered = change_contrast(img, level)
        canvas.paste(img_filtered, (width * n, 0))
    return canvas

change_contrast_multi(Image.open('img3.jpg'), [-100, 0, 100, 200, 300])
```

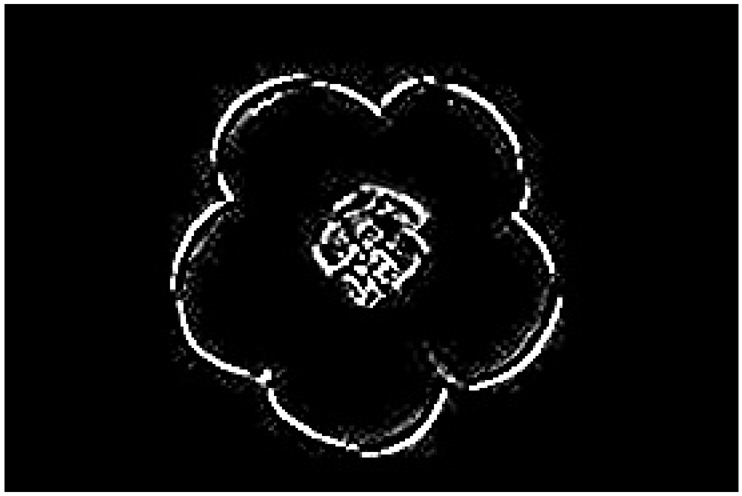
[158]:

[162]:
```
img_filtered = change_contrast(Image.open('img3.jpg'), 200)
img_filtered.save("img3_1.jpg","JPEG")
```

[3]:
```
img = cv2.imread('img3_1.jpg',flags=0)
img_blur = cv2.GaussianBlur(img,(3,3),0,0)
sobelxy = cv2.Sobel(src=img, ddepth=cv2.CV_64F, dx=1, dy=1, ksize=5)
```

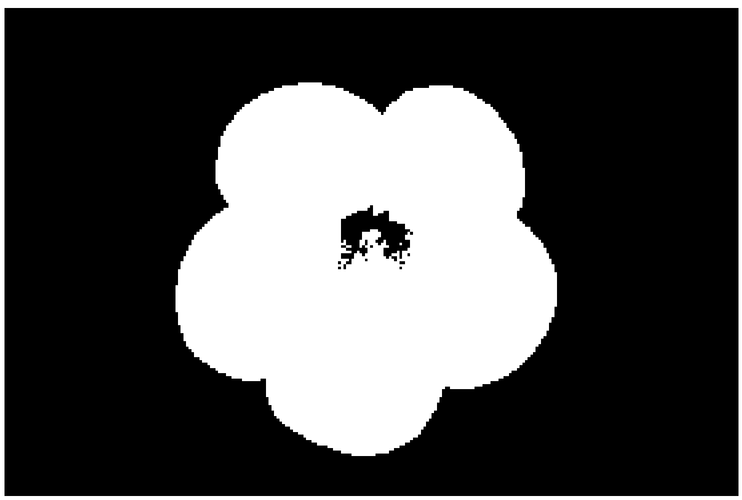
[4]:
```
cv2.imwrite("img3_2.jpg",sobelxy)
image = Image.open("img3_2.jpg") #Here I'm reading the image of the flower from␣
↪question
image
```

[4]:



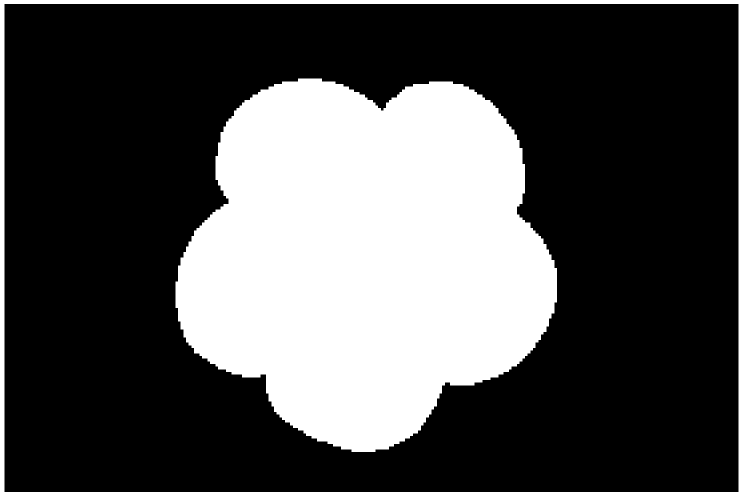
[8]:
```
img = cv2.imread('img3_1.jpg',flags=0)
re, th = cv2.threshold(img, 50, 255, cv2.THRESH_BINARY)
Image.fromarray(th)
```

[8]:



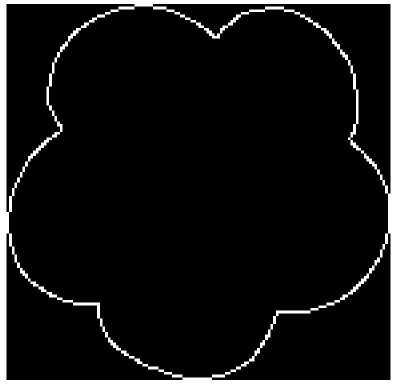
[9]:
```
cop = th.copy()
cv2.floodFill(cop,None,(0,0),255)[1]
Image.fromarray(cv2.bitwise_not(cop))
Image.fromarray(th)
OR=th | cv2.bitwise_not(cop)
Image.fromarray(OR)
```

[9]:

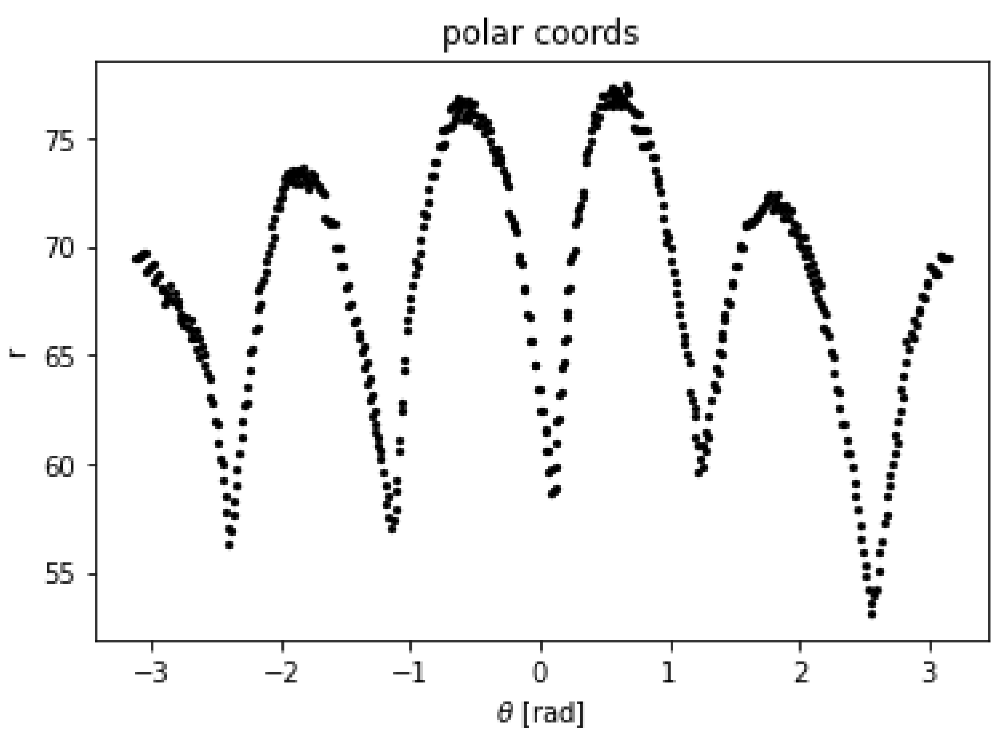


[10]:
```
Edges=cv2.Canny(OR,10,255)
Image.fromarray(Edges)
```
[10]:

[11]:
```
m,n=[i[0] for i in np.transpose(np.nonzero(Edges))],[i[1] for i in np.
 ↪transpose(np.nonzero(Edges))]
a,b,c,d=min(m),min(n),max(m),max(n)
Final=[]
for j in Edges[a:c+1]:Final.append(j[b:d+1]);
Final=np.array(Final)
Image.fromarray(Final)
```
[11]:



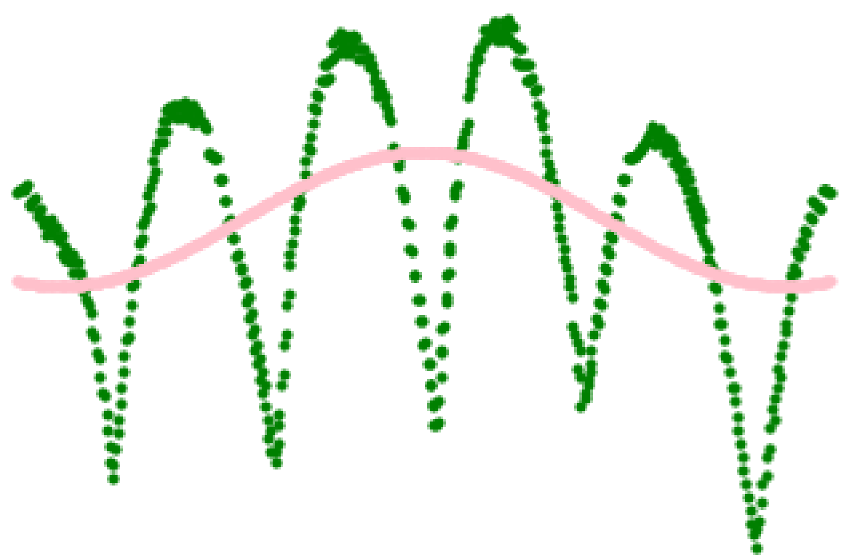
```
[12]: m=np.array([i[0] for i in np.transpose(np.nonzero(Final))])
n=np.array([i[1] for i in np.transpose(np.nonzero(Final))])
m=m*(-1)
n=n-(Final.shape[1]/2)
m=m+(Final.shape[0]/2)
r = np.sqrt(n*n + m*m)
theta = np.arctan2(n, m)
plt.scatter(theta, r,s=5,color="black",label="Original data")
plt.title('polar coords')
plt.xlabel('$\\theta$ [rad]')
plt.ylabel('r')
plt.show()
```



[20]:
```
from scipy import optimize

def test_func(x, a, b, c):
    return a * np.cos(b * x*np.pi/180) + c

params, params_covariance = optimize.curve_fit(test_func,  theta,r,
                                               p0=[10, 25, 65])

print(params)
```

```
[ 3.08505905 64.3169627  68.22754742]
```

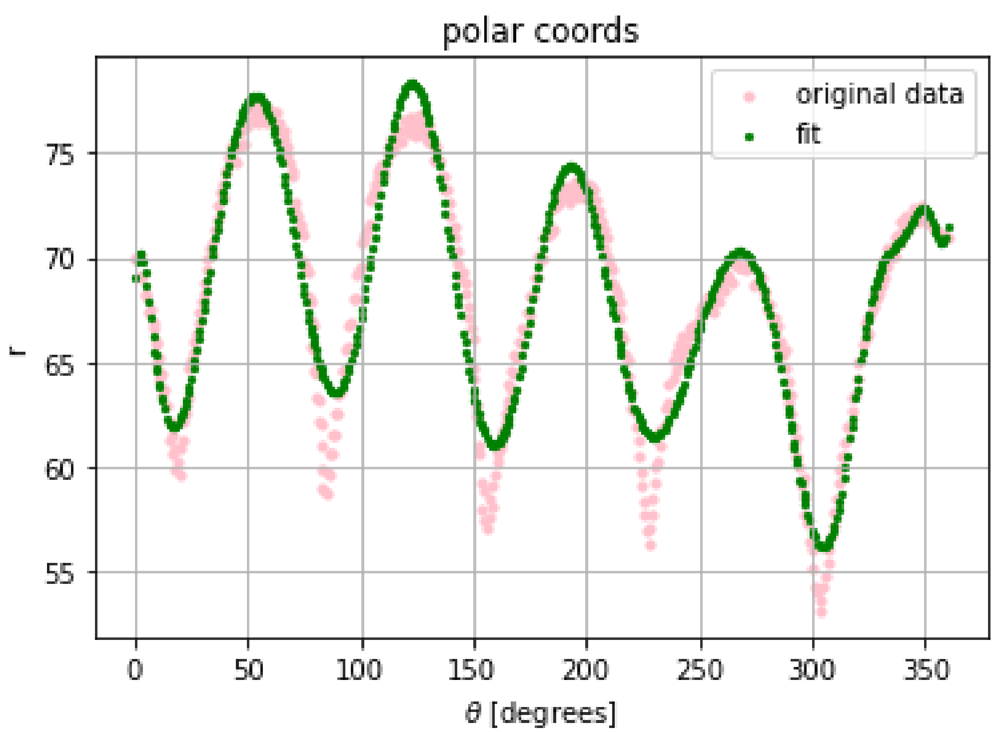
[21]:
```
plt.figure(figsize=(6, 4))
plt.scatter(theta, r, label='Original',color="Green",s=10)
plt.scatter(theta, test_func(theta, params[0], params[1], params[2]),
         label='CoS curve',color='Pink',s=10)
plt.axis("off")
plt.show()
```



[31]:
```
r = np.sqrt(n*n + m*m)
# make sure points are between 0 adn 360[degrees]
theta = np.degrees(np.arctan2(m, n)) % 360
len(theta)
plt.scatter(theta, r,color='pink',s=10)
plt.grid()
```

```
plt.title('polar coords')
plt.ylabel('r')
plt.xlabel('$\\theta$ [degrees]')

#Fitting a higher order polynomial
p = np.polyfit(theta, r, 30)

# plot fit
x_fit = np.linspace(90, 360, 270)
y_fit = np.polyval(p, theta)
plt.scatter(theta, y_fit,color='green',s=5)
plt.legend(['original data', 'fit'])
plt.show()
```

```
C:\Users\chand\nex\anaconda3\lib\site-
packages\IPython\core\interactiveshell.py:3437: RankWarning: Polyfit may be
poorly conditioned
  exec(code_obj, self.user_global_ns, self.user_ns)
```



[32]:
```
plt.scatter(n[0::1], m[0::1],s=5, color='Black')
plt.axis("off")
plt.show()
```

[33]:
```
x_out = np.polyval(p, theta) * np.cos(np.radians(theta))
y_out = np.polyval(p, theta) * np.sin(np.radians(theta))

#Original set of points
plt.scatter(x_out, y_out,s=5,color='Black')
plt.axis("off")
plt.show()
```