

```
In [ ]: import cv2
import numpy as np
import matplotlib.pyplot as plt
# from google.colab.patches import cv2_imshow ## only for colab
import os
os.environ["QT_QPA_PLATFORM"] = "xcb" # to prevent qt errors on some arch
```

Question 1

```
In [32]: cat_img = "cat.jpg"
```

```
In [33]: def imp_gray(img_loc):
    image = cv2.imread(img_loc)
    gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
    return gray_image
```

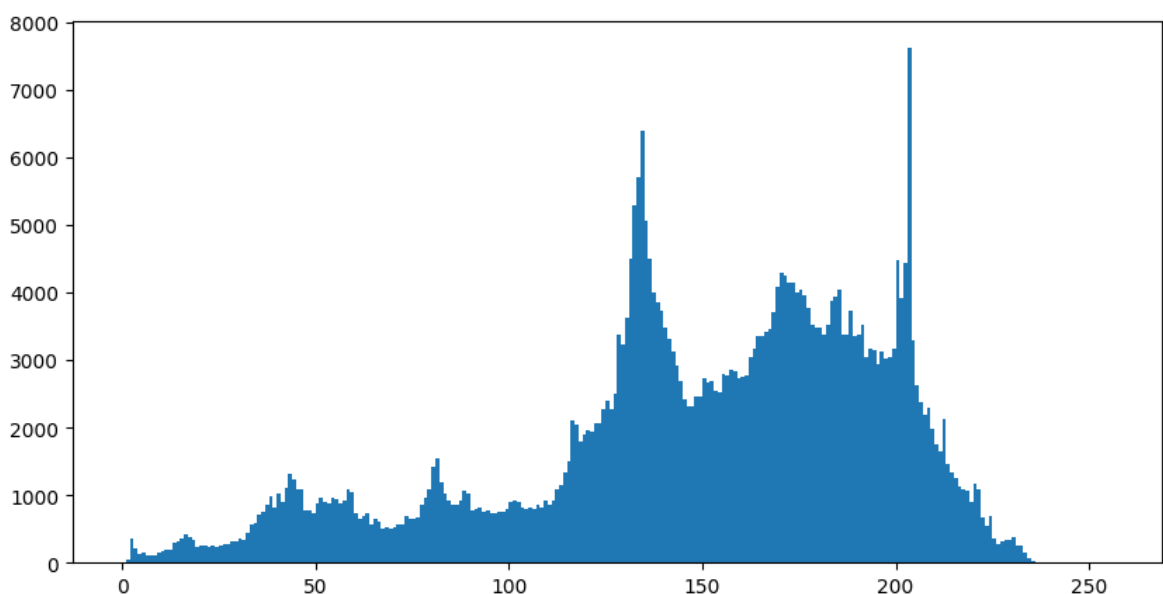
```
In [34]: cat_image = cv2.imread(cat_img)
cat_gray_image = cv2.cvtColor(cat_image, cv2.COLOR_BGR2GRAY)
print(cat_gray_image)
```

```
[[199 202 205 ... 194 195 199]
 [199 202 205 ... 195 196 200]
 [198 201 204 ... 195 197 202]
 ...
 [136 135 135 ... 59 56 51]
 [135 134 133 ... 57 56 49]
 [134 133 132 ... 54 55 46]]
```

```
In [35]: flatten_gimg = cat_gray_image.flatten()
print(flatten_gimg)
```

```
[199 202 205 ... 54 55 46]
```

```
In [36]: plt.figure(figsize=(10, 5))
hists = plt.hist(flatten_gimg, bins=256, range=(0, 256))
plt.show()
```



Question 2

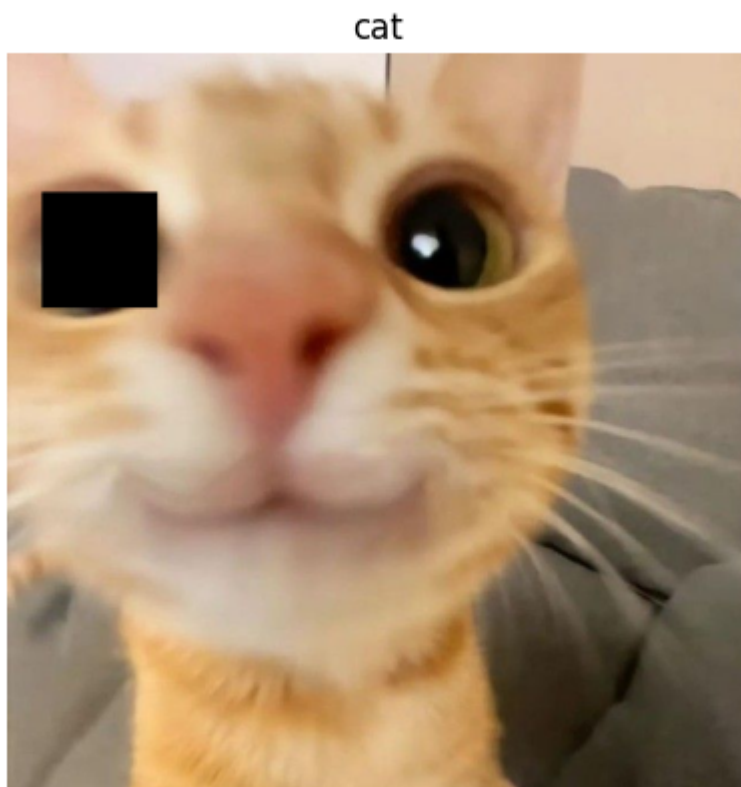
Verifying sum of freq = total no. of pixels

```
In [37]: print(np.sum(hists[0]))  
         print(cat_image.shape)  
         print(220*220)
```

```
409600.0  
(640, 640, 3)  
48400
```

Question 3

```
In [53]: # This changes overall intensity of the image  
         # image_int = image * 5  
         # cv2_imshow(image_int)  
  
         start_row = 120  
         start_colm = 30  
         width = 100  
  
         masked_image = cat_image.copy()  
         for i in range(start_row, start_row + width):  
             for j in range(start_colm, start_colm + width):  
                 masked_image[i][j] = 0  
  
         # Display inline using matplotlib instead of cv2.imshow  
         plt.imshow(cv2.cvtColor(masked_image, cv2.COLOR_BGR2RGB))  
         plt.title("cat")  
         plt.axis('off')  
         plt.show()
```



```
In [39]: people_img = "people.png"
```

```
people_gray = imp_gray(people_img)
print(people_gray)
```

```
[[ 0  0  0 ...  0  0  0]
 [ 0 209 212 ... 244 244  0]
 [ 0 211 213 ... 244 245  0]
 ...
 [ 0 130 129 ...  56  56  0]
 [ 0 130 129 ...  59  58  0]
 [ 0  0  0 ...  0  0  0]]
```

```
In [66]: height, width = people_gray.shape
```

```
img_LHS_reflection = people_gray.copy()
img_RHS_reflection = people_gray.copy()
img_center_reflection = people_gray.copy()

for y in range(height):
    for x in range(width):
        img_LHS_reflection[y][x] = people_gray[y][width - 1 - x]

# both will look the same logic wise
for y in range(height):
    for x in range(width):
        img_RHS_reflection[y][x] = people_gray[y][width - 1 - x]

for y in range(height):
    for x in range(width // 2):
        img_center_reflection[y, x] = people_gray[y, width - 1 - x]
        img_center_reflection[y, width - 1 - x] = people_gray[y, x]

plt.imshow(cv2.cvtColor(img_LHS_reflection, cv2.COLOR_BGR2RGB))
```

```
plt.title("lhs reflection")  
plt.axis('off')  
plt.show()
```

lhs reflection



```
In [65]: plt.imshow(cv2.cvtColor(img_RHS_reflection, cv2.COLOR_BGR2RGB))  
plt.title("rhs reflection")  
plt.axis('off')  
plt.show()
```

rhs reflection



```
In [62]: plt.imshow(cv2.cvtColor(img_center_reflection, cv2.COLOR_BGR2RGB))  
plt.title("central reflection")  
plt.axis('off')  
plt.show()
```

central reflection



Question 4

Theres 3 images of circle used here 8cm, 15cm, 30cm height. all the analysis is done on the 8cm one.

```
In [41]: circle_15cm_filled = "15cm_circle_filled.jpg"
circle_30cm_filled = "30cm_circle_filled.jpg"

circle_8cm_filled = "8cm_circle_filled.jpg"
```

```
In [42]: circle_15cm_filled_matrix = cv2.imread(circle_15cm_filled)
circle_30cm_filled_matrix = cv2.imread(circle_30cm_filled)
circle_8cm_filled_matrix = cv2.imread(circle_8cm_filled)

circle_15cm_filled_gray = cv2.cvtColor(circle_15cm_filled_matrix, cv2.COLOR_BGR2GRAY)
circle_30cm_filled_gray = cv2.cvtColor(circle_30cm_filled_matrix, cv2.COLOR_BGR2GRAY)
circle_8cm_filled_gray = cv2.cvtColor(circle_8cm_filled_matrix, cv2.COLOR_BGR2GRAY)

print(circle_15cm_filled_gray.shape)
print(circle_30cm_filled_gray.shape)

print(circle_8cm_filled_gray.shape)

(1496, 1496)
(1496, 1496)
(2992, 2992)
```

```
In [43]: hist_gray_15cm,_ = np.histogram(circle_15cm_filled_gray, bins=256, range=
hist_gray_30cm,_ = np.histogram(circle_30cm_filled_gray, bins=256, range=

bins = np.arange(256)

fig, axes = plt.subplots(1, 2, figsize=(12, 5))
```

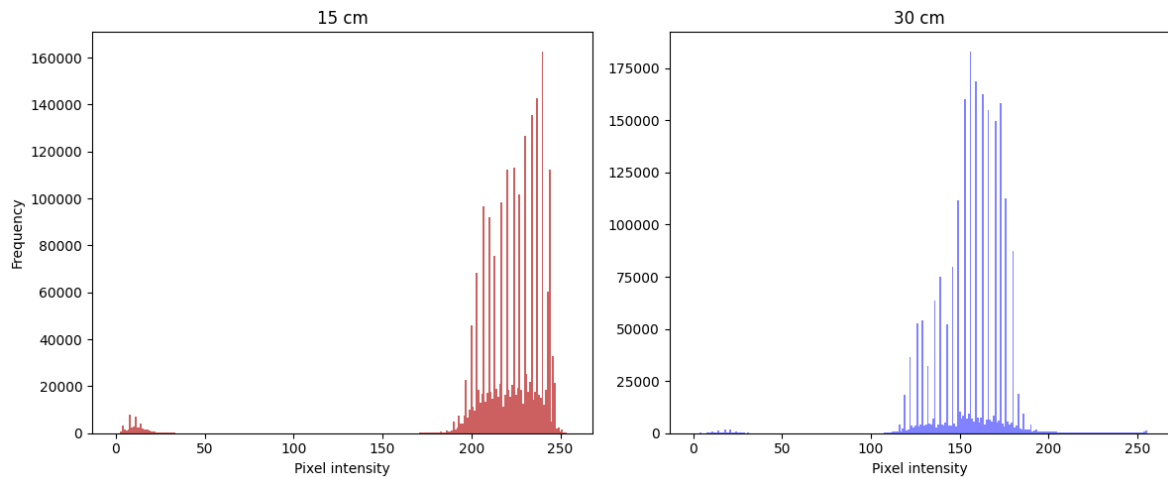
```

axes[0].bar(bins, hist_gray_15cm, width=1.0, color="#CC6060")
axes[0].set_title("15 cm")
axes[0].set_xlabel("Pixel intensity")
axes[0].set_ylabel("Frequency")

axes[1].bar(bins, hist_gray_30cm, width=1.0, color="#8082FF")
axes[1].set_title("30 cm")
axes[1].set_xlabel("Pixel intensity")

plt.tight_layout()
plt.show()

```



```

In [44]: print("Std dev of 15cm", np.std(hist_gray_15cm))
         print("Std dev of 30cm", np.std(hist_gray_30cm))

```

Std dev of 15cm 25376.487037862677

Std dev of 30cm 29817.14953326462

- 15cm is narrow while 30cm is wide. 30cm has more background with variation than 15cm. Thus 30cm having more contrast as it contains more background and vignetting. it will have more standard dev as well

```

In [45]: hist_gray_8cm,_ = np.histogram(circle_8cm_filled_gray, bins=256, range=(0
hist_gray_30cm,_ = np.histogram(circle_30cm_filled_gray, bins=256, range=

bins = np.arange(256)

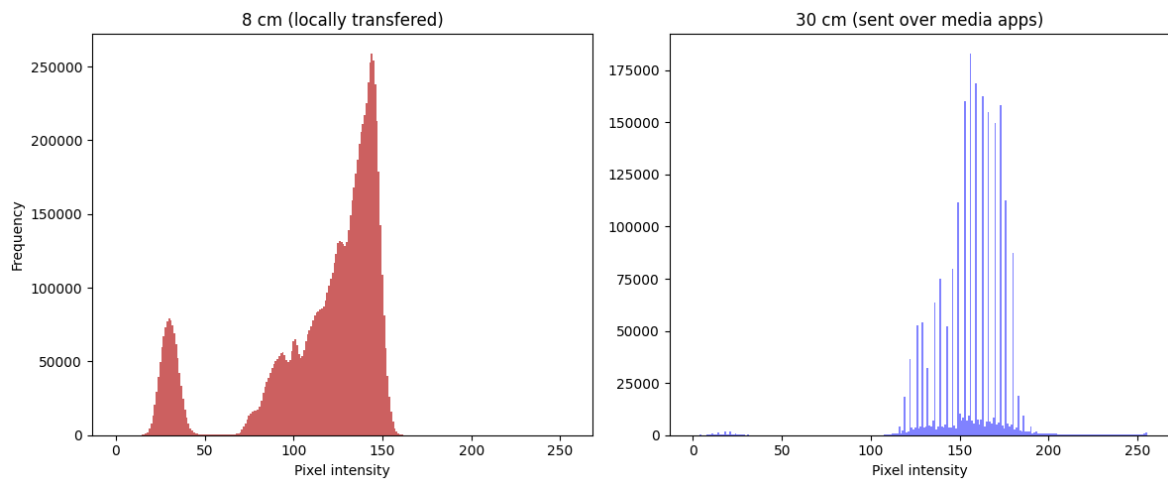
fig, axes = plt.subplots(1, 2, figsize=(12, 5))

axes[0].bar(bins, hist_gray_8cm, width=1.0, color="#CC6060")
axes[0].set_title("8 cm (locally transfered)")
axes[0].set_xlabel("Pixel intensity")
axes[0].set_ylabel("Frequency")

axes[1].bar(bins, hist_gray_30cm, width=1.0, color="#8082FF")
axes[1].set_title("30 cm (sent over media apps)")
axes[1].set_xlabel("Pixel intensity")

plt.tight_layout()
plt.show()

```



the left image is transferred using data cable directly from phone to pc while the right image is sent using a social media app (discord), we can see that media apps compress the image decreasing the resolution and creating these gaps in the data (removing some colors as a step of compression)

Question 5

```
In [46]: # Isolating the circle

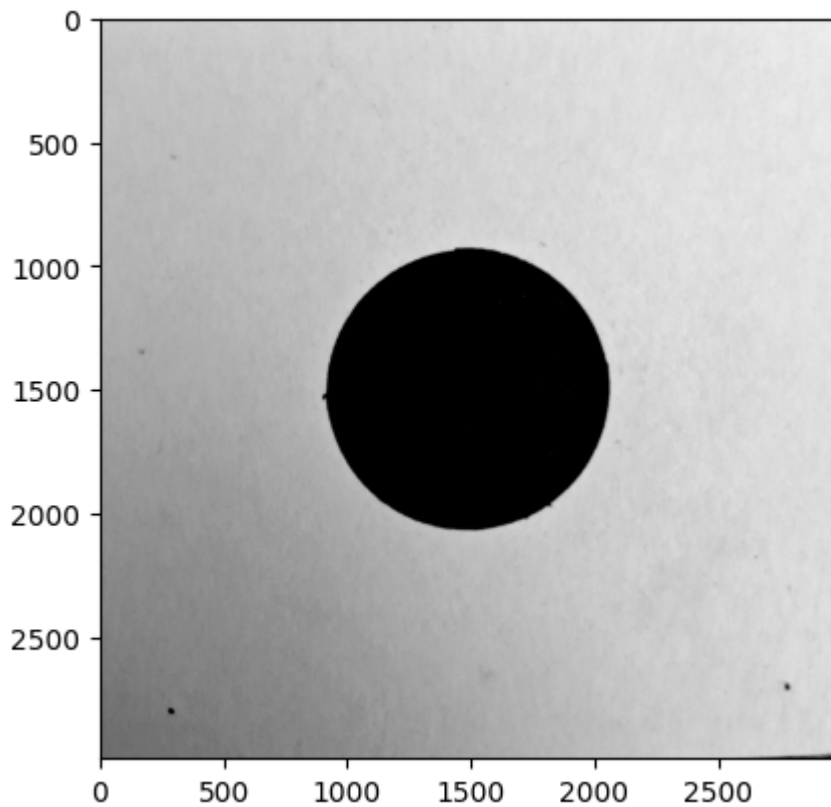
manual_threshold = 50

thresholed_8cm = []

for i in circle_8cm_filled_gray:
    row = []
    for j in i:
        if j > manual_threshold:
            row.append(j)
        else:
            row.append(0)
    thresholed_8cm.append(row)

plt.imshow(thresholed_8cm, cmap="gray")
```

```
Out[46]: <matplotlib.image.AxesImage at 0x7fcbad3de850>
```



```
In [47]: thresholed_8cm = np.array(thresholed_8cm)
         np.shape(thresholed_8cm)
```

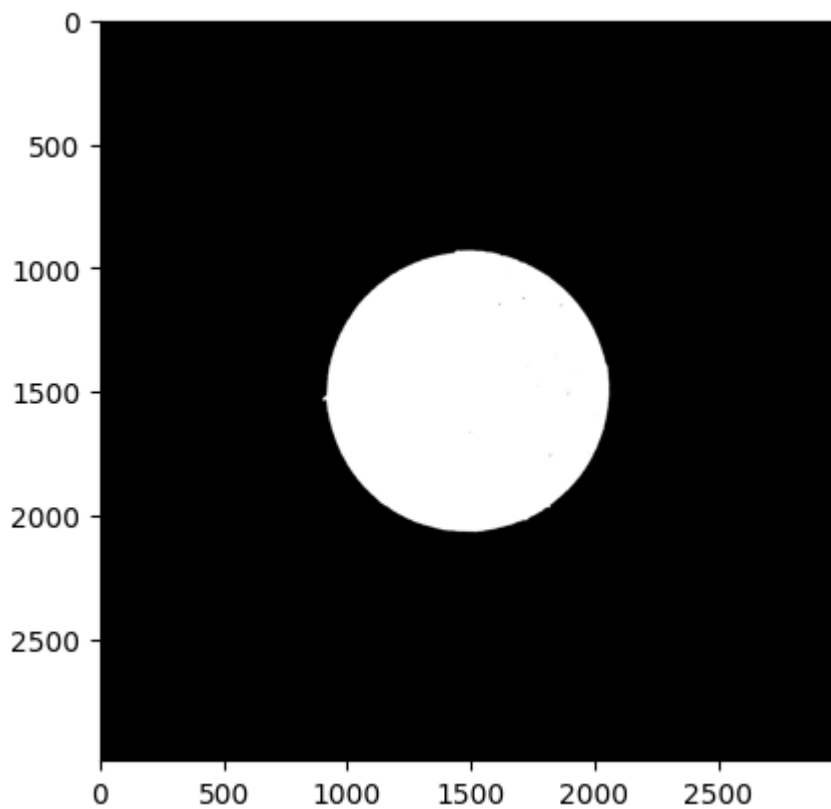
```
Out[47]: (2992, 2992)
```

```
In [48]: start_pixel = 700
         end_pixel = 700
         width = 1500

         isolated_circle_8cm = np.zeros(np.shape(thresholed_8cm), dtype=thresholed_8cm.dtype)

         for i in range(start_pixel, start_pixel + width):
             for j in range(end_pixel, end_pixel + width):
                 if thresholed_8cm[i, j] < 50:
                     isolated_circle_8cm[i, j] = 255

         plt.imshow(isolated_circle_8cm, cmap="gray")
         plt.show()
```

get area of the circle

```
In [49]: circle_pixels = 0

for i in isolated_circle_8cm:
    for j in i:
        if j != 0:
            circle_pixels += 1

r = np.sqrt(circle_pixels/np.pi) # pixels
"""
Actual Radius = 1.35cm
2992pixel = 7.5cm
"""
print("pixel radius =",r)

multiplier = 7.5/2992 # cm/pixels
radius = multiplier * r # cm

print("Image Radius in cm =",radius)
```

```
pixel radius = 567.069754244368
Image Radius in cm = 1.4214649588344788
```

calculating focal length

```
In [50]: actual_radius = 1.35
         image_radius = radius
         distance = 8/2

         f = (actual_radius*distance)/image_radius
         print("Focal Length in mm =", f*10)
```

Focal Length in mm = 37.98897726207543