```
!pip install image
```

```
Collecting image
  Downloading image-1.5.33.tar.gz (15 kB)
  Preparing metadata (setup.py) ... ent already satisfied: pillow
in /usr/local/lib/python3.11/dist-packages (from image) (11.1.0)
Collecting django (from image)
  Downloading Django-5.1.6-py3-none-any.whl.metadata (4.2 kB)
Requirement already satisfied: six in /usr/local/lib/python3.11/dist-
packages (from image) (1.17.0)
Collecting asgiref<4,>=3.8.1 (from django->image)
  Downloading asgiref-3.8.1-py3-none-any.whl.metadata (9.3 kB)
Requirement already satisfied: sqlparse>=0.3.1 in
/usr/local/lib/python3.11/dist-packages (from django->image) (0.5.3)
Downloading Django-5.1.6-py3-none-any.whl (8.3 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 8.3/8.3 MB 51.3 MB/s eta
0:00:00
age
  Building wheel for image (setup.py) ... age: filename=image-1.5.33-
py2.py3-none-any.whl size=19482
sha256=bd92ab12501073924657551fb159e4feb0f6ddb94b91c67b2133ee2e3570ed8
7
  Stored in directory:
/root/.cache/pip/wheels/62/40/4f/3c9a8d0f22a1a6f966975a460e5cb509a1e7d
c42e2ce5d9a6d
Successfully built image
Installing collected packages: asgiref, django, image
Successfully installed asgiref-3.8.1 django-5.1.6 image-1.5.33
```

```
!pip install pillow
```

```
Requirement already satisfied: pillow in
/usr/local/lib/python3.11/dist-packages (11.1.0)
```

#Getting Started with Image Processing with Python.

Introduction to Python Imaging Library(PIL) 2.1 Exercise - 1:

```python
from PIL import Image
import numpy as np
import matplotlib.pyplot as plt

from google.colab import files
uploaded = files.upload()
```

```
<IPython.core.display.HTML object>

Saving Lenna_(test_image).png to Lenna_(test_image) (1).png
```

Task1: Read and display the image.

• Read the image using the Pillow library and display it.

• You can also use matplotlib to display the image.

```
image_path = "Lenna_(test_image).png"
image = Image.open(image_path)

plt.figure(figsize=(6, 6))
plt.imshow(image)
plt.title("Original Image")
plt.axis("off")
plt.show()
```

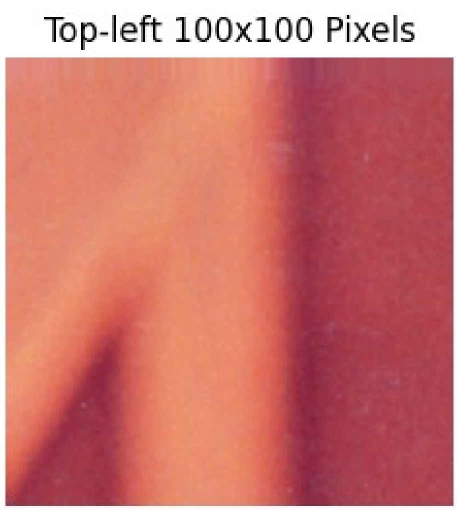
Original Image

Task2: Display only the top left corner of 100x100 pixels.

• Extract the top-left corner of the image (100x100 pixels) and display it using NumPy and Array Indexing.

```
image_array = np.array(image)
top_left = image_array[:100, :100]
```

```python
plt.figure(figsize=(3, 3))
plt.imshow(top_left)
plt.title("Top-left 100x100 Pixels")
plt.axis("off")
plt.show()
```



Show the three color channels (R, G, B).

• Separate the image into its three color channels (Red, Green, and Blue) and display them individually, labeling each channel as R, G, and B.{Using NumPy.}

```python
r_channel = image_array[:, :, 0]  # Red channel
g_channel = image_array[:, :, 1]  # Green channel
b_channel = image_array[:, :, 2]  # Blue channel

fig, ax = plt.subplots(1, 3, figsize=(12, 4))
ax[0].imshow(r_channel, cmap="Reds")
ax[0].set_title("Red Channel")
ax[0].axis("off")

ax[1].imshow(g_channel, cmap="Greens")
ax[1].set_title("Green Channel")
ax[1].axis("off")

ax[2].imshow(b_channel, cmap="Blues")
ax[2].set_title("Blue Channel")
ax[2].axis("off")

plt.show()
```

Task4: Modify the top 100 × 100 pixels to a value of 210 and display the resulting image:

• Modify the pixel values of the top-left 100 × 100 region to have a value of 210 (which is a light gray color), and then display the modified image.

```
modified_image = image_array.copy()
modified_image[:100, :100] = 210  # Setting top-left pixels to light gray

plt.figure(figsize=(6, 6))
plt.imshow(modified_image)
plt.title("Modified Image with Top-left 100x100 Set to 210")
plt.axis("off")
plt.show()
```

2.2

Exercise - 2:

1. Load and display a grayscale image.

• Load a grayscale image using the Pillow library.

• Display the grayscale image using matplotlib.

```
from PIL import Image
import matplotlib.pyplot as plt

image_path = "cameraman.png"
image = Image.open(image_path).convert("L")

plt.imshow(image, cmap="gray")
plt.axis("off")
plt.show()
```

1. Extract and display the middle section of the image (150 pixels).

• Extract a 150 pixel section from the center of the image using NumPy array slicing.

• Display this cropped image using matplotlib.

```
image_array = np.array(image)
height, width = image_array.shape
start_x = width // 2 - 75
end_x = width // 2 + 75
cropped_image = image_array[:, start_x:end_x]

plt.subplot(1, 4, 2)
plt.imshow(cropped_image, cmap="gray")
plt.axis("off")
plt.title("Cropped Section")
```

```
Text(0.5, 1.0, 'Cropped Section')
```

1. Apply a simple threshold to the image (e.g., set all pixel values below 100 to 0).

Apply a threshold to the grayscale image: set all pixel values below 100 to 0, and all values above 100 to 255 (creating a binary image).

Display the resulting binary image.

```
threshold_value = 100
binary_image = np.where(image_array < threshold_value, 0,
255).astype(np.uint8)

plt.subplot(1, 4, 3)
plt.imshow(binary_image, cmap="gray")
plt.axis("off")
plt.title("Threshold Image")
```

```
Text(0.5, 1.0, 'Binary Image')
```

1. Rotate the image 90 degrees clockwise and display the result.

• Rotate the image by 90 degrees clockwise using the Pillow rotate method or by manipulating the image array.

• Display the rotated image using matplotlib.

```
rotated_image = np.rot90(image_array, k=-1)

plt.figure(figsize=(5, 5))
plt.imshow(rotated_image, cmap="gray")
plt.axis("off")
plt.title("Rotated Image")
plt.show()
```

1. Convert the grayscale image to an RGB image.

• Convert the grayscale image into an RGB image where the grayscale values are replicated across all three channels (R, G, and B).

• Display the converted RGB image using matplotlib.

```
rgb_image = np.stack([image_array]*3, axis=-1)

plt.figure(figsize=(5, 5))
```

```
plt.imshow(rgb_image)
plt.axis("off")
plt.title("RGB Image")
plt.show()
```

3 Image Compression and Decompression using PCA.

1. Load and Prepare Data:

• Fetch an image of you choice.{If colour convert to grayscale}

• Center the dataset - Standaridze the Data.

• Calculate the covaraince matrix of the Standaridze data.

1. Eigen Decomposition and Identifying Principal Components: • Compute Eigen Values and Eigen Vectors.

• Sort the eigenvalues in descending order and choose the top k eigenvectors corresponding to the highest eigenvalues.

• Identify the Principal Components with the help of cumulative Sum plot.

1. Reconstruction and Experiment:

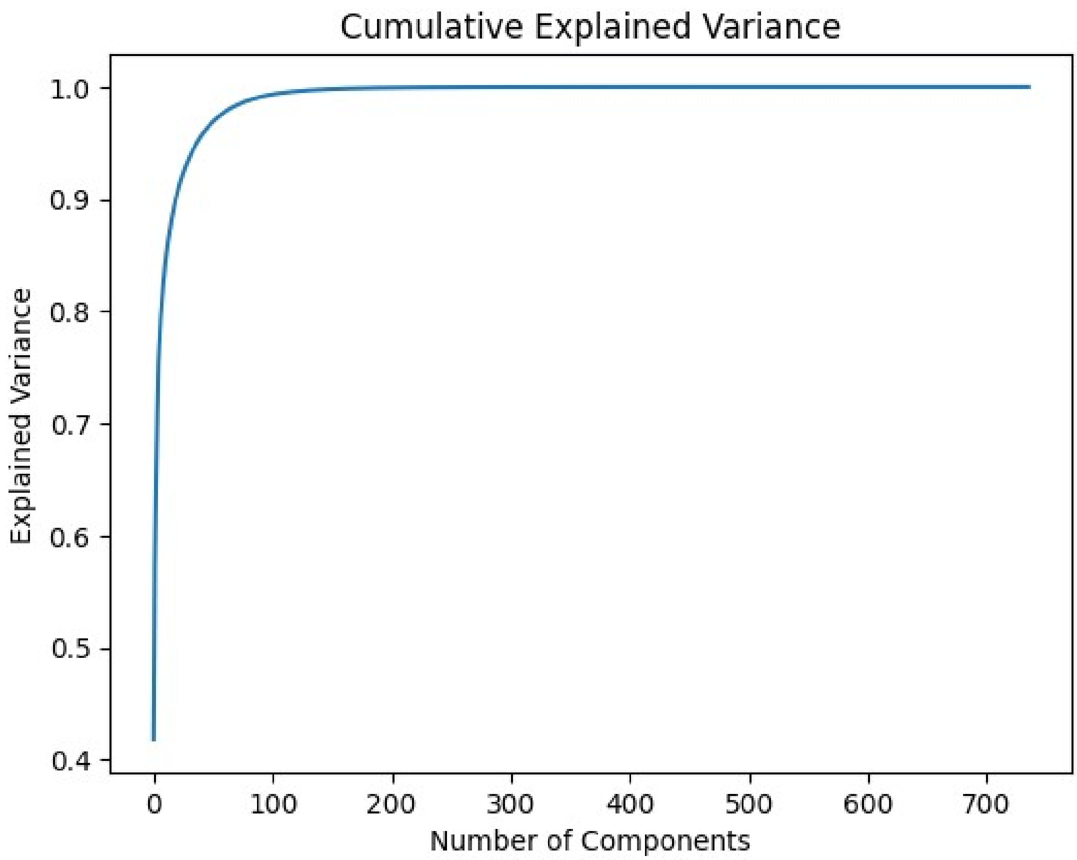
• Reconstruction: Transform the original data by multiplying it with the selected eigenvectors(PCs) to obtain a lower-dimensional representation.

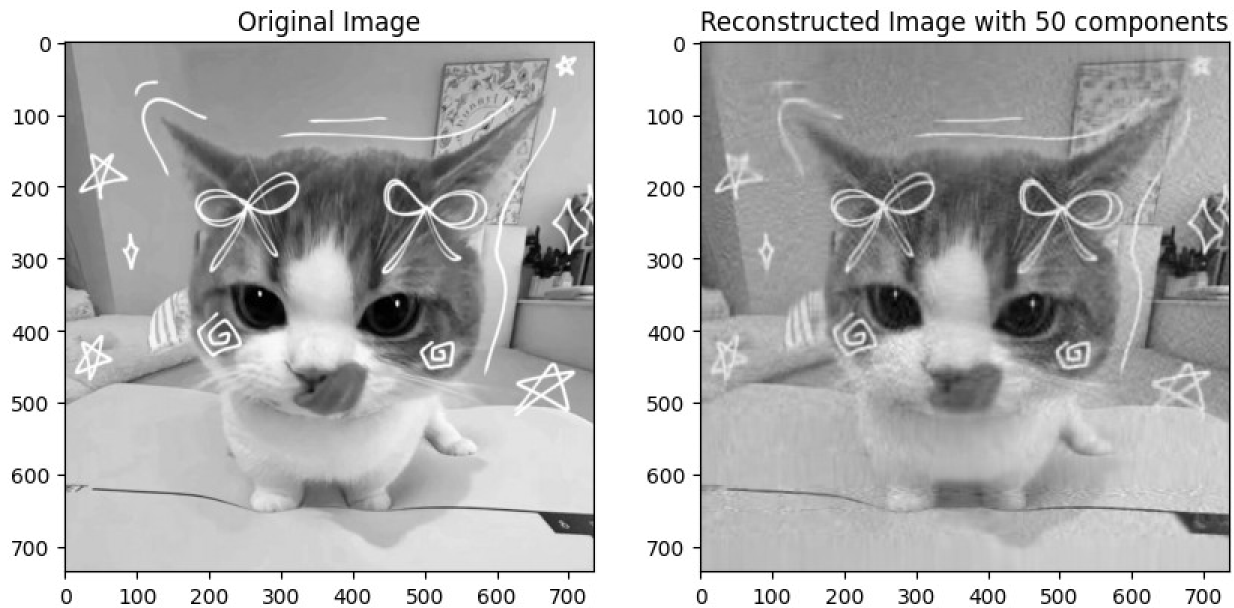
• Experiments: Pick Four different combination of principal components with various ex- plained variance value and compare the result.

• Display the Results and Evaluate.

```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.decomposition import PCA
from skimage import color, io

img = io.imread('catto.jpg')
gray_img = color.rgb2gray(img)
img_vector = gray_img.flatten()
mean_img = np.mean(gray_img, axis=0)
centered_img = gray_img - mean_img

cov_matrix = np.cov(centered_img.T)

eigenvalues, eigenvectors = np.linalg.eigh(cov_matrix)

sorted_indices = np.argsort(eigenvalues)[::-1]
eigenvalues = eigenvalues[sorted_indices]
eigenvectors = eigenvectors[:, sorted_indices]

explained_variance = eigenvalues / np.sum(eigenvalues)
cumulative_variance = np.cumsum(explained_variance)

plt.figure()
plt.plot(cumulative_variance)
plt.title('Cumulative Explained Variance')
plt.xlabel('Number of Components')
plt.ylabel('Explained Variance')
plt.show()

# Select Top k Components (based on explained variance)
k = 50  # Example: Top 50 components
top_k_eigenvectors = eigenvectors[:, :k]

# Data Reconstruction
compressed_data = np.dot(centered_img, top_k_eigenvectors)
reconstructed_img = np.dot(compressed_data, top_k_eigenvectors.T) +
mean_img

# Display Results
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.imshow(gray_img, cmap='gray')
plt.title('Original Image')

plt.subplot(1, 2, 2)
plt.imshow(reconstructed_img, cmap='gray')
```

```
plt.title(f'Reconstructed Image with {k} components')

plt.show()

# Evaluate Reconstruction (MSE or PSNR)
mse = np.mean((gray_img - reconstructed_img) ** 2)
psnr = 20 * np.log10(1.0 / np.sqrt(mse))  # Assuming image is in [0,
1] range
print(f'MSE: {mse}')
print(f'PSNR: {psnr} dB')
```






```
MSE: 0.0010984810216824702
PSNR: 29.59207441929432 dB
```