Worksheet-01

Exercise - 1:

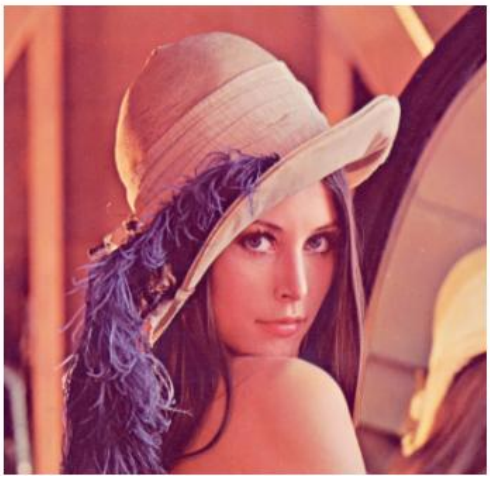
1. Read and Display Image

```
[6] colored_image = Image.open("/content/drive/MyDrive/AI and Machine Learning/lenna_image.png")
```

```
[7] print("Format: ", colored_image.format)
    print("Mode: ", colored_image.mode)
    print("Size: ", colored_image.size)
```

```
Format:  PNG
Mode:  RGBA
Size:  (366, 357)
```

```
colored_image = colored_image.convert("RGB")
display(colored_image)
```



```
image_array = np.array(colored_image)
plt.imshow(image_array)
plt.axis("off")
plt.title("Original Image")
plt.show()
```

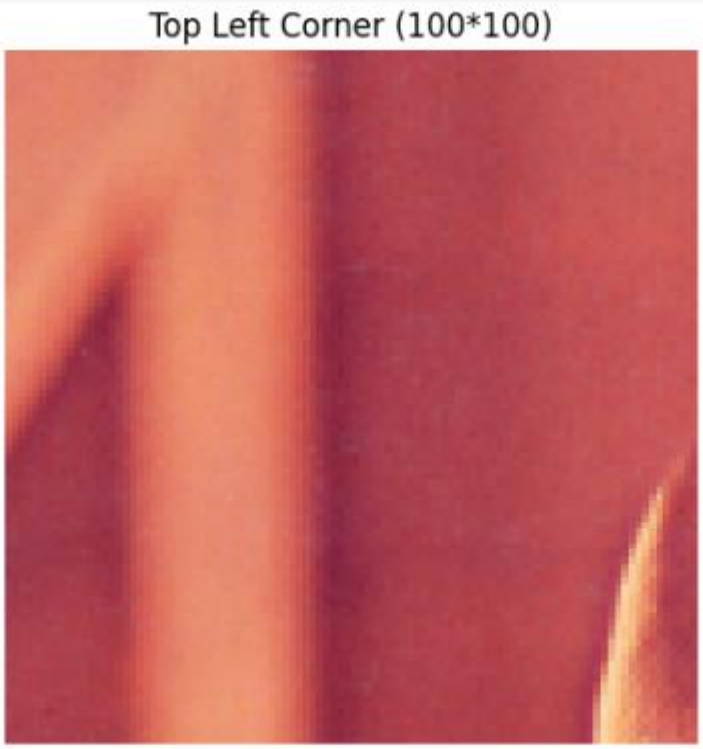
2. Display top corner of 100*100 pixels

```
[10] image_array = np.array(colored_image)

     top_left = image_array[:100, :100]

     plt.axis("off")
     plt.title("Top Left Corner (100*100)")
     plt.imshow(top_left)
     plt.show()
```

[10]

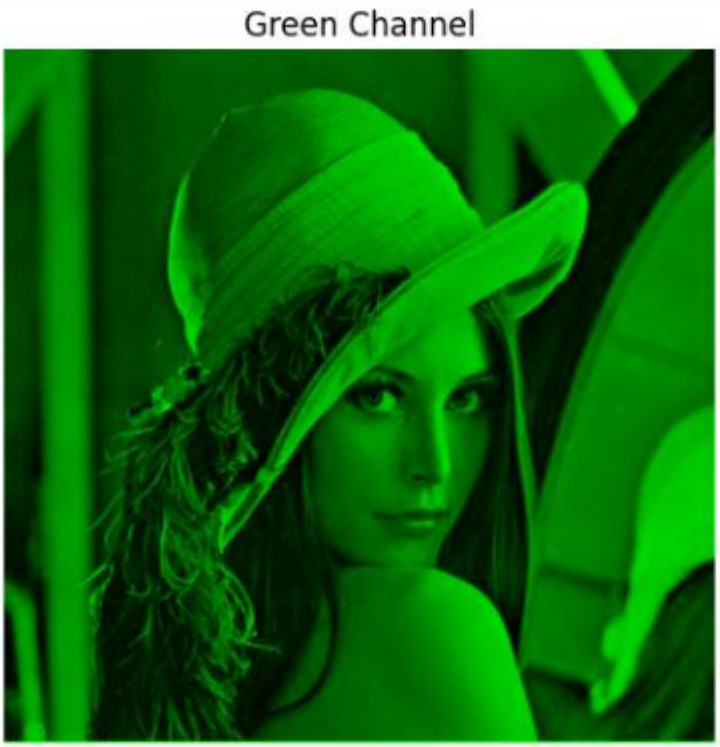


3. Displaying Color Channels

```
red_channel = image_array.copy()
red_channel[:, :, 1] = 0
red_channel[:, :, 2] = 0
plt.axis("off")
plt.title("Red Channel")
plt.imshow(red_channel)
plt.show()
```


```
[12] green_channel = image_array.copy()
     green_channel[:, :, 0] = 0
     green_channel[:, :, 2] = 0
     plt.axis("off")
     plt.title("Green Channel")
     plt.imshow(green_channel)
     plt.show()
```

[12]



[13]

```
blue_channel = image_array.copy()
blue_channel[:, :, 1] = 0
blue_channel[:, :, 0] = 0
plt.axis("off")
plt.title("Blue Channel")
plt.imshow(blue_channel)
plt.show()
```

4. Top 100 * 100 modification

```
image_modified = image_array.copy()
image_modified[:100, :100] = 210

plt.axis("off")
plt.title("Top 100 * 100 to 210 - Modified Image")
plt.imshow(image_modified)
plt.show()
```

[14]

Exercise - 2:

1. Load and Display Grayscale Image

[15]
```
image_grayscale = Image.open("/content/drive/MyDrive/AI and Machine Learning/camera_man.jpg").convert("L")
```

[16]
```
image_array = np.array(image_grayscale)

    plt.title("Original Grayscale Image")
    plt.axis("off")
    plt.imshow(image_array, cmap="gray")
    plt.show()
```

```
plt.show()
```

[16]

2. Extract Middle 150 pixels of Image

```
width, height = image_array.shape

col_start = (width // 2)
row_start = (height // 2 )
mid_section = image_array[row_start:row_start+150, col_start:col_start+150]


plt.title("Middle 150 * 150 pixels")
plt.axis("off")
plt.imshow(mid_section, cmap="gray")
plt.show()
```

[17] Middle 150 * 150 pixels

3.Apply a simple threshold to Image

3.Apply a simple threshold to Image

```
binary_image = np.zeros_like(image_array, dtype=np.uint8)

height, width = image_array.shape

for i in range(height):
    for j in range(width):
        if image_array[i, j] < 100:
            binary_image[i, j] = 0
        else:
            binary_image[i, j] = 255

plt.title("Thresholded Image")
plt.axis("off")
plt.imshow(binary_image, cmap="gray")
plt.show()
```

4. Rotate Image 90 deg

```
rotate_image = image_grayscale.rotate(-90, expand = True)

plt.title("Rotated Image Clockwise 90 deg")
plt.axis("off")
plt.imshow(rotate_image, cmap="gray")
plt.show()
```

5. Convert Grayscale to RGB image

```
[20] image_colored = Image.merge("RGB", (image_grayscale, image_grayscale, image_grayscale))

plt.title("Grayscale to RGB")
plt.axis("off")
plt.imshow(image_colored, cmap="gray")
plt.show()
```

Grayscale to RGB

Exercise - 3:

1. Load and Prepare Data

```
[21] image = Image.open("/content/drive/MyDrive/AI and Machine Learning/lenna_image.png").convert("L")
```

```
image_array = np.array(image)
print(image_array.shape)

height, width = image_array.shape

data = image_array.copy()

plt.title("Original Image")
plt.axis("off")
plt.imshow(image_array, cmap='gray')
plt.show()
```

```
(357, 366)
```


```
[23] mean = np.mean(data, axis = 0)
centered_data = data - mean
centered_data
```

```
array([[ 61.34173669,  62.17647059,  62.83473389, ..., -82.04761905,
```

```
[23] mean = np.mean(data, axis = 0)
     centered_data = data - mean
     centered_data
```

```
array([[ 61.34173669,  62.17647059,  62.83473389, ..., -82.04761905,
         -83.96638655, -87.30252101],
        [ 63.34173669,  61.17647059,  62.83473389, ..., -84.04761905,
         -83.96638655, -85.30252101],
        [ 61.34173669,  65.17647059,  61.83473389, ..., -81.04761905,
         -82.96638655, -87.30252101],
        ...,
        [-46.65826331, -45.82352941, -42.16526611, ..., -44.04761905,
         -32.96638655, -31.30252101],
        [-44.65826331, -42.82352941, -42.16526611, ..., -39.04761905,
         -28.96638655, -31.30252101],
        [161.34173669, 161.17647059, 160.83473389, ..., 123.95238095,
         124.03361345, 123.69747899]])
```

```
[24] cov_matrix = np.cov(centered_data, rowvar = False)
     cov_matrix
```

```
array([[1482.61322507, 1444.75413087, 1404.48079344, ..., -477.00334403,
         -463.70533944, -416.64351808],
        [1444.75413087, 1430.68506279, 1399.06857237, ..., -546.38764045,
         -531.51999339, -485.93803701],
        [1404.48079344, 1399.06857237, 1391.50350927, ..., -581.36182451,
         -565.21914833, -521.85069871],
        ...,
        [-477.00334403, -546.38764045, -581.36182451, ..., 3069.65783842,
         3039.86677368, 3007.1540931 ],
        [-463.70533944, -531.51999339, -565.21914833, ..., 3039.86677368,
         3036.6898782 , 3021.25177037],
        [-416.64351808, -485.93803701, -521.85069871, ..., 3007.1540931 ,
         3021.25177037, 3034.25092059]])
```

```
[25] cov_matrix.shape
```

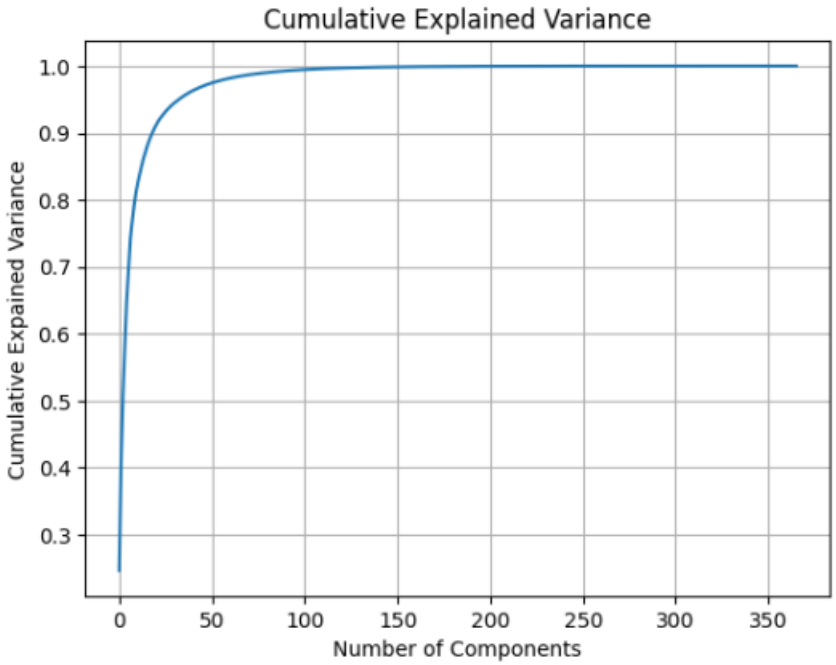
```
(366, 366)
```

2. Eigen Decomposition and Identifying Pricipal Components

```
[26] eigenvalues, eigenvectors = np.linalg.eigh(cov_matrix)
```

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

```
explained_variance_ratio = eigenvalues / np.sum(eigenvalues)
plt.plot(np.cumsum(explained_variance_ratio))
plt.title("Cumulative Explained Variance")
plt.xlabel("Number of Components")
plt.ylabel("Cumulative Expained Variance")
plt.grid(True)
plt.show()
```



3.Reconstruction and Experiment

```
[29] k1 = 10
     k2 = 20
     k3 = 50
     k4 = 100
     k5 = 150

     components1 = eigenvectors[:, :k1]
     components2 = eigenvectors[:, :k2]
     components3 = eigenvectors[:, :k3]
     components4 = eigenvectors[:, :k4]
     components5 = eigenvectors[:, :k5]
```

```
[30] compressed_data1 = np.dot(centered_data, components1)
     compressed_data2 = np.dot(centered_data, components2)
     compressed_data3 = np.dot(centered_data, components3)
     compressed_data4 = np.dot(centered_data, components4)
     compressed_data5 = np.dot(centered_data, components5)
```

```
[31] decompressed_data1 = np.dot(compressed_data1, components1.T) + mean
     decompressed_data2 = np.dot(compressed_data2, components2.T) + mean
     decompressed_data3 = np.dot(compressed_data3, components3.T) + mean
     decompressed_data4 = np.dot(compressed_data4, components4.T) + mean
     decompressed_data5 = np.dot(compressed_data5, components5.T) + mean
```

```
plt.figure(figsize=(15, 8))

plt.subplot(2, 3, 1)
plt.imshow(image_array, cmap="gray")
plt.title("Original Image")
plt.axis("off")

plt.subplot(2, 3, 2)
plt.imshow(decompressed_data1, cmap="gray")
plt.title("10 Components Image")
plt.axis("off")
```

```
plt.figure(figsize=(15, 8))

plt.subplot(2, 3, 1)
plt.imshow(image_array, cmap="gray")
plt.title("Original Image")
plt.axis("off")

plt.subplot(2, 3, 2)
plt.imshow(decompressed_data1, cmap="gray")
plt.title("10 Components Image")
plt.axis("off")

plt.subplot(2, 3, 3)
plt.imshow(decompressed_data2, cmap="gray")
plt.title("20 Components Image")
plt.axis("off")

plt.subplot(2, 3, 4)
plt.imshow(decompressed_data3, cmap="gray")
plt.title("50 Components Image")
plt.axis("off")

plt.subplot(2, 3, 5)
plt.imshow(decompressed_data4, cmap="gray")
plt.title("100 Components Image")
plt.axis("off")

plt.subplot(2, 3, 6)
plt.imshow(decompressed_data5, cmap="gray")
plt.title("150 Components Image")
plt.axis("off")

plt.tight_layout()
plt.show()
```


Original Image
10 Components Image
20 Components Image
50 Components Image
100 Components Image
150 Components Image