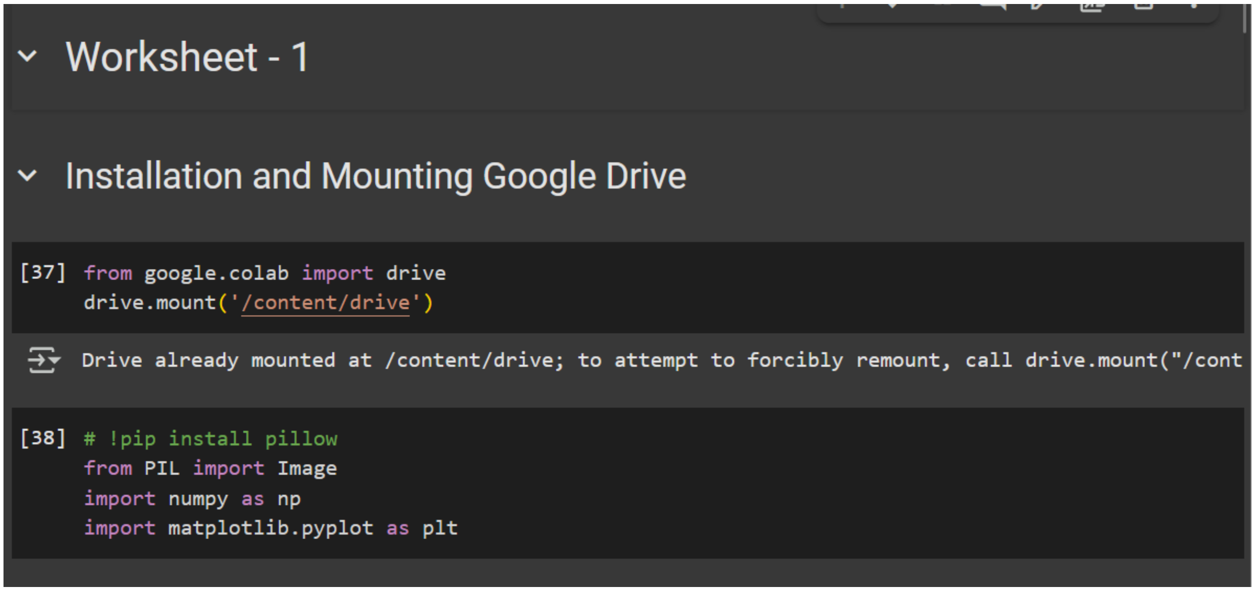


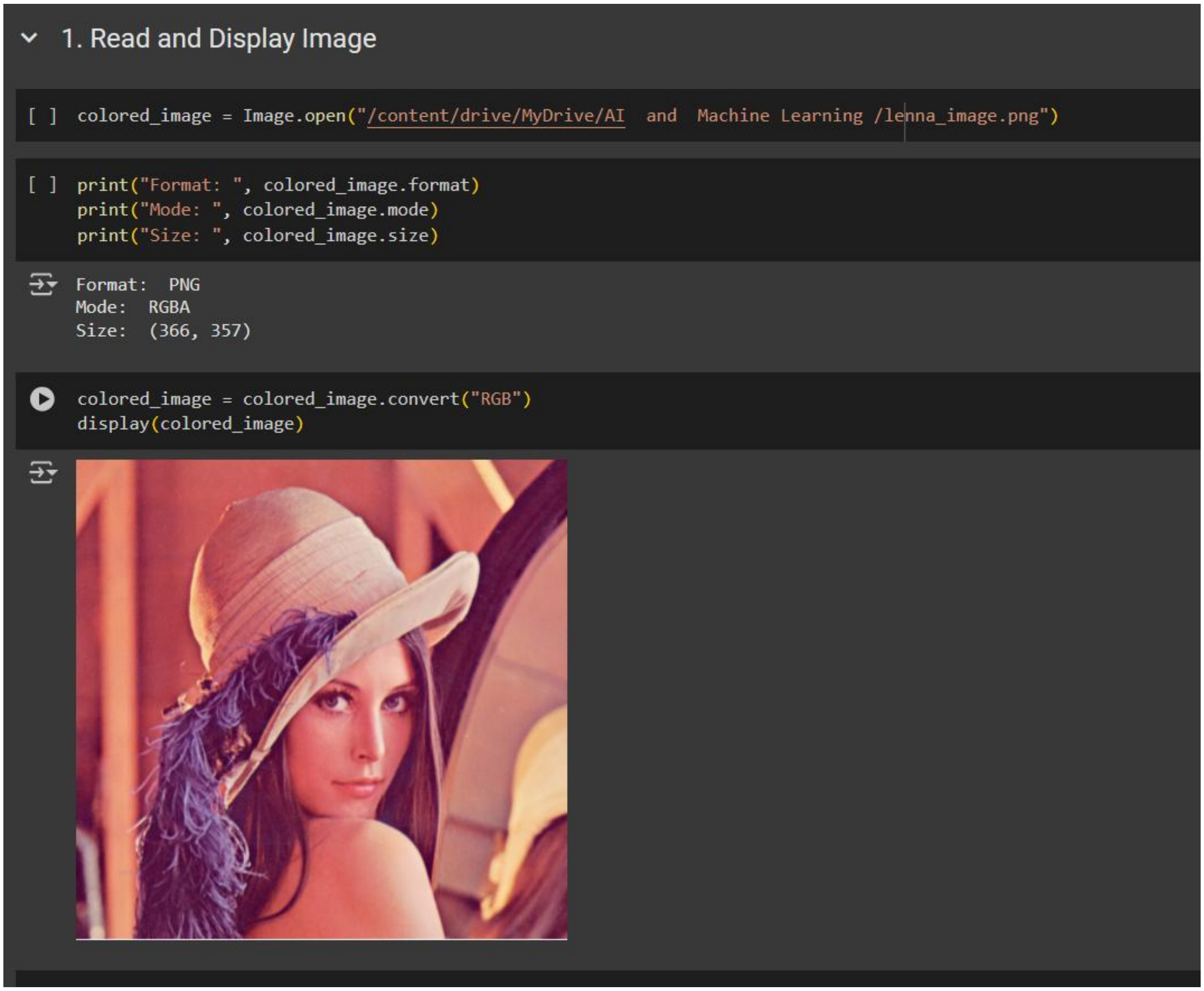
Worksheet - 1

Installation and Mounting Google Drive

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

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/cont
```

```
[38] # !pip install pillow
     from PIL import Image
     import numpy as np
     import matplotlib.pyplot as plt
```



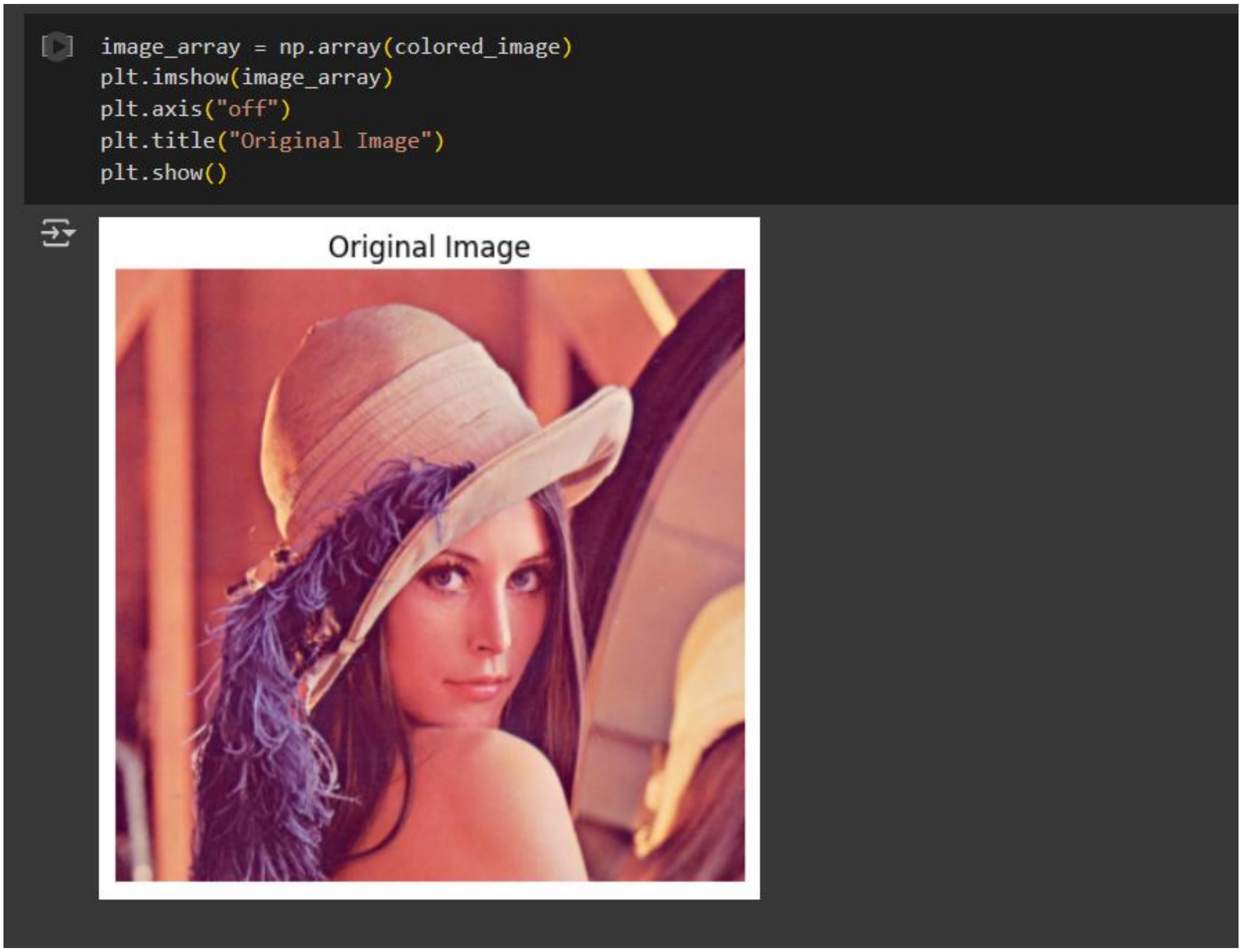
1. Read and Display Image

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

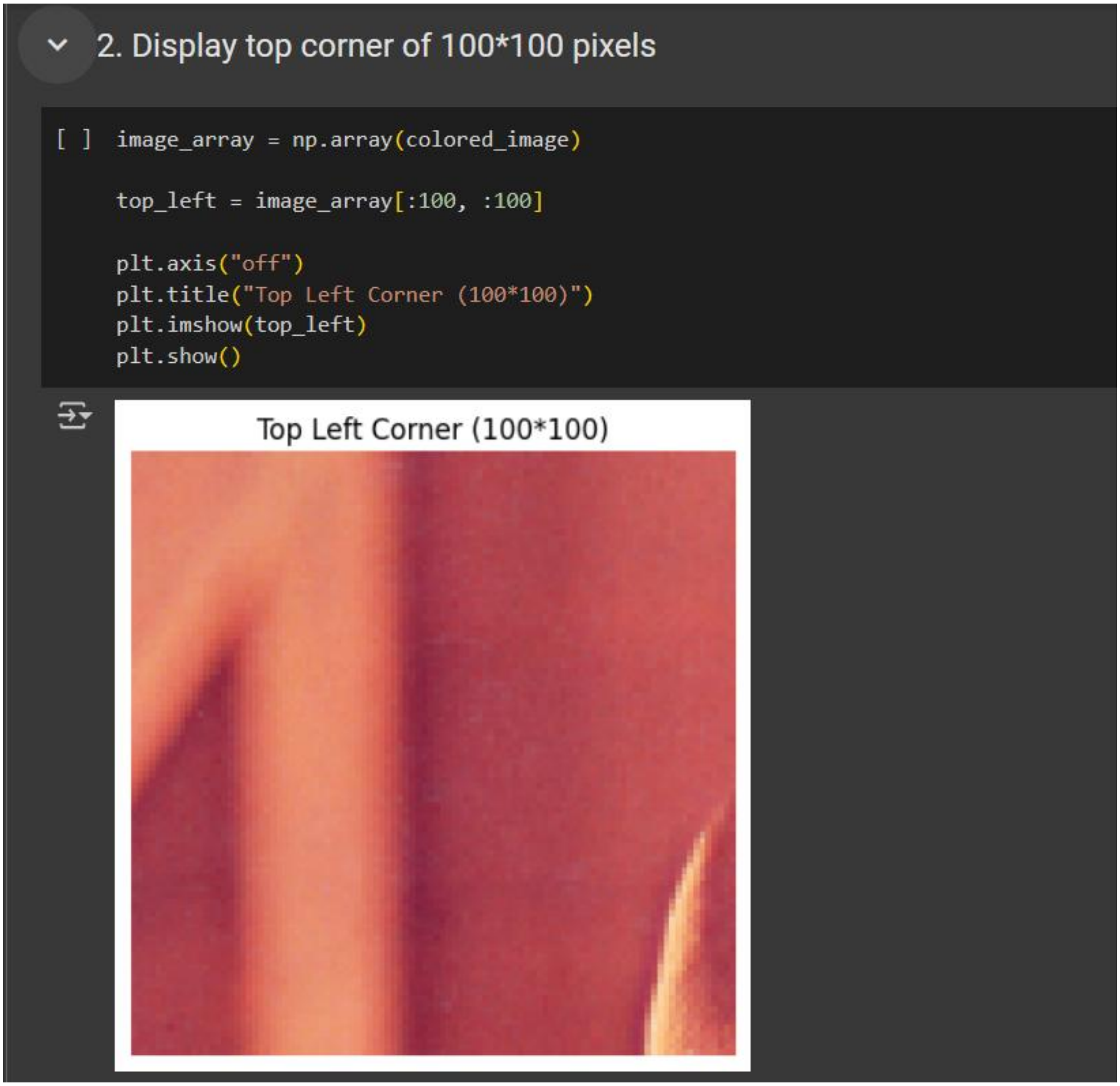
```
[ ] print("Format: ", colored_image.format)
    print("Mode: ", colored_image.mode)
    print("Size: ", colored_image.size)
```

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

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

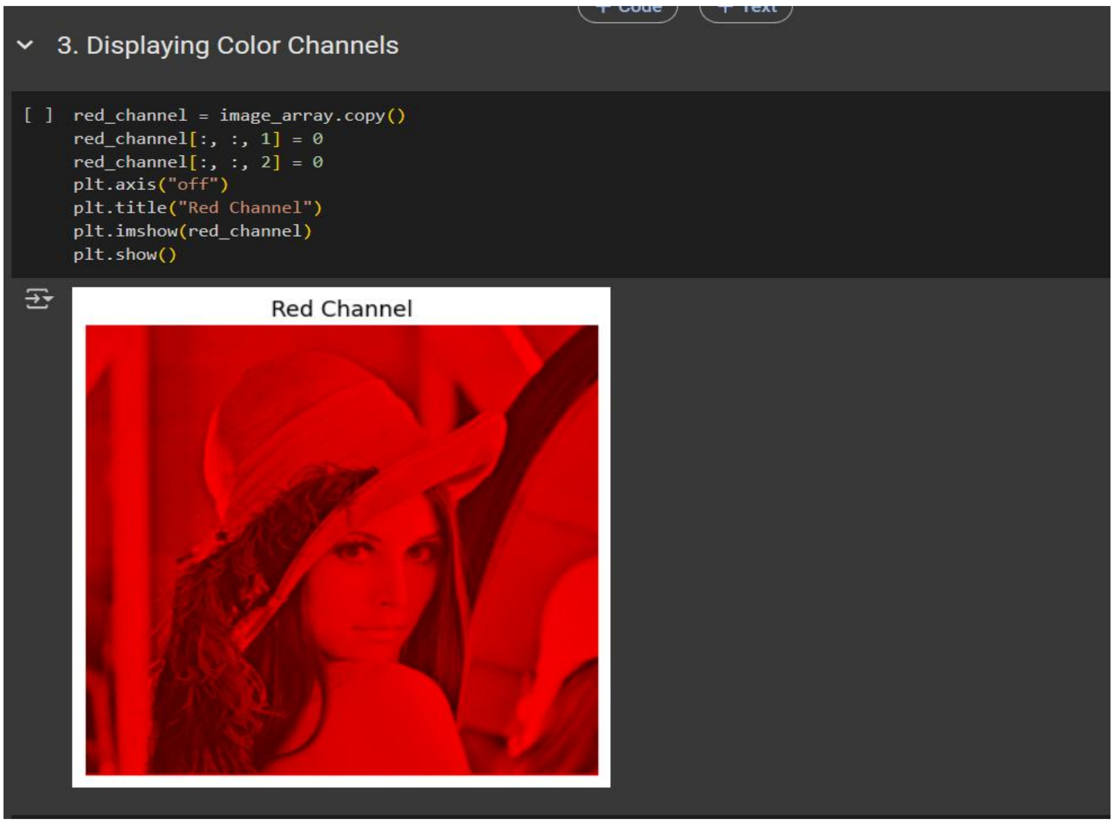


```
image_array = np.array(colored_image)
plt.imshow(image_array)
plt.axis("off")
plt.title("Original Image")
plt.show()
```



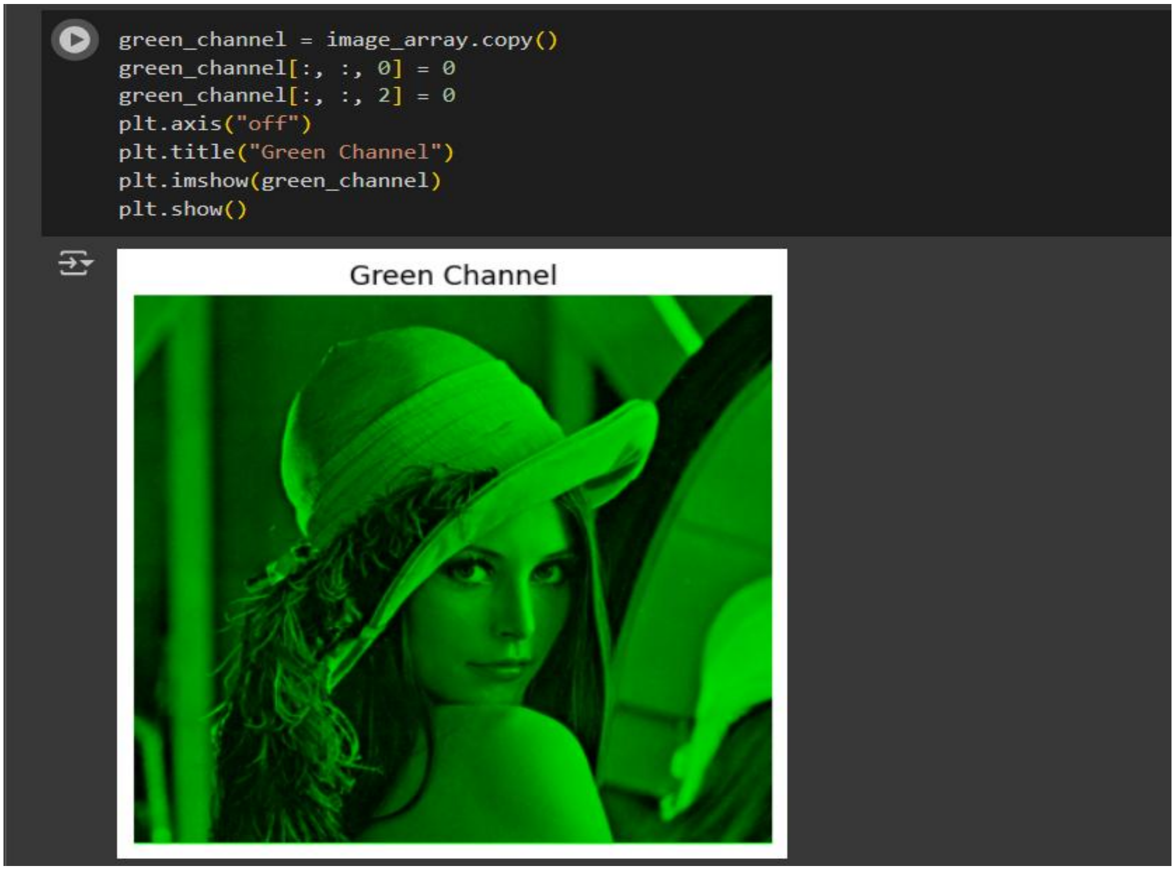
2. Display top corner of 100*100 pixels

```
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()
```

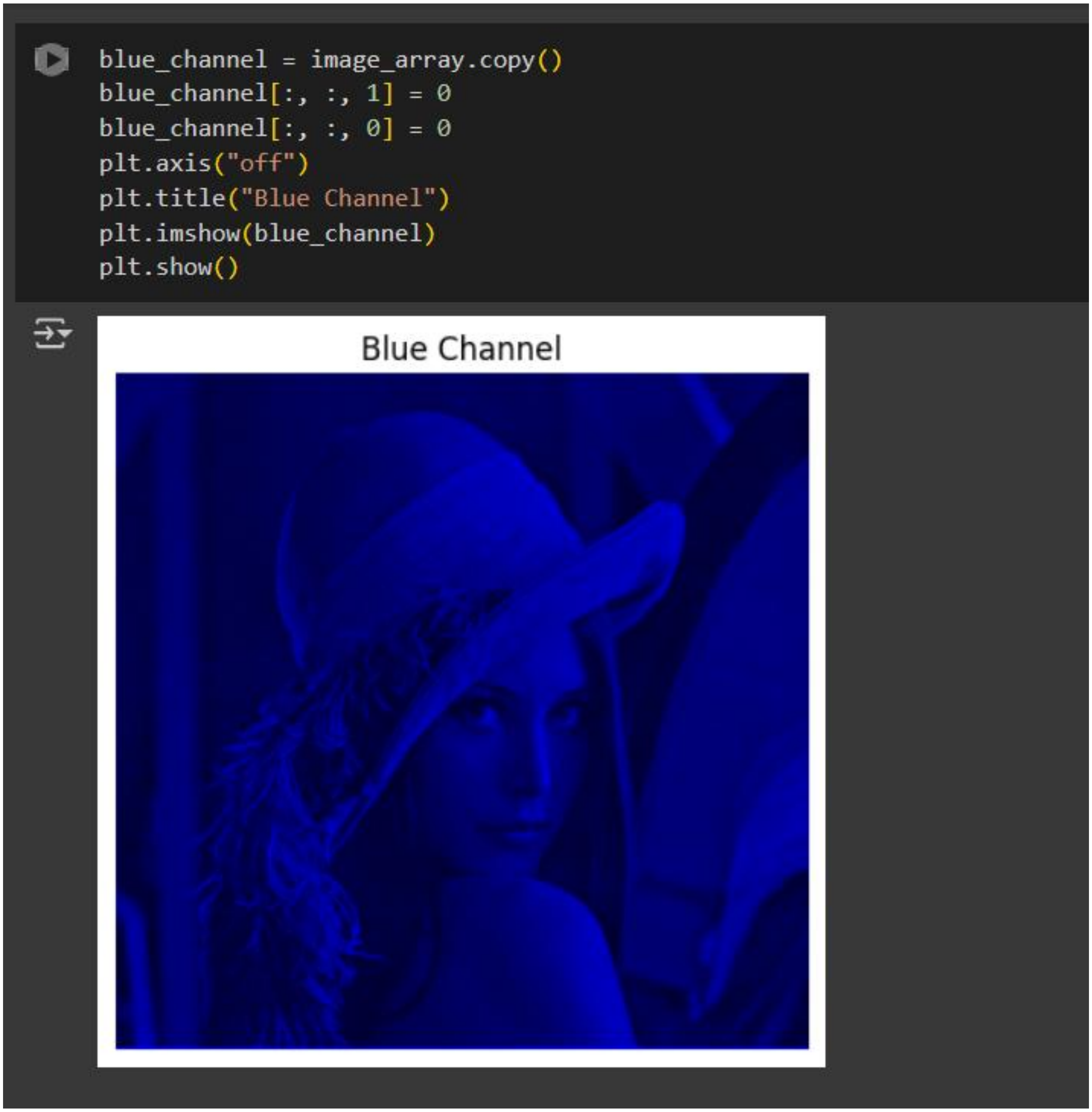


3. Displaying Color Channels

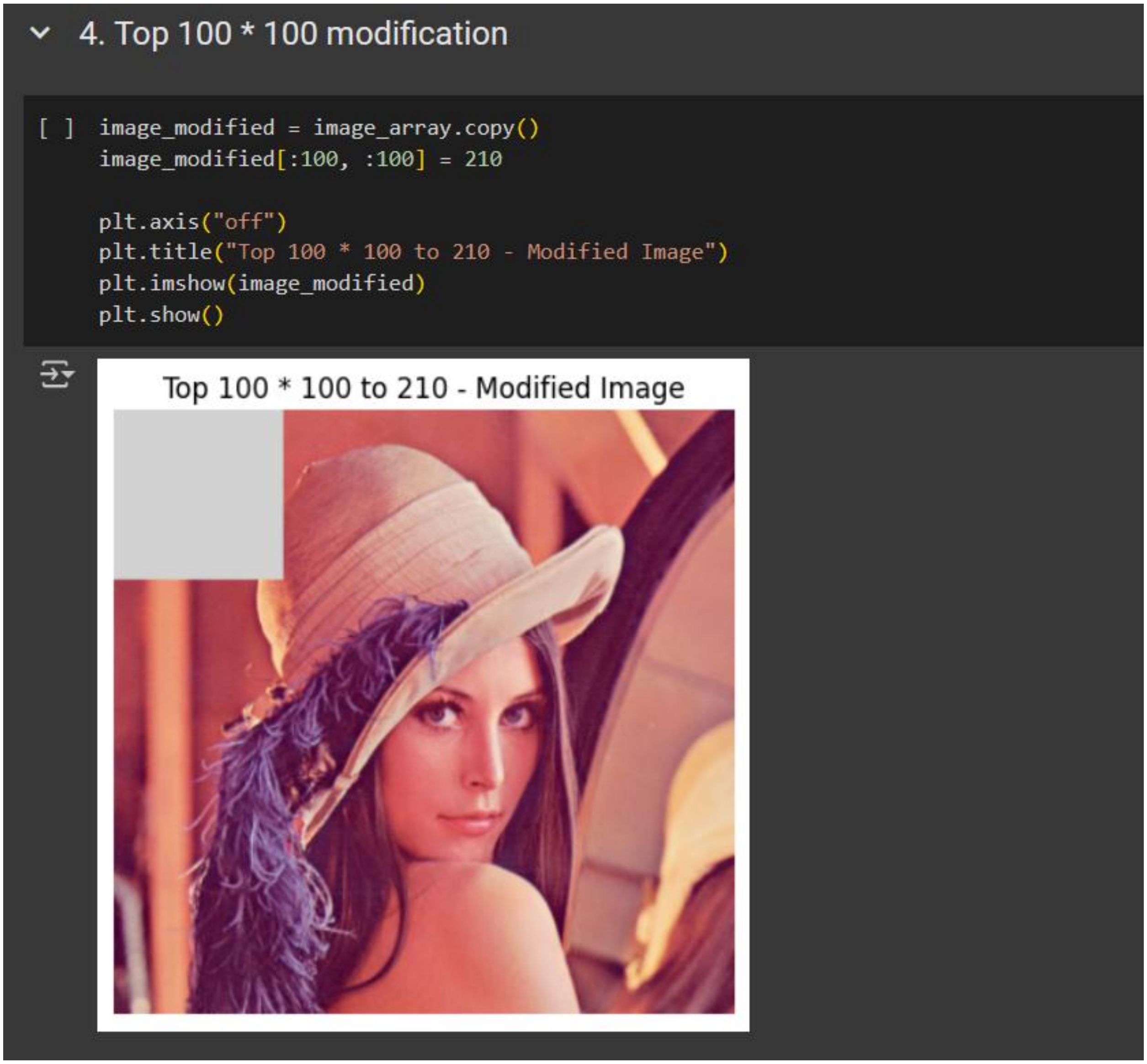
```
[ ]  red_channel = image_array.copy()
     red_channel[:, :, 1] = 0
     red_channel[:, :, 2] = 0
     plt.axis("off")
     plt.title("Red Channel")
     plt.imshow(red_channel)
     plt.show()
```



```
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()
```

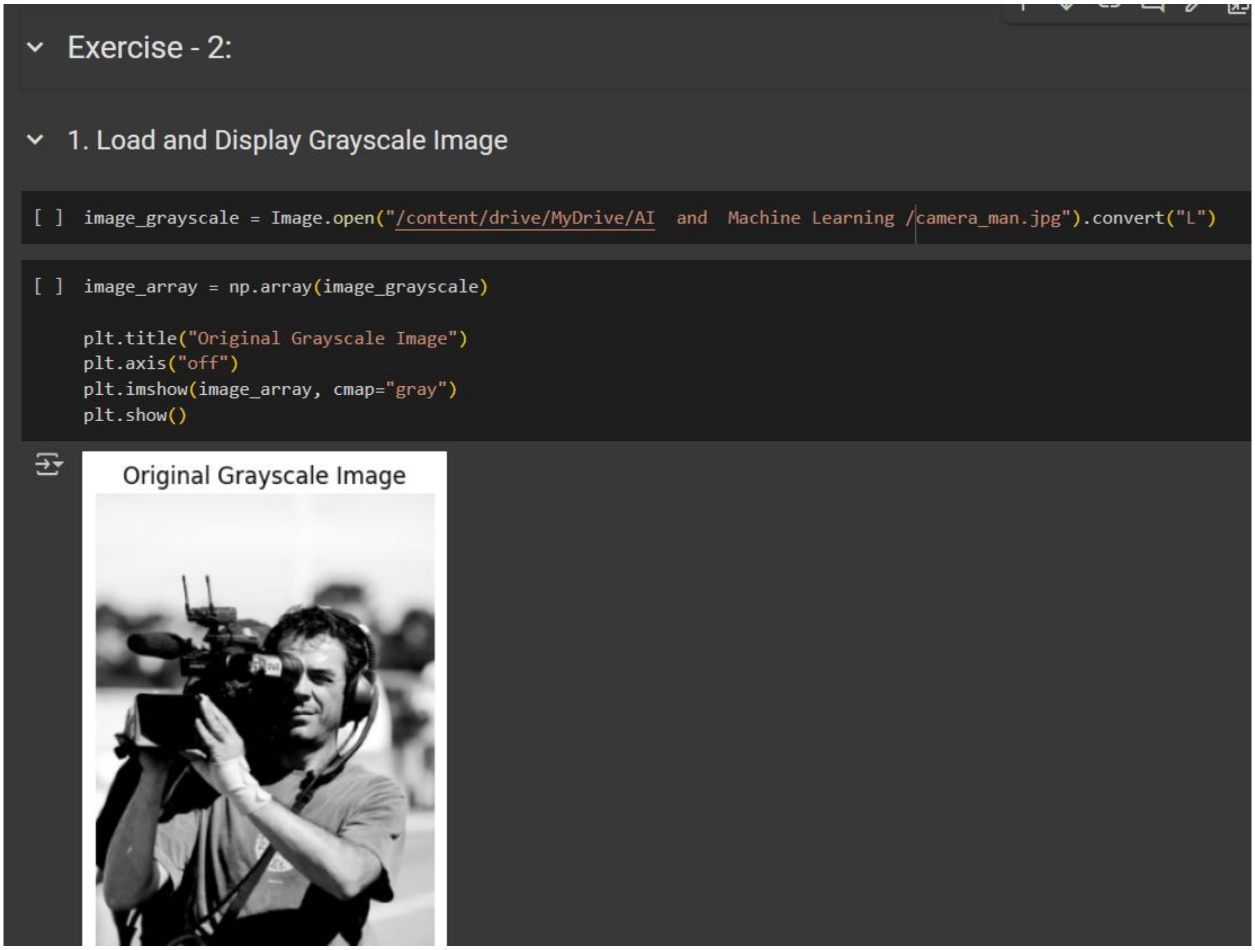


```
blue_channel = image_array.copy()
blue_channel[:, :, 1] = 0
blue_channel[:, :, 0] = 0
plt.axis("off")
plt.title("Blue Channel")
plt.imshow(blue_channel)
plt.show()
```



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()
```



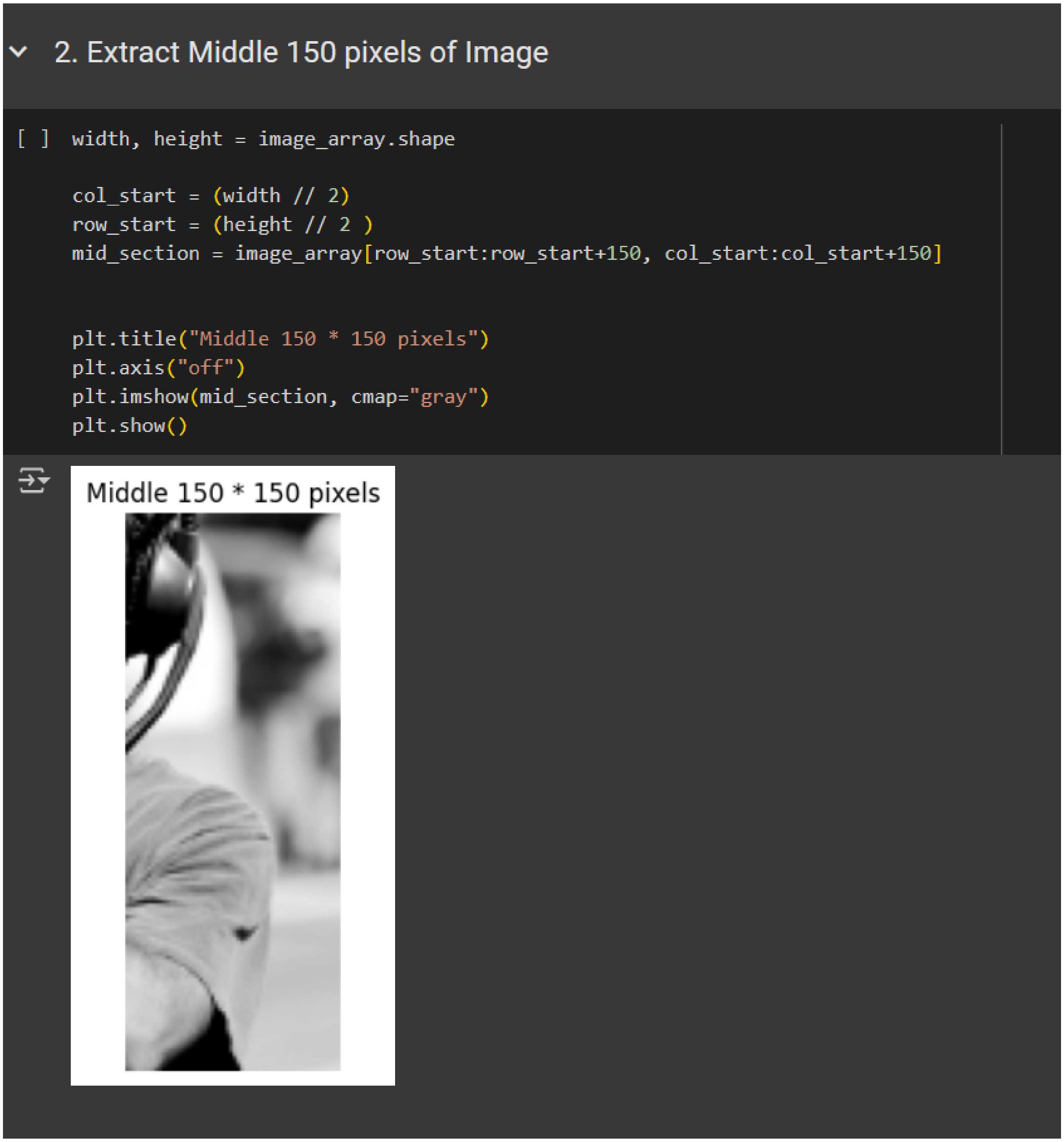
Exercise - 2:

1. Load and Display Grayscale Image

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

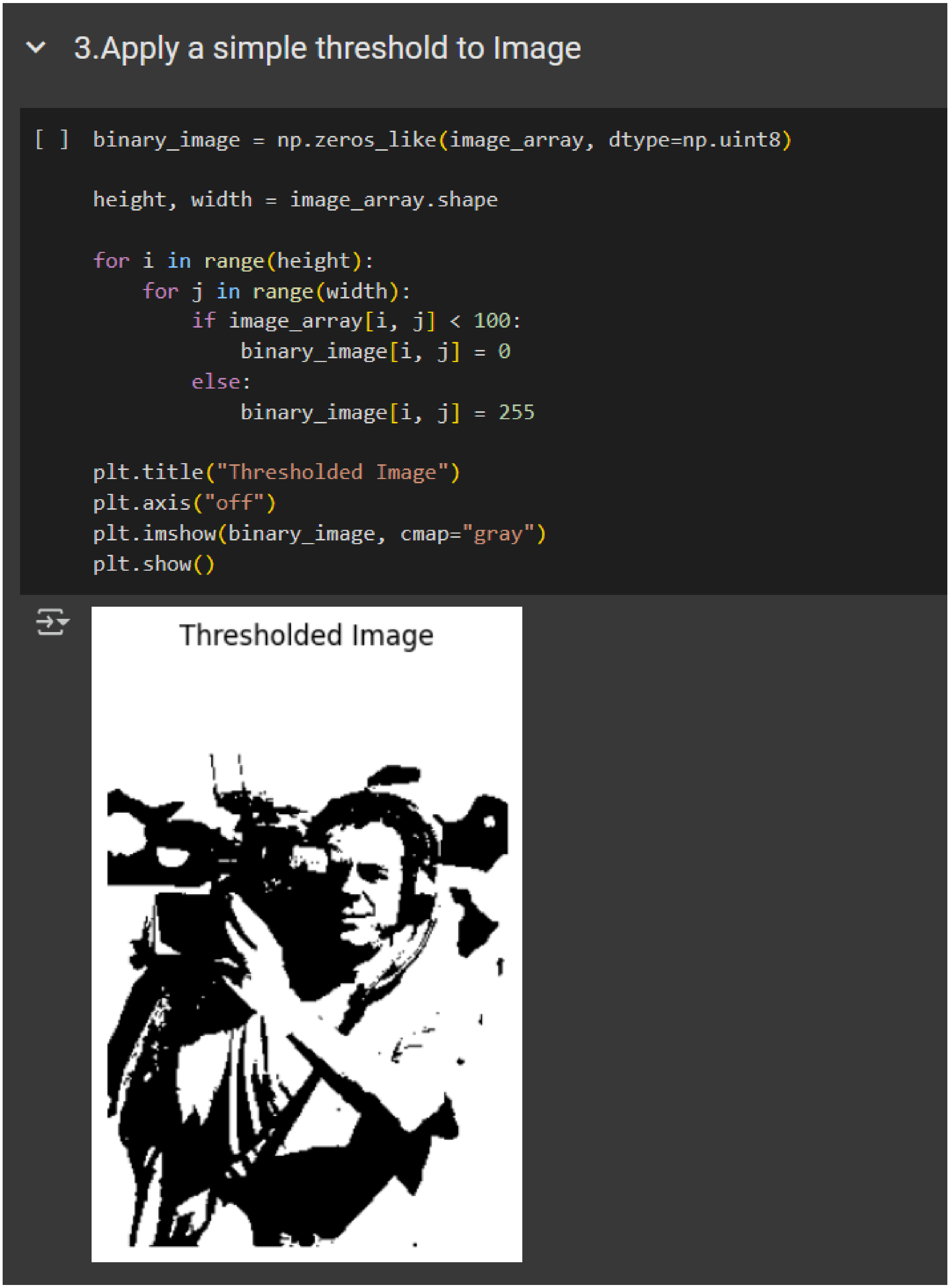
```
[ ] image_array = np.array(image_grayscale)

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

Original Grayscale Image



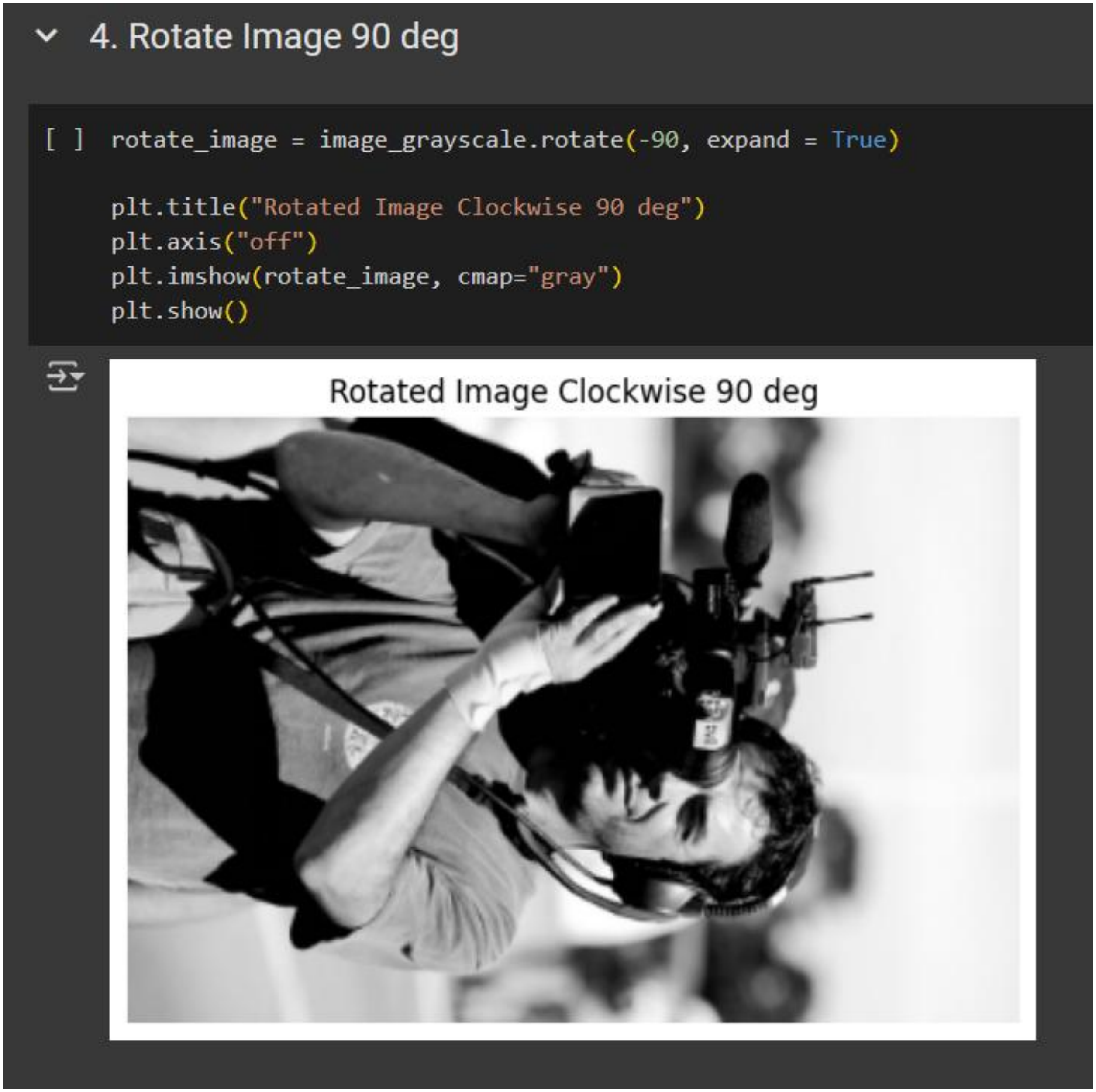
2. Extract Middle 150 pixels of Image

```
[ ] 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()
```



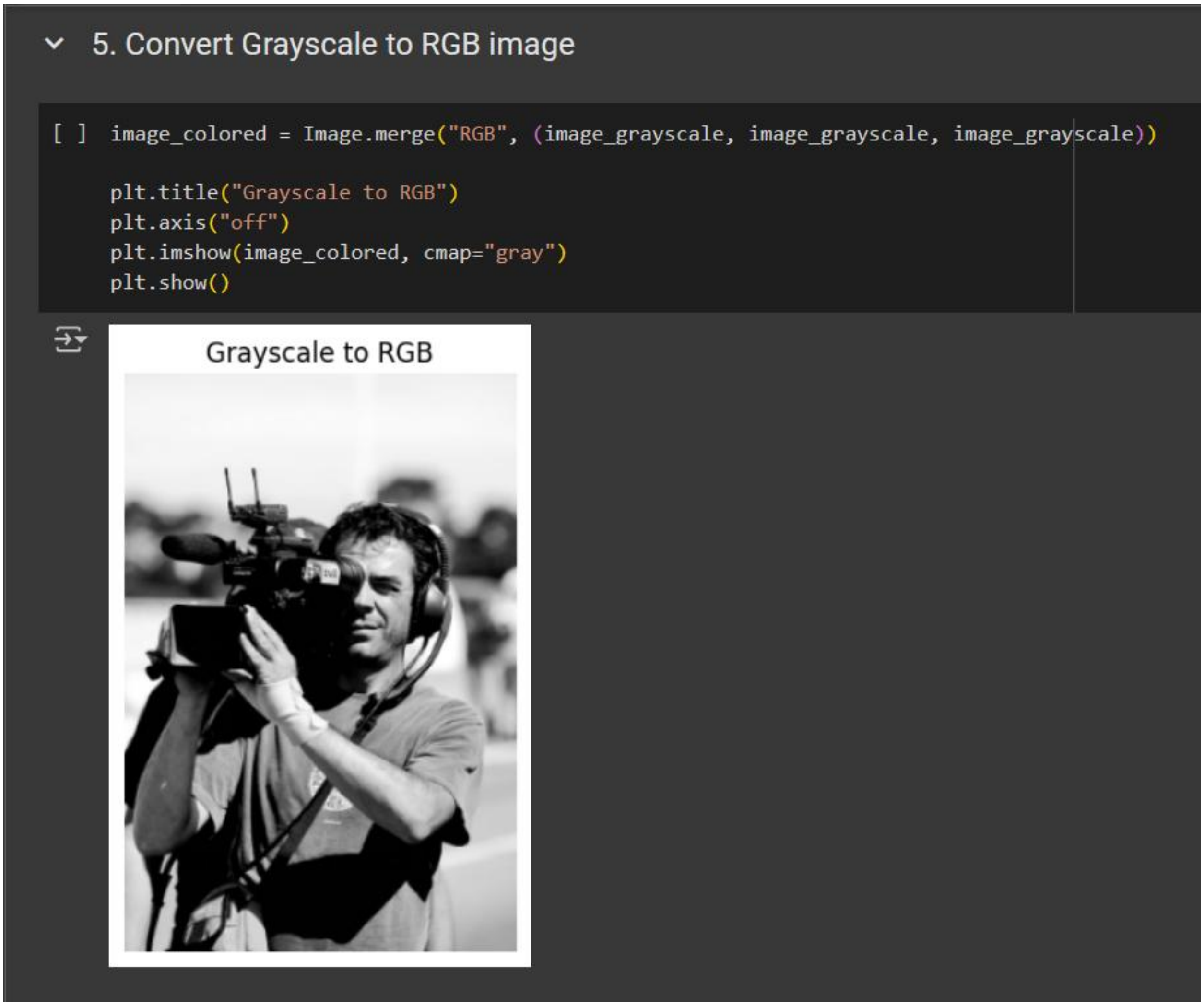
3.Apply a simple threshold to Image

```
[ ]  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()
```



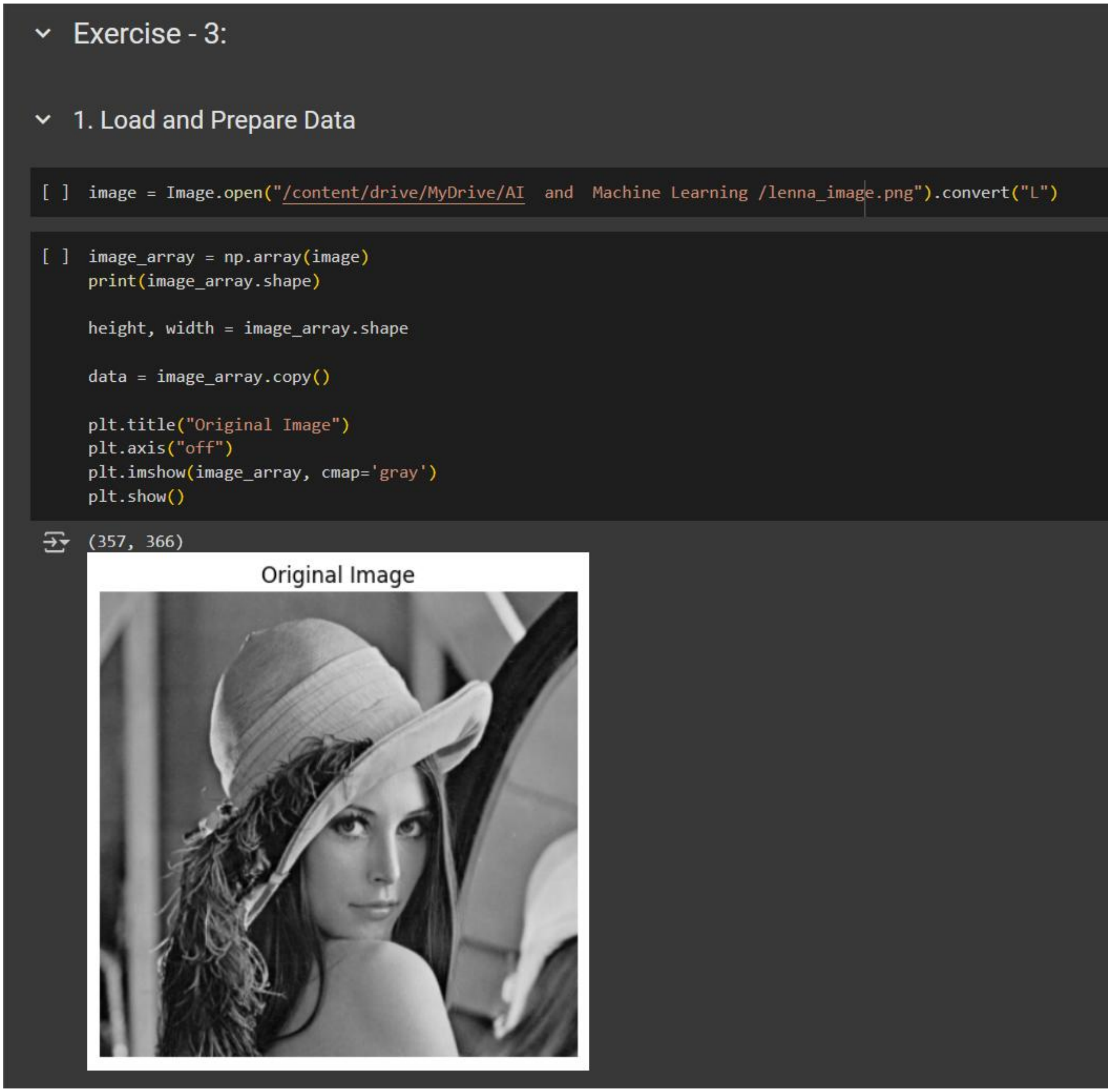
4. Rotate Image 90 deg

```
[ ] 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

```
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()
```



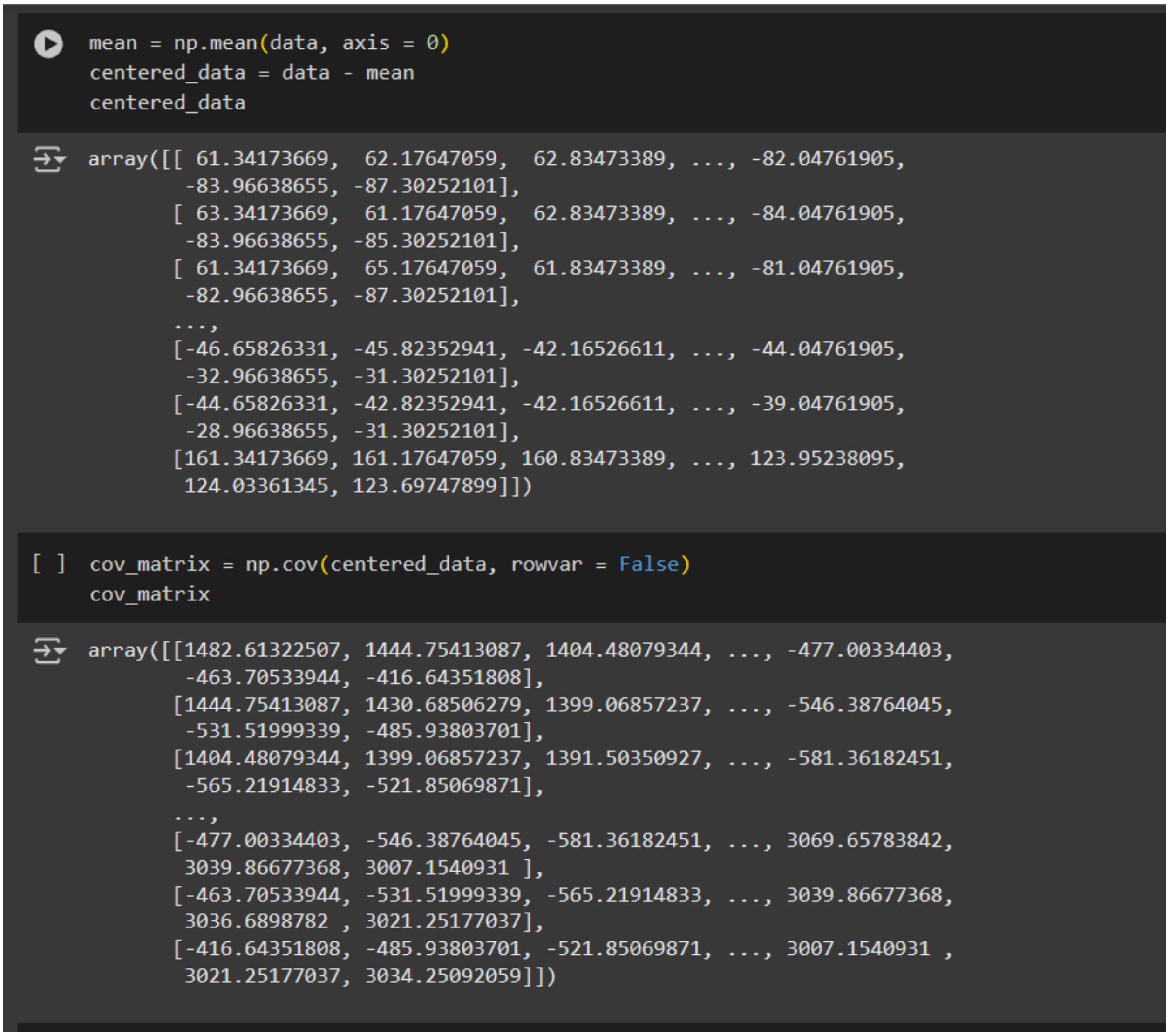
Exercise - 3:

1. Load and Prepare Data

```
[ ] 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)
```

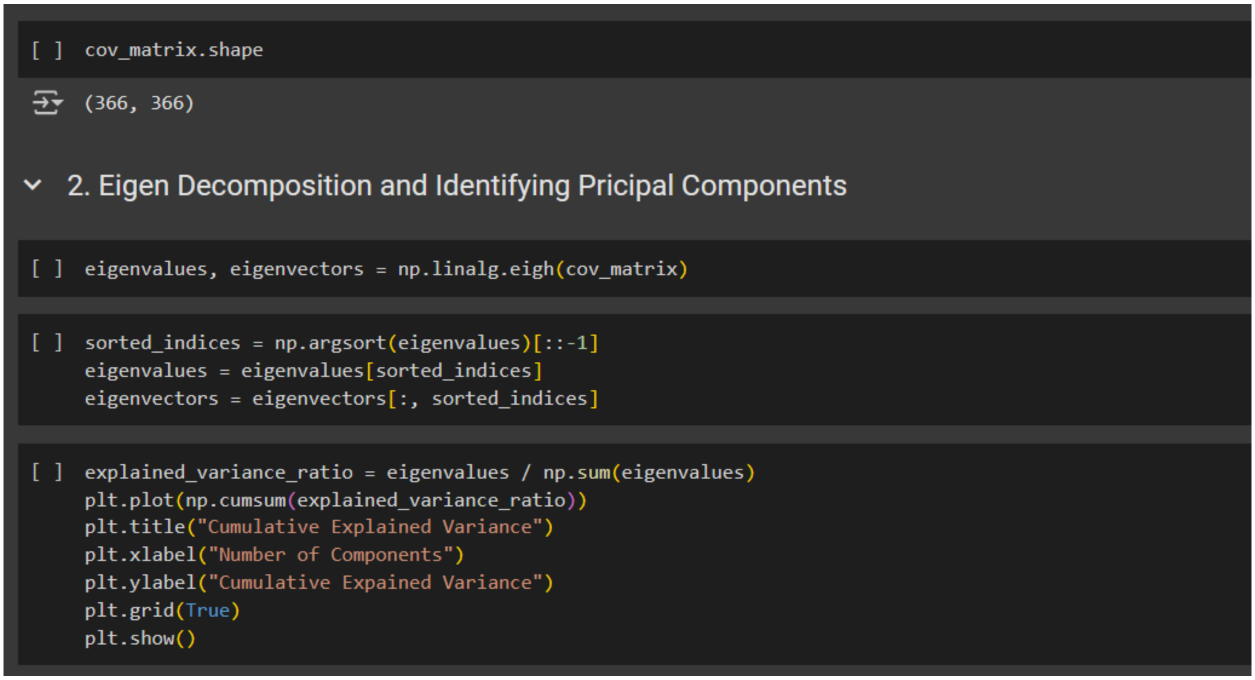


```
mean = np.mean(data, axis = 0)
centered_data = data - mean
centered_data
```

```
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]])
```

```
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]])
```



```
cov_matrix.shape
```

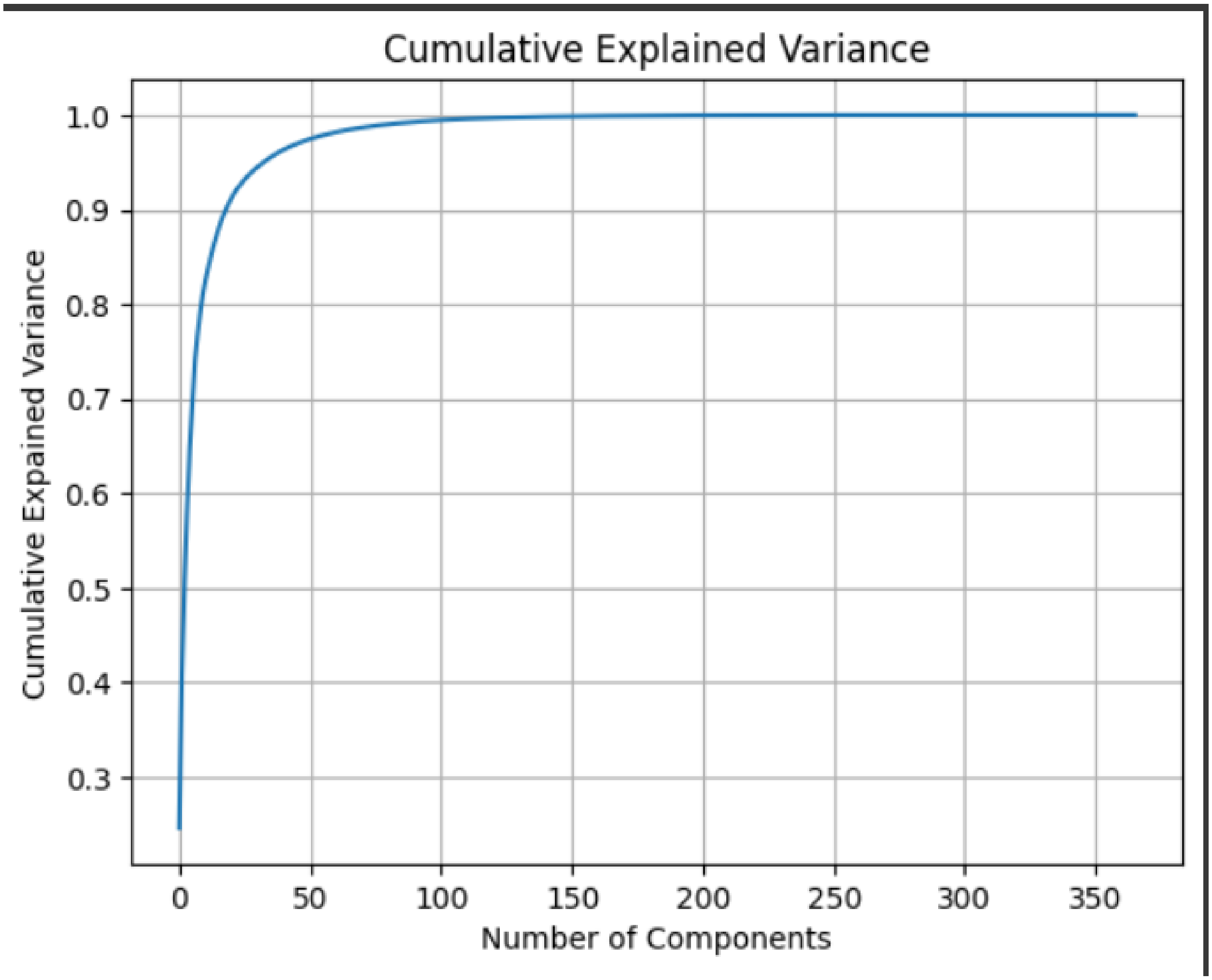
```
(366, 366)
```

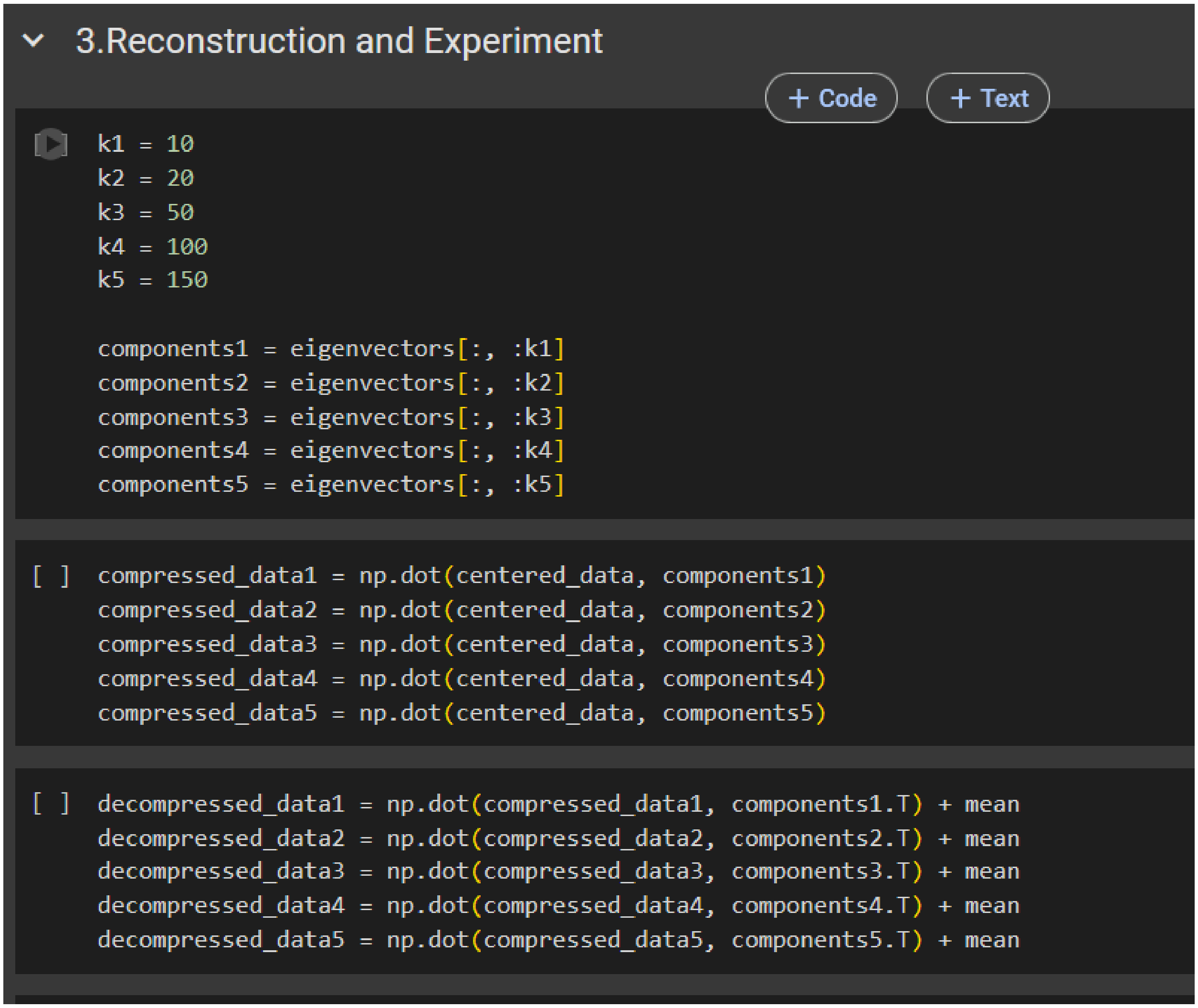
2. Eigen Decomposition and Identifying Pricipal Components

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

```
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()
```



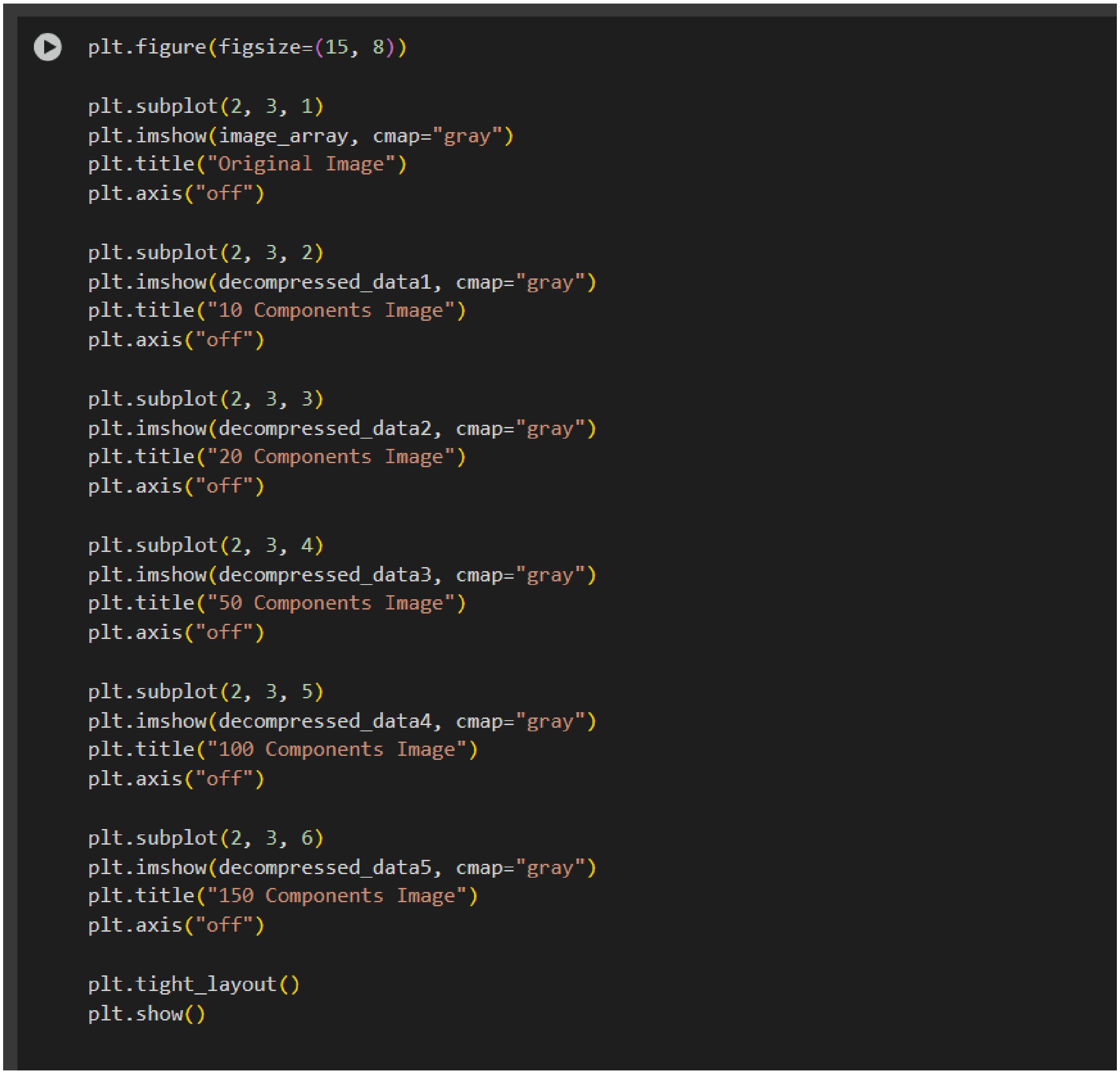


3.Reconstruction and Experiment

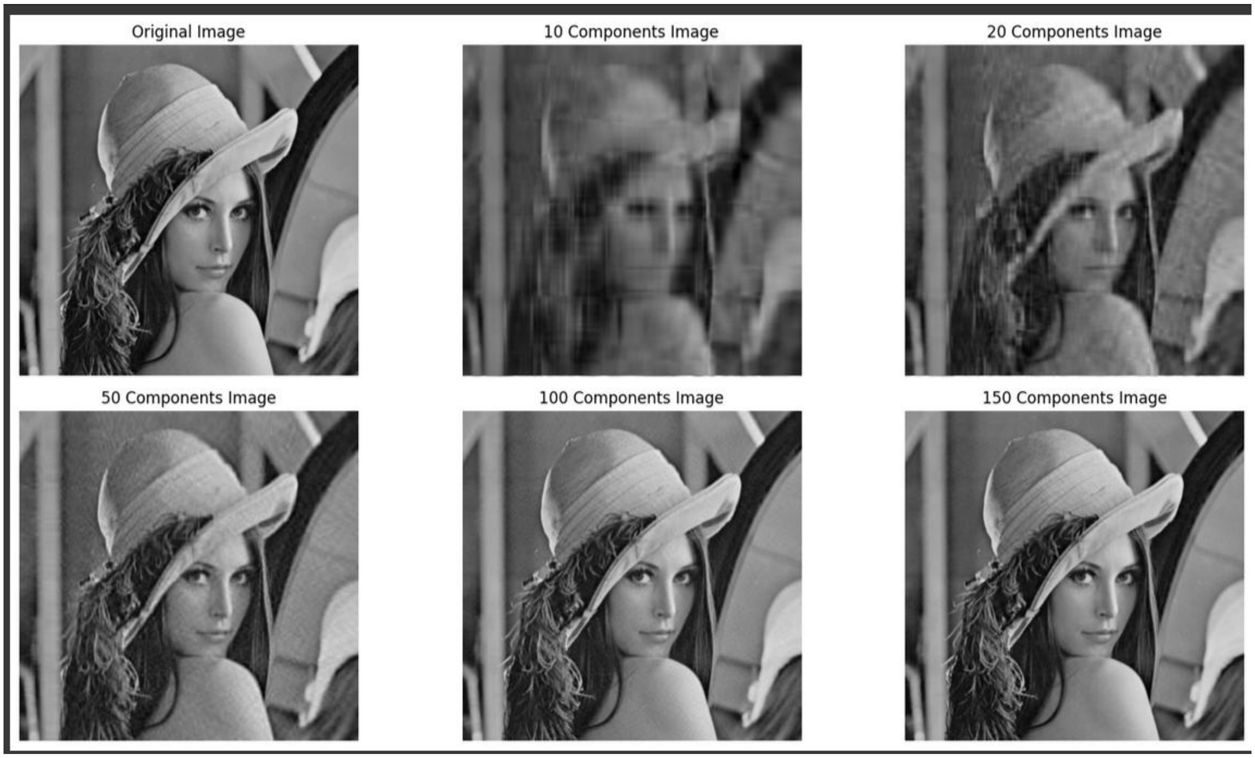
```
k1 = 10
k2 = 20
k3 = 50
k4 = 100
k5 = 150

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

```
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)
```

```
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.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