```
pip install numpy opencv-python
```

```
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (1.26.4)
Requirement already satisfied: opencv-python in /usr/local/lib/python3.10/dist-packages (4.10.0.84)
```

```
!pip install opencv-python matplotlib
```

```
Requirement already satisfied: opencv-python in /usr/local/lib/python3.10/dist-packages (4.10.0.84)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (3.8.0)
Requirement already satisfied: numpy>=1.21.2 in /usr/local/lib/python3.10/dist-packages (from opencv-python) (1.26.4)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (4.55.1)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (1.4.7)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (24.2)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (11.0.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (3.2.0)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (2.8.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.7->matplotlib) (1.16.0)
```

```python
import cv2
import numpy as np
import matplotlib.pyplot as plt
from google.colab.patches import cv2_imshow
```

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

```
Choose Files   download.jpeg
   • download.jpeg(image/jpeg) - 9257 bytes, last modified: 12/9/2024 - 100% done
```

```python
# Memuat gambar dari file yang diunggah
for filename in uploaded.keys():
    image = cv2.imread(filename, cv2.IMREAD_GRAYSCALE)
```

```python
# Definisikan kernel untuk berbagai operasi
# Kernel untuk blur
blur_kernel = np.ones((5, 5), np.float32) / 25

# Kernel untuk deteksi tepi Sobel
sobel_kernel = np.array([[1, 0, -1],
                         [2, 0, -2],
                         [1, 0, -1]])

# Kernel untuk penajaman
sharp_kernel = np.array([[0, -1, 0],
                         [-1, 5, -1],
                         [0, -1, 0]])
```

```python
# Fungsi untuk menerapkan konvolusi
def apply_convolution(image, kernel):
    return cv2.filter2D(image, -1, kernel)
```

```python
# Terapkan konvolusi untuk berbagai operasi
blurred_image = apply_convolution(image, blur_kernel)
sobel_image = apply_convolution(image, sobel_kernel)
sharpened_image = apply_convolution(image, sharp_kernel)
```

```python
# Tampilkan gambar asli dan hasil konvolusi
plt.figure(figsize=(15, 10))

plt.subplot(2, 2, 1)
plt.title('Gambar Asli')
plt.imshow(image, cmap='gray')
plt.axis('off')

plt.subplot(2, 2, 2)
plt.title('Gambar Blur')
plt.imshow(blurred_image, cmap='gray')
plt.axis('off')

plt.subplot(2, 2, 3)
plt.title('Gambar Sobel')
plt.imshow(sobel_image, cmap='gray')
plt.axis('off')

plt.subplot(2, 2, 4)
plt.title('Gambar Sharpened')
plt.imshow(sharpened_image, cmap='gray')
```

```
plt.axis('off')

plt.show()
```

Gambar Asli

Gambar Blur

Gambar Sobel

Gambar Sharpened