Machine Learning

Convolution Operator

Mostafa S. Ibrahim
Teaching, Training and Coaching for more than a decade!

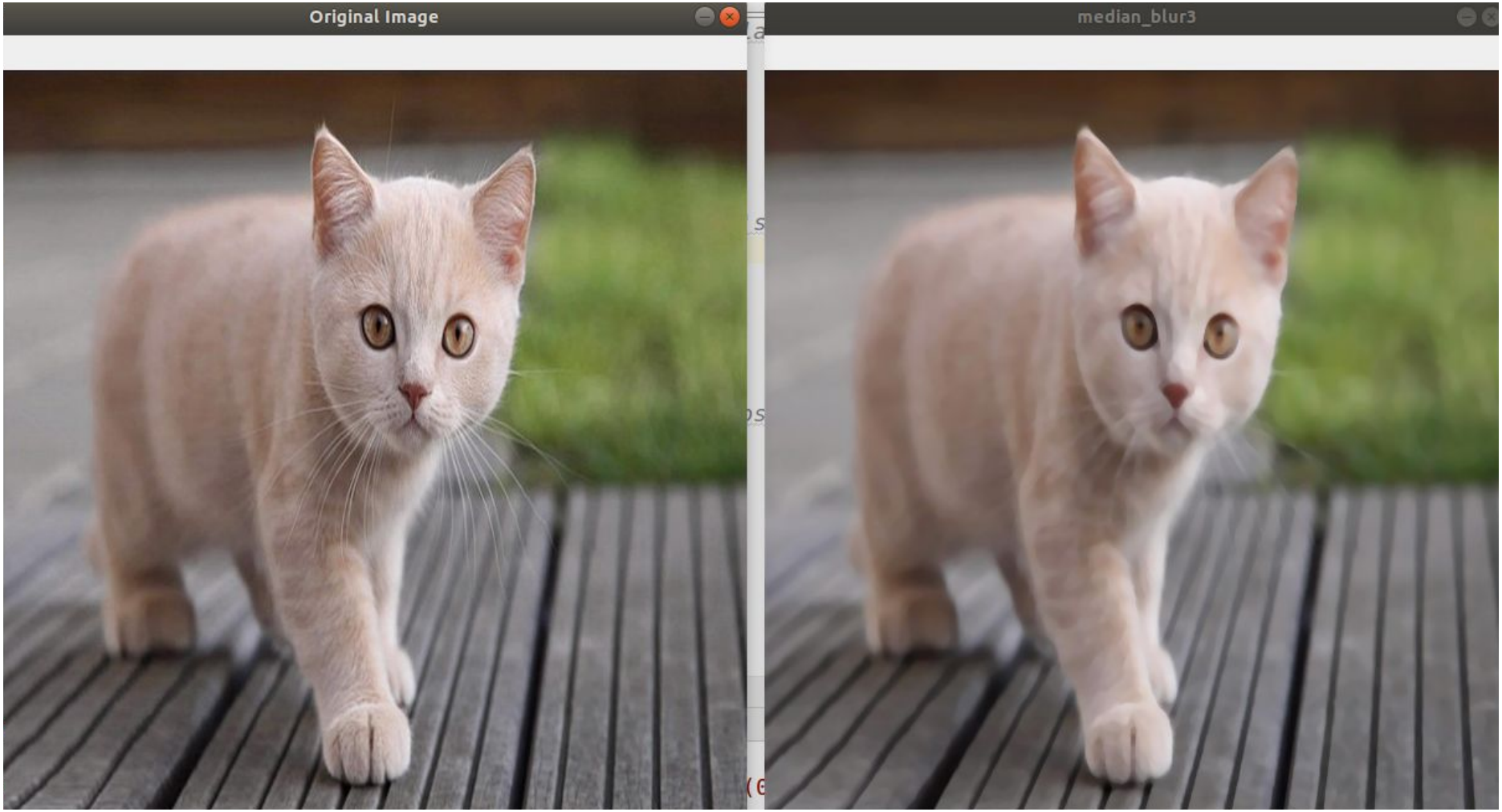
Artificial Intelligence & Computer Vision Researcher
PhD from Simon Fraser University - Canada
Bachelor / MSc from Cairo University - Egypt
Ex-(Software Engineer / ICPC World Finalist)

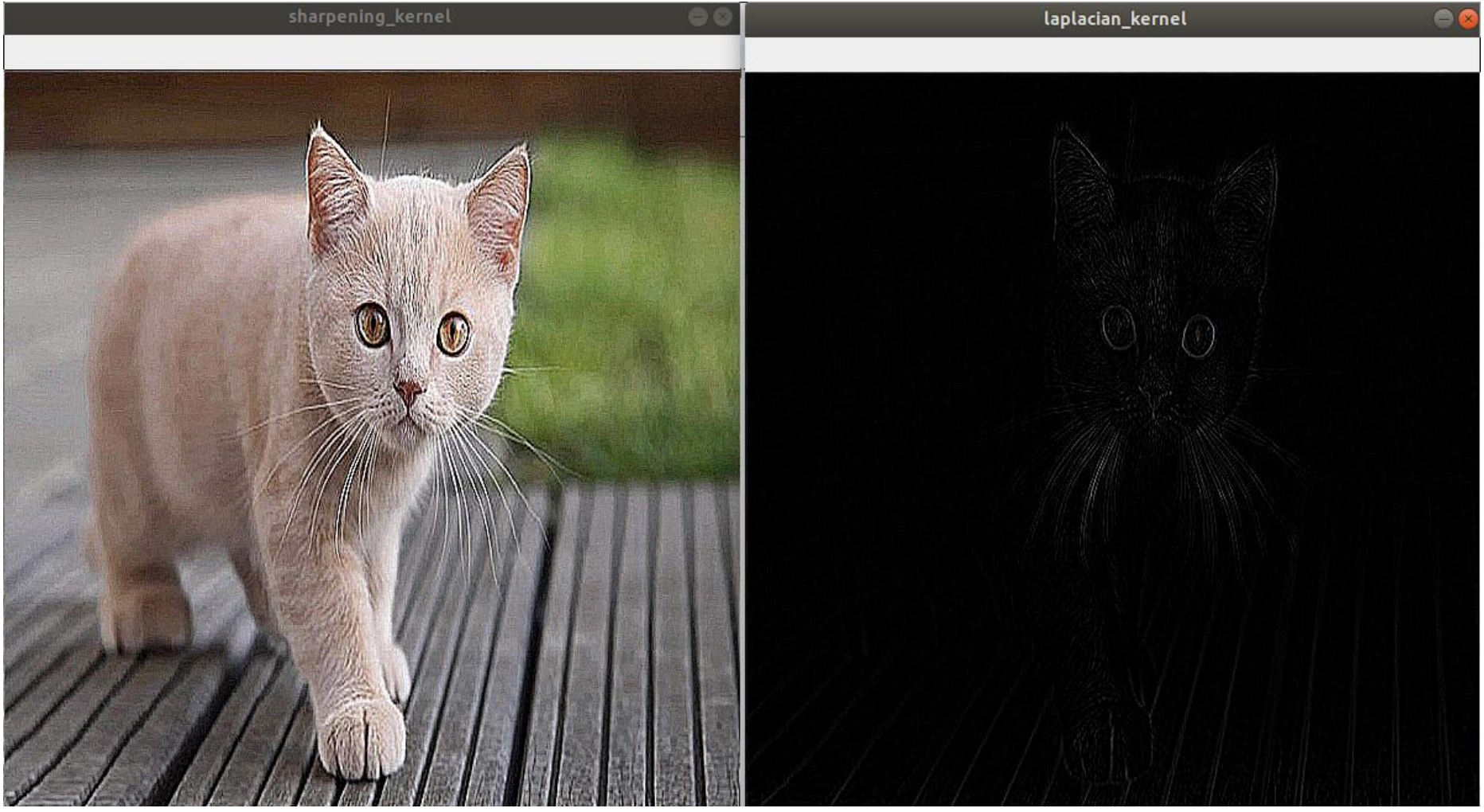
Convolution Operator

- Convolution is a common image-processing technique that changes the value of a pixel **according to the values of its surrounding pixels**.
- Many common image filters (aka kernels), such as blurring, detecting edges, sharpening, and embossing
  - You can also think in the kernel is a **‘feature detector’** as we will see
- OpenCV has many filters

OpenCV

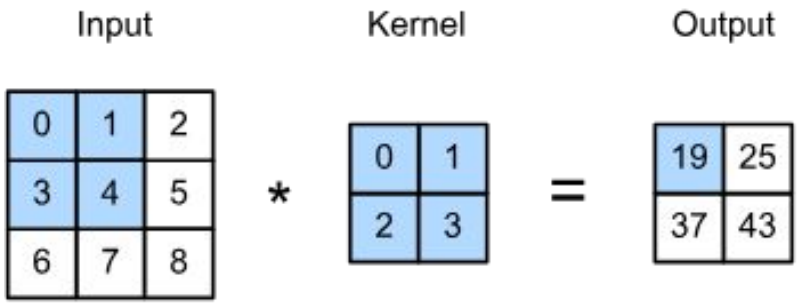
```
def apply_default_kernel(image):
    # gaussian_blur = cv2.GaussianBlur(image, (5, 5), 0)
    # bilateral_filter = cv2.bilateralFilter(image, 9, 75, 75)

    # Apply a Median blur filter
    median_blur1 = cv2.medianBlur(image, 5)
    median_blur2 = cv2.medianBlur(median_blur1, 5)
    median_blur3 = cv2.medianBlur(median_blur2, 5)

    cv2.imshow('median_blur1', median_blur1)
    cv2.imshow('median_blur2', median_blur2)
    cv2.imshow('median_blur3', median_blur3)
```


Original Image
median_blur3


sharpening_kernel
laplacian_kernel

How kernels work

- Kernels are 1D or 2D arrays of numbers.
- Works as follows:
- 1) Define your kernel
  - Build e.g. 2x2, 3x3, 5x5 matrix of values
- 2) Iterate over every pixel in the old image (sliding window)
- 3) Per pixel: Compute the **sum** of the **multiplication** of corresponding values



Img [src]

```python
def apply_custom_filter(image, kernel, kernel_name):
    new_image = cv2.filter2D(image, -1, kernel)
    cv2.imshow(kernel_name, new_image)


# Laplacian kernel for edge detection
laplacian_kernel = np.array([
    [0, 1, 0],
    [1, -4, 1],
    [0, 1, 0]
], dtype=np.float32)
apply_custom_filter(image, laplacian_kernel, 'laplacian_kernel')

sharpening_kernel = np.array([
    [-1, -1, -1],
    [-1, 9, -1],
    [-1, -1, -1]
], dtype=np.float32)
apply_custom_filter(image, sharpening_kernel, 'sharpening_kernel')
```

"Acquire knowledge and impart it to the people."

"Seek knowledge from the Cradle to the Grave."