

# My computer can see

*Alternative titles:*

- My computer can C.. but not really sharp
- I love pixels
- I'm sure I can make a model to detect that

# Computer vision?

# Some use cases...

# Identification



# Afghan Girl - 1984 portrait

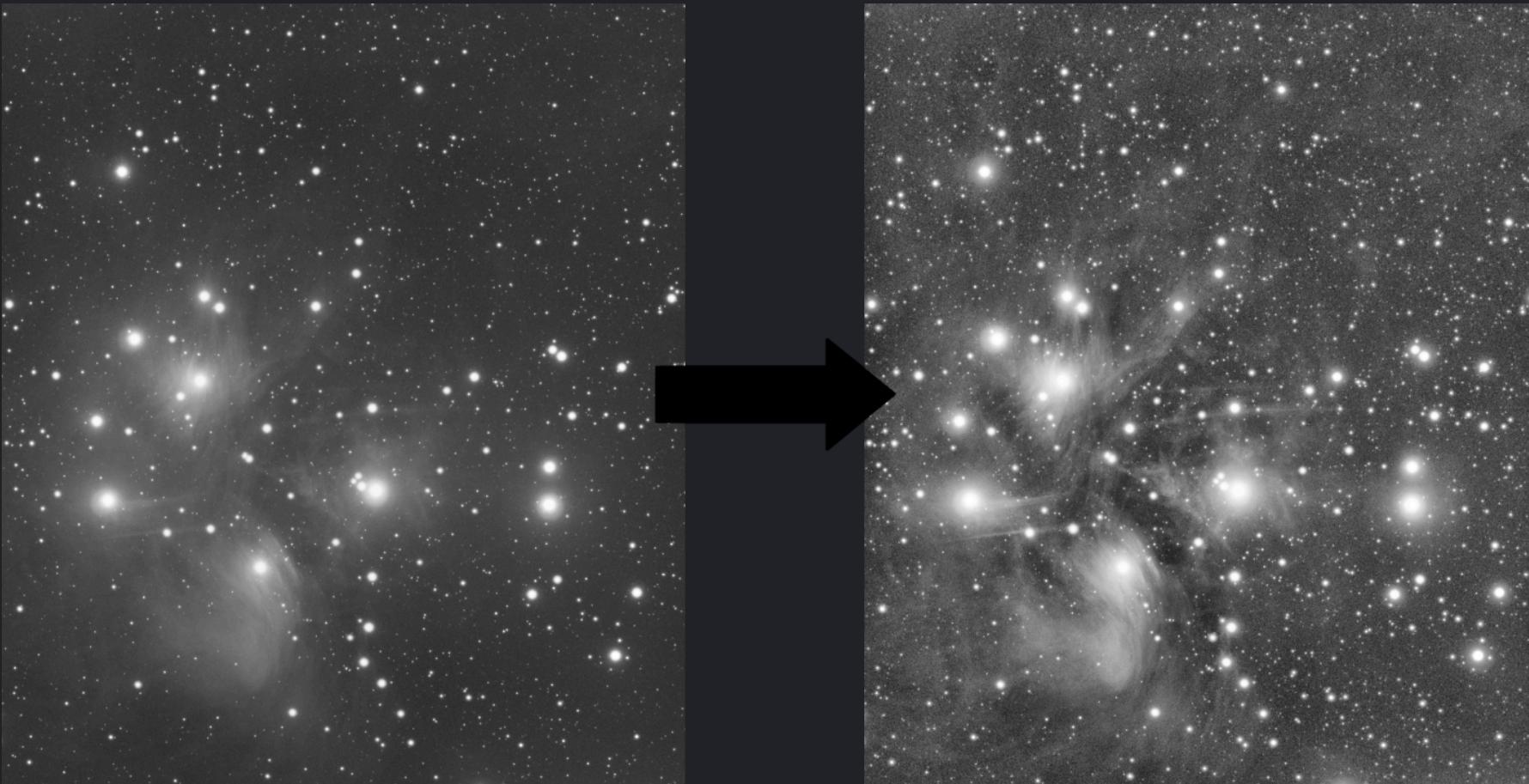


# Robotics





# Space



# Why computer vision?

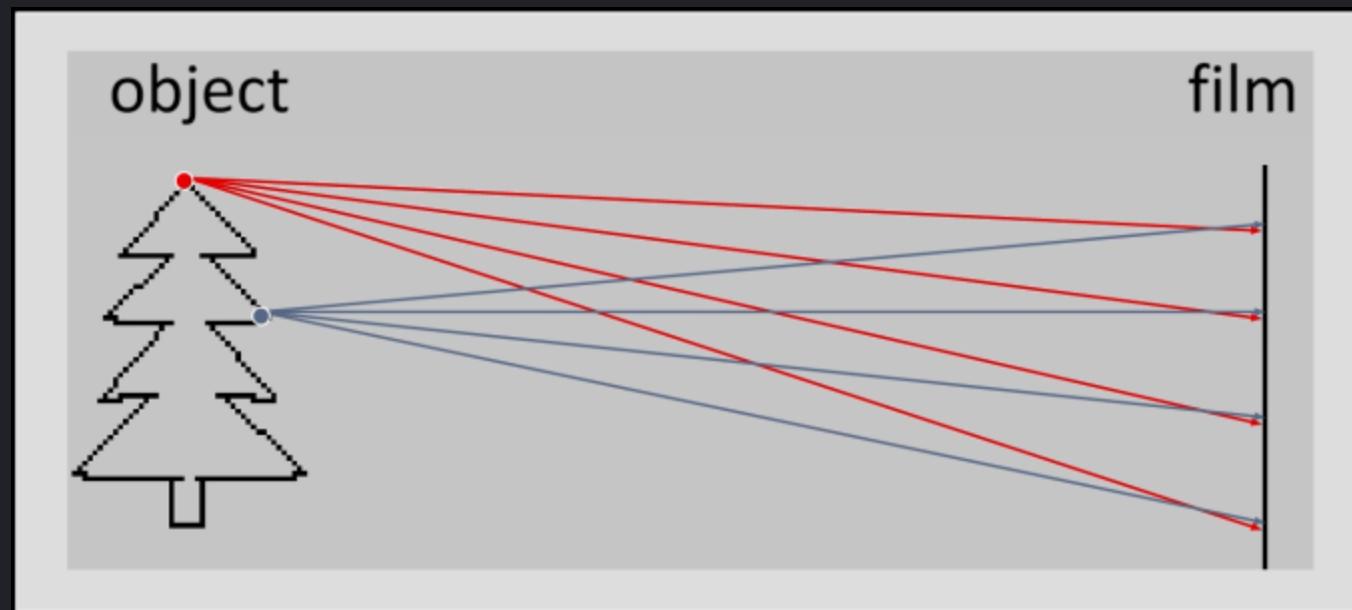
# We are not perfect

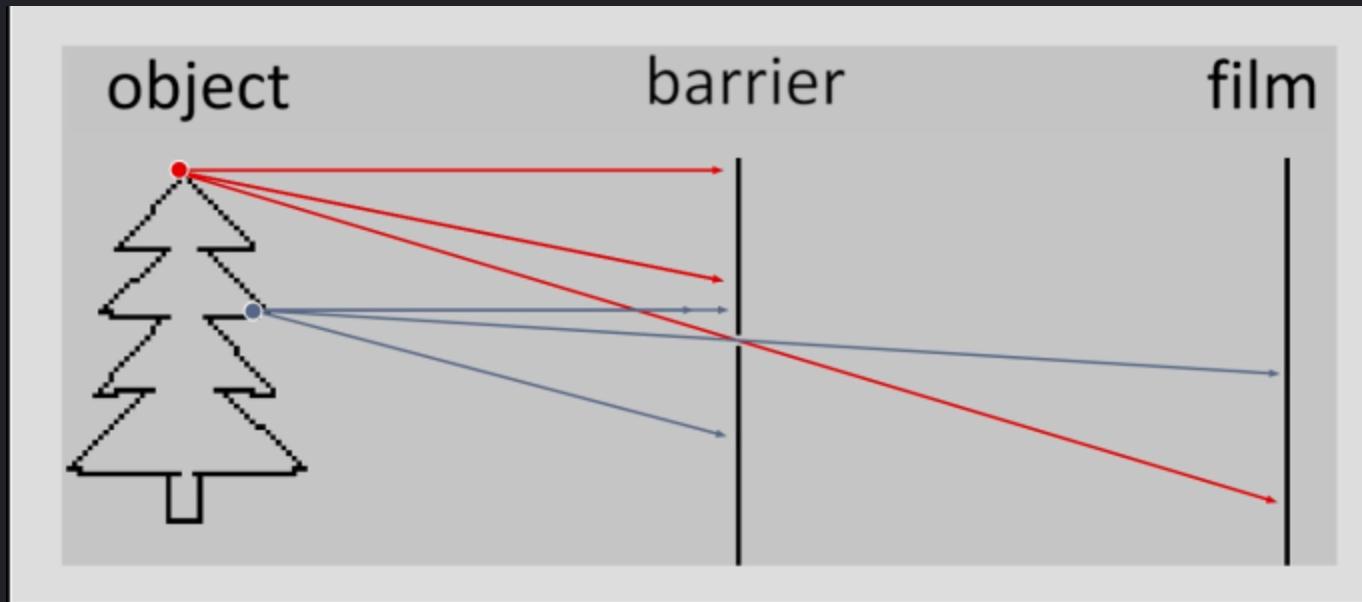
Bill Clinton and Al Gore

Same person - From Sinha and Poggio, 1996

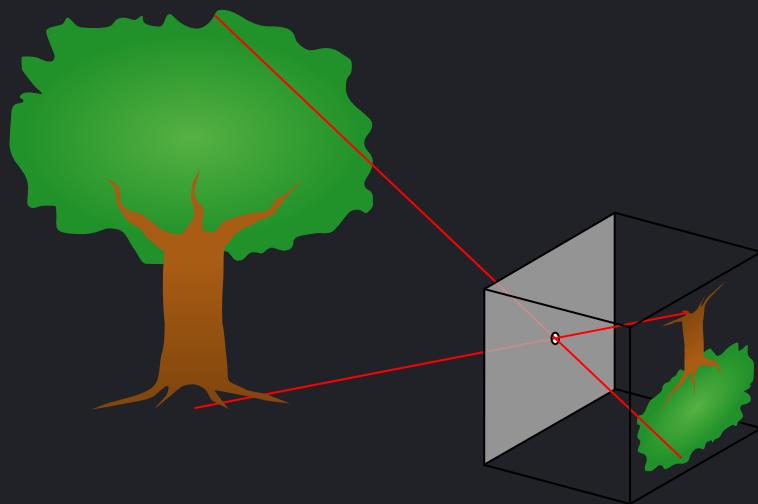
# What is an image?

It's a projection on a film





# Pinhole Camera



# Human VS Machine



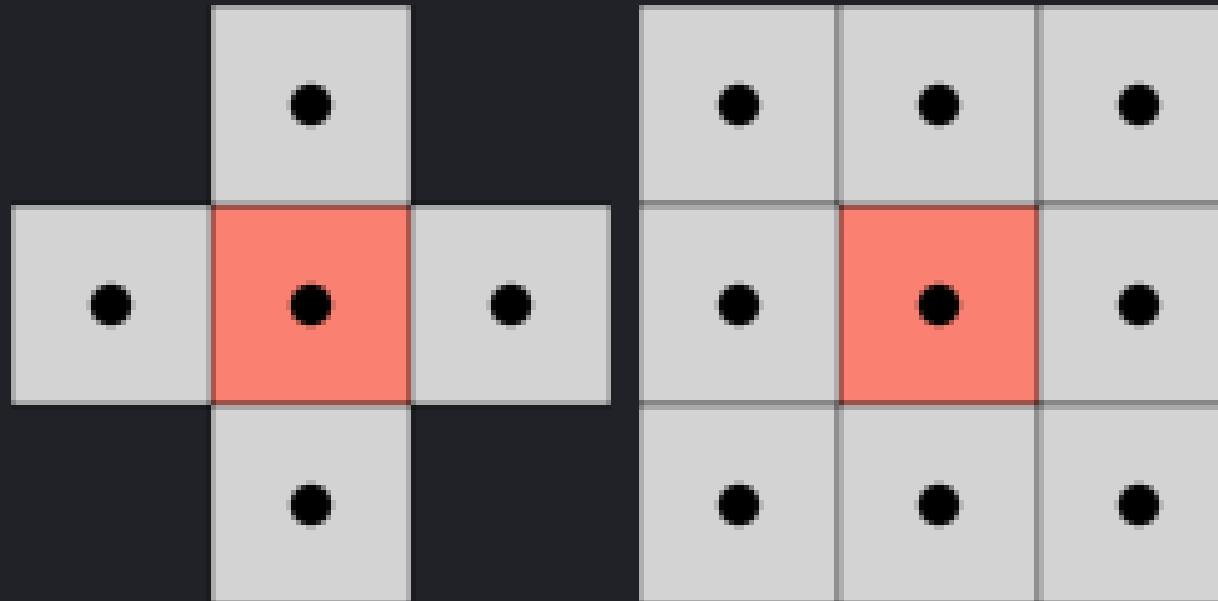


# The computer world

Lot of numbers

# Math

# Who is my neighbour?



# OpenCV

```
# Bash
python3 -m venv env
source env/bin/activate
pip install -r requirements.txt
```

```
import cv2 as cv
import numpy as np
from matplotlib import pyplot as plt
```

# Gaussian filter to reduce artifacts

$F[x, y]$

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	90	90	90	90	90	0	0
0	0	0	90	90	90	90	90	0	0
0	0	0	90	90	90	90	90	0	0
0	0	0	90	0	90	90	90	0	0
0	0	0	90	90	90	90	90	0	0
0	0	0	0	0	0	0	0	0	0
0	0	90	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

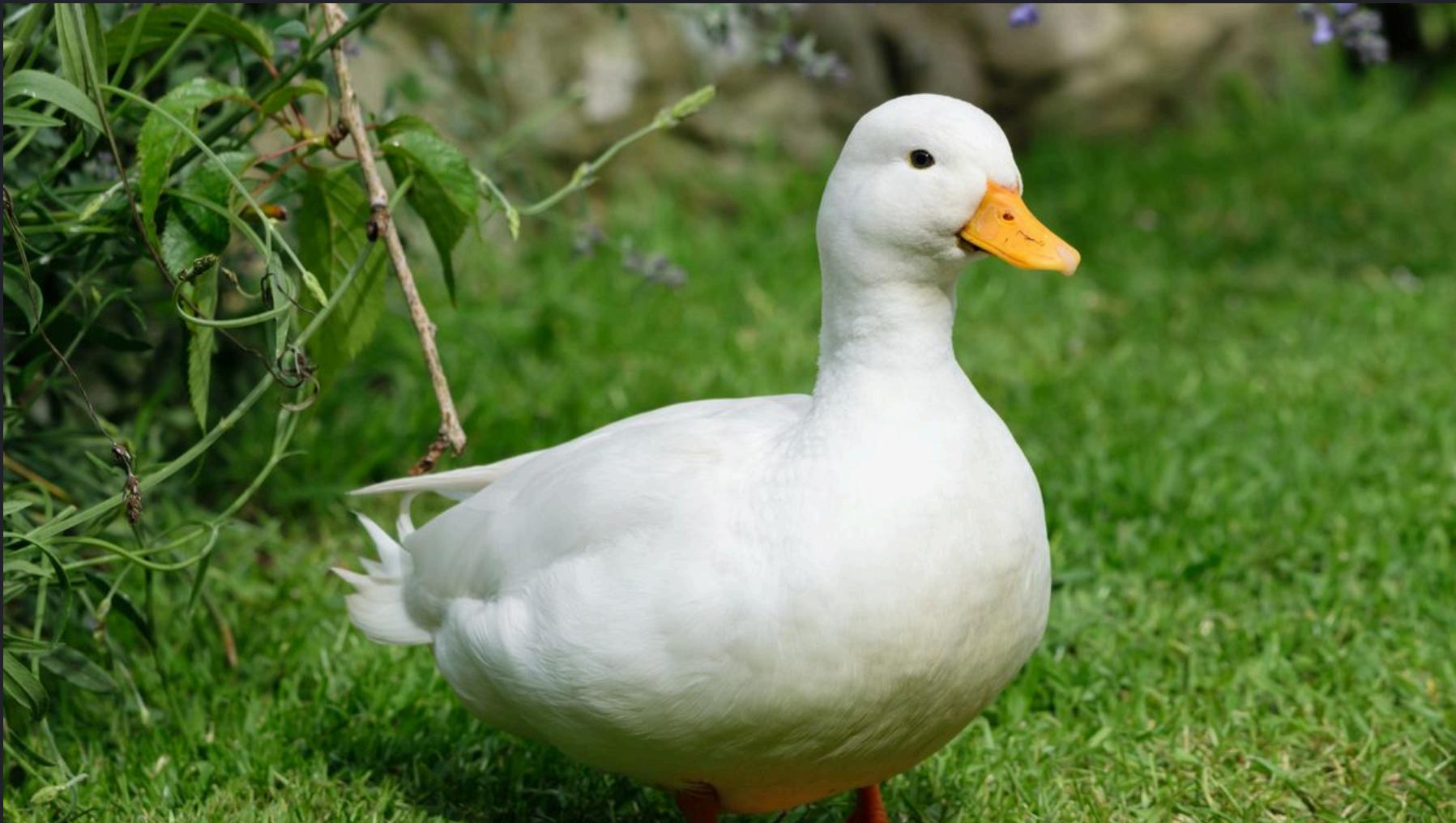
$G[x, y]$


```
# Load duck
img = cv.imread("duck.jpg")

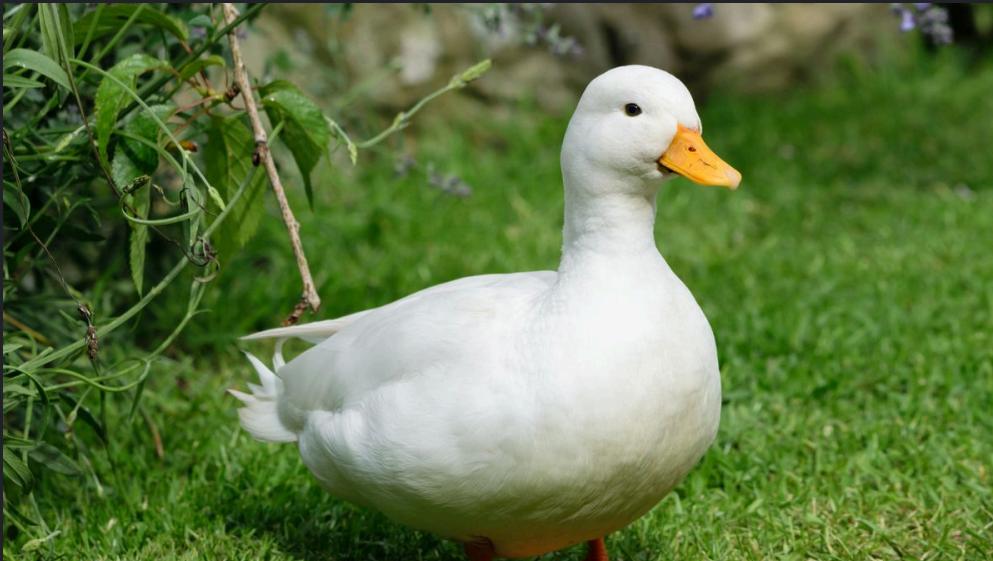
# 2D Convolution - 15x15 filter
kernel = np.ones((15, 15), np.float32) / 250
blur = cv.filter2D(img, -1, kernel)
cv.imwrite("duck-2dconv.jpg", blur)

# Default blur - 15x15 filter
blur = cv.blur(img, (15, 15))
cv.imwrite("duck-blur.jpg", blur)

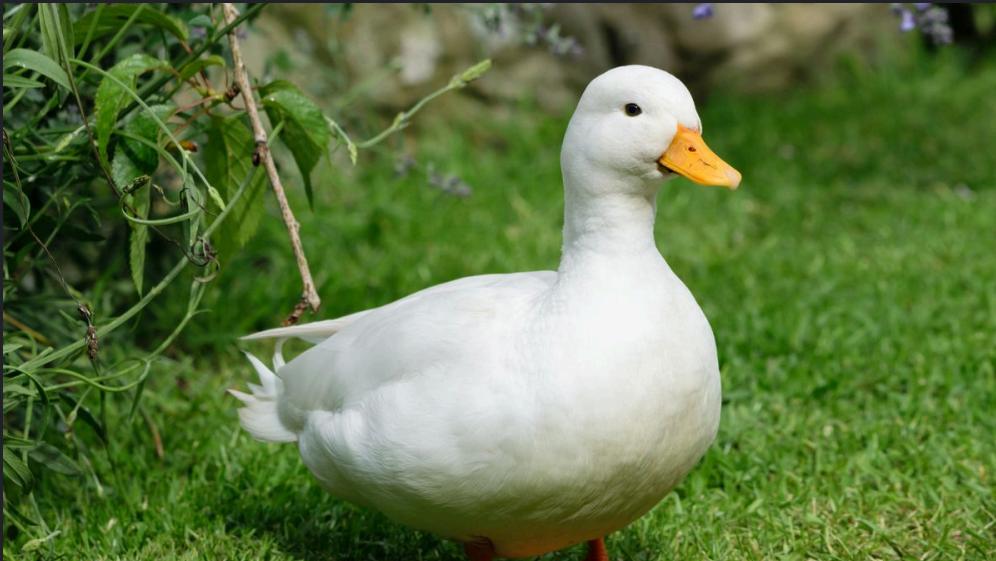
# Gaussian
blur = cv.GaussianBlur(img, (15, 15), 0)
cv.imwrite("duck-gaussian.jpg", blur)
```



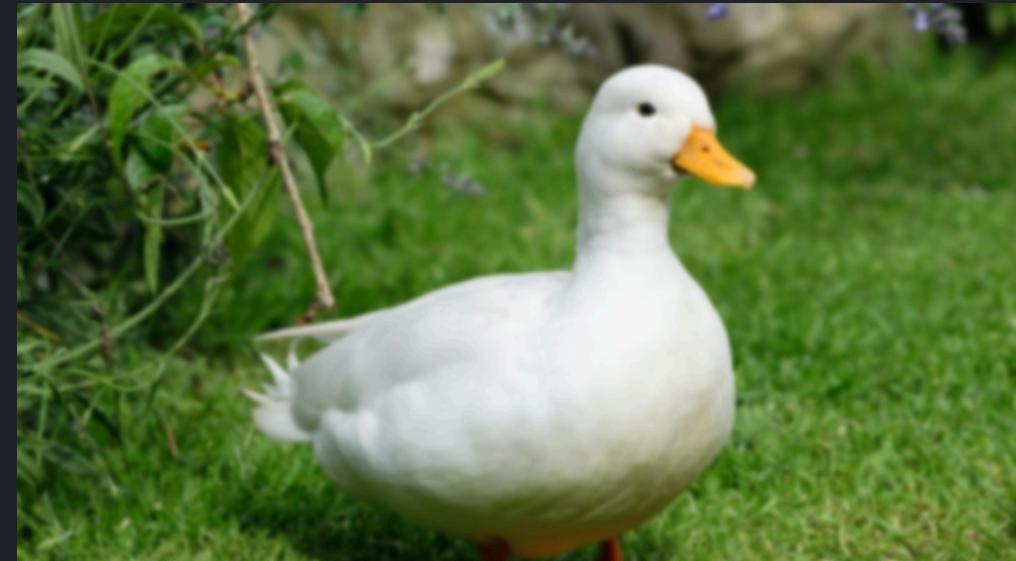
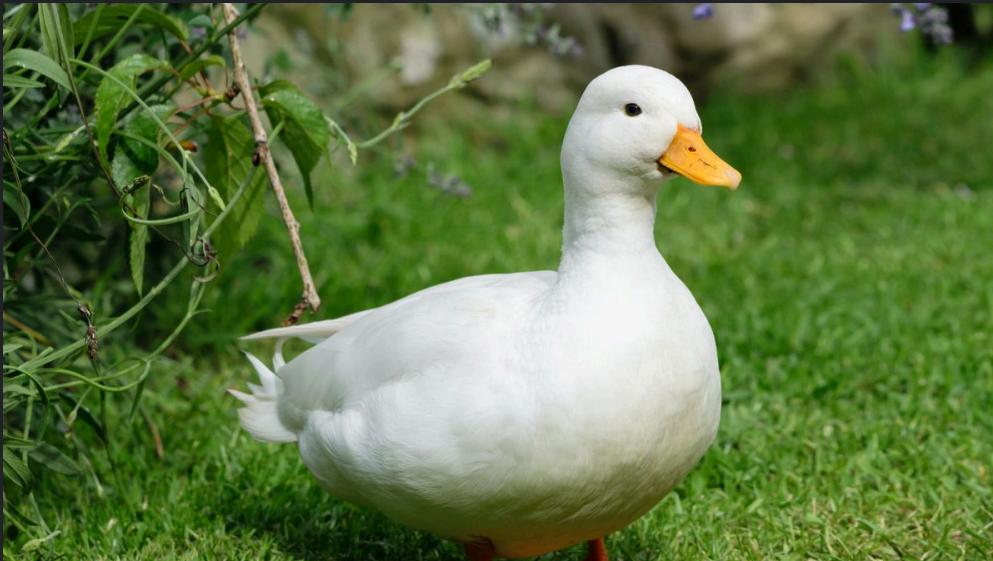
2D conv



# Blur



# Gaussian



# Edge detection with Canny

```
# Load frog
img = cv.imread("frog.jpg", cv.IMREAD_GRAYSCALE)

# Canny - img, Threshold1,Threshold2
edges = cv.Canny(img, 50, 200)

cv.imwrite("frog-canny.jpg", edges)
```





# Contrast equalization with CLAHE

```
# Apply CLAHE on grayscale
img = cv.imread("mountain.jpg", cv.IMREAD_GRAYSCALE)
clahe = cv.createCLAHE(clipLimit=2.0, tileGridSize=(8, 8))
cl1 = clahe.apply(img)

cv.imwrite("mountain-clahe-grayscale.jpg", cl1)

# Apply CLAHE on color
img = cv.imread("mountain.jpg", cv.IMREAD_ANYCOLOR)
img = cv.cvtColor(img, cv.COLOR_RGB2Lab)

clahe = cv.createCLAHE(clipLimit=10, tileGridSize=(8, 8))
img[:, :, 0] = clahe.apply(img[:, :, 0])
img = cv.cvtColor(img, cv.COLOR_Lab2RGB)

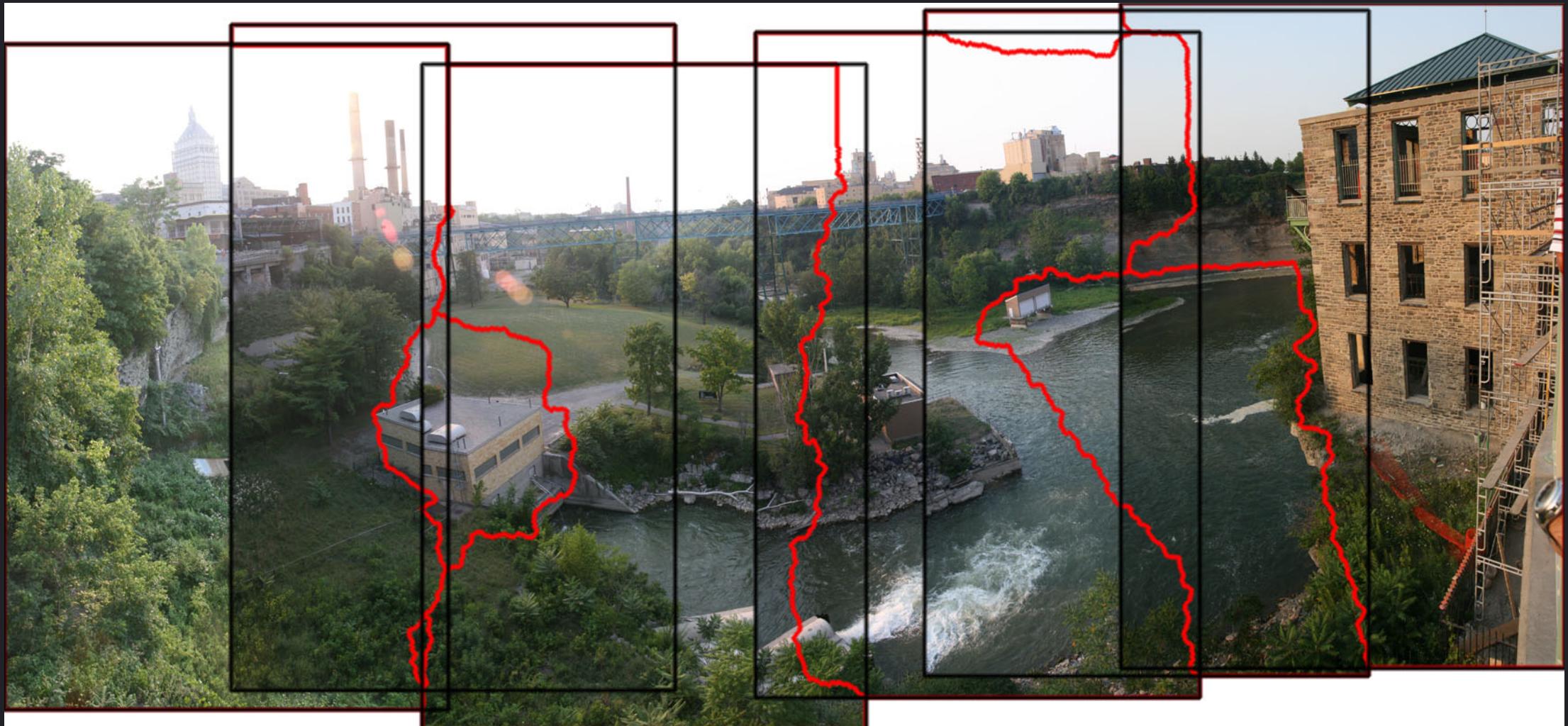
cv.imwrite("mountain-clahe-rgb.jpg", img)
```





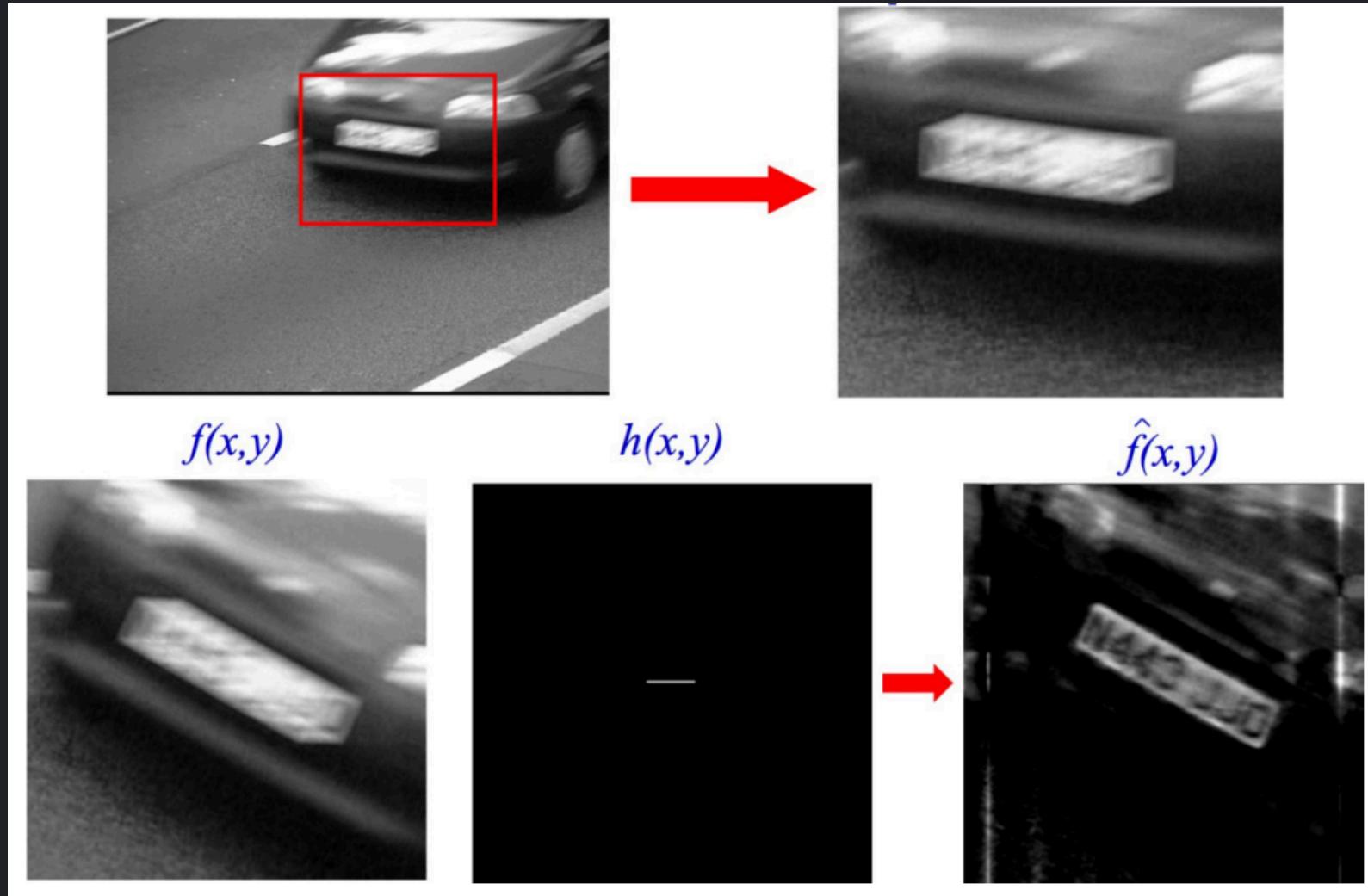


# Panoramic picture



# Unblur an image

# Spectral analysis - Wiener filter

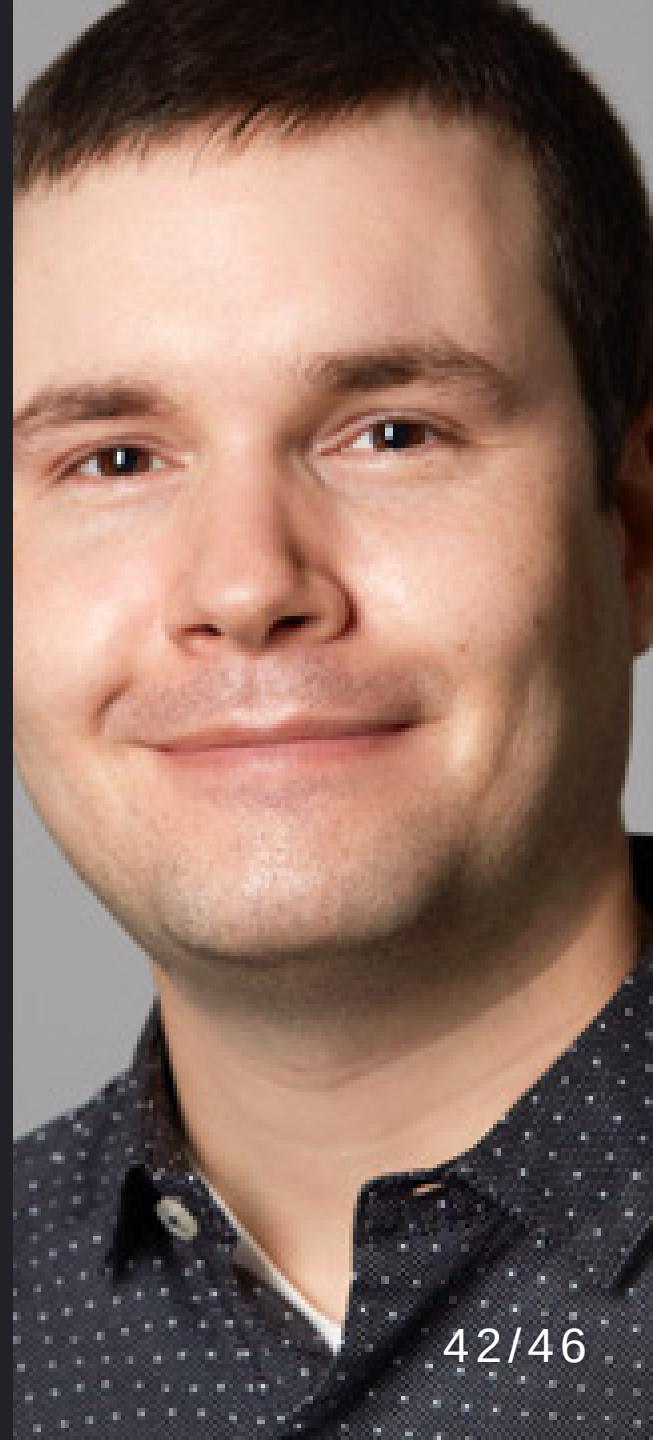


No AI today...  
maybe next time?

# Sources

Joël Lefebvre

[https://professeurs.uqam.ca/professeur  
/lefebvre.joel/](https://professeurs.uqam.ca/professeur/lefebvre.joel/)



- Afghan girl was Identified  
<https://www.cl.cam.ac.uk/~jgd1000/afghan.html>
- Spot <https://bostondynamics.com/products/spot/>
- Space CLAHE <https://siril.readthedocs.io/zh-cn/latest/processing/clah.html>
- Bill Clinton and Al Gore  
[https://www.researchgate.net/figure/Although-this-image-appears-to-be-a-fairly-run-of-the-mill-picture-of-Bill-Clinton-and-Al\\_fig6\\_228796924](https://www.researchgate.net/figure/Although-this-image-appears-to-be-a-fairly-run-of-the-mill-picture-of-Bill-Clinton-and-Al_fig6_228796924)

- Pinhole camera  
[https://en.wikipedia.org/wiki/Pinhole\\_camera](https://en.wikipedia.org/wiki/Pinhole_camera)
- Canny [https://en.wikipedia.org/wiki/Edge\\_detection](https://en.wikipedia.org/wiki/Edge_detection)
- Clahe  
<https://www.analyticsvidhya.com/blog/2022/08/image-contrast-enhancement-using-clahe/>

# Questions?

