Assignment 1: Image Sharpening

Tutorials

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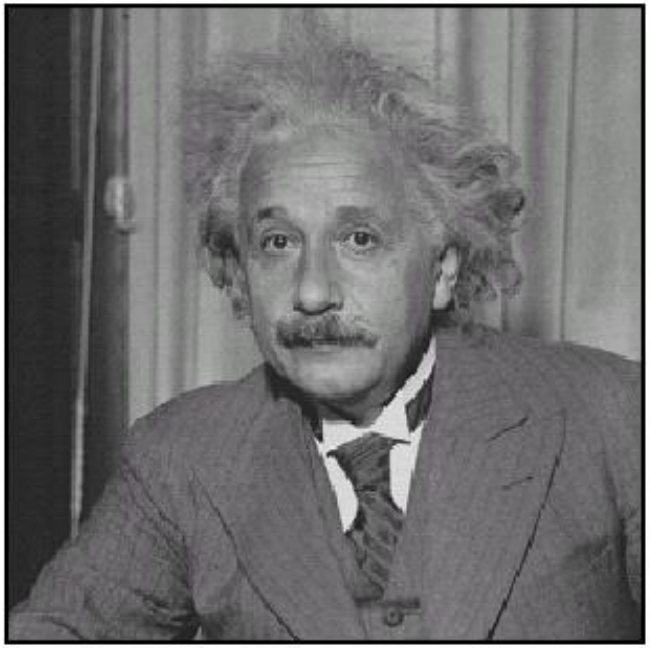
Tutorial sessions:

TUTORIAL	Tue 12:30 - 1:15pm	ERB 404
	Thu 11:30am - 12:15pm	ERB 803

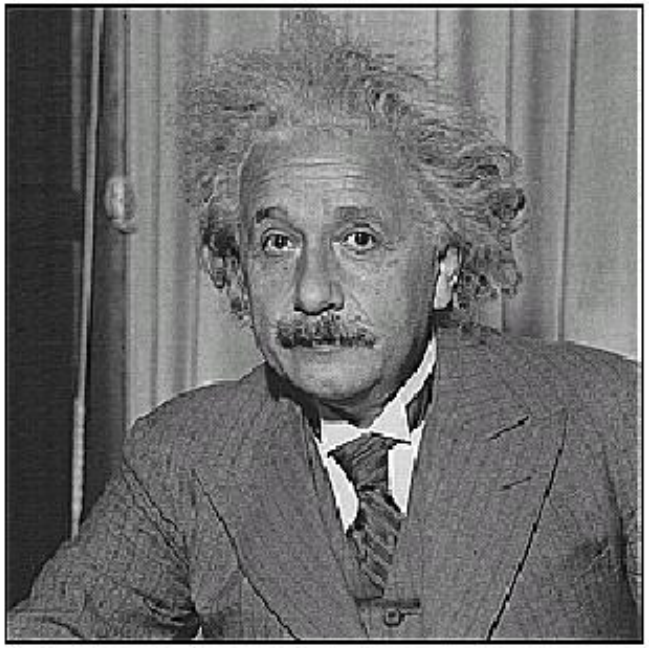
The two sessions have the same contents, so take either is ok.

Sharpening

Boost detail in an image without introducing noise or artifacts.



before



after

Sharpening

Input

=

Coarse + Fine

Sharpening

Input

=

Coarse + Fine

Sharpening

Input

How to decompose?

Coarse + Fine

Sharpening

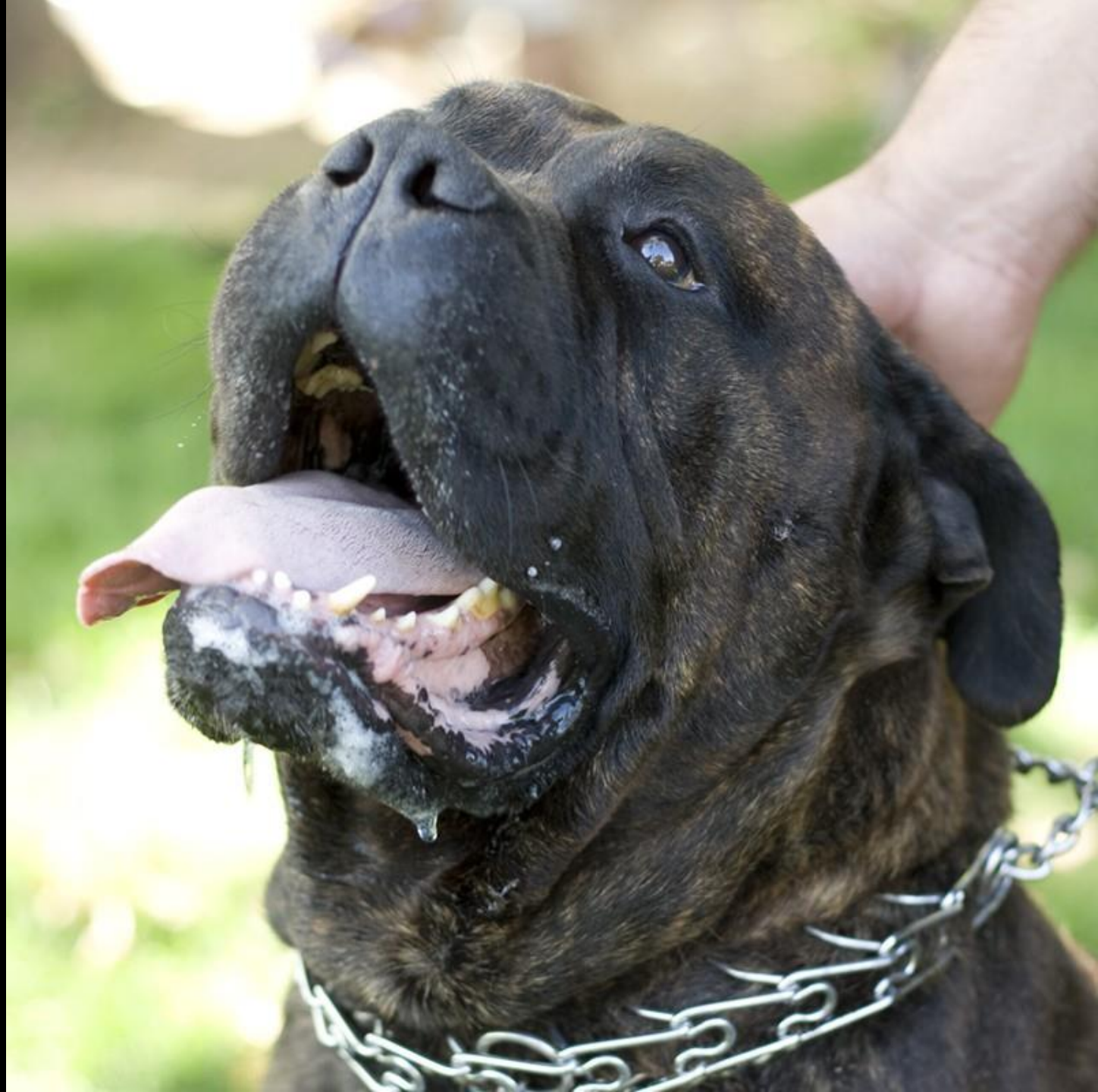
Coarse: remove details

- Box filter: average the neighbor pixels.
- Gaussian filter: weighted sum the neighbor pixels.
- …

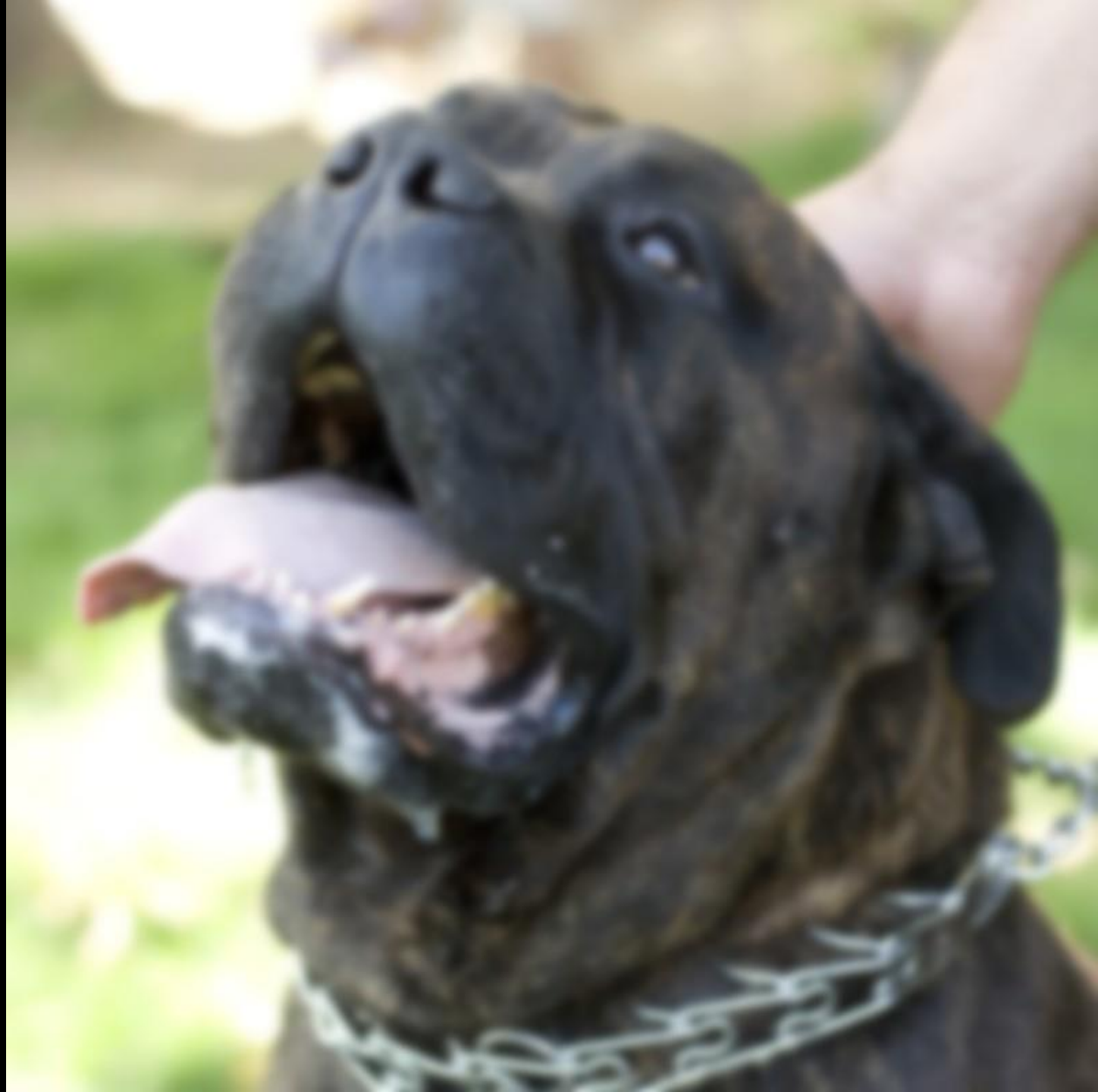
Fine: input – coarse

Image sharpening: input + fine

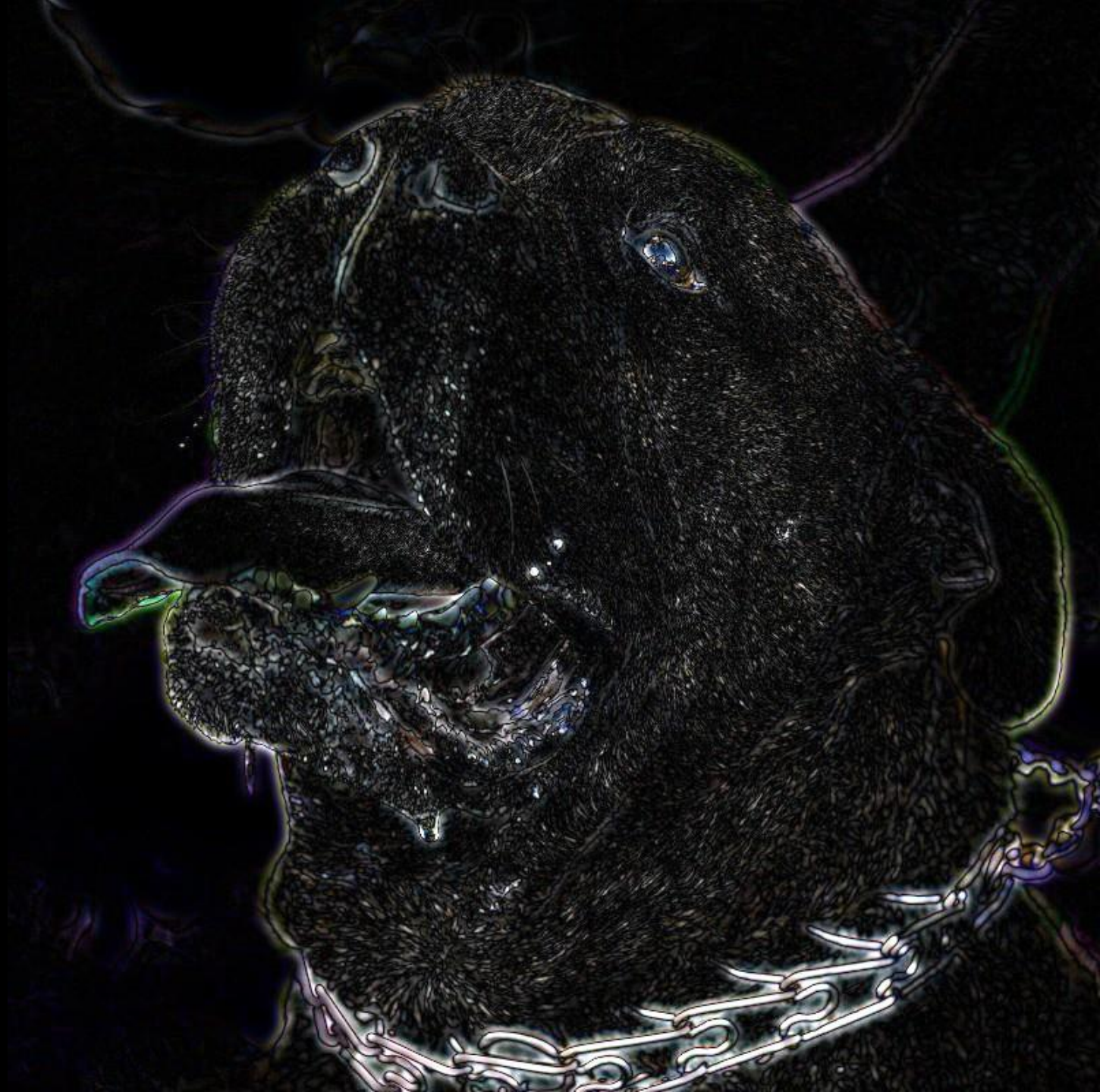
Input



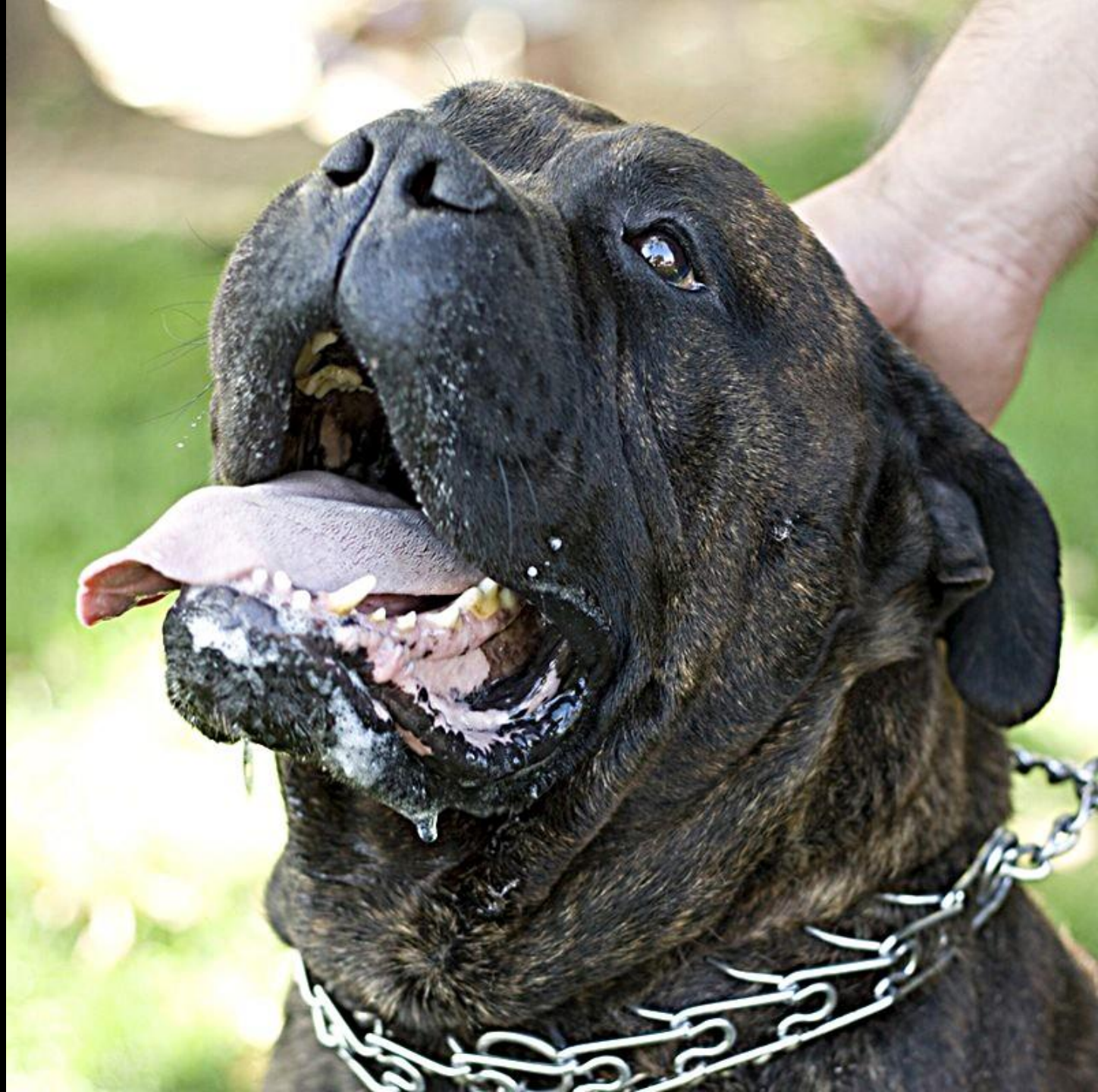
Coarse



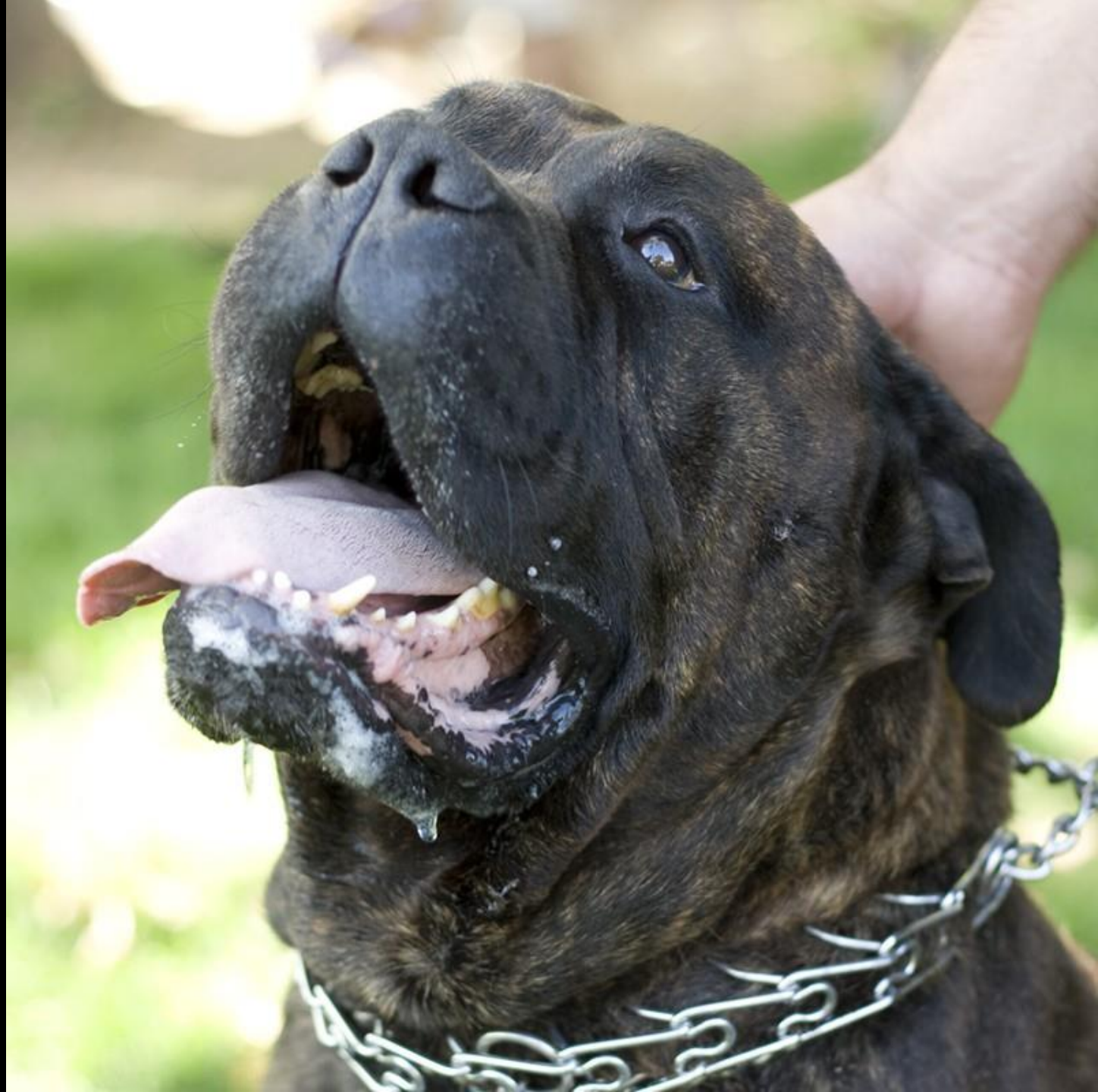
Fine



Input + Fine

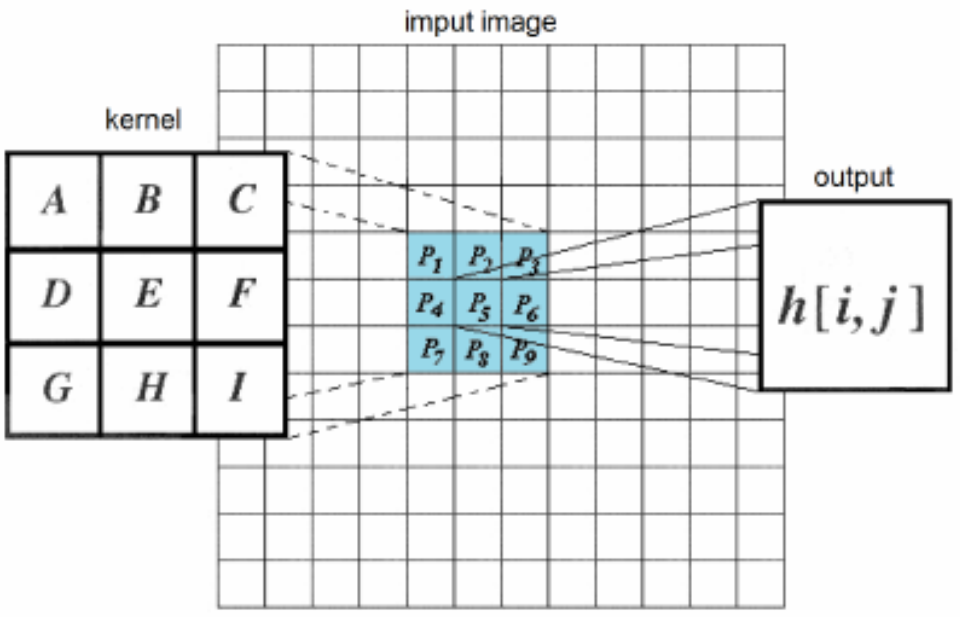


Input



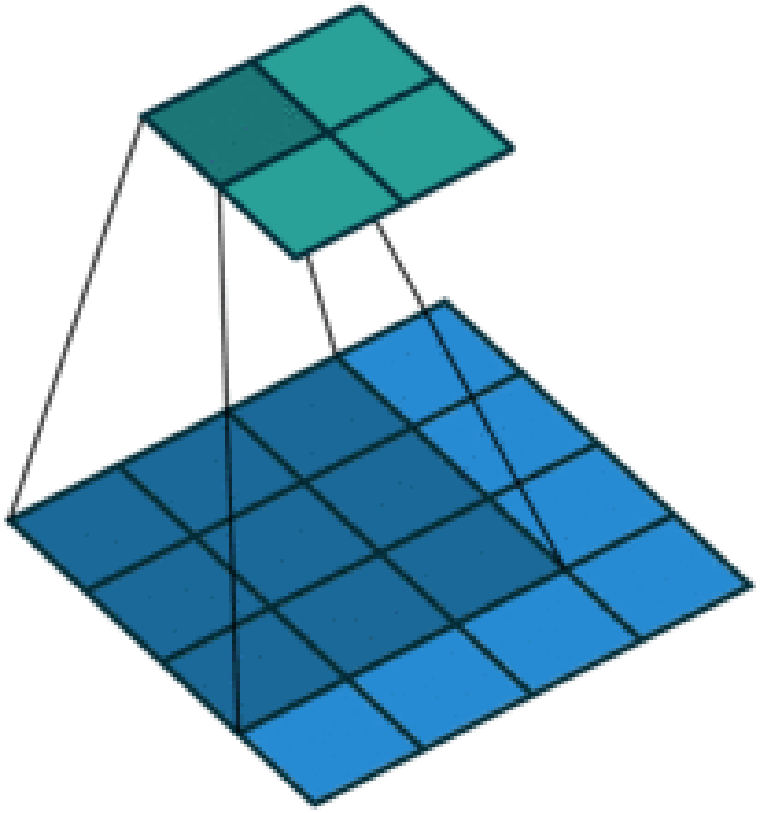
Filter basic: convolution

Linear combination of the pixels in the input pixel's neighborhood.



$$h[i, j] = A \times P_1 + B \times P_2 + C \times P_3 + D \times P_4 + E \times P_5 + F \times P_6 + G \times P_7 + H \times P_8 + I \times P_9$$

Filter basic: convolution

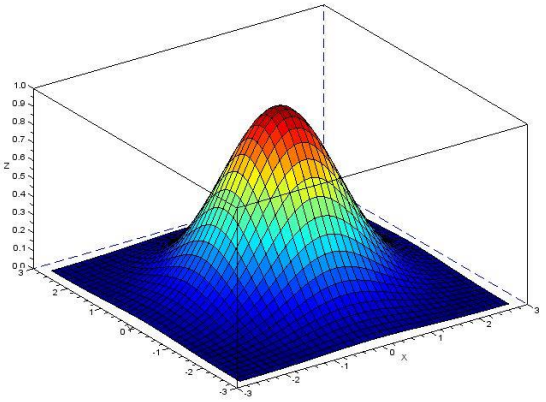


Kernel generation

Mean filtering kernel: Replace each pixel with an average of its neighborhood

$$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

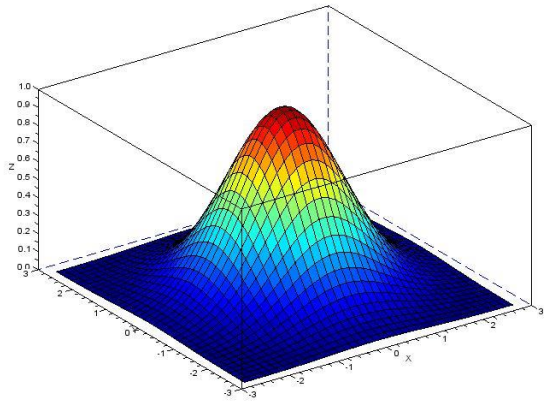
Gaussian smoothing: Using weighted sum



$$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

Gaussian kernel

Gaussian kernel



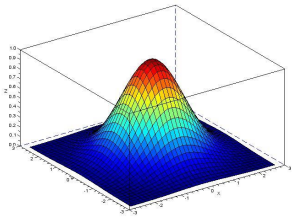
$$G_{2D}(x, y; \sigma) = \frac{1}{\sqrt{2\pi}\ \sigma} e^{-\frac{x^2}{2\sigma^2}} \times \frac{1}{\sqrt{2\pi}\ \sigma} e^{-\frac{y^2}{2\sigma^2}} = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Normalize:

$$K(x, y;\ \sigma) = \frac{1}{\sum_{i=0,j=0}^{i=m,j=n} G\_2D\ (i, j;\ \sigma)} * G_{2D}(x, y;\ \sigma)$$

Smoothing

*



=

Source: S. Lazebnik

Detail map

$$\frac{kernel\ size - 1}{2}$$

Tip: Gaussian smoothing will reduce the resolution by (kernel_size -1) / 2, so we need to crop the center region of original image to perform minus operation!

Detail map

Tip: Gaussian smoothing will reduce the resolution by (kernel_size -1) / 2, so we need to crop the center region of original image to perform minus operation!

Control sharpen level

Control the sharpening level via kernel size and sigma:

Soft Original

Mild Sharpening

Over Sharpening

Program details

Using Python 3.4+ (https://www.python.org/)

Assignment dependency:

- Imageio (https://pypi.org/project/imageio/)
- NumPy (https://pypi.org/project/numpy/)

Install:

```
pip install imageio
pip install numpy
```

OR

```
pip3 install imageio
pip3 install numpy
```

Implement the functions in pure Python 3.

NO SciPy, OpenCV, and …

Submission details

- Only need to submit “studentID_sharpening.py”
- Via Blackboard (https://blackboard.cuhk.edu.hk/)
- Insert personal information and declaration:

```
#
# CSCI3290 Computational Imaging and Vision *
# --- Declaration --- *
# I declare that the assignment here submitted is original except for source
# material explicitly acknowledged. I also acknowledge that I am aware of
# University policy and regulations on honesty in academic work, and of the
# disciplinary guidelines and procedures applicable to breaches of such policy
# and regulations, as contained in the website
# http://www.cuhk.edu.hk/policy/academichonesty/ *
# Assignment 1
# Name :
# Student ID :
# Email Addr :
#
```

Submission details

- Due date: Feb. 6, 2020 (23:59:59)
- Late submission penalty: 10 marks deduction per day.

THANK YOU!