CS4243
Computer Vision & Pattern Recognition

AY 2023/24

Lab Session 1

NUS National University of Singapore | School of Computing

Teaching Assistants

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Arrangement

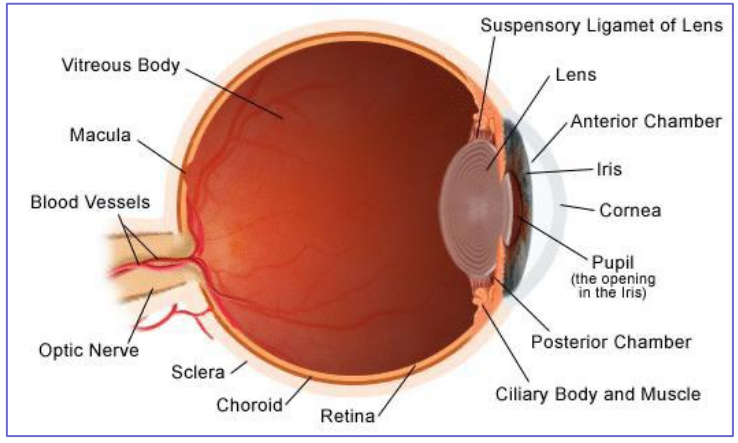
- Part 1 - Quick Recap from the Lecture (~20 min)
- Part 2 - Lab Tutorial (~30 min)
- Break (10 min)
- Part 3 - Lab Solution (~30 min)

Lab Materials

- GitHub Repo: https://github.com/ldkong1205/cs4243_lab
- Slides
- Notebook & Solution
- Other Materials (image, media, etc.)

Lesson 1

Introduction and Fundamentals

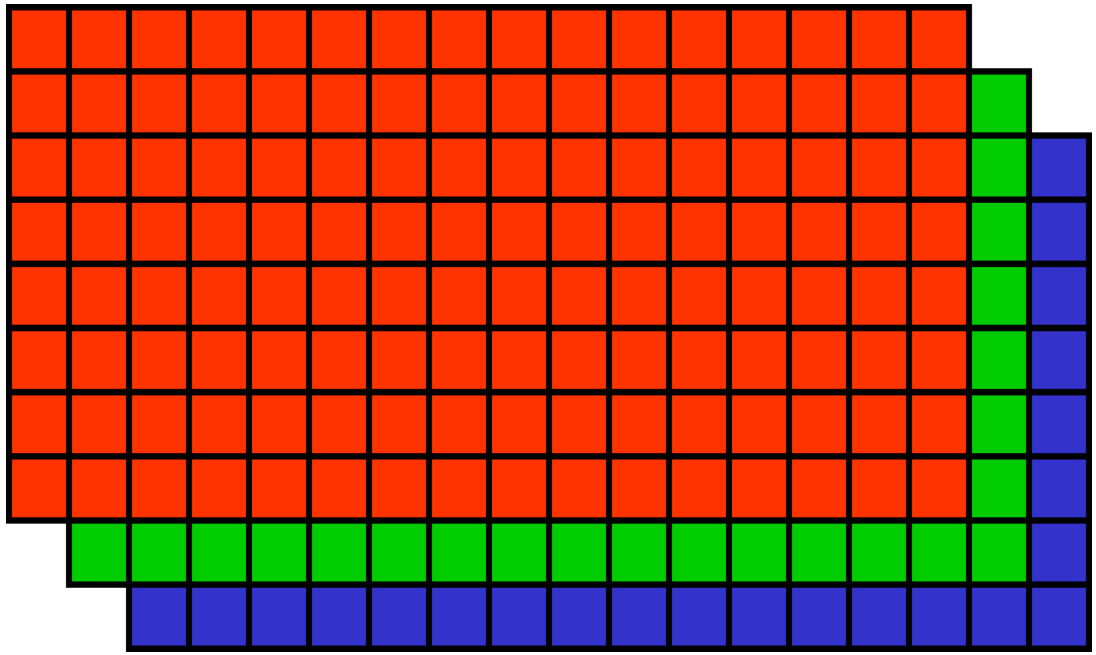


What is this?

A Color Image

- An M x N x 3 matrix
- Each pixel is an 8-bit number between 0 and 255
- RED, GREEN, BLUE
- M x N
  = resolution
  = number of pixels in columns / rows

Caution: OpenCV uses BGR format



Operations

Anything Can be applied on your Digital Image or Video

Logical Operations	Transforms	Statistical Operations	Geometrical Operations	Mathematical Operations
Morphology, Coding,	Fourier, Walsh, PCA	Histograms, Correlation, Max/Min	Affine Transforms	Filtering, *.**

Histogram

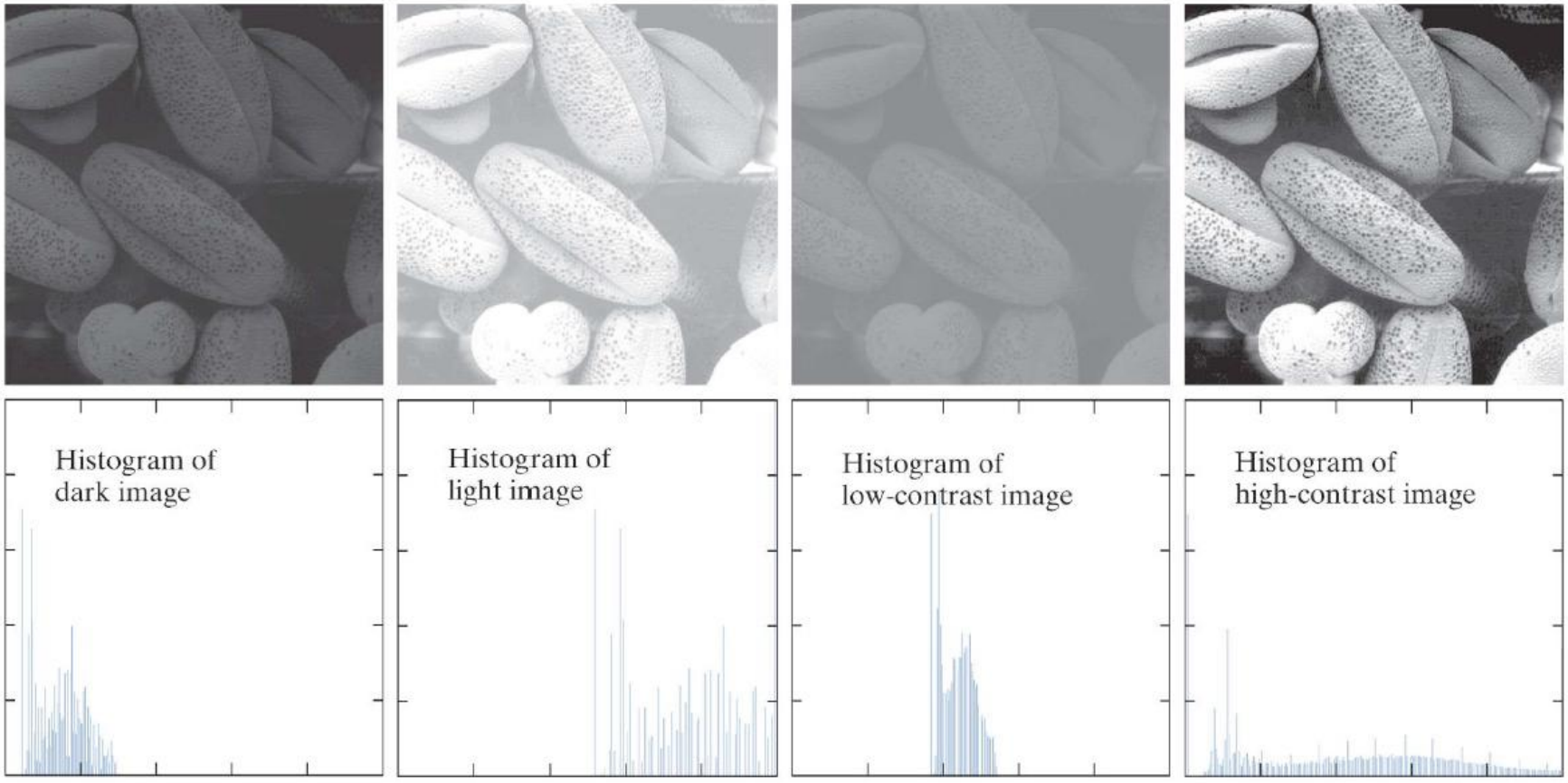
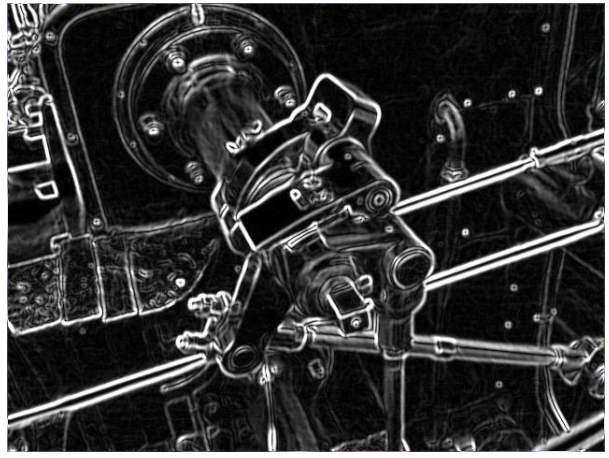


FIGURE 3.16
Four image types and their corresponding histograms. (a) dark; (b) light; (c) low contrast; (d) high contrast. The horizontal axis of the histograms are values of r_k and the vertical axis are values of $p(r_k)$.



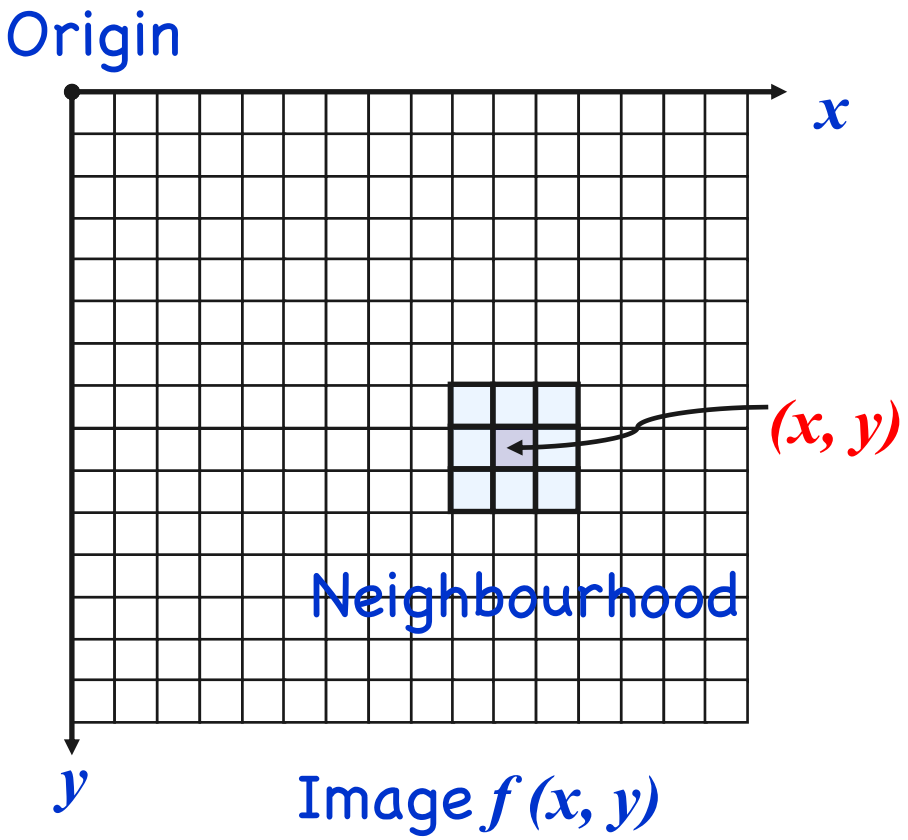
Lesson 2

Local Operations, Filtering, and Convolution

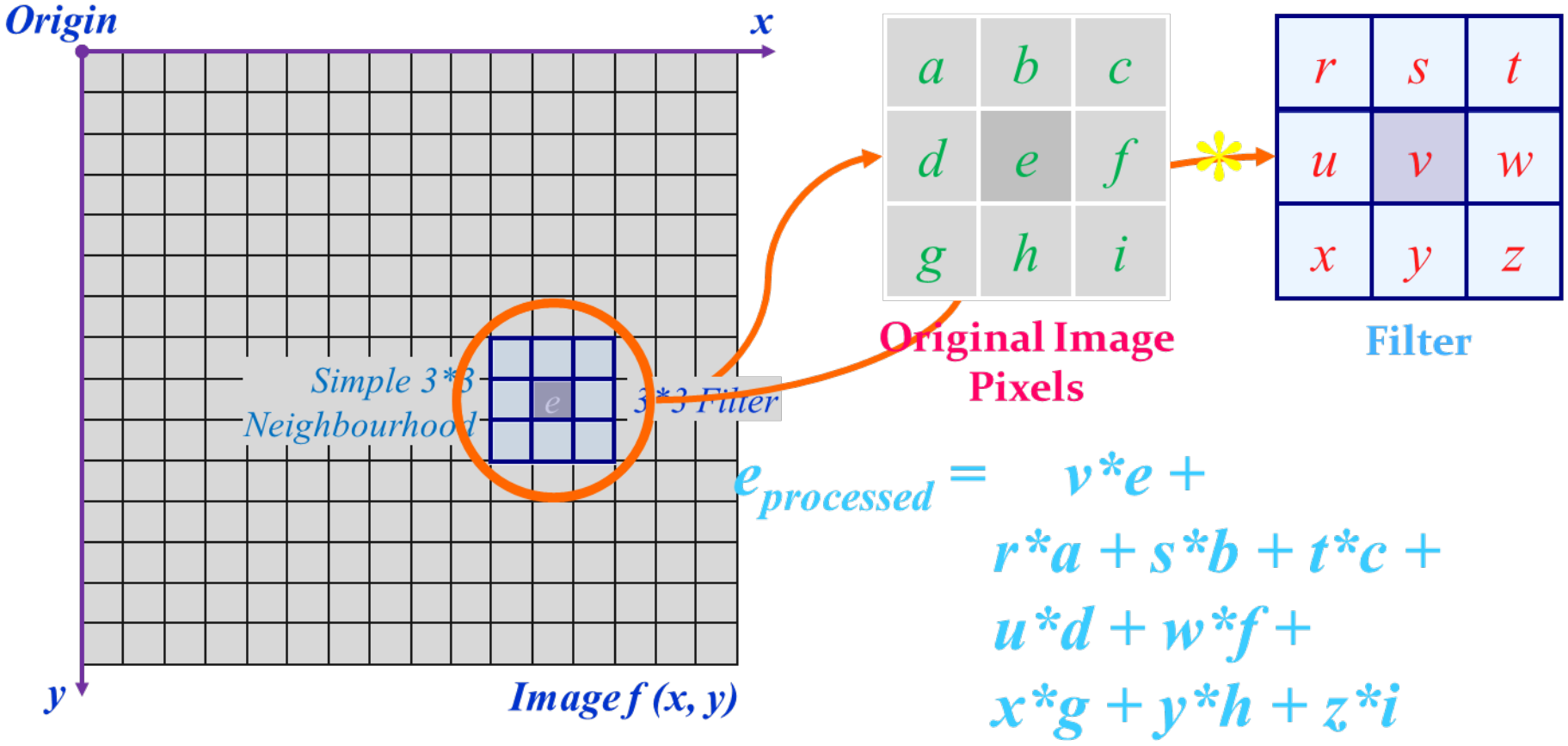
- Where we see how we can filter and image
- Every system in this big universe is a filter

Local Operations

- An image in the spatial domain
- A local operator uses the pixel and its neighbours to compute the new value of that pixel.
- E.g., replace each pixel f(x,y), with the average of that and its 8 neighbours.
- $g(x,y) = T[\ f(x \pm \Delta x, y \pm \Delta y)\ ]$

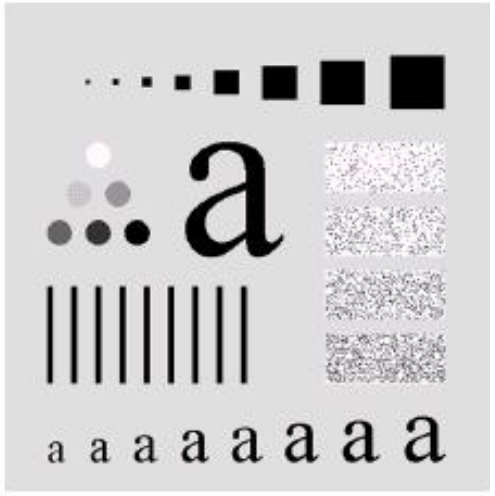


Local Operations



The **filter** would slide over the image, shift or stride is 1 column and then 1 row

Low-Pass Filters

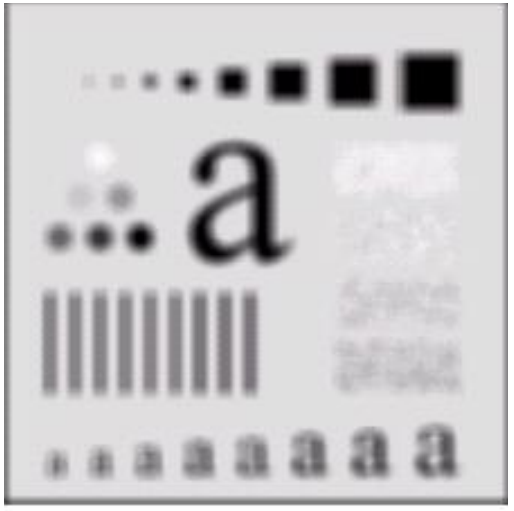


Original image

Filtered with 3x3

Filtered with 5x5

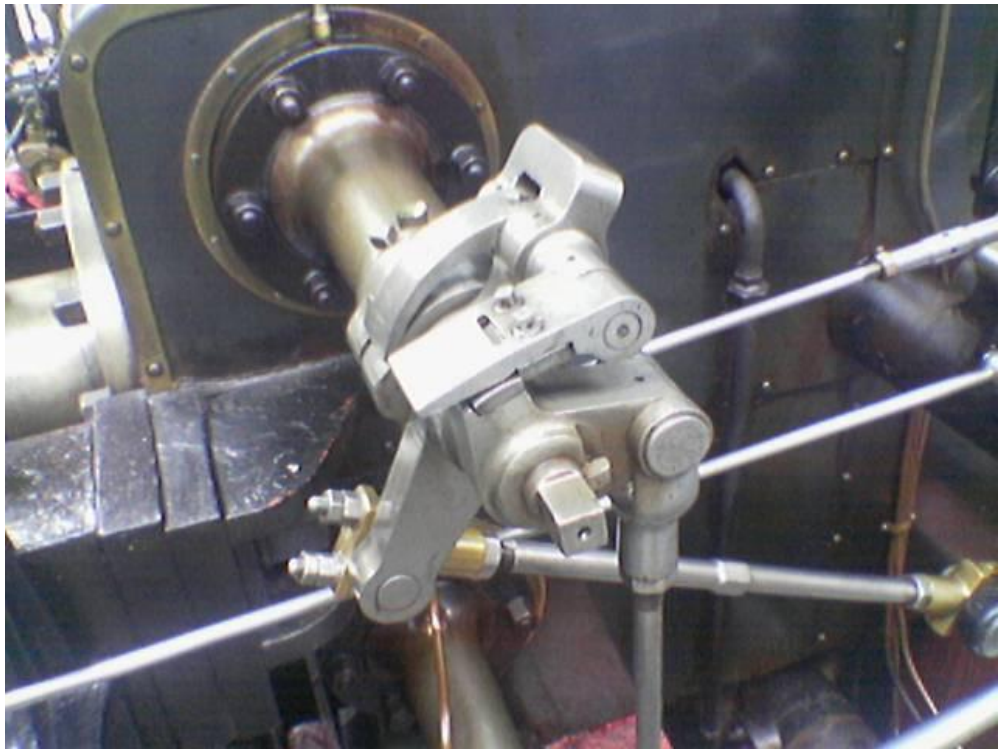
Filtered with 9x9

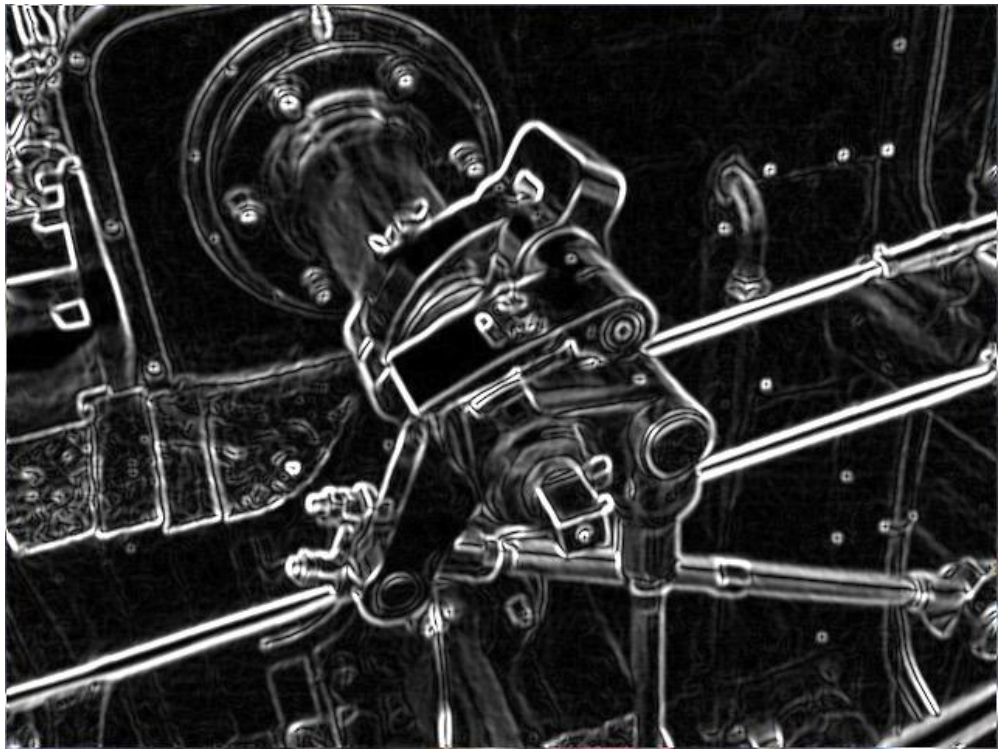


Filtered with 15x15

Filtered with 35x35

High-Pass Filters



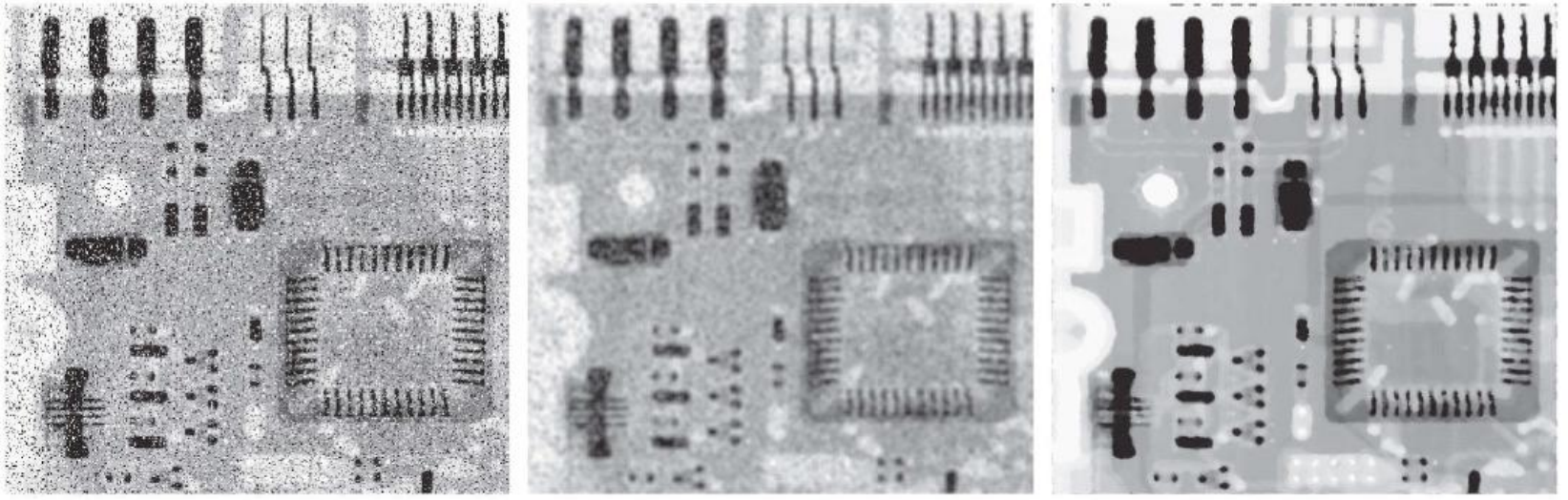


Discrete 1st derivative or **gradient** of an image.

An image and result of edge detection using the Sobel algorithm.

Median Filters

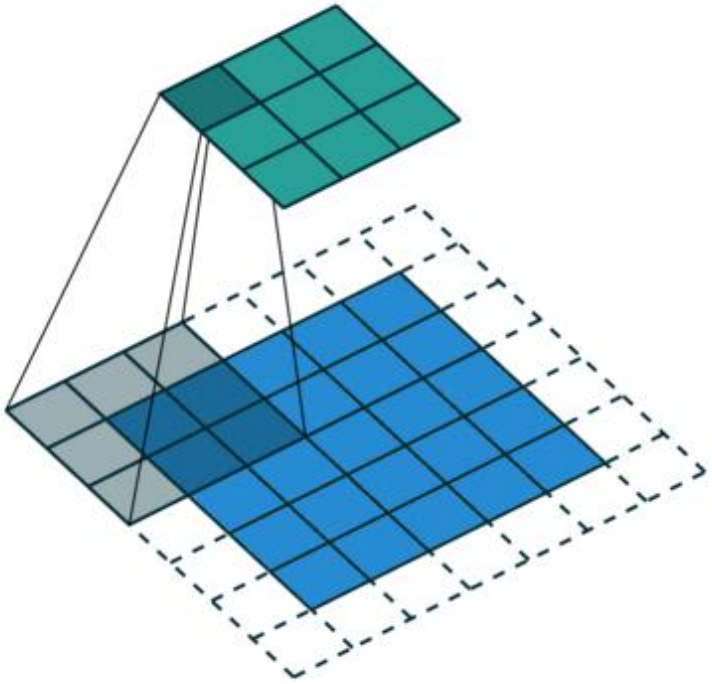
- In a small n x n patch/neighborhood
- Sort the pixels and find the median, *M*
- Replace the central pixel of your patch with *M*
- Slide one pixel to the next neighborhood



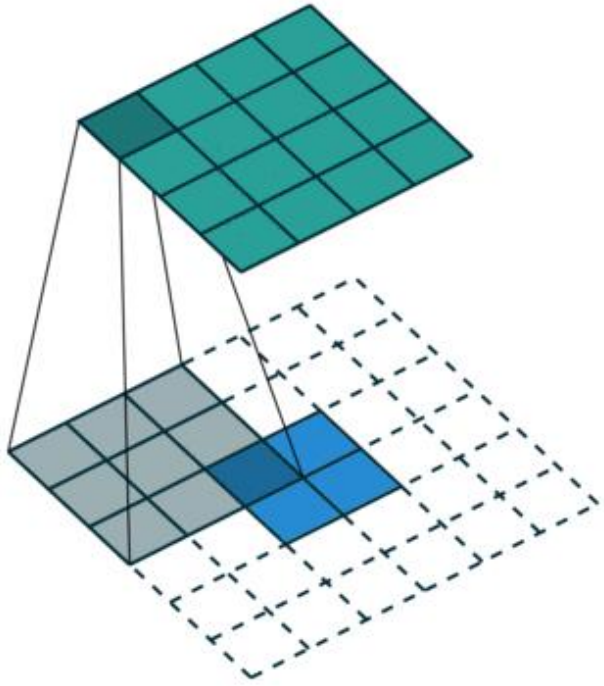
a b c

FIGURE 3.49
(a) X-ray image of a circuit board, corrupted by salt-and-pepper noise. (b) Noise reduction using a 19×19 Gaussian lowpass filter kernel with $\sigma = 3$. (c) Noise reduction using a 7×7 median filter. (Original image courtesy of Mr. Joseph E. Pascente, Lixi, Inc.)

Convolution, 2D

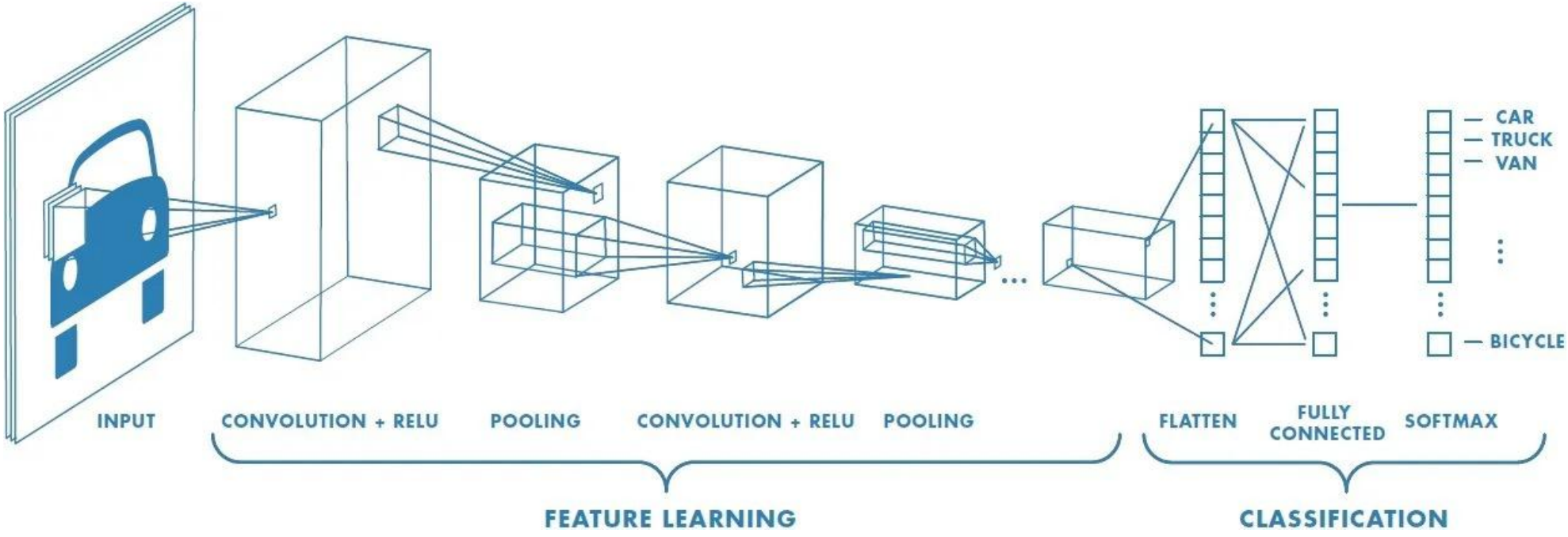


convolution with stride = 1



convolution with stride = 2

Convolutional Neural Nets (CNNs)



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Background & Global Operations

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