Digitale Bildverarbeitung in der medizinischen Physik

WUPPERTAL,16-OKTOBER-2017

DR. LILIANA CALDEIRA

Digital Image Processing in Medical Physics

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LILIANA CALDEIRA, PHD

Academic Path

- 2002-2007 MSc. Biomedical Engineering IST
  - **Master Thesis in collaboration with Erasmus Medical Center (Rotterdam, NL)**
- 2008-2013 Ph.D. Biomedical Engineering FCUL
  - **PhD Studentships in Industry with Institute of Biophysics and Biomedical Engineering (IBEB) and Siemens**
- 2013-2015 Marie Curie Intra-European Fellowship
  - **Forschungszentrum Juelich (Research Center Juelich)**
- 2015- Postdoctoral Fellowship
  - **Forschungszentrum Juelich (Research Center Juelich)**

Contacts

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Introduction

- Exercises start: 16th October
- First exercise lecture is Introduction (today!).
- Time schedule: Mondays, 16h-17h
- 23rd October – no exercises, no lecture
- 30th October – no exercises, no lecture
- 20th November – no exercises

How do the exercises work?

- Exercises are provided in class
- Exercises will be made by hand and then by computer
- Computer is advised, with specific software installed.
- Students can do exercises during class and/or at home.
- No grade will be awarded to the exercises! These are learning exercises.
- But exam strongly relies in these exercises.

Recommended Software

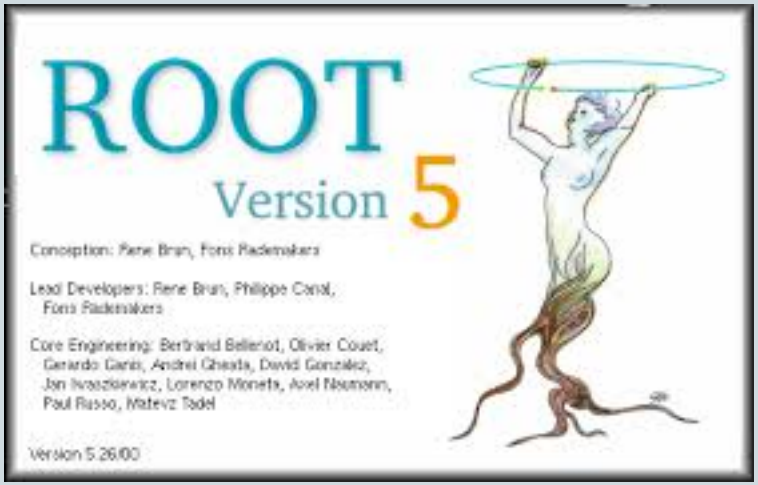
- FIJI – FIJI is Just ImageJ
- ROOT – Data Analysis Framework
- Matlab/Octave
- IDL/GDL

FIJI

- FIJI – FIJI is Just ImageJ
- http://fiji.sc/Fiji
- Free (GPL)!
- Easy to install

ROOT

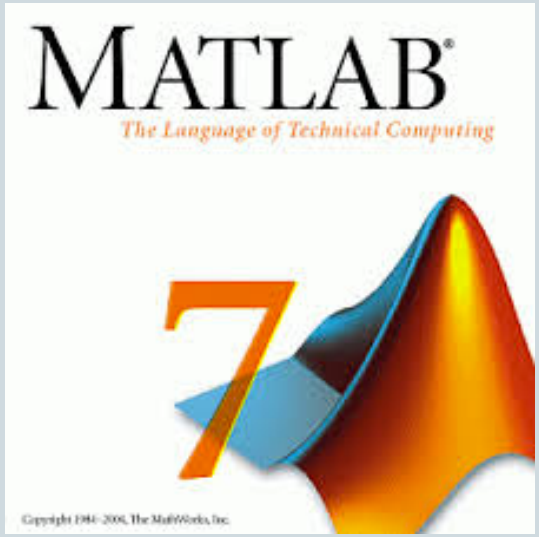
- Data Analysis Framework (C++)
- http://root.cern.ch/drupal/
- Free!



- A bit more complicated to install:
  - http://root.cern.ch/drupal/content/installing-root-source

Matlab - Octave

- Matlab – Matrix laboratory
- http://www.mathworks.de/products/matlab/
- Payed!
- Easy to install



Matlab - Octave

- Matlab – Matrix laboratory

- “Die Bergische Universität Wuppertal hat für zunächst ein Jahr (Mai 2014-April 2015) einen Studierenden-Campus-Vertrag "TAH Student License" mit der Firma The Mathworks abgeschlossen. Die Lizenzkosten teilen sich das ZIM und die Fachbereiche C, D und E.”

Matlab - Octave

- Matlab – Matrix laboratory

- “Alle Studierenden der Hochschule sind somit berechtigt, die Software kostenfrei auf ihren privaten Rechnern zu installieren und zu nutzen. Es ist nicht zulässig, die Software auf Rechnern der Hochschule oder auf Rechnern der Mitarbeiter zu installieren oder zu nutzen.”

Matlab - Octave

- Matlab – Matrix laboratory
- http://www.zim.uni-wuppertal.de/dienste/software/lizenzen/matlab.html

Matlab - Octave

- Matlab – Matrix laboratory
- Octave – Free alternative to Matlab
- https://www.gnu.org/software/octave/
- A bit more complicated to install

IDL - GDL

- Interface Data Language
- http://www.exelisvis.com/ProductsServices/IDL.aspx
- Payed!

IDL - GDL

- IDL - Interface Data Language
- GNU Data Language – Free alternative to IDL
- http://gnudatalanguage.sourceforge.net/
- A bit more complicated to install:

http://gnudatalanguage.sourceforge.net/documentation.php

Feedback from students

- Which Operating Systems do you use?
- Which image software programs have you used before?
- Which programming languages are you familiar with?

Recommended Books

- Gonzalez, R.C., Wintz, P.: Digital Imaging Processing

http://www.amazon.co.uk/Digital-Image-Processing-Rafael-Gonzalez/dp/0201025965

- Gonzalez, R.C., Woods, R.: Digital Imaging Processing

http://www.amazon.com/Digital-Image-Processing-3rd-Edition/dp/013168728X

Recommended Books

- Burger and Burg, Digitale Bilverarbeitung (also in English).

http://www.amazon.de/Digitale-Bildverarbeitung-algorithmische-Einf%C3%BChrung-X-media-press/dp/3642046037

http://www.amazon.com/Digital-Image-Processing-Algorithmic-Introduction/dp/1846283795

Recommended Books

- Pratt, W. K.: Digital Imaging Processing

http://www.amazon.com/Digital-Image-Processing-Scientific-Inside/dp/0471767778

- Rosenfeld, A.C.: Digital Picture Processing

http://www.amazon.com/Digital-Picture-Processing-Computer-Mathematics/dp/0125973012/ref=sr_1_1?s=books&ie=UTF8&qid=1412677253&sr=1-1&keywords=9780125973014

Recommended Books

- Sonka, Hlavac, Boyle: Digital Image Processing

http://www.amazon.com/Image-Processing-Analysis-Machine-Vision/dp/1133593607

- Jähne, B.: Digitale Bildverarbeitung

http://www.amazon.de/Digitale-Bildverarbeitung-Bernd-J%C3%A4hne/dp/3540249990

Recommended Books

- Haberäcker, Peter: Digitale Bilverarbeitung

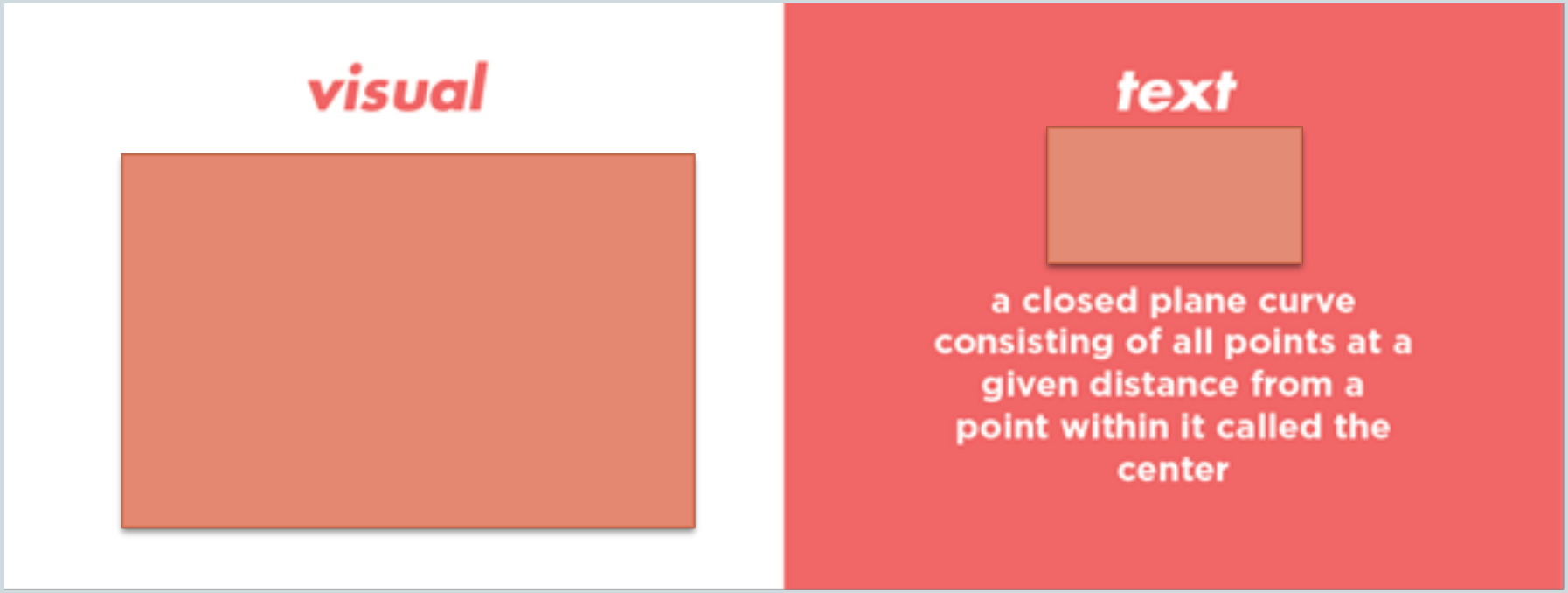
http://www.amazon.de/Digitale-Bildverarbeitung-Peter-Haber%C3%A4cker/dp/3446163395

- Handels, H.: Medizinische Bildverarbeitung

http://www.amazon.com/Medizinische-Bildverarbeitung-Mustererkennung-Visualisierung-computergest%C3%BCtzte/dp/3835100777/ref=sr_1_1?s=books&ie=UTF8&qid=1412677425&sr=1-1&keywords=9783835100770

Questions?

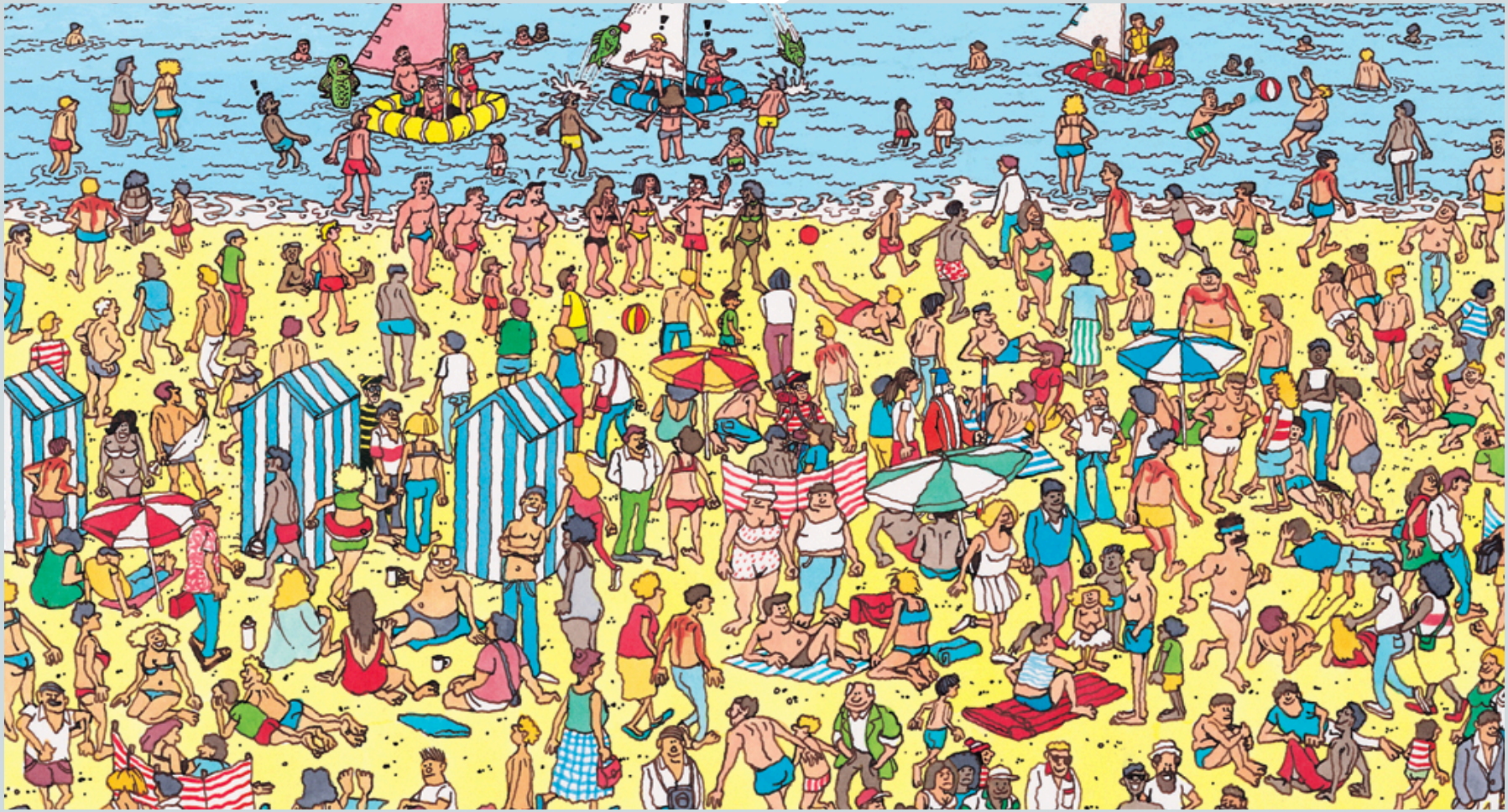
- *"One picture is worth more than thousand words"*
  - Anonymous



Why do we need digital image processing?

- Enhance information for human perception
- Automatize processes
- Efficient storage and transmission

Where is Waldo?



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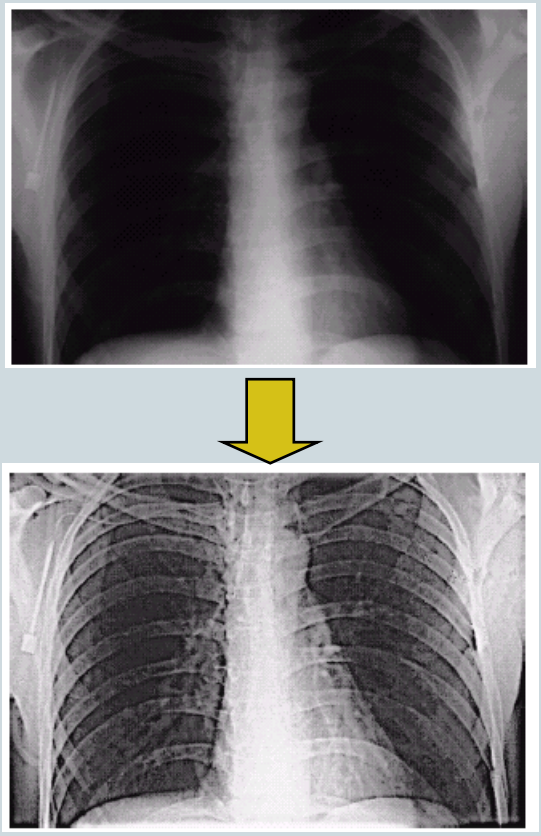
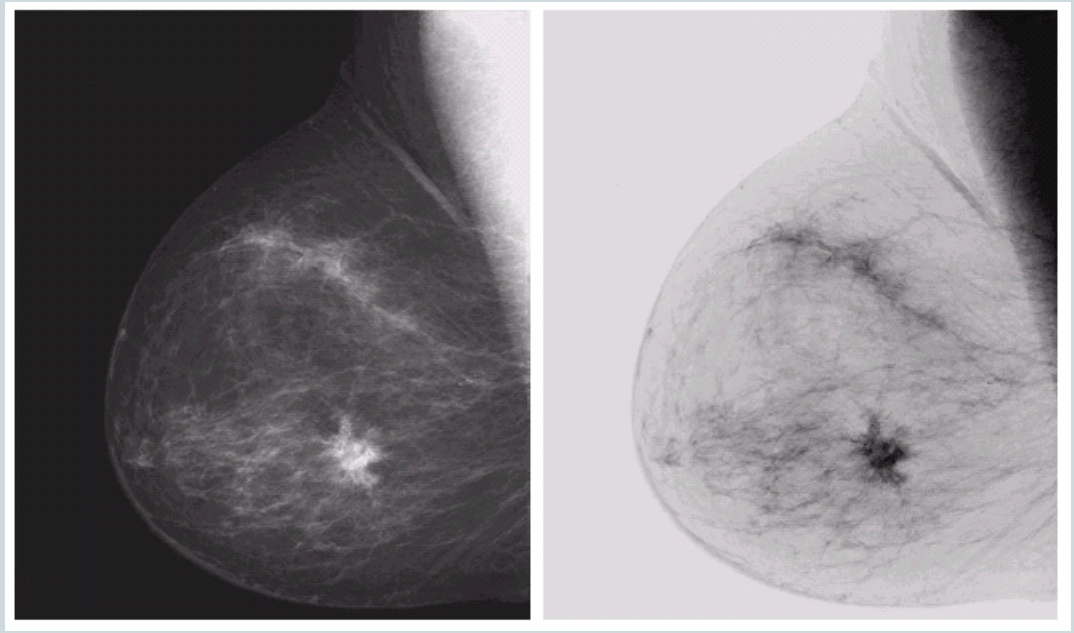
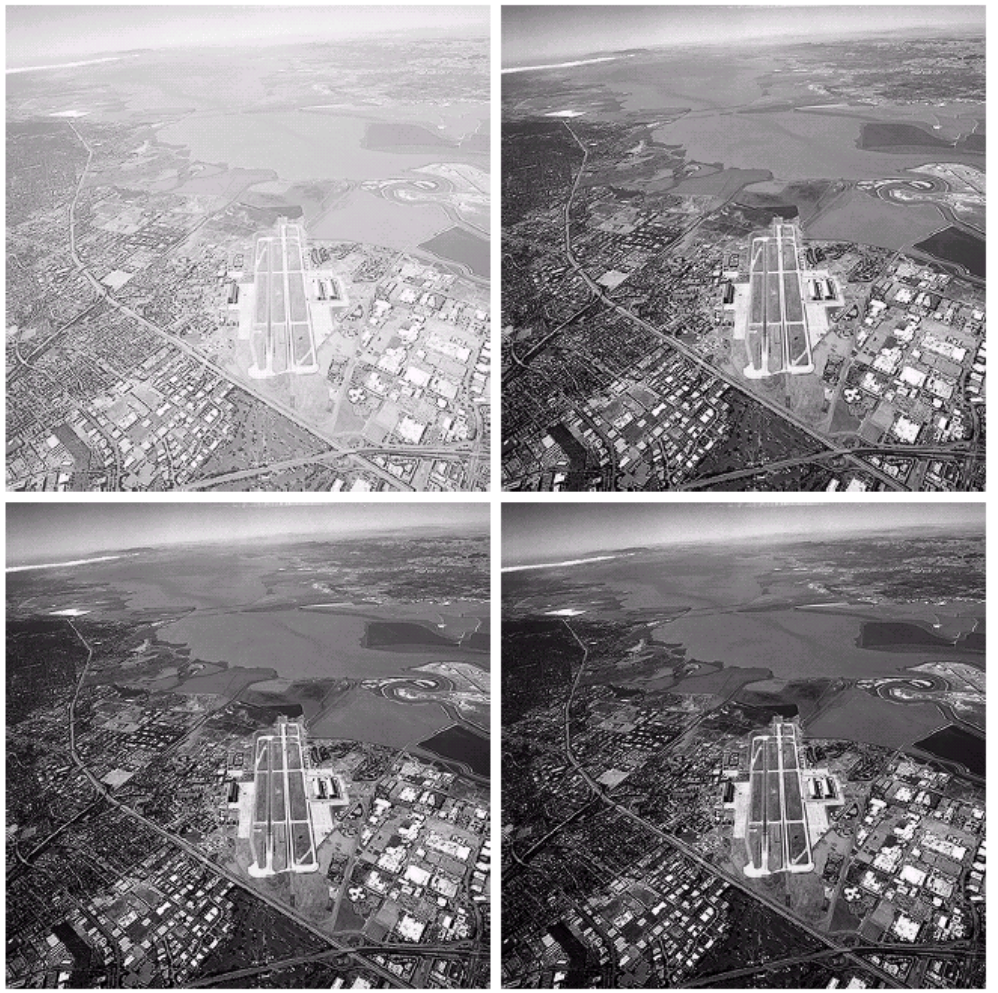
Medical Imaging





Remote Sensing



a b
c d

FIGURE 3.9
(a) Aerial image. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0,$ and 5.0, respectively. (Original image for this example courtesy of NASA.)

Biological applications

- Cell counting

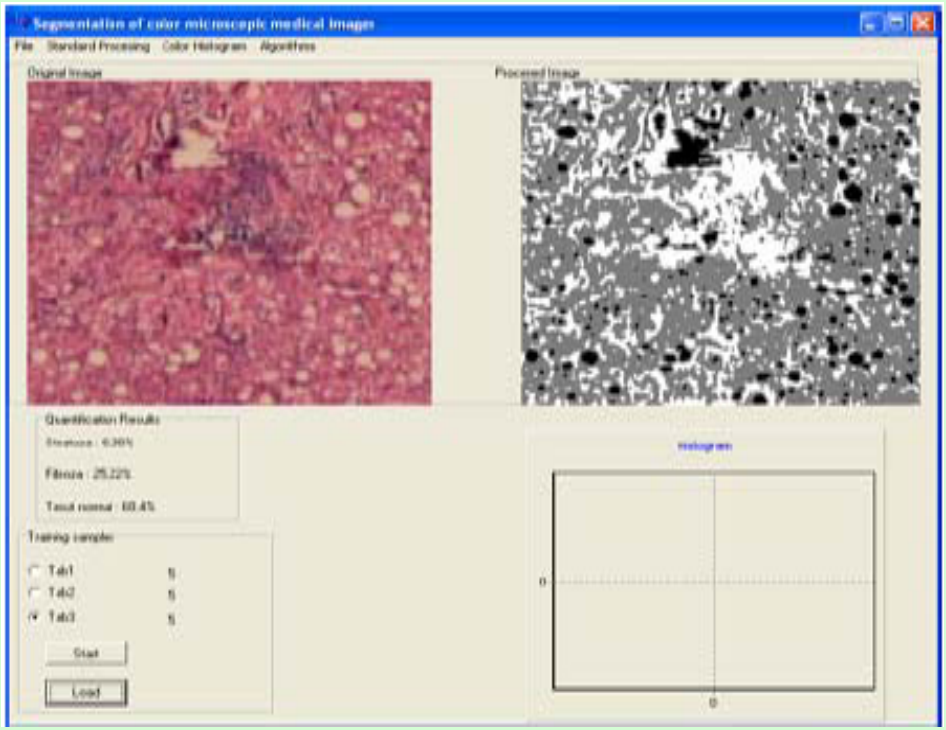


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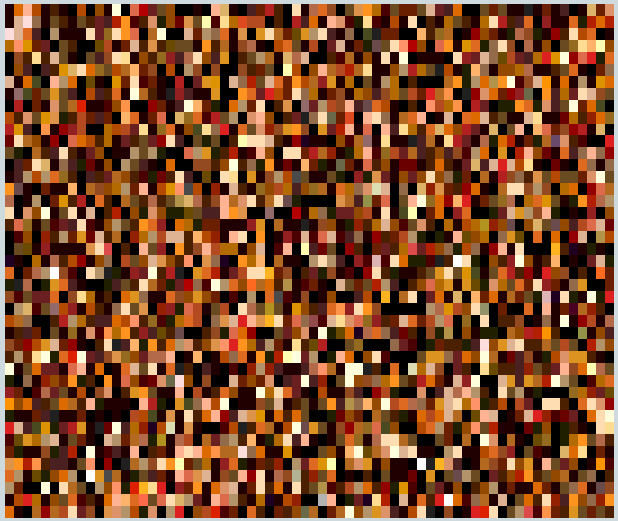
Image Characteristics

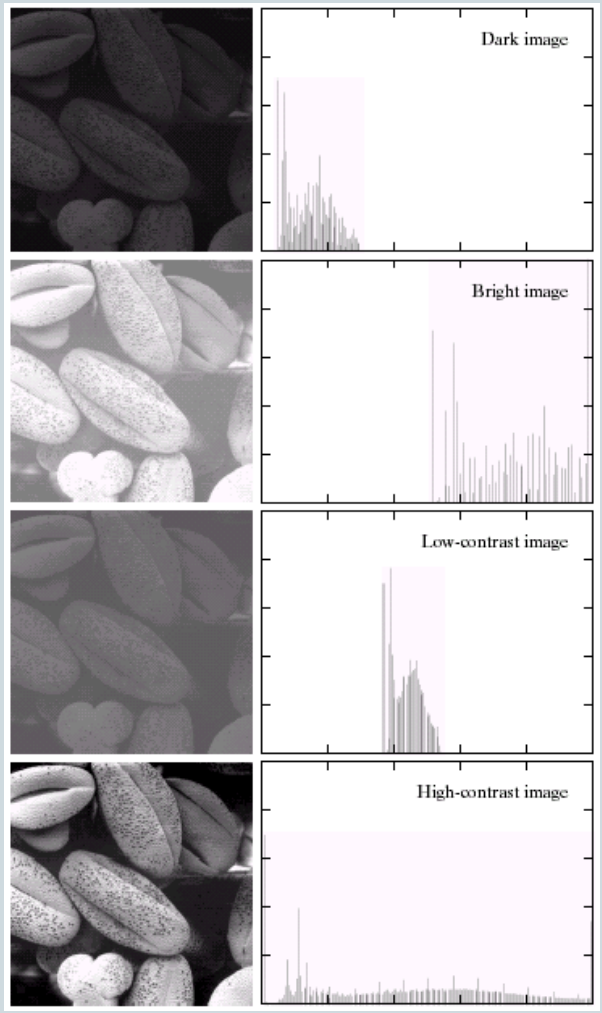
Average

Standard Deviation

Histogram

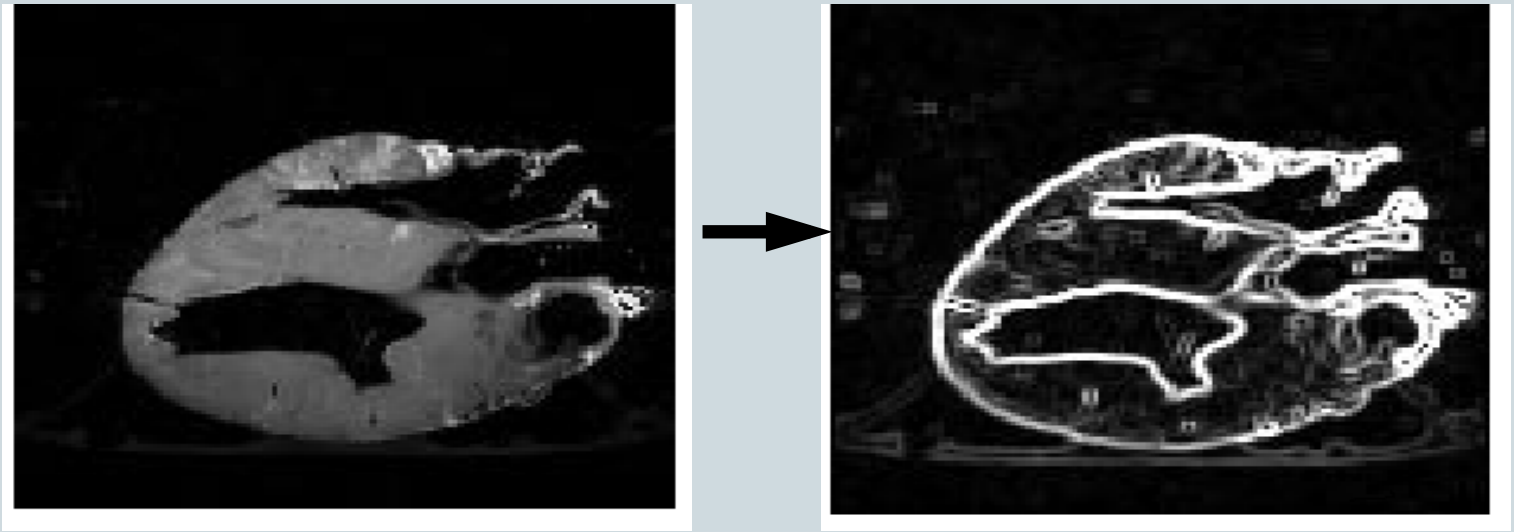


Histogram equalization



Edge Detection

- MRI scan of canine heart and find boundaries between types of tissue
  - Image with gray levels representing tissue density
  - Use a suitable filter to highlight edges



… Obviously, *digital image processing* is a very wide field, sooo…

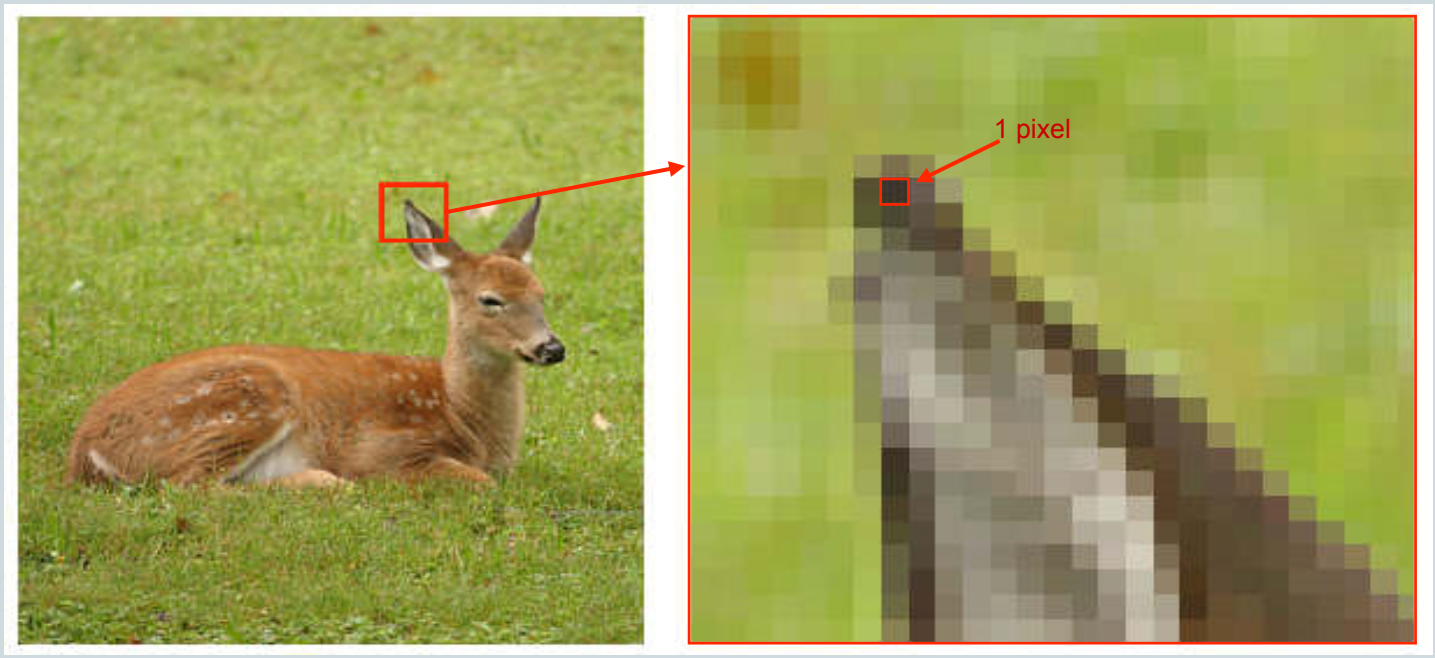
What will we study in 1 semester?

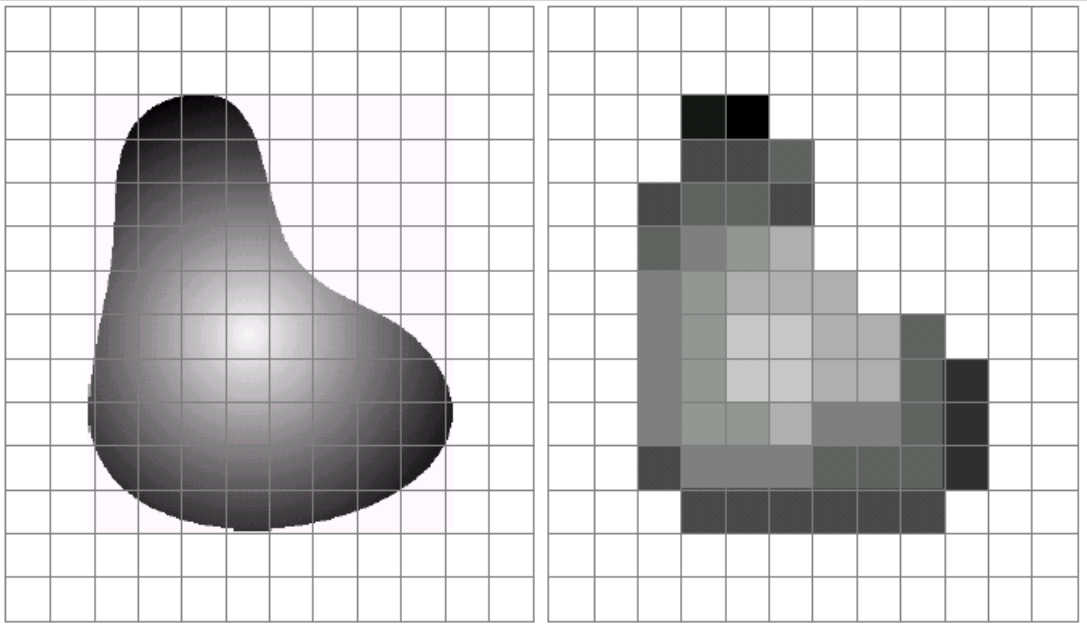
• *Simplification:*
  - mostly grey level images
  - mostly basic processing methods, without their combination

Contents

Image Processing

- How do you represent an image?
  - Number of divisions?
  - Number of values?
  - Data size?
  - Access data?


1 pixel



a b

FIGURE 2.17 (a) Continuos image projected onto a sensor array. (b) Result of image sampling and quantization.

Exercise 1

- Install (some of) these programs in your computer!
- Next week, we can go over main problems!
- And start playing with images!