Medical Image Analysis
Course FMAN30,
Study period 2, 2016

Kalle Åström
Centre for mathematical Sciences
Lund University
• Mathematical imaging group
  – http://www2.maths.lth.se/matematiklth/vision/

• Cardiac MR Group
  – http://www.med.lu.se/klinvetlund/klinisk_fysiologi/forskning/cardiac_mr_group
Learning objectives

• **Describe** different image acquisition techniques used in medical imaging, e.g. Röntgen, CT, MR, ultrasound, PET, Scint and SPECT.

• **Explain** and **use** medical image analysis algorithms to perform registration, segmentation and classification.

• **Decide** on appropriate algorithms for solving medical image analysis problems.

• **Implement** automated medical analysis systems.

• **Validate** the results of automated medical analysis systems.
Topics

• Introduction, validation, databases, dicom
• Ethics, regulatory aspects
• Image registration
• Image segmentation
• Machine learning
• Invited talks
  – For example: Helene Fransson – Medviso, Karl Sjöstrand – Exini Diagnostics, Olof Jarlman – Region Skåne, Kent Stråhlén – Cellavision
Who are we

- Einar Heiberg
  - Associate professor,
    Numerical Analysis,
    Clinical Physiology,
    Medical Image Analysis
- Anders Heyden
  - Professor, Mathematics,
    Image Analysis
- Niels Christian Overgaard
  - Associate professor,
    Mathematics, Image
    Analysis
- Kalle Åström
  - Professor, Mathematics,
    Image Analysis
- Helen Fransson
  - Medviso
- Karl Sjöstrand
  - Exini
    Diagnostics
- Olof Jarlman
  - Region
    Skåne
- Kent Stråhlén
  - Cellavision
Teaching form

- Lectures (16 lectures)
- 4 assignments
  - Assignments
  - Dates, times and room for supervision on assignments will be posted on the homepage
- Oral exam
- Grade based on assignments and oral exam?
Course material

- Website, homepage
  - http://www.maths.lth.se/course/medim/2016/
- Lecture notes
  - On website:
- Assignments
- Schedule
Examples
Detection and Diagnosis of Kidney Lesions
Scandinavian Conference on Image Analysis, 2011

<table>
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<th></th>
<th>LDA</th>
<th>QDA</th>
<th>ANN</th>
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<tbody>
<tr>
<td>Area under ROC curve (AUC)</td>
<td>0.964</td>
<td>0.935</td>
<td>0.960</td>
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<tr>
<td>Sensitivity (%)</td>
<td>96.5</td>
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<tr>
<td>Specificity (%)</td>
<td>84.8</td>
<td>61.2</td>
<td>83.4</td>
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<tr>
<td>Positive Predictive value (%)</td>
<td>35.0</td>
<td>17.4</td>
<td>32.9</td>
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<td>Negative Predictive value (%)</td>
<td>99.7</td>
<td>99.5</td>
<td>99.6</td>
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<tr>
<td>Mis-classification rate (%)</td>
<td>14.2</td>
<td>36.0</td>
<td>15.6</td>
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Hep-2 Staining Pattern Classification
Petter Strandmark, Johannes Ulén and Fredrik Kahl.
International Conference on Pattern Recognition (ICPR) 2012, Tsukuba Japan.

- Generate a lot of features using standard image processing techniques.
- Let machine learning algorithm handle the potential over fitting.
- We use random forest which is fast to train and extremely fast to classify, 50μs.
- High accuracy and confidence on each classification.
- The confidence measure can be used in semi-supervised setup.

Examples of the six different staining patterns.

Accuracy as a function of reject rate. We can remove the result we are most uncertain of. 11.1% removed give perfect result.
Diagnosis of Pulmonary Embolism
European Journal of Nuclear Medicine, 2000

ROC

The area is 85.5706 % of the total area.
Segmentation – shape variation methods
Understanding both appearance and shape
SCINT - Heart
Segmentation results
Exini Diagnostics
MR – knee injuries
SPECT – brain (dementia)
# Gated SCINT - heart

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<td>201 ml</td>
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<td>22 ml</td>
<td>186 ml</td>
<td>72 ml</td>
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Longitudinal expansion of left ventricle
Masters thesis suggestion of the day

- Detection and grading of cancer in histopathological images
- Pathological samples
- Staining
- Scanning
- High resolution
- GB sized images
- Large field of view