Master’s Programme in Image Analysis and Machine Learning

Programme Presentation Session

Department of Information Technology
Uppsala University
HT2021
Presentation of the programme and the individual courses, 10:00-11:00
10:00-10:20 Programme overview - Nataša
10:20-10:25 Data, Ethics and Law - Mikael
10:25-10:50 Introduction to Image Analysis and all the remaining courses - Nataša

(Break)

11:00-11:20 Practical issues - Olga
11:20-11:30 Presentation of UTN
11:30-12:00 Further information, Q&A
Homework

• **Schedule** your individual meeting with Nataša and Olga
  – Fill in the Doodle!

• **Prepare** for your individual meeting
  – Read the [syllabus of the Programme](#)
  – Read the [outline of the Programme](#)
  – Think of a course plan that would suit you!

• Make a draft of your ISP (fill in the template) and “bring it” to the individual meeting.
  – After the individual meeting, finalize the ISP and mail it to Nataša and Olga. Olga will register your courses to Ladok.
Master’s programme in Image Analysis and Machine Learning

Contribute to the visual intelligence of the machines of tomorrow – teach computers to make efficient and intelligent use of visual information!

Help medical doctors plan surgeries to fit each individual patient, ...

...support pathologists in detecting and curing cancer or rare diseases,...

...assist archaeologists and historians in analysing huge archives of historical documents,...

..or contribute to the development of robots who can see and understand human feelings.
Take a look at the IT20 events...

Ginevra Castellano on AI for Social Robotics (in English)
https://media.medfarm.uu.se/play/kanal/520/video/9762

Erik Vidholm on Medical Image Processing (in Swedish)
https://media.medfarm.uu.se/play/kanal/520/video/9418

Carolina Wåhlby on Image Processing in Life Sciences (in Swedish)
https://media.medfarm.uu.se/play/kanal/520/video/9419

Elisabeth Wetzer on AI in Medicine (in English)
https://media.medfarm.uu.se/play/kanal/520/video/9761
The program - summary

**Content:** State-of-the-art deep and machine learning approaches for image and video analysis, as well as modern image processing methods.

**Approach:** Students will have an opportunity to build a strong theoretical foundation, as well as learn best practices of utilisation of the latest and most effective tools and methods for visual data analysis in a variety of applications.

**Career paths:** Training for careers in industry, in many companies in a need of deep and machine learning, image and video analysis, as well as in research-oriented institutions, towards a continued academic career.
Programme

Specialisations:
- Medical IA
- IA for Life Sciences
- IA for Digital Humanities
- Visualisation
- Social robotics

Bridging courses

Image analysis

Machine learning

Applications

Machine learning for Image analysis

Spec.1 Spec.2 Spec.3 Spec.4 Spec.5

Master thesis
Pedagogical approach

Active student-centered learning

Teaching methods combine lectures, practical work for hands-on experience related to the theoretical concepts, seminar discussions, study visits, project work in real industrial environment, oral and written presentations, team working, project management
<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
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</thead>
<tbody>
<tr>
<td><strong>Introduction to image analysis (10hp)</strong></td>
<td><strong>Specialisations (7.5hp)</strong></td>
</tr>
<tr>
<td>Data ethics &amp; law (5hp)</td>
<td>• Digital imaging systems</td>
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<td>• Social robotics and human robot interaction</td>
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<tr>
<td><strong>Bridging courses (10hp)</strong></td>
<td>**Theoretical foundation of data science/</td>
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<tr>
<td></td>
<td>Data Engineering I, 7.5</td>
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<td><strong>Advanced probabilistic machine learning 7.5hp</strong></td>
<td><strong>Deep learning for image analysis (7.5hp)</strong></td>
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<tr>
<td><strong>Software development project in image analysis and machine learning (15hp)</strong></td>
<td><strong>Master project (E) (30hp)</strong></td>
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The red thread

Master project (and degree) in Image Analysis and Machine Learning (30hp)

Specializations in Image Analysis and Machine Learning (15 hp)
Software development project in image analysis and machine learning (15hp)
Deep Learning for Image Analysis (7.5hp)
Data, Ethics and Law (5hp)
Statistical Machine Learning (5hp)
Introduction to Image Analysis (7.5hp)
Programming II
Linear Algebra II
Multivariate Calculus
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<td>• Intelligent interactive systems</td>
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<td>Software development project in image analysis and machine learning (15hp)</td>
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</table>
Bridging courses (so far)

- Computer Programming II
- Linear Algebra II
- Multivariate Calculus

Make sure that you cover(ed) them all!
Specialisations
included courses

**Image Analysis (Medical, Biomedical, Humanities)**
- Digital imaging systems
- Advanced image analysis

**Visualisation**
- Computer graphics
- Scientific visualisation

**Social Robotics**
- Social robotics and human robot interaction
- Intelligent interactive systems
### Specialisations, prerequisites

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<th><strong>Image Analysis (Medical, Biomedical, Humanities)</strong></th>
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<th><strong>Social Robotics</strong></th>
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<td>• Introduction to image analysis</td>
<td>• Computer programming II</td>
<td>• 60 hp computer science, including human-computer interaction</td>
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<td>• 60 hp computer science, of which min 20 hp in programming/algorithms &amp; data structures</td>
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## Machine Learning Thread with prerequisites

<table>
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<tr>
<th>Statistical Machine Learning</th>
<th>Theoretical foundation of data science/Data Engineering I</th>
<th>Reinforcement learning</th>
<th>Advanced Probabilistic Machine Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Linear algebra II</td>
<td>• Computer programming II</td>
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</tr>
<tr>
<td></td>
<td>• Scientific computing, bridging</td>
<td>• Computer Programming II</td>
<td>• Calculus II</td>
</tr>
<tr>
<td></td>
<td>• Database design I</td>
<td></td>
<td>• Statistical Machine Learning</td>
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Bridging courses to select from

**Bridging, Period 1**

- 1TD722 Computer programming II
- 1MA323 Linear algebra II (master)
- 1TD045 Scientific computing
- 1DL210 Algorithms and Data structures I
- 1DL301 Database design I

**Bridging, Period 2**

- 1MA324 Multivariate calculus (master)
- 1TD184 Optimisation
- 1MA211 Fourier Analysis
- 1DL231 Algorithms and Data structures II
- 1MS035 Inference theory I
- 1DL301 Database design I
- 1MD016 Human-computer interaction
Homework

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**ISP template**

**Individual study plan Autumn 2021**

**Program: TBA2M, Master’s Programme in Image Analysis and Machine Learning**

**Name:**

**P/T number:**

**Fee-paying:**

**Arrival in Sweden:**

<table>
<thead>
<tr>
<th>Name of course</th>
<th>Credits</th>
<th>Course code</th>
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</thead>
<tbody>
<tr>
<td>Introduction to Image Analysis</td>
<td>10</td>
<td>1MD110</td>
</tr>
<tr>
<td>Data, Ethics and Law</td>
<td>5</td>
<td>1D002</td>
</tr>
<tr>
<td>Statistical Machine Learning</td>
<td>5</td>
<td>1RT700</td>
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Place and date
Master’s Programme in Image Analysis and Machine Learning

Course Presentation Session

Department of Information Technology
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HT2021
Introduction to Image Analysis  https://uppsala.instructure.com/courses/47186
Data, Ethics, and Law  https://uppsala.instructure.com/courses/43731
Statistical Machine Learning  https://uppsala.instructure.com/courses/24666
(or  https://uppsala.instructure.com/courses/44706 )

Computer Programming II  https://uppsala.instructure.com/courses/52938
Scientific Computing, Bridging  https://uppsala.instructure.com/courses/43691
Database design I  https://uppsala.instructure.com/courses/44914
Algorithms and Data Structures I  https://uppsala.instructure.com/courses/43598
Algorithms and Datastructures II  https://uppsala.instructure.com/courses/43599
Human-computer interaction  https://uppsala.instructure.com/courses/44401
Optimization  https://uppsala.instructure.com/courses/44457
Video presentations

Data, Ethics and Law
Statistical Machine Learning

Scientific computing, bridging course
Optimization

Inference theory I
Fourier analysis
Linear algebra II
1MD110
Introduction to Image Analysis
- course presentation -

Course syllabus
https://www.uu.se/en/admissions/master/selma/kursplan/?kpid=41724&type=1

Studium
https://uppsala.instructure.com/courses/47186

Nataša Sladoje
natasa.sladoje@it.uu.se
http://www.cb.uu.se/~natasa/
Motivation and Content

Images are a very rich source of information. Images are also appealing to our visual system.

We will learn about methods and algorithms which enable efficient automated extraction and analysis of information from image data.

We will discuss how these algorithms can be applied in real scenarios, in industry, healthcare, and research.
We will discuss a number of relevant and interesting topics:

• Representation of images in a computer, sampling, interpolation, colour.
• Pointwise analysis, frequency analysis.
• Image enhancement and image restoration.
• Mathematical morphology, discrete geometry, combinatorial optimization.
• Image segmentation.
• Feature extraction, shape and texture analysis.
• Image registration and motion analysis.
• Computer vision, 3D geometry.
• Classification and decision theory.
• Experimental design and evaluation.


**During the course**

10 credits

**Period 1&2** (September – January)

**Language of instruction:** English

**Entry requirements:** 120 credits including 30 credits maths and 30 credits computer science. Introductory programming, statistics and probability theory, linear algebra, and calculus.

**Instruction:**
16 lectures
2 seminar sessions
5 computer labs (teams of 2) in MATLAB
1 mini-project (teams of 2)

**Assessment:**
Written exam: 5 credits.
Assignments (labs, mini-project): 5 credits.

**Course literature:**
- Own material (lecture notes)
After the course

Year 1, Period 3  Digital Imaging Systems, 7.5 credits (1MD130)
Year 1, Period 4  Deep Learning for Image Analysis, 7.5 credits (1MD120)
Note: Important to take 1MD120 after 1MD110, if you want a complete picture of modern image analysis!

Year 2, Period 1&2  Software Development Project in Image Analysis & Machine Learning, 15 credits
Year 2, Period 2  Advanced Image Analysis, 7.5 credits
Year 2, Period 3&4  Degree project in Image Analysis & Machine Learning, 30 credits
Bridging courses

PERIOD 1

- Algorithms & Data Structures I
- Computer Programming II
- Database Design I
- Linear Algebra II
- Scientific Computing, bridging course
Bridging courses

PERIOD 2

Human-Computer Interaction
Algorithms & Data Structures 2
Fourier Analysis
Inference Theory I
Several Variable Calculus
Optimization