Machine Learning

DD2421, 7.5 credits

Atsuto Maki, Bob Sturm, Jörg Conradt

Spring, 2021

The aim of the course is to provide:

- basic knowledge of the most important algorithms and theory that form the foundation of machine learning
- a practical knowledge of machine learning algorithms and methods

Course contents:

- Lectures 1–11
- Lecture 12, mini lectures
- Labs 1–3 (**NB. there is a deadline for each**)
- Programming challenge ($\rightarrow$ points contribute to your exam)
- Written exam

DD2421 is:

- Compulsory for the Masters Programme in Machine Learning
- Prerequisite for DD2434 Machine Learning, Advanced Course

Intended outcomes – students will be able to:

- describe the most important algorithms and the theory that constitutes the basis for machine learning and artificial intelligence
- explain the principle for machine learning and how the algorithms and the methods can be used
- discuss advantages with and limitations of machine learning for different applications

in order to be able to identify and apply appropriate machine learning technique for classification, pattern recognition, regression and decision problems.

Recommended reading

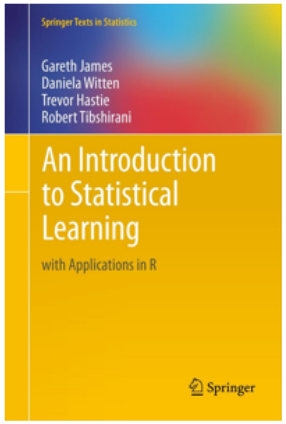
Gareth James, Daniela Witten,
Trevor Hastie and Robert Tibshirani

An Introduction to Statistical Learning

Springer, 2013

Available online:

https://faculty.marshall.usc.edu/gareth-james/ISL/



Recommended reading

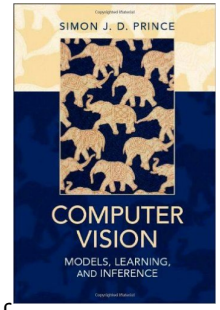
Simon Prince

Computer Vision: Models, Learning, and Inference

Cambridge University Press, 2012

Available online:

web4.cs.ucl.ac.uk/staff/s.prince/book/book.pdf



NB. Pointers to other reference materials under Lectures page.

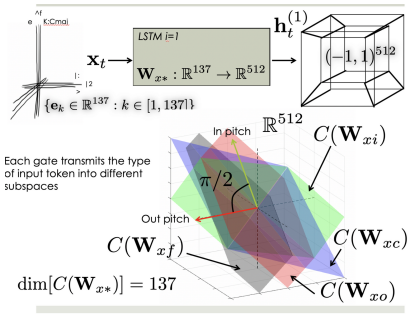
Who are teaching?

- **Atsuto Maki**
  Div. Robotics, Perception, and Learning
- **Bob L. T. Sturm**
  Div. Speech, Music, and Hearing
- **Jörg Conradt**
  Div. Computational Science and Technology

- Course Assistant: **Alexander Kozlov**
  Div. Computational Science and Technology
- 10+ teaching assistants (the majority is PhD students)

Bob Sturm

Research topics: Machine Music Listening, AI for Music Creation, Machine Learning Evaluation



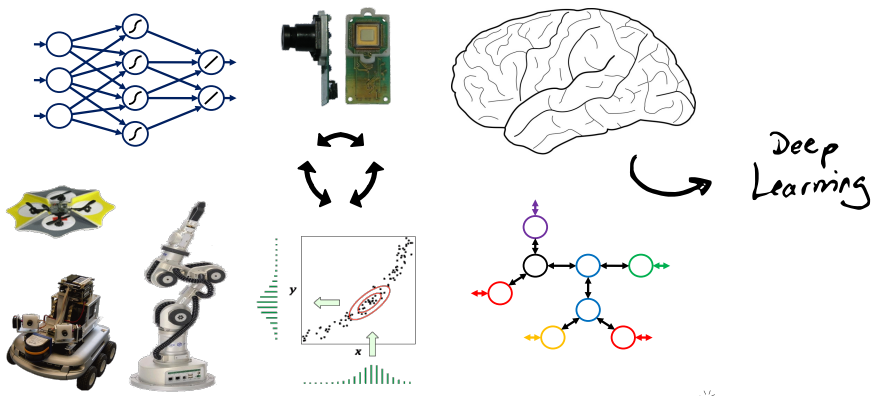
input : music
data processing

https://youtu.be/EC1TrQzBVSE

DT2470 "Music Informatics"

Jörg Conradt

Research Topic:
Neural Computation for Real-Time System Engineering

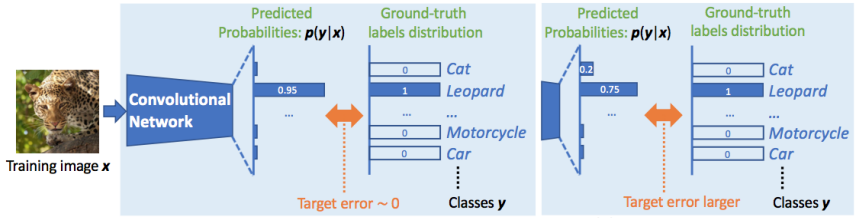


http://neurocomputing.systems

NCS

Atsuto Maki

Research topics: Computer Vision, Machine/Deep Learning



https://robotics.sciencemag.org/content/4/30/eaaw1329.full

https://www.kth.se/profile/atsuto

Course Information on Canvas

`https://kth.instructure.com/courses/22007`

Course Information on KTH Social

`https://www.kth.se/social/course/DD2421/`
`https://www.kth.se/social/course/DD2421/calendar/`
`https://www.kth.se/social/course/DD3431/`

calendar

Course registration needed!

Any inquiries to student office / service center (Email:service@eecs.kth.se).

For administrative questions please consult this page: www.kth.se/en/eecs/studentsupport

Lectures

1. Nearest Neighbour Classifier (Memory-based)
2. Decision Trees (Logical inference)
3. Challenges in Machine Learning
4. Regression
5. Probabilistic Methods
6. Learning as Inference
7. Learning with Latent Variables
8. Support Vector Machines
9. Artificial Neural Networks
10. Ensemble Methods
11. Dimensionality Reduction
12. Mini lectures (beyond the scope of DD2421), exam Q&A

questions about the yearning exam

Labs (3.5 credits)

1. Decision Trees
2. Support Vector Machines
3. Bayes Classifier & Boosting

10 days to complete labs

published on Canvas progressively

- labs are carried out by students and examined by TAs
- use Canvas to book time slots before the deadlines

Examination:

- It is your task to convince the examiner that you have done the assignment and understood the results.
- Strongly encouraged to work+report by pairs of two students (not 3).
- 10 minutes, **be there on time**.
- No programming code to be shown
- Bring your ID (tell the TA if you are yet to be registered)

schedule a 10 min in-person meeting when you're ready

Examination (4 credits)

A written "take-home" examination, not an in-class exam.
Date: Friday 19 March 14:00-18:00 (time to be finalised)

Exam Registration in advance!

https://www.kth.se/form/exams
Registration opens Tuesday February 9 and closes Tuesday February 23, 23:59

Chance for re-exam (on June 12).

register for on-line exam !

Examination (4 credits) cont'ed: a programming challenge.

Build and train a classifier given a labeled dataset.
Use it to infer the labels of a given unlabeled evaluation dataset.

Submit the inferred labels - will be compared to the ground truth.
Planned schedule (one week): ~~12-18 March~~ 18-24 OCTOBER
The accuracy is proportional to the point you receive.

Logistics found on Canvas:
https://canvas.kth.se/courses/22007/assignments/144318

FAQ

Q. Are course slides available?

A. Will be uploaded on the "Lectures" page on Canvas.

Q. Could we make a group of 3 students for the lab?

A. No – the slot is too short to examine three students.

Q. Can you register me to the course, please?

A. Please consult student office/service center: service@eecs.kth.se

Miscellaneous

Message board available on "Discussion" on KTH Canvas
(but bear with us – teachers cannot promise to respond :-)).

A form to get a KTH-account available at the reception of EECS
(for PhD-students from other universities). See instructions:
https://intra.kth.se/en/eecs/forskarutbildning/courses

Kursnämnd: It will be a great pleasure to have students' course committee (a.k.a. kursnämnd). Anyone volunteers, please?

↳ communication between professors and alumni.

Applications

Sample Applications

- Image recognition / Computer vision
- Speech recognition and synthesis
- Natural language processing
- Autonomous robots
- Spam-filter for e-mail
- ...

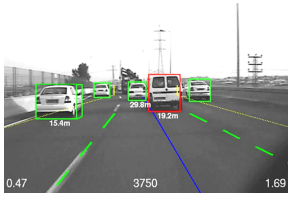
Where is machine learning useful?

A pattern exists

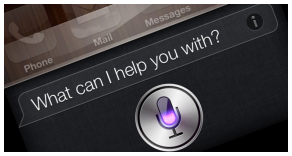
Data available for training

Hard/impossible to define rules mathematically

Driving assistants
(Google, Toyota, Volvo, . . .)



Personal assistants
(Apple Siri, Amazon Eco, . . .)



Board games
(DeepMind AlphaGo)

Types of Learning

- **Supervised Learning** (covered)
  - Function approximation
  - Well-defined problem. Battle-tested in industrial applications.
- **Unsupervised Learning** (briefly covered)
  - Clustering, dimensionality reduction, density estimation
  - Primarily used for preprocessing and exploratory data analysis
- **Reinforcement Learning** (not covered)
  - Behavior Selection: useful for learning how to act or behave when given occasional reward or punishment signals.
  - Consider how a baby learns to walk for instance.
- **Evolutionary Learning** (not covered)
  - General Purpose Optimization

Supervised vs Unsupervised learning paradigms

Conflates two different distinctions:

- **Supervised Learning**, a.k.a. predictive
  - Learning mappings from A to B.
    (Neutral mathematics.)
  - Learning from human supervision: B was provided by a human teacher, as in “This is a dog”.
    (Not scalable and biologically implausible.)
- **Unsupervised Learning**, a.k.a. descriptive
  - Analyzing unstructured raw data. There is no B, only A.
  - Learning without human supervision.
    (Scalable and biologically plausible.)