Course syllabus

Machine Learning
Maskininlärning

FMAN45, 7.5 credits, A (Second Cycle)

Valid for: 2024/25
Faculty: Faculty of Engineering LTH
Decided by: PLED F/Pi
Date of Decision: 2024-04-15
Effective: 2024-05-08

General Information

Main field: Machine Learning, Systems and Control **Depth of study relative to the degree requirements:** Second cycle, in-depth level of the course cannot be classified
Elective mandatory for: MMSR1
Elective for: BME4, C4-pvt, C4-pvs, D4-bg, D4-mai, D4-se, E5, F4, F4-bs, F4-bg, F4-r, F4-mai, I4, L4-gi, Pi4-bam
Language of instruction: The course will be given in English on demand

Aim

The aim of the course is to establish a solid foundation in the principles and methods of machine learning, based on pertinent knowledge from mathematics, statistics, and optimization.

Additionally, the course seeks to provide insight into advanced techniques within modern machine learning.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to account for the statistical principles used in machine learning
- be able to describe the scientific basis for the design and analysis of learning algorithms and systems
- demonstrate in-depth knowledge of methods and theories in the field of machine learning.

Competences and skills
For a passing grade the student must

- have demonstrated the abilitiy to develop learning techniques and learning systems for relevant technological problems
- have demonstrated the ability to identify, formulate, design, and implement learning components and applications.

Judgement and approach
For a passing grade the student must

- have demonstrated the ability to critically evaluate and compare different learning models and learning algorithms for different problem setups and quality characteristics.

Contents

- Training, testing, generalization, hypothesis spaces
- Linear regression and classification
- Optimization techniques and statistical tools for learning
- Neural networks, convolutional neural networks and deep learning
- Recurrent neural networks, transformers and reinforcement learning
- Clustering, autoencoders and generative models

Examination details

Grading scale: TH - (U, 3, 4, 5) - (Fail, Three, Four, Five)
Assessment: Compulsory assignments including computer work and written reports. Approved results on these are enough to pass the course. To get a higher grade, the student also has to pass an oral examination. For those who do not get all the assignments approved during the course there will be a chance to hand in improved versions during the following semester.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Modules
Code: 0116. **Name:** Machine Learning.
Credits: 7.5. **Grading scale:** TH - (U, 3, 4, 5). **Assessment:** For the grade 3 it is required to pass on all the assignments. For a higher grade one also has to study one or more individually assigned articles and be able to explain them sufficiently well at a seminar.

Admission

Admission requirements:

- FMAF05 Mathematics - Systems and Transforms **or** FMAF10 Applied Mathematics - Linear systems

Assumed prior knowledge: FMAF05 Mathematics - Systems and Transforms or FMAF10 Applied Mathematics - Linear Systems, and one of the basic courses in Mathematical Statistics, e.g. FMSF45.
The number of participants is limited to: 110
Selection: Completed university credits within the program. (Note that only credits which according to Ladok have been included in the program before the selection process count. For students taking master's programmes 180 credits corresponding to a bachelor's degree are added.) Priority is given to students enrolled on programmes

that include the course in their curriculum. Among these students place is guaranteed to those in the master's programme in Machine Learning, Systems and Control, for whom the course is compulsory.
Kursen överlappar följande kurser: EDAN96 BMEN35

Reading list

- Bishop, C. M: Pattern Recognition and Machine Learning. Springer, 2006, ISBN: 9780387310732. Reference text. https://www.microsoft.com/en-us/research/people/cmbishop/prmlbook/
- I. Goodfellow, Y. Bengio & A. Courville: Deep Learning. MIT press, 2016, ISBN: 978-0-262-03561-3. Reference text. http://www.deeplearningbook.org/
- T. Hastie, R. Tibshirani & J. Friedman: The Elements of Statistical Learning: Data Mining, Inference, and Prediction - 2nd edition. Springer, 2009, ISBN: 9780387848570. Reference text. https://web.stanford.edu/~hastie/Papers/ESLII.pdf
- Sutton, Richard S: Reinforcement learning : an introduction. Cambridge, MA : The MIT Press, 2018, ISBN: 0262039249. Reference text. http://incompleteideas.net/sutton/book/the-book-2nd.html
- Mikael Nilsson: Mostly self-contained. Will be available via the course home page during the course.

Contact

Course coordinator: Anders Holst, studierektor@math.lth.se
Teacher: Mikael Nilsson, mikael.nilsson@math.lth.se
Course administrator: Studerandeexpeditionen, expedition@math.lth.se
Course homepage: https://canvas.education.lu.se/courses/20372