



Course syllabus

Optimering för maskininlärning Optimization for Learning

FRTN50, 7,5 credits, A (Second Cycle)

Valid for: 2023/24 Faculty: Faculty of Engineering, LTH Decided by: PLED F/Pi Date of Decision: 2023-04-18

General Information

Elective for: D5-mai, E4, F5, F5-r, F5-mai, I4-fir, M4, Pi5-ssr, MMSR2 **Language of instruction:** The course will be given in English

Aim

Learning from data is becoming increasingly important in many different engineering fields. Models for learning often rely heavily on optimization; training a machine is often equivalent solving a specific optimization problem. These problems are typically of large-scale. In this course, we will learn how to solve such problems efficiently. The large-scale nature of the problems renders traditional methods inapplicable. We will provide a unified view of algorithms for large-scale convex optimization and treat algorithms for the nonconvex problem of training deep neural networks.

Learning outcomes

Knowledge and understanding For a passing grade the student must

- know basic convex analysis
- understand the connection between machine learning and optimization
- have an understanding on the role of regularization in learning from an optimization point of view
- understand unifying framework for large-scale convex optimization
- understand concepts such as nonexpansiveness, and averagedness and their relation to monotone operators and their role for convergence of algorithms
- understand how to derive specific algorithms from the few general ones

• understand methods for avoiding numerical issues in deep neural network training.

Competences and skills

For a passing grade the student must

- be able to describe optimality conditions that are useful for large-scale methods
- be able to describe the building blocks that are the foundations of large-scale optimization algorithms and why they are used
- be able to analyze performance of optimization algorithms
- be able to solve optimization problems numerically using software and own implementations
- be able to present results in writing.

Judgement and approach

For a passing grade the student must

- understand what algorithm that should be used for different machine learning training problems
- be able to participate in the team-work needed to solve the hand-in assignments.

Contents

The course has lectures, exercises, and four hand-in assigments.

The lectures will cover:

convexity, models for learning, unified convex optimization algorithm view, fixedpoint iterations, monotone operators, nonexpansive mappings, stochastic methods, reduced variance methods, block-coordinate methods, nonconvex stochastic gradient descent and variations for for deep learning training.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five) **Assessment:** Written exam (5 hours), 3 hand-in exercises. In case of less than 5 registered students, the exam may be given in oral form.

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.

Parts

Code: 0121. Name: Exam. Credits: 7,5. Grading scale: TH. Code: 0221. Name: Hand-in 1. Credits: 0. Grading scale: UG. Code: 0321. Name: Hand-in 2. Credits: 0. Grading scale: UG. Code: 0421. Name: Hand-in 3. Credits: 0. Grading scale: UG.

Admission

Assumed prior knowledge: FMAN61 Optimization The number of participants is limited to: 90 Selection: Completed university credits within the programme P

Selection: Completed university credits within the programme. Priority is given to students enrolled on programmes that include the course in their curriculum.

Reading list

• Lecture slides and notes.

Contact and other information

Course coordinator: Pontus Giselsson, pontusg@control.lth.se Director of studies: Björn Olofsson, bjorn.olofsson@control.lth.se Course homepage: http://www.control.lth.se/course/FRTN50 Further information: A student who has been offered a seat in the course must confirm his/her participation within a week, or else the seat will be offered to the next student according to the selection criteria.