CS-439 **Optimization for machine learning**

Jaggi Martin

Cursus	Sem.	Type
Computational science and Engineering	MA2, MA4	Opt.
Computer science	MA2	Opt.
Cybersecurity	MA2	Opt.
Data Science	MA2, MA4	Obl.
Data science minor	E	Opt.
Electrical Engineering		Obl.
SC master EPFL	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course teaches an overview of modern optimization methods, for applications in machine learning and data science. In particular, scalability of algorithms to large datasets will be discussed in theory and in implementation.

Content

This course teaches an overview of modern optimization methods, for applications in machine learning and data science. In particular, scalability of algorithms to large datasets will be discussed in theory and in implementation.
Basic Contents:
Convexity, Gradient Methods, Proximal algorithms, Stochastic and Online Variants of mentioned methods, Coordinate Descent Methods, Subgradient Methods, Frank-Wolfe, Accelerated Methods, Primal-Dual context and certificates, Lagrange and Fenchel Duality, Second-Order Methods, Quasi-Newton Methods. Gradient-Free and Zero-Order Optimization.
Advanced Contents:
Parallel and Distributed Optimization Algorithms, Synchronous and Asynchronous Communication.
Lower Bounds.
Non-Convex Optimization: Convergence to Critical Points, Saddle-Point methods, Alternating minimization for matrix and tensor factorizations
An optional, graded, mini-project allows to explore the real-world performance aspects of the algorithms and variants of the course.

Keywords

Optimization, Machine learning

Learning Prerequisites

Recommended courses

- CS-433 Machine Learning

Important concepts to start the course

- Previous coursework in calculus, linear algebra, and probability is required.
- Familiarity with optimization and/or machine learning is useful.

Learning Outcomes

By the end of the course, the student must be able to:

- Assess / Evaluate the most important algorithms, function classes, and algorithm convergence guarantees
- Compose existing theoretical analysis with new aspects and algorithm variants.
- Formulate scalable and accurate implementations of the most important optimization algorithms for machine learning applications
- Characterize trade-offs between time, data and accuracy, for machine learning methods

Transversal skills

- Use both general and domain specific IT resources and tools
- Summarize an article or a technical report.

Teaching methods

- Lectures
- Exercises with Theory and Implementation Assignments

Expected student activities

Students are expected to:

- Attend the lectures and exercises
- Give a short scientific presentation about a research paper
- Read / watch the pertinent material
- Engage during the class, and discuss with other colleagues

Assessment methods

- Final Exam

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

No

Websites

- https://github.com/epfml/OptML_course