Syllabus
High-dimensional statistics and optimization, 6hp

Issued by the WASP graduate school management group *2024-09-30*

Main field of study

AI/math

Course level

Advanced course for PhD students

- AI track: elective
- AS track: elective
- Joint curriculum: advanced

Course offered for

PhD students in the WASP graduate school

Entry requirements

The participants are assumed to be familiar with concepts in mathematics and applied mathematics at the advanced level. Useful concepts are:

- Basic analysis (metric spaces, Hilbert spaces)
- Probability theory (law of large numbers, central limit theorem, Markov chains)
- Statistics (point estimation, hypothesis testing, linear regression)
- Optimization (linear programming, convex analysis, and gradient descent)

Intended learning outcomes

After completed studies, the student is expected to be able to

- provide examples of high-dimensional statistical models and optimization methods and explain the challenges associated with high dimension,
- describe, explain, and compare high-dimensional models and methods in statistics and optimization,
- derive and explain inequalities and concentration of measures in high-dimensional probability theory,
- apply monotone operator theory to derive convergence results for optimization methods,
- apply theoretical concepts and methods in high-dimensional statistics and optimization to solve problems involving high-dimensional data.

Course content

Module 1

1. Introduction to high-dimensional statistics and optimization
2. Background on statistical models, optimization, and iterative methods

Module 2

3. Linear regression in high dimension, Lagrange relaxation and the Hahn-Banach theorem
4. Concentration of measures and Fenchel duality

Module 3

5. Stochastic approximation and Monotone operators
6. Compressed sensing / Random projections / Splitting methods

There is some overlap with the WASP course on Learning Theory (6 hp) on the section on concentration inequalities.

Teaching and working methods

The course is given as three 2-day meetings with teaching on-site, including a mixture of lectures, exercises, and group work. There will be three homework assignments, one for each module. There will be both individual assignments and group assignments. The expected workload is distributed as, roughly, 10% preparation for the meetings, 40% course meetings, and 50% homework.

Examination

Written homework assignments (3).

Grades

Fail or Pass