Summary
This course reviews recent advances in convex optimization and statistical analysis in the wake of Big Data. We provide an overview of the emerging convex formulations and their guarantees, describe scalable solution techniques, and illustrate the role of parallel and distributed computation.

Content
The course consists of the following topics
Lecture 2: Maximum likelihood principle as a motivation for convex optimization. Fundamental structures in convex analysis, such as cones, smoothness, and conjugation.
Lecture 4: Convex geometry of linear inverse problems. Structured data models (e.g., sparse and low-rank) and convex gauge functions and formulations that encourage these structures. Computational aspects of gauge functions.
Lecture 7: Constrained convex minimization-I. Introduction to convex duality. Classical solution methods (the augmented Lagrangian method, alternating minimization algorithm, alternating direction method of multipliers, and the Frank-Wolfe method) and their deficiencies
Lecture 9: Classical black-box convex optimization techniques. Linear programming, semidefinite programming, and the interior point method (IPM). Hierarchies of classical formulations. Time and space complexity of the IPM.
Lecture 14: Role of parallel and distributed computing. How to avoid communication bottlenecks and synchronization. Consensus methods. Memory lock-free, decentralized, and asynchronous algorithms.

Learning Prerequisites
Important concepts to start the course
Previous coursework in calculus, linear algebra, and probability is required. Familiarity with optimization is useful.
Learning Outcomes

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

• Choose an appropriate convex formulation for a data analytics problem at hand
• Estimate the underlying data size requirements for the correctness of its solution
• Implement an appropriate convex optimization algorithm based on the available computational platform
• Decide on a meaningful level of optimization accuracy for stopping the algorithm
• Characterize the time required for their algorithm to obtain a numerical solution with the chosen accuracy

Assessment methods

Homework assignments. (Continuous control)