

CS-435

Analytic algorithms

Vishnoi Nisheeth

Cursus	Sem.	Type
Computer science	MA1, MA3	Opt.
SC master EPFL	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	3 weekly
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

In the last decade, many fundamental algorithmic problems have benefited from viewing the underlying discrete problems through the lens of analytic methods. In this course we will introduce a selection of such techniques and explore their applications.

Content

- # Convexity, Gradient Descent and its variants
- # Multiplicative Weight Update method
- # Online convex optimization
- # Interior point methods for solving convex programs
- # Graphs, eigenvalues and Laplacians
- # Electrical and combinatorial flows
- # Conjugate Gradient Method
- # Graph Partitioning and Cheeger's Inequality
- # Ramanujan Graphs and Real Stable Polynomials
- # Applications

Keywords

Convex optimization, Spectral methods

Learning Prerequisites**Required courses**

Calculus (MATH105), Linear Algebra (MATH110), Algorithms (CS250), Theory of Computation (CS251) or equivalents.

Recommended courses

Advanced Algorithms (CS-450)

Important concepts to start the course

This is an advanced course and requires mathematical maturity including linear algebra, analysis, probability and algorithms.

Learning Outcomes

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

- Learn fundamental techniques which apply continuous methods to discrete problems
- Apply analytic techniques to a variety of related problems
- Read, understand, and explain state of the art papers in this area

Assessment methods

Homeworks, Scribe Notes, Exam and Project/Presentation*.

*Tentative

Resources

Bibliography

Books relevant to the course:

Vishnoi - $Lx=b$

Nesterov - Introductory lectures on convex optimization

Shalev-Schwartz - Online learning and online convex optimization

Renegar - A mathematical view of interior point methods in convex optimization

References for Basics:

Apostol - Calculus I and II

Strang - Linear algebra and its applications

Boyd and Vanderberghe - Convex optimization

Strogatz - Nonlinear dynamics and Chaos

Ressources en bibliothèque

- [Convex optimization / Boyd](#)
- [Linear algebra and its applications / Strang](#)
- [Nonlinear dynamics and Chaos / Strogatz](#)
- [Gaussian Hilbert Spaces / Janson](#)
- [Introductory lectures on convex optimization / Nesterov](#)
- [Mathematical view of interior point methods in convex optimization / Renegar](#)
- [Lx=b / Vishnoi](#)
- [Calculus I / Apostol](#)
- [Calculus II / Apostol](#)