

STAT5204 Optimization in Data Science

Term 1, 2025/2026

Lecturer

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Assessment

- a. 20% Four Assignments
- b. 40% One Midterm Test
- c. 40% Final Examination

Reference

Chong, E. K. P., Lu, W., & Zak, S. H. (2024). *An introduction to optimization: with applications to machine learning* (Fifth edition.). John Wiley & Sons, Inc.

Teaching Schedule

Week	Date	Topic	Remarks
1	Sep 5	Basics of Set-Constrained and Unconstrained Optimization, One-Dimensional Search Methods	
2	Sep 12	Gradient Methods, Newton's Method	Assignment 1 Released
3	Sep 19	Conjugate Direction Methods	
4	Sep 26	Quasi-Newton Methods	
5	Oct 3	Linear Programming	Assignment 2 Released
6	Oct 10	Simplex Method	
7	Oct 17	Midterm Test	YIA LT5
8	Oct 24	Problem with Equality Constraints	
9	Oct 31	Problems with Inequality Constraints	Assignment 3 Released
10	Nov 7	Convex Optimization Problems	
11	Nov 14	Duality	
12	Nov 21	Algorithms for Constrained Optimization	Assignment 4 Released
13	Nov 28	Stochastic Gradient Descent Algorithms	
14	Dec 5	Final Exam	YIA LT7

Use of AI Tools by Students in Learning Activities and Assessments

Prohibit all use of AI tools: Students are not allowed to use any AI tools in any kind of learning activity or assessment that will be counted towards students' final grade of the course, or used for evaluating students' attainment of the desired learning outcomes. Students are expected to produce their own work independently without any collaboration or use of AI tools. Such information should be spelt out clearly in the course outline or learning activity/assessment guide.

Description

This course offers an introduction to nonlinear optimization with applications in data science. The theoretical foundation and the fundamental algorithms for unconstrained and constrained nonlinear optimization are studied and applied to the supervised learning models.

Course Content

1. Basics about Optimization: linear optimization, convex optimization, non-linear optimization, constrained optimization.
2. Unconstrained optimization: convex optimization, non-linear optimization, gradient.
3. Constrained Optimization, i.e., equalities constraints – Lagrange multiplier, Inequalities constraints – KKT conditions, duality.
4. Gradient descent: Gradient descent and its variations, stochastic gradient descent and its variations, applications to the machine learning algorithms.