MATP6960 • Accelerations in Optimization • Fall 2026

Time: 10:00–11:50am TF Location: Ricketts Building 208

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Course page:	https://xu-yangyang.github.io/MATP6960.html

Course Objective

This topics course introduces acceleration techniques for first-order optimization methods, with emphasis on the principles behind accelerated algorithms, their convergence and complexity analysis, and their applications in machine learning. After taking the course, you are expected to

1. understand why and when first-order optimization methods can be accelerated;
2. derive and analyze representative accelerated methods for convex and nonconvex optimization;
3. compare acceleration frameworks and select suitable methods for structured optimization problems; and
4. implement accelerated algorithms and evaluate their performance on machine-learning and related applications.

Prerequisites

MATP6600/ISYE6780 or MATP6610 or MATH6800, or permission of the instructor. You should be familiar with calculus, linear algebra, and basic real analysis. Prior exposure to numerical optimization is recommended.

Textbooks

- *Acceleration Methods* by Alexandre d'Aspremont, Damien Scieur, and Adrien Taylor, 2024. (**recommended**)
- *Accelerated Optimization for Machine Learning: First-Order Algorithms* by Zhouchen Lin, Huan Li, and Cong Fang, Springer, 2020. (**recommended**)

- *First-order and Stochastic Optimization Methods for Machine Learning* by George Lan, Springer, 2020. (**recommended**)
- *Nonlinear Programming: theory and algorithms, 3rd edition* by Mokhtar S. Bazaraa, Hanif D. Sherali, and C. M. Shetty, 2006. (**recommended**)
- *Nonlinear Programming* by Dimitri Bertsekas (**recommended**)
- *Convex Analysis* by Rockafellar (**recommended**)
- *Numerical Optimization* by Jorge Nocedal and Stephen Wright (**recommended**)

Additional lecture notes and research papers will be posted on the course page.

Tentative Topics to cover

1. Review of first-order methods, convergence rates, and complexity bounds
2. Acceleration for quadratic optimization and Chebyshev methods
3. Momentum methods: Polyak's heavy-ball method and Nesterov acceleration
4. Estimate sequences and optimized gradient methods
5. Accelerated proximal-gradient methods for composite optimization
6. Proximal-point acceleration, Catalyst, and restart schemes
7. Acceleration for constrained, saddle-point, stochastic, and nonconvex problems
8. Applications of accelerated optimization in machine learning

Assignments and grading policy

- 3-4 projects will be assigned; for each project, a report by LaTex is required to include theoretical solutions, code, numerical results, and observations/discussions
- Each student will be assigned a different paper and required to deliver a presentation based on the assigned paper.
- Projects will account 75% of the total grade and the presentation for 25%.

Attendance

Attendance and participation in class is a vital part of the learning process. Regular class attendance is strongly encouraged. It is the students' responsibility to keep informed of any announcement, or policy changes made through Email.

Academic Integrity

Intellectual integrity and credibility are the foundation of all academic work. A violation of Academic Integrity policy is, by definition, considered a flagrant offense to the educational process. It is taken seriously by students, faculty, and Rensselaer and will be addressed in an effective manner.

If found responsible for committing academic dishonesty, a student may be subject to one or both types of penalties: an academic (grade) penalty administered by the professor and/or disciplinary action through the Rensselaer judicial process described in the Student Rights and Responsibilities Handbook and the Rensselaer Graduate Student Supplement.

Academic dishonesty is a violation of the Grounds for Disciplinary Action as described in the handbook. A student may be subject to any of the following types of disciplinary action should disciplinary action be pursued by the instructor: disciplinary warning; disciplinary probation; disciplinary suspension, expulsion and/or alternative actions as agreed on by the student and hearing officer. It should be noted that no student who allegedly commits academic dishonesty will be able to drop or change the grade option for the course in question and is not eligible to request an F examination for the course.

The academic integrity policy applies to all students, undergraduate and graduate, and to scholarly pursuits and research. Additionally, attempts to commit academic dishonesty or to assist in the commission or attempt of such an act are also violations of this policy.

Disability Services for Students

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