MATP6600/ISYE6780 • Introduction to Optimization • Fall 2023

Time: 12:00-1:50pm TF Location: DCC 236

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Course page:	https://xu-yangyang.github.io/MATP6600.html

Course Objective

This course is to introduce you optimization theory, methods, and applications. An emphasis will be placed on understanding theory and algorithms of nonlinear programming. After taking the course, you are expected to know

1. how to build up an optimization model for applications in areas such as machine and statistical learning, signal and image processing, engineering, and operations research
2. whether a given optimization problem is convex or non-convex and how to relax a non-convex problem into a convex one
3. how to characterize the first-order and/or second-order optimality conditions of an optimization problem and obtain analytic solutions for small-sized problems
4. how to find an approximate solution of an optimization model by applying certain optimization algorithm such as projected gradient descent, augmented Lagrangian method, the Newton's method, coordinate descent method, and recently popular first-order type methods.

Prerequisites

You should be familiar with calculus and linear algebra and have basic knowledge on probability and real analysis.

Textbooks

- *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**)
- *Convex Optimization* by Stephen Boyd and Lieven Vandenberghe (**recommended**)
- *Numerical Optimization* by Jorge Nocedal and Stephen Wright (**recommended**)

Topics to cover

1. Convex sets: definitions, Weierstrass' Theorem, Separation Theorem
2. Convex functions: definitions, subgradients, optimality conditions
3. Linear, convex qudratic, and conic optimization
4. Optimality conditions for constrained optimization: Fritz John and Karush-Kuhn-Tucker (KKT) conditions, constraint qualifications
5. Lagrangian duality and saddle point optimality conditions
6. Classic optimization algorithms and recently popular algorithms

Homework and exams

- **Homework:** 5 in total, approximately once every 2.5 weeks. The homework will be posted in LMS.
- **Exam:** two mid-term exams (tentative dates: Oct-13 and Dec-08)

Evaluation and Grading Policy

All students will be evaluated and graded by the following policy.

1. **Evaluation:** homework $6\% \times 5$, mid-term exam $35\% \times 2$.
2. **Late homework:**
    - Homework that is late up to one day will be penalized by 20%;
    - Homework that is late between one day and two days will be penalized by 40%;
    - No homework will be accepted if it is late more than two days unless you have a special reason (like illness with doctor's note) and notified the instructor at least two days ahead of the due time.
3. **Exam:**
    - No early exam will be taken (more details on how to monitor the exam will be announced).

- A make-up exam will be administered only at the discretion of the instructor in the event of a verifiable emergency. In the event of a verifiable emergency, the student must contact the instructor as soon as possible, and in any case, prior to the next regularly scheduled class.

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 LMS and/or 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.

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.