MATP6600/ISYE6780 • Introduction to Optimization • Fall 2018

Time: 12:00-1:50pm TF   Location: CARNEG210

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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. (**required**)
- *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. Optimization algorithms: gradient descent, Newton's method, interior-point method, and recent first-order and operator splitting methods
7. Integer programming: examples, convex relaxations
8. Stochastic programming: modeling, examples, stochastic approximation methods

Homework and exams

- **Homework:** 6 in total, approximately once every two weeks. The homework will be posted on the course page https://xu-yangyang.github.io/MATP6600.html
- **Exam:** two mid-term exams (tentative dates: Oct-16 and Dec-4)
- **Project:** one final project
- **Grades:** homework 5% $\times$ 6, mid-term exam 20% $\times$ 2, and the final project 30%. **No late homework will be accepted; no make-up exams**

Academic Integrity

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