ESE 533
Convex Optimization and Engineering Applications
Spring 2016

Instructor: Yue Zhao

Time and Location: Wed 10:00am - 1:00pm, Chemistry 126

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Office Hours: Wed and Fri 3:30pm - 5:00pm, or by appointment
(Hours may change. Please check Blackboard for most up-to-date information.)

Overview and Objectives

Convex optimization is a broad area whose development has greatly influenced the solution techniques in many engineering fields. In this course, we will i) learn extensive modeling techniques that transform engineering problems into convex optimization problems, ii) understand foundational theories that allow convex optimization to be solved efficiently, and iii) harness a wide spectrum of algorithms applicable to different types of optimization problems under different practical constraints. Areas of applications include resource allocation and utility maximization in information systems and networks, operation of energy and power systems, machine learning in the era of "big data", statistical estimation and signal processing, computer networking, circuit design, portfolio management, etc. To get hands-on experience, students will select their favorite topics and apply convex optimization tools to solve practical problems as a course project.

3 *credits.*

Recommended Text

- S. P. Boyd and L. Vandenberghe, *Convex Optimization*, Cambridge University Press, Cambridge, UK, 2004 (available online)

We will use CVX, a MATLAB software package for convex optimization.

Course Outline

- Introduction to optimization
- Convex sets, generalized inequalities
- Convex functions
- Convex optimization problems, optimality criterion, linear program, quadratic program, second order cone program, geometric program, semidefinite program

- Duality, KKT conditions, sensitivity analysis
- Unconstrained optimization, first order methods, Newton's method
- Constrained optimization, interior point methods
- Decomposition methods, distributed optimization
- Applications, network utility maximization, power system economic dispatch, machine learning, statistical estimation, experiment design, computer networking, circuit design, portfolio management, etc.

Grading

- Attendance 10%
- Homework 10%
- Project 40%
- Final exam 40%

Student Learning Outcomes

Upon completing this course, students will achieve the following learning objectives:

- Mastery of formulating engineering problems as convex optimization problems, either exactly or approximately.
- Good understanding of Lagrange duality theory, certificates of or distance to optimality via dual solutions, and sensitivity of solutions to constraints with interpretation in terms of prices. Know how to solve KKT conditions.
- Proficiency of using CVX to solve convex optimization problems of reasonable scales.
- Proficiency of implementing first order methods for large-scale convex optimization problems.
- Ability to decompose certain optimization problems in networks where decentralized algorithms are desirable.
- Extensive knowledge on applications of convex optimization in a variety of engineering fields.

Disability Support Services (DSS) Statement

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room 128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

Academic Integrity Statement

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management Statement

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.