ESE 605-001: Modern Convex Optimization

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Course website: https://nikolaimatni.github.io/courses/ese605-spring2021/index.html
Lectures: Tu/Th 3:00-4:30pm ET on Zoom (check Piazza for Link/Passcode)

Office hours

Nikolai Matni's Office Hours: Tu/Th 4:30-5:30pm ET (check Piazza for Zoom Link/Passcode)
Lisa Zhao's Office Hours: TBD
Alex Robey's Office Hours: TBD
Alp Aydinoglu's Office Hours: TBD

Course description

In this course, you will learn to recognize and solve convex optimization problems that arise in applications across engineering, statistics, operations research, and finance. Examples will be chosen to illustrate the breadth and power of convex optimization, ranging from systems and control theory, to estimation, data fitting, information theory, and machine learning. A tentative list, subject to change, of what we will cover includes: convex sets, functions, and optimization problems; the basics of convex analysis; least-squares, linear and quadratic programs, semidefinite programs, minimax, extremal volume, and other problems; optimality conditions, duality theory, theorems of alternatives, and applications; interior-point algorithms for solving convex optimization problems, and their complexity analysis; applications to signal processing, statistics and machine learning, control, digital and analog circuit design, and finance.

Course objectives

- to give students the tools and skills needed to identify convex optimization problems that arise in applications
- to introduce the basic theory of convex optimization problems, concentrating on results that are useful in understanding, improving, and extending computational methods
- to give students a deep and foundational understanding of how such problems are solved, and hands on experience in solving them
- to give students the background needed to feel comfortable in applying these methods in their own research work and/or applications

Prerequisites

This is a math intensive course. A solid foundation in linear algebra (at the level of Math 314), as well as comfort with analysis, probability, and statistics at an advanced undergraduate level is required. Familiarity with one of Matlab, Python, or Julia. Undergraduates need permission.

Intended audience

This course will benefit anyone who uses or will use scientific computation or optimization in engineering, statistics, signal processing, or related work (e.g., machine learning, finance). More specifically, convex optimization problems are likely to pop up in the work of people in the following departments and fields: Electrical Engineering (signal/image processing, communications, control), Aero/Astro Engineering (guidance, navigation, control, design), Mechanical & Civil Engineering (robotics, control, structural analysis), Computer Science (machine learning, robotics, computer graphics, algorithms & complexity, computer networking), & Operations Research (Wharton).

Textbook

The textbook is *Convex Optimization* by Boyd and Vandenberghe, available online. Additional optional references will be provided on the course website.

Grading

- **Homework (50%)**: there will be bi-weekly homework assignments, handed out on Tuesday, and due two weeks later on Friday by 5pm (except for the final assignment which will be due the last day of class). The homework assignments **must be LateXed and submitted on Canvas via Gradescope**. Please use the latex template provided on the course website – we ask that you write out detailed and rigorous solutions. You will be given ***6 free late days*** which you may use as you please throughout the semester, after which no late assignments will be accepted. You are allowed, even encouraged, to work on homework in small groups, but you must write up your own homework solutions and code to hand in -- please indicate who you collaborated with on your assignments. Each homework problem will be graded on a scale of 0-4.
- **Final exam (50%):** there will be a take-home final exam scheduled during the final exam period.

Note that these weights are approximate, and we reserve the right to change them later.

Code of Academic Integrity: All students are expected to adhere to the University's Code of Academic Integrity.