

EN.520.618: Modern Convex Optimization

Fall 2022

Instructor: Mahyar Fazlyab (mahyarfazlyab@jhu.edu)

Lecture Times: Tuesdays and Thursdays 1:30-2:45 pm from Aug 30th, 2022, Dec 8th, 2022

Location: Homewood Campus, **Shaffer 302**

Office Hours (Mahyar Fazlyab): Thursdays 4:00-5:00pm in Hackerman 224B

Course Assistants:

- Taha Entesari (tentesa1@jhu.edu)

Course Description: Convex optimization is at the heart of many disciplines such as machine learning, signal processing, control, medical imaging, etc. In this course, we will cover theory and algorithms for convex optimization problems. The theory part includes convex analysis, convex optimization problems (LPs, QPs, SOCPs, SDPs, Conic Programs), Duality Theory. We will then explore a diverse array of algorithms to solve convex optimization problems in a variety of applications, such as gradient methods, sub-gradient methods, accelerated methods, proximal algorithms, Newton's method, proximal algorithms, etc. A rough outline of the course is as follows.

- Gradient method for smooth non-convex optimization
- Gradient method for unconstrained convex optimization
- Subgradient method for non-smooth unconstrained convex optimization
- Proximal gradient method and proximal algorithms for non-smooth convex optimization
- General convex optimization problems (LPs, QPs, SOCPs, SDPs)
- Duality theory
- Operator splitting methods
- Newton's method
- Interior-point method
- Selected additional topics if time permits

Prerequisites: Students are expected to have a strong analytical/mathematical background. In particular, a solid knowledge of Linear Algebra is necessary to understand the materials and do the homework assignments. Students are also expected to be comfortable writing code in Python as some homework assignments will involve the implementation of the algorithms they learn in the class.

Textbook: The combination of Lectures and homework assignments are meant to be self-contained. There is no textbook requirement for this course. The following textbooks are recommended as a reference:

1. Convex Optimization by Boyd and Vandenberghe, which is available online for free (<http://www.stanford.edu/~boyd/cvxbook/>)
2. Bertsekas, Dimitri. Convex optimization algorithms. Athena Scientific, 2015.

Homework: Homework assignments are meant to play a complementary role to the materials learned in the class. We will usually focus on high-level concepts in the lectures and some important details will be relegated to homework. Assignments are a mixture of theoretical and algorithmic problems. There will be 6-8 homework assignments that are posted roughly every two weeks on the course website/blackboard. Late submissions are not accepted. While discussing homework among students is acceptable, each student is fully responsible for writing and submitting their solutions without getting help from others.

Scribing: Students will be “donating” to the course by helping with scribing the lectures. Depending on the number of students, one or two lectures will be scribed by each student.

Evaluation: Homework 25%, Midterm Exam (in-class) 35%, Final Project (or Final Exam) 30%, Class Participation and Scribing 10%

Accommodations for Students with Disabilities: Johns Hopkins University values diversity and inclusion. We are committed to providing welcoming, equitable, and accessible educational experiences for all students. Students with disabilities (including those with psychological conditions, medical conditions, and temporary disabilities) can request accommodations for this course by providing an Accommodation Letter issued by Student Disability Services (SDS). Please request accommodations for this course as early as possible to provide time for effective communication and arrangements. We will work with you to ensure that accommodations are provided as appropriate.

Your Health If you are struggling with anxiety, stress, depression, or other mental health-related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out their services. The Counseling Center is located at 3003 North Charles Street in Suite S-200 and can be reached at 410-516-8278 and online at

<http://studentaffairs.jhu.edu/counselingcenter/>