Math 450 - 558 (Fall 2020)
Selected Topics in Applied Mathematics:
Convex Optimization

Syllabus

Description
A major way of categorizing optimization problems is through their convexity. Finding globally optimal solutions of convex problems are usually tractable, whereas this is often deemed intractable for non-convex problems. Here, we focus on the former. After introducing the basic concepts regarding convex sets and convex functions, we present the optimality conditions and duality theory for convex optimization problems, where a special attention is paid to common convex optimization problems such as linear programs, convex quadratic programs, semidefinite programs.

The second part is mainly on the applications of convex optimization and the algorithms for their solution. The Newton method based algorithms and interior-point methods described in the second part exploit the optimality conditions and the duality theory developed in the first part.

Instructor
Emre Mengi
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Office Hours : Friday 16:30 - 17:20 (will be held remotely once a week or upon request)
`e-mail : emengi@ku.edu.tr`

Lecture Hours
Tuesday, Thursday & Friday 15:00 - 15:50
All lectures will be held remotely and synchronously (during the regular lecture hours). Recorded videos of the lectures will also be available on blackboard.

Course Webpage
`http://home.ku.edu.tr/~emengi/teaching/math450_558/math450_558.html`
Note that most of the course material will be posted on blackboard.

Textbook
Convex Optimization by Stephen Boyd and Lieven Vandenberghe
This book is freely available on the following website:
`http://web.stanford.edu/~boyd/cvxbook/`

On this website, you will find several other useful resources such as slide presentations of the topics and exercise questions.

Supplementary Books
– Lectures on Modern Convex Optimization, Aharon Ben-Tal and Arkadi Nemirovski
– Numerical Optimization, Jorge Nocedal and Stephen Wright
– Convex Analysis and Nonlinear Optimization, Jonathan Borwein and Adrian Lewis

Goals
– Pose or relax real problems as convex optimization problems
– Knowledge of duality theory and optimality conditions for convex optimization
– Knowledge of up-to-date algorithms for solving convex optimization problems
– Develop good software to solve convex optimization problems

Grading

$$\text{Total Score} \quad = \quad \%60 \text{ (Homeworks)} + \%40 \text{ (Final)}$$

You will be given at least one day to complete the final.

Homeworks
There will be 5-7 homeworks assigned throughout the semester. In each of the homeworks, about half of the problems will be conceptual and the remaining half will be computational. For each homework, you will have about two weeks to complete it.

For computational problems, you will be using Matlab and the Matlab software package `CVX` for convex optimization available at `http://cvxr.com/cvx/`

Interactions in the Lectures and Office Hours
The lectures will be held live through "zoom" during the regular lecture hours. Additionally, I will be holding a remote office hour every week.

I would highly recommend that you attend the live lectures regularly (even though attendance will not be taken), as this would give you the opportunity to interact while learning a subject. You are encouraged to ask questions during the lectures at any time through zoom; this can facilitate your learning during the lecture hours.

Participating in the office hours should have a different purpose. Sometimes, I may solve a few exercise questions related to the topics of the week during the office hours. Additionally, if you could study the topics of the week and solve problems on your own, office hours give you the opportunity to ask questions about the topics and problems that you are having difficulty with.

Important Enrollment Dates

- October 5, Monday : First Day of Classes
- October 5-9 : Add-Drop Period
- October 29, Thursday : Foundation of Turkish Republic
- January 8th, Friday : Last Day of Classes
- January 11 - January 20 : Final Period

Course Calendar
This calendar is tentative. The precise duration on various topics are likely to change. The chapters of the textbook corresponding to the topics are referred inside the parentheses.

– Week 1 (Oct 5)
Introduction (Chapter 1)

– Week 2 (Oct 12)
Convex Sets (Chapter 2)

– Week 3 (Oct 19)
Convex Functions (Chapter 3)

– Weeks 4-5 (Oct 26)
Convex Optimization Problems, Optimality Conditions (Chapter 4)

– Weeks 6-7 (Nov 9)
Lagrangian Duality (Chapter 5)

– Week 8 (Nov 23)
Applications: Approximation and Fitting Problems (Chapter 6)

– Week 9 (Nov 30)
Applications: Geometric Problems (Chapter 8)

– Weeks 10-11 (Dec 7)
Algorithms for Unconstrained Minimization (Chapter 9)

– Week 12 (Dec 21)
Algorithms for Equality Constrained Minimization (Chapter 10)

– Weeks 13-14 (Dec 28)
Interior-Point Methods for General Constrained Minimization (Chapter 11)