ORF523: Convex and Conic Optimization

Spring 2022

Instructor:	Liza (Elizaveta) Rebrova
Class:	Tue and Thu 1:30-2:50pm , Sherrerd 101
E-mail:	elre@princeton.edu
Webpage:	https://erebrova.github.io/ORF523.html (to be updated live)
Office hours:	Mon 9:30-11:30am, Sherrerd 324
	and by appointment https://calendly.com/liza-rebrova
AI Abraar Chaudhry:	azc@princeton.edu, OH Wed 5-7PM, Sherrerd 123 (tentative)

Course description

A mathematical introduction to convex, conic, and nonlinear optimization. Topics include convex analysis, duality, theorems of alternatives and infeasibility certificates, semidefinite programming, polynomial optimization, robust optimization, randomized approximations, computational complexity in numerical optimization, and convex relaxations in combinatorial optimization.

Course materials

- **Recommended Textbooks:**
    - S. Boyd and L. Vandenberghe, Convex Optimization
    - A. Ben-Tal and A. Nemirovski, Lecture Notes on Modern Convex Optimization
    - M. Laurent and F. Vallentin, Semidefinite Optimization

Grading

Your grade is formed based on the bi-weekly homework assignments, the midterm, and the final exam.

- Homeworks (50% of the grade; 4 to 5 total – approximately biweekly) You can collaborate on homeworks, you are encouraged to discuss the problems with others. However, you should write up all the problems individually, turn in HW in Gradescope for yourself only, and mark the names of all your collaborators. Homework will be due at the beginning of lecture (1:30 PM EST). Unless there is a valid reason, requests for extension on homework will not be accepted.

- Midterm (20% of the grade, around spring break, around 2 hours, in class or timed submission in gradescope, no collaborations)

- Final exam (30% of the grade, take home, for a couple of days, no collaborations)

Any grading complaints and requests for re-grading must be submitted to the instructor or AI within one week of receiving your score. Grading complaints not initiated within this period of time will not be considered.

Honor code

All work in this course must uphold the University's commitment to academic integrity. This includes the Honor Code (for written examinations, tests, and quizzes) and guidelines for the submission of original work on all other assignments.

Participation

This is an in-person class by current University guidelines. In the case of any excused absence, including the need to quarantine, it is possible to open a zoom link for virtual attendance. The student should discuss this by email elre@princeton.edu at least an hour before the class start time.

Tentative course schedule

Week	Date		Topics (very tentative, including the midterm date)
	T, Jan 25	1	Introduction
1	H, Jan 27	2	Review of math
	T, Feb 1	3	Unconstrained optimization and optimality conditions
2	H, Feb 3	4	Global optimization and convexity: definitions, properties
	T, Feb 8	5	Caratheodory theorem, convex optimization problems
3	H, Feb 10	6	Separability, Farkas lemma, connection to LP strong duality
	T, Feb 15	7	Applications of LP strong duality to combinatorial optimization
4	H, Feb 17	8	Characterizations of convex functions, strict and strong convexity, optimality conditions for convex problems.
	T, Feb 22	9	Convexity-preserving rules, convex envelopes, support vector machines
5	H, Feb 24	10	LP, QP, QCQP, SOCP, SDP
	T, Mar 1		Questions, leftovers, review
6	H, Mar 3		Midterm
	T, Mar 8		Spring break
7	H, Mar 10		Spring break
	T, Mar 15	11	LP, QP, QCQP, SOCP, SDP continueed
8	H, Mar 17	12	Applications of SDP in eigenvalue optimization
	T, Mar 22	13	Applications of SDP in combinatorial optimization
9	H, Mar 124	14	Nonconvex quadratic optimization and its SDP relaxation, the S-Lemma
	T, Mar 29	15	Computational complexity
10	H, Mar 31	16	Computational complexity
	T, Apr 5	17	Complexity of local optimization, the Motzkin-Straus theorem
11	H, Apr 7	18	Robust optimization
	T, Apr 12	19	Approximation algorithms based on convex optimization
12	H, Apr 14	20	Randomization in convex feasibility problems
	T, Apr 19	21	Random sketching in convex optimization
13	H, Apr 21		Questions, leftovers, review