Advanced Topics in Information Engineering I:
Convex and Stochastic Optimization and Applications
IERG6120 (Fall Term 2023)

Class Time and Room: Mon 2:30-3:15pm, Wed 2:30-4:15pm, Room SHB 801
Instructor: Prof. LIN Xiaojun
Email: xjlin@ie.cuhk.edu.hk
Office Hour: Fri 2:30-3:30pm (Room SHB708), or by appointment (via email)
Blackboard course: "2023R1 Advanced Topics in Information Engineering I (IERG6120)"

Course Description:

We plan to cover two topics:

- Convex optimization
- Stochastic optimization under uncertainty

We will take an application-driven approach of learning: each sub-topic of the theory will come with illustrative applications in wireless communications, networked systems, and machine learning.

- Theory: Lagrange duality, primal and dual decomposition, proximal optimizations, stochastic approximation, distributed/asynchronous algorithms, Markov decision program, dynamic programming
- Applications: Congestion control, wireless power control and opportunistic scheduling, cross-layer design, statistical learning

Course Objectives:

Students should be equipped with the basic theory of convex optimization and Markov decision program, and be able to apply to research problems.

Course Outline:

Week 1: Introduction. Affine and convex sets.
Week 2: Convex functions.
Week 3: Convex optimization problems.
Week 4: Formulations of convex optimization problems in applications.
Week 5: Optimization algorithms.
Week 6-8: Lagrange duality and applications.
Week 9: Asynchronous algorithms, stochastic optimization, proximal algorithms.
Week 10: Markov decision program.
Week 11: Stochastic shortest path problems.
Week 12: Infinite horizon problems.
Week 13: Constrained MDP and Whittle index.

References:

1. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press 2004. (Available online at http://www.stanford.edu/~boyd/cvxbook/)
2. D. Bertsekas and J. N. Tsitsikalis, Parallel and Distributed Computation: Numerical Methods, Athena Scientific, 1997. (Available online at http://web.mit.edu/dimitrib/www/pdc.html)
3. D. Bertsekas and S. Shreve, Stochastic Optimal Control: The Discrete-Time Case, Athena Scientific, 1996. (Available online at http://web.mit.edu/dimitrib/www/soc.html)
4. Notes and papers distributed in class.

Grades:

Homework: 20%
Midterm Exam (1): 40%
Projects: One assigned programming project (15%), and one student-selected final project (25%). See project handout for the instructions.

Midterm Exam: (Please mark your calendar)

Thursday, November 9th, 2023. (Take-home exam. Will take 2-4 hours.)

For up-to-date information about the course, check out the course webpage at:
https://staff.ie.cuhk.edu.hk/~xjlin/IERG6120

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