EE 367000 Introduction to Convex Optimization
(凸最佳化導論)
Spring 2024

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http://www.ee.nthu.edu.tw/cychi/

Units: **3**
Lecture hours: **M3, M4, T3, T4**
Classroom: **Delta 212**
Course web page:
ee.nthu.edu.tw/cychi/teaching/Introduction-to-Mathematics-for-Communications-Convex.php
Office hours: **10:00-12:00 (Thursday)**

This course aims to introduce ***convex optimization (CVXopt)***. Over the last two decades, the powerful convex optimization theory and tools have been extensively used for solving wide range of cutting edge optimization problems in sciences and engineering, such as (a) multiple-input multiple-output (**MIMO**) wireless communications and networking for 5G-beyong and 6G, (b) blind source separation (**BSS**) for biomedical and hyperspectral image analysis, and (c) ***artificial intelligence (AI) such as machine learning (ML) and deep learning***. The optimization problem under consideration can be optimally solved through reformulation into a convex problem in many instances, In view of the emerging convergence of ***CVXopt and AI in real-world applications.*** This course is to equip you with an essential mathematical foundation and off-the-shelf convex solver (CVX and SeDuMi) to efficiently learn advanced ***CVXopt, AI-aided CVXopt, and CVXopt-aided AI*** for the research in your post-graduate study, and for professionals who need to handle various optimization problems.
Youtube: https://www.youtube.com/watch?v=1isVbbMsGs4

Background & Prerequisite: A good background in linear algebra and calculus is desirable.
Outline:
1. Review on Basics of Calculus, Linear Algebra, Set Theory and Geometry/Topology
2. Convex Sets
3. Convex Functions
4. Convex Optimization Problems
5. Duality (introductory level)
6. Case studies of Convex Optimization in Engineering and Science

Textbooks:
• Chong-Yung Chi, Wei-Chiang Li, and Chia-Hsiang Lin, Convex Optimization for Signal Processing and Communications: From Fundamentals to Applications, CRC Press, Boca Raton, FL, 2017.
http://st-ebook.com.tw/bookcomment-2.aspx?BOKNO=TKCP00033 ***(科大文化圖書公司)***

† *The material of the textbook systematically introduces how to efficiently and effectively solve an optimization problem, from the fundamental theory, problem definition, reformulation into a convex problem, analysis, algorithm implementation, to cutting edge research in signal processing and*

communications (like an exploration journey rather than pure mathematics). It has been used for my 2-week (32 lecture hours) or 3-week (48 lecture hours) invited short course entitled "Convex Optimization for Signal Processing and Communications" at 10 top ranked universities in Mainland China over the last decade, including Shandong University, Tsinghua University, Tianjin University, Tianjin Beijing Jiaotong University (BJTU), University of Electronic Science and Technology of China, Chengdu (UESTC), Xiamen University, Sun-Yet-Sen University (SYSU), and Beijing University of Posts and Telecommunications, Beijing (BUPT), Shandong Normal University, Jinan, and Xidian University.

References:

• S. Boyd and L. Vandenberghe, Convex Optimization. Cambridge: Cambridge University Press, 2004. Free electronic version is available at: http://www.stanford.edu/~boyd/cvxbook/.

• R. A. Horn and C. R. Johnson, Matrix Analysis, 2nd ed. Cambridge: Cambridge University Press, 2012.

• C. H. Edwards, Advanced Calculus of Several Variables, Academic Press, 1973.

• Giuseppe Calafiore and Laurent El Ghaoui, Optimization Models, University Press, Cambridge, 2014.

• D. P. Bertsekas, Convex Analysis and Optimization, Athena Scientific, 2003.

Grading:

Homework: 20%

Midterm Exam: 40%

Final Exam: 40%

Teaching assistant: **Chien-Wei Huang** (黃健瑋, **e-mail:** s110064501@gmail.com)

Office: EECS Building 706,

Office hours: Wednesday: 15:00 – 17:00 and Friday: 15:00 – 17:00

Remarks:

1. The lecture language is Chinese (English if there are international students).
2. *Nonlinear adjustment* will be made as needed for the final term grade.
3. No make-up for examinations under any circumstances.