CDS270: Optimization, Game and Layering in Communication Networks

Basic Information:
6 units (2-0-4); pass/fail or letter grade
Instructor: Lijun Chen (chen@cds.caltech.edu)
Office hours: by appointment
Course webpage:
https://www.cds.caltech.edu/help/cms.php?op=wiki&wiki_op=view&id=187

Course Description:
This course discusses various equilibrium solution concepts and convergent algorithms in optimization and game theory, and their applications to network design and control. The underlying theme is "network protocols as distributed algorithms achieving various equilibria". The objective is to introduce mathematically rigorous tools for analyzing current network protocols and designing new ones. Topics will include: Equilibrium solution concepts and convergent algorithms in optimization and game theory, the utility maximization framework of TCP congestion control, layering as optimization decomposition, routing and path algebra, contention control, power control, and distributed mechanism design for network problems.

Prerequisites:
Basic optimization theory is required. Familiarity with communication networks is recommended.

Textbook:
No textbook required. Lecture notes and about 15 suggested journal/conference papers will be posted on the course webpage.

Reference Texts:
S. Boyd and L. Vandenberghe, *Convex Optimization*, Cambridge University Press, 2004. Available on-line at http://www.stanford.edu/~boyd/cvxbook/

M. J. Osborne and A. Rubinstein, *A Course in Game Theory*, MIT Press, 1994.

D. Fudenburg and J. Tirole, *Game Theory*, MIT Press, 1991.

A. Mas-Colell, M. Whinston and J. Green, *Microeconomic Theory*, Oxford University Press, 1995.

L. L. Peterson and B. S. Davie, *Computer Networks: A Systems Approach*, 3rd Edition, Morgan Kaufmann Publishers, 2003.

Course Outline:
1. Week 1: Overview and organizing meeting
2. Week 2: Network equilibria and dynamics (convergent algorithms)
3. Week 3: Lagrange duality and optimality conditions (guest lecture by Dr. Fazel)
4. Week 4: Network architecture / Duality model of TCP congestion control
5. Week 5: Layering as optimization decomposition
6. Week 6: Potential game, selfish routing and the price of anarchy

7. Week 7: Inerdomain routing and path algebra
8. Week 8: Random access game and contention control
9. Week 9: S-modular game and power control
10. Week 10-11: Distributed mechanism design

Grading:
No homework or exam, but some suggested reading. If prefer letter grade, may submit a write-up of no shorter than 6 pages. The write-up can be a project report, a survey on a particular topic, or a detailed review of a particular research paper.