CSE691: Optimization Algorithms with Engineering Applications
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TTH: 3:00pm—4:15pm, BYAC190

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Optimization is an important tool for research in computer networks and other engineering applications. In many cases, the optimal solution cannot be computed in a close form. Rather, the optimal solution is approximated via an iterative process. The algorithm generates a sequence, which, under certain conditions, converges to an optimal solution. In this course, we will cover the basic theory and algorithms for nonlinear optimization. This course is designed for graduate students in computer science and engineering and closely related fields. During your dissertation or thesis research, most of you will be faced with some non-trivial optimization problems. The following are some examples. In social networks, you may need to maximize the influence with a limited resource. In video-delivery, you may need to find the fastest way to deliver the video over a bandwidth limited network. In QoS routing, you may need to find a path subject to multiple QoS constraints. In wireless networks, you may need to find a good combination of channel assignment, transmission scheduling, and routing, in order to meet some communication requirement while satisfying fairness and/or interference constraints. Other applications include data center networks, VLSI design, bioinformatics, etc. The list goes on and on. If you have been trying to solve the optimization problems in your research and wish to have more powerful techniques, this may be the course you need to take.

In the first part of this course, we will study some fundamental theory and algorithms/techniques of optimization (linear, nonlinear, convex, as well as combinatorial). These include

- Convex sets and convex functions
- Optimality conditions
- Duality theory
- Unconstrained minimization
- Equality constrained minimization
- Interior-point methods for convex optimization

The materials for this part will be Part 1 and Part 3 of the book by Boyd and Vandenberghe, plus some materials from the book by Bazaraa+Sherali+Shetty.

In the second part of this course, we will study applications of these methods in engineering problems. We will also study techniques for designing provably good approximation algorithms and fully polynomial time approximation schemes (FPTAS) for NP-hard problems. The materials will be drawn from research papers from the literature (Science, Nature, SIAM Journal on Optimization, IEEE/ACM Transactions on Networking, IEEE Transactions on Communications, IEEE Transactions on Wireless Communications, IEEE Journal on Selected Areas in Communications, IEEE Infocom, ACM MobiCom, ACM MobiHoc).

Grading:
Your grade will be based on the following
70% homework: basics plus paper critiques/reviews;
30% class project.

References:

- Boyd and Vandenberghe, *Convex Optimization*, www.stanford.edu/~boyd/cvxbook
- Nonlinear Programming: Theory and Algorithms, Mokhtar S. Bazaraa, Hanif D. Sherali, and C.M. Shetty. This is optional.
- Lecture Notes and Selected Papers, will be available electronically.