ECE 592-084
Special Topics: Optimizations and Algorithms

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Objective or Description: This course introduces advances in optimization theory and algorithms with rapidly growing applications in machine learning, systems and control. Methods to obtain the extremum (minimum or maximum) of a non-dynamic system and the use of these methods in various engineering applications are given. The goal of this course is to prepare graduate students with a solid theoretical and mathematical foundation and applied techniques at the intersection of optimization, algorithms, and machine learning to conduct advanced research in the related fields. Students will gain expertise in designing algorithms based on common techniques and be able to deal with intractable problems and implement algorithms given the description. Students will need to undertake a half-semester long project that practices the optimization theory and algorithms at their areas of interest. For 700-level students, this project is required to investigate an open question in a specific research area; for 500-level students, it is allowed to be a replication or an improvement of a known solving strategy for a given optimization problem in order to assess/compare performance characteristics.

Prerequisites: Introductory courses in probability and linear algebra.

Textbook: E.K.P. Chong and S.H. Zak, "An Introduction to Optimization," John Wiley & Sons, 2008.
A list of important and trending papers will be provided on the course website. Useful reference books on optimization theory and mathematical backgrounds include:
S. Boyd and L. Vandenberghe, "Convex Optimization," Cambridge University Press, 2004.
Y. Nesterov, "Introductory Lectures on Convex Optimization: A Basic Course," Springer, 2004.
M. Bazarra, H.D. Sherali, and C.M. Shetty, "Nonlinear Programming: Theory and Algorithms," John Wiley & Sons, 2006.

Topics: This course aims to cover the following topics:

- Nonlinear unconstrained optimization, linear programming, nonlinear constrained optimization, computational and search methods for optimization; convex optimization and integer programming.
- Greedy, divide and conquer, dynamic programming; approximation algorithms.
- Stochastic optimization, sparsity, regularized optimization, interior-point methods, proximal methods, robust optimization.
- Convergence rate analysis, momentum-based acceleration, distributed and asynchronous algorithm design, saddle point escaping.

Grading:

Homework	20%
Midterm exam	25%
Final exam	35%
Project	20%
In-class/Piazza activity	3% (attendance and discussions)

Cross-listing in other departments: CSC 591-084 and CSC 791-053