Convex Optimization for Electrical Engineering

Instructor: Prof. Shuguang (Robert) Cui
Office: 235C WERC
Phone: 862-7957
Email: cui@ece.tamu.edu
Class website: http://www.ece.tamu.edu/~cui/ECEN689

Course description: With advancement in computing science, systematic optimization, especially convex optimization, has been recognized as a powerful tool in communication system design, circuit design, and efficient signal processing applications. As electrical engineers working in related fields, it is essential to learn basic optimization techniques and apply them in on-going research. In this class, we start with an introduction of convex optimization including convex set, convex functions, convex optimization problems, KKT conditions and duality, unconstrained optimization, and interior-point methods for constrained optimization. We then devote the rest of the class to specific application examples in communication/information theory, signal processing, circuit design, and networking, which are based on state-of-art research papers.

Topics:

- Convex Sets
  - Definition of convex sets and examples (2 hours)
  - Convexity-preserving operations (2 hours)
  - Generalized inequalities (1 hours)
- Convex Functions
  - Basic properties and examples (2 hours)
  - Convexity-preserving operations (2 hours)
  - Quasiconvex, log-concave, log-convex functions(3 hours)
  - Convexity with generalized inequalities (1 hours)
- Convex Optimization Problems
  - Optimization problems (1 hours)
  - Convex optimization problems (2 hours)
  - Linear optimization problems (1.5 hours)
  - Quadratic and geometric optimization problems (2.5 hours)
  - Semi-definite programming (2 hours)
- KKT Conditions and Duality
  - The Lagrange dual function and dual problem (3 hours)
  - Geometric and saddle-point interpretation (2 hours)
  - Optimality conditions (2 hours)
- Numerical Solutions
  - Unconstrained optimization (2 hours)
  - Interior Point Method for constrained optimization (2 hours)
- Applications in Information/Communication Theory (4 hours)
- Applications in Circuit Design and Signal Processing (4 hours)

- Applications in Cross-layer Network Design (4 hours)

Recommended Texts:

1. S. Boyd and L. Vandenberghe, *Convex Optimization*, http://www.stanford.edu/~boyd/cvxbook.html
2. Ben-Tal and A. Nemirovski, *Lectures on Modern Convex Optimization*, SIAM Press.
3. D. Bertsekas, Nonlinear Programming. Athena Scientific.

Grading Structure

10 Homework sets, 20pts/each, in average worth 20 points
One midterm, worth 30 points
Class participation (quizzes and class attendance), in average worth 10 points
Final Project, worth 40 points

Total 100 points

[85, 100] points A
[75, 84) points B
[65, 75) points C
[60, 65) points D
<60 points F

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"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."