AAE 590X Introduction to Convex Optimization

Description:
Convex optimization is a class of mathematical optimization: the objective function to be minimized and the constraints are both convex. Convex optimization problems arise frequently in engineering, and now a large class of these problems can be solved efficiently. This course covers basics of convex analysis and convex optimization problems, such as semidefinite programing (SDP), second order cone programing (SOCP), and geometric programing (GP), as well as duality in general convex and conic optimization problems. Basic algorithms of convex optimization and their complexities are also discussed. This course concentrates on formulating and solving convex optimization problems in engineering applications, such as traffic flow management, formation control, structure dynamics, etc.

Format: 3 lecture hrs per week

Credits: 3

Status: Elective, Dynamics and Control, Systems

Offered: Fall

Pre-Requisite: Graduate standing or permission of instructor.

Co-Requisite: Elementary linear algebra (vectors, matrices, Euclidean spaces); basic knowledge of calculus (including gradients and Hessians of multivariate functions); basic knowledge of Matlab.

Course Instructor: Dengfeng Sun

Text: Stephen Boyd and Lieven Vandenberghe, *Convex Optimization*, Cambridge University Press. Free download from `http://www.stanford.edu/~boyd/cvxbook/`.

Assessment Method: Homework 60%; Final Project 40%.

Course Objective:

- present the basic theory of convex optimization and algorithms of continuous optimization
- recognize convex optimization problems in engineering
- apply convex optimization method and use software tools in research or engineering work

Topics:

1. Convex sets
2. The separation theorem for convex sets
3. Convex functions
4. Convex optimization problems
5. Duality theorem
6. Optimality conditions in unconstrained and constrained optimization
7. Univariate unconstrained minimization (bisection; curve fitting; Armijo-terminated inexact line search)

8. Multivariate unconstrained minimization: gradient descent and Newton methods
9. The ellipsoid method, complexity of convex optimization, and polynomial solvability
10. Constrained minimization (active sets and penalty/barrier approaches, augmented Lagrangians, Sequential Quadratic Programming)
11. Applications

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