SIE 645: Nonlinear Optimization

Spring 2015

Course Description: (3 units) This course is devoted to structure and properties of practical algorithms for unconstrained and constrained nonlinear optimization.

Course Objective: In this course, the student will develop the knowledge in the basic theory and algorithms for nonlinear optimization (unconstrained and constrained), including: understanding how algorithms work; choosing appropriate method to solve the problem in different situations; interpreting the performance of algorithms and analyzing the solutions for decision making.

Prerequisites: SIE544 – Linear Programming, or SIE 545 – Fundamentals of Optimization, or equivalent. Knowledge of calculus, linear algebra, some mathematical analysis, and basic optimization models and methods.

Time and Location: TuTh 9:30AM-10:45AM, ENGR 301

Instructor: Dr. Neng Fan
Office: ENGR 312
Office Hours: TuTh 11:00AM-12:00PM
Email: nfan@email.arizona.edu

Course Website: We'll be using D2L. All class materials, including HW, lecture notes, supplemental readings, etc, will be distributed from D2L. You must check the announcements in D2L at least twice a week.

Book: J. Nocedal and S.J. Wright, Numerical Optimization (2nd edition), Springer, 2006.

References: R. Horst, P.M. Pardalos, and N.V. Thoai, Introduction to global optimization, 2nd edition, Kluwer Academic Publishers, 2000.
M.S. Bazaraa, H.D. Sherali, and C.M. Shetty, *Nonlinear Programming: Theory and Algorithms*, 3rd edition, Wiley & Sons Inc, New Jersey, 2006.
S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004. Available online at: http://www.stanford.edu/~boyd/cvxbook

Course Outline:

1. Introduction
   Optimization basics, Convex sets and functions, Complexity issues
2. Unconstrained nonlinear optimization
   Optimality conditions, Overview of algorithms
   Algorithms: line search, trust region, steepest descent, Newton's method, Quasi-Newton method
   Large-scale unconstrained nonlinear optimization
3. Constrained nonlinear optimization

Optimality conditions, Lagrangian-based methods
4. Quadratic programming
   General quadratic programming, Binary quadratic programming

Course Policies:

- Homework assignments: 10%*2
- Two take-home exams: 20% + 25% - submit electronically by a PDF file generated by LaTex or Word
- Class project: 35% (literature review 5%, modeling 5%, algorithm design 10%, numerical experiments 10%, presentation 5%)
  - Topics: will be given/decided for each student during the first or second month of class
  - In this project, you are expected to use modeling techniques to formulate a complex problem from industrial engineering, management science, data analytics, transportation engineering, etc; or make progress in some well-known nonlinear optimization problems; develop algorithms to solve the problem, and analyze the numerical results. Software, like Matlab, CPLEX solver will be used for numerical experiments.

You are encouraged to make recommendations to improve the class and my teaching skills.