**SIE 645: Nonlinear Optimization**

**Spring 2019**

**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:** SIE 544 – 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 12:30PM-1:45PM, ENGR 301

**Instructor:** Dr. Neng Fan
Office: ENGR 312
Office Hours: TuTh 11:30AM-12:30PM
Email: nfan@email.arizona.edu
Phone: (520) 621 6557

**Course Website:** We'll be using D2L. All class materials, including homework assignments, 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
   Line search methods, Quasi-Newton methods, Trust region
   Large-scale unconstrained nonlinear optimization: linear conjugate gradient method,

nonlinear conjugate gradient method

3. Constrained nonlinear optimization
   Optimality conditions, Quadratic programming, Penalty and augmented Lagrangian methods, Sequential quadratic programming, Interior-point methods

**Course Policies:**

- Homework assignments and/or take-home exams: 25%*2 - submit electronically by a PDF file generated by LaTeX or Word
- Class participation: 20% (paper reading and presentation)
    - Each student will be assigned several papers to read in the area of methodologies and typical applications of nonlinear optimization, and then prepare the slides based on these papers. The instructor will consult student area of interests before assigning papers.
    - A date of the class will be assigned to each student, and the student will lead the discussions on the assigned topic and papers for around 25 minutes.
- Course project: 30% (literature review 3%, modeling 5%, algorithm design 10%, numerical experiments 10%, and others 2%)
    - 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.