SIE 645: Nonlinear Optimization

Spring 2020

Instructor: Dr. Erfan Yazdandoost Hamedani
Office: ENGR 321
Office Hours: Tu/Th 1:00PM-02:00PM
Email: erfany@arizona.edu
Phone: 520-621-6548

Time and Location: Tu/Th 05:30PM-06:45 PM, Flex In-Person, ENGR 301

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

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.

Course Objective: In this course, students 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.

Course Website: This class will use web-based D2L (Desire to Learn) as the only means of distributing class materials including homework assignments, lecture notes, supplemental readings, etc. Students must check the announcements in D2L at least once a week.

Books:

1. J. Nocedal and S.J. Wright, Numerical Optimization(2nd edition), Springer, 2006.
2. M.S. Bazaraa, H.D. Sherali, and C.M. Shetty, Nonlinear Programming: Theory and Algorithms, 3rd edition, Wiley & Sons Inc, New Jersey, 2006.

Other References: S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004. Available online at: http://www.stanford.edu/ boyd/cvxbook

Course Outline: (Tentative)

1. Introduction
    - Optimization basics

- Convex set and function
- Complexity issues

2. Unconstrained nonlinear optimization
    - Optimality conditions
    - Overview of algorithms
    - Gradient methods
    - Line search methods
    - Quasi-Newton methods
    - Trust-region
    - Conjugate gradient
3. Constrained nonlinear optimization
    - Optimality conditions
    - Quadratic programming
    - Primal-dual first-order methods (saddle point)
    - Penalty and Augmented Lagrangian methods
    - Sequential quadratic programming methods
    - Interior point methods

Grading Scale and Policies:
The grade for this course will be determined as follow:

- Homework assignments: 15%×3–submit a PDF file via D2L.
- Project: 40% (literature review 10%, modeling and algorithm design 15%, numerical experiments 15%)
    - Topics will be given to or decided for each student during the first or second month of the class.
    - Students should find at least five related papers for the literature review.
    - 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, such as MATLAB, Python or CPLEX can be used for the numerical experiments.

  - Final report should be a PDF file in a Journal format (a Latex/Word template will be given).

- Project presentation: 15%. Last few lectures of the class will be assigned to students to present the results of their project in about 20 minutes.

Class Guidelines:
All students:

- Check D2L regularly.
- Turn-in assignments by due date/time.
- Treat instructors, speakers and peers with respect.
- Always behave in an ethical manner.
- All students are required to abide by the Student Code of Academic Integrity: Student Code of Academic Integrity.
- Threatening behavior by students is strictly prohibited. For detailed information see: Threatening behavior by students and disruptive behavior in an instructional setting.

Covid-policies:

- Meeting times for remote teaching: We will be meeting remotely until the University notifies us that in-person meetings may commence. We will meet on Tu/Th 05:30PM-06:45 PM by Zoom (links available in D2L).
- Meeting times and patterns for in-person teaching: When the COVID-19 situation permits teaching on campus, we will meet on Tu/Th 05:30PM-06:45 PM, at ENGR 301.
- Face coverings are required in our classroom: Per UArizonas Administrative Directive, face coverings that cover the nose, mouth, and chin are required to be worn in all learning spaces at the University of Arizona (e.g., in classrooms, laboratories and studios). Any student who violates this directive will be asked to immediately leave the learning space, and will be allowed to return only when they are wearing a face covering. Subsequent episodes of noncompliance will result in a Student Code of Conduct complaint being filed with the Dean of Students Office, which may result in sanctions being applied. The student will not be able to return to the learning space until the matter is resolved.

- Physical distancing is required in our classroom: During our in-person class meetings, we will respect CDC guidelines, including restricted seating to increase physical distancing and appropriately-worn face coverings. Per UArizonas Administrative Directive, face coverings that cover the nose, mouth, and chin are required to be worn in all learning spaces at the University of Arizona (e.g., in classrooms, laboratories and studios). Any student who violates this directive will be asked to immediately leave the learning space, and will be allowed to return only when they are wearing a face covering. Subsequent episodes of noncompliance will result in a Student Code of Conduct complaint being filed with the Dean of Students Office, which may result in sanctions being applied. The student will not be able to return to the learning space until the matter is resolved.
    - The Disability Resource Center is available to explore face coverings and accessibility considerations if you believe that your disability or medical condition precludes you from utilizing any face covering or mask option. DRC will explore the range of potential options as well as remote course offerings. Should DRC determine an accommodation to this directive is reasonable, DRC will communicate this accommodation with your instructor.

Classroom attendance:

- If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
- Notify your instructors if you will be missing an in person or online course.
- Campus Health is testing for COVID-19. Please call (520) 621-9202 before you visit in person.
- Visit the UArizona COVID-19 page for regular updates.