MATP6610/4820 • Computational Optimization • Spring 2019

Time: 2:00-3:50pm TF   Location: SAGE4101

Instructor:	Yangyang Xu
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Office hours:	TF 4:00pm – 5:00pm or By Appointment
Course page:	https://xu-yangyang.github.io/MATP6610.html

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Office hours:	Th 4:00 – 5:00pm or By Appointment

Course Objective

This course is to introduce you optimization methods and applications. An emphasis will be placed on understanding and implementing optimization algorithms. After taking the course, you are expected to know

1. how to estimate the per-iteration complexity and analyze convergence and/or convergence rate of certain iterative methods
2. how to numerically implement optimization methods and verify if a computed point is approximately a local/global optimal solution
3. how to choose appropriate optimization methods and apply them to applications such as in imaging, finance, and machine learning

Prerequisites

Multi-variable calculus, linear algebra, and some experience of Matlab.

Textbooks

- *Introduction to Mathematical Programming* by Michael Kupferschmid
- *An Introduction to Optimization* by Edwin K. P. Chong and Stanislaw H. Zak, 4th Edition, 2013 (**recommended**)
- *Numerical Optimization* by Jorge Nocedal and Stephen Wright, 2006 (**recommended**)

Topics to cover

1. Concepts of numerical algorithm and convergence
2. Fundamentals of unconstrained optimization
3. Gradient type methods: steepest gradient descent, projected gradient, conjugate gradient, proximal gradient, and Nesterov's accelerated proximal gradient methods
4. Newton type methods: Newton's method, quasi-Newton method, and Gauss-Newton method
5. Derivative free methods: coordinate descent method
6. Theory of functional constrained optimization: Karush-Kuhn-Tucker (KKT) conditions and Lagrangian duality
7. Simplex method and Interior-point methods for linear programming
8. Penalty methods, barrier function methods, and augmented Lagrangian method
9. Alternating direction method of multipliers and application in imaging and statistics
10. Trust-region method (**if time permits**)

Homework and exams

- **Homework:** roughly once every 1.5 weeks and will be due in class. The homework will be posted on the course page https://xu-yangyang.github.io/MATP6610.html
- **Exam:** one mid-term exam (tentative time: 2:00-3:50pm on Feb. 26, 2019)
- **Project:** one final project (to be assigned after mid-term)

Evaluation and Grading Policy

1. **Evaluation:** homework 40%, mid-term exam 30%, and the final project 30%.
2. **Grading of homework:**
    - For each homework, a random portion of assigned problems will be graded;
    - The score composes of two parts: completeness (50%, check if all problems are finished), and correctness (50%, check if graded problems are done correctly)
3. **Late homework:**
    - Homework that is late up to one day will be penalized by 30%;
    - Homework that is late between one day and two days will be penalized by 50%;
    - No homework will be accepted if it is late more than two days;

- Late homework needs be directly handed to the instructor or slide under the instructor's office door and notify the instructor by email.

4. **Exam:**
   - No early exam will be taken.
   - A make-up exam will be administered only at the discretion of the instructor in the event of a verifiable emergency. In the event of a verifiable emergency, the student must contact the instructor as soon as possible, and in any case, prior to the next regularly scheduled class.
5. **Project:** Each student is required to write the report and program individually. The project will be graded based on both the report and program code. **No late project will be accepted.**

Academic Integrity

Intellectual integrity and credibility are the foundation of all academic work. A violation of Academic Integrity policy is, by definition, considered a flagrant offense to the educational process. It is taken seriously by students, faculty, and Rensselaer and will be addressed in an effective manner.

Check Student Rights and Responsibilities Handbook for more information.