

**MATH 5750/6880 TOPICS IN OPTIMIZATION
FALL 2013 SYLLABUS**

Instructor: Fernando Guevara Vasquez.

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Office hours: MWF 2-3pm or by appointment.

Textbook: This class is mostly based on the book “Numerical Optimization” by Nocedal and Wright (second ed, Springer). ISBN-13: 978-0387303031. Price: about \$45 (as of Aug 2013).

Prerequisites: Vector calculus, Linear algebra and basic programming knowledge (knowing loops and arrays is sufficient).

Hours and Classroom: MWF 11:50-12:40, LCB 222

Course website:

- This syllabus can be found here:
http://www.math.utah.edu/~fguevara/math5750_f13
- Class notes, assignments and other important announcements are available from Canvas for registered students:
<https://utah.instructure.com/>

Description: We study numerical methods and theory for solving the rather general optimization problem:

$$\begin{aligned} &\min f(\mathbf{x}) \\ &\text{s.t. } g(\mathbf{x}) = 0 \\ &\text{and } h(\mathbf{x}) \geq 0. \end{aligned}$$

Here $\mathbf{x} \in \mathbb{R}^n$, and g and h are possibly vector valued functions. Most of the methods covered assume some knowledge about the derivatives of f , g and h . If time permits, we will also visit methods that do not require derivatives.

- Unconstrained optimization
 - Necessary and sufficient optimality conditions
 - Newton’s method
 - Globalization: line search
 - Quasi-Newton methods, non-linear least squares
 - Adjoint state method (for computing derivatives)
- Constrained optimization
 - Constraint qualifications, optimality conditions
 - Globalization: trust region methods
 - Linear programming (simplex and interior point methods)
 - Quadratic programming; Sequential Quadratic Programming
 - Semidefinite programming
- Other optimization methods

Intended Audience: Graduate students usually take MATH 6880. Undergraduate students take MATH 5750. The lectures are the same for everyone however there *may be* extra problems for graduate students.

Grading: homeworks 30%, midterm 15%, final 15%, project 40%. Homeworks will be given roughly bi-weekly. The project will consist in applying the methods in class to your particular research problem or to a problem chosen in conjunction with the instructor. The exams emphasize understanding over rote memorization.

Course Objectives: Be able to give necessary/sufficient conditions for a minimizer in both unconstrained and constrained problems · Reproduce and understand Newton's method convergence proof · Understand how different optimization techniques and algorithms work, what problems they solve and what are their limitations · Understand the computational cost of an algorithm · Program your own optimization routines · Apply optimization algorithms from class to your research or to a realistic project that will be given in class.

Other references: You are not required to buy these books. They are listed here for further reading.

- “Convex Optimization” by Boyd and Vandenberghe (Cambridge University Press). ISBN-13: 978-0521833783. The authors have kindly made this book available online here:
<http://www.stanford.edu/~boyd/cvxbook/>
- “Numerical Methods for Unconstrained Optimization and Nonlinear Equations” by Dennis and Schnabel (SIAM Classics in Applied Mathematics). ISBN: 0898713641.

Students with Disabilities: The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability Services.

