Course Description — Spring 2009

MATH 589
NONLINEAR PROGRAMMING

Official title: CONJUGATE DUALITY AND OPTIMIZATION

Our main topic is the role of convexity in continuos and discrete optimization.

MWF 10 am, Room: 343 Altgeld.

Instructor: Zoltan Furedi, 233B Illini Hall,
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This course has some intersection with the undergraduate course Math484 on nonlinear programming. But the present course is of a higher level: more proofs and methods. It will be based on the book *Nonlinear Optimization* by A. Ruszczyński, Princeton Univ. Press, 2006.

Some topics that we plan to cover are:

1. Elements of convex analysis – Convex sets, cones, extreme points. Convex functions. Conjugate duality. Helly, Radon, Carathéodory. Farkas Lemma. Polytopes, approximating convex bodies, volumes in high dimensions.
A recommended text: J. Matoušek: *Lectures on discrete geometry.*

2. Optimality conditions – Unconstrained minima of differentiable functions. Unconstrained minima of convex functions. Optimality conditions for smooth problems and for convex problems.

3. Lagrangian duality – The dual problem. Duality relations. Conic programming. Decomposition. Convex relaxation of nonconvex problems.

4. Unconstrained optimization of differentiable functions – Iterative algorithms. The method of steepest descent. Newton's method. The conjugate gradient method. Nongradient methods.

5. Constrained optimization of differentiable functions – Feasible points method. Penalty method. The basic dual method. Newton's method.

Another recomended books: *Convex Optimization* by Boyd and Vandenberghe (Cambridge 2006), and the excellent textbook (used at Math 484) A. Peressini, F. Sullivan and J. Uhl: *The Mathematics of Nonlinear Programming*, Undergraduate Text in Mathematics, Springer.

COURSE REQUIREMENTS: There will be a number problem sets, no exam. The problems require proofs related to or applying results from class.

PREREQUISITES: A course in linear algebra (415) and in real analysis (447).