George Mason University

Department of SEOR and Mathematical Sciences Department.

Spring 2013

Professor Roman A. Polyak

OR 644-001/Math 689-002/ OR 750-002: **Advance Nonlinear**

Optimization Wednesday 4:30-7:10 pm, Innovation 338

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Office Hours: Thursday 3 pm-5 pm or by appointment.

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Text: 1.D. Bertsekas "*Nonlinear Programming Second Edition Athena Scientific, Belmont, Massachusetts 1995.*

2. I.Griva, S.Nash, A.Sofer *"Linear and Nonlinear Programming" SIAM 2009*

Course Summary: A number of real life applications arising in statistical learning theory, structural optimization, antenna design, optimal power flow, radiation therapy planning, signal processing, economics and finance just to mention a few lead to Nonlinear Programming (NLP).

In the first half of the course we will consider theory and methods for unconstrained optimization: gradient, fast gradient, Newton, regularized Newton method as well as some method for non-smooth unconstrained optimization.

NLP with equality constraints as well as elements of convex analysis and convex optimization including optimality criteria and convex duality also will be covered in the first half of the course.

In the second half of the course we will cover recent advances in NLP including Interior Point Methods (IPMs) and Nonlinear Rescaling (NR) theory and methods in constrained optimization. Particular emphasis will be given to computational complexity as well as to the primal-dual approach in constrained optimization.

There will be homework assignment and projects .

Grading: 15% homework; 30% midterm exam; 20 % project; 35 % final exam.

Course Schedule

1. Real life applications and mathematical problems that lead to NLP formulation.

2. Basics in unconstrained optimization: gradient and Newton methods and their modifications.

3. Optimization problems with equality constraints. Lagrange system of equations and Lagrange duality.

4. R. Courant's penalty method for equality constrained optimization and its dual equivalent-N.Tichonov's regularization method for unconstrained optimization.

5. Convex functions, convex sets and convex optimization problem.

6. Karush-Kuhn-Tucker's optimality condition. Elements of duality theory.

7 Midterm

8. Sequential unconstrained minimization technique (SUMT).Classical barrier and distance functions.

9. Elements of Interior Point Methods.

10. Augmented Lagrangian. Lagrange multipliers method and its dual equivalent-quadratic proximal point method.

11. Nonlinear Rescaling (NR) principle for inequality constraint optimization and its realization: Modified Barrier Functions and correspondent methods.

12. NR multipliers methods and their dual equivalent-interior proximal point with entropy-like distance functions.

13. Primal-dual NR methods.

14. NR methods in constrained optimization: numerical realization of the NR methods and numerical results.

Final Exam: May 8, 2013