Nonlinear Programming   ORI 391Q.1 (18000)   Spring Semester 2006

General Information

Instructor:	David Morton
Time and location:	Tuesdays and Thursdays, 12:30-2:00pm, ETC 5.132
Office:	ETC 5.122
Telephone:	512-471-4104
Office Hours:	2:00-3:30pm on Tuesdays and Thursdays
E-mail:	`morton@mail.utexas.edu`
Web site:	Blackboard
Prerequisites:	Linear algebra, advanced calculus and linear programming.
Text:	Dimitri P. Bertsekas, *Nonlinear Programming*, Second Edition, Athena Scientific, Belmont, Massachusetts, 1999. D. Morton, ORI 391Q.1 Nonlinear Programming Class Notes.

Grading Policy

Problem Sets		30%
Midterm Exam		30%
Final Exam	Tuesday, May 16, 9am-noon	40%

Late problem sets will not be accepted.

Course Outline

- Unconstrained Optimization
  - Background
    - Taylor approximation, little "oh"
    - convexity of sets and functions, gradient inequality
  - Optimality Conditions
    - first-order, second-order necessary
    - sufficiency under convexity
  - Algorithms for Univariate Optimization
    - bisection, Newton, safeguarded Newton
    - golden section search, Fibonacci
    - rates of convergence
  - Algorithms for Multivariate Optimization
    - gradient methods: $x^{k+1} = x^k + \alpha^k d^k$
    - important special case: $x^{k+1} = x^k - \alpha^k D^k \nabla^T f(x^k)$
    - choosing the direction: steepest descent, Newton, quasi-Newton, conjugate gradient
    - choosing the steplength: Armijo, linesearch
    - the gradient-related condition and the general convergence theorem
    - rates of convergence

- Constrained Optimization Over a "Simple" Convex Set
  - Optimality Conditions
  - Projections
  - QP with Equality Constraints
  - Feasible Direction Methods
  - Frank-Wolfe Algorithm
  - Gradient Projection
  - Active Set Methods ($Ax \geq b$)

- Lagrange Multiplier Theory and Duality
  - Lagrange Multipliers
    - equality constraints and need for regularity condition
    - inequality constraints: KKT conditions and sufficiency for convex programs
  - Lagrangian Duality
    - weak duality and its implications
    - strong duality for convex programs
    - interpreting KKT via duality
  - Saddle Point Conditions

- Barrier Methods and Penalty/Augmented Lagrangian Methods
  - Barrier Methods
    - barrier functions
    - convergence

log-barrier for linear programming
Penalty/Augmented Lagrangian Methods
penalty weight and multipliers
convergence (as penalty grows)
inequality constraints
method of multipliers

- Special Topics
  - Cutting-Plane Algorithms
    - convergence of Kelly's cutting-plane method
    - special case of $\min_{x \in X} f(x)$
  - Nonsmooth Optimization
    - optimality conditions
    - subgradient methods
    - bundle methods

References

M.S. Bazaraa, H.D. Sherali, and C.M. Shetty, *Nonlinear Programming Theory and Algorithms*, Second Edition, John Wiley & Sons, New York, NY, 1993.

P.E. Gill, W. Murray, and M.H. Wright, *Practical Optimization*, Academic Press, London, 1981.

D.G. Luenberger, *Linear and Nonlinear Programming*, Second Edition, Addison-Wesley, Reading, MA, 1984.

S.G. Nash and A. Sofer, *Linear and Nonlinear Programming*, McGraw-Hill, New York, NY, 1996.

Additional Administrative Notes

The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4241 TDD or the College of Engineering Director of Students with Disabilities at 471-4382.

An engineering student must have the dean's approval to add or drop a course after the fourth class day of the semester or after the second class day of a summer term. Adds and drops are not approved after the fourth class day except for good cause. "Good cause" is interpreted to be documented evidence of an extenuating nonacademic circumstance (such as health or person problems) that did not exist on or before the fourth class day.

A Course-Instructor Survey from UT's Measurement and Evaluation Center will be administered near the end of the semester.