Linear Programming
ORI 391Q.5 Fall Semester 2008

General Information

Instructor: David Morton

Time and location: Tuesdays and Thursdays, 11am-12:30pm, ETC 5.132

Office: ETC 5.118

Telephone: 512-471-4104

Office Hours: 2-3pm on Tuesdays and Thursdays
If you want to see me outside these hours please send me an email.

E-mail: `morton@mail.utexas.edu`

Web site: Blackboard

Computer facilities: Obtain an account at: `http://hpc.me.utexas.edu/`

Prerequisites: ME 366L or equivalent and linear algebra. Knowing the difference between a plausible argument and a proof.

Texts:
- D. Bertsimas and J.N. Tsitsiklis, *Introduction to Linear Optimization,* Athena Scientific, Belmont, Massachusetts, 1997.
- D. Morton, Class Notes.
- A. Brooke, D. Kendrick, A. Meeraus and R. Raman, *GAMS: A User's Guide* This document can be downloaded from: `http://www.gams.com`

Grading Policy

Problem Sets		15%
Exam 1	Tuesday, 14 October (tentative)	25%
Exam 2	Tuesday, 18 November (tentative)	25%
Final	Friday, 12 December, 9:00am-noon	35%

The exams and final are closed book and closed notes; you may *not* use a calculator.
Problems sets are due at the beginning of class on designated days. Late problem sets will not be accepted.

Course Outline

- Introduction
  - mathematical programming overview
  - LP axioms / standard form
  - LP modeling / example formulations

- Mathematical Programming Modeling Languages
  - General Algebraic Modeling System (GAMS)

- LP Geometry
  - graphical solution method
  - requirement space

- Convex Analysis
  - convex sets
    - polyhedra / extreme points / extreme directions
    - Goldman resolution theorem
  - convex functions
    - gradient inequality / epi-graph / Hessian

- Linear Algebra Review
  - elementary linear algebra
  - matrix inversion / solving linear systems / elementary matrices
  - finding extreme points - two methods (select active columns or tight rows)
  - basic feasible solutions and extreme points

- Simplex Method
  - preliminaries
  - algebraic version
    - optimality test / improving direction / steplength
  - tableau method
  - unboundedness detection
  - infeasibility detection / phase I / two-phase method
  - sensitivity analysis / optimality ranges
  - degeneracy resolution / cycling prevention
    - lexicographic / perturbation method
    - finite convergence
  - revised simplex method
    - product form of the inverse / LU factorizations
  - other computational considerations
    - re-factorizations
    - steepest-edge pricing
  - simplex interpretation of the simplex method

- Duality
  - formulating the dual program
  - economic interpretation
  - weak duality
  - unbounded / infeasible relations
  - strong duality
  - complementary slackness / KKT optimality conditions
  - theorems of the alternative

- Simplex Method Variants
  - dual simplex method
  - simplex method for variables with simple bounds

- Interior Point Algorithms
  - method of Lagrange multipliers
  - Newton's method
  - barrier methods
  - first order conditions / KKT with μ-complementary slackness
  - primal interior point method

References

M.S. Bazaraa, J.J. Jarvis, and H.D. Sherali, *Linear Programming and Network Flows*, Second Edition, John Wiley & Sons, New York, NY, 1990.

S.P. Bradley, A.C. Hax, and T.L. Magnanti, *Applied Mathematical Programming*, Addison-Wesley, Reading, MA, 1977.

V. Chvátal, *Linear Programming*, W.H. Freeman and Company, New York, NY, 1983.

G.B. Dantzig, *Linear Programming and Extensions*, Princeton University Press, Princeton, NJ, 1963.

G.B. Dantzig and M.N. Thapa, *Linear Programming 1: Introduction*, Springer-Verlag, New York, NY, 1997.

G.B. Dantzig and M.N. Thapa, *Linear Programming 2: Theory and Extensions*, Springer-Verlag, New York, NY, 2003.

P.E. Gill, W. Murray, and M.H. Wright, *Numerical Linear Algebra and Optimization, Vol. 1*, Addison-Wesley, Redwood City, CA, 1991.

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.

C.H. Papadimitriou and Kenneth Steiglitz, *Combinatorial Optimization: Algorithms and Complexity*, Prentice-Hall Inc., Englewood, NJ, 1982.

L. Schrage, *LINDO: An Optimization Modeling System*, 4^{th} edition, Boyd & Fraser, Danvers, MA, 1991.

D. Solow, *Linear Programming: An Introduction to Finite Improvement Algorithms*, North-Holland, New York, NY, 1984.

R.J. Vanderbei, *Linear Programming: Foundations and Extensions*, Kluwer Academic Publishers, Boston, MA, 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 TTY 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.