CS 521: LINEAR PROGRAMMING Fall 2009, 3 Credits

INSTRUCTOR: Bahman Kalantari (kalantar@cs.rutgers.edu)

Office Hours: M 1:00-3:00, Hill Center 444, Tel: 732-445-2001 ext 3542.

LECTURE: M 3:20-6:20 PM, Hill Center 254, Busch Campus.

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PREREQUISITES: DCS graduate study admission requirements or permission of Instructor (Elements of Linear Algebra, Calculus and Multivariable Calculus).

GRADING: Homework assignments (written and MATLAB programming) %30, and the better of (I): midterm %30; final %40; and (II) final %70.

COURSE OUTLINE: Linear inequalities and the feasibility problem. The linear programming problem (LP). Related formulations of LP: The standard form, the homogeneous feasibility problem, the convex-hull problem, the strict feasibility problem, and the homogeneous quadratic feasibility problem. Farkas lemma, Gordan theorem, and geometric interpretations. Convex sets: Polyhedra, and polyhedral cones, extreme points, extreme directions, recession directions, edges, facets, basic feasible solutions. Representation theorems: Carathéodory, Farkas-Minkowski-Weyl, and Helly theorems. Fourier-Motzkin elimination method for solving the feasibility problem. Its worst-case complexity. Dantzig's simplex method. The Klee-Minty worst-case example. The revised simplex method. Phase I and Phase II methods, degeneracy, cycling, Bland's rule. Hirsh conjecture. Sensitivity analysis and parametric LP. Duality theorems, complementary slackness. The fundamental theorem of LP. Lagrange multipliers and Karush-Kuhn-Tucker optimality conditions. The dual simplex, and the primal-dual methods. Game theory and von Neumann's min-max theorem. Orthogonal projection matrix, rank-one update formula and its inverse. Taylor's theorem and properties of convex functions. Size of LP, rounding, and precision: Analysis for polynomial-time algorithms. Karmarkar's algorithm for LP, and simple variations. The positive semidefinite matrix scaling problem, and associated scaling dualities. The homogeneous potential function and the logarithmic barrier function. Potential-reduction and path-following Newton methods for matrix scaling/linear programming. Khachiyan's ellipsoid method for LP. Strongly polynomial-time algorithms. Total unimodularity and structured linear programming: shortest paths, mean cycle, max flows, bipartite and general matching, min-cost and multicommodity flows. TSP. Magic labeling problem.

TEXT: Lecture notes to be handed out. A highly recommended textbook to own: Chvátal, Linear Programming, Freeman and Company, 1983.

OTHER REFERENCES: Bazaraa, Jarvis and Sherali, Linear Programming and Network Flows, Wiley, 1990; Schrijver, Theory of Linear and Integer Programming, Wiley, 1986; Papadimitriou and Stieglitz, Combinatorial Optimization: Algorithms and Complexity, Prentice-Hall, 1982; survey articles.