INSTRUCTOR: Bahman Kalantari (kalantar@cs.rutgers.edu)
LECTURE: Thursday 5:00-8:00 PM, LSH-B267, LIV (Livingston).
OFFICE HOURS: Wed 2:00-4:00 PM, Hill Center 444.
TA: TBA
PREREQUISITES: DCS graduate study admission requirements or permission of Instructor (Elements of Linear Algebra, Calculus and Multivariable Calculus).
GRADING: Homework assignments (4 written HWKS and one MATLAB programming) %30, and the better of :
(I) midterm %30; final %40; and (II) final %70.
LECTURE DATES: Sept 8, 15, 22, 29; Oct 6, 13, 20, 27; Nov 3, 10, 17, 22 (Tuesday); Dec 1, 8.
EXAM DATES: MIDTERM: October 20, FINAL: December 15.
COURSE OUTLINE:
• The convex hull decision (membership) problem and its generalization: An introduction to linear programming (LP) and support vector machine (SVM) problems. A distance duality and the triangle algorithm, a geometric algorithm for the convex hull decision problem and SVM.
• Linear inequalities and the feasibility problem. The linear programming problem (LP). Related formulations of LP: The standard form, the convex hull decision problem, the strict feasibility problem.
• Farkas lemma, Gordan theorem, geometric interpretations. Algorithmic applications.
• The dual simplex method. The primal-dual method for LP and some applications.
• Convex sets, Polyhedra and polyhedral cones, extreme points, extreme directions, recession directions, edges, facets, basic feasible solutions. Fourier-Motzkin elimination method, its worst-case complexity and applications. Representation theorems: Caratheodory, Farkas-Minkowski-Weyl, and Helly theorems.
• Game theory and von Neumann’s min-max theorem.
• The triangle algorithm: A fully polynomial-time approximation scheme for the convex hull membership problem and for algorithmic separation of convex sets. The particular case of SVM.
• Khachiyan’s ellipsoid method for LP. Connections to the convex hull membership problem. Notions of size of LP, rounding, precision, and polynomial-time algorithms.
• Karmarkar’s algorithm and variations, connections to the convex hull membership problem.
• Some properties of convex functions. Taylor theorem.

• Strongly polynomial-time algorithms. Total unimodularity and structured LP. Topics from: shortest paths, mean cycles, max flows, bipartite matching, min-cost flows, multicommodity flows, minimum spanning tree, general weighted matching problem, TSP, and magic labeling problem.

**TEXT:** Lecture notes will be made available. Also some literature articles.

**OTHER REFERENCES** (to be placed on reserve at Math Library, Hill Center)

- Introduction to Linear Optimization by Bertsimas & Tsitsiklis, Athena Scientific, 1997)