RESEARCH

Department of Mathematics (cont'd)

Research Breakthrough
Large-Scale Matrix Cone Programming

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The development of convex matrix cone programming, including semi-definite programming (SDP), over the past two decades has been a major development in optimisation.

The SDP and convex conic programming more generally, is applied in a wide variety of areas such as linear matrix inequality in systems and control, combinatorial optimisation, quantum information, machine learning, signal processing and communications.

Professors Sun Defeng and Toh Kim Chuan have made a considerable contribution to this field through the development of algorithms that are among the most successful for solving large-scale problems with millions of constraints.

They have designed, analysed and implemented a variety of semi-smooth Newton-CG proximal-point and augmented Lagrangian algorithms for solving several important classes of large-scale optimisation problems such as large-scale linear and convex-quadratic SDP, log-determinant SDP, nuclear-norm regularised least-squares and minimisation problems, and covariance-selection problems.

The researchers have also produced highly successful specialised algorithms for solving large-scale nuclear norm minimisation problems (which typically arise from convex relaxation of rank minimisation problems) and large-scale SDPs arising from sensor network localisation and molecular conformation.

Prof Sun Defeng (left) and Prof Toh Kim Chuan

Publication:

X.Y. Zhao, D.F. Sun, and K.C. Toh, *A Newton-CG augmented Lagrangian method for semidefinite programming*, SIAM J. Optimization, 20 (2010), pp. 1737--1765.

K.C. Toh, and S.W. Yun, *An accelerated proximal gradient algorithm for nuclear norm regularized least squares problems*, Pacific J. Optimization, 6 (2010), pp. 615--640.

C.J. Wang, D.F. Sun, and K.C. Toh, *Solving log-determinant optimization problems by a Newton-CG primal proximal point algorithm*, SIAM J. Optimization, 20 (2010), pp. 2994--3013.

Y.J. Liu, D.F. Sun, and K.C. Toh, *An implementable proximal point algorithmic framework for nuclear norm minimization*, Mathematical Programming, accepted, Dec 2010.