PRESIDENT'S SCIENCE AWARD 2019

Professor Toh Kim Chuan

Department of Mathematics and Institute of Operations Research and Analytics,
National University of Singapore

"For his fundamental contributions to the theory, algorithms, and applications of convex optimisation, especially the development of algorithms and software for semi-definite and conic programming"

Professor Toh Kim Chuan is internationally recognised for his work on computational optimisation, and is a world-leading figure in algorithms for conic and semi-definite programming (SDP). Prof Toh is currently the Leo Tan Professor in Science at the National University of Singapore (NUS). He obtained his Bachelor of Science (Honours) and Master of Science degrees in Mathematics from NUS, and his PhD in Applied Mathematics from Cornell University.

Since the nineties, SDP has been a major development in optimisation, with experts likening it to the revolutionary development of linear programming in the 1950s. Prof Toh has made major contributions to SDP that now routinely solves critical optimisation problems that were previously regarded as too difficult to be dealt with in practice.

He has contributed significantly to the advancement and development of practical algorithms for solving SDP problems, which in turn has contributed to the explosive growth in the adaptation and application of SDP models in various scientific and engineering domains.

The SDPT3 software he co-developed is currently one of the most versatile and efficient solvers available for solving general medium-scale SDP problems. The software is now used as the computational engine in high-level optimisation modeling languages such as CVX and YALMIP, which are widely used interfaces for feeding SDP application problems to SDP solvers.

He has also pushed computational boundaries by developing highly efficient specialised algorithms for extremely-large scale structured SDP and conic programming problems arising from applications such as sensor network localisation, matrix completion, molecular conformation, 3D chromosome organisation, polynomial optimisation, as well as machine learning and data science. In addition, he has also co-developed the award-winning solver SDPNAL+ for solving large-scale nondegenerate SDP problems. This

solver is currently the only available tool for handling large-scale general SDP problems, especially for the extremely challenging class of doubly non-negative SDP problems.

Over his 23-year academic career, Prof Toh has published more than 100 papers in major international journals. His work has been cited more than 9,000 times, and the significance and impact of his research have been recognised locally and internationally.

In the course of his outstanding career, Prof Toh has garnered an impressive list of accolades. He received the Farkas Prize awarded by the INFORMS Optimization Society in 2017 for his fundamental contributions to the theory, practice, and application of convex optimisation, as well as the triennial Beale Orchard-Hays Prize awarded by the Mathematical Optimization Society in 2018 for Excellence in Computational Mathematical Programming. He was elected as a Fellow of the Society for Industrial and Applied Mathematics in 2018 for his contributions on the development of algorithms and software for semi-definite programming and conic programming.

Professor Toh holds editorial appointments in major optimisation journals, including the SIAM Journal of Optimization, Mathematical Programming, Mathematical Programming Computation, and ACM Transactions on Mathematical Software. He has also given talks at major conferences such as the SIAM Annual Meeting, and International Symposium on Mathematical Programming.

For his fundamental contributions to the theory, algorithms and applications of convex optimisation, especially the development of algorithms and software for semidefinite and conic programming, Prof Toh is awarded the 2019 President's Science Award.