

2015 Gödel Prize

The 2015 Gödel Prize is awarded to Daniel A. Spielman and Shang-Hua Teng for their series of papers on nearly-linear-time Laplacian solvers:

Spectral sparsification of graphs. *SIAM J. Computing* 40:981-1025, 2011.

A local clustering algorithm for massive graphs and its application to nearly linear time graph partitioning. *SIAM J. Computing* 42:1-26, 2013.

Nearly linear time algorithms for preconditioning and solving symmetric, diagonally dominant linear systems. *SIAM J. Matrix Anal. Appl.* 35:835-885, 2014.

Their works on nearly-linear-time Laplacian solvers resolved an outstanding open problem in numerical linear algebra: solving symmetric diagonally dominant linear systems in nearly linear time. This result delivered a new and extremely powerful algorithmic primitive: nearly linear time electrical flow computations.

Developing these algorithms required sophisticated technical tools, many of which were developed by Spielman and Teng. These techniques have found wide applications, including: spectral graph sparsifiers, new bounds on the spectral similarity of two graphs (equivalent to new bounds on the 2-norm of a sparse matrix), and recursive solvers, which are in some sense a theoretically-tractable version of the multigrid idea.

The impact of these papers has extended far beyond the results. The ability to solve Laplacian systems in nearly-linear time is an exceptionally powerful primitive, and it has been used to obtain substantial asymptotic improvements in the running time for several core problems in algorithmic graph theory, including maximum single- and multi-commodity flow problems, minimum s-t cut, graph sparsification, sampling random spanning trees, minimum cost flow problems, and computing the hitting and cover times of random processes.

Daniel A. Spielman is the Henry Ford II Professor of Computer Science, Mathematics, and Applied Mathematics at Yale University. He previously was a postdoc at U.C. Berkeley, and then taught in the Applied Mathematics Department at M.I.T. He received many awards, including the 1995 ACM Doctoral Dissertation Award, the 2002 IEEE Information Theory Paper Award, the 2008 Gödel Prize, the 2009 Fulkerson Prize, the 2010 Nevanlinna Prize, the 2014 Polya Prize, an inaugural Simons Investigator Award, and a MacArthur Fellowship. He is a Fellow of the Association for Computing Machinery and a member of the Connecticut Academy of Science and Engineering. He received his B.A. in Mathematics and Computer Science from Yale in 1992, and his Ph.D in Applied Mathematics from M.I.T. in 1995.

Shang-Hua Teng is the Seeley G. Mudd Professor of Computer Science and Mathematics at the University of Southern California. He previously taught at Boston University, UIUC, the University of Minnesota, and MIT, worked at Akamai and Xerox PARC, and consulted for Microsoft, Intel, IBM, and NASA. He received fifteen US Patents for his work on compiler

optimization, Internet technology, and network analysis. He is an ACM Fellow, Sloan Fellow, and a Simons Investigator. He received the 2008 ACM Gödel Prize, the 2009 AMS Fulkerson Prize, and a best paper award at the 2011 ACM Symposium on Theory of Computing. He earned a B.S. degree from the Shanghai Jiao Tong University, an M.S. degree from USC, and a Ph.D. degree from Carnegie Mellon University.

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