2003 Fulkerson Prize

The 2003 Delbert Ray Fulkerson Prize was presented at the 18th International Symposium on Mathematical Programming, held in Copenhagen, Denmark, August 18–22, 2003.

The prize was awarded to the authors of the following papers.

J. F. GEELEN, A. M. H. GERARDS, and A. KAPOOR, The excluded minors for GF(4)-representable matroids, *J. Combin. Theory Ser. B* **79** (2000), 247–299.

Matroid representation theory studies the question of when a matroid is representable by the columns of a matrix over some field. The matroids representable over GF(2) and GF(3) were characterized by their excluded minors in the 1950s and the 1970s respectively. Rota then conjectured that the matroids representable over any finite field GF(q) could be characterized in terms of a finite list of excluded minors.

For more than twenty-five years progress on Rota's conjecture stalled. The proofs for GF(2) and GF(3) relied on the uniqueness properties of representations over these fields, properties that do not hold for other fields. Thus the result of Geelen, Gerards, and Kapoor came as a big surprise. The paper of Geelen, Gerards, and Kapoor gives an excluded minor characterization for matroids represented over GF(4) by working around the nonuniqueness of the representation. It has reawakened interest in the area of matroid representation and brought renewed hope of progress toward the solution of Rota's conjecture.

J. F. Geelen is an associate professor in the Department of Combinatorics and Optimization at the University of Waterloo. A. M. H. Gerards leads the Networks and Logic—Optimization and Programming Theme at the Centrum voor Wiskunde en Informatica (CWI, Center for Mathematics and Computer Science) in Amsterdam, the Netherlands. A. Kapoor is at Realization Technologies.

BERTRAND GUENIN, A characterization of weakly bipartite graphs, *J. Combin. Theory Ser. B* **83** (2001), 112–168.

A long-standing area of interest in the field of discrete optimization is finding conditions under which a given polyhedron has integer vertices so that integer optimization problems can be solved as linear programs. In the case of a particular set-covering formulation for the maximum cut problem, a graph is called weakly bipartite if the polyhedron has integer vertices for that graph. Guenin's result gives a precise characterization of the graphs that are weakly bipartite in terms of an excluded minor. This solves the graphical case of a famous conjecture about ideal binary clutters made by Seymour in his 1977 Fulkerson Prize-winning paper. Guenin's proof makes ingenious use of a deep theorem of Lehman, itself a Fulkerson Prize winner. Guenin's work has motivated several remarkable subsequent papers.

Bertrand Guenin is an assistant professor in the Department of Combinatorics and Optimization at the University of Waterloo.

SATORU IWATA, LISA FLEISCHER, and SATORU FUJISHIGE, A combinatorial strongly polynomial algorithm for minimizing submodular functions, *J. ACM* **48** (July 2001), 761–777.

ALEXANDER SCHRIJVER, A combinatorial algorithm minimizing submodular functions in strongly polynomial time, *J. Combin. Theory Ser. B* **80** (2000), 346–355.

Submodular functions provide a discrete analog of convex functions, and submodular function minimization arises in such diverse areas as dynamic

and submodular flows, facility location problems, multiterminal source coding, and graph connectivity problems. The first polynomial-time algorithm for submodular function minimization was given by Grötschel, Lovász, and Schrijver in 1981; however, the algorithm relies on the ellipsoid method, requires advanced knowledge of bounds on the function values, and is not combinatorial. In 1999 the papers of Iwata, Fleischer, and Fujishige, and of Schrijver independently, gave combinatorial, strongly polynomial-time algorithms for this fundamental problem. These results are a significant step in the history of combinatorial, strongly polynomial-time algorithms for discrete optimization problems and can be compared with the Edmonds-Karp algorithm for the maximum flow problem and Tardos's algorithm for the minimum-cost flow problem.

Satoru Iwata is an associate professor of information science and technology in the Department of Mathematical Informatics at the University of Tokyo. Lisa Fleischer is an associate professor of operations research and mathematics at Carnegie Mellon University. Satoru Fujishige is a professor at the Research Institute for Mathematical Sciences at Kyoto University. Alexander Schrijver is the leader of the scientific cluster for Probability, Networks, and Algorithms at CWI in Amsterdam.

About the Prize

The Delbert Ray Fulkerson Prize recognizes outstanding papers in the area of discrete mathematics. Established in 1979, the prize is sponsored jointly by the Mathematical Programming Society (MPS) and the AMS. Up to three awards of $1,500 each are made every three years at each (triennial) international symposium of the MPS. The prize is made possible by a memorial fund established by friends of the late Delbert Ray Fulkerson to encourage mathematical excellence in the fields of research in which he worked.

The prize is presented for papers published during the six calendar years preceding the year in which the prize is given. The prize is given for single papers, not series of papers or books, and in the event of joint authorship the prize is divided. The topics of papers considered for the prize include graph theory, networks, mathematical programming, applied combinatorics, and related subjects.

The selection committee for the 2003 Fulkerson Prize consisted of Gérard Cornuéjols, Andrew Odlyzko, and David P. Williamson (chair).

—Allyn Jackson