Curriculum Vitae

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Research interests

My research focuses on fundamental methodological and computational aspects of optimization, with emphasis in large-scale, nonconvex and discrete optimization problems. Additionally, a recent research thrust has focused on analysis of cascading failures of power grids, a topic of increasing relevance to society and also one of fascinating mathematical complexity. In this line of research I am developing methodologies for computing real-time controls and for diagnosing the risk that an ongoing cascade will lead to an operational failure. My optimization research comprises both classical, hard discrete optimization problems such as the set covering problem, and large-scale nonconvex problems arising in science and engineering such as the AC (alternating current) optimal load flow problem. This problem addresses concerns the computation of an operating point (generator outputs, voltage amounts and phase angles) for a power grid, taking into account stability constraints (line flow, voltage magnitude and phase angle limits, and more complex decisions such as the need to commit or not a generator) while taking generator economics into account. This has become a pressing problem in current operation because of the need to accommodate renewables and because the rise in demand (without a corresponding capacity investment) has placed grids closer to the edge. My publications span this spectrum; recent emphasis has been placed on problems arising from power grids, which include both discrete and nonconvex (but continuous) features, are notoriously difficult, and are of a large-scale nature especially when dealing with continent-scale grids. An earlier focus was placed on optimization problems arising in telecommunications, in particular large-scale routing problems, which can be formulated as linear programs, albeit large and difficult enough to render commercial software unusable. In this area of work we have produced a book (below) a paper with the best theoretical result (joint with G. Iyengar, below) and a software system that is freely available for download. With a former student (M. Zuckerberg) we have formulated a new theory of reformulation operators for binary integer programs; in the case of set-covering problems this produces provably stronger formulations than classical reformulation operators such as Sherali-Adams and Lovász-Schriver. We have also developed practicaly methodology for solving mine-extraction schedules, which is now of wide use in practice. Finally, early on I established that the problem of testing for the existence of an odd-hole through a prescribed vertex in a graph is NP-complete, a problem of early interest in the context of the strong perfect graph theorem.

Awards and Honors

Fellow, Institute for Operations Research and Management Science (2013).
Semi-plenary Speaker, 2006 Mathematical Programming Sympsioum (Rio).
Plenary Speaker, 2005 SIAM Optimization Conference (Stockholm).
IBM Faculty Partnership Award (2005).
Presidential Young Investigator Award (1990 - 1995).
Zannetos Thesis Prize, M.I.T., 1985.

Recent research grants

- LANL, "Grid Science - Power System Control under Uncertainty," $288,000 (October 2013 - September 2015).
- ONR, 'Nonconvex, combinatorial, nonlinear optimization'", $364,000 (January 2013 - Dec 2015).
- DTRA, 'Power grid vulnerability and resilience to geographically correlated failures'", $350,000 (October 2012 - 2015).
- BHP Billiton gift to support research, $150,000. (January 2010 - 2012)

Service and Editorships

Editor-in-chief, *Mathematical Programming Computation.*

IPCO Steering Committee (2002 - 2010). Chairman (9/2007 - 2010) .

Commitee member, Informs Computing Society Prize (2012-).

Nicholson Award Committee (2007 - 2010).

Chairman, IPCO X Organizing Committee (June 2004).

Committee Member, Beale-Orchard-Hays Prize (ISMP 2003).

Committee member, IPCO, SODA, other refereed conferences.

Associate Editor of *Math. Programming C* (2008- 2014), *Annals of O.R.* (2011-), *Math. Programming* (1995-1999), *SIAM J. Disc. Math.* (1992 -), *Oper. Res.* (2002 - 2006), *Mgt. Science* (2002 - 2006), *Disc. Optimization* (2004 - 2012).

I created the MIP series of conferences on integer programming, now on its eleventh iteration.

Employment

8/89 - present. Dept. of Industrial Engineering and Operations Research, Columbia University. Associate Professor, 1990. Tenured, 1991. Full Professor, 1995. Joint appointment in Applied Physics and Applied Mathematics, May 2008.

8/85 - 4/86. Graduate School of Industrial Administration, Carnegie Mellon University.

4/86 - 8/89. Combinatorics and Optimization Research, Bellcore.

Education

5/82. B.A., Mathematics, Brandeis University (Summa Cum Laude).

6/85. Ph.D., Operations Research, M.I.T.

Professional Societies

Informs, Mathematical Programming Society, SIAM, IEEE.

Invited and Refereed Presentations (1989-present)

1989

Oberwolfach meeting on Combinatorial Optimization – "Generalized max-flow min-cut problems in the plane".
Cornell (School of O.R.) – "Obstructions to small face covers".
Rutgers (RUTCOR) – "Obstructions to small face covers".
ORSA/TIMS meeting (New York) – "Critical edge problems".
Courant Institute – "Provably hard crossing number problems".
DIMACS meeting on Network Survivability (Rutgers) – "Graph searching, path-width and tree-width".

1990

Integer Programming and Combinatorial Optimization Conference (Waterloo) – "Provably hard crossing number problems".
Sixth Ann. Symp. on Comp. Geometry (Berkeley) – "Provably hard crossing number problems".
Cornell (School of O.R.) – "Blocking small cuts in a network".
N.Y.U. (School of Business) – "Blocking small cuts in a network".
ORSA/TIMS meeting (Philadelphia) – "New results on crossing numbers".
M.I.T. (O.R. Center) – "Searching a network for a virus".
Georgia Tech. (Indust. and Syst. Eng.) – "Blocking small cuts in a network".

1991

U. of Montreal (Comp. Science) – "Searching a network for a virus".
Carleton University (Math.) – "New results on crossing numbers".
SUNY Stony Brook (Appl. Math.) – " Lot-sizing in trees, and network design".
IBM (Yorktown Hts.) – " Computational experience with an algorithm for local access network design".

1992

Cornell (School of O.R.) – "Computational experience with some difficult integer programs".
IBM (Yorktown Hts.) – "Computational experience with OSL on a difficult routing problem in lightwave networks".
Bellcore – " Computational experience with an algorithm for local access network problems".

1993

CORE (U. C. de Louvain, Belgium) – "Computational experience with a strong formulation for a difficult network design problem".
Telecommunications Systems Conference (Vanderbilt) – "Computational experience with an algorithm for a difficult problem in lightwave networks".
DIMACS Conference on Approximation Algorithms – "Several difficult combinatorial optimization problems in telecommunications".
DIMACS Conference on Hard Combinatorial Optimization Problems – "Computational experience with a cutting-plane algorithm for a difficult multicommodity flow problem".

1994

SUNY Stony Brook (Appl. Math.) – " Computational experience with a branch-and-bound quadratic programming algorithm".
ORSA meeting (Boston) – " Capacitated Network Design: Polyhedral Structure and Computation".
ORSA meeting (Boston) – " Solving real-life ATM network design problems".
Math. Programming Symposium – " Capacitated Network Design: Polyhedral Structure and Computation".
Math. Programming Symposium – " Solving real-life ATM network design problems".

Rice University – " Capacitated Network Design: Polyhedral Structure and Computation".
New York Academy of Sciences – "Mixed-integer, multicommodity flow problems".

1995

SUNY Stony Brook (Harriman School) – "Mixed-integer, multicommodity flow problems".
IPCO '95 (Copenhagen) – " Computational experience with a branch-and-bound quadratic programming algorithm".
Northwestern University – " Computational experience with a branch-and-bound quadratic programming algorithm".
ORSA meeting (N. Orleans) – " Computational experience with a branch-and-bound quadratic programming algorithm," "Algorithms for network design problems".
U. of Waterloo – "Algorithms for network design problems".

1996

Artemis meeting (Aussois, France) – "Combinatorial algorithms for network design problems".
Network day (DIMACS) - "Combinatorial algorithms for network design problems".
ORSA meeting (Atlanta) - "Combinatorial algorithms for network design problems".
Northwestern University - "Combinatorial algorithms for network design problems".

1997

IBM (Yorktown Hts) - "Computational experiments with a network design algorithm using ϵ-approximate linear programs."
ISMP '97 (Lausanne, Switzerland) -"Computational experiments with a network design algorithm using ϵ-approximate linear programs."
ISMP '97 (Lausanne, Switzerland) -"Network design with flow-survivability constraints."
ISMP '97 (Lausanne, Switzerland) -"Computational experience with an ATM network layout procedure."
Berlin -"Computational experiments with a network design algorithm using ϵ-approximate linear programs."
Lucent -"Computational experiments with a network design algorithm using ϵ-approximate linear programs."

1998

Cornell -"Computational experiments with a network design algorithm using ϵ-approximate linear programs."
INFORMS-"Polyhedral structure of survivable network design problems."
DIMACS-"Solving LP relaxations of large-scale network design problems"

1999

Oberwolfach - "Solving LP-relaxations of large-scale network design problems."
DIMACS Workshop on Logistics -"Solution of an airline maintenance scheduling problem."
IBM -"Solution of an airline maintenance scheduling problem."
IBM (Gomory meeting) -"Epsilon-approximate LP solutions: new bounds and computation"

2000

Symposium on Discrete Algorithms (SODA) -"Epsilon-approximate LP solutions: new bounds and computation".
Boca Telecomm. Conference -"Approximately solving linear programs: a tutorial".
Optimization Days (Stockholm) -"Approximately solving linear programs: a tutorial".
Telecommunications Coference (Salerno, Italy) -"Solving practical network design problems: theory and practice".
CORE Lecture Series (CORE, Belgium) -"Approximately solving large-scale linear programs" (five three hour lectures).

2001

MIT -"Approximation Algorithms for Linear Programming: From Theory to Growing Practice".
CMU -"Approximation Algorithms for Linear Programming: From Theory to Growing Practice".
UNC -"Approximation Algorithms for Linear Programming: From Theory to Growing Practice".
Donet Summer School/IPCO - 4-hour tutorial on approximation algorithms for large-scale linear programming.

Ga. Tech. -"Approximation Algorithms for Linear Programming: From Theory to Growing Practice".

2002

INFORMS Telecomm. Conference - Tutorial on approximate routing algorithms.
Royal Technical Institute, Stockholm - Faculty opponent for Mikael Prytz's thesis defense.
APMOD'02 (Italy) - "Combined pricing and network design."
Integer Programming Conference in honor of Egon Balas - "Subset algebra lifting algorithms for 0-1 Integer Programming."
Bell Laboratories - "Subset algebra lifting algorithms."
IMA Tutorial on Supply-Chain Optimization - "Large-scale Linear Programming."
IMA Workshop on Integer Programming - "Subset algebra lifting algorithms."
Lehigh University - "Subset algebra lifting algorithms."

2003

ZIB (Berlin Algorithms Day) - "Subset algebra lifting algorithms.".
GSIA, Carnegie Mellon - "Subset algebra lifting algorithms."
MIT - "High-Performance Network Design."
Rutgers - "Subset algebra lifting algorithms."
DIMACS Workshop on Geometric Optimization - "New Trends in Linear and Integer Programming."
ISMP 2003 (Copenhagen) - "Subset algebra lifting algorithms."
INFORMS Atlanta - "Combined network design and pricing"
U. of Buffalo - "Combined network design and pricing"
IBM (Yorktown Hts.) - "Concurrent flows in $O(1/\epsilon)$ iterations."
IBM (Yorktown Hts.) - "Subset algebra lifting algorithms."

2004

Lehigh University - "Subset algebra lifting algorithms."
Oberwolfach (Math. in the Supply Chain) - "Modeling the Lucent supply chain."
STOC 2004 (Chicago) - "Concurrent flows in $O(1/\epsilon)$ iterations."
France Télécom (Paris) - "Large-scale routing algorithms – the state of the art"
France Télécom (Paris) - "Lift-and-project algorithms for integer programming".
University of Chemnitz - "Tree-width and the Sherali-Adams operator."

2005

IBM (Yorktown Hts.) - "Large scale routing algorithms."
Plenary talk, SIAM Conference on Optimization (Stockholm) - "Discrete Optimization and Network Design".
Cornell - "New algorithms for the maximum throughput problem".
IMA - "Optimization and Robust Power Grids".
National Science Foundation - "Optimization and Robust Power Grids".
INFORMS (San Francisco) - "Computing robust basestock levels."

2006

Georgia Tech - "Computing robust basestock levels."
Oberwolfach - "New algorithms for the maximum throughput problem".
NSF Workshop on Adaptive Dynamic Programming (Mexico) - "Optimization and Robust Power Grids".
INFORMS Practice conference - "Robust optimization in supply-chain".
Semi-plenary speaker, 2006 Mathematical Programming Symposium (Rio).
MIT - "Experiments in Robust Portfolio Optimization".
INFORMS Boston Chapter - "Optimization and Robust Power Grids".
U. of Wisconsin - "Experiments in Robust Portfolio Optimization".
Duke University - "Experiments in Robust Portfolio Optimization".

2007

Tech. University Berlin - "Experiments in Robust Portfolio Optimization".

Carisma meeting (London) - “Experiments in Robust Portfolio Optimization”.
MIP Meeting (Montreal) - “Experiments in Robust Portfolio Optimization”.
Informs 2007 - “The attack problem in power grids”.
Informs 2007 - “Experiments in Robust Portfolio Optimization’.
McGill University – “The attack problem in power grids”.
Lehigh University - “The attack problem in power grids”.
Lehigh University - “Experiments in Robust Portfolio Optimization’.

2008

Informs Optimization Conference – “The attack problem in power grids”.
Carisma meeting (London) - “Experiments in Optimal Trade Execution”.
U. of Rome - “New results on knapsack problems.”.
Informs 2008 - “New results on knapsack problems.”.
Informs 2008 - “Finding weaknesses in power grids.”.

2009

U. of Wisconsin - “The N-k problem in power grids.”
U. of Washington - “New results on knapsack problems.”.
Ohio State University - “The N-k problem in power grids.”
Plenary speaker, International Network Optimization Conference (Pisa, Italy, April 2009).
Invited speaker, Laurence Wolsey birthday celebration (CORE, Belgium, May 2009).
MIP ’09 - “Eigenvalue techniques in nonconvex optimization.”
Los Alamos Nat’l Lab - “Continuing work on power grid problems.”
Alcatel-Lucent - “Continuing work on power grid problems.”
Cornell - “Eigenvalue techniques in nonconvex optimization.”
Georgia Tech - “Eigenvalue techniques in nonconvex optimization.”
CMU - “Eigenvalue techniques in nonconvex optimization.”
Texas A & M - “Continuing work on power grid problems.”

2010

U. of Florida - “Continuing work on power grid problems.”
Berkeley DOE meeting (plenary) – “Continuing work on power grid problems.”
EWMINLP10 (Marseille) - “Eigenvalue techniques in nonconvex optimization.”
CORE (Belgium) - “A new LP algorithm for precedence constrained production scheduling.”
IPCO (Lausanne) - “Eigenvalue techniques in nonconvex optimization.”
IPCO (Lausanne) - “A new LP algorithm for precedence constrained production scheduling.”
Snowbird DOE-SIAM meeging - “Optimal control of cascading power grid failures.”
Informs 2010 - “Eigenvalue techniques in nonconvex optimization.”
Informs 2010 - “A new LP algorithm for precedence constrained production scheduling.”

2011

Brookhaven Nat’l Lab - “Computational Math of the Power Grid.
Telcordia - “Computational Math of the Power Grid.
SIAM Conference on Optimization (Darmstadt) - “The N-K problem with AC power flows.”
FERC (Washington, DC) - “Online Control of Cascading Power Failures.”
IEEE Power Engineering Society Nat’l Meeting - “Online Control of Cascading Power Failures.”
SIAM Conference on Computational Science and Engineering (Reno) - “Online Control of Cascading Power Failures.”
DOE P.I. Meeting - “Online Control of Cascading Power Failures.”
Informs Nat’l Meeting - “Convex Optimization over Non-Convex Domains.”
Informs Nat’l Meeting - “Mitigating the Impact of a Pandemic Through Robust Optimization.”
Joint CDC-IEEE meeting - “Online Control of Cascading Power Failures.”

2012

Aussois - “Convex Optimization over Non-Convex Domains.” (A. Michalka).

Santa Fe conference on complex systems - "Online Control of Cascading Power Failures."
Federal Energy Regulatory Commission - "Chance-constrained optimal power flow."
STOC Workshop on Computational Sustainability - "Computational Challenges in Power Grid Modeling: Strong Algorithms for Power Flows and Understanding Cascades."
ISMP Berlin - "Convex Optimization over Non-Convex Domains."
ISMP Berlin - "Chance-constrained optimal power flow."

Informs Nat'l Meeting - "Strong formulationes over Non-Convex Domains."
Informs Nat'l Meeting - "Chance-constrained DC-OPF"

2013

USC - "Mitigating the Impact of a Pandemic Through Robust Optimization."
National Research Council Workshop on the Resiliency of the Electric Power Delivery System in Response to Terrorism and National Disasters – "Simulation and Control of Cascades."
SIAM Conference on Computational Science and Engineering - "Analysis of geographically correlated power grid cascades."
DIMACS Workshop on Energy Infrastructure - "Chance-constrained optimal power flow."
Federal Energy Regulatory Commission - "Synchronization aware OPF."
2013 IREP Symp. - "Synchronization-Aware and Algorithm-Efficient Chance Constrained OPF."
Allerton Conference - "Stochastic control of power line temperature."
MIT - "Convex Optimization over Non-Convex Domains."
Informs Nat'l Meeting - "Cutting planes for Convex Optimization over Non-Convex Domains."
U. Michigan - "Chance-constrained optimization problems in the power grid."
CDC - "Stochastic control of power line temperature."

2014

SODA - "Polynomial solvability of variants of the trust-region subproblem."
INFOCOM - "Power Grid Vulnerability to Geographically Correlated Failures - Analysis and Control Implications"
MINLP - "Recent results on solving QCQPs, and related problems."
FERC - "Multi-time-step Chance Constrained Generation Re-dispatch."
MIP - "Solving QCQPs."
IEEE PES - "Efficient Direct Test for Dynamics Following a Cleared Fault."
MOPTA - "Solving QCQPs."
INFORMS - "Solving QCQPs", "A new relaxation for AC-OPF."
Rutgers - "Modeling the power grid".
PGMO'14 (École Polytechnique) - "Solving QCQPs."

2015

Waterloo - "A new LP formulation for polynomial optimization."
LANL Winter School - "A new LP formulation for polynomial optimization."
Princeton - "A new LP formulation for polynomial optimization."

Doctoral Students

Gonzalo Muñoz.
Alexander Michalka. (Ph.D. August 2013).
Cecilia Zenteno (Ph.D. July 2012).
Aron Ahmadia (co-advised with David Keyes) (Ph.D. March 2010).
Abhinav Verma (Ph.D. December 2009).
Nuri Özbay.(Ph.D. May 2006).
Anton Riabov (Ph.D., May 2004)
Mark Zuckerberg (Ph.D., February 2004).

O. Raskina (Ph.D., December 2002).
Thomas Odenthal (Ph.D. May 1999).
Gabriella Muratore (Ph.D. April. 1999).
Yunhee Jang (Ph.D. June 1996).
Oktay Günlük (Ph.D. June 1994).
Nicole Diaz (Ph.D. May 1992).

Courses Taught (1989-present)

IEOR 3608 (Intro. to Mathematical Programming, 7 terms)
IEOR 6605 (Network Flows, 12 terms)
IEOR 4100 (Computer Graphics for IEOR Applications, 5 terms)
IEOR 4500 (Applications Programming for Financial Engineering, 15 terms)
IEOR 4600 (Applied Integer Programming, 8 terms)
IEOR 6603 (Combinatorial Optimization, 9 terms)
IEOR 6614 (Optimization II, 3 terms)
IEOR 6608 (Integer Programming, 6 terms)
IEOR 4007 (Optimization in Financial Engineering, 1 term)
IEOR 8100 (Topics in Discrete Optimization, 1 term)
IEOR 8100 (Computational Math of the Power Grid, 1 term)

Publications

Books

Potential Function Methods for Approximately Solving Linear Programming Problems, Theory and Practice, ISBN 1-4020-7173-6. Kluwer Academic Publishers, Boston (2002).
Under preparation: "Operations Research and the Power Grid" (SIAM), "Lifted formulations for discrete nonconvex optimization" (Springer).

Publications

1. LP formulations for mixed-integer polynomial optimization problems (with G. Muñoz), arXiv 1501.00288.
2. On linear relaxations of OPF problems (with G. Muñoz), arXiv 1411.1120. To appear, proc PES-GM '15.
3. Chance-constrained DC-OPF (with M. Chertkov and S. Harnett), *SIAM Review* **56** (2014), 461 – 495.
4. A note on polynomial solvability of the CDT problem, manuscript (2013). arXiv 1406.6429.
5. Approximation Algorithms for the Incremental Knapsack Problem via Disjunctive Programming (with C. Ye and J. Sethuraman), submitted.
6. Polynomial solvability of variants of the trust-region subproblem (with A. Michalka), *Proc.* 25^{th} *ACM-SIAM Symp. on Discrete Algorithms (SODA 2014)*, 380 – 390.
7. Strong formulations for convex functions over nonconvex sets (with A. Michalka), *SIAM J. Optimization* **24** (2014), 643-677.
8. Synchronization-Aware and Algorithm-Efficient Chance Constrained Optimal Power Flow (with R. Bent and M. Chertkov), Proc. 2013 IREP Symp. on Bulk Power System Dynamics and Control (Rethymnon, Greece).

9. Stochastic models and control for electrical power line temperature (with J. Blanchet and J. Li), Proc. 51st Annual Allerton Conference on Communication, Control and Computing (2013), 1344-1348.

10. Power line control under uncertainty of ambient temperature (with J. Blanchet and J. Li), CDC '13.

11. Models for managing the impact of an epidemic (with A.C. Zenteno), submitted.

12. Sensitivity Analysis of Power Grid Vulnerability to Large-Scale Cascading Failures (with A. Bernstein, D. Hay, M. Uzunoglu and G. Zussman), *ACM Performance Evaluation Review, Special issue of papers from ACM Greenmetrics12*, Vol. 40, No. 3 (Dec. 2012), pp. 33 –37. Also see: Power Grid Vulnerability to Geographically Correlated Failures - Analysis and Control Implications, *INFOCOM '14*.

13. Optimal control of cascading power grid failures, Proc. 2011 IEEE PES Meeting, Proc. 2011 joint CDC-IEEE meeting.

14. A New LP Algorithm for Precedence Constrained Production Scheduling (with M. Zuckerberg). IPCO 2010.

15. Eigenvalue techniques for proving bounds for convex objective, nonconvex programs. IPCO 2010, EWMINLP10.

16. Tightening simple mixed-integer sets with guaranteed bounds (with B. McClosky), *Math. Programming*. Published online 12/2010.

17. The $N-k$ Problem in Power Grids: New Models, Formulations and Numerical Experiments (with A. Verma) *SIAM J. Optimization* **20** (2010) 1052-6234.

18. Approximate formulations for 0-1 knapsack sets, *Operations Research Letters* **36** (2008), 317–320.

19. Computing robust basestock levels (with N. Özbay), *Discrete Optimization* **5** (2008), 389–414.

20. Histogram models for robust portfolio optimization, *J. Computational Finance* **11** (2007), 1–64.

21. Using mixed-integer programming to solve power grid blackout problems (with S. Mattia), *Discrete Optimization* **4** (2007), 115–141.

22. Scalable Optimization for Multi-Period Optical Network Capacity Planning with Elastic Demand, with O. Raskina, I. Saniee and Q. Wang. *Operations Research* **54** (2006), 261-276.

23. Approximate fixed-rank closures of covering problems (with M. Zuckerberg), *Math. Programming* **105** (2006), 9 – 27.

24. Faster approximation algorithms for covering and packing problems (with G. Iyengar), *SIAM J. Computing* **35** (2006) 825-854.

25. Solving fractional packing problems in O*(1/epsilon) iterations (with G. Iyengar), CORC report TR-2003-03. *Proc. 26th Ann. Symp. Theory of Computing* (Chicago, 2004) 146-155.

26. Tree-width and the Sherali-Adams operator (with N. Özbay), CORC report TR-2003-09. *Discrete Optimization* **1** (2004) 13-22.

27. Subset Algebra Lift Operators for 0-1 Integer Programming (with M. Zuckerberg), *SIAM J. Optimization* **15** (2004) 63-95.

28. Approximation Algorithms for Linear Programming: Theory and Practice, *CORE Lecture Series Monograph* ISSN-0771 3894, Core, UCL, Belgium (2001).

29. Asymptotic analysis of the flow deviation method for the maximum concurrent flow problem (with O. Raskina), *Math. Programming* **91** (2002), 379–492. (CORC Report 2000-02, download from http://www.corc.ieor.columbia/reports/techreports.html).

30. Approximately solving large-scale linear programs. I: Strengthening lower bounds and accelerating convergence, in preparation. CORC Report 1999-1. (An extended abstract for this work was published in the SODA '00 proceedings).

31. ATM network design: Traffic models and optimization-based heuristics (with I. Saniee), *Telecomm. Systems* **16** (2001), 399–421.

32. Strong inequalities for capacitated survivable network design problems (with G. Muratore), *Math. Programming* **89** (2000), 127-148.

33. Minimum-cost capacity installation for multicommodity flows (with O. Günlük, S. Chopra and C.Y. Tsai) (1996), *Math. Programming* **81** (1998), 177-199.

34. Capacity expansion in networks – new inequalities and computation (with O. Günlük), *ORSA J. Comp.* **8** (1996), 243-260.

35. Computational study of a family of mixed-integer quadratic programming problems, *Math. Programming* **74** (1996), 121-140.

36. A degree sequence problem related to network design (with O. Günlük), *Networks* **24** (1994), 195-205.

37. Probabilistic analysis of tour partitioning heuristics for the capacitated vehicle routing problem with unsplit demands (with J. Bramel and D. Simchi-Levi) *Math. Oper. Res.* **18** (1993), 786-802.

38. Computational experience with a difficult multicommodity flow problem (with O. Günlük), *Math. Programming* **68** (1995), 213-237.

39. Computational experience with an effective heuristic for some capacity expansion problems in local access networks, *Telecomm. Sys.* **1** (1993), 379-400.

40. Algorithmic implications of the Graph Minors project (with M. Langston), in *Handbook of Operations Research* (Ball, Magnanti, Monma, Nemhauser, eds.), North-Holland (1995).

41. Blocking small cuts in a network (with N. Diaz), *SIAM J. Computing* **22** (1993), 482-499.

42. A lot-sizing problem on trees, related to network design, *Math. Oper. Res.* **18** (1993), 402-422.

43. A note on the prize-collecting traveling salesman problem (with M. Goemans, D. Simchi-Levi and D. Williamson), *Math. Programming* **59** (1993), 413-420.

44. New results on rectilinear corssing numbers and plane embeddings (with N. Dean), *J. Graph Theory* **16** (1992), 389-398.

45. Bounds on rectilinear crossing numbers (with N. Dean), *J. Graph Theory* **17** (1993), 333-348.

46. A note on finding saddle points (with F.R.K. Chung, M. Fredman, A. Schäfer, P. Shor and S. Suri), *Amer. Math. Monthly* **98** (1991), 418-419.

47. On obstructions to small face covers in planar graphs (with N. Dean), *J. Comb. Theory B* **55** (1992), 163-189.

48. Further polynomially solvable special cases of the Steiner tree problem in planar networks (with M. Bern), *Annals of Operations Research* **33** (1991), 405-418.

49. Graph searching, path-width and tree-width (a survey), in *Reliability of Computer and Communication Networks* (Roberts, Hwang, Monma, eds.) DIMACS (1991), 33-49.

50. Some provably hard crossing number problems, *Disc. Comput. Geom.* **6** (1991), 443-459.

51. On the complexity of testing for odd holes and induced odd paths, *Discrete Math.* **90** (1991), 85-92. (Corrigendum: *D.M.* **102** (1992) 109).

52. Excluding a forest quickly (with N. Robertson, R. Thomas and P.D. Seymour), *J. Comb. Theory (B)* **52** (1991), 274-283.

53. Some generalized max-flow min-cut problems in the plane, *Math. Oper. Res.* **16** (1991), 310-333.

54. Monotonicity in graph searching (with P.D. Seymour), *J. of Algorithms* **12** (1991), 239-245.

55. An extremal problem on sparse 0-1 matrices (with E. Györi), *SIAM J. Disc. Math.* **4** (1991), 17-27.

56. Linear time test for small face covers in any fixed surface, *SIAM J. Comput.* **19** (1990), 907-911.

57. On a network design problem that is intractable on trees (with O. Marcotte), *Math. Oper. Res.* **15** (1990), 530-544.

58. On the structure of minimum-weight k-connected networks (with E.F. Brickell and C.L. Monma), *SIAM J. Disc. Math* **3** (1990), 320-329.

59. On embedding graphs in trees, *J. Comb. Theory B* **49** (1990), 103-136.

60. On the complexity of minimizing various distance measures in a planar graph (with C.L. Monma), *Algorithmica* **5** (1990), 93-109.

61. Optimal enclosing of vertices in a planar graph (with C.L. Monma), *Networks* **19** (1989), 79-94.

62. Average distance in graphs with removed elements (with E. Györi), *J. Graph Theory* **12** (1988), 375-390.

63. Some lattice-theoretic tools for network reliability analysis, *Math. Oper. Res.* **13** (1988), 467-478.

64. Optimizing resource acquisitions by stochastic programming (with J.F. Shapiro), *Mgt. Sci.* **34** (1988), 215-229.

65. On the complexity of covering vertices by faces in a planar graph (with C.L. Monma), *SIAM J. Comput.* **17** (1988), 53-76.

66. Reliability analysis of generalizations of Halin graphs, in *Applications of Discrete Mathematics* (R. Ringeisen and F. Roberts, eds.) SIAM (1988), 87-106.

67. Broadcasting with random faults, *Disc. Appl. Math* **20** (1988), 1-7.

68. Asymptotic analysis of some network reliability problems, *SIAM J. Disc. Math* **1** (1988), 14-21.

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