

Curriculum Vitae

Daniel Bienstock

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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 optimization problems related to analysis and operations of power transmission networks, including analysis of cascading failures of power grids, a topic of increasing relevance to society and also one of fascinating mathematical complexity and which I explore in a book recently published by SIAM. Another recent research thrust concerns the use of mixed-integer programming techniques toward solving mixed-integer or purely continuous quadratically constrained quadratic programs and polynomial optimization problems. Here my particular focus concerns lifted representation of nonconvex problems as higher-dimensional convex problems; another book (to be published by Springer) is nearing completion. .

Awards and Honors

Fellow, Institute for Operations Research and Management Science (2013).

Semi-plenary Speaker, 2006 Mathematical Programming Symposium (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

- DARPA, “Lagrange: Real-time control of network physical structures to bypass complexity: Optimization, Stochastics and Structure Recognition,” PI, joint with J. Blanchet, V. Goyal and G. Iyengar, \$782,000 (01/01/2018 - 06/30/2019).
- NSF, “Protecting Coastal Infrastructure in a Changing Climate by Integrating Optimization Modeling and Stakeholder Observations,” joint with K. Mandli and G. Deodatis, approximately \$500,000 (October 2017 - October 2019).
- ONR, “Practical Algorithms for Polynomial Optimization”, approximately \$400,000 (October 2016 - October 2019).
- ARPA-E (joint with several colleagues), “Grid Data”, my part approx. \$200,000 (June 2016 - May 201).
- DOE (joint with LANL and other colleagues), “Advanced machine learning for synchrophasor technology”, my part approx. \$150,000 (June 2016 - September 2019).
- DARPA (joint with other institutions), ”Machine-Intelligence for Advance Notification of Threats and Energy - Grid Survivable Situational Awareness”, my part approx. \$300,000. (June 2016 - May 2019).
- DTRA, ‘Power grid vulnerability and resilience to geographically correlated failures’, \$350,000 (October 2012 - 2016. Extended through 2019).

- BHP Billiton gift to support research, \$150,000. (2012)

Current service and Editorships

Upcoming chair of INFORMS Optimization Society.

Editor-in-chief, *Mathematical Programming Computation* (1/2015 -).

Program Committee, *International Symposium on Mathematical Programming 2018*.

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

Publications

Books

Electrical Transmission System Cascades and Vulnerability: An Operations Research Viewpoint, ISBN 978-1-611974-15-7. SIAM-MOS Series on Optimization (2015).

Potential Function Methods for Approximately Solving Linear Programming Problems, Theory and Practice, ISBN 1-4020-7173-6. Kluwer Academic Publishers, Boston (2002).

Special Volumes

Analytic Research Foundations for the Next-Generation Electric Grid (coauthor), *The National Academies Press* (2016).

Journal and Conference Publications

1. Computing undetectable grid attacks, with M. Escobar. To appear, *2018 SIAM Network Science Workshop*. Journal version forthcoming.
2. Simpler derivation of bounded pitch inequalities for set covering and knapsack sets, with M. Zuckerberg. Journal version forthcoming.
3. Approximate global optimal training of deep networks of bounded size, with G. Muñoz. Journal version forthcoming.

4. Outer-Product-Free Sets for Polynomial Optimization and Oracle-Based Cuts, with C. Chen and G. Muñoz, arXiv:1610.04604, submitted. **Winner, 2017 MIP Workshop poster award.**
5. Variance-Aware Optimal Power Flow, with A. Shukla. To appear, *PSCC 2018*. Also see arXiv:1711.00906.
6. LP formulations for polynomial optimization problems (with G. Muñoz), arXiv 1501.00288, to appear, *SIAM J. Optimization (2018)*. **Winner, 2016 Informs Optimization Society Student Paper Prize; Winner, 2015 MIP Workshop poster award.**
7. Non-Stationary Streaming PCA, with A. Shukla and S. Yun, *Proc NIPS Time Series Workshop (2017)*.
8. Robust linear control of storage in transmission systems, and extensions to robust network control problems, with G. Muñoz, S. Yang and C. Matke. Proc. CDC '17. Also see arXiv:1610.09432.
9. A Modified Benders Decomposition for Chance-Constrained Unit Commitment with N-1 Security and Wind Uncertainty, (with K Sundar, H Nagarajan, L Roald, S Misra, R Bent), arXiv:1703.05206, submitted.
10. Unit commitment with N-1 security and wind uncertainty, (with K. Sundar, H. Nagarajan, M. Lubin, L. Roald, S. Misra and R. Bent). *PSCC '16*, 1–7.
11. Analyzing Vulnerability of Power Systems with Continuous Optimization Formulations (with S. Harnett, T. Kim and S. Wright). *IEEE Trans. Network Science and Eng.* **3** (2016), 132 – 146.
12. A note on polynomial solvability of the CDT problem (2013). arXiv:1406.6429. Appeared online in: *SIAM J. Optimization* **26** (2016) 486–496.
13. Stochastic models and control for electrical power line temperature (with J. Blanchet and J. Li), *Energy Systems* **7** (2016) 173 – 192. An earlier version of this work appeared in *Proc. 51st Annual Allerton Conference on Communication, Control and Computing (2013)*, 1344-1348.
14. Temperature-based instanton analysis: Identifying vulnerability in transmission networks, with J. Kerulis, I. Hiskens, M. Chertkov and S. Backhaus, *2015 PowerTech*, 1-6.
15. On linear relaxations of OPF problems (with G. Muñoz), arXiv:1411.1120. *Proc. PES-GM '15*.
16. Chance-constrained DC-OPF (with M. Chertkov and S. Harnett), *SIAM Review* **56** (2014), 461 – 495.
17. Approximation Algorithms for the Incremental Knapsack Problem via Disjunctive Programming (with C. Ye and J. Sethuraman), arXiv:1311.4563.
18. Polynomial solvability of variants of the trust-region subproblem (with A. Michalka), *Proc. 25th ACM-SIAM Symp. on Discrete Algorithms (SODA 2014)*, 380 – 390.
19. Strong formulations for convex functions over nonconvex sets (with A. Michalka), *SIAM J. Optimization* **24** (2014), 643-677.
20. 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).
21. Power line control under uncertainty of ambient temperature (with J. Blanchet and J. Li), CDC '13.
22. Robust modeling of probabilistic uncertainty in smart grids: Data ambiguous chance constrained optimum power flow, with M. Chertkov and S. Harnett, *Proc 2013 CDC*, 4335-4340.
23. Models for managing the impact of an epidemic (with A.C. Zenteno), arXiv:1507.08648.
24. 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*.

25. Optimal control of cascading power grid failures, Proc. 2011 IEEE PES Meeting, Proc. 2011 joint CDC-IEEE meeting.
26. Solving LP Relaxations of Large-Scale Precedence Constrained Problems (with M. Zuckerberg), *Proc. IPCO 2010*, 1–14.
27. Eigenvalue techniques for proving bounds for convex objective, nonconvex programs. IPCO 2010, EWMINLP10.
28. Tightening simple mixed-integer sets with guaranteed bounds (with B. McClosky), *Math. Programming*. Published online 12/2010.
29. The $N - k$ Problem in Power Grids: New Models, Formulations and Numerical Experiments (with A. Verma) *SIAM J. Optimization* **20** (2010) 1052-6234.
30. Approximate formulations for 0-1 knapsack sets, *Operations Research Letters* **36** (2008), 317–320.
31. Computing robust basestock levels (with N. Özbay), *Discrete Optimization* **5** (2008), 389–414.
32. Histogram models for robust portfolio optimization, *J. Computational Finance* **11** (2007), 1–64.
33. Using mixed-integer programming to solve power grid blackout problems (with S. Mattia), *Discrete Optimization* **4** (2007), 115–141.
34. 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.
35. Approximate fixed-rank closures of covering problems (with M. Zuckerberg), *Math. Programming* **105** (2006), 9 – 27.
36. Faster approximation algorithms for covering and packing problems (with G. Iyengar), *SIAM J. Computing* **35** (2006) 825-854.
37. 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.
38. Tree-width and the Sherali-Adams operator (with N. Özbay), CORC report TR-2003-09. *Discrete Optimization* **1** (2004) 13-22.
39. Subset Algebra Lift Operators for 0-1 Integer Programming (with M. Zuckerberg), *SIAM J. Optimization* **15** (2004) 63-95.
40. Approximation Algorithms for Linear Programming: Theory and Practice, *CORE Lecture Series Monograph* ISSN-0771 3894, Core, UCL, Belgium (2001).
41. 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>).
42. 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).
43. ATM network design: Traffic models and optimization-based heuristics (with I. Saniee), *Telecomm. Systems* **16** (2001), 399–421.
44. Strong inequalities for capacitated survivable network design problems (with G. Muratore), *Math. Programming* **89** (2000), 127-148.
45. Minimum-cost capacity installation for multicommodity flows (with O. Günlük, S. Chopra and C.Y. Tsai) (1996), *Math. Programming* **81** (1998), 177-199.

46. Capacity expansion in networks – new inequalities and computation (with O. Günlük), *ORSA J. Comp.* **8** (1996), 243-260.
47. Computational study of a family of mixed-integer quadratic programming problems, *Math. Programming* **74** (1996), 121-140.
48. A degree sequence problem related to network design (with O. Günlük), *Networks* **24** (1994), 195-205.
49. 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.
50. Computational experience with a difficult multicommodity flow problem (with O. Günlük), *Math. Programming* **68** (1995), 213-237.
51. Computational experience with an effective heuristic for some capacity expansion problems in local access networks, *Telecomm. Sys.* **1** (1993), 379-400.
52. Algorithmic implications of the Graph Minors project (with M. Langston), in *Handbook of Operations Research* (Ball, Magnanti, Monma, Nemhauser, eds.), North-Holland (1995).
53. Blocking small cuts in a network (with N. Diaz), *SIAM J. Computing* **22** (1993), 482-499.
54. A lot-sizing problem on trees, related to network design, *Math. Oper. Res.* **18** (1993), 402-422.
55. A note on the prize-collecting traveling salesman problem (with M. Goemans, D. Simchi-Levi and D. Williamson), *Math. Programming* **59** (1993), 413-420.
56. New results on rectilinear crossing numbers and plane embeddings (with N. Dean), *J. Graph Theory* **16** (1992), 389-398.
57. Bounds on rectilinear crossing numbers (with N. Dean), *J. Graph Theory* **17** (1993), 333-348.
58. 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.
59. On obstructions to small face covers in planar graphs (with N. Dean), *J. Comb. Theory B* **55** (1992), 163-189.
60. Further polynomially solvable special cases of the Steiner tree problem in planar networks (with M. Bern), *Annals of Operations Research* **33** (1991), 405-418.
61. Graph searching, path-width and tree-width (a survey), in *Reliability of Computer and Communication Networks* (Roberts, Hwang, Monma, eds.) DIMACS (1991), 33-49.
62. Some provably hard crossing number problems, *Disc. Comput. Geom.* **6** (1991), 443-459.
63. On the complexity of testing for odd holes and induced odd paths, *Discrete Math.* **90** (1991), 85-92. (Corrigendum: *D.M.* **102** (1992) 109).
64. Excluding a forest quickly (with N. Robertson, R. Thomas and P.D. Seymour), *J. Comb. Theory (B)* **52** (1991), 274-283.
65. Some generalized max-flow min-cut problems in the plane, *Math. Oper. Res.* **16** (1991), 310-333.
66. Monotonicity in graph searching (with P.D. Seymour), *J. of Algorithms* **12** (1991), 239-245.
67. An extremal problem on sparse 0-1 matrices (with E. Györi), *SIAM J. Disc. Math.* **4** (1991), 17-27.
68. Linear time test for small face covers in any fixed surface, *SIAM J. Comput.* **19** (1990), 907-911.
69. On a network design problem that is intractable on trees (with O. Marcotte), *Math. Oper. Res.* **15** (1990), 530-544.

70. 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.
71. On embedding graphs in trees, *J. Comb. Theory B* **49** (1990), 103-136.
72. On the complexity of minimizing various distance measures in a planar graph (with C.L. Monma), *Algorithmica* **5** (1990), 93-109.
73. Optimal enclosing of vertices in a planar graph (with C.L. Monma), *Networks* **19** (1989), 79-94.
74. Average distance in graphs with removed elements (with E. Györi), *J. Graph Theory* **12** (1988), 375-390.
75. Some lattice-theoretic tools for network reliability analysis, *Math. Oper. Res.* **13** (1988), 467-478.
76. Optimizing resource acquisitions by stochastic programming (with J.F. Shapiro), *Mgt. Sci.* **34** (1988), 215-229.
77. On the complexity of covering vertices by faces in a planar graph (with C.L. Monma), *SIAM J. Comput.* **17** (1988), 53-76.
78. Reliability analysis of generalizations of Halin graphs, in *Applications of Discrete Mathematics* (R. Ringeisen and F. Roberts, eds.) SIAM (1988), 87-106.
79. Broadcasting with random faults, *Disc. Appl. Math* **20** (1988), 1-7.
80. Asymptotic analysis of some network reliability problems, *SIAM J. Disc. Math* **1** (1988), 14-21.
81. An algorithm for reliability analysis of planar graphs, *Networks* **16** (1986) 411-422.
82. A Collocational Model of Information Transfer (with R. Smith and E. Housman), *Information Interaction: Proceedings of the Annual Meeting of the American Society of Information Science* **19** (1982), 281-84.