

## Curriculum Vitae

**Daniel Bienstock**

Dept. of IEOR, Columbia University  
<http://www.columbia.edu/~dano>

### 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

- ARPA-E (joint with several colleagues), “GO competition, challenge 1”, my part approx. \$250,000 (November 2018 - November 2019).
- 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 - 08/30/2019).
- ONR, “Practical Algorithms for Polynomial Optimization”, approximately \$480,000 (October 2016 - August 2020).
- 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).
- DTRA, ‘Power grid vulnerability and resilience to geographically correlated failures’, \$350,000 (October 2012 - 2016. Extended through May 2020).
- 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).

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

## Current service and Editorships

Program Committee Chair, *International Symposium on Mathematical Programming 2020*.

Chair, *INFORMS Optimization Society*, 2019, 2020.

I created the MIP series of conferences on integer programming, now on its fourteenth 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. Learning from power system data stream: phasor-detective approach, with M. Escobar and M. Chertkov, arXiv:1811.07139. To appear, Powertech '19.
2. Outer-Product-Free Sets for Polynomial Optimization and Oracle-Based Cuts, with C. Chen and G. Muñoz, arXiv:1610.04604. To appear, IPCO '19. **Winner, 2017 MIP Workshop poster award.**
3. On inequalities with bounded coefficients and pitch for the min knapsack polytope, with Y. Faenza, I. Malinovic, M. Mastrolilli, O. Svensson and M. Zuckerberg, submitted.

4. Non-Stationary Streaming PCA, with A. Shukla and S. Yun, *Proc NIPS Time Series Workshop* (2017), submitted.
5. Principled Deep Neural Network Training through Linear Programming, with G. Muñoz and S. Pokutta, arXiv:1810.0321, submitted.
6. Variance-Aware Optimal Power Flow, with A. Shukla, *Proc. PSCC 2018*. Also see arXiv:1711.00906, submitted.
7. Stochastic defense against complex grid attacks, with M. Escobar, arXiv:1807.06707. Also see: Computing undetectable grid attacks, *Proc. 2018 SIAM Network Science Workshop*. To appear, *Proc. 2019 SIAM Network Science Workshop*. Submitted.
8. Simpler derivation of bounded pitch inequalities for set covering and knapsack sets, with M. Zuckerberg, arXiv 1806.07435.
9. LP formulations for polynomial optimization problems (with G. Muñoz), arXiv 1501.00288, *SIAM J. Optimization* **28** (2018), 1121–1150. **Winner, 2016 INFORMS Optimization Society Student Paper Prize; Winner, 2015 MIP Workshop poster award.**
10. 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.
11. 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.
12. 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.
13. 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.
14. A note on polynomial solvability of the CDT problem (2013). arXiv:1406.6429. Appeared online in: *SIAM J. Optimization* **26** (2016) 486–496.
15. 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.
16. Temperature-based instanton analysis: Identifying vulnerability in transmission networks, with J. Kersulis, I. Hiskens, M. Chertkov and S. Backhaus, *2015 PowerTech*, 1-6.
17. On linear relaxations of OPF problems (with G. Muñoz), arXiv:1411.1120. *Proc. PES-GM '15*.
18. Chance-constrained DC-OPF (with M. Chertkov and S. Harnett), *SIAM Review* **56** (2014), 461 – 495.
19. Approximation Algorithms for the Incremental Knapsack Problem via Disjunctive Programming (with C. Ye and J. Sethuraman), aXiv:1311.4563.
20. Polynomial solvability of variants of the trust-region subproblem (with A. Michalka), *Proc. 25<sup>th</sup> ACM-SIAM Symp. on Discrete Algorithms (SODA 2014)*, 380 – 390.
21. Strong formulations for convex functions over nonconvex sets (with A. Michalka), *SIAM J. Optimization* **24** (2014), 643-677.
22. 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)*.

23. Power line control under uncertainty of ambient temperature (with J. Blanchet and J. Li), CDC '13.
24. 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.
25. Models for managing the impact of an epidemic (with A.C. Zenteno), arXiv:1507.08648.
26. 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*.
27. Optimal control of cascading power grid failures, Proc. 2011 IEEE PES Meeting, Proc. 2011 joint CDC-IEEE meeting.
28. Solving LP Relaxations of Large-Scale Precedence Constrained Problems (with M. Zuckerberg), *Proc. IPCO 2010*, 1–14.
29. Eigenvalue techniques for proving bounds for convex objective, nonconvex programs. IPCO 2010, EWMINLP10.
30. Tightening simple mixed-integer sets with guaranteed bounds (with B. McClosky), *Math. Programming*. Published online 12/2010.
31. The  $N - k$  Problem in Power Grids: New Models, Formulations and Numerical Experiments (with A. Verma) *SIAM J. Optimization* **20** (2010) 1052-6234.
32. Approximate formulations for 0-1 knapsack sets, *Operations Research Letters* **36** (2008), 317–320.
33. Computing robust basestock levels (with N. Özbay), *Discrete Optimization* **5** (2008), 389–414.
34. Histogram models for robust portfolio optimization, *J. Computational Finance* **11** (2007), 1–64.
35. Using mixed-integer programming to solve power grid blackout problems (with S. Mattia), *Discrete Optimization* **4** (2007), 115–141.
36. 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.
37. Approximate fixed-rank closures of covering problems (with M. Zuckerberg), *Math. Programming* **105** (2006), 9 – 27.
38. Faster approximation algorithms for covering and packing problems (with G. Iyengar), *SIAM J. Computing* **35** (2006) 825-854.
39. 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.
40. Tree-width and the Sherali-Adams operator (with N. Özbay), CORC report TR-2003-09. *Discrete Optimization* **1** (2004) 13-22.
41. Subset Algebra Lift Operators for 0-1 Integer Programming (with M. Zuckerberg), *SIAM J. Optimization* **15** (2004) 63-95.
42. Approximation Algorithms for Linear Programming: Theory and Practice, *CORE Lecture Series Monograph* ISSN-0771 3894, Core, UCL, Belgium (2001).
43. 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>).

44. 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).
45. ATM network design: Traffic models and optimization-based heuristics (with I. Saniee), *Telecomm. Systems* **16** (2001), 399–421.
46. Strong inequalities for capacitated survivable network design problems (with G. Muratore), *Math. Programming* **89** (2000), 127-148.
47. Minimum-cost capacity installation for multicommodity flows (with O. Günlük, S. Chopra and C.Y. Tsai) (1996), *Math. Programming* **81** (1998), 177-199.
48. Capacity expansion in networks – new inequalities and computation (with O. Günlük), *ORSA J. Comp.* **8** (1996), 243-260.
49. Computational study of a family of mixed-integer quadratic programming problems, *Math. Programming* **74** (1996), 121-140.
50. A degree sequence problem related to network design (with O. Günlük), *Networks* **24** (1994), 195-205.
51. 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.
52. Computational experience with a difficult multicommodity flow problem (with O. Günlük), *Math. Programming* **68** (1995), 213-237.
53. Computational experience with an effective heuristic for some capacity expansion problems in local access networks, *Telecomm. Sys.* **1** (1993), 379-400.
54. Algorithmic implications of the Graph Minors project (with M. Langston), in *Handbook of Operations Research* (Ball, Magnanti, Monma, Nemhauser, eds.), North-Holland (1995).
55. Blocking small cuts in a network (with N. Diaz), *SIAM J. Computing* **22** (1993), 482-499.
56. A lot-sizing problem on trees, related to network design, *Math. Oper. Res.* **18** (1993), 402-422.
57. A note on the prize-collecting traveling salesman problem (with M. Goemans, D. Simchi-Levi and D. Williamson), *Math. Programming* **59** (1993), 413-420.
58. New results on rectilinear crossing numbers and plane embeddings (with N. Dean), *J. Graph Theory* **16** (1992), 389-398.
59. Bounds on rectilinear crossing numbers (with N. Dean), *J. Graph Theory* **17** (1993), 333-348.
60. 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.
61. On obstructions to small face covers in planar graphs (with N. Dean), *J. Comb. Theory B* **55** (1992), 163-189.
62. Further polynomially solvable special cases of the Steiner tree problem in planar networks (with M. Bern), *Annals of Operations Research* **33** (1991), 405-418.
63. Graph searching, path-width and tree-width (a survey), in *Reliability of Computer and Communication Networks* (Roberts, Hwang, Monma, eds.) DIMACS (1991), 33-49.
64. Some provably hard crossing number problems, *Disc. Comput. Geom.* **6** (1991), 443-459.
65. On the complexity of testing for odd holes and induced odd paths, *Discrete Math.* **90** (1991), 85-92. (Corrigendum: *D.M.* **102** (1992) 109 ).

66. Excluding a forest quickly (with N. Robertson, R. Thomas and P.D. Seymour), *J. Comb. Theory (B)* **52** (1991), 274-283.
67. Some generalized max-flow min-cut problems in the plane, *Math. Oper. Res.* **16** (1991), 310-333.
68. Monotonicity in graph searching (with P.D. Seymour), *J. of Algorithms* **12** (1991), 239-245.
69. An extremal problem on sparse 0-1 matrices (with E. Györi), *SIAM J. Disc. Math.* **4** (1991), 17-27.
70. Linear time test for small face covers in any fixed surface, *SIAM J. Comput.* **19** (1990), 907-911.
71. On a network design problem that is intractable on trees (with O. Marcotte), *Math. Oper. Res.* **15** (1990), 530-544.
72. 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.
73. On embedding graphs in trees, *J. Comb. Theory B* **49** (1990), 103-136.
74. On the complexity of minimizing various distance measures in a planar graph (with C.L. Monma), *Algorithmica* **5** (1990), 93-109.
75. Optimal enclosing of vertices in a planar graph (with C.L. Monma), *Networks* **19** (1989), 79-94.
76. Average distance in graphs with removed elements (with E. Györi), *J. Graph Theory* **12** (1988), 375-390.
77. Some lattice-theoretic tools for network reliability analysis, *Math. Oper. Res.* **13** (1988), 467-478.
78. Optimizing resource acquisitions by stochastic programming (with J.F. Shapiro), *Mgt. Sci.* **34** (1988), 215-229.
79. On the complexity of covering vertices by faces in a planar graph (with C.L. Monma), *SIAM J. Comput.* **17** (1988), 53-76.
80. Reliability analysis of generalizations of Halin graphs, in *Applications of Discrete Mathematics* (R. Ringeisen and F. Roberts, eds.) SIAM (1988), 87-106.
81. Broadcasting with random faults, *Disc. Appl. Math* **20** (1988), 1-7.
82. Asymptotic analysis of some network reliability problems, *SIAM J. Disc. Math* **1** (1988), 14-21.
83. An algorithm for reliability analysis of planar graphs, *Networks* **16** (1986) 411-422.
84. 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.