Philip N. Klein
Professor
Department of Computer Science
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Brief Bio

Phil Klein is Professor of Computer Science at Brown University. He is a Fellow of the ACM (2010) and a recipient of the National Science Foundation's Presidential Young Investigator Award (1991). He is a recipient of Brown University's Philip J. Bray Award for Excellence in Teaching in the Sciences (2007). He was the program chair for the 28th Annual ACM-SIAM Symposium on Discrete Algorithms (2017), the premier conference focused on design and analysis of algorithms. He was a Fellow at the Radcliffe Institute for Advanced Study at Harvard University (2015-16). His research focuses on algorithms for optimization problems in graphs.

Education

- Ph.D. in Computer Science, Massachusetts Institute of Technology, 1988. Dissertation title: *Efficient Parallel Algorithms for Planar, Chordal, and Interval Graphs*, supervised by Professor David Shmoys. Minor in Numerical Analysis.
- S.M. in Computer Science, Massachusetts Institute of Technology, 1986. Thesis title: *An Efficient Parallel Algorithm for Planarity*, supervised by Professor David Shmoys.
- A.B., *summa cum laude* in Applied Mathematics, Harvard College, 1984. Thesis title: *Parallel Recognition of Context-Free Languages*, supervised by Professor John Reif.

Academic Appointments

- 2000—: Professor, Brown University
- 2015-16: Radcliffe Fellow, Harvard University
- August 2008–August 2015 Research Affiliate, MIT CSAIL
- January 2008–August 2008: Visiting Scientist, MIT CSAIL
- August 2007-January 2008: Research Affiliate, MIT CSAIL
- 1994–2000: Associate Professor, Brown University
- 1989–1994: Assistant Professor, Brown University
- 1993: Visiting Scientist, Princeton University
- 1992-93: Visiting Scholar, MIT Mathematics Department
- 1988-89: Postdoctoral fellow, Harvard University

Publications

Refereed Conference Articles

- "On the computational tractability of a geographic clustering problem arising in redistricting," Vincent Cohen-Addad, Philip N. Klein, Dániel Marx, Archer Wheeler, and Christopher Wolfram, *Proceedings of the 2nd Symposium on Foundations of Responsible Computing*, pp. 3:1–3:18 (2021)
- "A quasipolynomial $2+\epsilon$-approximation for planar sparsest cut," Vincent Cohen-Addad, Anupam Gupta, Philip N. Klein, and Jason Li, *Proceedings of the 53rd Annual ACM SIGACT Symposium on Theory of Computing*, pp. 1056–1069 (2021)
- "The impact of highly compact algorithmic redistricting on the rural-versus-urban balance," Archer Wheeler and Philip N. Klein, *Proceedings of the 28th ACM International Conference on Advances in Geographic Information Systems*, pp. 397-400.

- "On light spanners, low-treewidth embeddings and efficient traversing in minor-free graphs," Vincent Cohen-Addadd, Arnold Filtser, Philip N. Klein, and Hung Le, *Proceedings of the 61st Annual IEEE Symposium on Foundations of Computer Science* (2020), pp. 589-600.
- "New hardness results for planar graph problems in P and an algorithm for sparsest cut," Amir Abboud, Vincent Cohen-Addad, Philip N. Klein, *Proceedings of the 52nd Annual ACM Symposium on Theory of Computing* (2020), pp. 996-1009
- "A PTAS for bounded-capacity vehicle routing in planar graphs," Amariah Becker, Philip N. Klein, and Aaron Schild, *Proceedings of the 16th International Symposium on Algorithms and Data Structures* (2019), pp. 99-111
- "Embedding planar graphs into low-treewidth graphs with applications to efficient approximation schemes for metric problems," Eli Fox-Epstein, Philip N. Klein, and Aaron Schild, *Proceedings of the 30th Annual ACM-SIAM Symposium on Discrete Algorithms* (2019), pp. 1069–1088.
- "Polynomial-time approximation schemes for k-center, k-median, and capacitated vehicle routing in bounded highway dimension," Amariah Becker, Philip N. Klein, David Saulpic, *Proceedings of the 26th Annual European Symposium on Algorithms* (2018), 8:1-8:15.
- "Balanced power diagrams for redistricting," Vincent Cohen-Addad, Philip N. Klein, and Neal E. Young, *Proceedings of the 26th International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL)* (2018), pp. 389–396.
- "Polynomial-time approximation schemes for k-center, k-median, and bounded-capacity vehicle routing in metrics with bounded highway dimension," Amariah Becker, Philip N. Klein, and David Saulpic, *Proceedings of the 26th Annual European Symposium on Algorithms* (2018), 8:1-8:15
- "A quasi-polynomial-time approximation scheme for vehicle routing on planar and bounded-genus graphs," Amariah Becker, Philip N. Klein,and David Saulpic, *Proceedings of the 25th Annual European Symposium on Algorithms* (2017), pp. 12:1-12:15.
- "Engineering an approximation scheme for traveling salesman in planar graphs," Amariah Becker, Eli Fox-Epstein, Philip N. Klein, and David Meierfrankenfeld, *Proceedings of the 16th International Symposium on Experimental Algorithms* (2017), pp. 8:1-8:17
- "Local search yields approximation schemes for k-means and k-median in Euclidean and minor-free metrics," Vincent Cohen-Addad, Philip N. Klein, and Claire Mathieu, *Proceedings of the 57th IEEE Symposium on Foundations of Computer Science* (2016), pp. 353-364
- "Approximating connectivity domination in weighted bounded-genus graphs," Vincent Cohen-Addad, Eric Colin de Verdiére, Philip N. Klein, and Claire Mathieu, David Meierfrankenfeld, *Proceedings of the 48th ACM Symposium on Theory of Computing* (2016), pp. 584-597.
- "Correlation clustering and two-edge-connected augmentation for planar graphs," Philip N. Klein, Claire Mathieu, and Hang Zhou, *Proceedings of the 32nd Symposium on Theoretical Aspects of Computer Science* (2015), pp. 554-567.
- "A polynomial-time bicriteria approximation scheme for planar bisection," Kyle Fox, Philip N. Klein, and Shay Mozes, *ACM Symposium on Theory of Computing* (2015), pp. 841-850.
- "Approximating k-center in planar graphs," David Eisenstat, Philip N. Klein, Claire Mathieu, *Proceedings of the 25rd Annual ACM-SIAM Symposium on Discrete Algorithms* (2014), pp. 617-627.
- "A subexponential parameterized algorithm for Subset TSP on planar graphs," Philip N. Klein, Dániel Marx, *Proceedings of the 25rd Annual ACM-SIAM Symposium on Discrete Algorithms* (2014), pp. 1812-1830.
- "Structured recursive separator decompositions for planar graphs in linear time," Philip N. Klein, Shay Mozes, Christian Sommer, *Proceedings of the ACM Symposium on Theory of Computing* (2013), pp. 505-514.
- "Linear-time algorithms for max flow and multiple-source shortest paths in unit-weight planar graphs," David Eisenstat, Philip N. Klein *Proceedings of the ACM Symposium on Theory of Computing* (2013), pp. 735-744.
- "Solving planar k-terminal cut in $O(n^{c\sqrt{k}})$ time," Philip N. Klein and Dániel Marx, *Proceedings*

of the 39th International Colloquium on Automata, Languages, and Programming (2012), pp. 569-580.

- "A polynomial-time approximation scheme for planar multiway cut," MohammadHossein Bateni, MohammadTaghi Hajiaghayi, Philip N. Klein, and Claire Mathieu, *Proceedings of the 23rd Annual ACM-SIAM Symposium on Discrete Algorithms* (2012), 639-655.
- "An efficient polynomial-time approximation scheme for Steiner forest in planar graphs," David Eisenstat, Philip N. Klein, and Claire Mathieu, *Proceedings of the 23rd Annual ACM-SIAM Symposium on Discrete Algorithms* (2012), pp. 626-638.
- "Multiple-source multiple-sink maximum flow in directed planar graphs in near-linear time," Glencora Borradaile, Philip N. Klein, Shay Mozes, Yahav Nussbaum, and Christian Wulff-Nilsen, *Proceedings of the 52nd Annual IEEE Symposium on Foundations of Computer Science* (2011), pp. 170-179.
- "Linear-space approximate distance oracles for planar, bounded-genus and minor-free graphs," Ken-ichi Kawarabayashi, Philip N. Klein, and Christian Sommer, *Proceedings of the 38th International Colloquium on Automata, Languages, and Programming* (2011), pp. 135-146
- "Multiple-source single-sink maximum flow in directed planar graphs in $O(\text{diameter } nlogn)$ time," Philip N. Klein and Shay Mozes, *Proceedings of the 12th Algorithms and Data Structures Symposium* (2011), pp. 571-582.
- "Node-weighted Steiner tree and group Steiner tree in planar graphs," Erik D. Demaine, MohammadTaghi Hajiaghayi and Philip Klein, *Proceedings of the 36th International Colloquium on Automata, Languages and Programming* (2009), pp. 328-340.
- "Shortest paths in directed planar graphs with negative lengths: a linear-space $O(n \log^2 n)$-time algorithm," Philip N. Klein, Shay Mozes, and Oren Weimann, *Proceedings of the 20th Annual ACM-SIAM Symposium on Discrete Algorithms* (2009), pp. 236-245.
- "The two-edge connectivity survivable network problem in planar graphs," with Glencora Borradaile, *Proceedings of the 35th International Conference on Automata, Languages, and Programming* (2008), pp. 485-501.
- "A polynomial-time approximation scheme for Euclidean Steiner forest," with Glencora Borradaile and Claire Mathieu, *Proceedings of the 49th Annual IEEE Symposium on Foundations of Computer Science* (2008), pp. 115-124.
- "Steiner tree in planar graphs: An $O(n \log n)$ approximation scheme with singly-exponential dependence on epsilon," with Glencora Borradaile and Claire Mathieu, *Proceedings of the 10th International Workshop on Algorithms and Data Structures* (2007), pp. 275-286.
- "A polynomial-time approximation scheme for Steiner tree in planar graphs," with Glencora Borradaile and Claire Kenyon-Mathieu, *Proceedings of the 18th Annual ACM-SIAM Symposium on Discrete Algorithms* (2007), pp. 1285–1294.
- "A subset spanner for planar graphs, with application to subset TSP", *Proceedings of the 38th Annual ACM Symposium on Theory of Computing* (2006), pp. 749–756.
- "An $O(n \log n)$ algorithm for maximum st-flow in a directed planar graph," with Glencora Borradaile, *Proceedings of the 17th Annual ACM-SIAM Symposium on Discrete Algorithms* (2006), pp. 524–533.
- "A linear-time approximation scheme for TSP for planar weighted graphs", *Proceedings of the 46th Annual IEEE Symposium on Foundations of Computer Science* (2005), pp. 647–656.
- "Multiple-source shortest paths in planar graphs," *Proceedings of the 16th Annual ACM-SIAM Symposium on Discrete Algorithms* (2005), pp. 146–155.
- "Shock-based Indexing into Large Shape Databases," with Thomas Sebastian and Benjamin B. Kimia, *Proceedings of the 7th European Conference on Computer Vision, Volume III* (2002), pp. 731–746.
- "Preprocessing an undirected planar network to enable fast approximate distance queries," *Proceedings of the 13th Annual ACM-SIAM Symposium on Discrete Algorithms* (2002), pp. 820–827.
- "Recognition of shapes by editing shock graphs," with Thomas B. Sebastian and Benjamin B.

Kimia, *Proceedings of the 8th International Conference on Computer Vision* (2001), pp. 755-762.

- "Alignment-based recognition of shape outlines," with Thomas B. Sebastian and Benjamin B. Kimia, *International Workshop on Visual Form* (2001), pp. 606-618.
- "Shape matching using edit-distance: an implementation,", with Thomas B. Sebastian and Benjamin B. Kimia, *Proceedings of the 12th Annual ACM-SIAM Symposium on Discrete Algorithms*(2001), pp. 781–790.
- "A tree-edit-distance algorithm for comparing simple, closed shapes," with Srikanta Tirthapura, Daniel Sharvit, and Benjamin Kimia, *Proceedings of the 11th Annual ACM-SIAM Symposium on Discrete Algorithms* (2000), pp. 696–704.
- "Finding the closest lattice vector when it's unusually close," *Proceedings of the 11th Annual ACM-SIAM Symposium on Discrete Algorithms* (2000), pp. 937–941.
- "Using router stamping to identify the source of IP packets," with Thomas Doeppner and Andrew Koyfman, *Proceedings of the 7th ACM Conference on Computer and Communication Security* (2000), pp. 184-189.
- "Constructing 2D curve atlases," with Thomas Sebastian, Joseph J. Crisco, and Benjamin Kimia, *Proceedings of the IEEE Workshop on Mathematical Methods in Biomedical Image Analysis* (2000), pp. 70–77.
- "On the number of iterations for Dantzig-Wolfe optimization and packing-covering approximation algorithms," with Neal E. Young, *Proceedings of the 7th International Conference on Integer Programming and Combinatorial Optimization* (1999), pp. 320-327.
- "Indexing based on edit-distance matching of shape graphs," with Srikanta Tirtapura, Daniel Sharvit, and Benjamin Kimia, *Proceedings of the SPIE International Symposium on Voice, Video, and Data Communications* (1998), pp. 25–36.
- "Space-efficient approximation algorithms for MAXCUT and COLORING semidefinite programs," with Hsueh-I Lu, *Proceedings, of the 9th International Symposium on Algorithms and Computation* Lecture Notes in Computer Science 1533, Springer-Verlag, pp. 387-396. (1998).
- "Computing the edit distance between unrooted ordered trees," *Proceedings of the 6th European Symposium on Algorithms* (1998), pp. 91–102.
- "A polynomial-time approximation scheme for weighted planar graph TSP," with Sanjeev Arora, Michelangelo Grigni, David Karger and Andrzej Woloszyn, *Proceedings of the 9th Annual ACM-SIAM Symposium on Discrete Algorithms* (1998), pp. 33–41.
- "Race-condition detection in parallel computation with semaphores," with Hsueh-I Lu and Robert H. B. Netzer, *Proceedings of the 4th Annual European Symposium on Algorithms* (1996).
- "Efficient approximation algorithms for semidefinite programs arising from MAXCUT and COLORING," with Hsueh-I Lu, *Proceedings of the 28th ACM Symposium on Theory of Computing* (1996), pp. 338–347.
- "Finding minimum spanning forests in logarithmic time and linear work using random sampling," with Richard Cole and Robert E. Tarjan, *Proceedings of the 8th ACM Symposium on Parallel Algorithms and Architectures* (1996), pp. 243–250.
- "A linear-work parallel algorithm for finding a minimum spanning tree,"with Richard Cole and Robert E. Tarjan, *Proceedings of the 6th ACM Symposium on Parallel Algorithms and Architectures* (1994), pp. 11–15.
- "A linear-processor, polylog-time algorithm for shortest paths in planar graphs," with Sairam Subramanian, *Proceedings of the 34th IEEE Symposium on Foundations of Computer Science* (1993), pp. 259–270.
- "Detecting race conditions in parallel programs that use one semaphore," with Hsueh-I Lu and Robert H. B. Netzer, *Proceedings of the 3rd Workshop on Algorithms and Data Structures* (1993), pp. 471–482.
- "Excluded minors, network decomposition, and multicommodity flow," with Serge Plotkin and Satish Rao, *Proceedings of the 25th ACM Symposium on Theory of Computing* (1993), pp. 682–690.
- "When cycles collapse: a general approximation technique for constrained two-connectivity prob-

lems," with R. Ravi, *Proceedings of the 3rd Symposium on Integer Programming and Combinatorial Optimization* (1993) pp. 39–55.

- "On Gazit and Miller's parallel algorithm for planar separators: achieving greater efficiency through random sampling," *Proceedings of the 5th ACM Symposium on Parallel Algorithms and Architectures* (1993), pp. 43–49.
- "Approximation through local optimality: designing networks with small degree," with R. Ravi and Balaji Raghavachari, *Proceedings of the Twelfth Annual Conference on Foundations of Software Technology and Theoretical Computer Science*, published as *Lecture Notes in Computer Science 652*, edited by R. Shyamasundar, Springer-Verlag, New York (1992), pp. 279–290.
- "Ordering problems approximated: register sufficiency, single-processor scheduling and interval graph completion," with Ajit Agrawal and R. Ravi, *Proceedings of the 18th International Conference on Automata, Languages, and Programming* (1991), published as *Lecture Notes in Computer Science*, vol. 510, pp. 751-762.

Refereed Journal Articles

- "Local search yields approximation schemes for k-means and k-median in Euclidean and minor-free metrics," *SIAM Journal on Computing* 48(2), pp. 644-667 (2019).
- "Multiple-source multiple-sink maximum flow in directed planar graphs in near-linear time," Glencora Borradaile, Philip N. Klein, Shay Mozes, Yahav Nussbaum, and Christian Wulff-Nilsen, *SIAM Journal on Computing* 46(4), pp. 1280-1303 (2017).
- "The two-edge connectivity survivable-network design problem in planar graphs," *ACM Transactions on Algorithms* 12(3), 30:1-30:29 (2016)
- "On the number of iterations for Dantzig-Wolfe optimization and packing-covering approximation algorithms," *SIAM Journal on Computing* 44(4): 1154-1172 (2015).
- "A polynomial-time approximation scheme for Euclidean Steiner forest," Glencora Borradaile, Philip N. Klein, and Claire Mathieu, *ACM Transactions on Algorithms*, 11(3):19:1-19:20 (2015).
- 'Node-weighted Steiner tree and group Steiner tree in planar graphs," Erik D. Demaine, Mohammad Taghi Hajiaghayi, and Philip N. Klein. *ACM Transactions on Algorithms*, 10(3):13 (2014).
- "Identifying and bounding ethnic neighborhoods," John R. Logan, Seth Spielman, Hongwei Xu, and Philip N. Klein, *Urban Geography*, vol. 32, No.3, pp. 334-359 (2011)
- "Shortest paths in directed planar graphs with negative lengths: a linear-space $O(n \log^2 n)$-time algorithm," with Shay Mozes and Oren Weimann, *ACM Transactions on Algorithms* 6 (2010) (Special Issue devoted to Selected Papers from SODA 2009).
- "An $O(n \log n)$ approximation scheme for Steiner tree in planar graphs," with Glencora Borradaile and Claire Mathieu, *ACM Transactions on Algorithms* 5 (2009), Article 31 (Special Issue devoted to Selected Papers from SODA 2007).
- "An $O(n \log n)$ algorithm for maximum st-flow in a directed planar graph," with Glencora Borradaile, *Journal of the ACM* 56 (2009).
- "A linear-time approximation scheme for TSP in undirected planar graphs with edge-weights," *SIAM Journal on Computing* 37 (2008), pp. 1926-1952 (Special Issue devoted to Selected Papers from FOCS 2005).
- "Approximation algorithms for finding low-degree subgraphs," with Radha Krishnan, Balaji Raghavachari, and R. Ravi *Networks* 44 (2004), pp. 203–215.
- "Rounding algorithms for a geometric embedding relaxation of minimum multiway cut," with David R. Karger, Clifford Stein, Mikkel Thorup, and Neal E. Young, *Mathematics of Operations Research* 29 (2004), pp. 436–460. Preliminary version appeared in *Proceedings, ACM Symposium on Theory of Computing* (1999), pp. 668–678.
- "Recognition of shapes by editing their shock graphs," with Thomas Sebastian and Benjamin Kimia, *IEEE Transactions on Pattern Matching and Machine Intelligence* 26 (2004), pp. 550–571.
- "On aligning curves," with Thomas Sebastian and Benjamin Kimia, *IEEE Transactions on*

Pattern Matching and Machine Intelligence 25 (2003), pp. 116–125.

- "Detecting race conditions in parallel programs that use semaphores," with Hsueh-I Lu and R. H.B. Netzer, *Algorithmica* 35 (2003), pp. 321-345 .
- "A fully dynamic approximation scheme for shortest paths in planar graphs," with Sairam Subramanian, *Algorithmica* 23 (1998), pp. 235-249. Preliminary version appeared in *Proceedings, Workshop on Algorithms and Data Structures* (1993), pp. 442-451.
- "Approximation algorithms for Steiner and directed multicuts," with Serge Plotkin, Satish Rao, and Éva Tardos, *Journal of Algorithms* 22 (1997), pp. 241-269.
- "A randomized parallel algorithm for single-source shortest paths," with Sairam Subramanian, *Journal of Algorithms* 25 (1997), pp. 205-220. Preliminary version appeared as "A parallel randomized approximation scheme for shortest paths," *Proceedings, 24th Symposium on Theory of Computing* (1992), pp. 750-758.
- "Faster shortest-path algorithms for planar graphs," with Satish Rao, Monika Rauch Henzinger, and Sairam Subramanian, *Journal of Computer and System Sciences* 55 (Special Issue on Selected Papers from 1994 STOC) (1997), pp. 3-23. Preliminary version appeared in *Proceedings, 26th Symposium on Theory of Computing* (1994), pp. 27–37.
- "Efficient parallel algorithms for chordal graphs," *SIAM J. Comput. 25* (1996), pp. 797-827. Preliminary version appeared in *Proceedings, 29th Annual IEEE Symposium on Foundations of Computer Science* (1988), pp. 150-161.
- "A randomized linear-time algorithm for finding minimum spanning trees," with David Karger and Robert E. Tarjan, *Journal of the ACM* 42 (1995), pp. 321-328. Preliminary version appeared in *Proceedings, 26th Symposium on Theory of Computing* (1994), pp. 9–15.
- "A nearly best-possible approximation algorithm for node-weighted Steiner trees," with R. Ravi, *Journal of Algorithms* 19 (1995), pp. 104-115. Preliminary version appeared in *Proceedings, 3rd Symposium on Integer Programming and Combinatorial Optimization* (1993), pp. 323-332.
- "When trees collide: An approximation algorithm for the generalized Steiner problem on networks," with Ajit Agrawal and R. Ravi, *SIAM J. Comput.* 24 (1995), pp. 440-456. Preliminary version appeared in *Proceedings, 23nd ACM Symposium on Theory of Computing* (1991), pp. 134-144.
- "An approximate max-flow min-cut relation for undirected multicommodity flow, with applications," with Satish Rao, Ajit Agrawal, and R. Ravi, *Combinatorica 15* (1995), pp. 187-202. Preliminary version appeared as part of "Approximation through multicommodity flow," *Proceedings, 31st Annual Symposium on Foundations of Computer Science* (1990), pp. 726-737.
- "Faster approximation algorithms for the unit capacity concurrent flow problem with applications to routing and finding sparse cuts," with Serge Plotkin, Clifford Stein, and Éva Tardos, *SIAM J. Comput. 23* (1994), pp. 466-487. A preliminary version appeared as "Leighton-Rao might be practical: faster approximation algorithms for concurrent flow with uniform capacities," with Clifford Stein and Eva Tardos, *Proceedings, 22nd ACM Symposium on Theory of Computing* (1990), pp. 310-321.
- "A data structure for bicategories, with application to speeding up an approximation algorithm," *Information Processing Letters 52* (1994), pp. 303-307.
- "Towards overcoming the transitive-closure bottleneck: efficient parallel algorithms for planar digraphs," with Ming-Yang Kao, *Journal of Computer and System Sciences 47* (Special Issue on Selected Papers from 22nd STOC) (1993), pp. 459-500. Preliminary version appeared in *Proceedings, 22nd ACM Symposium on Theory of Computing* (1990), pp. 181-192.
- "Parallelism, preprocessing, and reachability: a hybrid algorithm for directed graphs," *Journal of Algorithms 14* (1993), pp. 331-343. Preliminary version appeared in Proceedings of the AMS-IMS-SIAM Joint Summer Research Conference on Graphs and Algorithms (1987).
- "The lattice structure of flow in planar graphs," with Samir Khuller and Joseph Naor, *SIAM Journal on Discrete Mathematics 6* (1993), pp. 477-490.
- "A parallel algorithm for approximating the minimum cycle cover," with Clifford Stein, *Algorithmica 9* (1993), pp. 23-31.

- "Approximating concurrent flow with uniform demands and capacities: an implementation," with James Borger and Sarah Kang, *Network Flows and Matching: First DIMACS Implementation Challenge*, edited by D. S. Johnson and C. C. McGeoch, vol. 12 of DIMACS Series in Discrete Mathematics and Theoretical Computer Science, American Mathematical Society (1993), pp. 371–381.
- "Cutting down on fill using nested dissection: provably good elimination orderings," with Ajit Agrawal and R. Ravi, *Graph Theory and Sparse Matrix Computation*, edited by A. George, J. Gilbert, and J. W. H. Liu, volume 56 in the *IMA Volumes in Mathematics and Its Applications*, Springer-Verlag (1993), pp. 31-55. Preliminary version appeared as part of "Approximation through multicommodity flow," with Ajit Agrawal, R. Ravi, and Satish Rao, *Proceedings, 31st Annual Symposium on Foundations of Computer Science* (1990), pp. 726-737.
- "On the time-space complexity of reachability queries for preprocessed graphs," with Lisa Hellerstein and Robert Wilber, *Information Processing Letters 35* (1990), pp. 261-267.
- "A parallel algorithm for eliminating cycles in undirected graphs," with Clifford Stein, *Information Processing Letters 34* (1990), pp. 307-312.
- "An efficient parallel algorithm for planarity," with John H. Reif, *Journal of Computer and System Sciences* (1988), pp. 190-246 (Special Issue on Selected Papers from 27th FOCS). A preliminary version appeared in *Proceedings, 27th Annual IEEE Symposium on Foundations of Computer Science* (1986), pp. 465-477.
- "Parallel time $O(\log n)$ acceptance of deterministic CFLs on an exclusive-write P-RAM," with John H. Reif, *SIAM J. Comput.* 17 (1988), pp. 463-485.

Books

- *A Cryptography Primer: Secrets and Promises*, Cambridge University Press (2014).
- *Coding the Matrix: Linear Algebra through Computer Science Applications*, Newtonian Press (2013).
- In draft form: *Optimization Algorithms for Planar Graphs* with Shay Mozes, `http://planarity.org`

Chapters in Books

- "Approximation algorithms for NP-hard optimization problems," with Neal Young, Ch. 34 of *CRC Handbook on Algorithms and Theory of Computation*, CRC Press (1998).
- "Parallel algorithms for chordal graphs," *Synthesis of Parallel Algorithms*, edited by John H. Reif, Morgan-Kaufman (1993), pp. 341-407.

Reviews

- Invited review of "Fast approximation algorithms for multicommodity flow problems," *Computing Reviews*, July 1992.

Invited Lectures

- Department of Computer Science, New York University, *"Algorithmic Nonpartisan Redistricting: Three plus epsilon Myths Busted," 2020*
- Workshop: Quantitative Redistricting, The Statistical and Applied Mathematical Sciences Institute, *"Towards Algorithms for Districting Plans that Perfectly Balance Population and Nearly Minimize Dispersion," 2018*
- Workshop: Algorithms on Topologically Restricted Graphs, part of the joint STOC/SoCG 2016 workshop day, *"Approximation Schemes for Planar Graphs: A Survey," 2016*
- Dagstuhl Seminar on Algorithms for Optimization Problems in Planar Graphs , *"Approximation Schemes for Planar Graphs: A Survey," 2016*

- SIAM Conference on Applied Linear Algebra, *"Coding the Matrix: Linear Algebra through Computer Science Applications," 2015*
- Harvard University, CS Theory Seminar, *"Approximation Schemes for Planar Graphs: A How-To Guide," 2015*
- Harvard University, Radcliffe Fellows' Presentation Series,, *"Planarity-Exploiting Algorithms,", 2015*
- Hebrew University Computer Science and Engineering, CS Theory Seminar, *"Approximation Schemes for Planar Graphs: A How-To Guide," 2014*
- Weizmann Institute of Technology Foundations of Computer Science Seminar, *"Approximation Schemes for Planar Graphs: A How-To Guide," 2014*
- Haifa Workshop on Interdisciplinary Applications of Graph Theory, Combinatorics, and Algorithms, *"The world is flat: algorithms for classical optimization problems restricted to planar graphs," 2014*
- MIT Theory of Computation Colloquium, *"The world is flat: algorithms for classical optimization problems restricted to planar graphs", 2013*
- Dagstuhl, Seminar on Algorithms for Optimization Problems in Planar Graphs, , "Some techniques for approximation schemes in planar graphs", 2013
- US Naval Academy, *"Recent algorithms for classical discrete optimization problems restricted to planar graphs: a survey", 2012*
- Princeton University, *"New Approximation Schemes for Optimization Problems in Planar Graphs", 2011*
- Applied Mathematics Colloquium Series, MIT, *"Quickly Computing Approximate Solutions to NP-hard Optimization Problems in Planar Graphs", 2011*
- Shonan Meeting on *Graph Algorithm and Combinatorial Optimization*, *"A polynomial-time approximation scheme for planar multiterminal cut", 2011*
- Department of Industrial Engineering and Operations Research, Columbia University, *"Planarity-exploiting algorithms for optimization problems", 2008*
- Harvard University, *"A planar-graph decomposition, and its application to TSP and Steiner Tree", 2007*
- Yale University, *"A planar-graph decomposition, and its application to TSP and Steiner Tree," 2007*
- INFORMS Annual Meeting, *"A linear-time approximation scheme for planar weighted TSP", 2005*
- Cornell University, *"Multiple-source shortest paths in planar graphs," 2004*
- Carnegie Mellon University, *"Multiple-source shortest paths in planar graphs," 2004*
- IBM Thomas J. Watson Research Center, *"Multiple-source shortest paths in planar graphs," 2004*
- MIT, *"Multiple-source shortest paths in planar graphs," 2003*
- Princeton, *"Multiple-source shortest paths in planar graphs," 2003*
- UCSD, *"Multiple-source shortest paths in planar graphs," 2003*
- Northwestern University, *"A commercial shortest-path engine that employs preprocessing," , 2002*
- IBM/NYU/Columbia Theory Day, *"A commercial shortest-path engine that employs preprocessing," , 2002*
- IEEE 4th International Conference on Intelligent Transportation Systems, *"Beyond Right-Here, Right-Now," , 2001*
- Google, Inc., *"Tree-edit-distance algorithms for comparing shapes," 2000*
- DIMACS Workshop on Faster Algorithms for NP-Hard Problems, Princeton, *"Finding the closest lattice vector when it's unusually close," 2000*
- Dartmouth College, *"Finding the closest lattice vector when it's unusually close," 1999*
- Carnegie Mellon University, *"Finding the closest lattice vector when it's unusually close," 1999*

- Princeton University, *"A polynomial-time approximation scheme for planar graph TSP," 1997*
- Schloss Dagstuhl: Internationales Begegnungs- und Forschungszentrum fur Informatik, *"A polynomial-time approximation scheme for planar graph TSP," 1997*
- Dartmouth College, *"Where the continuous meets the discrete: using semidefinite programming on computers with small memories," 1996*
- Schloss Dagstuhl: Internationales Begegnungs- und Forschungszentrum fur Informatik, *"Approximation algorithms for semidefinite programs arising from MAX CUT and COLORING," 1996*
- University of California, Berkeley, *"Approximation algorithms for semidefinite programs arising from MAX CUT and COLORING," 1996*
- University of Maryland, *"Faster algorithms for shortest paths in planar graphs," 1994*
- Mathematisches Forschungsinstitut Oberwolfach, *"A randomized linear-time algorithm for finding minimum spanning tree," 1994*
- SIAM Conference on Discrete Mathematics, *"An approximation algorithm for a generalization of the minimum feedback arc-set problem, with application to minimum 2CNF-clause deletion," 1994*
- University of Waterloo, *"A randomized linear-time algorithm for finding minimum spanning trees," 1994*
- Princeton University, *"A randomized linear-time algorithm for finding minimum spanning trees," 1994*
- New York University, *"A randomized linear-time algorithm for finding minimum spanning trees," 1994*
- International Computer Science Institute, University of California, Berkeley, *"A randomized linear-time algorithm for finding minimum spanning trees," 1994*
- Massachusetts Institute of Technology, *"A randomized linear-time algorithm for finding minimum spanning trees," 1993*
- DIMACS Workshop on Parallel Algorithms, Rutgers, *"A linear-processor, polylog-time parallel algorithm for shortest paths in planar graphs," 1993*
- Theory Day, Columbia University, *"A randomized linear-time algorithm for minimum spanning tree," 1993*
- University of California, Berkeley, *"Excluded minors, network decomposition, and multicommodity flow," 1993*
- DIMACS Workshop on Disjoint Paths, *"An approximate max-flow min-cut relation for multicommodity flow," 1992*
- Dartmouth College, *"Parallel and dynamic approximation schemes for shortest paths in planar networks," 1992*
- Massachusetts Institute of Technology, *"An approximate max-flow min-cut theorem for multicommodity flow," 1992*
- University of Massachusetts, Amherst, *"Some approximate max-min relations in combinatorial optimization, with algorithmic applications," 1992*
- Cornell University, *"An approximate max-flow min-cut theorem for multicommodity flow, with algorithmic applications," 1992*
- Brown University IPP Symposium on Programming Techniques for Constraint Problems and Combinatorial Optimization, *"Advances in combinatorial optimization: approximation algorithms," 1991*
- IBM Thomas J. Watson Research Center, *"When trees collide: an approximation algorithm for the generalized Steiner tree problem on networks," 1991*
- Duke University, *"Towards overcoming the transitive-closure bottleneck: efficient parallel algorithms for planar digraphs," 1990*
- Xerox Palo Alto Research Center, *"Towards overcoming the transitive-closure bottleneck: efficient parallel algorithms for planar digraphs," 1989*

- Stanford University, *"Leighton-Rao might be practical: faster approximation algorithms for concurrent flow with uniform capacities," 1989*
- University of Washington, *"Towards overcoming the transitive-closure bottleneck: efficient parallel algorithms for planar digraphs," 1989*
- Harvard University, *"Towards overcoming the transitive-closure bottleneck: efficient parallel algorithms for planar digraphs," 1989*
- CORS/TIMS/ORSA Conference, Vancouver, *"Efficient parallel algorithms for chordal graphs," 1989 "Parallelism, preprocessing, and reachability," 1989*
- Duke University, *"Efficient parallel algorithms for chordal graphs," 1989*
- Rice University, *"Efficient parallel algorithms for chordal graphs," 1989*
- University of California, Davis, *"Efficient parallel algorithms for chordal graphs," 1989*
- University of Southern California, *"Efficient parallel algorithms for chordal graphs," 1989*
- Xerox Palo Alto Research Center, *"Efficient parallel algorithms for chordal graphs," 1989*
- Carnegie Mellon University, *"Efficient parallel algorithms for chordal graphs," 1989*
- University of California, Berkeley, *"Efficient parallel algorithms for chordal graphs," 1988*
- Graphs and Algorithms: A Summer Research Conference, University of Colorado, *"Parallelism, preprocessing, and reachability," 1987*
- Bell Laboratories, *"Parallelism, preprocessing, and reachability," 1987*
- Harvard University, *"Stacktracking: $O(\log n)$ time acceptance of DCFLs," 1983*

Research Grants and Awards

Current grants

National Science Foundation, research grant, "Redistricting via clustering in Euclidean and planar-graph metrics," 2018, PI, $100,000

Completed grants

National Science Foundation, research grant, "Fast and accurate optimization in planar graphs and beyond," 2013, PI, $649,987. This was part of a collaborative award for which Brown University was the lead institution.

National Science Foundation, research grant, "Solutions to Planar Optimization Problems," 2010, PI, $624,988. This was part of a collaborative award for which Brown University was the lead institution.

Google Research Award, "Exploiting planarity in optimization problems on road maps", 2009, $40,000

National Science Foundation, research grant, "Exploiting planarity in optimization algorithms," 2006-2009, PI, $300,000

Gift to support research, Northern Telecom, Inc.
1999 and 1997

National Science Foundation, Research Grant,
1997-2003

National Science Foundation, Curriculum Development Award,
1996-97

National Science Foundation, Presidential Young Investigator Award,
1991-1996

Received matching-fund contributions from Xerox, Thinking Machines, Honeywell, DEC, CPLEX
(NSF Research Opportunities for Undergraduates supplement awarded 1991) Co-PI on ONR Grant "High-Performance Design Environments"
1991–1994

Grant to organize workshop, National Science Foundation
1993

Research Initiation Award, National Science Foundation
1990–1992
(NSF Research Experiences for Undergraduates supplement awarded 1992)

Service

To the University

Served on Undergraduate Science Education Committee, 2007
Reviewed undergraduate admissions folders, 2006
Visited high schools to recruit for Brown, 2004
Organized CS Department participation in STEM In-Depth 2004
Advising Workshop, 2003
First-year advisor 1990-91,1993-94, 1994-95, 1995-96, 1996-97, 1997-98, 2002-03,2003-04,2004-05, 2005-2006, Fall 2006, 2008-2009, 2011-12
Sophomore advisor 1991-92, 1996-97, 1997-98, 2002-03, 2003-04, 2004-05, 2009-2010, 2011-2012, 2014-15
Science Day 1990
Academic Expo 1990, 1994
Academic Forum, Third World Weekend, 1994
Day on College Hill, 1994, 2003,2004
Commencement Speakers Committee 1990-91, 1991-92, 1992-93
Points on the Compass, 1994
Parents' Weekend, 1995
Sophomore Concentration Forum, 1996, 1997

Preliminary Examinations for Engineering: Meir Balzohar (March 1991), Jayashree Subrahamonia (May 1991), Chi Yin Lee (March 1992), Joseph DiBiase (June 1996)

To the Department

Chair, Curriculum Committee, 2013-2015.
Member, Undergraduate Recruiting Committee, 2013-14,
Member, Lecture Series Committee, 2012-2014,
Chair, Vision Committee, Fall 2011
Director, *Artemis*; department's summer program for rising ninth-grade girls, Summer 2011
Developed new course on linear algebra to serve concentrators
Chair, Curriculum Committee, 2008-2011
Co-developed new introductory sequence for concentrators.
Organized search for new administrative staffperson, Fall 2004
Director, Master's Degree Program, 2004-06
Colloquium Committee 1989-90, 1990-91
Curriculum Committee 1990-91, 2002-2003, 2003-04
Graduate Admissions Committee 1990-91, 1991-92, 2002-2003, 2008-2009, 2009-2010
Algorithmics Seminar 1992

Comprehensive Exam Review Committee 1992
Head Concentration Advisor, 1993–2000 (1993-95: including acting as departmental representative to most concentration events, e.g. departmental open house. Introduced concentration contracts.)

To the Profession

Served on Program Committee for ACM-SIAM Symposium on Discrete Algorithms (2015).
Served on Program Committee for IEEE Symposium on Foundations of Computer Science (2009).
Editor for Algorithmica (2008-2011)
Served on the Local Arrangements Committee for IEEE Symposium on Foundations of Computer Science (2007).
Served on NSF Panel to review grant proposals (multiple years)
Editor for SIAM Journal on Discrete Mathematics (2007-2010)
Served on Program Committee for APPROX2003 (2003), APPROX99 (1999), International Conference on Computing and Combinatorics (1998), IEEE Symposium on Foundations of Computer Science (1997), Workshop on Randomized Parallel Computing at the International Parallel Processing Symposium (1996), Fifth ACM-SIAM Symposium on Discrete Algorithms (1994). Organized DIMACS Workshop on Approximation Algorithms (March 1993)

Served on NSF panel to review *Research Initiation Award* proposals

Review of articles for publication in conference proceedings

Review of articles for publication in journals: *ACM Transactions on Algorithms, Algorithmica, Combinatorica, Journal of the ACM, SIAM Journal on Computing, SIAM Journal on Discrete Math, Journal of Computer and System Sciences, Journal of Algorithms, Mathematical Systems Theory,* and others

Served on Ph.D. thesis committees for Solomon Shimony (August 1991), Jyh-Han Lin (March 1992), David Williamson (MIT, August 1993), Naveen Garg (1994), Michael Littman (1996), Sharon Caraballo (2000), Siamak Tazari (2010).

Academic honors

Fellow at the Radcliffe Institute of Advanced Study, 2015-16.
Named an ACM Fellow, 2010.

Teaching

Recipient of the 2007 Philip J. Bray Award for Excellence in Teaching in the Sciences.

Regular courses

Approximation Algorithms, Fall 2011 and Spring 2015 and Spring 2018
Multiplicative-Weights/Packing-Covering Method for Approximating Linear and Semidefinite Programs, Spring 2011
Directions: The Matrix in Computer Science: Fall 2008, 2009, 2010,2011,2012,2013,2014,2016,2017
Optimization Algorithms for Planar Graphs: Spring 2005, 2009, 2010,2011, 2016
Computer Science: An Integrated Introduction: Fall 1998, Spring 1999, Fall 1999, Spring 2000, Spring 2003, Fall 2003, Spring 2004, Spring 2005, Spring 2006, Fall 2006, Fall 2018
Topics in Algorithms: Fall 2002, Fall 2004, Fall 2005

Undergraduate honors theses advised

Todd Lipcon, 2007, Neil Picciotto, 1997; Brendan Miller, 1996; Amy Flynn, 1994; Cyril Saint Girons, 2004

Master's theses advised

Raphael Bost, 2013; Ryan Lester, 2013; David Gondek, 2000; Andrew Koyfman, 2000; Srikanta Tirtapura, 1998; Murat Gorguner, 1997; Hoong-Shen Wong, 1995

Ph.D. theses advised

Amariah Becker, 2019; David Eisenstat, 2014; Shay Mozes, 2012; Glencora Borradaile, 2007; Hsueh-I Lu, 1996; Sairam Subramanian, 1995; R. Ravi, 1993; Ajit Agrawal, 1991

Current Ph.D. students

Archer Wheeler.

Other

In 2017, supervised research internship for David Saulpic (École normale supérieure).