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Benjamin Recht

Academic Employment

Assistant Professor, 2009-present
University of Wisconsin, Madison, WI
Computer Sciences Department
Department of Electrical and Computer Engineering (*courtesy*)
Department of Mathematics (*courtesy*)
Department of Statistics (*courtesy*)
Wisconsin Institute for Discovery

Post-doctoral Fellow, 2006-2009
California Institute of Technology, Pasadena, CA
Center for the Mathematics of Information

Research Assistant, 2000-2006
Massachusetts Institute of Technology, Cambridge, MA
Media Laboratory/Center for Bits and Atoms
Advisor: Neil Gershenfeld

Education

PhD, 2006
Massachusetts Institute of Technology, Cambridge, MA
Thesis: Convex Modeling with Priors
Advisor: Neil Gershenfeld

Master of Science, 2002
Massachusetts Institute of Technology, Cambridge, MA
Thesis: Spingineering: Quantum Control in the Presence of Relaxation
Advisor: Neil Gershenfeld

Bachelor of Science, 2000
University of Chicago, Chicago, IL

Articles under Submission

1. Blind Deconvolution using Convex Programming. Ali Ahmed, Benjamin Recht, and Justin Romberg. Submitted to *IEEE Transactions on Information Theory*. 2012.
2. "Compressed Sensing off the Grid." Gongguo Tang, Badri Bhaskar, Parikshit Shah, and Benjamin Recht. Submitted to *IEEE Transactions on Information Theory*. 2012.
3. "Decomposition Methods for Large Scale LP Decoding." Siddharth Barman, Xishuo Liu, Stark C. Draper, and Benjamin Recht. Submitted to *IEEE Transactions on Information Theory*. 2012.
4. "Atomic Norm Denoising with Applications to Line Spectral Estimation." Badri Narayan Bhaskar, Gongguo Tang, and Benjamin Recht. Submitted to *IEEE Transactions on Signal Processing*. 2012.
5. "Dynamic Modeling of Heart Rate Variability." Na Li, Jerry Cruz, Dan Bahmiller, Chenghao Chien, Somayeh Sojoudi, Marie Csete, David Stone, Benjamin Recht, and John C. Doyle. Submitted to *Science Translational Medicine*. 2011.

Journal Publications

6. “Parallel Stochastic Gradient Algorithms for Large-Scale Matrix Completion.” Benjamin Recht and Christopher Ré. Submitted to *Mathematical Programming Computation*, 2011.
1. “Alterations in Cerebrospinal Fluid Proteins in a Presymptomatic Primary Glioma Model.” John C. Whitin, Taichang Jang, Milton Merchant, Tom T-S. Yu, Kenneth Lau, Benjamin Recht, Harvey J. Cohen, and Lawrence Recht. *PLOS One*. Vol. 7, no 11, e49724. doi:10.1371/journal.pone.0049724
2. “The Convex Geometry of Linear Inverse Problems.” Venkat Chandrasekaran, Benjamin Recht, Pablo A. Parrilo, and Alan Willsky. *Foundations of Computational Mathematics*. Vol. 12, no 6, pages 805-849. 2012.
3. “Simple Bounds for Recovering Low-complexity Models.” Emmanuel Candès and Benjamin Recht. *Mathematical Programming*, Ser A. Online First, 2012. DOI 10.1007/s10107-012-0540-0.
4. “Probability of Unique Integer Solution to a System of Linear Equations.” Olvi Mangasarian and Benjamin Recht. *European Journal of Operational Research*. Vol. 214, no 1, pages 27—30. 2011.
5. “Null space conditions and thresholds for rank minimization.” Benjamin Recht, Weiyu Xu, and Babak Hassibi. *Mathematical Programming*. Ser B. Vol. 127, pages 175–202. 2011.
6. “Tensor completion and low-n-rank tensor recovery via convex optimization.” Silvia Gandy, Benjamin Recht and Isao Yamada. *Inverse Problems*, Vol. 25, no 3. 025010. 2011.
7. “A Simpler Approach to Matrix Completion.” Benjamin Recht. *Journal of Machine Learning Research*, Vol. 12, pages 3413—3430. 2011.
8. “Exact Matrix Completion via Convex Optimization.” Emmanuel Candès and Benjamin Recht. *Foundations of Computational Mathematics*. Vol. 9, no 6, pages 717–772. 2009. (*Communications of the ACM Research Highlight*, Vol. 55 no. 6, pages 111-119, 2012.)
9. “Guaranteed Minimum Rank Solutions to Linear Matrix Equations via Nuclear Norm Minimization.” Benjamin Recht, Maryam Fazel, and Pablo A. Parrilo. *SIAM Review*. Vol 52, no 3, pages 471-501. 2010.
10. “Gliomas undergo a distinct phenotypic change at the time of MRI detection.” Taichang Jang, Binulal Sathy, Yi-Hua Hsu, Milton Merchant, Benjamin Recht, Chen Chang, and Lawrence Recht. *Journal of Neurosurgery*. Vol 108, no 4, pages 782-790. 2008.
11. “Learning to Transform Time Series with a Few Examples.” Ali Rahimi, Benjamin Recht, and Trevor Darrell. *IEEE Transactions on Pattern Analysis and Machine Intelligence*. Vol 29, no 10, pages 1759-1775. 2007.
12. “Distributed Control of Systems over Discrete Groups.” Benjamin Recht and Raffaello D'Andrea. *IEEE Transactions on Automatic Control*. Vol 49, no 9, pages 1446-1452. 2004.
13. “Efficient Discrete Approximations of Quantum Gates.” Aram W. Harrow, Benjamin Recht, and Isaac L. Chuang. *Journal of Mathematical Physics*. Vol 43, no 9, pages 4445-4451. 2002.
14. “Physical One-Way Functions.” Ravikanth Pappu, Benjamin Recht, Jason Taylor, and Neil Gershenfeld, *Science*. Vol 297, no 5589, pages 2026-2030. 2002.

Refereed Conference Proceedings

1. “Factoring Nonnegative Matrices with Linear Programs.” Victor Bittorf, Benjamin Recht, Christopher Re, and Joel A. Tropp. *Advances in Neural Information Processing*, 2012.
2. “Query Complexity of Derivative-free Optimization” Kevin Jamieson, Robert Nowak, and Benjamin Recht. *Advances in Neural Information Processing Systems*, 2012.
3. “Linear System Identification via Atomic Norm Regularization.” Parikshit Shah, Badri Narayan Bhaskar, Gongguo Tang, and Benjamin Recht. To appear in the *51st Annual Conference on Decision and Control*. 2012.
4. “Security of Point-of-Sale Systems.” WesLee Frisby, Benjamin Moench, Benjamin Recht, Thomas Ristenpart. In *Proceedings of the 6th USENIX Workshop on Offensive Technologies*. 2012.
5. “Beneath the Valley of the Noncommutative Arithmetic-Geometric Mean Inequality: conjectures, case-studies, and consequences.” Benjamin Recht and Christopher Re. Submitted to *Conference on Learning Theory (COLT)* 2012.
6. “Towards a Unified Architecture for in-RDBMS Analytics.” Xixuan Feng, Arun Kumar, Benjamin Recht, and Christopher Re. *Proceedings of the ACM SIGMOD Conference*, 2012.
7. “Tight Measurement Bounds for Exact Recovery of Structured Sparse Signals.” Nikhil Rao, Benjamin Recht, and Robert Nowak. *Proceedings of the Fifteenth International Conference on Artificial Intelligence and Statistics*, 2012.
8. “HOGWILD!: A Lock-Free Approach to Parallelizing Stochastic Gradient Descent.” Feng Niu, Benjamin Recht, Christopher Ré, and Stephen J. Wright. *Advances in Neural Information Processing Systems*, 2011.
9. “Decomposition Methods for Large Scale Linear Programming Decoding.” Siddharth Barman, Stark Draper, Xishuo Liu, and Benjamin Recht. *Proceedings of the Forty-Ninth Annual Allerton Conference on Communication, Control, and Computing*. 2011.
10. “Atomic Norm Denoising with Applications to Line Spectral Estimation.” Badri Bhaskar and Benjamin Recht. *Proceedings of the Forty-Ninth Annual Allerton Conference on Communication, Control, and Computing*. 2011.
11. “A Framework for Incorporating General Domain Knowledge into Latent Dirichlet Allocation using First-Order Logic.” David Andrzejewski, Xiaojin Zhu, Mark Craven, and Benjamin Recht. *Proceedings of the 22nd International Joint Conference on Artificial Intelligence*. 2011.
12. “Dimensionality reduction: beyond the Johnson-Lindenstrauss bound.” Yair Bartal, Benjamin Recht, and Leonard Schulman. *Proceedings of the ACM-SLAM Symposium on Discrete Algorithms*. 2011.
13. “Practical Large-Scale Optimization for Max-Norm Regularization” Jason Lee, Benjamin Recht, Ruslan Salakhutdinov, Nathan Srebro, and Joel A. Tropp. *Advances in Neural Information Processing Systems*. 2010.
14. “Transduction with Matrix Completion: Three Birds with One Stone.” Andrew Goldberg, Xiaojin Zhu, Benjamin Recht, Junming Sui, and Robert Nowak. *Advances in Neural Information Processing Systems*. 2010.
15. “Online Identification and Tracking of Subspaces from Highly Incomplete Information.” Laura Balzano, Robert Nowak, and Benjamin Recht. *Proceedings of the 48th annual Allerton*

Conference on Communication, Control, and Computing. 2010.

16. "The Convex Algebraic Geometry of Linear Inverse Problems." Venkat Chandrasekaran, Benjamin Recht, Pablo A. Parrilo, and Alan S. Willsky. *Proceedings of the 48th annual Allerton Conference on Communication, Control, and Computing*. 2010.
17. "High-Dimensional Matched Subspace Detection When Data are Missing" Laura Balzano, Robert Nowak, and Benjamin Recht. *Proceedings of the 2010 IEEE International Symposium on Information Theory*.
18. "Sample Complexity for 1-bit Compressed Sensing and Sparse Classification." Ankit Gupta, Robert Nowak, and Benjamin Recht. *Proceedings of the 2010 IEEE International Symposium on Information Theory*.
19. "Learning kernels from indefinite similarities," Yihua Chen, Maya R. Gupta, and Benjamin Recht, *Proceedings of the International Conference on Machine Learning*. 2009.
20. "Necessary and Sufficient Conditions for Success of the Nuclear Norm Heuristic for Rank Minimization." Benjamin Recht, Weiyu Xu, and Babak Hassibi. *Proceedings of the 47th IEEE Conference on Decision and Control*. 2008.
21. "Determining Interconnections in Biochemical Networks Using Linear Programming." Elias August, Antonis Papachristodoulou, Benjamin Recht, Mark Andrew James Roberts, and Ali Jadbabaie. *Proceedings of the 47th IEEE Conference on Decision and Control*. 2008.
22. "Weighted Sums of Random Kitchen Sinks: Replacing minimization with randomization in Learning." Ali Rahimi and Benjamin Recht. *Advances in Neural Information Processing Systems*. 2008.
23. "Uniform Approximation of Functions with Random Bases." Ali Rahimi and Benjamin Recht. *Proceedings of the 46th Annual Allerton Conference on Communication, Control, and Computing*. 2008.
24. "Random Features for Large-Scale Kernel Machines." Ali Rahimi and Benjamin Recht. *Advances in Neural Information Processing Systems*. 2007.
25. "Guaranteed Minimum Rank Solutions to Linear Matrix Equations via Nuclear Norm Minimization." Benjamin Recht, Maryam Fazel, and Pablo A. Parrilo. *Proceedings of the 45th Annual Allerton Conference*. 2007.
26. "Determining Interconnections in Chemical Reaction Networks." Antonis Papachristodoulou and Benjamin Recht. *Proceedings of the American Control Conference*. 2007.
27. "Estimating Observation Functions in Dynamical Systems using Unsupervised Regression." Ali Rahimi and Benjamin Recht. *Advances in Neural Information Processing Systems*. 2006.
28. "Interaction Techniques for Musical Performance with Tabletop Tangible Interfaces." James Patten, Benjamin Recht, and Hiroshi Ishii. *Advances in Computer Entertainment*. 2006.
29. "Learning Appearance Manifolds from Video." Ali Rahimi, Benjamin Recht, and Trevor Darrell. *Computer Vision and Pattern Recognition*. 2005.
30. "Clustering with Normalized Cuts is Clustering with a Hyperplane." Ali Rahimi and Benjamin Recht. *Statistical Learning in Computer Vision*. 2004.
31. "Exploiting Symmetry for the Distributed Control of Spatially Interconnected Systems."

Benjamin Recht and Raffaello D'Andrea. *Proceedings of the 42nd IEEE Conference on Decision and Control*. 2003.

32. "Musically Expressive Sound Textures from Generalized Audio." Benjamin Recht and Brian Whitman. *Proceedings of the 6th International Conference on Digital Audio Effects*. 2003.

33. "Audiopad: A Tag-based Interface for Musical Performance." James Patten, Benjamin Recht, Hiroshi Ishii. *Proceedings of the Conference on New Interfaces for Musical Expression*. 2002.

Invited Talks

1. LIDS Seminar. Massachusetts Institute of Technology. 2012.
2. FOCS Workshop on Randomized Numerical Linear Algebra (RandNLA): Theory and Practice. October 2012.
3. NYU Numerical Analysis and Scientific Computing Seminar. October 2012.
4. University of Edinburgh. Mathematics Department. June 2012.
5. West Coast Optimization Meeting. Seattle, May 2012.
6. Microsoft Research. May 2012.
7. Computer Science Colloquium. University of Washington. May 2012.
8. DSP Seminar. Rice University. April 2012.
9. Probabilistic Techniques and Algorithms. Austin, Texas. April 2012.
10. IMA Workshop on Machine Learning: Theory and Computation. Minneapolis. March, 2012.
11. Electrical Engineering Colloquium. UCLA. March 2012.
12. Applied Math Colloquium, Caltech. February 2012.
13. NIPS workshop on Optimization. Sierra Nevada, Spain. December 2011.
14. Mathematics Colloquium. University of Wisconsin-Madison. November 2011.
15. Computer Science Seminar. Duke University. November 2011.
16. Applied Algebra Days. University of Wisconsin-Madison. October 2011.
17. Statistics Colloquium. University of Wisconsin-Madison. September 2011.
18. Duke Workshop on Sensing and Analysis of High-Dimensional Data. Durham, North Carolina. July 2011
19. Foundations of Computational Mathematics. Budapest. July 2011.
20. Workshop on Sublinear Algorithms. Bertinoro International Center for Informatics, Italy. May 2011.
21. Optimization and Applications Seminar. ETH, Zurich. May 2011.

22. ORIE Colloquium. Cornell University. April 2011.
23. Tutte Seminar Colloquium. Department of Combinatorics and Optimization. University of Waterloo. April 2011.
24. Workshop on Sparse and Low-Rank Approximation. Banff International Research Station for Mathematical Innovation and Discovery. March 2011.
25. Georgia Tech CSIP Seminar. February 2011.
26. Georgia Tech Stochastics Seminar. February 2011.
27. Wharton High Dimensional Statistics Seminar, University of Pennsylvania. February 2011.
28. Workshop on Sparse Statistics, Optimization and Machine Learning. Banff International Research Station for Mathematical Innovation and Discovery. January 2011.
29. US-Mexico Workshop on Optimization and Applications. Oaxaca, January 2011.
30. Annual meeting of the Canadian Mathematical Society. Vancouver, December 2010.
31. Duke Electrical Engineering Systems Seminar. November 2010.
32. IPAM Workshop on Modern Trends in Optimization and Its Application: Numerical Methods for Continuous Optimization. October 2010.
33. Workshop on Sparsity and Computation, Bonn, Germany. June 2010.
34. AIM workshop on tensors, March 2010.
35. Center for the Mathematics of Information Anniversary Workshop, November 2009
36. Toyota Technical Institute, October 2009
37. International Symposium on Mathematical Programming, Chicago, September 2009.
38. Controls Seminar. University of Santa Barbara, April 2009.
39. Computer Science Department. University of Wisconsin, April 2009.
40. Electrical Engineering Seminar. Princeton University, April 2009.
41. Electrical Engineering Seminar. Massachusetts Institute of Technology, April 2009.
42. DIMACS/DyDAn Workshop on Streaming, Coding, and Compressive Sensing, March 2009.
43. Computer Science Seminar. New York University, March 2009.
44. Electrical Engineering Seminar. University of California, Berkeley, March 2009.
45. Market Systems Seminar. University of Pennsylvania, March 2009.
46. Computer Science Seminar. University of Chicago, February 2009.

47. Complex Systems Seminar. Rice University, February 2009.
48. CS Theory Seminar. University of Washington, November 2008.
49. Workshop on Geometry and Algorithms. Princeton University, October 2008.
50. Asilomar Conference on Signals, Systems, and Computers, October 2008.
51. Electrical Engineering Seminar. University of California Los Angeles, October 2008.
52. Optimization Seminar. University of Wisconsin, Madison, September 2008.
53. Allerton Conference on Communication, Control, and Computing, September 2008.
54. University of Pennsylvania Learning Seminar, May 2008
55. Facebook, Palo Alto, CA, April 2008.
56. MIT LIDS Seminar, April 2008.
57. MIT Statistical Learning Theory and Applications, Guest Lecture, April 2008.
58. Pomona College Computer Science Seminar, April 2008.
59. Southern California Algebra and Optimization Day. Caltech, March 2008.
60. UC Berkeley CS Theory Seminar, March 2008.
61. MIT Statistical Learning Theory and Applications, Guest Lecture, April 2007.
62. AI Seminar, University of California, San Diego, October 2006.
63. Connections II: Workshop on Fundamentals of Network Science, Caltech, August 2006.
64. Special Seminar Department of Neurology, University of Massachusetts, January 2005.
65. Center for Bits and Atoms, MIT, December 2004.
66. Connections Conference, Caltech, July 2004.
67. Stochastic Systems Group Seminar, MIT, February 2004.
68. Avogadro Scale Engineering Workshop, MIT, November 2003.
69. Center for Bits and Atoms, MIT, October 2003.
70. Dorkbot NYC, Columbia University, November 2002.

Teaching Experience

CS525 – Linear Programming. University of Wisconsin-Madison, Spring 2010, Fall 2011.

CS726 – Nonlinear Optimization I. University of Wisconsin-Madison, Fall 2010, Fall 2012.

CS838 – Topics in Optimization: The Convex Geometry of High-Dimensional Data Analysis. University of Wisconsin-Madison. Spring 2010.

CDS213 - Robust Control. California Institute of Technology, Winter 2007. Instructor: John

Doyle. Delivered a series of lectures on Modern System Identification.

The Nature of Mathematical Modeling. Massachusetts Institute of Technology, Spring 2005. Instructor: Neil Gershenfeld. Wrote and delivered lectures on applications of convex optimization to mathematical modeling. Ran weekly recitation sections.

Analysis. University of Chicago, 1998-2000. Instructor: Diane Hermann. Ran weekly recitation sections and graded problem sets.

Young Scholars Program. University of Chicago, 1996-2000. Tutor at enrichment program for talented high school students in the Chicago Public Schools.

Grants and Awards

Lagrange Prize in Continuous Optimization. Awarded jointly by the Mathematical Optimization Society (MOS) and the Society for Industrial and Applied Mathematics (SIAM) for outstanding work in the area of continuous optimization over the past six years. 2012.

Alfred P. Sloan Research Fellowship. 2012.

CIF: Small: Decoding Error-Correcting Codes using Large-Scale Decomposition Methods. National Science Foundation. \$425,000. 2012-2015. Co-PI with Stark Draper

CAREER: Efficient Atomic Decompositions of Massive Data Sets. National Science Foundation. \$450,000. 2012-2017.

Denoising, Decomposition, and Deconvolution of Moment Sequences by Convex Optimization. National Science Foundation. \$215,000. 2011-2013.

Efficient Atomic Decompositions of Large-Scale and Incomplete Data. Office of Naval Research. \$350,000. 2011-2014.

Advanced Computing Approaches for Event Detection and Reconstruction within IceCube. University of Wisconsin-Madison, Graduate School. \$132,000. co-PI with Chris Re. Proposal with Michael Ferris, Francis Halzen, and Gary Hill. 2011.

Mathematical and Computational Framework for Matrix Completion with Nonuniform Sampling in Resource Constrained Environments. Office of Naval Research SBIR. In collaboration with Physical Layer Systems. \$20,000. 2010.

System Identification from Incomplete Data: Theory, Algorithms and Applications. Office of Naval Research. ONR BAA-001. PIs Emmanuel Candès and Ben Recht. \$100,000/yr. 2008-2009.

Microfluidic Integrated Transduction RealNose. DARPA RealNose BAA 07-21. PI: Shuguang Zhang, MIT. Total Budget: \$9,700,000. 2008-2010. Total allotted as co-PI: \$200,000/yr.

Industrial Design Excellence Award, Industrial Designers Society of America, 2004

Best in Show, Best in Academic Category, and Best Interactivity in Designing Interactive Systems Design Competition, 2004

3rd place, Vida 6.0 Art & Artificial Life International Competition, 2003

MIT Presidential Fellowship, 2000-2001

Paul Cohen Prize as outstanding graduating senior in Mathematics, 2000

Goldwater Scholarship, 1998-2000

Phi Beta Kappa, 1999

University of Chicago College Honor Scholarship, 1996-2000

Professional Service

1. Editorial Board *Journal of Machine Learning Research*. 2009-present.
2. Cluster Chair, *International Symposium on Mathematical Programming*, 2012.

Selected Exhibitions

1. "Rope and Sound" with Squid Labs. Cooper Hewitt Museum, New York. 2005.
2. "Frequency Reallocation Project." with Noah Vawter and Brian Whitman. Spectropolis Festival. New York. 2004.
3. "Concrete Music." with Brian Whitman, Noah Vawter, and Ethan Bordeaux. ARCO Festival. Madrid, Spain. 2004.
4. "Audiopad." with James Patten. Museu d'Art Contemporani de Barcelona, Barcelona Spain. 2003. Ars Electronica Center. Linz, Austria. 2003.
5. "a meow mix." with Ethan Bordeaux, Noah Vawter, and Brian Whitman. Cyberarts Festival. Boston, Massachusetts. 2003.

Professional Music Experience

Extensive experience performing, composing, and producing electronic music. Released music on labels Barge Records, Kompakt, Beat Research, Three:four Recordings, and Unfoundsound. Performed throughout U.S. and Europe with The Fun Years, Localfields, Mike Uzzi, and The Dan Bensons Project.

Consulting

Technical Consulting on Data Processing, Mathematical Modeling, and Machine Learning for The Echo Nest, Inc. (2005-2009), Makani Power (2007-2009), and All Protect, Inc. (2007-2008).