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Mikhail Belkin — Curriculum Vitae

Research Interests

- Machine learning, pattern recognition and statistical analysis of natural data.
- Manifold and spectral methods for machine learning. Algorithms for semi-supervised learning and clustering.
- Understanding the value of unlabeled data in pattern recognition.

Academic Experience

- Ohio State University, Assistant Professor,
Department of Computer Science and Engineering, Sept 2005 – present.
Department of Statistics (courtesy appointment), Feb 2009 – present.
- Statistical and Applied Mathematical Sciences Institute (SAMSI),
Research Fellow, Jan 2007 – March 2007.
- University of Chicago, Department of Computer Science,
Research Associate, Dec 2003 – Aug 2005.
- Institute for Pure and Applied Mathematics, UCLA,
Program on Multiscale Geometry and Analysis in High Dimensions,
invited participant, Fall 2004.
- University of California, Berkeley, Department of Statistics,
Visiting Research Fellow, Feb – Mar 2004.
- Max Planck Institute for Biological Cybernetics, Tübingen,
Research Scientist, Aug – Dec 2003.

Degrees and Education

- University of Chicago, Ph.D. in Mathematics, 2003.
Thesis: Problems of Learning on Manifolds.
Thesis adviser: Partha Niyogi.
- University of Chicago, M.Sc. in Mathematics, 1997.
- University of Toronto, Hon.B.Sc. with High Distinction,
Major in Mathematics, 1995.

Grants, Awards and Scholarships

- AFOSR grant, Networks of Memories (co-PI), 2009 – 2012.
- NSF Conference Grant, 2009 Machine Summer School on Computational Learning (PI), 2009.
- NSF Early Career Award: Geometry and High-dimensional Inference (PI), 2007 – 2012.
- NSF/DARPA Computational and Algorithmic Representation of Geometric Objects incubationary grant (Senior Personnel), 2003 – 2004.
- University Fellowship, University of Chicago, 1996 – 1997.
- National Science and Engineering Research Council of Canada Postgraduate Scholarship, 1995 – 1997.
- National Science and Engineering Research Council of Canada Undergraduate Summer Research Award, 1995.
- Several merit-based undergraduate scholarships and awards, including Galois Award in Mathematics, Ted Mossman Scholarship, Alfred T. Delury Scholarship in Mathematics, Samuel Beatty Award.
- Moscow Mathematical Olympiad, second prize, 1990.

Teaching Experience

- The Ohio State University, Assistant professor, 2005 – present.
- The University of Chicago, Lecturer, 1998 – 2003.

Industry Experience

- University Community Healthcare, Chicago.
 - Senior Software Engineer, 1998 – 2000.

Journal Papers

- *On Learning with Integral Operators*,
L. Rosasco, M. Belkin, E. de Vito, The Journal of Machine Learning Research (accepted, pending minor revisions).
- *Data Spectroscopy: Eigenspaces of Convolution Operators and Clustering*,
Tao Shi, Mikhail Belkin, Bin Yu,
The Annals of Statistics, vol. 37, Number 6B (2009), 3960-3984.
- *Towards a Theoretical Foundation for Laplacian-Based Manifold Methods*,
M. Belkin, P. Niyogi,
Journal of Computer and System Sciences, Volume 74 , Issue 8 (December 2008), pp. 1289-1308
Special Issue on Learning Theory, invited.
- *Consistency of Spectral Clustering*,
U. von Luxburg, M. Belkin, O. Bousquet,
The Annals of Statistics, 2008, Vol. 36, No. 2, 555-586.
- *Manifold Regularization: a Geometric Framework for Learning from Examples*,
M. Belkin, P. Niyogi, V. Sindhwani,
Journal of Machine Learning Research, 7(Nov):2399–2434, 2006.

- *Semi-supervised Learning on Riemannian Manifolds*,
M. Belkin, P. Niyogi,
Machine Learning, 56, 209-239, 2004. Special issue on clustering, invited.
- *Laplacian Eigenmaps for Dimensionality Reduction and Data Representation*,
M. Belkin, P. Niyogi,
Neural Computation, June 2003; 15 (6):1373-1396.

Book Chapter

- *The Geometric Basis of Semi-supervised Learning* ,
V. Sindhwani, M. Belkin, P. Niyogi,
Semi-supervised Learning (Chapelle, Schoelkopf, Zien: editors), MIT Press, 2006.

Preprints

- *Training Laplacian SVM in the Primal*
S. Melacci, M. Belkin,
submitted.
- *Learning Gaussian Mixtures with Arbitrary Separation*,
M. Belkin, K. Sinha,
<http://arxiv.org/pdf/0907.1054>
- *Laplacian Support Vector Machines Trained in the Primal*,
S. Melacci, M. Belkin
- *Convergence of Laplacian Eigenmaps*,
M. Belkin, P. Niyogi,
http://www.cse.ohio-state.edu/~mbelkin/papers/CLEM_08.pdf

Refereed and Invited Conference Proceedings

- *Semi-supervised Learning Using Sparse Eigenfunction Bases*,
K. Sinha, M. Belkin,
Twenty-Third Annual Conference on Neural Information Processing Systems (NIPS), 2009.
- *A Note on Learning with Integral Operators*,
L. Rosasco, M. Belkin, E. de Vito, The 22nd Annual Conference on Learning Theory (COLT), 2009.
- *Constructing Laplace Operator from Point Clouds in \mathbf{R}^d*
M. Belkin, J. Sun, Y. Wang, ACM-SIAM Symposium on Discrete Algorithms (SODA), 2009.
- *Data Spectroscopy: Learning Mixture Models using Eigenspaces of Convolution Operators*,
T. Shi, M. Belkin, B. Yu, The 25th International Conference on Machine Learning (ICML 2008).
- *Component Based Shape Retrieval Using Differential Profiles*,
L. Ding, M. Belkin, ACM International Conference on Multimedia Information Retrieval (MIR), 2008.
- *Probabilistic Mixtures of Differential Profiles for Shape Recognition*,
L. Ding, M. Belkin, The 19th International Conference on Pattern Recognition (ICPR), 2008.

- *Discrete Laplace Operator for Meshed Surfaces*,
M. Belkin, J. Sun, Y. Wang, The 24th Annual Symposium on Computational Geometry (SOCG), 2008.
- *The Value of Labeled and Unlabeled Examples when the Model is Imperfect*,
K. Sinha, M. Belkin,
Twenty-First Annual Conference on Neural Information Processing Systems (NIPS), 2007.
- *Convergence of Laplacian Eigenmaps*,
M. Belkin, P. Niyogi,
Twentieth Annual Conference on Neural Information Processing Systems (NIPS), 2006.
- *On the Relation Between Low Density Separation, Spectral Clustering and Graph Cuts*,
H. Narayanan, M. Belkin, P. Niyogi,
Twentieth Annual Conference on Neural Information Processing Systems (NIPS), 2006.
- *Heat Flow and a Faster Algorithm to Compute the Surface Area of a Convex Body*,
M. Belkin, H. Narayanan, P. Niyogi,
47th Annual IEEE Symposium on Foundations of Computer Science (FOCS), 2006.
- *Maximum Margin Semi-Supervised Learning for Structured Variables*,
Y. Altun, D. McAllester, M. Belkin,
Nineteenth Annual Conference on Neural Information Processing Systems (NIPS), 2005.
- *Beyond the Point Cloud: from Transductive to Semi-supervised Learning* ,
V. Sindhwani, P. Niyogi, M. Belkin,
The 22nd International Conference on Machine Learning (ICML) 2005.
- *Towards a Theoretical Foundation for Laplacian-based Manifold Methods*
M. Belkin, P. Niyogi, The Eighteenth Annual Conference on Learning Theory (COLT), 2005.
- *On Manifold Regularization*,
M. Belkin, P. Niyogi, V. Sindhwani,
The Tenth International Workshop on Artificial Intelligence and Statistics (AISTATS), 2005.
- *Limits of Spectral Clustering*, **outstanding student paper award**,
U. von Luxburg, O. Bousquet, M. Belkin,
Eighteenth Annual Conference on Neural Information Processing Systems (NIPS), 2004.
- *Regularization and Semi-Supervised Learning on Large Graphs*,
M. Belkin, I. Matveeva, P. Niyogi,
The Seventeenth Annual Conference on Learning Theory (COLT), 2004.
- *On the Convergence of Spectral Clustering on Random Samples: the Normalized Case*,
U. von Luxburg, O. Bousquet, M. Belkin,
The Seventeenth Annual Conference on Learning Theory (COLT), 2004.
- *Tikhonov Regularization and Semi-Supervised Learning on Large Graphs* (Invited),
M. Belkin, I. Matveeva, P. Niyogi,
2004 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2004),
Special Session: Manifolds and Geometry and Signal Processing, 2004.

- *Using Manifold Structure for Partially Labeled Classification*, M. Belkin, P. Niyogi, Sixteenth Annual Conference on Neural Information Processing Systems (NIPS), 2002.
- *Using Eigenvectors of the Bigram Graph to Infer Morpheme Identity*, M. Belkin, J. Goldsmith, Proceedings of the Morphology/Phonology Learning Workshop of ACL-02, Association for Computational Linguistics, 2002.
- *Laplacian Eigenmaps and Spectral Techniques for Embedding and Clustering*, M. Belkin, P. Niyogi, Fifteenth Annual Conference on Neural Information Processing Systems (NIPS), 2001.

Ph.D. Thesis

- *Problems of Learning on Manifolds*, University of Chicago, Department of Mathematics, 2003.

Co-organizer

- 2009 Machine Learning Summer School/Workshop on Theory and Practice of Computational Learning.
- Workshop on Geometry, Random Matrices, and Statistical Inference, SAMSI, Jan 2007.
- 2005 Chicago Machine Learning Summer School.

Invited Talks

- Center for Imaging Science, John Hopkins University, Nov 2009.
- Forum on Geometric Aspects of Machine Learning and Visual Analytics: Recent Developments and Future Challenges, Atlantic City, Oct 2009.
- Summer School on Neuroinformatics, Marine Biological Laboratory, Woods Hole, Aug 2009.
- Summer School on Manifold Learning in Image and Signal Analysis, Ven, Denmark, Aug 2009.
- 1st Sino-USA Summer School in Vision, Learning and Pattern Recognition, Beijing, July 2009.
- Seoul National University, Seoul, July 2009.
- Microsoft Research Asia, Beijing, June 2009.
- Zhejiang University, Computer Science, July 2009.
- Peking University, Department of Statistics, June 2009.
- LANL Seminar, Los Alamos, Apr 2009.
- Information Theory and Applications Workshop, University of California, San Diego, Feb 2009.
- Carnegie Mellon University, Department of Statistics, Nov 2008.
- IMA workshop on Multi-Manifold Data Modeling and Applications, Minneapolis, Oct 2008.
- BIRS workshop on Understanding the New Statistics: Expanding Core Statistical Theory, Banff, Sept 2008.
- 2nd LANL/OSU Workshop, Columbus, Sept 2008.
- 2008 Beijing International Conference on Machine Learning and Data Mining, Beijing, June 2008.
- FOCM Workshop on Learning Theory, Hong Kong, June 2008.

- Ohio State University, Department of Mathematics, May 2008.
- OSU Cognitive Science Center Colloquium, March 2008.
- Workshop on Geometric and Topological Approaches to Data Analysis, University of Chicago, Oct 2007.
- 56th Session of the International Statistical Institute (ISI), Lisbon, August 2007.
- 6th International Congress on Industrial & Applied Mathematics, Zurich, July 2007.
- PASCAL Workshop on Graph Theory and Machine Learning (keynote talk), Bled, June 2007.
- Conference on Applied Inverse Problems (AIP) 2007, Vancouver, June 2007.
- SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, May 2007.
- The North Carolina State University, EECS, March 2007.
- Duke University, Computer Science, Feb 2007.
- Information Theory and Applications Workshop, University of California, San Diego, Feb 2007.
- University of California, Davis, Department of Mathematics, Oct 2006.
- AMS Sectional Meeting, Cincinnati, Oct 2006.
- Ohio State University, Department of Statistics, Oct 2006.
- JSM (Joint Statistical Meeting), Seattle, Aug 2006.
- IMS (Institute of Mathematical Statistics) Annual Meeting, Rio de Janeiro, July 2006.
- EURO 2006, Reykjavik, July 2006.
- WNAR/IMS meeting, Flagstaff, June 2006.
- Workshop on New Perspectives in Geometric Analysis, The University of Toledo, May 2006.
- The Ohio State University, Department of Computer Science, Oct 2005.
- University of Genoa, Department of Computer Science, June 2005.
- SAMSI workshop on Random Graphs and Stochastic Computation, June 2005.
- Interface/CSNA, Session on Graph Theoretic Methods in Pattern Recognition, June 2005.
- The University of Andes, Colombia, Minicourse on Spectral Methods in Learning, Department of Mathematics, March 2005.
- IPAM Program on Multiscale Geometry and Analysis in High Dimensions, Culminating Conference, Lake Arrowhead, Dec 2004.
- University of California, San Diego, Computer Science, Oct 2004.
- Moscow State University, Faculty of Mathematics, Kolmogorov Complexity Seminar, Sept 2004.
- Max Planck Institute for Biological Cybernetics, Tübingen, Aug 2004.
- MIT CSAIL, Brains and Machines seminar series, July 2004.
- ICASSP 2004, Workshop on Manifolds and Geometry in Signal Processing, Montreal, May 2004.
- University of Montreal, Department of Informatics, May 2004.
- University of Wisconsin, Madison, Electrical and Computer Engineering, Mar 2004.
- University of California, Berkeley, Statistics Colloquium, Mar 2004.
- Brown University, Applied Mathematics, Feb 2004.
- Toyota Technological Institute at Chicago, Jan 2004.

- University College London, Department of Computer Science, Nov 2003.
- University of Birmingham, Department of Computer Science, Nov 2003.
- Max Planck Institute for Biological Cybernetics, Tübingen, Oct 2003.
- University of Toronto, Department of Statistics, Apr 2003.
- University of Amsterdam, The Netherlands, Department of Computer Science, Feb 2003.
- EURANDOM, The Netherlands, Feb 2003.
- NIPS 2002, Workshop on Spectral Methods, Dec 2002.
- University of Chicago, Department of Computer Science, Feb 2002.

Refereed and served on program committees for

- The Annals of Statistics, IEEE Transactions on Pattern Analysis and Machine Intelligence, Bernoulli, ACM Transactions on Sensor Networks, IEEE Transactions on Image Processing, IEEE Transactions on Signal Processing, International Journal of Computer Vision, Machine Learning Journal, Journal of Machine Learning Research, Journal of the American Statistical Association (JASA), Pattern Recognition, FOCS, NIPS, ICML, COLT, AISTATS, AAAI, ICCV.