Matthew J. Hirn

Curriculum Vitae

Michigan State University
Department of Computational Mathematics, Science and Engineering
Department of Mathematics

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Current Position

2015-Present *Assistant Professor*, Michigan State University
Department of Computational Mathematics, Science, and Engineering
Department of Mathematics

Research Interests

Applied mathematics and data analysis, with particular emphasis on:

- Applied harmonic analysis
- Wavelet theory and deep learning
- Quantum chemistry
- Manifold learning
- Smooth extensions and interpolations
- Applications: image analysis, hyperspectral image analysis, flow cytometry, dynamical systems, fluid mechanics

Appointments Held

2013-2015 *Postdoctoral Researcher*, École normale supérieure, Département d'Informatique
Member of the Data team, headed by Stéphane Mallat

Jun-Aug, 2013 *Visiting Assistant Professor*, Cornell University, Department of Mathematics
Directed an NSF REU on high dimensional data analysis

2009-2013 *Postdoctoral Associate*, Yale University, Department of Mathematics
Mentor: Ronald R. Coifman

Education

2004-2009 PhD in Mathematics, University of Maryland
Thesis: Enumeration of harmonic frames and frame based dimension reduction
Advisors: John J. Benedetto and Kasso Okoudjou

2000-2004 BA in Mathematics, Cornell University
Senior Thesis: The refinability of step functions
Advisor: Robert R. Strichartz

Fellowships & Grants

2013 SIAM Early Career Travel Award (declined)
2012-2014 AMS-Simons Travel Grant
2009 Ann G. Wylie Dissertation Fellowship, University of Maryland
2009 VIGRE Dissertation Fellowship, University of Maryland (declined)

Short-Term Visits

2012 Scientific Researcher, Fields Institute (2 weeks)
2011 Visiting Researcher, Institute of Research of Mathematics of Rennes (3 weeks)
2010 American Institute of Mathematics (1 week)
2010 United States Army Research Laboratory (1 week)

Papers

Preprint / In preparation

2015 Ariel Herbert-Voss, Matthew J. Hirn, and Frederick McCollum. Computing minimal interpolants in $C^{1,1}(\mathbb{R}^d)$. Submitted to *Revista Matemática Iberoamericana*. arXiv:1411.5668.

2015 Matthew J. Hirn, Stéphane Mallat, and Nicolas Poilvert. Wavelet scattering regression of quantum chemical energies. In preparation.

2015 Matthew J. Hirn and Nicholas Marshall. Time-coupled diffusion maps. In preparation.

Journal

2014 Matthew J. Hirn and Erwan Le Gruyer. A general theorem of existence of quasi absolutely minimal Lipschitz extensions. *Mathematische Annalen*, volume 359, number 3-4, pages 595-628, 2014. arXiv:1211.5700.

2014 Ronald R. Coifman and Matthew J. Hirn. Diffusion maps for changing data. *Applied and Computational Harmonic Analysis*, volume 36, number 1, pages 79-107, 2014. arXiv:1209.0245.

2013 Ronald R. Coifman and Matthew J. Hirn. Bi-stochastic kernels via asymmetric affinity functions. *Applied and Computational Harmonic Analysis*, volume 35, number 1, pages 177-180, 2013. arXiv:1209.0237.

2010 Matthew J. Hirn. The number of harmonic frames of prime order. *Linear Algebra and Its Applications*, volume 432, number 5, pages 1105-1125, 2010. arXiv:1209.0153.

2008 Matthew J. Hirn. The refinability of step functions. *Proceedings of the American Mathematical Society*, volume 136, number 3, pages 899-908, 2008.

Conference

2012 Martin Ehler and Matthew J. Hirn. Sparse endmember extraction and demixing. In *Proceedings of the IEEE 2012 International Geoscience and Remote Sensing Symposium*, pages 1385-1388, Munich, Germany, July 22-27, 2012.

2010 John J. Benedetto, Wojciech Czaja, Martin Ehler, Justin C. Flake, and Matthew J. Hirn. Wavelet packets for multi and hyperspectral imagery. In *Proceedings of IS&T/SPIE Electronic Imaging 2010, Wavelet Applications in Industrial Processing VII*, San Jose, California, January 2010.

2009 John J. Benedetto, Wojciech Czaja, Justin C. Flake, and Matthew J. Hirn. Frame based kernel methods for automatic classification in hyperspectral data. In *Proceedings of the IEEE 2009 International Geoscience and Remote Sensing Symposium*, volume 4, pages 697-700, Cape Town, South Africa, July 12-17, 2009.

Expository

2013 Matthew J. Hirn. Distinguished lecture series: Assaf Naor on the Lipschitz extension problem. *Fields Notes*, volume 12, number 3, page 14, Winter 2013.

Unpublished

2015 Matthew J. Hirn, Nicolas Poilvert, and Stéphane Mallat. Quantum Energy Regression using Scattering Transforms. 2015. arXiv:1502.02077.

2013 Matthew J. Hirn. Algorithms for computing the optimal Lipschitz constant of interpolants with Lipschitz derivative. 2013. arXiv:1307.3292.

2007 Matthew J. Hirn and David Widemann. Frames for subspaces of $\mathbb{C}^n$. 2007. arXiv:1410.5206.

Talks

Conference

Jun 1, 2015 Quantum Energy Regression by Scattering Transforms. PASC15 Conference, Minisymposium on Big Data Analytics for Novel Materials Discovery. Zürich, Switzerland.

Jan 11, 2015 High dimensional learning rather than computing in quantum chemistry. Joint Mathematics Meetings, AMS Session on Numerical Analysis and Computer Science. San Antonio, Texas.

Dec 12, 2014 High dimensional learning rather than computing in quantum chemistry. Foundations of Computational Mathematics Conference 2014, Workshop A2: Computational Harmonic Analysis, Image and Signal Processing. Universidad de la República.

May 23, 2014 Minimal $C^{1,1}$ extensions. 5^{th} International Conference on Computational Harmonic Analysis. Vanderbilt University.

Sep 3, 2013 Diffusion maps for changing data. Statistics, Mathematics, and Applications Conference. Fréjus, France.

Aug 28, 2012 A general theorem of existence of quasi absolutely minimal Lipschitz extensions. Workshop on Whitney type extension and trace problems. The Fields Institute.

Jul 21, 2012 Diffusion maps for changing data. Operator Algebras, Frames, and Undergraduate Research: A Conference in Honor of the 70^{th} Birthday of David R. Larson. Texas A&M University.

Aug 4, 2011 Wells' construction of interpolants in $C^{1,1}(\mathbb{R}^n)$. Fourth Whitney Problems Workshop. College of William and Mary.

Aug 21, 2009 Harmonic frames of prime order. Mini-Conference in Harmonic Analysis on the Occasion of John Benedetto's 70^{th} Birthday. University of Maryland.

May 9, 2009 Frame based kernel methods for hyperspectral imagery data. Recent Advances in Harmonic Analysis and Elliptic Partial Differential Equations. University of Virginia.

May 1, 2009 Frame based kernel methods for hyperspectral imagery data. Graduation Conference 2009, University of Maryland.

Aug 2, 2002 Mock Fourier series for the standard Cantor measure. Mathematical Association of America Mathfest. Burlington, Vermont.

Seminar

May 7, 2015 Regression of Quantum Energies by Scattering. Data Team Seminar, École normale supérieure.

Feb 26, 2015 Interpolation for Physical Big Data. Colloquium, University of Minnesota.

Feb 18, 2015 Interpolation for Physical Big Data. Colloquium, City College of New York.

Feb 4, 2015 High Dimensional Learning rather than Computing in Quantum Chemistry. Applied Mathematics Seminar, Yale University.

Jan 16, 2015 Interpolation for Physical Big Data. Colloquium, Michigan State University.

Apr 15, 2014 Minimal $C^{1,1}$ Extensions. Analyse non-linéaire et EDP seminar, Institut Henri Poincaré.

Oct 23, 2013 Diffusion based manifold learning (joint talk with Guy Wolf). Sierra group meeting, École normale supérieure.

Jul 3, 2013 Diffusion geometry for high dimensional data. REU Smorgasbord Seminar, Cornell University.

Feb 21, 2013 Quasi absolutely minimal Lipschitz extensions. Analysis Seminar, Yale University.

Dec 3, 2012 New developments in the theory of absolutely minimal Lipschitz extensions. Analysis Seminar, Cornell University.

Nov 29, 2012 Diffusion maps for changing data. Colloquium, Kansas State University.

Nov 5, 2012 Diffusion maps for changing data. Image Analysis Seminar, University of Houston.

Oct 17, 2012 Diffusion maps for changing data. Computational Analysis Seminar, Vanderbilt University.

Oct 2, 2012 Diffusion maps for changing data. Norbert Wiener Center Seminar, University of Maryland.

Jul 26, 2012 Diffusion maps for changing data. Mathematics Colloquium and Informal Seminar, Bell Labs.

Jan 23, 2012 Diffusion maps for changing data. Applied Mathematics Seminar, Duke University.

Dec 7, 2011 Minimal interpolants in $C^{1,1}(\mathbb{R}^n)$. Groupe de travail "applications des mathématiques," École Normale Supérieure de Cachan, Antenne de Bretagne, France.

Oct 6, 2009 Sparse endmember extraction and demixing. Applied Mathematics Seminar, Yale University.

Nov 8, 2007 Uncertainty principles in sparse representation and compressed sensing. Norbert Wiener Center Seminar, University of Maryland.

Sep 20, 2007 Uncertainty principles for finite abelian groups. Norbert Wiener Center Seminar, University of Maryland.

Teaching

Michigan State University

2015, Fall Math 414: Linear Algebra II

Yale University

2010, Fall Math/Amth 244: Discrete Mathematics.
2009, Fall Math/Amth 244: Discrete Mathematics.

University of Maryland

2007, Summer Review Course for Analysis PhD Qualifying Exam.
2006, Spring Math 111: Introduction to Probability.
2005, Fall Math 111: Introduction to Probability.

Guest Lectures for Graduate Courses

Nov 22, 2013 Manifold learning. MVA (Mathematics/Vision/Learning) masters course: Sparse Wavelet Representations and Classification, École normale supérieure de Cachan.
Nov 18, 2008 Introduction to compressed sensing. Math 648W: Wavelet Theory and Waveform Design, University of Maryland.

Service to the Profession

2015 Co-organizer of the Whitney Problems Workshop 2015, Centre International de Rencontres Mathématiques (CIRM)
2012-2013 Applied Mathematics Seminar co-organizer, Yale University
2010-2013 Reference for six undergraduate students
2009-2014 Journal referee for:

- Applied and Computational Harmonic Analysis (top 10^{th} percentile of reviewers)
- IEEE Signal Processing Letters
- IEEE Transactions on Information Theory
- Linear Algebra and Its Applications
- Neural Computation
- Proceedings of the American Mathematical Society
- SIAM Journal on Applied Dynamical Systems
- Signal Processing

2009 Speaker at Putnam Exam review sessions, Yale University
2007-2008 Norbert Wiener Center Seminar co-organizer, University of Maryland