Matthew J. Hirn

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Research Interests

Pure, applied, and computational harmonic analysis; data science; machine learning

- Mathematical foundations of deep learning (scattering transforms, convolutional neural networks, generative models)
- Machine learning and multiscale physics (quantum chemistry, materials science, turbulence)
- Geometric and graphical models for high dimensional data analysis (manifold learning, graph learning, geometric deep learning, biomedical data)
- Smooth extension, interpolation, and regression of data, with efficient algorithms (Whitney extensions, statistical learning theory)

Positions Held

- *Assistant Professor*, Michigan State University
  Department of Computational Mathematics, Science & Engineering
  Department of Mathematics
  2015 – Present
- *Postdoctoral Researcher*, École normale supérieure
  Department of Computer Science
  Mentor: Stéphane Mallat
  2013 – 2015
- *Postdoctoral Associate*, Yale University
  Department of Mathematics, Program in Applied Mathematics
  Mentor: Ronald R. Coifman
  2009 – 2013

Education

- *PhD in mathematics*, University of Maryland, College Park
  Advisors: John J. Benedetto, Kasso Okoudjou
  2004 – 2009
- *BA in mathematics*, Cornell University
  Advisor: Robert Strichartz
  2000 – 2004

Awards & Honors

N.B. Some of these awards come with financial support; these monetary details are listed in the following section on Grants & Funding.

Total number of awards: 6 · Awards at MSU: 5 · Early career awards (highly competitive): 5

- NSF CAREER (2019) [15% award rate across across all of mathematics]
- DARPA Director's Fellowship (2018) [7 awarded from the 27 Young Faculty Awards]
- Kavli Fellow (2017) [awarded by the National Academy of Sciences]
- Alfred P. Sloan Fellowship in Mathematics (2016) [20 awarded across all mathematics]
- DARPA Young Faculty Award (2016) [27 awarded across applied science and engineering]
- Ann G. Wylie Dissertation Fellowship (2009) [awarded by the University of Maryland]

Grants & Funding

Total number of grants: 7 · Grants awarded at MSU: 6 · Total funding awarded at MSU: $2,981,172 · Personal share of MSU funding: $2,003,784

Awarded

- NIH #R01GM135929
  Matthew Hirn (PI), Smita Krishnaswamy (Yale, co-PI), Guy Wolf (Montreal, co-PI)
  $1,440,100 total / $582,712 personal share (2019 – 2023)
  My role: Project leader and PI; MSU is the lead institution; sub-awards to Yale and Montreal
- NSF #1912906
  Anna Little (PI), Matthew Hirn (co-PI), Yuying Xie (co-PI)
  $150,000 total / $30,000 personal share (2019 – 2021)
  My role: I contributed 20% to the proposal
- NSF #1845856 (CAREER)
  $400,000 (2019 – 2024)
  My role: Single PI
- DARPA #D16AP00117 (Young Faculty Award + Director's Fellowship)
  $744,297 (2016 – 2020)
  My role: Single PI
- Sloan Foundation #FG-2016-6607 (Alfred P. Sloan Fellowship)
  $55,000 (2016 – 2020)
  My role: Single PI
- NSF #1620216
  $191,775 (2016 – 2020)
  My role: Single PI
- AMS-Simons Travel Grant
  $4,000 (2012 – 2015)
  My role: Single PI

ADVISING

*I am the scientific leader of the **C**ompl**E**x **D**ata **A**nalysis **R**esearch (CEDAR) team at MSU, which currently has 9 members (the 3 postdocs and 6 graduate students listed below). The team has 3 alumni (1 graduate student, and 2 undergraduate students).*

POSTDOCTORAL ADVISING (ALL CURRENT)

- Anna Little, CMSE, 2017 – Present
  Co-mentored with Prof. Yuying Xie
- Michael Perlmutter, CMSE/Mathematics, 2017 – Present
  Co-mentored with Prof. Mark Iwen
- Paul Sinz, CMSE, 2017 – Present

GRADUATE ADVISING

Current

- Nathan Brugnone, 4th year, Community Sustainability/CMSE
  Co-advised with Prof. Robert Richardson
- Xavier Brumwell, 4th year, CMSE
- Jieqian He, 4th year, CMSE/Statistics
- Ryan LaRose, 3rd year, CMSE/Physics
- Renming Liu, 1st year, CMSE
  Co-advised with Prof. Arjun Krishnan
- Sarah McGuire, 1st year, CMSE
  Co-advised with Prof. Elizabeth Munch

Alumni

- Feng Gao, Dual PhD in Plant, Soil & Microbial Sciences and CMSE
  Advisor: Prof. Stephen Boyd
  I mentored Feng extensively on machine learning, and was on his PhD committee. He was an active member of the CEDAR team and had a permanent desk with my group.
  Currently a postdoc at Yale University working in the lab of Prof. Smita Krishnaswamy

UNDERGRADUATE ADVISING

All undergraduate advising has been through NSF funded Research Experiences for Undergraduates (REUs). They are described below.

2018 REU project co-leader on "Machine Learning from Quantum Computing," which was part of the MSU ACRES REU. I co-mentored two students with Prof. Yue Qi of the ChEMS department:

- Muawiz Chaudhary (undergraduate at WWU)
- Nikhil Shankar (undergraduate at UM, Ann Arbor)

2013 REU project leader on "High Dimensional Data Analysis," which was part of the Cornell University Mathematics Department REU. I mentored six students:

- Ariel Herbert-Voss (went on to graduate school at Harvard for computer science)
- Nicholas Marshall (went on to graduate school at Yale for applied mathematics)
- Frederick McCollum (went on to be an NSF graduate fellow at NYU for financial math)
- Christian Smith: (went on to graduate school at UW, Madison for sociology)
- Keyi Wu: (went on to be a software engineer at Bloomberg LP)
- Wendy Zeng: (went on to graduate school at UCSD for economics)

Short Term Visits

- *Senior Fellow*, Institute for Pure and Applied Mathematics (IPAM)
  For the program on "Understanding Many-Particle Systems with Machine Learning"
  2016 (fall semester)
- *Visiting Assistant Professor*, Cornell University
  Department of Mathematics
  Directed NSF REU project on "High Dimensional Data Analysis"
  2013 (summer)
- *Scientific Researcher*, Fields Institute
  For the "Focus Program on Whitney Problems"
  2012 (two weeks)
- *Visiting Researcher*, Institute of Research of Mathematics of Rennes
  For research collaboration
  2011 (three weeks)

Papers

Authors are listed in alphabetical order and are equal contributors (per the convention in Mathematics), unless otherwise noted as: John Smith (first author); Jane Doe† (principal investigator).*

Total number of papers: 29 · Reviewed and published research papers: 17 (14 in journals/conferences, 3 in workshops) · Invited, published conference papers (not reviewed): 2 · Published expository magazine articles: 1 · Publicly available technical research reports that are not reviewed nor published: 4 · Submitted preprint articles for publication: 5.

Total citations: 327 · h-index: 12 · i10-index: 13 (from Google Scholar, October 5, 2019)

Associated codes and software packages: 7 (each is listed with the relevant paper(s)).

Peer Reviewed Journal and Conference Papers

All papers in this list are rigorously peer reviewed.

14. Kevin R. Moon*, David van Dijk*, Zheng Wang*, Scott Gigante, Daniel Burkhardt, William Chen, Kristina Yim, Antonia van den Elzen, Matthew J Hirn, Ronald R Coifman, Natalia B Ivanova, Guy Wolf† and Smita Krishnaswamy†.

Visualizing Structure and Transitions for Biological Data Exploration.
Nature Biotechnology, accepted, 2019.
Available on bioRχiv.
Code: `PHATE`.

13. Feng Gao[*], Guy Wolf and Matthew Hirn[†].
Geometric Scattering for Graph Data Analysis.
Proceedings of the 36th International Conference on Machine Learning, PMLR, volume 97, pages 2122–2131, 2019.
Code: `geo-scattering-graph-data`.

12. Nicholas F. Marshall[*] and Matthew J. Hirn[†].
Time-coupled diffusion maps.
Applied and Computational Harmonic Analysis, volume 45, number 3, pages 709–728, 2018.

11. Michael Eickenberg, Georgios Exarchakis, Matthew Hirn, Stéphane Mallat and Louis Thiry.
Solid Harmonic Wavelet Scattering for Predictions of Molecule Properties.
The Journal of Chemical Physics, volume 148, pages 241732-1–241732-9, 2018.
Editor's pick.
Code: `Kymatio`.

10. Michael Eickenberg, Georgios Exarchakis, Matthew Hirn and Stéphane Mallat.
Solid Harmonic Wavelet Scattering: Predicting Quantum Molecular Energy from Invariant Descriptors of 3D Electronic Densities.
Advances in Neural Information Processing Systems 30, pages 6540–6549, 2017.
Code: `Kymatio`.

9. Matthew J. Hirn, Stéphane Mallat, and Nicolas Poilvert.
Wavelet scattering regression of quantum chemical energies.
Multiscale Modeling and Simulation, volume 15, number 2, pages 827–863, 2017.
Code: `ScatNet-QM-2D`.

8. Ariel Herbert-Voss, Matthew J. Hirn, and Frederick McCollum.
Computing minimal interpolants in $C^{1,1}(\mathbb{R}^d)$.
Revista Matemática Iberoamericana, volume 33, number 1, pages 29–66, 2017.
Code: `C-1-1-Interpolation`.

7. 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.

6. 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.
Code: `Diffusion Maps for Changing Data`.

5. 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.

4. 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.

3. Matthew J. Hirn.
The number of harmonic frames of prime order.
Linear Algebra and Its Applications, volume 432, number 5, pages 1105–1125, 2010.
2. 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.
1. Matthew J. Hirn.
The refinability of step functions.
Proceedings of the American Mathematical Society, volume 136, number 3, pages 899–908, 2008.

PEER REVIEWED WORKSHOP PAPERS

All papers in this list are reviewed, but mostly for fit to the conference or workshop. Papers [2,3] received competitive recognition.

3. Xavier Brumwell*, Paul Sinz*, Kwang Jin Kim, Yue Qi and Matthew Hirn†.
Steerable Wavelet Scattering for 3D Atomic Systems with Application to Li-Si Energy Prediction.
In *NeurIPS Workshop on Machine Learning for Molecules and Materials*, 10 pages, 2018.
Contributed spotlight talk (only 9 out of 49 papers received a spotlight talk).
2. Michael Perlmutter*, Guy Wolf and Matthew Hirn†.
Geometric Scattering on Manifolds.
Extended abstract in *NeurIPS Workshop on Integration of Deep Learning Theories*, 5 pages, 2018.
Contributed spotlight talk (only 3 out of 40 papers receive a spotlight talk).
Longer version available on arXiv.
1. Tobias Welp*, Guy Wolf, Matthew Hirn and Smita Krishnaswamy†.
A Diffusion-based Condensation Process for Multiscale Analysis of Single Cell Data.
In *ICML Workshop on Computational Biology*, 5 pages, New York, June 24, 2016.

INVITED CONFERENCE PAPERS

These are invited, published research papers that are not reviewed.

2. Feng Gao, Matthew Hirn, Michael Perlmutter and Guy Wolf.
Geometric wavelet scattering on graphs and manifolds.
In *Proceedings of SPIE 11138, Wavelets and Sparsity XVIII*, San Diego, California, August 2019.
1. 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.

EXPOSITORY PAPERS

These are invited expository articles in magazine style publications.

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

Preprints

All preprint papers are submitted to journals or conferences.

5. Nathan Brugnone*, Alex Gonopolskiy*, Mark Moyle, Manik Kuchroo, David van Dijk, Kevin R. Moon, Daniel Colon-Ramos, Guy Wolf†, Matthew Hirn† and Smita Krishnaswamy†.
   Coarse Graining of Data via Inhomogeneous Diffusion Condensation.
   Submitted, 2019.
   Available on arXiv.
   Code: `condensation`.
4. Michael Perlmutter*, Feng Gao, Guy Wolf and Matthew Hirn†.
   Geometric scattering networks on compact Riemannian manifolds.
   Submitted, 2019.
   Available on arXiv.
3. Michael Perlmutter*, Jieqian He and Matthew Hirn†.
   Scattering Statistics of Generalized Spatial Poisson Point Processes.
   Submitted, 2019.
   Available on arXiv.
2. Mathieu Andreux, Tomás Angles, Georgios Exarchakis, Roberto Leonarduzzi, Gasper Rochette, Louis Thiry, John Zarka, Stéphane Mallat, Joakim Andén, Eugene Belilovsky, Joan Bruna, Vincent Lostanlen, Matthew J. Hirn, Edouard Oyallon, Sixhin Zhang, Carmine Cella and Michael Eickenberg.
   Kymatio: Scattering Transforms in Python.
   Submitted, 2019.
   Available on arXiv.
   Code: `Kymatio`.
1. Adam Gustafson, Matthew Hirn, Kitty Mohammed, Hariharan Narayanan and Jason Xu.
   Structural Risk Minimization for $C^{1,1}(\mathbb{R}^d)$ Regression.
   Submitted, 2018.
   Available on arXiv.

Unpublished Papers and Technical Reports

4. A. Tkatchenko*, M. Afzal, C. Anderson, T. Baker, R. Banisch, S. Chiama, C. Draxl, M. Haghighatlari, F. Heidar-Zadeh, M. Hirn, J. Hoja, O. Isayev, R. Kondor, L. Li, Y. Li, G. Martyna, M. Meila, K.S. Ruiz, M. Rupp, H. Sauceda, A. Shapeev, M. Stöhr, K. R. Müller†, S. Shankar†.
   IPAM Program on Machine Learning & Many-Particle Systems - Recent Progress and Open Problems.
   Report for the Institute for Pure and Applied Mathematics (IPAM), 2017.
3. Matthew J. Hirn*, Nicolas Poilvert, and Stéphane Mallat†.
   Quantum Energy Regression using Scattering Transforms.
   arXiv:1502.02077, 2015.
2. Matthew J. Hirn.
   Algorithms for computing the optimal Lipschitz constant of interpolants with Lipschitz derivative.
   arXiv:1307.3292, 2013.

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

Invited Talks

Listed future talks are confirmed and I have committed to attending.

Total number of talks: 64 · Conference/workshop talks: 35 (4 particularly notable ones, see below) · Seminar talks: 29 (6 colloquia)

Conference and Workshop Talks

Particularly notable conference talks have a footnote explaining their significance.

35. SIAM Conference on Mathematical Aspects of Materials Science.
Mini-symposium on Machine Learning for Interatomic Potentials.
Bilbao, Spain.
Title TBA.
May 18–22, 2020
34. 2020 Materials Research Society Spring Meeting.
Symposium on Artificial Intelligence for Material Design, Processing and Characterizations.
Phoenix, Arizona, USA.
Title TBA.
April 13–17, 2020
33. The 11^{th} ICSA International Conference.
Session on Deep Learning and Applications.
Hangzhou, China.
Title TBA.
December 20–22, 2019
32. SPIE Wavelets and Sparsity XVIII.
Session on Applications of Frames and Transforms in Neural Networks.
San Diego, California.
Geometric wavelet scattering transforms on graphs and manifolds.
August 14, 2019
31. Fitting Smooth Functions to Data.[1]
University of Texas at Austin.
Fitting $C^{1,1}(\mathbb{R}^n)$ Functions to Data
August 8, 2019
30. International Congress on Industrial and Applied Mathematics.
Mini-symposium on Molecular simulation: dynamics, statistics, learning, and high performance computing.
Universitat de València.

[1] This five day conference consisted of ten lectures by Fields Medalist Charles Fefferman, in addition to five invited lectures on complementary topics delivered by leading experts in the field. I delivered one of the five invited lectures on a complementary topic.

Statistically Robust Multi-Reference Alignment with Wavelet Invariants.
July 16, 2019

29. International Congress on Industrial and Applied Mathematics.
Mini-symposium on Machine Learning for Materials.
Universitat de València.
Learning Material Properties with Multiscale Wavelet Scattering Transforms.
July 15, 2019

28. Third International Conference on Mathematics of Data Science.
City University of Hong Kong.
Learning on graphs and manifolds with geometric wavelet scattering transforms.
June 22, 2019

27. Understanding Many-Particle Systems with Machine Learning 2nd Reunion.
Institute for Pure and Applied Mathematics, UCLA.
Learning with Wavelet Scattering Transforms: Recent Results and Future Directions.
June 12, 2019

26. Scientific Computing Across Scales: Quantum Systems in Cold-matter Physics and Chemistry.
Fields Institute, University of Toronto.
Multiscale Machine Learning for Quantum Many Particle Physics with Wavelet Scattering Transforms.
April 23, 2019

25. AMS Sectional Meeting.
Special Session on Extensions-Interpolation-Shape Matching in $\mathbb{R}^d$, Symmetry-Invariance, Algorithms and Related Topics.
University of Michigan.
Fitting Smooth Functions to High Dimensional Data.
October 21, 2018

24. Understanding Many-Particle Systems with Machine Learning 1st Reunion.
Institute for Pure and Applied Mathematics, UCLA.
Solid Harmonic Wavelet Scattering for Prediction of Molecular Properties.
June 14, 2018

23. Understanding Many-Particle Systems with Machine Learning 1st Reunion.[2]
Institute for Pure and Applied Mathematics, UCLA.
Introduction to Understanding Many-Particle Systems with Machine Learning.
June 11, 2018

22. 7th International Conference on Computational Harmonic Analysis.
Vanderbilt University.
Multiscale machine learning for many particle physics with wavelet scattering transforms.
May 15, 2018

21. The Mathematics of Deep Learning.
Institute for Advanced Study, Hong Kong University of Science and Technology.
Three dimensional deep learning and many body physics.
January 8, 2018

[2] This was an evening lecture presented to the entire congregation at Lake Arrowhead, which consisted of researchers from three separate IPAM long programs.

20. Geometry and Topology of Data.
Institute for Computational and Experimental Research in Mathematics, Brown University.
Transferring diffusion based manifold learning to trajectories and time varying data.
December 11, 2017

19. Big Data driven Materials Science.
Centre Européen de Calcul Atomique et Moléculaire, EPFL.
Solid Harmonic Wavelet Scattering.
September 11, 2017

18. The 9$^{\text{th}}$ Applied Inverse Problems Conference.
Session on Inverse Problems and Low Complexity Models.
Zhejiang University.
Deep Wavelet Scattering: Towards Mathematical Understanding of Convolutional Networks through Physics, Probability and Manifolds.
June 1, 2017

17. First International Conference on Mathematics of Data Science.
Hong Kong Baptist University.
Learning Many Body Physics with Multiscale, Multilayer Machine Learning Architectures.
March 20, 2017

16. Understanding Many-Particle Systems with Machine Learning Culminating Workshop.
Institute for Pure and Applied Mathematics, UCLA.
Scattering Transform Kernels.
December 13, 2016

15. Understanding Many-Particle Systems with Machine Learning Tutorials.
Institute for Pure and Applied Mathematics, UCLA.
Wavelet Tutorial, Part II.
September 14, 2016

14. Understanding Many-Particle Systems with Machine Learning Tutorials.
Institute for Pure and Applied Mathematics, UCLA.
Wavelet Tutorial, Part I.
September 13, 2016

13. Understanding Many-Particle Systems with Machine Learning Opening Day.[3]
Institute for Pure and Applied Mathematics, UCLA.
Multiscale Machine Learning.
September 12, 2016

12. The 11$^{\text{th}}$ American Institute of Mathematical Sciences (AIMS) Conference on Dynamical Systems, Differential Equations and Applications.
Special Session on Harmonic Analysis and Partial Differential Equations.
Orlando, Florida.
Deep Wavelet Scattering for Quantum Energy Regression.
July 1, 2016

[3] This lecture was one of four given during the opening day retreat, and was meant to set the stage for the semester long program on "Understanding Many-Particle Systems with Machine Learning."

11. American Physical Society March Meeting 2016.[4]
Session on Predicting and Classifying Materials via High-Throughput Databases and Machine Learning.
Baltimore, Maryland.
Deep Wavelet Scattering for Quantum Energy Regression.
March 15, 2016

10. 8th Whitney Problems Workshop.
CIRM, Luminy, France.
Computing Minimal Interpolants in $C^{1,1}(\mathbb{R}^d)$ (with A. Herbert-Voss and F. McCollum).
October 22, 2015

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

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

7. 5th International Conference on Computational Harmonic Analysis.
Vanderbilt University.
Minimal $C^{1,1}$ *extensions.*
May 23, 2014

6. Statistics, Mathematics, and Applications.
Fréjus, France.
Diffusion maps for changing data.
September 3, 2013

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

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

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

2. Mini-Conference in Harmonic Analysis on the Occasion of John Benedetto's 70th Birthday.
University of Maryland, College Park.

[4] This was a 36 minute invited talk at the March APS meeting, which requires a nomination by the session organizers. It was the only invited talk for this session.

Harmonic frames of prime order.
August 21, 2009

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

SEMINAR TALKS

29. Rensselaer Polytechnic Institute.
Mathematical Sciences Colloquium.
Title TBA.
Date TBD
28. University of Minnesota.
Data Science Seminar.
Title TBA.
March 31, 2020
27. Pennsylvania State University.
Computational and Applied Mathematics Colloquium.
Title TBA.
March 2, 2020
26. Lawrence Berkeley National Lab.
Title TBA.
November 21, 2019
25. University of Notre Dame.
Statistics Seminar.
Invariant Data Representations with Multiscale Mathematical Models for ConvNets.
October 1, 2019
24. Michigan State University.
NSCL/FRIB Nuclear Theory Seminar.
Machine Learning for Quantum Many-Particle Physics.
November 13, 2018
23. Michigan State University.
ACRES REU Seminar Series.
Computational Harmonic Analysis and Data Science.
June 6, 2018
22. RWTH-Aachen University.
Center for Computational Engineering Science Seminar.
Multiscale Machine Learning and Many Body Physics.
September 18, 2017
21. Shanghai Jiao Tong University.
Applied Math Seminar.
Multiscale Machine Learning and Many Body Physics.
June 6, 2017

20. Johns Hopkins University.
    Data Analysis Seminar.
    Learning Many Body Physics with Multiscale, Multilayer Machine Learning Architectures.
    March 8, 2017
19. Michigan State University.
    Physical Chemistry Seminar.
    High Dimensional Learning Rather than Computing in Quantum Chemistry.
    November 17, 2015
18. Michigan State University.
    Computer Science and Engineering Lecture Series.
    High Dimensional Learning Rather than Computing in Quantum Chemistry.
    October 9, 2015
17. Michigan State University.
    Applied Math Seminar.
    Quantum Energy Regression by Scattering Transforms.
    September 11, 2015
16. University of Minnesota.
    Mathematics Colloquium.
    Interpolation for Physical Big Data.
    February 26, 2015
15. City College of New York.
    Mathematics Colloquium.
    Interpolation for Physical Big Data.
    February 18, 2015
14. Yale University.
    Applied Mathematics Seminar.
    High Dimensional Learning rather than Computing in Quantum Chemistry.
    February 4, 2015
13. Michigan State University.
    Mathematics Colloquium.
    Interpolation for Physical Big Data.
    January 16, 2015
12. Institut Henri Poincaré.
    Analyse non-linéaire et EDP seminar.
    Minimal $C^{1,1}$ *Extensions.*
    April 15, 2014
11. École normale supérieure.
    Sierra group meeting.
    Diffusion based manifold learning (joint talk with Guy Wolf).
    October 23, 2013
10. Cornell University.
    REU Smorgasbord Seminar.
    Diffusion geometry for high dimensional data.
    July 3, 2013

9. Yale University.
   Analysis Seminar.
   Quasi absolutely minimal Lipschitz extensions.
   February 21, 2013
8. Cornell University.
   Analysis Seminar.
   New developments in the theory of absolutely minimal Lipschitz extensions.
   December 3, 2012
7. Kansas State University.
   Mathematics Colloquium.
   Diffusion maps for changing data.
   November 29, 2012
6. University of Houston.
   Image Analysis Seminar.
   Diffusion maps for changing data.
   November 5, 2012
5. Vanderbilt University.
   Computational Analysis Seminar.
   Diffusion maps for changing data.
   October 17, 2012
4. University of Maryland.
   Norbert Wiener Center Seminar.
   Diffusion maps for changing data.
   October 2, 2012
3. Bell Labs.
   Mathematics Colloquium and Informal Seminar.
   Diffusion maps for changing data.
   July 26, 2012
2. Duke University.
   Applied Mathematics Seminar.
   Diffusion maps for changing data.
   January 23, 2012
1. École Normale Supérieure de Cachan, Antenne de Bretagne, France.
   Groupe de travail "applications des mathématiques,"
   Minimal interpolants in $C^{1,1}(\mathbb{R}^n)$.
   December 7, 2011

Teaching

Number of distinct courses taught: 6 · Distinct courses taught at MSU: 4 · Courses developed: 2

Michigan State University

- CMSE 890: Mathematics of Deep Learning.
  Topics level graduate course that I am developing.
  Spring 2020

- MATH 994: Computational Harmonic Analysis and Data Science.
  Topics level graduate course that I developed.
  Spring 2018, Spring 2020
- CMSE 820: Mathematical Foundations of Data Science.
  New qualifying exam course for the Department of Computational Mathematics, Science & Engineering (CMSE), which I developed. In addition to teaching the course, I wrote two qualifying exams associated with it and organized weekly summer review sessions.
  Spring 2017
- CMSE 201: Introduction to Computational Modeling.
  Flipped class. Spring 2016 was the first time the course ran.
  Spring 2016, Fall 2018
- MATH 414: Linear Algebra II.
  Fall 2015

Yale University

- MATH/AMTH 244: Discrete Mathematics.
  Fall 2009, Fall 2010

University of Maryland

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

Service

Conference and Seminar Organization

- Co-organizer of the summer school on "Machine Learning Applied to Nuclear Physics"
  Held at the Facility for Rare Isotope Beams, Michigan State University
  Personally delivered 3 lectures on *Unsupervised Learning and Exploratory Data Analysis*
  May 2019
- Organized mini-session on "Kernel Learning and Harmonic Analysis"
  Held during the "Culminating Workshop of the IPAM long program on Understanding Many-Particle Systems with Machine Learning"
  December 2016
- Co-organizer of the "8$^{\text{th}}$ Whitney Problems Workshop 2015"
  Held at the Centre International de Rencontres Mathématiques (CIRM)
  October 2015
- Applied Mathematics Seminar co-organizer
  Yale University
  2012 – 2013

- Norbert Wiener Center Seminar co-organizer
  University of Maryland
  2007 – 2008

Grant Evaluation

- Reviewer for DOE grant proposals: 2017
- Joint NSF/NIH panel member: 2016

Journal and Conference Reviewer

- Applied and Computational Harmonic Analysis: 2011 – 2019 (top 10% reviewer)
- European Journal of Operational Research: 2018 – 2019
- IEEE Signal Processing Letters: 2013 – 2014
- IEEE Transactions on Circuits and Systems for Video Technology: 2018
- IEEE Transactions on Information Theory: 2012
- International Conference on Machine Learning (ICML): 2019 (top 5% reviewer)
- International Journal of Quantum Chemistry: 2018
- Linear Algebra and Its Applications: 2009
- Neural Computation: 2013
- Neural Information Processing Systems (NeurIPS): 2019
- NPJ Computational Materials: 2017
- Proceedings of the American Mathematical Society: 2011
- SIAM Journal on Applied Dynamical Systems: 2013
- Signal Processing: 2014

University Committees

- Chair of the CMSE Undergraduate Studies Committee
  During this period the Departments of CMSE, Computer Science, and Statistics developed a new undergraduate degree in *Data Science*. As chair of the committee, I am also a member of the College of Natural Science Undergraduate Chairs and Directors Meetings and the College of Engineering Undergraduate Studies Committee.
  2017 – 2020 (three years)
- CMSE Long Term Steering Committee
  2017 – 2018
- CMSE/CSE/ECE Hiring Committee
  Connected and autonomous networked vehicles for active safety (CANVAS). Resulted in the hiring of Shaunak D. Bopardikar (ECE) and Bahare Kiumarsi (ECE).
  2017 – 2018
- CMSE/CSE/BME/ECE Hiring Committee
  Deep learning
  2017 – 2020 (three year search)

- Mathematics/CMSE Hiring Committee
  Fixed term to tenure stream conversion. Resulted in the conversion of Ekaterina A. Rapinchuk (Math/CMSE) from fixed term to tenure track.
  2017 – 2018
- CMSE/ChEMS Hiring Committee
  Computational materials science. Resulted in the hiring of Hui-Chia Yu (CMSE/ChEMS).
  2016 – 2017

UNIVERSITY OUTREACH

- Panel member on "Getting Started at MSU"
  University wide new faculty orientation at Michigan State University
  August 23, 2018
- CMSE Department promotional talk
  Shanghai Jiao Tong University
  June 6, 2017
- CMSE Department promotional talk
  Fudan University
  June 5, 2017
- Panel member on "Getting Grants"
  Michigan State University, College of Natural Science.
  September 9, 2016
- Panel member on "How to look for an academic job"
  Michigan State University, Department of Mathematics.
  November 5, 2015
- Speaker at Putnam Exam review sessions
  Yale University
  Fall 2009