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RESEARCH INTERESTS

Analysis of partial differential equations, viscosity solutions, numerical analysis, applied probability, machine learning, image processing and computer vision

APPOINTMENTS

- 2016–present Assistant Professor, University of Minnesota
- 2014–2016 Morrey Assistant Professor, University of California, Berkeley
 ▷ Mentors: Professor Craig Evans and Professor James Sethian

EDUCATION

- 2010–2014 Ph.D. in Applied Mathematics, University of Michigan, Ann Arbor
 ▷ Thesis advisors: Professor Selim Esedoğlu and Professor Alfred Hero
 ▷ Thesis title: Hamilton-Jacobi equations for sorting and percolation problems
 ▷ Rackham Predoctoral Fellow
- 2008–2010 M.Sc. in Mathematics, Queen’s University, Kingston, Ontario, Canada
 ▷ Thesis advisor: Professor Abdol-Reza Mansouri
 ▷ Thesis title: Sobolev gradient flows and image processing
- 2003–2008 B.Sc. in Mathematics and Engineering with Professional Internship, Queen’s University
 ▷ Thesis title: Region tracking over an image sequence
 ▷ Keyser Fellowship for best thesis, 1st in class

FUNDING

1. co-PI (with Peter Olver): *Geometric Analysis for Classification and Reassembly of Broken Bones*. NSF-DMS:1816917, 2018–2021 (\$418,069).
2. PI: *Partial Differential Equation Continuum Limits in Machine Learning and Applications*. Grant in Aid, University of Minnesota (\$44,000).
3. PI: *Industrial Research Collaboration*. Corning Inc., 2018–2019 (\$69,603).
4. PI: *Nonlinear Partial Differential Equations, Monotone Numerical Schemes, and Scaling Limits for Semi-Supervised Learning on Graphs*. NSF-DMS:1713691, 2017–2020 (\$163,136).
5. PI: *Nonlinear Partial Differential Equations and Continuum Limits for Large Discrete Sorting Problems*. NSF-DMS:1500829, 2015–2017 (\$76,362).

PREPRINTS

1. M. Flores, **J. Calder**, and G. Lerman. Algorithms for Lp-based semi-supervised learning on graphs. *arXiv:1901.05031*, 2019
2. **J. Calder** and D. Slepčev. Properly-weighted graph Laplacian for semi-supervised learning. *arXiv:1810.04351*, 2018
3. **J. Calder** and A. Yezzi. PDE Acceleration: A convergence rate analysis and applications to obstacle problems. *arXiv:1810.01066*, 2018
4. M. Benyamin, **J. Calder**, G. Sundaramoorthi, and A. Yezzi. Accelerated PDE's for efficient solution of regularized inversion problems. *arXiv:1810.00410*, 2018
5. A. M. Oberman and **J. Calder**. Lipschitz regularized Deep Neural Networks converge and generalize. *arXiv:1808.09540*, 2018
6. **J. Calder** and C. K. Smart. The limit shape of convex peeling. *arXiv:1805.08278*, 2018
7. **J. Calder**. Consistency of Lipschitz learning with infinite unlabeled data and finite labeled data. *arXiv:1710.10364*, 2017

PUBLICATIONS

1. J. Calder. The game theoretic p-Laplacian and semi-supervised learning with few labels. *Nonlinearity*, 32(1), 2018
2. T. Gangwar, **J. Calder**, T. Takahashi, J. Bechtold, and D. Schillinger. Robust variational segmentation of 3D bone CT data with thin cartilage interfaces. *Medical Image Analysis*, 47:95–110, 2018
3. B. Abbasi, **J. Calder**, and A. M. Oberman. Anomaly detection and classification for streaming data using partial differential equations. *SIAM Journal on Applied Mathematics*, 78(2):921–941, 2018
4. W. Thawinrak and **J. Calder**. High-order filtered schemes for the Hamilton-Jacobi continuum limit of nondominated sorting. *Journal of Mathematics Research*, 10(1):90–109, 2018
5. **J. Calder**. Numerical schemes and rates of convergence for the Hamilton-Jacobi equation continuum limit of nondominated sorting. *Numerische Mathematik*, 137(4):819–856, 2017
6. **J. Calder**. A direct verification argument for the Hamilton-Jacobi equation continuum limit of nondominated sorting. *Nonlinear Analysis Series A: Theory, Methods, & Applications*, 141:88–108, 2016
7. K.-J. Hsiao, K. Xu, **J. Calder**, and A. O. Hero. Multi-criteria similarity-based anomaly detection using Pareto Depth Analysis. *IEEE Transactions on Neural Networks and Learning Systems*, 27(6):1307–1321, 2016
8. K.-J. Hsiao, **J. Calder**, and A. O. Hero. Pareto-depth for multiple-query image retrieval. *IEEE Transactions on Image Processing*, 24(2):583–594, 2015
9. **J. Calder**. Directed last passage percolation with discontinuous weights. *Journal of Statistical Physics*, 158(45):903–949, 2015
10. **J. Calder**, S. Esedoğlu, and A. O. Hero. A PDE-based approach to nondominated sorting. *SIAM Journal on Numerical Analysis*, 53(1):82–104, 2015
11. **J. Calder**, S. Esedoğlu, and A. O. Hero. A continuum limit for non-dominated sorting. In *Information Theory and Applications Workshop*, 2014

12. **J. Calder**, S. Esedođlu, and A. O. Hero. A Hamilton-Jacobi equation for the continuum limit of non-dominated sorting. *SIAM Journal on Mathematical Analysis*, 46(1):603–638, 2014
13. K.-J. Hsiao, K. Xu, **J. Calder**, and A. O. Hero. Multi-criteria anomaly detection using Pareto Depth Analysis. In *Advances in Neural Information Processing Systems 25*, pages 854–862. 2012
14. **J. Calder** and S. Esedođlu. On the circular area signature for graphs. *SIAM Journal on Imaging Sciences*, 5(4):1355–1379, 2012
15. **J. Calder** and A.-R. Mansouri. Anisotropic image sharpening via well-posed Sobolev gradient flows. *SIAM Journal on Mathematical Analysis*, 43(4):1536–1556, 2011
16. **J. Calder**, A.-R. Mansouri, and A. Yezzi. New possibilities in image diffusion and sharpening via high-order Sobolev gradient flows. *Journal of Mathematical Imaging and Vision*, 40(3):248–258, 2011
17. **J. Calder**, A. M. Tahmasebi, and A.-R. Mansouri. A variational approach to bone segmentation in CT images. In *SPIE Medical Imaging*, volume 7962, 2011
18. **J. Calder**, A.-R. Mansouri, and A. Yezzi. Image sharpening via Sobolev gradient flows. *SIAM Journal on Imaging Sciences*, 3(4):981–1014, 2010
19. R. Deriche, **J. Calder**, and M. Descoteaux. Optimal real-time Q-ball imaging using regularized Kalman filtering with incremental orientation sets. *Medical Image Analysis*, 13(4):564–579, 2009
20. R. Deriche and **J. Calder**. Real-time magnetic resonance Q-ball imaging using Kalman filtering with Laplace-Beltrami regularization. In *SPIE Medical Imaging*, volume 7259, 2009
21. **Patent: J. Calder** and T. Sun. Efficient implementation of branch intensive algorithms in VLIW and superscalar processors, 2011. US Patent Number 8019979, Issued on September 13, 2011

TALKS

- Center for Nonlinear Analysis Seminar
Carnegie Mellon University, November 13, 2018.
- Session on Effective Behavior in Random Environments
AMS Sectional Meeting, Northeastern University, April 21, 2018.
- Probability Seminar
University of Minnesota, April 20, 2018.
- PDE Geometric Analysis Seminar
University of Wisconsin-Madison, April 9, 2018.
- Mini-symposium on Partial Differential Equations in Machine Learning and Data Science
SIAM Conference on the Analysis of PDEs, December, 2017.
- Center for Scientific Computation and Mathematical Modeling seminar
University of Maryland, November 2017.
- Workshop on Generative Models, Parameter Learning and Sparsity
Isaac Newton Institute for Mathematical Sciences, Cambridge, UK, November 2017.
- Workshop on Stochastic PDEs, Mean Field Games and Biology
Gran Sasso Science Institute, L’Aquila, Italy, September 2017.
- Conference on Nonlinear Partial Differential Equations and the Calculus of Variations
UC Berkeley, May 2017.
- IMA Data Science Seminar
University of Minnesota, March 7, 2017.

- Center for Applied Mathematics Colloquium
Cornell University, Ithaca, February 24, 2017.
- Probability Seminar
University of Minnesota, February 3, 2017.
- Department of Industrial and Systems Engineering Seminar
University of Minnesota, January 25, 2017.
- Center for Nonlinear Analysis Seminar
Carnegie Mellon University, Pittsburgh, March 31, 2016.
- Applied Math Colloquium
University of California, Los Angeles, January 20, 2016.
- Level Set Collective
University of California, Los Angeles, January 19, 2016.
- Computational, Applied Mathematics and PDE seminar
University of Chicago, November 24, 2015.
- Mathematics Colloquium
University of Minnesota, November 19, 2015.
- Applied Mathematics Seminar
McGill University, September 9, 2015.
- Mathematical Foundations for Fast Multi-resolution Interactions and Large Data Analysis
Duke University, August 29, 2015.
- Mathematics and Computer Science Colloquium
Santa Clara University, May 26, 2015.
- Analysis and PDE Seminar
UC Berkeley, February 2, 2015.
- Applied Mathematics Seminar
McGill University, January 12, 2015.
- Minisymposium on *Numerical Methods for Viscosity Solutions and Applications*
SIAM Annual Meeting, July 8, 2014.
- Differential Equations Seminar
University of Michigan, February 6, 2014.
- Contributed session on Hamilton-Jacobi Equations and First-order Systems
SIAM Conference on Analysis of PDE, December 10, 2013.
- Analysis and Applied Mathematics Seminar
University of Toronto, November 8, 2013.
- Mathematics Colloquium
Queen's University, October 29, 2013.
- Minisymposium on Recent Developments in Numerical Methods for PDEs
SIAM Annual Meeting, July 12, 2013.
- Applied Mathematics Seminar
University of California, Los Angeles, May 6, 2013.
- Workshop on PDE in the social and life sciences: Emergent challenges in modeling, analysis, and computation
Banff International Research Station, April 1, 2013.
- Inverse Problems and Image Analysis Seminar
Fields Institute for Research in Mathematical Sciences, University of Toronto, December 14, 2012.
- SIAM Conference on Imaging Science, May 22, 2012.

HONORS

2014	NSERC Postdoctoral Fellowship – Declined
2013–2014	Rackham Predoctoral Fellowship
2008–2012	NSERC Postgraduate Scholarship
2008	Ontario Graduate Scholarship – Declined
2008	Keyser Fellowship for best thesis presentation, Queen’s University
2008	Annie Bentley Lillie Prize in Mathematics, Queen’s University
2007	Nellie & Ralph Jeffrey Award in Mathematics, Queen’s University
2006	James H. Rattray Memorial Scholarship in Applied Science, Queen’s University

MENTORING AND SUPERVISION

Former PhD students

- Mauricio Flores Rios (co-advised with Gilad Lerman) graduated December 2018. Thesis title: “Algorithms for ℓ_p -based semi-supervised learning on graphs”. Job placement: Lead Data Scientist at Target Corporation.

Current PhD students

- PhD advisor to Brendan Cook, 3rd year PhD student. Brendan is studying convergence rates in continuum limits for discrete sorting problems that find applications in multi-objective optimization and machine learning.
- PhD advisor to Amber Yuan, 4th year PhD student. Amber is studying continuum limits for machine learning problems on directed graphs, such as Google’s PageRank.
- PhD advisor to Drisana Mosaphir, 2nd year PhD student. Drisana is planning to work on developing numerical schemes to solve a class of degenerate elliptic PDEs that appeared recently in machine learning prediction problems.

Current Postdocs

- Faculty mentor for MCFAM postdoc Nadejda Drenska, 2018-2021.

Undergraduate students

- Faculty mentor (with Peter Olver) for Research Experience for Undergraduates (REU) for Pedro Angulo-Umana, Jacob Elafandi, Bo Hessburg, Riley O’Neill, and Jacob Theis focused on reassembly and classification of broken bone fragments in an archeological context. Project is ongoing since 2017.
- Faculty mentor for Quincy Gu’s undergraduate senior project in Fall 2018. Quincy studied the multi-grid method for solving elliptic partial differential equations.
- Faculty mentor for Alexander Luetzow’s undergraduate senior project in Summer 2018. Alex studied deep learning and applied it to classification of MNIST digits.
- Faculty mentor for Zheran Li’s undergraduate senior project in Fall 2017. Zheran studied spectral graph theory and applications in machine learning.
- Faculty mentor for Hoang Nguyen’s undergraduate senior project in Fall 2017. Hoang worked on fast approximate convex hull algorithms.
- Faculty mentor for Undergraduate Research Opportunities Program (UROP) award for Warut Thawinrak in Summer 2017. Warut worked on high order filtered schemes for Hamilton-Jacobi equations.
- Faculty mentor for Jacob Warhol’s undergraduate senior project in Spring 2017. Jacob investigated the asymptotic fluctuations in convex hull peeling.
- Faculty mentor for reading course for Ho Fai Matthew Mok in Spring 2015 on optimal control and Pontryagin’s maximum principle, UC Berkeley.

- Faculty mentor for Jessica Nadalin’s undergraduate honors thesis in Fall 2014. Jessica worked on compressed sensing for functional magnetic resonance imaging (fMRI), UC Berkeley.
- Faculty mentor for Euijae Kim’s honors thesis in Fall 2014. Euijae worked on partial differential equations for image processing, UC Berkeley.

SERVICE

- Co-organizing IMA Data Science Seminar with Gilad Lerman and Will Leeb (2018–present)
- Co-organized minisymposium *Partial Differential Equations in Machine Learning and Data Science* with Nadejda Drenska at the SIAM Conference on Analysis of PDE, December 2017.
- Co-organized minisymposium *Numerical Methods for PDE and Applications in Computational and Data Science* with Adam Oberman at the SIAM Conference on Analysis of PDE, December 2015.
- Co-organized minisymposium *Numerical Methods for Viscosity Solutions and Applications* with Adam Oberman at the SIAM Annual Meeting, Chicago, July 2014.
- SIAM Student Chapter Vice President, University of Michigan, 2010–2011. Helped organize the first annual SIAM student conference at the University of Michigan
- Manuscript reviewer for SIAM Journal on Mathematics of Data Science (SIMODS), European Journal of Applied Mathematics (EJAM), SIAM Books, American Mathematical Monthly (AMM), SIAM Journal on Imaging Sciences (SIIMS), SIAM Journal on Mathematical Analysis (SIMA), Neural Information Processing Systems (NIPS), Journal of Computational and Applied Mathematics (CAM), Inverse Problems and Imaging (IPI), Journal of Mathematical Imaging and Vision (JMIV), IEEE Signal Processing Letters, Medical Image Computing and Computer Assisted Intervention (MICCAI) Conference, Medical Image Analysis (MIA), Image Processing On Line (IPOL).

TEACHING

Spring 2019	Math 1272 – Calculus II
Fall 2018	Math 8590 – Topics in Partial Differential Equations: Viscosity Solutions, University of Minnesota
Fall 2017	Math 8583 – Partial Differential Equations I, University of Minnesota
Spring 2017	Math 5588 – Elementary Partial Differential Equations II, University of Minnesota
Fall 2016	Math 5587 – Elementary Partial Differential Equations I, University of Minnesota
Spring 2016	Math 222B – Graduate Partial Differential Equations, UC Berkeley
Fall 2015	Math 222A – Graduate Partial Differential Equations, UC Berkeley Math 126 – Partial Differential Equations, UC Berkeley
Spring 2015	Math 185 – Complex Analysis, UC Berkeley
Fall 2014	Math 104 – Real Analysis, UC Berkeley

PROFESSIONAL MEMBERSHIPS

2010–present	Society for Industrial and Applied Mathematics
2011–present	American Mathematical Society
2012–present	The Honor Society of Phi Kappa Phi, University of Michigan