

Matt Jacobs – Curriculum Vitae

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Employment

- July 2023-** UCSB Department of Mathematics
Assistant Professor
- 2022-2023** Purdue University Department of Mathematics
Assistant Professor
- Fall 2021** Simons Institute for the Theory of Computing
Simons Fellow
- 2017- 2021** UCLA Department of Mathematics
Assistant Adjunct Professor, Mentor: Stanley Osher, Wilfrid Gangbo

Education

- 2011-2017** Ph.D. in Mathematics - University of Michigan
Advisor: Selim Esedoglu
- 2007-2011** B.A. - Columbia University
Summa cum laude, honors in mathematics.

Publications

Preprints

1. C. Collins, M. Jacobs, I. Kim, **Free boundary regularity for tumor growth with nutrients and diffusion** September 2023, arXiv:2309.05971.
2. L. Bungert, N. García Trillos, M. Jacobs, D. McKenzie, D. Nikolic, Q. Wang, **It begins with a boundary: A geometric view on probabilistically robust learning**, May 2023, arXiv:2305.18779.
3. N. García Trillos, M. Jacobs, J. Kim, **On the existence of solutions to adversarial training in multiclass classification.**, April 2023, arXiv:2305.00075
4. M. Jacobs, **Non-mixing Lagrangian solutions to the multispecies Porous Media Equation**, August 2022, arXiv:2208.01792.
5. M. Jacobs, O. Walch, **A partial differential equations approach to defeating partisan gerrymandering**, February 2019, arXiv:1806.07725.

Published papers

6. N. Garcia Trillos, M. Jacobs, **An Analytical and Geometric Perspective on Adversarial Robustness** Notices of the AMS, September 2023
7. M. Jacobs, **Existence of solutions to reaction cross diffusion systems**, SIAM Journal on Mathematical Analysis, Accepted June 2023.

8. M. Jacobs, I. Kim, J. Tong, **Tumor Growth with Nutrients: Regularity and Stability**, Communications of the AMS, May 2023.
9. W. Gangbo, M. Jacobs, I. Kim, **Well-posedness and regularity for a polyconvex energy**, ESAIM:COCV, May 2023.
10. N. Garcia Trillos, J. Kim, M. Jacobs, **The Multimarginal Optimal Transport Formulation of Adversarial Multiclass Classification**, JMLR, January 2023.
11. M. Jacobs, I. Kim, J. Tong, **The L^1 contraction principle in optimal transport**, *Annali Scuola Normale Superiore*, July 2021.
12. S. Liu, M. Jacobs, L. Nurbekyan, S. Osher, **Computational Methods for First-Order Nonlocal Mean Field Games with Applications**, *SIAM Journal on Numerical Analysis*, July 2021
13. M. Jacobs, I. Kim, J. Tong, **Darcy's law with a source term**, *Archive for Rational Mechanics and Analysis*, March 2021.
14. J. Kim, M. Jacobs, N. Admal, S. Osher, **A crystal symmetry-invariant Kobayashi–Warren–Carter grain boundary model and its implementation using a thresholding algorithm**, *Computational Materials Science*, February 2021.
15. M. Jacobs, W. Lee, F. Léger, **The back-and-forth method for Wasserstein gradient flows**, *ESAIM: COCV*, February 2021.
16. M. Jacobs, X. Zhou, S. Huang, M. Marszewski, L. Pilon, S. Osher, S. Kodambaka, S. Tolbert, and J. Mar-
ian, **Demonstration of room temperature rectification in tapered-channel thermal diodes through
confinement induced liquid-solid phase change** *Journal of Applied Physics*, January 2021.
17. C. Wu, B. Wang, J. de Rutte, M. Ouyang, Alexis Joo, M. Jacobs, K. Ha, A. Bertozzi, D. Di Carlo **Monodisperse drops templated by 3D-structured microparticles**, *Science Advances*, November 2020.
18. M. Jacobs, I. Kim, A. Mészáros, **Weak solutions to the Muskat Problem with surface tension via optimal transport**, *Archive for Rational Mechanics and Analysis*, October 2020
19. M. Jacobs, F. Léger, **A fast approach to optimal transport: The back-and-forth method**, *Numerische Mathematik*, September 2020.
20. M. Jacobs, F. Léger, W. Li, S. Osher, **Solving Large-Scale Optimization Problems with a Convergence Rate Independent of Grid Size**, *SIAM Journal on Numerical Analysis* May 2019.
21. M. Jacobs, E. Merkurjev, S. Esedoğlu, **Auction dynamics: A volume constrained MBO scheme**, *Journal of Computational Physics*, February 2018.
22. S. Esedoğlu, M. Jacobs, **Convolution kernels and stability of threshold dynamics methods**, *SIAM Journal on Numerical Analysis*, September 2017.
23. M. Jacobs, **A fast MBO scheme for multiclass data classification**, *Accepted to the Sixth International Conference on Scale Space and Variational Methods in Computer Vision*, July 2017.
24. S. Esedoğlu, M. Jacobs, P. Zhang, **Kernels with prescribed surface tension & mobility for threshold dynamics schemes**, *Journal of Computational Physics*, May 2017.

Awards and Honors

2021	NTT Research Fellow
2021	Simons-Berkeley Research Fellowship <i>Awarded to exceptional young scientists to spend a semester at the Simons Institute.</i>
2019	IDRE Postdoctoral Fellowship <i>Research fellowship awarded annually to 4-5 UCLA postdocs across all divisions.</i>
2016	First Place University of Michigan Mobile Apps Challenge <i>UM App design competition, 30+ entrants.</i>
2016	Second place MHacks refactor

- Multi-university programming competition, 1000+ participants.*
- 2015** Grand Prize HackNTU
Multi-university programming competition, 1000+ participants.
- 2015** Grand Prize MHacks V
Multi-university programming competition, 1000+ participants.
- 2011** John Dash Van Buren Jr. Prize in Mathematics (Columbia University)
Awarded to the graduating senior who scores highest on an exam set by the math department.

Invited Talks and Workshops

- August 2023** ICIAM, "Adversarial robustness at the interface of analysis, geometry, and statistics"
Adversarial learning and the generalized Wasserstein barycenter problem
- May 2023** AIMS Conference on Dynamical Systems, Differential Equations and Applications
Cell growth models and the back-and-forth method
- May 2023** BIRS-IMAG Workshop, "Nonlinear Diffusion and nonlocal Interaction Models"
Lagrangian solutions to the porous media equation
- April 2023** Purdue: Special CCAM seminar
Adversarial learning and the generalized Wasserstein barycenter problem
- April 2023** UIC: Analysis and applied math seminar
Lagrangian solutions to the porous media equation
- April 2023** Purdue: Special CCAM seminar
Cell growth models and the back-and-forth method
- April 2023** MSU: PDE & analysis seminar
Lagrangian solutions to the porous media equation
- March 2023** UW Madison: PDE seminar
Lagrangian solutions to the porous media equation
- March 2023** University of Minnesota: IMA data science seminar
Adversarial learning and the generalized Wasserstein barycenter problem
- Jan 2023** UCSB Math Colloquium
Lagrangian solutions to the porous media equation
- Jan 2023** CMU Math Colloquium
Cell growth models and the back-and-forth method
- Jan 2023** JMM: "AMS Special Session on Data Science at the Crossroads of Analysis, Geometry, and Topology"
Computational methods for the generalized Wasserstein barycenter problem
- Dec 2022** PRIMA Congress 2022: "Optimal transport and applications"
Adversarial learning and the generalized Wasserstein barycenter problem
- Nov 2022** Purdue University: PDE seminar
Lagrangian solutions to the porous media equation
- Nov 2022** Carnegie Mellon: Center for Nonlinear Analysis Seminar.
Adversarial learning and the generalized Wasserstein barycenter problem
- Sept 2022** SIAM Data Science minisymposium: "Optimal Transport, Manifold Learning, and Dimensionality Reduction"
Adversarial learning and the generalized Wasserstein barycenter problem
- March 2022** SIAM PDE minisymposium: "Population dynamics: Individual-based and continuum models"
Existence of solutions to systems of reaction cross diffusion equations
- March 2022** INRIA MOKAPLAN seminar
Extending the JKO scheme beyond W_2 gradient flows
- March 2022** Purdue University: CCAM seminar
Congestion driven cell growth with nutrients
- Oct 2021** Simons Institute workshop: "Dynamics and Discretization: PDEs, Sampling, and Optimization"
Extending the JKO scheme beyond W_2 gradient flows
- Aug 2021** IFIP2021 minisymposium: "Non local methods for inverse problems"
Solving large scale optimization problems independent of grid size
- Feb 2021** Conference: "Geometric and Functional Inequalities and Recent Topics in Nonlinear PDE"

Darcy's law with a source term

Feb 2021 Purdue: Math seminar

A fast approach to optimal transport: the back-and-forth method

Jan 2021 UT Austin: Math seminar

The power of duality in optimal transport

Nov 2020 IMA workshop: "Optimal Control, Optimal Transport, and Data Science"

A fast approach to optimal transport: the back-and-forth method

Nov 2020 UT Austin: Oden Institute Seminar

A fast approach to optimal transport: the back-and-forth method

Oct 2020 University of Arizona: Analysis, Dynamics, and applications seminar

A fast approach to optimal transport: the back-and-forth method

Oct 2020 UCSB: Applied math seminar

A fast approach to optimal transport: the back-and-forth method

Aug 2020 IFIP2020 minisymposium: "Non local methods for inverse problems" (cancelled)

July 2020 Insitut Mittag Leffler workshop: "New trends in numerical multiscale methods and beyond" (cancelled)

May 2020 BIRS workshop: "Optimal Transport and Analysis for Machine Learning" (cancelled)

April 2020 UCI: Applied math seminar

A fast approach to optimal transport: the back-and-forth method

Jan 2020 Duke: Applied math seminar

A fast approach to optimal transport: the back-and-forth method

Jan 2020 University of Toronto: Special Colloquium

A fast approach to optimal transport: the back-and-forth method

Jan 2020 UCLA: Analysis and PDE Seminar

Well-posedness and regularity for a polyconvex energy

July 2019 ICIAM minisymposium: "Optimal transport for nonlinear problems"

A fast approach to optimal transport: the back-and-forth method

2017-2019 UCLA: 5 talks at the Level Set Collective

Darcy's law with a source term

A PDE approach to defeating partisan gerrymandering

Weak solutions to the Muskat problem with surface tension via optimal transport

A fast approach to optimal transport: the back-and-forth method

Solving large scale optimization problems with a convergence rate independent of grid size

Nov 2018 McGill University: Math in Machine Learning Seminar

Solving large scale optimization problems with a convergence rate independent of grid size

Nov 2018 University of Minnesota: Data Science Seminar

Solving large scale optimization problems with a convergence rate independent of grid size

May 2017 UCLA: Applied Math Seminar *Auction dynamics: a volume preserving MBO scheme*

Students Mentored

- Wonjun Lee (Former UCLA applied math Ph.D. student)
A large part of Wonjun's thesis was adapting the back-and-forth method to solve Wasserstein gradient flow type equations. This work became a joint paper that was published in ESAIM:COCV. Wonjun is currently a Postdoc at University of Minnesota. Wonjun and I are continuing to collaborate to extend our methods to tumor growth models.
- Siting Liu (Former UCLA applied math Ph.D. student)
I helped supervise Siting on a project using numerical methods for solving non-local mean field games. The approach was based on using primal-dual algorithms to solve a variational formulation of the mean field game. A joint work was published in SIAM numerical analysis. Siting is now a postdoc at UCLA.
- Stephanie Wang (Former UCLA applied math Ph.D. student)

I worked with Stephanie during the last year of her Ph.D. at UCLA on polyconvex variational problems. We studied these problems as a complement to the computational work she had done in computer graphics. Stephanie is currently a Postdoc at UCSD

Service

- **Journal Referee:** Journal of Computational Physics, Journal of Scientific Computing, Communications in PDE, SIAM Journal on Mathematical Analysis, SIAM Journal on Multiscale Modeling and Simulation, Networks and Heterogeneous Media, Kinetic and Related Models, and others.
- **Purdue math department student mentoring program (2022)** *Faculty mentors help guide students through the early part of the Ph.D. program before they have found an advisor. Currently mentoring Alejandro Cano and Chrisil Ouseph.*
- **2021 UCLA-CSU Summer Bridge Program co-organizer**
The program is a 5 week bootcamp designed to help prepare local CSU students to apply to Ph.D. programs in math.
- **UCLA Math Department Equity, Diversity and Inclusion Committee (2020-2021)**
Created in 2020 to coordinate EDI efforts throughout the math department.

Selected Teaching

- Purdue Math 341 (Undergraduate analysis)
- UCLA Math 273a (Graduate optimization)
- UCLA Math 182 (Algorithms)
- UCLA Math 164 (Optimization)
- UCLA Math 199 (Directed undergraduate research)
Along with Luminita Vese, I supervised a directed research course for an undergraduate, Damien Lefebvre, exploring PDE based methods for combating partisan gerrymandering.
- UCLA Math 156 (Machine Learning)
- UM MIDAS Summer Camp: "A visual tour of Fourier Series"
I created the curriculum and helped teach a weeklong summer camp for high school students exploring Fourier series and linear algebra through digital images and programming.

Apps

- **Squigglish!** (iOS app)
Squigglish! is an app that automatically animates any line drawing. Squigglish! has been featured in The Verge and has been downloaded over 100,000 times.
- **Sketch Anything** (iOS app)
Sketch Anything uses the power of Fourier series and image processing to take any image and create step by step drawing guides. Sketch Anything won the grand prize at MHacks V and first place in the UM mobile apps challenge.