

Wonjun Lee

JOINT IMA-NIST POSTDOCTORAL ASSOCIATE, UMN

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Research Interests

My research focuses on developing partial differential equations (PDE)-based algorithms to solve high-dimensional machine learning problems and analyze the theoretical properties of the algorithms.

Machine learning, generative modeling, contrastive learning, optimal transport, gradient flows, mean field games.

Academic Positions

University of Minnesota, Twin Cities

Minneapolis, MN

IMA-NIST Postdoctoral Fellow

Aug 2022 - Present

- A joint NIST-IMA Postdoctoral Fellowship in Analysis of Machine Learning at the Institute for Mathematics and its Applications (IMA) in the College of Science and Engineering at the University of Minnesota (UMN).
- Working on machine learning research with Prof. Jeff Calder, Prof. Gilad Lerman, and Prof. Li Wang.

University of California, Los Angeles

Los Angeles, CA

Assistant Adjunct Professor

Jun 2022 - Aug 2022

- Taught introductory programming course in C++ (PIC 10A) as a main instructor.

Education

University of California, Los Angeles

Los Angeles, CA

Ph.D. in Mathematics

Sep 2017 - Jun 2022

- **Advisor:** Professor Stanley Osher.
- **Thesis:** Algorithms For Optimal Transport And Their Applications To PDEs.

George Mason University

Fairfax, Virginia

B.S. in Mathematics

May 2015

- Concentration in Applied Mathematics and Mathematical Statistics.
- GPA: 3.84/4.0 *magna cum laude*, Phi Beta Kappa.

Honors and Awards

2022 Rising Star in Data Science from the University of Chicago. [PROFILE LINK.](#)

2021 UCLA Dissertation Year Fellowship (\$20,000)

2014 2014 Outstanding Presentation Award at the Joint Mathematical Meetings, Baltimore, MD.

Publications

- J. Calder, **W. Lee**, A.M. Neuman *Spectral convergence rate on graph p -Laplacian*, **In preparation**
- **W. Lee**, L. Wang, W. Li *Generalized Deep JKO: an IMEX particle method for kinetic Fokker-Planck equations*, **In preparation**
- **W. Lee**, R. O'Neill, D. Zou, J. Calder, G. Lerman *Geometry-Preserving Encoder/Decoder In Latent Generative Models*, **In preparation**
- M. Jacobs, **W. Lee** *An efficient numerical scheme for tumor growth models*, **In preparation**
- J. Calder, **W. Lee** *Understanding Contrastive Learning through Variational Analysis and Neural Network Optimization Perspectives*, **Submitted**
- J. Calder, **W. Lee**, *Monotone Discretizations of Levelset Convex Geometric PDEs*, Numerische Mathematik, 2024
- Y. Yang, **W. Lee**, D. Zou, G. Lerman *Improving Hyperbolic Representations via Gromov-Wasserstein Regularization*, ECCV, 2024
- **W. Lee**, L. Wang, W. Li *Deep JKO: Time-Implicit Particle Methods For General Nonlinear Gradient Flows*, Journal of Computational Physics, 2024
- **W. Lee**, Y. Yang, D. Zou, G. Lerman *Monotone Generative Modeling via a Gromov-Monge Embedding*, Preprint, 2023
- **W. Lee**, S. Liu, W. Li, S. Osher, *Mean Field Control Problems For Vaccine Distribution*, Research in the Mathematical Sciences, 2022
- W. Li, **W. Lee**, S. Osher, *Computation Mean-Field Information Dynamics Associated With Reaction Diffusion Equations*, Journal of Computational Physics, 2022
- S. Agrawal, **W. Lee**, S. W. Fung, L. Nurbekyan, *Random Features for High-Dimensional Nonlocal Mean-Field Games*, Journal of Computational Physics, 2022
- A. Vepa, A. Choi, N. Nakhaei, **W. Lee**, N. Stier, A. Vu, G. Jenkins, X. Yang, M. Shergill, M. Desphy, K. Delao, M. Levy, C. Garduno, L. Nelson, W. Liu, F. Hung, F. Scalzo, *Weakly-Supervised Convolutional Neural Networks for Vessel Segmentation in Cerebral Angiography*, Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (WACV), 2022
- **W. Lee**, W. Li, B. Lin, A. Monod, *Tropical Optimal Transport and Wasserstein Distances in Phylogenetic Tree Space*, Information Geometry, 2021
- M. Jacobs, **W. Lee**, F. Léger *The back-and-forth method for Wasserstein gradient flows*, ESAIM: COCV, 27:28, 2021.
- **W. Lee**, S. Liu, H. Tembine, W.C. Li, S. Osher. *Controlling propagation of epidemics via mean-field games*, SIAM Journal on Applied Math, 2020
- **W. Lee**, R.J. Lai, W. Li, S. Osher. *Generalized unnormalized optimal transport and its fast algorithms*, Journal of Computational Physics, 2020
- H. Gao, **W. Lee**, W. Li, Z. Han, S. Osher, and H. V. Poor, *Energy-efficient Velocity Control for Massive Rotary-Wing UAVs: A Mean Field Game Approach*, IEEE Globecom, 2020.
- Y. Kang, S. Liu, **W. Lee**, W. Li, H. Zhang, and Z. Han, *Joint Task Assignment and Trajectory Optimization for a Mobile Robot Swarm by Mean-Field Game*, IEEE Globecom, 2020.

Teaching Experience

University of Minnesota

Minneapolis, MN

Instructor

Aug 2022 – Present

Fall 2024 **Math 2243:** Linear Algebra and Differential Equations

Summer 2024 **Summer School:** Machine Learning Summer Camp for high school students

Spring 2024 **Math 2243:** Linear Algebra and Differential Equations

Summer 2023 **Summer School:** Machine Learning Summer Camp for high school students

Summer 2023 **Summer School:** Random Structures in Optimizations and Related Applications

Spring 2023 **Math 2243:** Linear Algebra and Differential Equations

University of Minnesota

Minneapolis, MN

Mentor from Directed Reading Program (DRP)

Aug 2023 – May 2024

- Mentoring undergraduate students for the quarter-long independent study project in math.
- Topics: survey of optimization methods and their applications in neural networks.

University of California, Los Angeles

Los Angeles, CA

Teaching Assistant

Aug 2017 – Jun 2021

- PIC 10ABC: Intro, intermediate, advanced C++ programming.
- PIC 16: Python with Applications - Python modules such as PyQt, SciPy, Pandas, and NLTK.
- Math 164: Fundamentals of optimization. Linear / nonlinear programming.
- Math 151B: Applied numerical methods with analysis of algorithms and computer implementations.

University of California, Los Angeles

Los Angeles, CA

Mentor from Directed Reading Program (DRP)

Jan 2021 – Mar 2022

- Mentoring undergraduate students for the quarter-long independent study project in math.
- Topics: unsupervised learning of image segmentation, generative adversarial networks, applications of mean field games in finance.

Service

2024 Co-organized a minisymposium 'Theory and Applications of Optimal Transport in Machine Learning' with Jeff Calder, **SIAM Annual Meeting 2024**

Work Experience

University of California, Los Angeles

Los Angeles, CA

Research Assistant

Aug 2017 – Aug 2022

- Developed efficient algorithms using PDEs and optimal transport to solve challenging problems, including Wasserstein gradient flows, Navier-Stokes equations, and epidemic models. (PyTorch, C++)

George Mason University

Research Assistant

Fairfax, VA

May 2017 – May 2018

- Developed deep learning methods using SVD and diffusion map for classification tasks. (Tensorflow)

Cheiron, Inc

Actuary

Washington D.C.

Feb 2015 - Sep 2016

- Evaluated the likelihood of undesirable events using actuarial pricing and projection models.
- Worked on actuarial valuation reports for public, single-employer, and multi-employer plans.

Presentations, Talks

- 2024 *Understanding Contrastive Learning from Variational and Neural Network Optimization Perspectives*, **Upcoming**: UMTC-UMD Postdoc Seminar Program, **UMD**
- 2024 *Geometry-preserving encoder and decoder on latent diffusion models*, **Upcoming**: (Poster) SIAM Conference on Mathematics of Data Science (MDS24), **Atlanta Georgia**
- 2024 *Understanding Contrastive Learning from Variational and Neural Network Optimization Perspectives*, **Upcoming**: SIAM Conference on Mathematics of Data Science (MDS24), **Atlanta Georgia**
- 2024 *Geometry-preserving encoder and decoder on latent diffusion models*, SIAM Annual Meeting (SIAM AN24), **Spokane, Washington**
- 2024 *Monotone Generative Modeling via a Gromov-Monge Embedding.*, Computational and Applied Math (CAM) Seminar, **Georgia Tech**
- 2024 *Monotone Generative Modeling via a Gromov-Monge Embedding.*, Applied Math Seminar, **UC Santa Barbara**
- 2023 *Monotone Generative Modeling via a Gromov-Monge Embedding.*, Workshop on Models and Algorithms for Path Planning (MAPP), **UT Austin**
- 2023 *Monotone discretizations of levelset convex geometric PDEs.*, Analysis and Probability Seminar, **Iowa State University**
- 2023 *Monotone Generative Modeling via a Gromov-Monge Embedding.*, A Monthly Seminar at The Mokaplan Research, Mokameeting, **Inria Paris**
- 2023 *Monotone Generative Modeling via a Gromov-Monge Embedding.*, Kernel Club, **Colorado School of Mines**
- 2023 *Monotone Generative Modeling via a Gromov-Monge Embedding.*, ACMD Seminar, **National Institute of Standards and Technology (NIST)**
- 2023 *Deep JKO for general gradient flows.*, Workshop on kinetic and optimal transport, **University of Minnesota**
- 2023 *Monotone generative modeling via Gromov-Monge Embedding.*, 2023 Algorithms for Threat Detection PI Workshop (Poster session), **Washington D.C.**
- 2023 *Monotone discretizations of levelset convex geometric PDEs.*, The Level Set Collective II, **UCLA**
- 2023 *Monotone discretizations of levelset convex geometric PDEs.*, SIAM Conference on Computational Science and Engineering, **CSE23**
- 2022 *The back-forth method for Wasserstein gradient flows.*, IMA Data Science Seminar, **University of Minnesota**

- 2021 *Mean field control problems for vaccine distribution.*, Optimal transport and Mean field games Seminar, **University of South Carolina**
- 2021 *The back-forth method for Wasserstein gradient flows.*, Current Literature in Applied Mathematics Seminar, **UCLA**
- 2020 *The back-forth method for Wasserstein gradient flows.*, Optimal transport and Mean field games Seminar, **University of South Carolina**
- 2020 *Numerical Methods and Applications of Optimal Transport.*, The Level Set Collective, **UCLA**
- 2019 *Tropical Wasserstein Distances in Phylogenetic Tree Space.*, Optimal transport and Mean field games Seminar, **UCLA**
- 2019 *Energy-efficient Velocity Control for Massive Rotary-Wing UAVs: A Mean Field Game Approach.*, Optimal transport and Mean field games Seminar, **UCLA**

Skills and Hobbies

Programming C/C++, Python, Matlab
Language English, Korean
Hobbies Movies and video games