

# Wonjun Lee

JOINT IMA-NIST POSTDOCTORAL ASSOCIATE, UMN

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## Research Interests

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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, constrastive learning, optimal transport, gradient flows, mean field games.

## Academic Positions

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### 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

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### 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

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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

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- J. Calder, **W. Lee**, A.M. Neuman, *Spectral convergence rate of the graph  $p$ -Laplacian on a manifold with boundary*, **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

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### 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

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

## Work Experience

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### 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

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- 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

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