Wonjun Lee

Postdoctoral Associate at IMA, UMN

Minneapolis, Minnesota

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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, optimization, optimal transport, mean field games, gradient flows.

Academic Positions

University of Minnesota, Twin Cities *Minneaplis, 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 projects 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

- **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.

Presentations, Talks

2022 **IMA Data Science Seminar, UMN**
The back-forth method for Wasserstein gradient flows.

2021 **Optimal transport and Mean field games Seminar, University of South Carolina**
Mean field control problems for vaccine distribution.

2021 **Current Literature in Applied Mathematics Seminar, UCLA**
The back-forth method for Wasserstein gradient flows.

2020 **Optimal transport and Mean field games Seminar, University of South Carolina**
The back-forth method for Wasserstein gradient flows.

2020 **The Level Set Collective, UCLA**
Numerical Methods and Applications of Optimal Transport.

2019 **Optimal transport and Mean field games Seminar, UCLA**
Tropical Wasserstein Distances in Phylogenetic Tree Space.

2019 **Optimal transport and Mean field games Seminar, UCLA**
Energy-efficient Velocity Control for Massive Rotary-Wing UAVs: A Mean Field Game Approach

Teaching Experience

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.

Work Experience

University of California, Los Angeles *Los Angeles, CA*

Research Assistant *Aug 2017 – Aug 2022*

- Developing a new algorithm to compute the Wasserstein distance between large point clouds. Applications in machine learning models such as generative adversarial networks (GAN). (PyTorch, C++)
- Developed a fast and accurate algorithm that computes the solution of the Wasserstein gradient flows on 2D or 3D grids. (C++)
- Developed a new mean-field control model in controlling the propagation of epidemics in response to COVID pandemic. (C++)
- Studied Regularity theory for minimizers of polyconvex functionals related to incompressible / compressible Navier-Stokes equations under Prof. Wilfrid Gangbo.

George Mason University *Fairfax, VA*

Research Assistant *May 2017 – May 2018*

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

Cheiron, Inc *Washington D.C.*

Actuary *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.

Skills

Programming C/C++, Python, Matlab
Language English, Korean