Shu Liu

CONTACT
INFORMATION

Math Department
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Google scholar

EDUCATION

Georgia Institute of Technology, GA, USA   August 2016– May 2022

- Ph.D. in Computational Science and Engineering, home unit in School of Mathematics
- Advisor: Prof. Haomin Zhou.

Zhejiang University (Chu Kochen Honors College), China.   August 2012–June 2016

- B.Sc., **Mathematics & Applied Mathematics**.
- Thesis advisor: Daoyuan Fang.

EMPLOYMENT   Hedrick Assistant Adjunct Professor, **University of California, Los Angeles**,   July 2022 -

RESEARCH
INTERESTS

  My research focuses on scientific computing, numerical analysis, and machine learning, with an emphasis on efficient, scalable algorithms for partial differential equations (PDEs).

- Design numerical methods with accuracy guarantees for simulating Wasserstein geometric flows.
- Primal-dual algorithms for numerical PDEs, including classical and machine learning methods.

I am also interested in sampling and optimal control problems on discrete graphs.

PUBLICATIONS

- **Published**

  - Yijie Jin, Shu Liu, Hao Wu, Xiaojing Ye, Haomin Zhou. Parameterized Wasserstein Gradient Flow. **Journal of Computational Physics**, 2024. doi, arXiv: 2404.19133.

  - Shu Liu, Siting Liu, Stanley Osher, Wuchen Li. A first-order computational method for Reaction-Diffusion type equations via Primal-Dual Hybrid Gradient method. **Journal of Computational Physics** Volume 500, 1 March 2024, 112753. doi, arXiv: 2305.03945, 2023.

  - Jianbo Cui, Shu Liu, Haomin Zhou. Optimal control for stochastic nonlinear Schrodinger equation on graph. **SIAM Journal on Control and Optimization** Vol. 61, Iss. 4, pp. 2021–2042, 2023. doi, arXiv:2209.05346, 2022.

  - Jianbo Cui, Shu Liu, Haomin Zhou. Stochastic Wasserstein Hamiltonian Flows. **Journal of Dynamics and Differential Equations**, doi, arXiv: 2111.15163.

  - Jiaojiao Fan*, Shu Liu*, Shaojun Ma, Haomin Zhou, and Yongxin Chen. Neural Monge Map estimation and its applications. **Transaction on Machine Learning Research** Featured Certification. Openreview, arXiv:2106.03812, 2021. ∗ Equal contribution.

    A short version is published at **ICLR 2022 Workshop** on Deep Generative Models for Highly Structured Data (DGM4HSD). Openreview.

  - Jianbo Cui, Shu Liu, Haomin Zhou. Wasserstein Hamiltonian flow with common noise on graph. **SIAM Journal on Applied Mathematics**, Vol. 83, Iss. 2 pp. 484 - 509, 2023. doi, arXiv:2204.01185.

  - Shu Liu, Wuchen Li, Hongyuan Zha, and Haomin Zhou. Neural parametric Fokker-Planck equations. **SIAM Journal on Numerical Analysis**, Vol. 60, Iss. 3, pp. 1385-1449, 2022. doi, arXiv:2002.11309,2020. SIAM Student Paper Prize

    A shorter version is published in **Geometric Science of Information**, pages 715–724, Cham, 2019. Springer International Publishing. Link, arXiv: 1903.10076.

  - Jianbo Cui, Shu Liu, and Haomin Zhou. What is a stochastic Hamiltonian process on finite graph? An optimal transport answer. **Journal of Differential Equations**, Vol. 305, 25 December 2021, Pages 428-457. doi, arXiv: 2101.08420.

  - Shu Liu*, Haodong Sun*, and Hongyuan Zha. A particle-evolving method for approximating the optimal transport plan. **Geometric Science of Information**, pages 878–887, Cham, 2021. Springer International Publishing. Link. Complete version at arXiv:2105.06088, 2021. ∗ Equal contribution.

- Shaojun Ma, Shu Liu, Hongyuan Zha, and Haomin Zhou. Learning stochastic behaviour from aggregate data. Proceedings of the 38th International Conference on Machine Learning (**ICML**), volume 139 of Proceedings of Machine Learning Research, pages7258–7267. PMLR, 18–24 Jul 2021. Link.
- **Preprints**
  - Shu Liu, Stanley Osher, Wuchen Li. A Natural Primal-Dual Hybrid Gradient Method for Adversarial Neural Network Training on Solving Partial Differential Equations. arXiv: 2411.06278
  - Xinzhe Zuo, Jiaxi Zhao, Shu Liu, Stanley Osher, Wuchen Li. Numerical Analysis on Neural Network projected schemes for approximating one dimensional Wasserstein Gradient Flows.arXiv: 2402.16821. Submitted.
  - Jianbo Cui, Shu Liu, Haomin Zhou. A supervised learning scheme for computing Hamilton-Jacobi equation via density coupling. arXiv: 2401.15954. Under revision.
  - Shu Liu, Xinzhe Zuo, Stanley Osher, Wuchen Li. Numerical analysis of a first-order computational algorithm for reaction-diffusion equations via the primal-dual hybrid gradient method. arXiv: 2401.14602. Under revision.
  - Hao Wu, Shu Liu, Xiaojing Ye, Haomin Zhou. Parametrized Wasserstein Hamiltonian flow arXiv: 2306.00191, 2023. Accepted by **SIAM Journal on Numerical Analysis**.
  - Shu Liu*, Shaojun Ma*, Yongxin Chen, Hongyuan Zha, and Haomin Zhou. Learning high dimensional Wasserstein geodesics. arXiv:2102.02992, 2021. * Equal contribution.

CONFERENCE ATTENDED

- CCoM and CSME Seminars at UCSD, November 12, 2024.
- AMS Fall Western Sectional Meeting at UCR, October 26-27, 2024.
- SIAM Conference on Mathematics of Data Science (MDS24), October 21-25, 2024.
- The 9th SIAM Central States Section Annual Meeting at UMKC, October 5-6, 2024.
- 2024 SIAM Annual Meeting (AN24), July 8 - 12, 2024.
- Interacting Particle Systems: Analysis, Control, Learning and Computation, ICERM, May 6 - 10, 2024.
- Southern California Applied Mathematics Symposium (SOCAM), UCSD, Saturday, April 27th, 2024.
- International Conference on Multiscale Modeling and Simulation based on Physics and Data, IPAM, UCLA, April 25 - 26, 2024.
- RTG Seminars on Data Science, University of South Carolina, April 19, 2024.
- Scientific Computing and Large Data workshop, University of South Carolina, December 16-22, 2023.
- PDE & Applied Mathematics seminar at UCR, October 25, 2023.
- SIAM New York-New Jersey-Pennsylvania Section 2023 Annual Meeting, October 21, 2023.
- ICIAM Minisymposium Mean field games and optimal transport with applications in data science and biology, August 21, 2023.
- SIAM conference on Data science and mathematics, September 26, 2022.
- SIAM Southeastern Atlantic Section Conference, Auburn University, AL, USA, September 18 - 19, 2021.
- Geometric Science of Information 5th International Conference, GSI 2021, Sorbonne University, Paris, France, July 21 - 23, 2021.
- Remote participation in the Long Program on high dimensional Hamilton-Jacobi PDEs at IPAM, UCLA, CA, USA, March 9 - June 12, 2020.
- Geometric Science of Information 4th International Conference, GSI 2019, Ecole Nationale de l'Aviation Civile, Toulouse, France, August 27 – 29, 2019.
- Participation in Graduate Summer School: Mean Field Games and Applications at IPAM, UCLA, CA, USA, June 18 - 29, 2018.

GRANT APPLICATION	In application:

- NSF DMS-Computational Mathematics: Scalable Natural Primal-Dual Gradient (NPDG) method for Scientific Computing problems involving adversarial neural network training

HONORS AND AWARDS	• SIAM Student Paper Prize (A spotlight can be found at this link.)	2024
	• (Georgia Tech School of Mathematics) Best PhD thesis	2022
	• (Georgia Tech School of Mathematics) Top Graduate Student Award	2021
	• The 6th National College Students Mathematical Competition, Final round, First prize	2015
	• 2014 Mathematical Contest in Modeling, SIAM Prize Recipient, with Yuan Gong and Yandi Shen	2014

TEACHING RECORDS

At UCLA (2022-)

Instructor for PIC 10A Introduction to programming (C++)

Instructor for PIC 20A Java Language and its application

At Georgia Institute of Technology (2016-2022)

TA for MATH 2551 [Multivariable Calculus]

TA for MATH 2552 [Differential Equations]

TA for MATH 1551 [Differential Calculus]

TA for MATH 1552 [Integral Calculus]

REVIEW SERVICE

I used to be the reviewer for the following journals. (The numbers in parentheses indicate the number of papers I have reviewed for each journal.)

- Inverse Problems and Imaging (2),
- Applied and Computational Harmonic Analysis (1),
- Journal of Computational Physics (2),
- Communications on Applied Mathematics and Computation (1),
- SIAM Journal on Image Sciences (1),
- Journal of Machine Learning (1),
- Entropy (1),
- Engineering Applications of Artificial Intelligence (1).

SKILLS   Python (Proficient), LaTeX(Proficient), MATLAB (Proficient), C++ (Competent), Java (Competent).

LANGUAGE   Chinese (Mother tongue), English (Fluent).