Tong Ding

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Education

Ph.D. in Applied Mathematics 2025/12 (expected)
Purdue University, West Lafayette, IN
Joint with Computational Interdisciplinary Graduate Programs (CIGP)
Advisor: Prof. Jianlin Xia

B.S. in Mathematics, Minor in Computer Science 2015–2019
Purdue University, West Lafayette, IN

Research Interests

- **Matrix analysis/fast solver for neural networks:** second-order methods, structure-exploiting solvers, conditioning and spectra of NN-induced matrices.
- **Randomized numerical linear algebra:** dimension reduction, error analysis, scalable implementations.

Publications & Preprints

1. Z. Cai, **T. Ding**, M. Liu, X. Liu, and J. Xia. *A Structure-Guided Gauss–Newton Method for Shallow ReLU Neural Networks*. Submitted to *SIAM Journal on Scientific Computing (SISC)*. 2024
   arXiv:2404.05064
2. Z. Cai, **T. Ding**, M. Liu, and J. Xia. *Matrix Analysis from Shallow ReLU Neural Network Least-Squares Approximations*. In preparation for SIAM Journal on Matrix Analysis and Applications (SIMAX). 2025

Research Projects

1. **Neural Network Optimization: Structure-Guided Gauss-Newton Methods** 2024–present
   - Quantifying network training struggles (stability, approximation bias) from matrix conditioning and spectra
   - Design efficient solvers by leveraging matrix structures
   - Developing scalable second-order optimization algorithms for shallow ReLU networks
2. **Error analysis for randomized methods** 2025–present
   - Probabilistic error bounds for a randomized SVD method
   - Error convergency analysis for an adaptive Nyström method

Conferences & Workshops

Talks

- *Why Neural Network Optimization Matrices Are Ill-Conditioned and Why That's Okay*. Workshop on Network Algorithms, Analysis, and Learning for Science. Berkeley, CA. 2025/11
- *Matrix Analysis and Fast Solvers in Neural Networks*. SIAM Central States Section Annual Meeting (minisymposium). Fayetteville, AR. 2025/10
- *Matrix Analysis for Shallow ReLU Neural Network Least-Squares Approximations*. 22nd Copper Mountain Conference on Multigrid Methods. Copper Mountain, CO. 2025
- *A Structure-Guided Gauss–Newton Method for Shallow ReLU Neural Networks*. International Conference on Preconditioning (minisymposium). Atlanta, GA. 2024

Posters

- CBMS Conference on Research at the Interface of Applied Mathematics and Machine Learning. Houston, TX. 2025/12
- *Matrix Analysis for Shallow ReLU Neural Network Least-Squares Approximations*. NSF Computational Mathematics PI Meeting. Salt Lake City, UT. 2025
- *Fast Solvers for Neural Network Least-Squares Approximations*. NSF Computational Mathematics PI Meeting. Seattle, WA. 2024
- *Particle Method for the Landau Equation*. Purdue Undergraduate Research Exhibition. West Lafayette, IN. 2019

Workshop Attendance

- ICERM Workshop on Randomized Numerical Linear Algebra. Providence, RI. 2026/2

Teaching

Guest Lecturer, Department of Mathematics, Purdue University Spring 2025

- Delivered lectures in MA 303: Differential Equations and Partial Differential Equations for Engineering and the Sciences; prepared materials and facilitated discussions for undergraduate students.

Teaching Assistant, Department of Mathematics, Purdue University

- MA 16600: Calculus II — led recitations; office hours. Spring 2020

Graduate Grader, Department of Mathematics, Purdue University

- MA 52700: Advanced Mathematics for Engineers; MA 35100: Linear Algebra; MA 45000: Abstract Algebra.

Honors & Awards

- Travel Grant, CBMS-AMML Workshop, University of Houston 2025
- SIAM Student Travel Award, SIAM Central States Section Annual Meeting 2025
- T. T. Moh Graduate Scholarship Fund, Purdue University 2019, 2024
- Spira Undergraduate Research Award 2019
- Jandos Scholarship 2018
- Jean E. Rubin Memorial Scholarship 2017, 2018

Leadership & Service

President, SIAM Student Chapter, Purdue University 2024–present

- Organized annual student conferences (2024,2025 and 2026);
- Co-ran CCAM seminar series;
- Community building and professional development.

Mentor, Women in Science Program, Purdue University 2018–2019

- Mentored first-year students; supported retention and inclusion in STEM.

Technical Skills

- **Scientific computing:** MATLAB (advanced); PyTorch/C/C++(foundational)
- **Languages:** English (fluent); Mandarin Chinese (native).