

JIAYI ZHOU

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EDUCATION

School of Mathematical Sciences, Peking University

B.S. in Computational Mathematics

Beijing, China

2022 - 2026 (expected)

GPA: 3.624 / 4.000

Selected Courses: Ordinary Differential Equations (90.5), Partial Differential Equations (91), Mathematical Statistics (100), Quantum Algorithms for Scientific Computation (93), Inverse Problems and Data Assimilation (95).

Research Interests: Operator Learning & Out-of-distribution Generalization \subset Scientific Machine Learning, Boundary Element Methods \subset Computational Fluid Dynamics

PUBLICATIONS

[3] **Jiayi Zhou**, Atharva Aalok, Valentin Duruisseaux, Xinyi Li, Juan Alonso, Anima Anandkumar. Robust Shape Optimization with Neural Shape Representations and Neural Operators. *In preparation*.

[2] **Jiayi Zhou**, Valentin Duruisseaux, Daniel Zhengyu Huang, Anima Anandkumar. Boundar Augmented Neural Operators for Better Generalization to Unseen Geometries. *NeurIPS AI4Science Workshop*, 2025.

[1] Chenyu Zeng*, Yanshu Zhang*, **Jiayi Zhou***, Yuhao Wang, Zilin Wang, Yuhao Liu, Lei Wu, Daniel Zhengyu Huang. Point Cloud Neural Operator for Parametric PDEs on Complex and Variable Geometries. *Computer Methods in Applied Mechanics and Engineering*, 2025. * denotes equal contribution

RESEARCH EXPERIENCES

Shape Optimization with Neural Representations and Neural Operators | Caltech

Advisor: Prof. Anima Anandkumar

Jan 2025 - Present

- Leader of the project, fully founded by Caltech.
- Developed a neural shape representation for closed curves and surfaces based on normalizing flow that guarantees non-self-intersection and enables stable optimization.
- Constructed high-fidelity Euler and RANS airfoil datasets.
- Achieved a 16% improvement in lift on the subsonic Euler dataset.
- Exploring 3D surface representations with encoder-decoder architectures for robustness against out-of-distribution geometries.

Operator Learning for Geometric Generalization | Peking University & Caltech

Advisors: Prof. Daniel Zhengyu Huang & Prof. Anima Anandkumar

Sep 2024 - Present

- Leader of the project.
- Developed a neural operator architecture that explicitly encodes boundary geometry and conditions and enables full-field prediction from boundary inputs.
- Generated a high-quality dataset of Poisson problems using the boundary element method.
- Investigated the geometric generalization behavior — model trained on single airfoils successfully predicts flow over airfoils with flap with about 10% relative L_2 error.
- Exploring analytical formulations of the solution operator for different equations on variable geometries and methods to incorporate normal information.

Operator Learning for Singularity and Scale-Invariance | Tsinghua University

Advisor: Prof. Mahdi Hormozi

Apr 2025 - Jun 2025

- Developed a Mellin transform based operator learning framework to strictly enforce scale-invariance.

- Analyzed scale-invariant behaviors in classical equations such as the Lévy and Smoluchowski equations.

Operator Learning for Complex and Variable Geometries | Peking University

Advisor: Prof. Daniel Zhengyu Huang

Feb 2024 - Apr 2025

- Extended the Fourier Neural Operator using Riemann-sum numerical integration and accounting for point density functions to support complex point-cloud geometries.
- Compared basis functions among Gaussian kernels, PCA bases, and Fourier bases, concluding that the Fourier basis provides greater stability and general applicability.
- Explored low-rank approximations of convolution kernels, including Tucker decomposition and \mathcal{H} -matrix structures, to reduce parameter counts.
- Incorporated derivative information as local features, yielding around 10% performance improvement across multiple datasets.
- Validated the model on diverse datasets, including Darcy, Airfoils with flap, Shape-Net Cars, and the Ahmed Bodies, etc.

AWARDS AND HONORS

SURF Award | Caltech

Selective undergraduate summer research fellowship, about \$8,000.

2025

National First Prize | China Undergraduate Mathematical Contest in Modelling

Top 300 out of about 65,000 teams in China's largest mathematical modeling competition.

2024

The Third Prize Scholarship | Peking University

University-level Scholarship awarded annually, approximately ¥4,000 per year.

2022-2024

Merit Student | Peking University

Awarded to 10% students based on overall comprehensive evaluation.

2022-2024

VOLUNTEER AND LEADERSHIP

Youth League Secretary | SMS Class 6, Peking University

Led class-wide communication and student activities for a cohort of 30 students.

2022-2025

Office of International Relations | Peking University

Volunteered at campus-wide events for international students.

2023-2024

SKILLS

Languages: Chinese, English (TOEFL 107, GRE 325)

Programming: Python (NumPy, PyTorch), C/C++, MATLAB, \LaTeX .

Hobbies: Badminton, Piano, Saxophone.