HAIYU ZHANG

Email: zhanghaiyu827@gmail.com

EDUCATION

Southern University of Science and Technology 2024 - 2026 (expected)
M.S. in Mathematics
GPA: 3.52/4.0 (89/100)
Courses: Advanced Probability, Convex Optimization Algorithms, Dynamical System, Machine Learning

Southern University of Science and Technology 2020 - 2024
B.S. in Mathematics
GPA: 3.68/4.0 (88/100)
Courses: Algebraic Topology, Differential Geometry, Abstract Algebra, Functional Analysis

University of California, Irvine 2023
Exchange Program
GPA: 4.0/4.0
Courses: Group Theory, Introduction to Programming Data Science, Geometry and Spacetime

PAPER

Topology-enhanced machine learning for consonant recognition *Preprint*

Pingyao Feng, Qingrui Qu, **Haiyu Zhang**, Siheng Yi, Zhiwang Yu, Zeyang Ding, Yifei Zhu

RESEARCH EXPERIENCE

Fractal Structure and Generalization Bounds with Intrinsic Dimension for Stochastic Optimization Algorithms 2025 - Present
Master Thesis, Advisor: Yifei Zhu

- Derive a generalization bound based on the hypothesis complexity (Persistent Homology dimension of the invariant measure of stochastic optimization algorithms) and hypothesis stability (the information theoretic quantities between the loss and data).
- Explicitly establish the relationship between the generalization, the PH dimension and the hyperparameters of the stochastic optimization algorithm.
- Explain the phenomenon of grokking by tracking the evolution of intrinsic dimension of weight trajectories and data representation manifolds.

Topology-enhanced machine learning for consonant recognition 2024 - 2025
Research Project, Key Contributor

- Proposed a topological methodology for time series analysis using time-delay embedding and persistent homology to extract topological acoustic features from speech signals.
- Enhanced the recurrent neural networks with topological features and applied the new framework to consonant classification.

Topological Data Analysis and Topological Deep Learning with Applications to Image Data 2023 - 2024
Undergraduate Thesis, Advisor: Yifei Zhu

- Reproduced the work of Gabrielsson and Carlsson on topology of neural networks by applying persistent homology to study the topological manifolds of Prewitt and Laplacian convolution kernels in image classification model.
- Proposed an optimized topological CNN model for image classification based on the work of Love et al., using convolution kernels sampled from distributions on these manifolds.

Deep Parametric Portfolio Policies with Nonlinear Feature Learning 2025
Course Project, Key Contributor

Developed a framework combining autoencoder-based nonlinear feature learning with Parametric Portfolio Policies (PPP) to address the challenges of high-dimensional stock features and limitations of traditional linear methods in prior portfolio constructions.

AWARDS

Outstanding Teaching Assistant Award 2024
Outstanding Undergraduate Thesis Award 2024
Honorable Mention of Mathematical Contest in Modeling (MCM) in the United States 2023
Third Class of the Merit Student Scholarship 2021
Second Class of the Freshmen Scholarship 2020

SEMINARS AND PRESENTATIONS

Applied and Computational Topology Seminar Fall 2023 - Present
Included topics in topological data analysis and topological deep learning such as persistent homology, along with their applications in machine learning.

Dynamical System Seminar Spring 2024
Included the theory of iteration of expanding maps and topics in geometric measure theory of the underlying invariant fractal sets.

CONFERENCES

International Workshop on Algebraic Topology (IWoAT) 2025
The 4th Annual Centre for Topological Data Analysis Conference in Oxford (Spires 2024) 2024
Greater Bay Area Topology Conference 2024

TEACHING

Teaching assistant for Calculus 2024
Teaching assistant for Applied and Computational Topology 2025

SKILLS

Code: Python (Practised) Matlab (Practised) Java (Beginner) Julia (Beginner)
Edit: LaTeX (Practised)
Languages: English (IELTS 7.0) Mandarin (Native)

PERSONAL INTERESTS

Psychology Classical music Badminton and table tennis