

Liu, Viola(Jingzhou)-C.V.

Personal Information

Email: violal1016@gmail.com

Google Scholar: <https://scholar.google.com/citations?user=-s8oeYkAAAAAJ&hl=en>

PersonalWeb: <https://www.violalequivariant.com/>

Github: <https://github.com/violal1016>

LinkedIn: <https://www.linkedin.com/in/viola-liu/>

Expertise

Mathematics: Theory of Machine/Deep Learning, Equivariant Degree Theory (Nonlinear analysis), Dynamical Systems.

Machine/Deep Learning: Transformer, CNNs, Equivariant Neural Networks; Support Vector Machines, Principal Component Analysis, Random Forest, etc.

Programming: G.A.P., Python (Pytorch, Scikit-learn), Mathematica

Education

Ph.D., Mathematics, University of Texas at Dallas, Richardson, TX, USA May 2026

M.S., Statistics and Data Analytics, Southern Methodist University, Dallas, TX, USA May 2019

Publications

- 1. Nonlinear Dynamics In Optimization Landscape of Shallow Neural Networks with Tunable Leaky ReLU.** Jingzhou Liu (2026)
 - Contributions:
 - (a) Studied activation-induced topological transitions in leaky ReLU loss landscapes with neuron-permutation symmetries.
 - (b) Established a theoretical framework proving that, for any number of neurons $k \geq 4$, branches of critical points bifurcate from the global minima as the leaky slope varies.
 - (c) Analyzed the general structure of the S_k -isotypic decomposition of \mathbb{R}^{k^2} for all integer $k \geq 4$, and provided a concrete numerical example and interpretation for the case $k = 5$.
 - (d) Computed the basic degree using G.A.P, providing a key step toward identifying the symmetries of critical-point branches in this network architecture.
- 2. Nonlinear Vibrational Modes of Molecule with Octahedral Configuration.** (Accepted, *Journal of Nonlinear Science*) Jingzhou Liu (2026)
- 3. Global Bifurcation In Four-Component Bose-Einstein Condensates In Space.** (Under revision, *Nonlinearity*) with Carlos García-Azpeitia, Anna Gołębiewska, Wieslaw Krawcewicz (2025)
- 4. Global Bifurcation of Non-Radial Solutions For Symmetric Sub-linear Elliptic Systems On The Planar Unit Disc.** (Published, *Journal of Fixed Point Theory and Applications* 26.4 (2024)): 44
- 5. Existence of Non-Radial Solutions To Semi-Linear Elliptic Systems On A Unit Ball In \mathbb{R}^3 .** (Published, *Journal of Fixed Point Theory and Applications* 25.4 (2023)): with Carlos García-Azpeitia, Wieslaw Krawcewicz

Manuscripts In Preparation

- 1. Critical Points and Their Symmetries In Deep ReLU Networks** (2026)
 - (a) Developing an equivariant degree framework on manifolds for deep ReLU networks with non-analytic loss functions.
 - (b) Addressing the challenging problem of S_k -isotropy lattices for arbitrary neuron number k by bringing tools from O’Nan–Scott theory and primitive group theory into the study of neural-network symmetries.
 - (c) Using Mathematica to compute critical points in the fundamental domains of fixed-point subspaces, a key step in computing the equivariant degree.

Employment

- 1. Independent AI Alignment Research** May 2026–Present
 - (a) Trained linear probes on language model activations to identify truthfulness, deception, and high-stakes interactions, and used causal interventions to assess the behavior influence.
 - (b) Built and analyzed SAE circuits using latent gradients, transcoders, attribution graphs, and causal interventions to trace end-to-end computation in transformers.

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2. **Teaching Associate/Assistant**, University of Texas at Dallas, USA Aug 2020- May 2026
 - (a) Taught various mathematics courses and took full responsibility for lectures, exam and homework design, student mentoring and course coordination.
 - (b) Led undergraduate TAs in organizing peer-to-peer study sessions for classes of 50+ students, helping promote student engagement.
3. **Data Scientist**, FooData.LLC, TX, USA (Python) Nov 2019- Jul 2020
 - (a) Preprocessed large raw audio datasets from diverse sources and extracted MFCC features using Librosa.
 - (b) Developed data monitoring systems to detect anomalies, validate data correctness, and track overall data health.
4. **Data Scientist**, Institute of Science & Technical Information of Shanghai (Python) Jul 2013-Aug 2017
 - (a) Leveraged statistical analysis to extract insights from operational data, forecast demand trends, and model customer behavior, resulting in a 10% improvement in prediction accuracy.
 - (b) Designed algorithms to analyze purchasing and weeding data, automating a 30-year manual workflow and improving efficiency by 5%.

Conference/Talks

1. **Nonlinear Dynamics of Shallow Neural Networks.**
Nonlinear Analysis Seminar, University of Texas at Dallas, USA Feb 2026
2. **Nonlinear Vibrational Modes of Molecules with Octahedral Configuration**
Nonlinear Analysis Seminar, University of Texas at Dallas, USA Jan 2026
3. **Global Bifurcation In Four-Component Bose-Einstein Condensates In Space.**
7th Annual Meeting of SIAM Texas-Louisiana Section, Baylor University, USA Oct 2024
Nonlinear Analysis Seminar, University of Texas at Dallas, USA Sep 2024
4. **Existence of Non-Radial Solutions To Semi-Linear Elliptic Systems On a Unit Ball In \mathbb{R}^3**
Nonlinear Analysis Seminar, University of Texas at Dallas, USA Jun 2023

Projects

1. **Equivariant Degree Theory in Lean 4** Jun 2025- Aug 2025
Explored the formalization of foundational concepts in equivariant degree theory within Lean 4's mathlib.
2. **Gentrification Since 1991 Based on New York Housing Data** Feb 2019- Jun 2019
 - (a) Applied multiple imputation techniques to address missing data and improve data completeness.
 - (b) Conducted a Z-test to assess whether the proportion of missing values differed between gentrified and non-gentrified categories.
 - (c) Experimented with multiple classification models, including logistic regression, random forest, and SVM, and addressed class imbalance using weighted logistic regression and adjusted sigmoid decision thresholds.
3. **Lending Club Data Analysis to Decide Factors Related to Interest Rates** Sep 2017- Dec 2017
 - (a) Conducted ANOVA hypothesis testing to identify statistically significant differences in interest rates across credit grade groups.
 - (b) Built a multiple linear regression model to identify the main predictors of clients' interest rates, including loan amount, average current balance, and annual income.