Liu, Viola(Jingzhou)-C.V.

Personal Information

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Expertise

Mathematics: Equivariant Degree Theory (Topological method for nonlinear analysis), Dynamical Systems, Theory of Machine/Deep Learning.

Programming: G.A.P(Group and representation computation), Python, Mathematica, Lean 4

Education

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

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

July 2013, B.S., Mathematics and Applied Mathematics, Shanghai Maritime University, China

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 symmetry and their impact on training dynamics.

   (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.** (Under revision with *Journal of Nonlinear Science*) Jingzhou Liu (2025)

3. **Global bifurcation in four-component Bose-Einstein Condensates in space.** (Under revision with *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.** (*Journal of Fixed Point Theory and Applications 26.4 (2024)): 44* with Casey Crane, Ziad Ghanem

5. **Existence of non-radial solutions to semi-linear elliptic systems on a unit ball in $\mathbb{R}^3$.** (*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-progress: 80%)

   (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.

2. **Optimization with Symmetry Constraint** with Wieslaw Krawcewicz (2025+)

Conference/Talks

1. **Nonlinear Dynamics of Shallow Neural Networks.**

   February 2026, Nonlinear Analysis Seminar, University of Texas at Dallas, USA

2. **Nonlinear Vibrational Modes of Molecules with Octahedral Configuration**

   January 2026, Nonlinear Analysis Seminar, University of Texas at Dallas, USA

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3. **Global Bifurcation In Four-Component Bose-Einstein Condensates In Space.**

   October 2024, 7th Annual Meeting of SIAM Texas-Louisiana Section, Baylor University, USA
   September 2024, Nonlinear Analysis Seminar, University of Texas at Dallas,USA

4. **Existence of Non-Radial Solutions To Semi-Linear Elliptic Systems On a Unit Ball In $\mathbb{R}^3$**

   June 2023, Nonlinear Analysis Seminar, University of Texas at Dallas, USA

Employment

1. **Aug 2025- Dec 2025, Teaching Associate, University of Texas at Dallas, USA**
   (a) Led course MATH 2312 (Precalculus) and mentored 26 undergraduate students.
   (b) Took full responsibility for lectures, exam and homework design, student mentoring, and course coordination.
   (c) Integrated modern technologies, including AI, to present abstract mathematical concepts in an accessible and engaging way.

2. **Aug 2020- July 2025, Teaching Assistant, University of Texas at Dallas, USA**
   (a) Taught various mathematics courses and participated in course design, homework and exam creation, and grading.
   (b) Led undergraduate TAs in organizing peer-to-peer study sessions for a class of 50+ students, helping promote student engagement.

3. **Nov 2019- Jul 2020, Data Scientist, FooData.LLC, TX, USA** (Python: tensorflow, numpy, etc.)
   (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. **Jul 2013-Aug 2017, Data Scientist, Institute of Science & Technical Information of Shanghai** (Python: numpy, scikit-learn, matplotlib, etc.)
   (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%.

Projects

1. **January 2026-Now, Deep learning architectures in Tensorflow/Pytorch**

   Developed implementations of deep learning architectures, including DQN agents and Transformer-based language models.

2. **June 2025-August 2025, Equivariant Degree Theory in Lean 4**

   Explored the formalization of foundational concepts in equivariant degree theory within Lean 4's mathlib, as part of a long-term project building on existing foundations developed by the automated theorem proving community.

3. **Feb 2019- Jun 2019, Gentrification Since 1991 Based on New York Housing Data** (SQL, Python, S.A.S)
   (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.

4. **Sep 2017-Dec 2017, Lending Club Data Analysis to Decide Factors Related to Interest Rates** (S.A.S)
   (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.