Miguel Liu-Schiaffini

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Education

California Institute of Technology — Pasadena, CA

B.S. in Computer Science — *Sept. 2021 – June 2025*

- **GPA:** 4.3 / 4

Research Experience

NVIDIA Research — Pasadena, CA

Research Intern – Learning and Perception Research Group — *June 2024 – Present*

- **Function space diffusion models:** Developing function space diffusion models for efficient image generation at arbitrary resolutions using operator learning. Designing and validating neural operators for natural images.
- Supervisors: Dr. Nikola Kovachki, Dr. Jean Kossaifi, and Dr. Jan Kautz.

Anima Anandkumar Lab, Caltech — Pasadena, CA

Undergraduate Researcher — *Sept. 2021 – Present*

- **Local neural operator:** Developed learnable finite-difference kernels and local convolutions into existing neural operator frameworks. Developed method for converting U-Net and other convolutional neural networks to neural operators mapping between function spaces.
- **Tipping point forecasting:** Designed novel method for predicting tipping points (drastic/abrupt changes) in complex systems defined over function spaces (e.g., rapid melting of ice caps). Proposed novel recurrent neural operator architecture for learning in non-stationary dynamical systems defined on function spaces.
- **Probabilistic neural operator:** Designed and developed conditional generative adversarial neural operator model for learning solutions to stochastic partial differential equations and for forecasting noisy real-world spatiotemporal systems.
- **Markov neural operator:** Developed Markov neural operator framework for learning the dynamics of chaotic systems (e.g., turbulent fluid flows) from data. Proposed novel methods to enforce dissipative dynamics and encourage stability for long autoregressive roll-outs.
- **Neural operator reviews and other contributions:** Contributed to neural operator Perspective paper published in *Nature Reviews Physics*. Contributed several models to Neural Operator GitHub library.
- Supervised undergraduate student applying neural operators to fusion applications.

University of Texas Institute for Geophysics — Austin, TX

Research Intern — *June – Aug. 2019 / June 2020 – May 2023*

- **Deep learning for accelerating ice thickness measurements:** Proposed and initiated project to automate generation of ice thickness measurements using radar data for ice sheets and glaciers. Designed a novel neural network/probabilistic graphical model framework with several orders of magnitude speed-up over prior methods.
- **Machine learning for Mars surface characterization:** Led a team of interns designing unsupervised graph neural networks and clustering methods for analyzing the Martian terrain.
- **Investigated ice surface elevation measurement error:** Hypothesized reason for offsets in surface elevation measurements derived from laser and radar-sounding instruments in the Arctic.

Publications

* Equal contribution

[1] **Liu-Schiaffini, M.***, Berner, J.*, Bonev, B.*, Kurth, T., Azizzadenesheli, K., & Anandkumar, A. (2024). Neural Operators with Localized Integral and Differential Kernels. *International conference on machine learning (ICML 2024).*

- Spotlight at ICLR 2024 Workshop on AI4DifferentialEquations in Science

[2] Li, Z.*, **Liu-Schiaffini, M.***, Kovachki, N., Liu, B., Azizzadenesheli, K., Bhattacharya, K., Stuart, A., & Anandkumar, A. (2022). Learning Dissipative Dynamics in Chaotic Systems. *Advances in Neural Information Processing Systems (NeurIPS 2022).*

[3] **Liu-Schiaffini, M.**, Ng, G., Grima, C. & Young, D. (2022). Ice Thickness from Deep Learning and Conditional Random Fields: Application to Ice Penetrating Radar Data with Radiometric Validation. *IEEE Transactions on Geoscience and Remote Sensing.*

[4] **Liu-Schiaffini, M.**, Singer, C. E., Kovachki, N., Schneider, T., Azizzadenesheli, K., & Anandkumar, A. (2023). Tipping Point Forecasting in Non-Stationary Dynamics on Function Spaces. *arXiv preprint arXiv:2308.08794.*

[5] Azizzadenesheli, K., Kovachki, N., Li, Z. **Liu-Schiaffini, M.**, Kossaifi, J., & Anandkumar, A (2024). Neural Operators for Accelerating Scientific Simulations and Design. *Nature Reviews Physics.*

[6] Duruisseaux, V.*, **Liu-Schiaffini, M.***, Berner, J., & Anandkumar, A. (2024). Towards Enforcing Hard Physics Constraints in Operator Learning Frameworks. *AI for science workshop at ICML 2024.*

[7] Jatyani, A., Wang, J., Wu, Z., **Liu-Schiaffini, M.**, Tolooshams, B., Anandkumar, A. (2024). Unifying Subsampling Pattern Variations for Compressed Sensing MRI with Neural Operators. *Workshop on Machine Learning and Compression at NeurIPS 2024.*

Awards and Honors

Barry Goldwater Scholar	2024
Henry Ford II Scholar Award (Caltech)	2024
Mellon Mays Undergraduate Fellowship	2023
Mellon Mays Summer Undergraduate Research Fellowship	2023
Stephen Adelman Memorial Summer Undergraduate Research Fellowship	2022
UT Jackson School of Geosciences Student Research Symposium: First Place in High School category	2021
Applied Materials Foundation "Mathematics & Science" Scholarship recipient	2021
National Merit Battelle Scholarship Recipient	2021

Teaching

California Institute of Technology Pasadena, CA

Computing and Mathematical Sciences Department / Deans' Office *Oct. 2022 – June 2024*

- **Head TA for ACM 104 (Applied Linear Algebra)**
  - Led team of 10 TAs for a 175-student class.
- **TA for IDS 157 (Graduate-level Statistical Inference)**
- **TA for ACM 216 (Graduate-level Markov Chains)**
- **2022-2023 Lead Deans' Tutor for Ma1 (First-year Mathematics)**
  - Selected by Deans to lead weekly study sessions for first-year students.

Talks and Presentations

Invited Talks

- Human-Centered AI Conference (invited Spotlight Talk), Pepperdine University (2024). "Tipping Point Forecasting in Non-Stationary Systems on Function Spaces."
- kAI Sabanci, Sabanci University (2023). "Learning Chaotic & Non-Stationary Dynamics With Neural Operators."
- Xiaojing Fu Research Group, Caltech (2023). "Tipping Point Forecasting on Function Spaces."
- Austin Geological Society (2021). "Ice Thickness Estimates Using Deep Learning."

Presentations

- ICML AI for Science Workshop (2024). "Towards Enforcing Hard Physics Constraints in Operator Learning Frameworks."
- MMUF Western Regional Conference (2023). "Tipping Point Forecasting in Non-Stationary Systems on Function Spaces."
- Caltech SURF Seminar (2023). "Tipping Point Forecasting in Non-Stationary Dynamics on Function Spaces."
- Caltech AI4Science Workshop (2023). "Learning Dissipative Dynamics in Chaotic Systems."

- Caltech SURF Seminar (2022). "Learning Dissipative Dynamics in Chaotic Systems."
- 52nd Lunar and Planetary Science Conference (2021). "Machine Learning Classification of the Martian Surface: Application to Radar Reflectometry."
- American Geophysical Union Fall Meeting (2020). "Application of Deep Learning Techniques to Ice Sheet Surface and Bed Interface Detection."
- American Geophysical Union Fall Meeting (2019). "Investigating Ice Surface Elevations Derived from Laser and Radar-sounding Measurements Over Devon Ice Cap, Canadian Arctic."

Reviewing

Conferences

- NeurIPS [2023, 2024]
- ICLR [2024, 2025]
- ICML [2024]
- AAAI [2025]
- AISTATS [2025]

Journals

- Journal of Machine Learning Research
- IEEE Transactions on Geoscience and Remote Sensing
- IEEE Geoscience and Remote Sensing Letters
- The Cryosphere

Code Contributions

- Markov Neural Operator GitHub Repository (https://github.com/neuraloperator/markov_neural_operator)
- Neural Operator PyTorch Library (https://github.com/neuraloperator/neuraloperator)

Skills and Languages

Languages: English (native), Spanish (native), Chinese (native)
Programming: Python, MATLAB, Java, C/C++, R
Libraries: PyTorch, TensorFlow, Keras, NumPy, SciPy
Hobbies: Cello (orchestra and chamber music), football, chess