

Miguel O'Malley

Summary

PhD Mathematician and Machine Learning Research Scientist with expertise bridging topological data analysis (TDA), metric space invariants, and deep neural network architectures. Expert in designing, training, and deploying time-series and full-stack ML applications. Specialized in optimizing neural network efficiency, loss function design, and model interpretability for complex datasets.

Technical Skills

Languages	Python, C++, C#, JavaScript, TypeScript
AI / Machine Learning	PyTorch, TensorFlow, Deep Learning, Reinforcement Learning, Time-Series
Web & Software Dev	Svelte, Node.js, Unity, Git, Frontend/Backend Architecture
Advanced Mathematics	Topological Data Analysis (TDA), Geometric Data Analysis, Optimization, Fractal Geometry

Experience

- 2023–present **Scientist**, *Max Planck Institute for Mathematics in the Natural Sciences*, Leipzig, DE
- Leveraged metric space invariants related to TDA to optimize deep reinforcement learning policies, improving model convergence rates and long-tail recognition.
- 2023–present **Applied Mathematician & ML Engineer**, *ScaDS.AI – University of Leipzig*, Leipzig, DE
- Engineered and deployed deep time-series models (Transformers, ConvLSTM) in PyTorch and Tensorflow for complex audio processing, achieving state-of-the-art accuracy in automated sequence generation. Architected a secure full-stack web application (Svelte/JavaScript/Pyodide) to orchestrate data collection for interactive ML topology challenges, scaling to handle public deployment at international conferences.

Selected Projects

- ITGPT ○ Transformer based model for DDR/ITG stepchart generation from audio. [Code & App](#). [GUI](#).
- Fence Challenge App ○ Full-stack + ML development for interactive topology puzzle challenge. Showcase at SPIN 2030, Heidelberg Laureate Forum, et.al. [Webapp](#).

Selected Technical Papers & Publications

- 2023 **Alpha Magnitude**, *M. O'Malley, S. Kalisnik, N. Otter*
Journal of Pure and Applied Algebra
- 2024 **Approximately Optimal Search on a Higher-dimensional Sliding Puzzle**, *SC Merleau, M. O'Malley, S. Mukherjee*
- 2026 **ITGPT**, *M. O'Malley*
Transformer model for DDR/ITG stepchart generation from audio.
- 2026 **Cardinality augmented loss functions**, *M. O'Malley*
Developed novel loss functions to stabilize neural network training on highly imbalanced mat-sci datasets.

Education

- 2017–2023 **PhD, Mathematics**, *Wesleyan University*, Middletown, CT
Advisor: Sara Kalisnik
- 2013–2017 **BA, Mathematics**, *College of New Jersey*, Ewing, NJ
Cum Laude

