

MICAH DARRELL, PhD

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WORK EXPERIENCE

Scientific Software Engineer

Stellar Science | Remote | April 2024 - Present

- **AFSIM Core Maintainer Team**

- Contribute to architecture decisions and maintain code quality for AFSIM, a 6 million+ LOC C++ simulation platform, utilizing modern C++20 practices.
- Modernized core mathematics libraries, enhancing simulation accuracy by identifying and resolving subtle, long-standing mathematical errors.
- Developed reinforcement learning demos using Python and Ray PPO integrated with AFSIM.

- **Parallel Simulation Architecture (AFSIM):**

- Collaborated with a team on designing the Parallel Discrete Event Simulation (PDES) architecture for a major initiative to parallelize AFSIM's simulation back-end.
- Working with a small team on implementation, achieving massive throughput improvements on key simulations in early testing phases.
- Translated PDES algorithms from research papers into high performance implementations, rigorously benchmarking their performance.

- **Specialized Compiler Project:**

- Served as Technical Lead for a specialized language compiler project designed for large-scale machine learning experiments on supercomputers and distributed systems.
- Designed language specifications and compiler architecture that produces optimized scripts for high-performance computing environments.
- Managed the development timeline and ensured alignment with project requirements through regular stakeholder presentations.

Machine Learning Engineer

Elder Research Inc. | Washington, D.C. / Remote | 2016-2017

- Applied state-of-the-art deep learning methods in graph convolutional networks for network analysis component of a large fraud detection model for a national government agency.
- Built music recommendation model for popular streaming service, presented results to CEO.
- Hired on after internship to work remotely part-time during school year.

EDUCATION

PhD in Mathematics

Northwestern University | Evanston, IL | 2023

- Dissertation: "Topological Restriction Homology is Locally Even in Characteristic p "
- Research area: Intersection of p -adic Hodge Theory, Homotopy Theory, and Algebraic Geometry.
- Solved a long-standing problem from the 1990s involving highly complex manual computations and novel theoretical techniques.

- Research published in Selecta Mathematica.

Bachelor of Science in Mathematics

University of Cincinnati | Cincinnati, OH | 2018

- Thesis: "Bourgain Spaces and Applications to Non-Linear Evolution Equations"

NOTABLE INVITED ADDRESSES AND WORKSHOPS

- **Arbeitsgemeinschaft Workshop** Oberwolfach, Germany | 2018, 2019
Prestigious mathematics research workshop (one of only 15 total invitees)
- **MSRI Research Group Invitee** Berkeley, California | 2020
One of 30 top researchers invited to work on p-adic Hodge Theory for MSRI focus year
- **Speaker, MIT Topology Seminar** Cambridge, Massachusetts | 2020
- **Michigan p-adic Hodge Theory Conference** Ann Arbor, Michigan | 2022

TECHNICAL PROJECTS

- **MiniCC:** A C compiler developed from scratch in Rust targeting Linux x86-64; features an SSA based IR and multiple optimization passes. 2024
- **mdb:** A gdb inspired Linux command-line debugging tool in C++23, capable of setting (hardware or software) breakpoints and dumping register and stack info. 2025
- **Carrara:** Computer algebra library written in Rust, with focus on high performance and long-term goal of providing new computations of algebraic K-theory groups. Being developed by several mathematicians. 2022-2023
- **Topology of Diffusion Models:** Research project quantifying the extent to which diffusion models learn the underlying topology of their data distribution. Built a family of generative diffusion models in PyTorch and confirmed that diffusion models learn topological invariants of their distribution stage. 2023
- **LaTeX LLM:** Built and trained a specialized LLM from scratch to generate realistic algebraic geometry LaTeX code. Optimized to run efficiently on limited hardware. 2022

SKILLS

- **Programming Languages:** C++, Python, Rust, CUDA, Bash, Verilog, R, Lean
- **Technologies:** Linux, CMake, Git, Qt