# Madeline "Maddie" Preston (She/Her)

Computational Scientist | Applied Mathematician | HPC & Simulation Engineering

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## SUMMARY

Computational scientist and applied mathematician specializing in high-performance simulation, HPC computing, and numerical modeling of complex systems. Skilled in Python, Fortran, and C++ for scalable algorithm development, parallelization, and simulation optimization. Experienced in transforming advanced mathematical models into efficient, production-ready software tools, benchmarking accuracy against analytical solutions, and running large-scale experiments on HPC clusters. Independent problem solver who thrives in collaborative environments and cross-disciplinary teams.

## RESEARCH & APPLIED COMPUTING PROJECTS

### Domain-Mapping Monte Carlo Methods for Non-Conservative PDEs

Master's Thesis - University of North Carolina, Chapel Hill
*Technologies: Python, Fortran, C++, Bash, NumPy, pandas, Git, HPC (UNC Longleaf)*

- Built a scalable Monte Carlo simulation framework to solve non-conservative PDEs in complex domains using conformal domain mapping.
- Engineered modular, high-performance code in Python and Fortran with support for coordinate transformations and tensor-based computations.
- Deployed on UNC's Longleaf HPC cluster, running millions of particle simulations to evaluate algorithm stability and efficiency in large-scale environments.
- Validated performance against analytical benchmarks, improving simulation accuracy in domains where traditional solvers fail.

### Surrogate Modeling for Nonlinear PDEs

Independent Research Project
*Technologies: Python, C++, PyTorch, NumPy, SciPy*

- Designing a workflow for generating surrogate models of nonlinear PDEs using neural networks to approximate high-fidelity solver outputs.
- Implementing finite-difference solvers to generate training datasets and training PyTorch-based models for predictive accuracy across varying boundary/initial conditions.
- Evaluating surrogate performance against traditional solvers, quantifying improvements in runtime efficiency and identifying tradeoffs in accuracy and stability.

## EXPERIENCE

### Graduate Research Assistant

UNC Chapel Hill - Fluids Lab — 01/2023 - 08/2025

- Coordinated large-scale simulation campaigns on UNC's Longleaf HPC cluster, optimizing workflows for job scheduling, data storage, and result aggregation.
- Developed processes for validating computational experiments against benchmarks and documenting reproducibility for long-term research use.
- Produced visualizations and reports to communicate findings across faculty, peers, and cross-disciplinary collaborators.

### Mathematics AI Trainer

Outlier — 10/2024 - Present

- Evaluated LLM-generated mathematical solutions for accuracy, edge cases, and clarity.
- Built prompt-based testing frameworks to identify failure modes and guide model refinement.
- Partnered with AI teams to improve model reliability and performance.

### Graduate Teaching Assistant & Instructor of Record

UNC Chapel Hill Mathematics Department — 08/2020 - 08/2025

- Developed and delivered undergraduate math curriculum as instructor of record, creating instructional materials and leading lectures.
- Mentored students individually and in groups, improving performance through targeted feedback.

## SKILLS

**Programming Languages**
Python, C++, Fortran, Bash/Unix, SQL, Java

**Scientific & Numerical Computing**
PDE Solvers, Monte Carlo Methods, Numerical Analysis, Stochastic Modeling, Scientific Simulation, CFD

**High-Performance Computing (HPC)**
Parallelization, Cluster Computing, Simulation Optimization, Performance Tuning, Model Scaling, Distributed Computing

**Machine Learning & Libraries**
PyTorch, TensorFlow, scikit-learn, NumPy, SciPy, pandas, SymPy, Hugging Face

**Tools & Systems**
Git, Docker, Jupyter, REST APIs, PostgreSQL, SLQAlchemy/Prisma, Mathematica

## EDUCATION

### M.S. in Applied Mathematics

University of North Carolina at Chapel Hill
2025 Chapel Hill, NC

- Graduate research in scientific computing, HPC simulation, and PDE-based modeling.
- Completed advanced coursework in numerical PDEs, stochastic modeling, and machine learning.

### B.S. in Applied Mathematics (Cum Laude)

Furman University
2020 Greenville, SC

- Undergraduate research in predictive modeling and recommender systems; presented findings at academic conferences.
- Relevant Coursework: Probability & Statistics, Numerical Methods, Linear Algebra, Optimization

## SELECTED PROJECTS

### MNIST CNN + Transfer Learning

- Building a Convolutional Neural Network (CNN) in PyTorch for MNIST digit classification and extending with transfer learning from ResNet.
- Designing experiments to compare baseline vs. transfer models on accuracy, runtime, and performance visualization.

### C++ Simulation Benchmarking Tool

- Developing a benchmark framework in C++ to evaluate simulation kernels under varying compiler optimizations and runtime conditions.
- Structuring the tool to be extensible, enabling future testing of additional simulation methods and datasets.