

Hariprashad Ravikumar

PhD Candidate in Physics, specializing in HPC & Machine Learning for High-Dimensional Data

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Experience

Graduate Research Assistant, New Mexico State University (Aug 2021 - Present)

PhD Project: Lattice QCD and Machine Learning Approaches to TMD Physics

- Designed and implemented a novel machine learning model using symbolic regression (PySR) to extract interpretable analytical functions from high-dimensional, noisy Monte Carlo simulation data.
- Engineered custom, physics-constrained loss functions to regulate simulation outputs on HPC clusters, enhancing model accuracy by over 93% and ensuring system stability by enforcing fundamental physical principles.
- Developed a high-performance data processing pipeline using parallelized Lua on HPC clusters to efficiently process multi-terabyte lattice QCD datasets, handling over 30,000 correlator evaluations.
- Leveraged stochastic sampling methods (jackknife, bootstrap) to rigorously quantify model uncertainties, delivering robust and reliable physical observables from simulation outputs.

Independent Collaborations

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1. **Los Alamos National Laboratory** - Collaborated with scientists on Computational Physics
 - Developed and optimized parallelized C++/CUDA kernels for GPU-accelerated HPC clusters (NERSC Perlmutter), significantly reducing calculation time for multi-terabyte datasets.
 - Architected and executed large-scale Monte Carlo simulations, implementing robust statistical methods (Jackknife, chi-squared with covariance) to ensure numerical stability and validate results.
 2. **North Carolina State University** - Collaborated with professor on Mathematical Physics
 - Implemented and managed Mathematica symbolic computation workflows on HPC clusters (NERSC Perlmutter) to analyze complex algebraic structures and symmetry constraints.

Technical Projects

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1. **AI-DataScience-Lab: Cloud-Hosted Forecasting App** GitHub | Live App
 - Developed an end-to-end forecasting platform featuring CSV upload, pandas for data cleaning, and scikit-learn for linear regression modeling (R^2 , MSE)
 - Engineered a Flask backend deployed on Azure and a React frontend on GitHub Pages, with a full CI/CD pipeline using GitHub Actions for automated testing and deployment.
 - Integrated the GPT-3.5 API to generate automated, natural-language summaries of forecasting results.
 2. **Neural Network from Scratch with NumPy** GitHub
 - Implemented a two-layer neural network from the ground up in NumPy, building a deep understanding of backpropagation, activation functions (ReLU, softmax), and optimization.
 - Trained the model on 5,000 samples from the MNIST dataset, achieving 80% accuracy within 60 epochs by tuning the learning rate.
 3. **\mathbb{Z}_2 Lattice Gauge Monte Carlo Simulation** GitHub
 - Built a Python-based large-scale Monte Carlo simulation of \mathbb{Z}_2 gauge theory using the Metropolis-Hastings algorithm on HPC clusters. Validated the simulation's accuracy by benchmarking results against established analytical predictions.

Technical Skills

Programming	Python, C++, CUDA, Bash, SQL, JavaScript, Lua, HTML/CSS, YAML
ML & APIs	TensorFlow, PyTorch, Scikit-learn, Pandas, Flask, FastAPI, RAG
Cloud & MLOps	Azure, AWS (Lambda, S3), CI/CD, Docker, Git, SLURM
Methods & HPC	MPI, GPU acceleration, Parallel Computing, Regression, Monte Carlo methods

Education

PhD in Physics , New Mexico State University, USA	<i>Aug 2021 – July 2026 (expected)</i>
MS in Physics , New Mexico State University, USA	<i>Aug 2021 – May 2024</i>
MSc in Physics , National Institute of Technology Jalandhar, India	<i>July 2019 – May 2021</i>
BSc in Physics , Dr. N.G.P. Arts and Science College, India	<i>June 2015 – May 2018</i>

Certifications

- (Jun 2025) Getting Started with Accelerated Computing in CUDA C/C++ by NVIDIA
- (Jun 2025) Supervised Machine Learning: Regression and Classification by DeepLearning.AI
- (Apr 2025) Google Advanced Data Analytics Professional Certificate

Awards

- **2025 NMC Collaboration Grant**, awarded by the New Mexico Consortium to conduct my independent research project in collaboration with scientists at Los Alamos National Laboratory
- **2023 George and Barbara Goedecke Physics Excellence Fund Scholarship**, awarded by the NMSU Physics Department
- **2021 Graduate Success Scholarship**, awarded by the NMSU Graduate School

Selected Talks

- (Jun 3, 2025) *"First Principles Lattice QCD Calculations of $nEDMs$ "*, T-2 Seminar, Theoretical Division, Los Alamos National Laboratory, USA
- (May 16, 2024) *"Lattice QCD Calculations of x Dependence of Sivers TMD"*, T-2 Seminar, Theoretical Division, Los Alamos National Laboratory, USA

Full list available at: hariprashad-ravikumar.github.io/talks