

# Hariprashad Ravikumar

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

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## Experience

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**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 that improved model accuracy and generalizability, ensuring predictions adhered to 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.
- Utilized 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 data analysis codes for GPU-accelerated HPC clusters (NERSC Perlmutter), significantly reducing processing time for multi-terabyte datasets.
    - Designed and executed large-scale Monte Carlo simulations with advanced statistical analyses (Jackknife resampling, chi-squared with covariance matrices) to extract hadronic matrix elements, enabling precision studies of beyond the Standard Model physics.
  2. **North Carolina State University** - Collaborated with professor on theoretical physics
    - Implemented Mathematica symbolic computation to analyze algebraic structures and symmetry constraints in interpolated Poincaré and conformal algebras.

## 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 from first principles using the Metropolis-Hastings algorithm. Validated the simulation's accuracy by benchmarking results against established analytical predictions.

## Technical Skills

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

## Education

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<b>PhD in Physics</b> , New Mexico State University, USA	<i>Aug 2021 – July 2026 (expected)</i>
<b>MS in Physics</b> , New Mexico State University, USA	<i>Aug 2021 – May 2024</i>

## Certifications

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- (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

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- **2025 NMC Collaboration Grant**, awarded by the New Mexico Consortium at Los Alamos.
- **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

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- (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](https://hariprashad-ravikumar.github.io/talks)