Harihara Maharna

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Education

PhD in Applied and Computational Mathematics, University of Notre Dame – Notre Dame, IN, USA — Aug 2024 – Current
Advisor: Dr. Zhiliang Xu, Professor, ACMS Department

MSc in Mathematics, IISER Thiruvananthapuram – Kerala, India — Aug 2022 – July 2024
Advisor: Dr. K. R. Arun, School of Mathematics

BSc in Mathematics, M. P. C. Autonomous College – Odisha, India — Aug 2019 – July 2022

Experience

GRADUATE RESEARCH ASSISTANT, University of Notre Dame – Notre Dame, IN, USA — June 2025 – Present
Project: Deep Learning for Multiscale Models
Advisor: Dr. Zhiliang Xu, Professor, ACMS Department

- Architected and implemented an **Energetic Variational Deep Neural Network** (EVNN) solver in **PyTorch** to model **Cahn-Hilliard phase-separation dynamics**.
- Ensured model **stability and physical consistency** by enforcing **energy conservation laws** directly within the neural network architecture, resulting in more **robust and reliable simulations**.
- Scaling this EVNN framework to model complex, coupled **Cahn–Hilliard–Navier–Stokes** systems to improve training stability for **high-dimensional fluid dynamics**.

MASTERS RESEARCH, IISER Thiruvananthapuram – Kerala, India — Jan 2024 – May 2024
Project: An Asymptotic-Preserving and Energy-Stable Scheme for the Euler System (Publication)
Advisor: Dr. K. R. Arun, Associate Professor, School of Mathematics

- Developed a **semi-implicit finite-volume scheme** for barotropic Euler equations with a congestion pressure law, ensuring **positivity of density** and **energy stability** at the discrete level.
- Proved **entropy stability** and **asymptotic-preserving properties**, ensuring reliability in stiff regimes.

SUMMER RESEARCH INTERN, NISER Bhubaneswar – Odisha, India — Summer 2023
Guide: Dr. Anupam Pal Choudhury, Reader - F, Mathematical Sciences

- Investigated **scalar conservation laws** with applications to traffic flow modeling and shockwave dynamics.
- Analyzed weak solutions, Rankine–Hugoniot conditions, and entropy criteria to understand discontinuous flows.

Honors & Awards

Departmental Award, ACMS Department, University of Notre Dame — 2025
- Awarded for the highest score in the Applied Mathematics qualifying exam; USD 500.

NBHM Master's Fellowship, National Board for Higher Mathematics — Aug 2022 – Aug 2024
- Merit-based national fellowship awarded to 33 students across India through an national exam; INR 168,000.

Valedictorian in BSc Mathematics, M. P. C. Autonomous College — 2022

Skills

- **Computational Methods:** Deep Neural Networks, Physics-Informed Neural Networks, Computational Fluid Dynamics, Numerical Analysis, Finite Element Methods, Finite Volume Methods, Finite Difference Methods.
- **Programming:** Python (PyTorch, SimVascular, NGSolve, SciPy, Pandas), MATLAB, R.
- **Tools & Platforms:** Github, Linux, LaTeX, Jupyter Notebooks.

Selected Publication and Talk

- K. R. Arun, A. Krishnamurthy, and H. Maharna. **An asymptotic preserving and energy stable scheme for the Euler system with congestion constraint**, Applied Mathematics and Computation, vol. 495, p. 129306, 2025.
- Lightning Talk: **Energetic Variational Neural Network Discretization of the Cahn-Hilliard Equation**, Scientific Machine Learning: Theory, Algorithm, and Applications Workshop, Purdue University, IN, USA, September 27–28, 2025.