Harihara Maharna

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Summary

PhD student in Applied and Computational Mathematics at the University of Notre Dame, specializing in deep learning, numerical methods for differential equations, and efficient computational techniques for multiscale models. Enthusiastic about developing innovative mathematical and computational solutions to real-world problems.

Education

PhD in Applied and Computational Mathematics GPA-4.0/4.0 (grade card)
Department of Applied and Computational Mathematics and Statistics (ACMS),
University of Notre Dame, Notre Dame, IN, USA 2024-current
- Advisor: Dr. Zhiliang Xu, Professor, ACMS Department

MSc in Mathematics CGPA-8.45/10 (grade cards)
School of Mathematics, IISER Thiruvananthapuram, Kerala, India 2022-2024

BSc in Mathematics CGPA 9.09/10 (grade card)
Department of Mathematics, M. P. C. Autonomous College, Odisha, India (valedictorian) 2019-2022

Projects and Internships

Graduate Research Assistant, University of Notre Dame, Notre Dame, IN June 2025-current
Topic: Deep Learning for Multiscale Models
Advisor: Dr. Zhiliang Xu, Professor, ACMS Department
- Architected and implemented an **Energetic Variational Deep Neural Network** (EVNN) solver with adaptive refinement 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**.

Numerical Hemodynamics and Uncertainty Quantification Class Project, University of Notre Dame Spring 2025
Project: Impact of hemodynamic parameters on rupture risk in abdominal aortic aneurysm (AAA) (Report)
Guide: Dr. Daniele E. Schiavazzi, Associate Professor, ACMS Department
- Performed **finite element analysis** by solving **time-dependent Navier–Stokes equations** in SimVascular to model blood flow as an incompressible Newtonian fluid.
- Computed and analyzed hemodynamic metrics to asses the vascular flow characteristics and evaluated the rupture risk in AAA models comparing representative and virtually repaired geometries.

Master's Research Project, IISER Thiruvananthapuram, Kerala Spring 2024
Project: An Asymptotic-Preserving and Energy-Stable Scheme for the Euler System (Publication)
Guide: Dr. K. R. Arun, 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 Project Summer 2023
Topic: Differential Equations.
Guide: Dr. Anupam Pal Choudhury, School of Mathematics, NISER Bhubaneswar, India
- Investigated **scalar conservation laws** with applications to traffic flow modeling and shockwave dynamics.
- Analyzed weak solutions, Rankine–Hugoniot conditions, and entropy criteria to understand discontinuities in flow behavior.

Fellowships and Scholastic Achievements

- Departmental Award for highest score in Applied Mathematics qualifying examination, USD 500, ACMS Department, University of Notre Dame, 2025
- NBHM Master's Fellowship, INR 168,000 (over two years), National Board for Higher Mathematics (NBHM), 2023–2024
- Valedictorian in BSc Mathematics (2019–2022 batch), Maharaja Purna Chandra (MPC) Autonomous College, Odisha, India

Work Experience

Teaching Assistant, University of Notre Dame Aug 2024 – Present

- Provided instructional support for advanced courses in Applied Mathematics, Statistics, and Data Science; managed grading, held office hours, and delivered lectures when needed.

  Spring 26

  - Scientific Programming (ACMS 40210, ACMS 60210)
  - Introduction to Probability (ACMS 30530)

  Fall 25

  - Nonlinear Dynamical Systems (ACMS 60630, ACMS 40630)
  - Numerical Analysis I (ACMS 60690)
  - Probability and Statistics for Data Science (DS 60505)

  Spring 25

  - Scientific Programming (ACMS 40210, ACMS 60210)
  - Numerical Analysis (ACMS 40390)

  Fall 24

  - Probability and Statistics for Data Science (DS 60505)
  - Introduction to Numerical Analysis (ACMS 20350)

Online Education Support

- Chegg Subject Matter Expert in Calculus. Feb 2022- July 2023

Workshops

Scientific Machine Learning: Theory, Algorithm, and Applications Workshop
Purdue University, IN, USA September 27–28, 2025
Lightning Talk: *"Energetic Variational Neural Network Discretization of the Cahn-Hilliard Equation"*

Mathematics Training and Talent Search Programme (MTTS) Level-1
IISER Thiruvananthapuram, India Summer 2022

- In this 4-week summer school, I attended various lectures in analysis and algebra.

Mathematics Training and Talent Search Programme (MTTS) Level-O (Remote) Summer 2021

Skills

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

Publications

1. K. Arun, A. Krishnamurthy, and H. Maharna. An asymptotic preserving and energy stable scheme for the euler system with congestion constraint. Applied Mathematics and Computation, Applied Mathematics and Computation, vol. 495, p. 129306, 2025. https://doi.org/10.1016/j.amc.2025.129306