Harihara Maharna

PhD Student at University of Notre Dame, IN, US

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Summary

I am a PhD student in Applied and Computational Mathematics in the Department of Applied and Computational Mathematics and Statistics (ACMS) at the University of Notre Dame, IN, USA. I am enthusiastic about learning numerical methods for solving differential equations and developing efficient computational techniques for complex mathematical problems.

Education

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

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 sheet)
Department of Mathematics, M. P. C. Autonomous College, Odisha, India 2019-2022

Projects and Internships

Graduate Research Assistant, University of Notre Dame, Notre Dame, IN June 2025-current
Advisor: Dr. Zhiliang Xu, Professor, ACMS Department
Topic: Deep Learning for Multiscale Models

- 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**.

Master's Research Project, IISER Thiruvananthapuram, Kerala Jan-May 2024
Guide: Dr. K. R. Arun, School of Mathematics
Project: An Asymptotic-Preserving and Energy-Stable Scheme for the Euler System (Publication)

- 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
Guide: Dr. Anupam Pal Choudhury, School of Mathematics, NISER Bhubaneswar, India
Topic: Differential Equations.

- 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
- Ranked first 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.

  Fall 24

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

  Spring 25

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

  Fall 25

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

Online Education Support

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

Workshops and Online Courses

Scientific Machine Learning: Theory, Algorithm, and Applications Workshop
Purdue University, IN, US 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 (Online) Summer 2021

Online Foundation Course in Mathematics (OFCM) (Online) October 2020

Technical skills

- **Programming Languages:** Python, Matlab, C++, R.
- **Python Libraries:** PyTorch, NGSolve, SimVascular, NumPy, SciPy, Pandas, Matplotlib.
- **Tools:** LaTeX, Git, 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

References

- Dr. Zhiliang Xu, *Professor, Departmen of Applied and Computational Mathematics and Statistics, University of Notre Dame, IN, USA.*
  Email address: zhiliangxu@nd.edu. Connection: PhD advisor.
- Dr. K. R. Arun, *Associate Professor, School of Mathematics, Indian Institute of Science Education and Research, Thiruvananthapuram, India.*
  Email address: arun@iisertvm.ac.in. Connection: Master's project guide.