

Deepanshu Verma

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Education

Doctor of Philosophy, Computational Math <i>George Mason University, Fairfax, VA, USA</i> Advisor: Dr. Harbir Antil	Aug 2018 – Aug 2021 GPA: 4.0/4.0
Master of Science, Mathematics <i>Indian Institute of Technology, Bombay, India</i>	2015-2018 CPI: 9.65/10
Bachelor of Science, Mathematics <i>University of Delhi, New Delhi, India</i>	2011-2014 Percent Grade: 95%

Professional Experience

Distinguished Visiting Assistant Professor <i>Emory University, Atlanta, GA, USA</i> <ul style="list-style-type: none">Conduct innovative research in optimal control with a focus on using Neural Networks as function approximators under the guidance of Dr. Lars Ruthotto.Create Python packages for implementing deep learning techniques to solve high-dimensional Hamilton-Jacobi-Bellman problems.Collaborate with interdisciplinary teams to address complex scientific challenges, and present findings at national and international conferences.Provide mentorship and guidance to graduate and undergraduate students alongside the supervisor.Played an instrumental role in the REU/RET site, enhancing the research capabilities and reputation of the department.Active participation in departmental seminars, workshops, and other academic activities, contributing to the intellectual environment of the institution.Instruct two courses annually during the academic year.	August 2021 – Present
Graduate Research Assistant <i>Department of Mathematics, George Mason University, Fairfax, VA, USA</i> <ul style="list-style-type: none">Managed several applied and methodological research projects under supervision.Developed MATLAB packages for implementing machine learning and PDE-constrained optimization methods.Assisted in conducting literature reviews on advanced mathematical and machine learning techniques, preparing comprehensive reports with data analysis and visualization to support academic pursuits.	Aug 2018 – Aug 2021
Summer Graduate Computing Student Intern <i>Lawrence Livermore National Lab, Livermore, CA, USA</i> <ul style="list-style-type: none">Evaluated existing methods for approximating the Signed Distance Function (SDF) used to determine the distance of a point from the boundary of a surface.Developed an SDF solver in MFEM, a C++ library for finite element methods.	May 2021 – Aug 2021

Research Projects

Deep Learning for Optimal Control <ul style="list-style-type: none">Enhanced learning algorithms utilizing control theory to solve high-dimensional optimal control problems through the Hamilton-Jacobi-Bellman equation. This unsupervised learning method informs decision-making in deep brain simulations, finance, robotics, and more.Developed a novel learning algorithm combining HJB and finite element methods (FEM) to address PDE-constrained optimization in applications like contaminant containment and wildfire control.Demonstrated the superiority of the HJB approach over Reinforcement Learning for various applications.
Enhancing Deep Learning with Control Strategies <ul style="list-style-type: none">Introduced the fractional-DNN method, employing fractional calculus to mitigate the vanishing/exploding gradient issue in deep learning.Utilized PDE-constrained optimization techniques in DL for dynamical data analysis and modeling.Designed deep learning algorithms to learn dynamics in stiff ODEs (chemical reactions), Navier-Stokes equations and Hamiltonian differential equations (Hamiltonian mechanics).
Optimal Control of Fractional PDEs <ul style="list-style-type: none">Investigated external source identification problems within optimal control, including the development of functional analytic tools for solution existence and uniqueness.Conducted error analysis for FEM and created MATLAB packages for solving these problems efficiently..

Publications

- L. Ruthotto, **D. Verma**, N. Winovich, and B. v Bloemen Waanders. Amortized PDE control with HJB and Reinforcement Learning. *In preparation*.
- Z. Wang, R. Baptista, Y. Marzouk, L. Ruthotto and **D. Verma**. Neural Network approaches for conditional sampling and

density estimation motivated by optimal transport. *In preparation*.

- **(advised)** E. Hayes, M. Heider and C. Vanty. HINNs: Hamiltonian Inspired Neural Networks. *In preparation*.
- M. Madondo, **D. Verma**, L. Ruthotto, and N. A. Yong (2023). Learning Control Policies of Hodgkin-Huxley Neuronal Dynamics. Submitted to *ML4H*.
- X. Li, **D. Verma** and L. Ruthotto. (2022) A Neural Network approach for Stochastic Optimal Control problems. [arXiv](#)
- B. P. Lamichhane, N. Nataraj, and **D. Verma**. (2023) A mixed finite element method using a biorthogonal system for optimal control problems governed by a biharmonic equation. Accepted in *ANZIAMJ 2023*.
- H. Antil, H.C. Elman, A. Onwunta, and **D. Verma**. (2023) A deep neural network approach for parameterized PDEs and Bayesian inverse problems. *Mach. Learn.: Sci. Technol.* 4 035015. DOI: [Link](#)
- H. Antil, T.S. Brown, R. Löhner, F. Togashi, and **D. Verma**. (2022) Deep Neural Nets with Fixed Bias Configuration. *Numer. Algebra Control Optim.* DOI: [Link](#)
- T.S. Brown, H. Antil, R. Löhner, F. Togashi, and **D. Verma**. (2022) Parallel Deep ResNets for Chemically Reacting Flows. *AIAA SciTech Forum*. DOI: [Link](#)
- H. Antil, R. Khatri, R. Löhner and **D. Verma**. (2020) Fractional Deep Neural Network via Constrained Optimization. *Machine Learning: Science and Technology 2020*. DOI: [Link](#)
- H. Antil, T.S. Brown, **D. Verma** and M. Warma. (2021) Optimal Control of Fractional PDEs with State and Control Constraints. Accepted in *Pure and Applied Functional Analysis*. [arXiv](#)
- H. Antil, **D. Verma** and M. Warma. (2020) Optimal Control of Fractional Elliptic PDEs with State Constraints and Characterization of the dual of Fractional Order Sobolev Spaces. *J Optim Theory Appl*. DOI: [Link](#)
- H. Antil, **D. Verma** and M. Warma. (2020) External Optimal Control of Space-Time Fractional Parabolic PDEs. *ESAIM: COCV 26 (2020) 20*. DOI: [Link](#)

Awards and scholarships

George Mason University

- Dean's Graduate Award for Excellence 2019-2020
- Presidential Merit Fellowship 2018-2021
- Presidential Scholar Summer Research Fellowship 2020

Indian Institute of Technology, Bombay

- Institute Silver Medal Aug 2017
- Mrs. Rama Mathur Award Aug 2017
- Prof. P.V. Sukhatme Memorial Prize Award Aug 2017
- Institute Academic Prize Aug 2016

Skills

- **Research:** Research methodology & design; machine learning; finite element methods; numerical optimization; written and oral presentation; communication and interpersonal skills
- **Software:** Proficient in FEniCS, PyTorch, Python, Matlab, MS office with Basic Proficiency in C++

Research Interest

- Numerical Analysis
- Optimization
- Inverse Problems
- Scientific Computing
- Deep Learning
- Optimal Control

Mentorship

- Oliver Wang **Emory Honors Program** Summer 2022 - May 2023
Current: *Ph.D student in Aeronautics and Astronautics at MIT, August 2023*
- Sylvia Vincent **Masters Thesis, IIT Bombay** August 2022 - May 2023
Current: *Ph.D student in Statistical Sciences at Duke University, August 2023*
- **Emory REU Mentees** Summer 2022
Emma Hayes Carnegie Mellon University
Mathias Heider University of Delaware
Current: *Masters in CS at University of Delaware*
Carrie Vanty Middlebury College

Leadership

- **Executive Board member**, Emory REU/RET Computational Mathematics for Data Science. Summer 2022
Organized tutorials, seminars, professional development opportunities; designed the REU/RET schedule, deliverables; and support of logistics.
- **Minisymposia co-organiser**, various national and international conferences.
- **Executive Board member**, SIAM GMU Student Chapter. August 2019-2021
- **Support Team Member & SIAM Representative**, East Coast Optimization Meeting. August 2019-2021
- **Poster Judge**, SIAM conference on Mathematics of Data Science, San Diego, CA. September 2022
- **Student Coordinator**, PDE-Control Seminar, George Mason University. August 2019-2021
- **Core Member of Public Relations Team**, Mathematics Olympiad, IIT Bombay, India. July 2016-2017
Conceptualized a mathematics talent search test for high school and under-graduate students.