Amartya (Marty) Mukherjee

+1 226-505-7700 a29mukhe@uwaterloo.ca
/in/amartya-marty-mukherjee-142246164/
amartyamukherjee.github.io

Research Interests

My research centers on methods and applications of deep learning with partial differential equations, addressing challenges in optimal control, reinforcement learning, computer vision, and gaming. I am particularly intrigued by the potential of diffusion models and neural operators in bridging the gap between formal methods and machine learning algorithms.

Education

University of Waterloo **September 2022 – April 2027 (Expected)**
Doctor of Philosophy, Applied Mathematics, Supervisor: Jun Liu

University of Waterloo **September 2017 – April 2022**
Bachelor of Mathematics, Applied Mathematics with Scientific Computing, Minor in Statistics

Preprints

- **Amartya Mukherjee**, Ruizhi Deng, He Zhao, Yuzhen Mao, Leonid Sigal, Frederick Tung (2025). *ADiff4TPP: Asynchronous Diffusion Models for Temporal Point Processes.* Submitted to NeurIPS 2025. arxiv:2504.20411
- **Amartya Mukherjee**, Melissa Stadt, Lena Podina, Mohammad Kohandel, and Jun Liu (2024). *Denoising Diffusion Restoration Tackles Forward and Inverse Challenges in the Laplacian Operator.* Submitted. arxiv:2402.08563
- Milad Farsi, Ruikun Zhou, **Amartya Mukherjee**, Christopher Song, Ye Yuan, and Jun Liu (2024). *Online Model-based Reinforcement Learning for Optimal Control with Provable Stability Guarantees.* Submitted. [Link]

Publications

- **Amartya Mukherjee**, Thanin Quartz, and Jun Liu (2025). *Manifold-Guided Lyapunov Control with Diffusion Models.* American Control Conference (ACC 2025). arxiv:2403.17692
- Yiming Meng, Ruikun Zhou, **Amartya Mukherjee**, Maxwell Fitzsimmons, Christopher Song, and Jun Liu (2024). *Physics-Informed Neural Policy Iteration: Algorithms, Convergence, and Verification.* 41st International Conference on Machine Learning (ICML 2024). [Link]
- **Amartya Mukherjee** and Jun Liu (2024). *Enhancing Reinforcement Learning in Vision-Based Environments with Optical Flow.* Journal of Computational Vision and Imaging Systems, 9(1), 1–3. DOI: https://doi.org/10.15353/jcvis.v9i1.10000
- **Amartya Mukherjee** and Jun Liu (2023). *Actor-Critic Methods using Physics-Informed Neural Networks: Control of a 1D PDE Model for Fluid-Cooled Battery Packs.* ICML Workshop on New Frontiers in Learning, Control, and Dynamical Systems. [OpenReview]
- **Amartya Mukherjee** and Jun Liu (2023). *Bridging Physics-Informed Neural Networks with Reinforcement Learning: Hamilton-Jacobi-Bellman Proximal Policy Optimization (HJBPPO).* ICML Workshop on New Frontiers in Learning, Control, and Dynamical Systems. [OpenReview]
- **Amartya Mukherjee**, Yusuf Aydogdu, Thambirajah Ravichandran, and Navaratnam Sri Namachchivaya (2022). *Stochastic Parameterization Using Compressed Sensing: Application to the Lorenz-96 Atmospheric Model.* Tellus A: Dynamic Meteorology and Oceanography, 74(2022), pp.300–317. DOI: http://doi.org/10.16993/tellusa.42

Patents

- Sheral Kumar, **Amartya Mukherjee**, Seel Patel, Rui Xiang Chai, Wentao Liu, Yuanhao Yu, Yang Wang, Jin Tang. *Methods and Devices for Extracting Motion Vector Data from Compressed Video Data.* US Patent 11,729,395 B2, filed November 26, 2021, published August 15, 2023. [Google Patents]

Research Internship Experience

Machine Learning Research Intern, Royal Bank of Canada Borealis **Sep 2024– Dec 2024**

Mentor: Dr. Fred Tung

- Worked on asynchronous diffusion models for temporal point process generation.
- Trained transformer-based variational auto-encoders on benchmark temporal point process datasets to generate latent vectors.
- Introduced asynchronous diffusion models to aid in the cascaded generation of tabular data applied to temporal point processes.

Computer Vision, Noah's Ark Lab at Huawei Technologies Canada **May 2021– Dec 2021**

Mentor: Dr. Wentao Liu

- Developed and implemented innovative solutions for accelerating video AI tasks on smartphones by focusing on motion vector extraction.
- Integrated customized H.264 and HEVC video decoders into the Android Media framework, enabling the extraction of motion vector information from video streams.
- Achieved significant performance improvements by reducing computation times for optical flow and action recognition models by 55% and 34%, respectively, through the efficient use of motion vector data.
- Filed a patent, that has been approved by the United States Patent and Trademark Office.

Fields CQAM Laboratory for Inference and Prediction **May 2020– Apr 2021**

Mentor: Professor N. Sri Namachchivaya (Department of Applied Mathematics, University of Waterloo)

- Worked on data-driven dimensionality reduction methods in two-time-scaled dynamical systems.
- Replaced regression with a combination of sparse optimization and data assimilation in modeling dynamical systems.
- Reduced the mean squared prediction error of Rossby waves by 21% using Compressed Sensing and further by 64% using Ensemble Kalman Filter.
- Lead author of a journal publication.

Notable Teaching Assistant Experience

AMATH 731 - Applied Functional Analysis **Sep 2023– Dec 2023**

Department of Applied Mathematics

- Assisted with curriculum development by providing expertise on topics like Sobolev spaces and Ritz method that the instructor was less familiar with.
- Collaborated closely with the course instructor in writing relevant assignment and exam questions.
- Assisted students with research projects on applications of functional analysis in quantum physics, economics, and computer graphics.
- Wrote marking schemes for assignments and designed grade distributions.

AMATH 242/CS 371 - Introduction to Computational Mathematics **Jan 2023– Aug 2023**

Department of Applied Mathematics, Department of Computer Science

- Recorded Matlab tutorials for floating-point numbers.
- Graded and assisted students with course projects on root-finding methods applied to fluid flow problems.
- Reviewed students' Matlab, python, C, C++, and Fortran code for the implementation of numerical linear algebra, interpolation, integration, and discrete Fourier methods.

Notable Software Internships

Data Scientist **Jan 2020– Apr 2020**

Zeitspace *Waterloo, ON, Canada*

- Implemented an automated rider sorting system for races based on skill levels, leveraging unsupervised learning techniques.
- Employed the TrueSkill algorithm to assess rider rankings, using historical race results to determine skill levels accurately.
- Used K-Means Clustering to group riders with similar ranks and experience into the same race, creating a more competitive and engaging racing experience.
- Deployed the algorithm to the backend of the system, using Python in conjunction with Flask.

Presentations

Department Learning Seminars

- *Reinforcement Learning: Zero to ChatGPT* [Slides]
  Hosted a Machine Learning seminar for students and faculty in the Department of Applied Mathematics, University of Waterloo. The presentation provided an introductory journey into reinforcement learning, exploring key concepts such as proximal policy optimization (PPO) and reinforcement learning with human feedback (RLHF). The talk highlighted the practical application of these techniques in training large language models (LLMs), using ChatGPT as a case study.

Invited Talks

- *GibbsDDRM: A Partially Collapsed Gibbs Sampler for Solving Blind Inverse Problems with Denoising Diffusion Restoration* [Slides]
  Presented at an event on Diffusion Models, hosted by the Department of Computer Science at the University of Waterloo. The presentation delved into the paper titled "GibbsDDRM," published in ICML 2023. The talk provided a comprehensive overview of the mathematical background and detailed the parameter update process, offering insights into solving blind linear inverse problems with pre-trained diffusion models. Finally, I talk about the extension of this work to my own research project on partial differential equations.
- *Adversarial Reinforcement Learning for Procedural Content Generation* [Slides]
  Presented at a Reinforcement Learning event hosted by the Department of Computer Science at the University of Waterloo. The talk centered around the application of reinforcement learning techniques detailed in a paper published by EA. Specifically, it explored the use of these techniques for procedural content generation in games, with a focus on dynamically adjusting game difficulty based on the intended level of challenge.

Honors and scholarships

- American Control Conference Student 2025 Travel Grant - 650 USD
- University of Waterloo Graduate Scholarship - 1,000 CAD
- International Conference on Machine Learning 2023 Student Travel Grant - 1,030 USD
- President's Scholarship (University of Waterloo) - 2,000 CAD
- Founder's Scholarship (K. International School Tokyo) - 300,000 JPY

Technical Skills

Programming languages
Python, Matlab, Julia, C++, C, SQL, Java, R
Software
LaTeX, Git, Flask, PyTorch, OpenCV, PySindy, PySpark, FEniCS
Languages
English (fluent), Japanese (N3), Mandarin (basic)