Pinak Mandal

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Professional Summary

PhD in Applied Mathematics and Deep Learning with 8+ years of experience developing advanced algorithms for dynamical systems, generative AI, and data-driven optimization. Expert in designing and executing computational experiments to validate ideas. Author of several software projects that deliver scalable ML systems with a strong emphasis on usability and performance.

Education and Employment

- **University of Sydney, Sydney** 2023 - 2025
  Postdoc (Machine Learning and Dynamical Systems)
  Supervisor: **Georg Gottwald**
- **International Centre for Theoretical Sciences, Bengaluru** 2017 - 2023
  PhD (Applied Mathematics and Deep Learning)
  Supervisors: **Amit Apte**, **Vishal Vasan**
  Thesis: Numerical Filter Stability, Fokker-Planck Equations and Infinite Dimensional Optimization with Deep Learning
- **Jadavpur University, Kolkata** - MSc (Mathematics) 2014 - 2016
- **Jadavpur University, Kolkata** - BSc (Mathematics) 2011 - 2014

Work Experience

I have worked on a broad range of applied problems with a recent focus in fundamental machine learning. Some of them are listed below.

- **Unlearning via orthogonalization in generative models, USyd** 2025
  Developed new model-agnostic algorithms for forgetting undesired training data in generative models that are ∼10-20x faster than gradient surgery.
  https://arxiv.org/pdf/2506.04712.pdf
- **Learning dynamical systems from data with Random Feature Maps, USyd** 2024
  Developed data-driven sampling for tanh random feature maps; implemented deep and local variants of RFMs, achieving state-of-the-art forecast times for chaotic dynamical systems with ∼15-20x smaller models than traditional ML architectures.
  https://www.nature.com/articles/s41467-025-61195-1
  https://www.aimsciences.org/article/doi/10.3934/fods.2025006
- **Solving partial differential equations and constrained optimization problems with deep learning, ICTS** 2021-2023
  Developed deep learning algorithms for solving high-dimensional Fokker-Planck equations and problems in calculus of variations and identified a special failure mode of physics-informed neural networks for parabolic equations.
  https://arxiv.org/pdf/2306.07068.pdf,
  https://arxiv.org/pdf/2401.01292.pdf
- **Data Assimilation, ICTS** 2020-2021
  Developed a fast, scalable method for assessing the stability of numerical filters, including EnKF and particle filters, and demonstrated exponential stability in both cases.

https://www.sciencedirect.com/science/article/abs/pii/S0167278923001197, https://ieeexplore.ieee.org/document/9703185

- **Predicting Visual Stimuli from fMRI Data, Neuromatch Academy** 2021
  Used fMRI data to predict images seen by human subjects (in collaboration with an international group of graduate students).
- **Atmospheric Plume Modelling, ICTS** 2019
  Developed a PDE-based model for atmospheric plume, and combining with it open-source data from OpenStreetMap, estimated air pollution levels in Peenya.
- I have also worked as a consultant for **Adam Spencer**. 2024

Selected Conferences and Seminars

- Mathematical and Computational Foundations of Climate Modeling - **BIRS, CMI** | **Talk**: Unlearning via orthogonalization in generative models 2025
- Co-organized minisymposium titled: Data-driven reconstruction and forecasting of dynamical systems - **SIAM DS25, Denver** 2025
- Machine learning seminar - **USyd** | **Talk**: Learning dynamical systems with hit-and-run random feature maps 2025
- Numerical methods for complex high dimensional systems - **Jervis Bay** | **Talk**: From Random to Reliable: Good sampling for random features in ML 2024
- New directions for SDE and machine learning - **ICMS, Edinburgh** | **Poster**: Success and failure of PINNs and solving Fokker-Planck equations 2024
- Variational principles of plasma confinement in 3D magnetic fields - **ANU** | **Talk**: Deep learning for stellarator design (with Zhisong Qu) 2023
- 7th Indian Control Conference - **IIT Bombay** | **Talk**: Stability of nonlinear filters - numerical explorations of particle and ensemble Kalman filters 2021

Achievements

- 2nd place at national level mathematics exam IIT-JAM 2014
- 9th place at national level mathematics exam TIFR-GS 2016
- 15th place at national level math exam (for lecturership in India) NET 2016
- Future Research Talent Fellow (Australian National University) 2021
- Recipient of Infosys-TIFR Leading Edge travel grant 2023

Publications and Visualizations

- First author of several articles in high-impact journals, including **Nature Communications, Foundations of Data Science, Physica D,** and **IEEE**. A list of my research articles can be found **here.**
- A gallery of visualizations illustrating snippets from my projects is available on my **GitHub page**.

Technical Skills

- **Languages:** Python (primary), C, MATLAB, SQL
- **Libraries:** PyTorch, TensorFlow, NumPy, SciPy, Pandas, Matplotlib
- **AI/ML:** Deep Learning (AutoDiff, SGD, LSTM, CNN), Generative Models (VAE, GAN, WGAN, WGAN-GP, Diffusion Transformer, Flow Matching), Fine-tuning (LoRA), Model Compression (Quantization, Mixed Precision Training)
- **Other:** Git, GPU Computing, Data Visualization, Google Colab, Hugging Face
- **Some open-source GitHub projects authored by me: DeepRFM**, **forget**, **fp-solvers** and more. DeepRFM has garnered significant **interest from the climate modelling community**, and is slated for integration with other climate modelling systems.

Referees

Georg Gottwald
University of Sydney, Sydney

Amit Apte
IISER Pune, India

Vishal Vasan
ICTS, Bengaluru

Sreekar Vadlamani
TIFR-CAM, Bengaluru

Tarun Malviya
Commonwealth Bank, Sydney