Dr. Shashank Kumar Roy

Postdoctoral Researcher, Lab-STICC

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Research interests

General state estimation and prediction problems in geosciences, Machine Learning, Data Assimilation, Weather and Climate modelling, Physics-based Modelling and Simulation, Bayesian inference, Gaussian processes, Markov chain Monte-Carlo methods, Generative modelling for probability distributions, Dynamical systems.

Publications

[1] 4DVarNet-LU: An end-to-end Generative Model for Neural Data Assimiation, Shashank K. Roy, Ronan Fablet. *In Preparation*

[2] Spatiotemporal Coherent Displacements for Ensemble-Based Neural Data Assimilation, Shashank K. Roy, Ronan Fablet. *Submitted to Climate Informatics 2026*

[3] A note on the sensitivity of Lyapunov Vectors to trajectory perturbations, Shashank Kumar Roy, Amit Apte. *Accepted(In Press), NPG, 2025. doi.org/10.5194/egusphere-2023-2168*

[4] Probing robustness of nonlinear filter stability numerically using Sinkhorn divergence Pinak Mandal, Shashank Kumar Roy, Amit Apte, *Physica D, 2022, doi.org/10.1016/j.physd.2023.133765.*

[5] Stability of nonlinear filters - numerical explorations of particle and ensemble Kalman filters Pinak Mandal, Shashank Kumar Roy, Amit Apte, *2021 Seventh Indian Control Conference (ICC), Mumbai, India, 2021, pp. 307-312, doi: 10.1109/ICC54714.2021.9703185.*

Education

PhD, Physics, International Center for Theoretical Sciences Bangalore, India

Advisors: Prof. Amit Apte and Prof. Samriddhi Sankar Ray July 2020 – Jan 2025

Title: A study of dynamical instability and filter stability using the ensemble Kalman filter. PhD awarded, Jan 2025.

International Center for Theoretical Sciences Bangalore, India

Masters in Physics, *GPA: 7/10* July 2017 – December 2020

Mentors: Prof. Amit Apte, Prof R. Loganayagam

University of Delhi New Delhi, India

Bachelors in Physics (Honours) *Percentage: 87 %* July 2014 – July 2017

Seminar/ Conf. Presentations

Performance Gains and Advantages of 4DVarNet in End-to-End Learning for Data Assimilation Shashank Kumar Roy, Ronan Fablet, *EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-4300, doi.org/10.5194/egusphere-egu25-4300.*

Automatic differentiation for 4DVar data assimilation with single layer quasi-geostrophic dynamics Space Application Center, India Space Research Organisation (ISRO) Ahmedabad, India

Workshop lecture: AI for Data Assimilation - 4DVar & 4DVarNet for Ocean dataset, National Atmospheric Research Laboratory, Department of Space, GOI. Tirupati, India.
4DVarNet: A neural network model for data assimilation Seminar, Department of Data Science, IISER Pune. India
Tutorial on 4DVarNet: A neural data assimilation framework, BIRS-CMI Mathematical and computational foundations of climate modelling, Chennai Mathematical Institute. India

Projects

4DVarNet-LU: An end-to-end trainable ensemble model for data assimilation. Oceanix, Lab-STICC, IMT Atlantique
Generates an ensemble of reconstructions based on a positional-uncertainty model based on using Gaussian random fields, given a sequence of observations Aug – Jan 2026

Neural-ODE approach to weak-4DVar with sparse and noisy pseudo-altimetry observations , Oceanix, Lab-STICC, IMT Atlantique
Solving a 4DVar optimisation problem for quasi-geostrophic model and LBFGS, SGD, etc. as optimisers leveraing automatic-differentiation in PyTorch. Jan – July 2024

Sequential filtering algorithm for high-dimensional chaotic system with partial and noisy observation , Mentor: Prof. Amit Apte, Semester Project, ICTS August – Dec 2019
Implementing ensemble kalman filter for Lorenz-96 ode to compute conditional distribution.

Cytoplasmic streaming driven by Surface flows using Vector Spherical Harmonics
Mentor: Prof Vijay Kumar Krishnamurthy, Biophysics Group at ICTS
Analytical solution of Stokes equation for spherical geometry for bulk flow inside a sphere driven by a surface flow May – August 2018

An Interdisciplinary Study of Light Pollution in Indian Context (Extension)
Late Dr.N.Rathnasree, Former Director, Nehru Planetarium, and Dr Ashok Kumar, Department of Physics, Ramjas College .
University of Delhi under Innovation Project Scheme 2015-2016 (RC302) Oct 2015 – Nov 2016

Academic Visits

Prof. David Greenberg's Lab, Hereon Zentrum Hamburg, Germany. Feb 2024
University de Grenoble, Host: Dr. Julien Lessomer Grenoble, France, August 2024
Department of Data Science, IISER Pune, Host: Prof. Amit Apte Pune, India, Feb 2025

Teaching experience

Teaching assistant, Computational Tools for Climate Science, Climatematch Academy, US A course on climate data analysis and modelling for understanding and answering questions through coding in python and jupyter notebook. My role as a teaching assistant was to initiate discussions, motivate questions and guide students though the coding exercises. July 2023
Teaching assistant, Department of Data Science, IISER Pune, India, DS4233: Time Series Course on basic time series analysis and modelling. Curating Jupyter notebooks for demonstrations and taking tutorial sessions. Jan-April 2023
Advanced Physics Subject Matter Expert (Chegg.com) July 2020- July 2021
Freelance Tutor for solving university level doubts and problems for students.

Licences and Certifications

NVIDIA, Deep Learning Institute — Summer 2022
[1] Applications of AI for Anomaly Detection — Issued on July 2022
[2] Accelerating Data Engineering Pinelines — Issued on Feb 2022
[3] Fundamentals of Deep Learning — Issued on Feb 2022

IBM, Qiskit
[1] Quantum Computation -Certified Associate Developer — Januray 2022
[2] IBM Quantum Challenge 2021 Achievement - Advanced — June 2021

Neuromatch Academy - Deeplearning Course and Project view — August 2021
Imperial College London-Online course on Data Assimilation view — 11-15 July 2022

Achievements

Secured 10th best score in IBM Quantum Challenge — 2021
Department of Atomic Energy Fellowship for pursuing PhD in Physics — 2019
Joint Entrance Screening Test AIR-95, Percentile-98.8 and IIT-JAM 2017, AIR-259 — 2017
Awarded ISC-2014 School Topper in Science, 3rd at district level, Senior Secondary Exam — 2014

Conferences and Workshops

Conference on Nonlinear Systems and Dynamics 2022, IISER Pune, India, Presented a poster titled,*"Reconstructing Covariant Lyapunov Vectors using Nonlinear Filtering"* Dec 2022

ECMWF–ESA Machine Learning for Earth Observation and Prediction 14-17 Nov 2022
Workshop on machine learning and data assimilation on using earth observations data.

Qiskit Global Summer School on Quantum Machine Learning, IBM July-August 2021
Summer School focusing on quantum machine learning formalisms and algorithms with hands-on experiemnts via IBM-Quantum lab.

ICTS Workshop on Climate Studies July-Aug 2021
Talks and lectures on climate modeling, topics relevant to climate change and related policies.

Indo-US Workshop on Recent Advances in AI ML for Climate Sciences Nov 13-15 2021
Technology Innovation Hub, Indian Statistical Institute, Kolkata and IEEE GRSS Kolkata Chapter, on the problems and applications in climate data science

Meta- Heuristic Optimization, Machine Learning and AI-Workshop March 8-12 2021
Talks and tutorials organized by SAMSI, on the theory and practical applications of metaheuristic optimization methods in statistics such as swarm and evolutionary algorithms.

Numerical Analysis in Data Science Workshop August 26-27 2021
Workshop on inverse problems and uncertainty quantification, sensitivity analysis, Reinforcement Learning and dimension Reduction in time series.

The Fields Institute Second Symposium on Machine Learning and Dynamical Systems
On the intersection of machine learning and dynamical systems theory to solve problems in representation leanring, analysis and prediction. September 2020

Technical Skills

Programming languages and frameworks
Pytorch, Python, Xarray, Pandas, Numpy, Scipy, Jax
Familiar with C++, Fortran

Languages
English (advanced), Hindi (fluent)