Tanisha Gupta

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PROFESSIONAL SUMMARY

Applied Mathematician with research experience in **Bayesian inverse problems, uncertainty quantification, and statistical learning theory**. Skilled in developing **PAC-Bayesian frameworks for PDE-governed systems**, high-performance numerical solvers, and Hessian-aware sampling for large-scale inference. Currently a **Research Assistant** at the *Mathematics Laboratory, University of Delhi*, focusing on finite-sample generalization bounds for inverse heat equations. Previous experience as a **Business Intelligence Analyst** at Allpay Ltd (UK) building SQL–Power BI analytics pipelines. Research interests include **Bayesian inference, stochastic optimization, and scientific machine learning**.

WORK EXPERIENCE

Research Assistant — Mathematics Laboratory, Janki Devi Memorial College (University of Delhi), India *March 2025 – Present*

– Conducting research on **Bayesian inverse problems** and **uncertainty quantification**, focusing on the **PAC-Bayes framework for PDE-governed systems**.

– Developed and validated **finite-sample generalization bounds** for the inverse heat equation, integrating Bayesian inference with statistical learning theory.

– Designed **mesh-robust numerical solvers** for reliable posterior estimation in high-dimensional inverse problems.

– Collaborating with faculty on manuscripts submitted to *SIAM/ASA Journal on Uncertainty Quantification* and related applied mathematics venues.

– Mentoring undergraduate students on computational mathematics and statistical inference projects.

Business Intelligence Analyst — Allpay Ltd, Hereford, United Kingdom *April 2025 – 11 November 2025*

– Built end-to-end **SQL–Power BI pipelines** for high-frequency financial payment systems, automating validation and reconciliation workflows.

– Designed and maintained **star-schema data models** linking transactional, compliance, and operational datasets for KPI analytics.

– Developed **Power BI and SSRS reports** monitoring payment success, login activity, and support metrics with improved data reliability.

– Authored optimized **SQL stored procedures and parameterized queries** to enhance reporting efficiency and accuracy.

– Partnered with finance and product teams to deliver analytical insights driving strategic and regulatory decisions.

Junior Research Data Assistant — AI & Machine Learning Lab, University of Liverpool, UK *August 2024 – April 2025*

– Researched **verification frameworks for Deep Reinforcement Learning (DRL)** models, emphasizing algorithmic safety and robustness.

– Designed **Lyapunov Barrier Certificate**-based methods reducing instability in DRL controllers by 20%.

– Conducted over 50 experiments improving model generalization and convergence behavior.

– Tuned deep-learning hyperparameters to reduce false positives by 15% and contributed to peer-reviewed AI journal submissions.

– Tools: **Python (PyTorch, TensorFlow, Scikit-learn)**, **MATLAB**, **AWS**, **SQL**, **Power BI**.

PROJECTS

PAC-Bayes Certificates for Bayesian Inverse Problems: A Case Study on the Heat Equation GitHub Link
Implements **PAC-Bayes certified uncertainty** for Bayesian inverse PDEs on the 1D heat equation. Provides finite-sample generalization bounds, a mesh-robust decomposition of error, Gibbs/tempered posterior implementation, and a complete, reproducible experiment pipeline (data generation $\rightarrow$ posterior sampling $\rightarrow$ certificate computation).

Mixed-Precision Multigrid Solvers for PDEs [GitHub Link](#)
High-performance multigrid framework with adaptive mixed precision and CUDA acceleration. Demonstrates up to **6.6× GPU speedup** vs. CPU, **1.7× mixed-precision gain** with **35% lower memory**, and verified $O(h^2)$ convergence. Includes benchmarks, visualization tools, and comprehensive tests.

Hessian Aware Sampling in High Dimensions [GitHub Link](#)
Hessian-informed MCMC samplers (Metropolis, Langevin, adaptive variants) for efficient exploration of high-dimensional posteriors. Achieves **2–10× ESS improvements** on ill-conditioned targets, robust to $d > 10^3$. Ships with benchmarks, diagnostics, and publication-quality plotting utilities.

EDUCATION

2023 – 2024	**University of Liverpool, United Kingdom**	
	Master of Science in Data Science & Artificial Intelligence	**Distinction**
	Relevant Coursework: Deep Learning, Natural Language Processing, Reinforcement Learning, Big Data, Cloud Computing, Bayesian Statistics, Optimisation Methods, Data Visualisation.	
2019 – 2022	**Janki Devi Memorial College (University of Delhi), India**	
	Bachelor of Science (Honours) in Mathematics	**GPA: 3.6/4.0**
	Relevant Coursework: Probability & Statistics, Computational Modelling, Linear Algebra, Numerical Analysis.	

PUBLICATIONS

1. Tanisha Gupta . *PAC-Bayes Certificates for Bayesian Inverse Problems: A Case Study on the Heat Equation.* TechRxiv, July 2025. [DOI link](#). (Preprint, under peer review at *SIAM Journal on Uncertainty Quantification*).

   - **Methodological novelty:** Introduces the first PAC-Bayesian generalization certificates for Bayesian inverse partial differential equations, combining Gibbs posteriors and tempered Bayesian inference to provide finite-sample, mesh-robust generalization guarantees for inverse-PDE uncertainty quantification.

KEY SKILLS

- **Mathematical & Statistical Modelling:** Bayesian inference, PAC-Bayesian analysis, uncertainty quantification, inverse problems, stochastic optimization, Monte Carlo & MCMC methods, and PDE-constrained optimization.

- **Numerical & Computational Methods:** Finite-difference & finite-element PDE solvers, Crank–Nicolson schemes, multigrid & Krylov methods, Hessian-aware sampling, high-performance (CUDA) computing, and mesh-robust error analysis.

- **Programming & Scientific Computing:** Python (NumPy, SciPy, PyTorch, TensorFlow), MATLAB, R, SQL, LaTeX, Git, Linux, CUDA, and Power BI for scientific data visualisation.

- **Machine Learning & AI Foundations:** Statistical learning theory, reinforcement learning (safe & constrained), neural-symbolic reasoning, model interpretability, and optimization-based learning.

- **Research Communication & Reproducibility:** Technical writing (TechRxiv, SIAM), GitHub-based reproducible experiments, computational documentation, academic presentation, and interdisciplinary collaboration.

CERTIFICATIONS & TECHNICAL ACHIEVEMENTS

- **AI & Machine Learning Specialization (Coursera)** — Comprehensive foundation in AI algorithms, optimization methods, and model deployment.

- **Data Science with R** — Advanced certification in statistical computing and regression modelling from SimpliLearn.

- **Cloud Data Engineering (AWS, GCP)** — Experience with BigQuery, Spark, and distributed computation environments.

- **AI-Powered Fraud Detection Model** — Designed Python-based ML pipelines that reduced false positives by **25%**, demonstrating applied statistical inference.