Akshat Sachin Valse

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Applied probability for the systems that run machine learning: a renewal law for prefix-cache collapse in LLM agent serving, tested in registered experiments on real engines; Langevin sampling and its discretization, large deviations and rare-event simulation, the stability of learned PDE solvers, online calibration with early feedback, and the reliability of tool-using agents.

Education

Iowa State University, Honors Program Expected May 2028
B.S. Statistics · B.S. Mathematics · B.A. Computer Science · B.S. Data Science
Cumulative GPA 3.86 / 4.00.

In progress, Fall 2026 (all four at the PhD level, 6000-series). Foundations of Probability Theory, measure-theoretic (STAT 6541); Advanced Topics in Machine Learning (COMS 6730); Advanced Topics in Artificial Intelligence (COMS 6720); Advanced Topics in High-Performance Computing (COMS 6250).

Planned, Spring 2027. Advanced Probability Theory; Advanced Stochastic Processes.

Graduate and advanced coursework, completed.
Probability and statistics: Theory of Probability and Statistics II (STAT 5430); Stochastic Process Models (STAT 5540); Empirical Methods for the Computational Sciences (STAT 5830); Introduction to Multivariate Data Analysis (STAT 5750); Introduction to Categorical Data Analysis (STAT 5770); Introduction to Statistical Computing (STAT 5860).
Mathematics: Numerical Methods for Differential Equations (MATH 5810); Analysis I (MATH 4140); Introduction to Mathematical Finance (MATH 4430X); Introduction to Partial Differential Equations (MATH 3850); Theory of Linear Algebra, honors (MATH 3170).
Computing and machine learning: Concepts and Applications of Machine Learning, honors (DS 3030); Introduction to the Design and Analysis of Algorithms (COMS 3110); Software Development Practices (COMS 3090).

Preprints

1. *Inside the Trap: A Renewal Law for Prefix-Cache Collapse in LLM Agent Serving.* With A. Jannesari. arXiv:2611.08902, November 2026. Code, data and registrations: github.com/AkshatValse/surviving-llm-stampede.

Research Experience

Metastable Failures in Prefix-Cached LLM Agent Serving Aug. 2026 – present
Research project, Advanced Topics in High-Performance Computing (COMS 6250), Department of Computer Science, Iowa State University. Advisor: Prof. Ali Jannesari, SwAPP Lab.

- Ran five registered paired tests on Iowa State's Nova HPC cluster through SLURM, on two serving engines (SGLang, vLLM), two GPUs (NVIDIA A100, H200) and two 7–8B models: a 200-session burst left the engine at zero hits to the end in all 30 burst runs (registered rule met at 9 of 10 rates), every matched no-burst run stayed good, and a client-side session cap prevented the trap in all 30 capped runs. In further registered tests the cap rescued 9 of 9 established traps at the same load without shedding a session.
- Proved that, along FIFO orbits, the cycles of an idealized fluid server on which every turn misses obey a linear renewal recursion whose Perron root, above the all-miss capacity, carries every trapped state to a known self-similar regime; with nothing fitted to trap data, the model matches 57 stuck runs retrospectively. Built the discrete-event simulator, the real-engine load generator and the SLURM job

scripts, with each registered test committed to git before its jobs were submitted and every number in the paper traced to its source file and commit or SLURM job. Preprint on arXiv, November 2026; code, data and registrations are public.

Langevin Sampling and Diffusion Estimation for Molecular Systems May 2026 – present
Research Collaborator, Department of Mathematics, Iowa State University. Advisor: Prof. David Herzog. Funded by NSF award DMS-2246491.

- Built an end-to-end Python simulation pipeline implementing MALA and projected Euler–Maruyama samplers for overdamped Langevin dynamics, staged from a one-dimensional periodic potential to a solvated ion in a three-dimensional Lennard-Jones bath; estimated self-diffusion and mobility coefficients from long-run trajectory data.
- Derived the closed-form Lifson–Jackson diffusivity $D = 1/I_0(1)^2 \approx 0.62386$ as an exact benchmark and validated the estimators against it before scaling to three dimensions, where the pipeline reproduces published solvated-ion results.
- Author weekly technical reports, including a companion note supporting the group's CLT-based error analysis.

Large Deviation Theory for Rare-Event Analysis in Queueing Systems Nov. 2024 – present
Undergraduate Research Fellow, Department of Mathematics, Iowa State University. Advisor: Prof. Ruoyu Wu. Dean's High Impact Undergraduate Research Award.

- Developing importance-sampling estimators for rare events in mean-field join-the-shortest-queue load-balancing systems, with the change of measure guided by large-deviation asymptotics for the system's empirical measure, and studying how the estimators behave as the number of servers grows.
- Built a reproducible Python simulation framework with deterministic seeding, checked against crude Monte Carlo wherever crude Monte Carlo is reliable. Results are held back pending submission. The project is paused while Prof. Wu is on sabbatical.

Stability Analysis of Cell-Average Neural Networks for PDEs May 2026 – present
Undergraduate Researcher, Department of Mathematics, Iowa State University. Advisor: Prof. Jue Yan. Funded by the NSF D4 NRT. Joint with Mengyuan Yang.

- Adapting von Neumann stability analysis to neural-network PDE solvers: deriving the linearized amplification factor of the learned time-stepping scheme and characterizing how perturbations propagate through it, toward stability conditions on the trained weights analogous to those of classical finite-difference methods.
- Reimplemented the group's solver in Python to enable systematic stability experiments across schemes and step sizes.

Calibrating Volatility Forecasts with Early, One-Sided Feedback Aug. 2026 – present
Research project, Advanced Topics in Machine Learning (COMS 6730), Department of Computer Science, Iowa State University. Advisor: Prof. Hongyang Gao.

- A forecast of a cumulative quantity is scored only when its horizon ends, yet a miss can become certain before then. Developing a model-agnostic calibration method for quantile forecasts that uses this early, one-sided feedback, now in the experimentation and development phase.
- Built a leakage-audited data pipeline with a sealed test set, a simulation study with pre-registered hypotheses, and delayed-feedback conformal and classical volatility baselines, including a temporal convolutional network. Results are held back until publication.

Reliability of Tool-Using LLM Agents Aug. 2026 – present
Research project, Advanced Topics in Artificial Intelligence (COMS 6720), Department of Computer Science, Iowa State University. Advisor: Prof. Yang Li.

- When an agent stalls, when is restarting it worth more than waiting, and how can the probability of a failure too rare for direct simulation be estimated? Now in the experimentation and development phase, starting from two pre-registered pilot designs on real agents, one on restart policies and one on rare failures. Results are held back until publication.

Manuscripts

1. *Langevin Dynamics and Transport-Coefficient Estimation for Molecular Systems.* With D. Herzog, O. Smith and D. Wu. Draft in advisor review.
2. *Stability Certificates for Cell-Average-Based Neural Network Solvers: von Neumann Analysis of Trained Flux Networks.* With M. Yang and J. Yan. In preparation.
3. *Large-Deviation-Guided Importance Sampling for Rare Events in the Mean-Field Join-the-Shortest-Queue Model.* With R. Wu. Paused during the advisor's sabbatical.

Awards and Honors

- Dean's High Impact Undergraduate Research Award, Iowa State University, 2026.
- Schillmoeller Family Scholarship in Statistics.
- Mead Fund Award in Statistics.
- James L. Cornette Mathematics and Interdisciplinary Studies Award.
- Dean's List, every semester.

Leadership and Service

- Treasurer, Iowa State Data Science Club, 2025 – present. Secured $60,000+ in funding supporting 130+ members.
- Research Ambassador, Iowa State University Honors Program.
- FAA Private Pilot Certificate; high-performance endorsement, 2025. Volunteer pilot and recruitment advisor, Pilots N Paws animal-rescue flights.

Technical Skills

Languages and tools. PyTorch and CUDA for neural-network and GPU-accelerated simulation; Python (NumPy, SciPy, pandas, scikit-learn, matplotlib, asyncio); SLURM on GPU clusters and LLM serving engines (SGLang, vLLM); R; LaTeX; git.

Methods. Measure-theoretic probability and stochastic differential equations; MCMC (MALA, Metropolis–Hastings) and importance sampling; large-deviation asymptotics; numerical analysis of time-stepping schemes and von Neumann stability; discrete-event simulation and queueing models; online conformal calibration; reproducible computation with recorded seeds, parameter sidecars and pre-registered predictions, so every figure regenerates from saved results.