Aniket Deshpande

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Physics student pursuing research in quantum information, statistical learning theory, and optimization.

Education

University Of Illinois, Urbana-Champaign Urbana, IL

B.S. Physics, Specialization in Mathematical Physics 2023 - 2027 *(expected)*

- **Mathematics:** (Graduate) Representation-theoretic Quantum Information, (Graduate) Measure Theory, Abstract Linear Algebra, Differential Equations, Stochastic Processes
- **Computing:** Modern Computational Physics, Data Structures & Algorithms
- **Physics:** Quantum Information Processing, Quantum Mechanics I, Electromagnetic Fields I & II, Classical Mechanics I & II, Special Relativity
- Minors in Mathematics and Scientific Computing

Talks & Posters

Quantum Circuit Volume for Graph Models, *Illinois Math Lab Open House* *12.2024*

Poster developed with the *Illinois Mathematics Lab*

- Developed quantum circuits simulating birth-death process graph channels with optimized resource scaling using EQ_k, P_k, and RY gates.
- Established $O(\sqrt{n}) \leq l(\Phi) \leq O(n)$ bounds on simulation cost via Lipschitz complexity and Kraus rank methods.
- Optimized circuit depth ($O(n \log n)$) and ancilla space ($O(n)$) under locality constraints, presenting a general framework for graph channel simulation.

Research

Computation & Neurodynamics Lab | Urbana, IL 01.2025 - Present

- Simulating heterogeneous networks of FitzHugh-Nagumo neurons under noisy time-varying inputs; analyzing sliding window covariances between intrinsic timescales and membrane potential dynamics to uncover interpretable neuron-level models.
- Applying neural-symbolic regression to extract compact, interpretable equations describing neuron activity as a function of internal parameters and shared time-varying inputs.
- PI: Dr. Matthew Singh

Lab for Numerical Parallel Algorithms | Urbana, IL 09.2024 - Present

- Collaborating on the development of a novel Monte Carlo algorithm for contracting general tensor networks, with applications to quantum circuit simulation.
- Investigating randomized methods such as TensorSketch for efficient estimation of trace-like quantities in large-scale tensor networks.
- PI: Dr. Edgar Solomonik

Polymer Physics Theory Group | Urbana, IL 08.2024 - 01.2025

- Performed computational simulations of free-draining bottle brush polymers with explicit side-chains using a coarse-grain model
- Refactored and improved coarse-grain model using stochastic differential equations and brownian motion results. Implemented the model in `C`.

Industry

Space Dynamics Laboratory | Ionospheric Analyst Intern 05 - 08.2024

- Developed a `Python` scraper to expedite the data collection of NICT ionograms to $600+$ ionograms downloaded per hour.
- Researched numerical analysis methods to improve the noise reduction of ionograms using various filtering methods. Implemented filters in `Python` and `Julia` and ran statistical analysis (PSNR, MSE, SSIM) to compare efficiencies.
- Researched methods to improve automatic ionogram scalers using deep learning architecture (CNNs) and techniques.

Projects

Quantum PDE Solver via Tensor Networks ***Source Code***, *01.2025 – Present*

Developed a C++ framework for simulating quantum partial differential equations using matrix product states and general tensor networks. Implemented efficient multi-leg tensor contraction, index tracking, and sparse network representation. Achieved stable time evolution with < 5% deviation in norm and energy; validated correctness via thermal and unitary test suites with trace and expectation value errors $<10^{-4}$.

Learning

QSim Summer School – *NSF RQS (hosted at IBM, NYC)*, *08.2025*

Lectures covering theoretical and experimental perspectives on quantum error correction, simulation, and state tomography.

Uncertainty Quantification & Machine Learning for Physical Systems – *IMSI hosted at the University of Chicago*, *05.2025*

Lectures on Bayesian inference, sensitivity analysis, and physics-informed neural networks, with applications to complex physical systems.

LPNA Reading Group – *University of Illinois*, *01.2025 – Present*

Weekly discussions on random matrix theory, graph partitioning, tensor network applications, and quantum error correction.

Outreach

Membership Director *SIAM @ University of Illinois*, *05.2025 - Present*

SIAM@UIUC executive officer. Responsibilities include managing membership status, involvement, and recruitment.

Professional Affiliations

Society of Industrial & Applied Mathematics, *05.2025 - Present*

Member

Skills

Programming: Python, C/C++, Java, Julia, Mathematica

Scientific Computing: Numerical simulation, stochastic modeling, time series analysis, statistical signal processing, sliding window statistics, ODE/SDE solvers

Libraries & Frameworks: NumPy, SciPy, Pandas, Matplotlib, scikit-learn, SymPy, Jupyter

Tools & Environments: Git, LaTeX, Conda, Shell, Jupyter