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Aniket Deshpande

My interests lie in mathematical and statistical methods for quantum information, namely tensor network methods, random matrix theory, and machine learning. I also enjoy learning about mathematical finance and theoretical neuroscience.

Education

University Of Illinois, Urbana-Champaign — Urbana, IL
B.S. Physics, Specialization in Mathematical Physics — 2023 - 2027 *(expected)*

- *Relevant Coursework:*

  Undergraduate: Numerical Analysis, Quantum Dynamics Simulations, Modern Computational Physics, Quantum Mechanics I, Electromagnetic Fields I & II, Classical Mechanics I & II, Special Relativity & Mathematical Methods, Stochastic Processes, Real Analysis, Differential Equations, Abstract Linear Algebra

  Graduate-level: Quantum Information Processing

- 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.

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.

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