

Tharmashastha SAPV

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PhD Student | Qiskit Advocate

Indraprastha Institute of Information Technology - Delhi

Specialization: Quantum Algorithms, Quantum Complexity Theory, Cryptography

EDUCATION

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- **Indraprastha Institute of Information Technology - Delhi** New Delhi, India
Doctor of Philosophy Aug. 2019 - Present
 - **Integrated Science Education and Research Center, Visva Bharati** Santiniketan, India
Integrated Master's in Mathematics with First Class and A+ Grade Aug. 2013 - May 2018

SELECTED PROJECTS

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- **Solving Maximum Independent Set using Variational Quantum Algorithms**
 - Implemented and benchmarked hybrid quantum-classical algorithms like VQE, QAOA, ADAPT-QAOA, and DC-QAOA for solving the combinatorial optimization problem of Maximum Independent Set of a graph using Qiskit.
 - Evaluated algorithm performance across various ansatz settings (fixed depth, fixed parameter count, and fixed number of layers), classical optimizers (local vs. global, gradient-based vs. gradient-free), and multiple graph classes.
 - Currently simulating NISQ noise models and applying error mitigation techniques such as Zero Noise Extrapolation and Twirled Readout Error Extinction to assess algorithm performance under realistic hardware conditions.
 - **Efficient Quantum Agnostic Improper Learning of Decision Trees**
Collaborators: Sagnik Chatterjee and Debajyoti Bera
 - Developed the first poly-time quantum algorithm to learn decision trees without using membership queries (MQ) where the instances have uniform marginals and are susceptible to adversarial noise. Prior methods used MQ or had exponential costs
 - Designed a new quantum agnostic boosting algorithm that is quadratically faster than prior adaptive boosting algorithms.
 - The work was presented at AISTATS 2024 and published in PMRL.
 - **Low-space Quantum Algorithms for Estimate-Mark-Amplify Tasks**
Collaborator: Debajyoti Bera
 - Developed a log-space quantum amplitude amplification algorithm that uses a noisy marking oracle, improving upon prior works that use linear space with just a logarithmic time overhead.
 - Developed close-to-optimal queries, low-space quantum algorithms for various probability and amplitude threshold problems
 - The work was presented at the Italian Conference on Theoretical Computer Science (ICTCS) 2024.
 - **Quantum Space-Time Tradeoff Lower Bounds for Decision Problems**
Collaborator: Debajyoti Bera
 - Proved the first-ever non-trivial quantum time-space lower bound for decision problems in quantum branching programs.
 - We proved non-trivial optimal lower bounds and optimal algorithms for OR_n function and k vs $k + 1$ Hamming weight distinction problem for arbitrary k in the Generalized Quantum Branching Program model.
 - Currently working on proving tighter time-space lower bounds for functions like k -Threshold, and Element Distinctness.
 - **Realization of maximally-entangling two-qutrit gates using the Cross-Resonance scheme**
Collaborators: Sagnik Chatterjee and Yash Saxena
 - Led a team of three where we realized the first cross-resonance-based two-qutrit entangling gates on superconducting transmons using microwave pulses that directly allow entangling on both $0 - 1$ and $1 - 2$ levels.
 - Used Qiskit Dynamics to simulate the two-qutrit gates with gate fidelities of $> 99.7\%$ and obtained a concurrence of $> 99\%$.
 - The work was presented at the APS March Meeting 2025 and will be presented at Quantum Innovation 2025, RIKEN.

PROJECT MENTORSHIPS

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- **Qiskit Advocate Mentorship Program**
Project Mentor: Luciano Bello, IBM Zurich Mar 2021 - May 2021
 - **Topic:** Good first issues in Qiskit Terra
 - Resolved 15 GitHub issues within three months, including feature enhancements to Qiskit Terra, like classically-conditioned gates on single bits, and resolving 7 critical bugs related to visualization.
 - We introduced testing the LaTeX drawer in Binder. Additionally, we added more than 20 tests to the test suite to ensure future commits do not break existing code.

• Co-mentored a Project Student at IIIT-Delhi

Mentor: Debajyoti Bera

- Co-mentored a B.Tech student on his research project along with Dr. Debajyoti Bera.
- Assisted in performing a comparative study and implementation of quantum phase estimation algorithms in Qiskit ([Repo](#))
- Aided in implementing the High-Dist framework to solve k-distinctness, min-entropy, and max frequency problems in Qiskit

• Project Mentor in BraQIIIT Summer of Code

Supervisor: Debajyoti Bera

- Taught six lectures on the basics of quantum computing.
- Mentored six students of two teams working on the topics 'Implementing Shor's algorithm in a quantum computer using Qiskit' and 'Designing a quantum simulator using Julia'.

RELEVANT SKILLS

- **Quantum Programming:** Qiskit (Advanced), QuTiP (Beginner)
- **General Programming:** Python (Advanced), C (Advanced)
- **Tools:** Git (Advanced), Mathematica (Intermediate)

SELECTED RESEARCH PUBLICATIONS AND BOOKS

- Sagnik Chatterjee, Tharmrashastha S., Bera D. Efficient quantum agnostic improper learning of decision trees. International Conference on Artificial Intelligence and Statistics, [PMLR 2024](#).
- Saxena Y., Tharmrashastha S., Chatterjee S. Realization of maximally-entangling two-qutrit gates using the Cross-Resonance scheme. [arxiv:2504.15265](#). Accepted for talk at [APS March Meeting 2025](#) and Quantum Innovation 2025, RIKEN.
- Bera D., Tharmrashastha S. Quantum Query-Space Lower Bounds Using Branching Programs. Poster QIP 2025 [arxiv:2407.06872](#)
- Bera D., Tharmrashastha S. Low-space Quantum Algorithms for Estimate-Mark-Amplify Tasks. [ICTCS 2024](#).
- Bera D., Tharmrashastha S. A Generalized Quantum Branching Program. [FSTTCS 2023](#).
- Debajyoti Bera and Tharmrashastha SAPV. Quantum and Randomized Algorithms for Non-linearity Estimation, [ACM Trans. Quantum Comput., Vol. 2, No. 2, Article 5](#) (2021). Also presented as poster at ACM-ARCS 2022.
- Tharmrashastha S., Bera D., Maitra A., Maitra S. Quantum Algorithms for Cryptographically Significant Boolean Functions: An IBMQ Experience. [Springer Briefs in Computer Science](#), Springer 2021, ISBN 978-981-16-3060-6, pp. 1-116
- Bera D., Maitra S., Tharmrashastha S. (2019) Efficient Quantum Algorithms Related to Autocorrelation Spectrum. [INDOCRYPT 2019](#). Lecture Notes in Computer Science, vol 11898. Springer, Cham.
- Debajyoti Bera and Tharmrashastha PV. Error reduction of quantum algorithms. [Phys. Rev. A](#), 100:012331, Jul 2019.

SELECTED INVITED TALKS

- Introduction to Quantum Computing. ABV-Indian Institute of Information Technology and Management, Gwalior, 14 May 2025
- Quantum Computing with Qiskit. Academic Exchange and Student Conference on Advancement in Physics(AESCAP), Delhi Technological University(DTU) and Deen Dayal Upadhyaya College(DDUC), New Delhi, 09 - 12 Apr 2025.
- Quantum Computing Mastery: Theory & Practical Insights workshop at Indian Institute of Technology-Delhi. 30 Mar 2025.
- Quantum Algorithms on Quantum Simulators. Continuing Education Program on Post Quantum Cryptography at Center for Artificial Intelligence and Robotics - Defense Research and Development Organization, Bangalore, 13 - 17 Jun 2022.
- Hands-on Programming in Basic and Advanced Qiskit. ATAL Faculty Development Program on Quantum Computing and Machine Learning at JNTUA College of Engineering, Pulivendula, India. 30 Nov - 05 Dec 2020.
- Hands-on workshop in Qiskit. ATAL Faculty Development Program on Quantum Computing and Quantum Algorithm for CFD at Vardhaman College of Engineering, Shamshabad, India. 05-09 Oct 2020
- Various talks on Introduction to Quantum Computing and Introduction to Qiskit at IIIT-Delhi.

OTHER RELATED WORKS AND ACHIEVEMENTS

- **Teaching Assistant of Quantum Computing course:** Teaching assistant for the Introduction to Quantum Computing course at IIIT-Delhi during the Winter 2020 and Winter 2024 semesters.
- **Co-taught a Quantum Communications and Networks course:** Co-taught a course on Quantum Communications and Networks at IIIT-Delhi during the Monsoon 2023 and Monsoon 2024 semesters.
- **IBM Q Award - Teach Me Quantum:** Won second position in the international IBM Quantum Awards 2019 in the Teach Me Quantum category.
- **Attended ICTP-Quantinuum Hackathon 2023:** One of the two members from India to be invited to ICTP-Quantinuum Hackathon 2023.
- **Qiskit Advocate:** Accepted into the IBM Qiskit Advocate Program in Sept 2020.