Koustubh Phalak

koustubhphalak.kp@gmail.com
Linkedin
Personal Homepage

+1(814)-996-8980
Google Scholar

Research Interests

Quantum Computing, Quantum Algorithms, Machine Learning, Generative AI

Work Experience

Jun – Aug, 2024 **Quantum Algorithms Scientist,** Rigetti Computing.

- Worked on implementing **novel qubit efficient QAOA algorithm** for large scale combinatorial optimization problems.
- Built **multi-qubit gates for QAOA circuit from scratch** while taking hardware constraints into account.
- Ran qubit efficient QAOA circuits on **Rigetti Ankka-9Q-3 QPU**.

Education

2020 – · · · · **Ph.D. Computer Science, Penn State University** in Quantum Machine Learning, Quantum Security.

2016 – 2020 **Undergrad., Electrical & Electronics Engineering, BITS Pilani Hyd Campus**

Research Publications

Journal Articles

1. **K. Phalak**, J. Li, and S. Ghosh, "Dataset distillation for quantum neural networks," *arXiv preprint arXiv:2503.17935*, 2025.
2. S. Upadhyay, **K. Phalak**, J. Lee, K. M. Hill, and S. Ghosh, "Quantum computing and cybersecurity education: A novel curriculum for enhancing graduate stem learning," *ASEE*, 2025.
3. C. Beaudoin, **K. Phalak**, and S. Ghosh, "Predicting side effect of drug molecules using recurrent neural networks," *IEEE TETCI*, 2024.
4. **K. Phalak**, A. Ghosh, and S. Ghosh, "Optimizing quantum embedding using genetic algorithm for qml applications," *arXiv preprint arXiv:2412.00286*, 2024.
5. **K. Phalak**, A. Chatterjee, and S. Ghosh, "Quantum random access memory for dummies," *Sensors*, vol. 23, no. 17, p. 7462, 2023.
6. **K. Phalak** and S. Ghosh, "Shot optimization in quantum machine learning architectures to accelerate training," *IEEE Access*, vol. 11, pp. 41 514–41 523, 2023.
7. **K. Phalak**, J. Li, and S. Ghosh, "Trainable pqc-based qram for quantum storage," *IEEE Access*, vol. 11, pp. 51 892–51 899, 2023.
8. **K. Phalak**, M. Alam, A. Ash-Saki, R. O. Topaloglu, and S. Ghosh, "Optimization of quantum read-only memory circuits," *arXiv preprint arXiv:2204.03097*, 2022.

9. **K. Phalak**, J. Li, and S. Ghosh, "Approximate quantum random access memory architectures. arxiv 2022," *arXiv preprint arXiv:2210.14804*, 2022.

10. **K. Phalak**, A. Ash-Saki, M. Alam, R. O. Topaloglu, and S. Ghosh, "Quantum puf for security and trust in quantum computing," *IEEE JETCAS*, vol. 11, no. 2, pp. 333–342, 2021.

Conference Proceedings

1. **K. Phalak** and S. Ghosh, "Qualiti: Quantum machine learning hardware selection for inferencing with top-tier performance," in *IEEE VLSID*, 2025, pp. 296–301.

2. C. Beaudoin, **K. Phalak**, and S. Ghosh, "Altgraph: Redesigning quantum circuits using generative graph models for efficient optimization," in *GLSVLSI*, 2024, pp. 44–49.

3. **K. Phalak** and S. Ghosh, "Non-parametric greedy optimization of parametric quantum circuits," in *IEEE ISQED*, 2024, pp. 1–7.

4. D. Bhattacharjee, A. Saha, J. Li, *et al.*, "Software flow for quantum computing," in *Springer ICCTE*, Springer, 2023, pp. 206–227.

5. A. Chatterjee, **K. Phalak**, and S. Ghosh, "Quantum error correction for dummies," in *IEEE QCE*, vol. 1, 2023, pp. 70–81.

6. A. A. Saki, M. Alam, **K. Phalak**, A. Suresh, R. O. Topaloglu, and S. Ghosh, "A survey and tutorial on security and resilience of quantum computing," in *IEEE ETS*, 2021, pp. 1–10.

Key Research Projects

Optimal Quantum Embedding Search Problem

GENETIC ALGORITHM , **QML**

ISQED 24

- Developed a **novel genetic algorithm** for searching optimal state preparation circuit **for Quantum Neural Networks**
- **Finds optimal angle embedding permutation** that yields best inferencing performance
- **Competitive results** with current State-of-the-Art methods

Greedy Parametric Quantum Circuit optimization

GREEDY ALGORITHM , **QML**

ISQED 23

- Proposed a **novel greedy algorithm** to **optimize the post-transpilation circuit depth and gate count** of Parametric Quantum Circuit of a QNN
- Used Hilbert-Schmidt distance as main metric to **convert parametric 1Q rotation gates to equivalent non-parametric representations**
- Observed upto **14% and 48% reduction** in circuit depth and gate count respectively

Key Research Projects (continued)

Quantum Random Access Memory for Storage

QUANTUM STORAGE , CLASSIFICATION

IEEE Access 23

- Designed a **novel trainable Parametric Quantum Circuit-based Quantum Random Access Memory** to store classical data
- Stored two types of data: **image data and binary data**
- QRAM Storage yielded **faster convergence for image data** for classification task and **error-free storage for upto 4-bit binary data**
- Additional **results from IBM Oslo and IBM Jakarta hardware** for image data classification task shows **competitive results** with state-of-the-art methods

Shot Optimization for QML Algorithms

QUANTUM CIRCUIT EXECUTIONS , QML

- Proposed a **gradient-free methodology to reduce total shot usage** in QML algorithms
- Presented **two methods** where the number of shots are function of the iterations completed, **one linear and one step function**
- Incorporated the methodology for **classification task** and **molecular property prediction task**, where **linear works better for first and step function performs better for later**

Technical Skills

Languages	English, Hindi, Marathi (Mother tongue)
Programming–Languages	Python, MySQL, MATLAB, LaTeX, C++ (beginner), Unix Shell
Machine Learning/ – Deep Learning Tools	PyTorch, Numpy, Pandas, SciPy, Matplotlib
Quantum Tools	Qiskit, Pennylane

Miscellaneous Experience

2025

- **Alumni Award nomination**, Nominated for BITS 30 under 30 alumni awards (ongoing)
- **Podcast talk**, Invited to Physics Frontiers Podcast to give a talk on QRAM (upcoming later this year)
- **Quantum Hackathon**, Participated in BlueQubit Quantum Hackathon and finished at rank 17