Satwik Kundu

(814)-996-8738 | satwikkundu25@gmail.com | satwikkundu | Google Scholar

Education

Pennsylvania State University — *University Park, PA*

Ph.D. in Computer Science and Engineering | GPA - 3.82/4.0 — *Aug 2021 - Dec 2025 (Expected)*

- **Thesis (Tentative):** Enhancing Efficiency and Security of Variational Quantum Algorithms, **Advisor:** Prof. Swaroop Ghosh.
- One of two students from the CSE Department to receive the **Graduate Researcher Award** for outstanding research contributions in 2022.
- **Courses:** Computer Architecture, Parallel Processors and Processing, Operating Systems, Advanced Algorithms, Computer Vision II, Large-Scale Machine Learning, Vision and Language, Pattern Recognition and Machine Learning.

Jadavpur University — *Kolkata, India*

B.E. in Information Technology | GPA - 8.45/10 — *July 2017 - June 2021*

- **Thesis:** Facial Expression Recognition using Convolution Neural Networks, **Advisor:** Prof. Somenath Dhibar.
- Graduated First Class with Honors.

Skills

Languages	Python, C/C++, HTML/CSS, JavaScript, SQL, LaTeX, Flask.
Developer Tools	GDB, VS Code, Docker, Eclipse, GitHub, MATLAB, gem5, MySQL, SQLite.
Frameworks	Qiskit, PennyLane, Mitiq, OpenMP, MPI, CUDA, TensorFlow, PyTorch, NumPy, Scikit, Pandas, Keras.

Research Experience

Pennsylvania State University — *University Park, PA*

Graduate Research Assistant — *Aug 2021 - Present*

- Developed a novel ensemble-based framework to safeguard QNNs against cloud-based adversaries; enhanced model security by ≈70%.
- Evaluated efficacy of model stealing attacks on QNNs. Proposed novel hardware and architecture variation based defense techniques.
- Implemented a new parameter prediction technique to accelerate optimization process of VQAs by upto 3.3× while requiring 2.5× fewer shots.
- Explored QNN design space, focusing on encoding techniques and parameterized quantum circuit, to optimize image classification accuracy.
- Evaluated performance gain for NbAs-based interconnects in cache memories using gem5 and observed an IPC improvement of up to 23.8%.
- **Tech Stack:** Python, PennyLane, Qiskit, PyTorch, NumPy, Matplotlib, Scikit-learn, Git, Bash, C++, gem5.

Indian Institute of Technology Kharagpur — *Kharagpur, India*

Research Intern — *June 2020 - Nov 2020*

- Developed a Docker containerized client-server encryption framework, with the client sending plaintext and the server responding with encryption using a secret key.
- Conducted a microarchitectural side-channel attack (Flush+Reload) on the framework, demonstrating the challenges of key extraction via cache attacks in containerized environments.
- **Tech Stack:** C++ with Linux, Bash, Docker, Git.

Jadavpur University — *Kolkata, India*

Undergraduate Researcher — *Nov 2019 - May 2021*

- **Language Identification:** Developed a spoken language identification framework using MFCC features for the recognition of the six most widely used spoken languages in India.
- Trained a SVM Classifier with static and delta features. Discovered that the best results are obtained using only 13 static features and adding delta and delta-delta features reduces performance.
- **Emotion Recognition:** Developed a Keras-based facial expression recognition system for identifying facial expressions. Trained the model on the FER2013 database and achieved an accuracy of 72.34%.
- **Tech Stack:** Python with Keras, NumPy, Matplotlib, Pandas, Scikit-learn, Git.

Publications

Security Concerns in Quantum Machine Learning as a Service
Satwik Kundu, Swaroop Ghosh
Hardware and Architectural Support for Security and Privacy (HASP). 2024

STIQ: Safeguarding Training and Inferencing of Quantum Neural Networks from Untrusted Cloud
Satwik Kundu, Swaroop Ghosh
arXiv preprint arXiv:2405.18746 (under review). 2024

Evaluating Efficacy of Model Stealing Attacks and Defenses on Quantum Neural Networks
Satwik Kundu, Debarshi Kundu, Swaroop Ghosh
Proceedings of the Great Lakes Symposium on VLSI (GLSVLSI), 2024

DyPP: Dynamic Parameter Prediction to Accelerate Convergence of Variational Quantum Algorithms
Satwik Kundu, Debarshi Kundu, Swaroop Ghosh
arXiv preprint arXiv:2307.12449 (under review). 2023

Knowledge Distillation in Quantum Neural Network Using Approximate Synthesis
Mahabubul Alam, Satwik Kundu, Swaroop Ghosh
Asia and South Pacific Design Automation Conference (ASP-DAC), 2023

Quantum Machine Learning For Material Synthesis and Hardware Security
Collin Beaudoin*, Satwik Kundu*, Rasit Onur Topaloglu, Swaroop Ghosh
IEEE/ACM International Conference on Computer-Aided Design (ICCAD), 2022

Security Aspects of Quantum Machine Learning: Opportunities, Threats and Defenses
Satwik Kundu, Swaroop Ghosh
Proceedings of the Great Lakes Symposium on VLSI (GLSVLSI), 2022

On The Reliability of Conventional and Quantum Neural Network Hardware
Mehdi Sadi, Yi He, Yanjing Li, Mahabubul Alam, Satwik Kundu, Swaroop Ghosh, Javad Bahrami, Naghmeh Karimi
IEEE 40th VLSI Test Symposium (VTS), 2022

Quantum-Classical Hybrid Machine Learning for Image Classification
Mahabubul Alam, Satwik Kundu, Rasit Onur Topaloglu, Swaroop Ghosh
IEEE/ACM International Conference On Computer Aided Design (ICCAD), 2021

Spoken Language Identification of Indian Languages using MFCC Features
Mainak Biswas, Saif Rahaman, Satwik Kundu, Pawan Kumar Singh, Ram Sarkar
Machine Learning for Intelligent Multimedia Analytics: Techniques and Applications. Springer, 2021

Patents

Parameter Prediction to Accelerate Convergence of Hybrid Quantum Algorithms
Satwik Kundu, Debarshi Kundu, Swaroop Ghosh
Provisional Patent Application No. 63/498,829, 2023

Accelerating Deep Learning with Parameter Prediction
Satwik Kundu, Debarshi Kundu, Swaroop Ghosh
Invention Discloser # 2023-5622 (under review), 2023

Honors and Awards

2024	**IBM Quantum Credits**, Received $70,000 worth of credits from IBM for my research work.	*University Park, PA*
2022	**Graduate Researcher Award**, Department of Computer Science and Engineering, Penn State.	*University Park, PA*
2015	**Gold Medal**, International Olympiad of Mathematics (iOM).	*Kolkata, India*
2015	**Silver and Bronze Medal**, International Young Mathematicians' Convention (IYMC).	*Lucknow, India*

Services

Reviewer QCE'23, QCE'24

Sub-reviewer MICRO'22, MICRO'23, MICRO'24, ISCA'24, ICCAD'24, ASP-DAC'23, ASP-DAC'24, HOST'23, HOST'24, ICCD'23

Academic Projects

Composed Image Retrieval using CLIP *University Park, PA*

Pennsylvania State University *Sep 2023*

- Developed a CLIP-based Composed Image Retrieval (CIR) system, achieving precise image identification from text-modified queries.
- Designed a custom fusion module integrating image and text features, reaching development scores up to 0.9.

CUDA-based Blocked All-Pair Shortest Path Algorithm *University Park, PA*

Pennsylvania State University *April 2023*

- Developed a CUDA-based blocked APSP algorithm, achieving 56x speedup by optimizing memory access with shared memory and loop unrolling.
- Found an optimal 16x16 block size, reducing execution time to 101 ms for a 2,000-vertex graph, compared to 5.75 seconds sequentially.

Parallel Sudoku Solver Using OpenMP *University Park, PA*

Pennsylvania State University *Feb 2023*

- Developed a parallel Sudoku solver using OpenMP, achieving a 3.1x speedup over sequential version by optimizing a backtracking algorithm.
- Partitioned tasks across threads, reducing execution time through parallelism and atomic operations to manage shared memory.

References available upon request.