

Gopal Ramesh Dahale

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There are many links embedded in this CV. Please click anywhere with † for more information!

Education

Indian Institute of Technology, Bhilai **Chhattisgarh, India**
BTech in Electrical with Honors in Computer Science, 9.08/10.00 *2018 – 2022*
Relevant course: (CS614†) Quantum Symmetric-Key Cryptanalysis: Reviewed Grover's Search algorithm on SAES, AES, SIMON, and PRESENT. Created a quantum circuit for Simplified AES with 72 qubits, optimized it to 32 qubits. Implemented the BHT algorithm for finding claws in pairs of functions based on Grover's search. Paper† and code†.

Publications and Presentations

1. Z. Dong, M. C. Cara, G. R. Dahale, R. T. Forestano, S. Gleyzer, D. Justice, K. Kong, T. Magorsch, K. T. Matchev and K. Matcheva, *et al.* " $\mathbb{Z}_2 \times \mathbb{Z}_2$ Equivariant Quantum Neural Networks: Benchmarking against Classical Neural Networks", **arXiv 2311, 18744†**, Nov 2023.
2. R. T. Forestano, M. C. Cara, G. R. Dahale, Z. Dong, S. Gleyzer, D. Justice, K. Kong, T. Magorsch, K. T. Matchev and K. Matcheva, *et al.* "A Comparison Between Invariant and Equivariant Classical and Quantum Graph Neural Networks", **arXiv 2311, 18672†**, Nov 2023.
3. G. R. Dahale, "Quantum Simulations for Carbon Capture on Metal-Organic Frameworks," 2023 IEEE International Conference on Quantum Computing and Engineering (QCE), Bellevue, WA, USA, 2023, pp. 89-93, doi:10.1109/QCE57702.2023.10189†.

Experience

Qkrishi† **Remote**
Research Software Engineer *Sept 2023 – Present*
Designing and implementing quantum algorithms for problems in the financial industry including portfolio optimization and fraud detection. Collaborating with experienced researchers in the domain. Leading the development of Qkrishi's QFinBox, a quantum finance sandbox that allows businesses to explore the potential of quantum computing.

Google Summer of Code† with ML4SCI† **Remote**
Open Source Contributor, Advisor: Prof. Sergei V. Gleyzer† *May 2023 – Oct 2023*
Devising a Quantum Graph Neural Network for identifying particle images. Code on GitHub†.

- Modified the existing architectures using a data re-uploading scheme for the quantum circuit with hybrid models.
- Implemented Ego-QGNNs for large graphs to reduce qubit count and model parameters. Benchmarked with MUTAG dataset.

Deloitte's Quantum Climate Challenge 2023† **Remote**
Open Source Contributor — Runner-up *Jan 2023 – April 2023*
Designed a quantum-hybrid solution to calculate the minimum of the potential energy surface of gas molecules and ions. Conceptualized scaling the calculation from one binding site to a 3D unit cell in metal-organic frameworks. Code on GitHub†.

- Explored the minimum of PES of CO₂ with metal ions (Mn²⁺ and Cu⁺) using hardware-efficient ansatzes and VQE.
- Examined the potential of Amines for carbon capture with CO₂ + CH₃NH₂ system. Performed ideal and noisy simulations.
- Modelled H₂O + Cu-MOF-74 using Density Matrix Embedding Theory (DMET). Estimated quantum resources.

Xanadu's QHack 2023† **Remote**
Winner of the Quantum Chemistry and AWS Challenge *Feb 2023 – March 2023*
Investigated the minimum of the Potential Energy Surface (PES) of the BeH₂. Developed an algorithm that efficiently calculates the minimum of the PES for systems related to CO₂ capture using MOFs. Code on GitHub†.

- Implemented and tested a de-parameterisation approach to reduce parameters for simplifying the energy landscape.
- Extended this to CO₂ and metal ions. Achieved a relative error within 10⁻⁵ and 10⁻¹ in simulation and QPU run respectively.

Qiskit Advocate Mentorship Program, Fall 22 Cohort† **Remote**
Open Source Contributor/Mentee, Mentor: Alberto Maldonado Romo† *Sept 2022 – Dec 2022*
Designed and analysed tensor network quantum circuits performance over various data encoding schemes. Code† and Blog†.

- Accomplished 93.5 test accuracy on binary classification with MNIST dataset within a few epochs and 80 train samples.
- Devised Hybrid-QCNN for multi-class classification with generalization on test data. Achieved train/test accuracy of 0.85/0.80.

Atonarp Micro-Systems[†]

Data Scientist

Bangalore, India

Sept 2022 – Nov 2022

Contributed to the algorithms and analytics division by analysing data for revolutionary miniaturized spectroscopy.

- Preprocessed and analysed data from Coherent Anti-Stokes Raman Spectroscopy (CARS) improving the signal-to-noise ratio.
- Developed ML models using spectroscopic data to predict chemical compositions. Constructed a CARS UI to support the Bio team in analysing data.

Google Summer of Code[†] with ML4SCI[†]

Open Source Contributor, Advisor: Prof. Sergei V. Gleyzer[†]

Remote

June 2022 – Sept 2022

Investigated the potential of Quantum Convolutional Neural Networks (QCNNs) for high-energy physics data classification. Code[†] and Blog[†].

- Formulated and tested data encoding schemes including amplitude, angle and basis with various ansatzes.
- Trained hybrid and fully-quantum CNNs. Attained an AUC of 0.77 with only 538 trainable parameters in a hybrid model.
- Benchmarked CNNs and evaluated the performance of QCNNs. CNNs saturate at 0.76. Summarized the results.

Achievements

- **The Blaise Pascal [Re]generative Quantum Challenge**, within the top 20 out of 75 projects[†] (Nov 2023)
- **Unitary Fund microgrant recipient** for open source project: Qiskit-Qulacs[†] (Sept 2023)
- **Unitary Hack**, resolved 4 issues across 4 projects. Within the top 5 out of 72 hackers[†] (Jun 2023)
- **Runner-up in Deloitte's Quantum Climate Challenge**, out of 120+ teams, 33+ countries[†] (Apr 2023)
- **Xanadu's QHack Open Hackathon**, 1st in Quantum Chemistry[†], winner in AWS Challenge[†] (Feb 2023)
- **Rank 21 in Xanadu's QHack Coding Challenge** out of 800+ teams from 100+ countries[†] (Feb 2023)
- **IBM Qiskit's Quantum Explorers: Certificate of Quantum Excellence[†]** (Feb 2023)
- **Rank 19 in Xanadu's PennyLane Code Camp** out of 400+ teams[†] (Nov 2022)
- **IBM Quantum Challenge Fall 2022 Achievement - Advanced[†]** (Nov 2022)
- **IBM Qiskit Global Summer School 2022 - Quantum Excellence[†]** (Aug 2022)
- **IBM Quantum Qiskit Advocate[†]** (Jul 2022)
- **IBM Certified Associate Developer - Quantum Computation using Qiskit v0.2X[†]** (Jul 2022)
- **IBM Quantum Spring Challenge 2022 Achievement[†]** (Jun 2022)

Skills

Quantum Programming: Qiskit, TensorFlow Quantum, Cirq, PennyLane, AWS Braket, cuQuantum, Pulser

Programming Frameworks: PyTorch, TensorFlow, Scikit-Learn, JAX

Programming Languages: Python, C, C++

Courses

- Qubit by Qubit's Intro to Quantum Computing[†]
- Coursera's Neural Networks and Deep Learning[†]
- Womanium Global Quantum 2023[†]
- Coursera's Exploring Quantum Physics[†] (in progress)

Volunteering Activity

Qiskit Global Summer School 2023[†]

Mentor

June 2023 – July 2023

Addressed quantum computing and machine learning queries from students. Delivered supplementary Qiskit tutorials to those needing further clarification.

Quantum Explorers[†]

Mentor

July 2023 – Present

Providing technical support and subject matter expertise (quantum machine learning) to participants. Encouraging and engaging participants towards quantum computing.