Dr. Shahnawaz Ahmed

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EDUCATION

- Chalmers University of Technology, Göteborg, Sweden | October 2018 - September 2023

  Ph.D. in Machine learning for quantum information and computing. Thesis
- Birla Institute of Technology and Science (BITS) Pilani (Goa), India | August 2013 - July 2018

  Dual degree in Physics (M.Sc.) and Electrical & Electronics Engineering (B.E.)

EXPERIENCE

Embedl AB, Sweden | *Oct 2023 – Present*

Deep Learning Research Engineer

- Research and development in deep learning model optimization techniques: quantization, pruning, and neural architecture search.
- Optimize models for edge devices, working with hardware like Qualcomm NPUs and NVIDIA GPUs.
- Develop and implement new methods for model optimization, including LLM optimization for edge hardware.
- Collaborate on model optimization with engineers at customer companies within pilot projects.
- Drive and lead research projects on deep learning model optimization with external partners.

Xanadu Quantum Technologies, Canada | *May 2023 – Present*

Research collaborator within Quantum Machine Learning

- Exploring the feasibility of quantum machine learning (QML) to solve real-world problems.
- Co-authored a benchmarking paper evaluating 9 quantum models with 200,000 executions on an HPC cluster, prompting critical discourse in QML research. Blog
- Co-authored a paper on developing a method to train quantum generative models scaled upto 1000 qubits link.
- Collaborating on scaling quantum models for HPC implementation with National Energy Research Scientific Computing (NERSC).

Chalmers University of Technology, Sweden | *Oct 2018 – Sep 2023*

Ph.D. – Quantum Information and Computing

- Developed machine learning and optimization techniques for quantum computing applications: Generative neural networks for quantum tomography PRL 127, 140502 (2021), a Riemannian optimization algorithm for learning quantum processes from data PRL 130, 150402 (2023). Also collaborated on various experiments such as continuous-variable quantum gate optimization to create non-classical photonic states (GKP, CAT) PRX Quantum 3, 030301 (2022), performance analysis of superconducting quantum gates npj Quantum Inf 9, 44 (2023).
- Developed a Bayesian data analysis technique in collaboration with Prof. Ann L'Huillier's (Physics Nobel laureate 2023) team at Lund University to analyze experimental data in the first ever quantum state tomography of photoelectrons.

Xanadu Quantum Technologies, Canada | *May 2022 – Aug 2022*

Quantum Algorithms Intern (Funded by Mitacs Accelerate Fellowship)

- Developed an implicit differentiation approach for variational quantum algorithms, applied to quantum chemistry and condensed-matter systems (arXiv:2211.13765).

- Contributed to the PennyLane software and developed tutorials explaining quantum machine learning techniques (e.g., a data re-uploading classifier).

Quantum Toolbox in Python (QuTiP) | *2016 – Present*

Core Contributor and Admin Team Member

- Maintained and enhanced QuTiP, a widely-used quantum simulation library.
- Developed JAX-based tools for quantum physics applications (qgrad, qutip-jax).
- Contributed to the developement of software for pulse-level simulation of quantum circuits (Quantum 6, 630 (2022)).

Cluster for Pioneering Research, Riken, Japan | *Jul 2017 – Jul 2018*

Theoretical Quantum Physics Intern

- Developed neural network-based constrained optimization techniques (e.g., Sudoku solving).
- Contributed to developing code and software to simulate large open quantum systems, contributing to publications (Phys. Rev. A 98, 063815).

Google Summer of Code (Python Software Foundation) | *May 2016 – Aug 2016*

Intern – DIPY Project

- Developed a Python module for MRI reconstruction (demo).
- Mentored subsequent GSoC projects for QuTiP, contributing to publications (Quantum 6, 630 (2022)).

SKILLS

- **Python-based software development** - continuous integration, release cycle management, automation with GitHub actions, and Sphinx documentation. Experienced in setting up and maintaining **Jupyterhub** servers for research groups.
- **Deep learning tools** such as **JAX, TensorFlow, PyTorch, Scikit-learn**, inference engines and runtimes, e.g., **TensorRT, ONNXRuntime, Qualcomm's AI Engine Direct SDK (QNN)**. Optimizing deep learning models to run on various edge hardware such as NVIDIA Orin, Qualcomm HTPs and DSPs, ARM CPUs and other edge hardware.
- **Machine learning and data analysis** with a focus on **custom deep-neural-network architectures** for scientific applications, **optimization on manifolds**, **Bayesian estimation, and Gaussian processes**. Also familiar with **reinforcement learning** and **Markov Decision Processes**.
- **Modelling, simulation and optimization** for scientific computing problems specializing in quantum information and computing and **simulating open quantum systems**. **Gradient-based optimization** for learning problems such as **quantum tomography**, optimization in **quantum control** and **variational quantum algorithms**. Also familiar with basics of **convex programming** and **Riemennian** optimization.
- Skilled in **data visualization**, presentation of complex research concepts through **talks, scientific manuscripts** as well as **code-based tutorials**.

OPEN SOURCE

- gd-qpt: Gradient desecent quantum process tomography (with JAX), 2022
- qst-cgan: Quantum state tomography with conditional GANs (with TensorFlow), 2022
- qutip-tensorflow: Tensorflow backend for QuTiP (Google Summer of Code project mentor), 2021
- qgrad: Quantum simulation in JAX for autodiff, (developer and mentor for Google Summer of Code project), 2020

- matsubara: Hierarchichal Eq. of motion solver for quantum dynamics, 2020 make-your-code-count: A guide to building open-source scientific computing projects (co-developer), 2019
- pennylane: Differential programming of quantum circuits (contributed to core library, developed many tutorials and demos for applications), 2019
- piqs: Permutational Invariance Quantum Solver for Lindblad open quantum systems (co-developer), 2018
- dipy: Developed the IVIM module as a Google Summer of Code project, 2016

TALKS AND PRESENTATIONS

- QTML Invited speaker: ML for quantum states and operations: from neural networks to optimization on a manifold, 2022
- ML(QC)2: Quantum process tomography with gradient descent, 2022
- APS March Meeting: Deep neural networks for quantum state characterization, 2021
- QTML: Classification and reconstruction of optical quantum states, 2020
- FOSDEM: Make your code count: Quantum simulations and collaborative code development, 2019
- Nature Blogs: The rise of open source in quantum physics research, (2019)
- PyData, Poland: Bit to QuBit: Data in the age of quantum computing, 2018
- CQIS: Make your code count: Developing open-source quantum simulation tools, 2018
- Beyond Digital Computing symposium (awarded travel scholarship): Solving Sudokus with neural networks, 2018

AWARDS & ACHIEVEMENTS

- 2022: MITACS Accelerate fellow, Xanadu and UWaterloo, Canada
- 2017: International Program Associate, RIKEN, Japan
- 2016: Summer Research Fellow, Indian Academy of Sciences, Bengaluru
- 2013: Selected for merit scholarship (NEST), Center for Excellence in Basic Sciences, Mumbai

TEACHING

Chalmers University of Technology

- Learning from data (TIF285) | Teaching assistant (2019, 2020, 2021, 2022)

  Master's level course taught by Prof. Christian Forssén on methods to perform scientific data analysis using Bayesian statistical inference and machine learning. Developed various term projects on neural-network applications to science.

- **Quantum capsule neural networks** | Master's thesis supervisor (2020)

  Supervised a master thesis by Sieglinde Bogaert, a student of the Erasmus Mundus Nano program in collaboration with KU Leuven on the topic of quantum neural networks. I conceived the idea and supervised the thesis with Dr. Anton Frisk Kockum.

- **Applied machine learning** | Teaching assistant (2019, 2020, 2021)

  Master's level course taught by Prof. Richard Johansson focusing on applied machine learning with Python.

- **Advanced simulation and machine learning** | Teaching assistant (2020, 2021, 2022)

  Master's level course by Prof. Andreas Ekström on advanced topics in machine learning, e.g, Gaussian processes, Bayesian regression

- **Deep machine learning and reinforcement learning** | Teaching assistant (2020, 2021)

  Evening course by Prof. Mats Granath focusing on basic machine learning concepts and Python-based implementations of deep and reinforcement learning.

- **C programming** | Lab assistant (2019, 2020)

  Evening course by Prof. Andreas Heinz. Assisted with grading lab exercises in basic C-programming.

BITS Pilani, K.K. Birla Goa Campus

Quantum Mechanics - I | Teaching assistant (Jan 2016 - May 2016)

PUBLICATIONS

See Google scholar for updated list of publications.

1. Gaikwad A., Torres ME, **Ahmed S**, Kockum AF. "Gradient-descent methods for fast quantum state tomography." *arXiv:2503.04526* (2025).
2. Recio-Armengol E., **Ahmed S**, Bowles J. "Train on classical, deploy on quantum: scaling generative quantum machine learning to a thousand qubits." *arXiv:2503.02934* (2025).
3. Bowles J, **Ahmed S**, Schuld M. "Better than classical? The subtle art of benchmarking quantum machine learning models." *arXiv:2403.07059v2* (2024).
4. **Ahmed S**, Killoran N, Carrasquilla J.F. "Implicit differentiation of variational quantum algorithms." arXiv:2211.13765 (2022).
5. **Ahmed S**, Quijandría, F., & Kockum, AF. "Gradient-descent quantum process tomography by learning Kraus operators." Phys. Rev. Lett. 130, 150402 (2023). arXiv:2208.00812.
6. Chen L, Li HX, Lu Y, Warren CW, Križan CJ, Kosen S, Rommel M, **Ahmed S**, et al. "Transmon qubit readout fidelity at the threshold for quantum error correction without a quantum-limited amplifier". npj Quantum Inf 9, 26 (2023). arXiv:2208.05879.
7. Kudra, M., Kervinen, M., Strandberg, I., **Ahmed S**, et al. "Robust preparation of Wigner-negative states with optimized SNAP-displacement sequences." PRX Quantum, 3(3), 030301 (2022). arXiv:2111.07965
8. Warren, C. W., Fernández-Pendás, J., **Ahmed S**, et al. "Extensive characterization of a family of efficient three-qubit gates at the coherence limit.". npj Quantum Inf 9, 44 (2023). arXiv:2207.02938.
9. **Ahmed S**, Muñoz CS, Nori F, Kockum AF. "Quantum State Tomography with Conditional Generative Adversarial Networks." Phys. Rev. Lett. 127, 140502 (2021). arXiv:2008.03240.
10. **Ahmed S**, Muñoz CS, Nori F, Kockum AF. "Classification and reconstruction of optical quantum states with deep neural networks." Phys. Rev. Research 3, 033278 (2021). arXiv:2012.02185.
11. Li B, **Ahmed S**, Saraogi S, Lambert B, Nori F, Pitchford A, Shammah N. "Pulse-level noisy quantum circuits with QuTiP." Quantum 6, 630 (2022). arXiv:2105.09902.
12. Lambert N, Raheja T, **Ahmed S**, Pitchford A, Nori F. "BoFiN-HEOM: A bosonic and fermionic numerical hierarchical-equations-of-motion library with applications in light-harvesting, quantum control, and single-molecule electronics." Phys. Rev. Research 5, 013181 (2023). arXiv:2010.10806.
13. Fadnavis S, Farooq H, Afzali M, Lenglet C, Georgiou T, Cheng H, Newman S, **Ahmed S**, Henriques RN, Peterson E, Koudoro S. "Fitting IVIM with Variable Projection and Simplicial Optimization," arXiv:1910.00095.
14. Lambert N, **Ahmed S**, Cirio M, Nori F. "Modelling the ultra-strongly coupled spin-boson model with unphysical modes," Nature Communications 10, 3721 (2019). arXiv:1903.05892.
15. Shammah N, **Ahmed S**, Lambert N, Liberato S. D., and Nori F. "Open quantum systems with local and collective incoherent processes: Efficient numerical simulations using permutational invariance," Physical Review A 98 (6), 063815 (2018).
16. Bergholm V, Izaac J, Schuld M, Gogolin C, Alam MS, **Ahmed S**, et al. "PennyLane: Automatic differentiation of hybrid quantum-classical computations," arXiv:1811.04968.