

# Shahnawaz Ahmed

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## EDUCATION

### Chalmers University of Technology

PH.D. CANDIDATE IN MACHINE LEARNING FOR QUANTUM INFORMATION AND COMPUTING  
Advisor: Anton Frisk Kockum

*Göteborg, Sweden*

*October 2018 - September 2023*

### Birla Institute of Technology and Science (BITS) Pilani

DUAL DEGREE  
M.Sc.(Hons.) Physics  
B.E. (Hons.) Electrical and Electronics Engineering

*K.K. Birla Goa Campus, India*

*August 2013 - July 2018*

## EXPERIENCE

### Xanadu quantum technologies, Canada

**QUANTUM ALGORITHMS GROUP | MITACS ACCELERATE RESEARCH FELLOW**

*May 2022 - August 2022*

Supervisors: [Prof. Juan Carrasquilla](#) and [Dr. Nathan Killoran](#)

- Developed an approach to take implicit gradients of variational quantum algorithm to compute quantities of interest in condensed-matter systems, quantum chemistry, generation of quantum entanglement as well as hyperparameter tuning of quantum machine-learning algorithms ([arXiv:2211.13765](#), [demo using JAX and PennyLane](#)).
- Previously, as a core contributor to the [PennyLane](#) software, developed tutorials and demos on quantum machine learning e.g., [data-reuploading quantum classifier](#), [barren plateaus in quantum neural networks](#).

### Quantum Toolbox in Python (QuTiP)

**QuTiP | ADMIN**

*2016 - Present*

- Core admin team member involved in the maintenance of QuTiP — a software used by thousands of physicists worldwide.
- Worked towards developing tools for automatic differentiation applications in quantum physics, e.g, a JAX-based version of QuTiP functionalities — ([qgrad](#)), TensorFlow backend for QuTiP ([qutip-tensorflow](#)). Also part of the [qutip-qip](#) project focused on pulse-level simulation of quantum circuits ([Quantum 6, 630 \(2022\)](#)).

### Cluster for Pioneering Research, Riken, Japan

**THEORETICAL QUANTUM PHYSICS GROUP | INTERN**

*Jul 2017 - July 2018*

Guides: [Prof. Franco Nori](#), Dr. Neill Lambert, Dr. Nathan Shammah, Dr. Clemens Gneiting

- Worked on a project exploring constrained optimization using neural networks, e.g., for solving Sudoku ([poster](#))
- Developed simulation techniques for large open quantum systems and worked on their open-source implementations resulting in two publications during my master thesis ([Phys. Rev. A 98, 063815](#), [Nat Commun 10, 3721 \(2019\)](#)).

### Ritsumeikan University, Japan

**NEXT GENERATION COMPUTING LAB | INTERN**

*Dec 2016 - Jan 2017*

Guide: [Prof. Shigeru Yamashita](#), NGC Lab

- Developed a pipeline for optimization of topological quantum circuits as an intern during my bachelor's studies.

### Summer of code, Google

**PYTHON SOFTWARE FOUNDATION (DIPY) | INTERN**

*May 2016 - Aug 2016*

Mentor: [Dr. Ariel Rokem](#), Senior Data Scientist and a Data Science Fellow at the University of Washington eScience Institute

- Developed a [python module for Magnetic Resonance Image \(MRI\) reconstruction](#) based on the IVIM model resulting in a publication () and open-source implementation ().

## SKILLS

### Programming

Python (with a good knowledge of scientific computing, data analysis and machine learning tools such as TensorFlow, Jax, Scikit-learn, Pandas). Also familiar with Julia, Matlab and C.

### Operating Systems

Windows, Linux, MacOS

### Independent Study

Scalable Machine Learning using PySpark - [UC, Berkeley through edX](#)

## OPEN SOURCE

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- 2022 [gd-qpt](#), Gradient descent quantum process tomography (with Jax)
- 2022 [qst-cgan](#), Quantum state tomography with conditional GANs (with TensorFlow)
- 2021 [qutip-tensorflow](#), Tensorflow backend for qutip (Google Summer of Code project mentor)
- 2020 [qgrad](#), Quantum simulation in Jax for autodiff (Google Summer of Code project mentor)
- 2020 [matsubara](#), Hierarchical Eq. of motion solver for quantum dynamics
- 2019 [make-your-code-count](#), A guide to building open-source scientific computing projects
- 2019 [pennylane](#), Differential programming of quantum circuits
- 2018 [piqs](#), Permutational Invariance Quantum Solver for Lindblad open quantum systems
- 2016 [dipy](#), Developed the [IVIM](#) module as a [Google Summer of Code](#) project

## AWARDS & ACHIEVEMENTS

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- 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

## TALKS & PRESENTATIONS

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- 2022 **QTM (Invited)**, ML for quantum states and operations: from neural networks to optimization on a manifold
- 2022 **ML(QC)2**, [Quantum process tomography with gradient descent](#)
- 2021 **APS March Meeting**, [Deep neural networks for quantum state characterization](#)
- 2020 **QTM**, [Classification and reconstruction of optical quantum states](#)
- 2019 **FOSDEM**, [Make your code count](#)
- 2019 **Nature Blogs**, [The rise of open source in quantum physics research](#)
- 2018 **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

## TEACHING

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### Quantum capsule neural networks | Master thesis supervision

CHALMERS UNIVERSITY OF TECHNOLOGY

2020

Conceived the project idea and supervised a master thesis by a student of the Erasmus Mundus Nano program in collaboration with KU Leuven with Dr. Anton Frisk Kockum. The thesis entitled "Quantum capsule neural networks" was awarded a prize by Imec for being the best master thesis at KU Leuven in the area of micro- and nano-electronics.

### Learning from data | Teaching assistant

CHALMERS UNIVERSITY OF TECHNOLOGY

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 term project on neural-network applications to science.

### Applied machine learning | Teaching assistant

CHALMERS UNIVERSITY OF TECHNOLOGY

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

CHALMERS UNIVERSITY OF TECHNOLOGY

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

UNIVERSITY OF GOTHENBURG

2020, 2021

- Evening course by [Prof. Mats Granath](#) focusing on basics and Python-based implementations of deep learning.

### C programming | Lab assistant

UNIVERSITY OF GOTHENBURG

2019, 2020

- Evening course by [Prof. Andreas Heinz](#). Assisted with grading lab exercises in basic C-programming.

## PUBLICATIONS

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1. “Implicit differentiation of variational quantum algorithms”. **Ahmed S**, Killoran N, Carrasquilla J.F. [arXiv:2211.13765](#) (2022).
2. “Gradient-descent quantum process tomography by learning Kraus operators”. **Ahmed S**, Quijandría, F., & Kockum, AF. [arXiv:2208.00812](#) (2022) (accepted for publication in PRL).
3. “Transmon qubit readout fidelity at the threshold for quantum error correction without a quantum-limited amplifier”. Chen L, Li HX, Lu Y, Warren CW, Križan CJ, Kosen S, Rommel M, **Ahmed S**, et al. [npj Quantum Inf 9, 26 \(2023\)](#) | [arXiv:2208.05879](#) (2022).
4. “Robust preparation of Wigner-negative states with optimized SNAP-displacement sequences”. Kudra, M., Kervinen, M., Strandberg, I., **Ahmed S**, Scigliuzzo, M., Osman, A., ... & Gasparinetti, S. [PRX Quantum, 3\(3\), 030301 \(2022\)](#).
5. “Extensive characterization of a family of efficient three-qubit gates at the coherence limit”. Warren, C. W., Fernández-Pendás, J., **Ahmed S**, Abad, T., Bengtsson, A., Biznárová, J., ... & Bylander, J. [arXiv:2207.02938](#) (2022).
6. “Quantum State Tomography with Conditional Generative Adversarial Networks”. **Ahmed S**, Muñoz CS, Nori F, Kockum AF. [Phys. Rev. Lett. 127, 140502 \(2021\)](#) | [arXiv:2008.03240](#).
7. “Classification and reconstruction of optical quantum states with deep neural networks”. **Ahmed S**, Muñoz CS, Nori F, Kockum AF. [Phys. Rev. Research 3, 033278 \(2021\)](#) | [arXiv:2012.02185](#).
8. “Pulse-level noisy quantum circuits with QuTiP”. Li B, **Ahmed S**, Saraogi S, Lambert B, Nori F, Pitchford A, Shammah N. [Quantum 6, 630 \(2022\)](#) | [arXiv:2105.09902](#).
9. “BoFiN-HEOM: A bosonic and fermionic numerical hierarchical-equations-of-motion library with applications in light-harvesting, quantum control, and single-molecule electronics”. Lambert N, Raheja T, **Ahmed S**, Pitchford A, Nori F. [Phys. Rev. Research 5, 013181 | arXiv:2010.10806 \(2020\)](#).
10. “Fitting IVIM with Variable Projection and Simplicial Optimization”. Fadnavis S, Farooq H, Afzali M, Lenglet C, Georgiou T, Cheng H, Newman S, **Ahmed S**, Henriques RN, Peterson E, Koudoro S. [arXiv:1910.00095](#).
11. “Modelling the ultra-strongly coupled spin-boson model with unphysical modes”. Lambert N, **Ahmed S**, Cirio M, Nori F. [Nature Communications 10, 3721 \(2019\)](#).
12. “Open quantum systems with local and collective incoherent processes: Efficient numerical simulations using permutational invariance”. Shammah N, **Ahmed S**, Lambert N, Liberato S. D., and Nori F. [Physical Review A 98 \(6\), 063815 \(2018\)](#).
13. “PennyLane: Automatic differentiation of hybrid quantum-classical computations”. Bergholm V, Izaac J, Schuld M, Gogolin C, Alam MS, **Ahmed S**, Arrazola JM, Blank C, Delgado A, Jahangiri S, McKiernan K, Meyer JJ, Niu Z, Száva A, ... Killoran N. [arXiv:1811.04968](#).