# Anthony Polloreno, Ph.D.

**Ph.D.** Machine Learning and Quantum Computation
**B.A.** Computer Science, Math, Physics

Research engineer with 7 years of experience building robust tools for information processing


Website : https://www.ampolloreno.com


Languages: Python, Julia, C++, Mathematica

## Work and Research Experience

2023 | Postdoctoral Associate at JILA
*Machine Learning and Reservoir Computation*
Developed a characterization of limits imposed on reservoir computers (a kind of recurrent network) due to noise and other physical considerations. Proved that the useful learning space is exponentially smaller than the natural space of outputs. Numerical simulations performed using Jax, Amazon EC2 and V100 tensor core GPUs.

2021 - 2023 | Graduate Student Intern at Sandia National Laboratories
*Statistical Analysis and Characterization of Quantum Devices*
Developed a cohesive theory of a general statistical technique for characterizing quantum computers that increases the number of qubits that can be characterized by a factor of 10x and is 100x faster than state-of-the-art techniques. Demonstrated that this characterization technique provides a detailed model of a quantum computer and predicts the behavior of complex circuits. Found that errors that occur during logical operations are 2x worse than other errors.

2019 - 2023 | Graduate Student at JILA and University of Colorado, Boulder
*Characterization of Quantum Information Processing Devices*
Simulated annealing and evolution strategies optimizer to optimize $p = 1$ QAOA with a single measurement per point in parameter space, giving a 10000x speed up and enabling optimization on a neutral atom quantum computer. Broadband sensing and optimality results of sensors over a broadband, speeding up axion detection by at least 10x. Developed novel computational technique for Penning traps, enabling quantum computation on 10x more qubits than current leading quantum computing platforms.

2019 | Software Engineering Consultant at Ψ-inf
Developed tools for storing, structuring and retrieving data from various experiments (Python/SQLAlchemy). Migrated data to backwards compatible Postgres database and collaborated with in-house scientists to automate data storage and retrieval. Improved engineer analysis productivity 2x with structured data logging and retrieval.

2016 - 2019 | Full Stack Software Engineer at Rigetti Computing
Implemented a novel machine learning algorithm using implicit kernels on the quantum processor, improving the error rate by .7% over a baseline of a linear classifier on the MNIST data set. Developed, tested and simulated efficient routines for device bring-up and characterization, replacing 100s of experiments from automated calibration routine (Julia). Primary maintainer and developer of control software suite for experiments and largest internal repository, reviewing and merging 100s of pull requests. Refactored routines used in automated device calibration using a Python DSL for expressing pulse sequences, increasing engineering development speed by more than 2x. Implemented matched filtering of RF signals (C++) to reduce data transfer overhead by more than 10x during experiments. Refactored a statistical analysis technique (randomized benchmarking) into a server (Lisp) to speed up experiment generation time by more than 10x.

2015 - 2016 | Student Intern at Sandia National Laboratories
*Control Theory and Convex Optimization*
Used optimal control theory to robustly reduce errors on quantum logical gates by more than an order of magnitude, both in simulation and experiment with real hardware at Rigetti Computing. By formulating the problem as an instance of convex optimization, I demonstrated a reduction of the number of required FPGA controls by 90%, improved the simulability of the controls by 10x, and showed a 5x increase in gate performance over 87.5% of feasible operating parameter values. Generated controls using gradient descent.

## Education

2019 - 2023 | Ph.D., Physics
*Thesis Title: Characterizing Quantum Devices Using the Principles of Quantum Information*
University of Colorado, Boulder

2019 - 2022 | M.S., Physics
University of Colorado, Boulder

2012 - 2016 | B.A., Computer Science, Mathematics, and Physics
University of California, Berkeley

### Awards

NASA Space Technology Graduate Research Opportunity (NSTGRO) Fellowship
QISE-NET Award (Cohort 4)
C.U. Boulder Domestic Graduate Travel Grant
Pomerantz Physics Scholarship
U.C. Berkeley Regents' and Chancellor's Scholarship

## Publications

1. Anthony M. Polloreno. Limits to reservoir learning. *arXiv preprint arXiv:2307.14474*, 2023
2. Anthony M. Polloreno et al. The impact of markovian errors on random circuits. *in progress*, 2023
3. Anthony M. Polloreno et al. A theory of direct randomized benchmarking. *arXiv preprint arXiv:2302.13853*, 2023
4. Anthony M. Polloreno et al. A note on noisy reservoir computation. *arXiv preprint arXiv:2302.10862*, 2023
5. Anthony M. Polloreno et al. Opportunities and limitations in broadband sensing. *Physical Review Applied*, 19(1), January 2023
6. Anthony M. Polloreno et al. The qaoa with few measurements. *arXiv preprint arXiv:2205.06845*, 2022
7. Anthony M. Polloreno et al. Individual qubit addressing of rotating ion crystals in a penning trap. *Physical Review Research*, 4(3), July 2022
8. Anthony M. Polloreno et al. Robustly decorrelating errors with mixed quantum gates. *Quantum Science and Technology*, 2021
9. Sabrina S. Hong et al. Demonstration of a parametrically activated entangling gate protected from flux noise. *Physical Review A*, 101(1), January 2020
10. C. M. Wilson et al. Quantum kitchen sinks: An algorithm for machine learning on near-term quantum computers. *arXiv:1806.08321*, 2018
11. S. A. Caldwell et al. Parametrically activated entangling gates using transmon qubits. *Physical Review Applied*, 10(3), September 2018
12. Matthew Reagor et al. Demonstration of universal parametric entangling gates on a multi-qubit lattice. *Science Advances*, 4(2):eaao3603, February 2018

## Patents

1. Michael Justin Gerchick Scheer et al. Modular quantum processor architectures, November 4 2021. US Patent App. 17/119,089
2. Alexander Papageorge et al. Operating a quantum processor having a three-dimensional device topology. Library Catalog: Google Patents