

# Anthony Polloreno, Ph.D.

Ph.D. Physics

B.A. Computer Science, Math, Physics

Data engineer with over a decade of hands-on experience in software development, data analysis, and system optimization. Adept in transforming complex data into scalable solutions across industry, academia and government.

Website : <https://www.ampolloreno.com>

Languages : Python, Julia, SQL, C++, Java, Mathematica

Frameworks: NumPy, PyTorch, Jax  
pandas, SQLAlchemy, Slurm  
MPI, CVXOPT, Hadoop  
Scikit-Learn

## EDUCATION

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2019 - 2023 | Ph.D., Physics  
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

## WORK AND RESEARCH EXPERIENCE

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2023 | Data Engineering Researcher at JILA  
*Noise-Resilient Data Architectures in Deep Learning Systems*  
Developed robust data infrastructures for analyzing the impact of stochastic disturbances on the efficacy of reservoir computing models, focusing on Echo State Networks (ESNs) for high-stakes time series analysis. Engineered and implemented distributed data processing workflows to facilitate the evaluation of ESN configurations under Gaussian noise interference. Conducted sophisticated data analytics leading to new insights on signal noise scalability, thereby solidifying the viability of ESNs in noisy data environments. Enhanced machine learning operations via Python programming, leveraging the Jax library, and executed resource-intensive computations on parallelized AWS EC2 instances equipped with V100 tensor core GPUs to ensure computational efficiency and reduced model training periods. Extended foundational theoretical concepts for reservoir computing limitations and probed their integrative use with reinforcement learning paradigms.

2021 - 2023 | Data Engineering Intern at Sandia National Laboratories  
*Data Engineering-Driven Quantum Error Characterization and Prediction*  
Pioneered a breakthrough data engineering methodology to extend the characterization capacity of quantum computing systems, increasing qubit analysis throughput by 10x and achieving operational speeds 100x faster than existing methods. Provided a detailed predictive model for quantum circuit operations through advanced statistical analysis. Uncovered and quantified discrepancies in error rates, pinpointing that logical operation discrepancies are significantly more impactful, prompting strategic data-driven enhancements. Designed and maintained robust data pipelines for the capture, transformation, and efficient storage of quantum state information, employing best practices for data hygiene and integrity. Employed data visualization tools to communicate complex error characterization findings to interdisciplinary teams, enhancing strategic decision-making based on data-driven insights. Authored internal reports and documentation on data engineering processes.

2019 - 2021 | Data Engineering Graduate Researcher at JILA and University of Colorado, Boulder  
*Scalability and Optimization in Quantum Information Processes via Advanced Data Engineering*  
Applied multi-node programming and SLURM workload management to develop data-intensive solutions for scaling quantum computations in Penning trap systems, significantly exceeding current qubit processing capabilities by an order of magnitude. Utilized parallel computing and high-performance computing clusters to manage and process large volumes of data, ensuring timely insights and scalability. For the optimization of the  $p = 1$  QAOA process, utilized evolutionary strategies and simulated annealing, achieving a computational speed increase by 10000x, which facilitated rapid optimization in a neutral atom quantum computer environment. Advanced the field of broadband sensing with data-centric optimization algorithms, enhancing axion detection rates by 10x or greater.

2019 | Data Engineering Consultant at  $\Psi$ -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 by linearizing the problem, averaging over trajectories with Gaussian quadrature and using gradient descent.

## PUBLICATIONS

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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. Ariel Shlosberg et al. Towards demonstrating fault tolerance in small circuits using bacon-shor codes. *arXiv:2108.02079*, 2021
8. Anthony M. Polloreno et al. Individual qubit addressing of rotating ion crystals in a penning trap. *Physical Review Research*, 4(3), July 2022
9. Anthony M. Polloreno et al. Robustly decorrelating errors with mixed quantum gates. *Quantum Science and Technology*, 2021
10. Sabrina S. Hong et al. Demonstration of a parametrically activated entangling gate protected from flux noise. *Physical Review A*, 101(1), January 2020
11. C. M. Wilson et al. Quantum kitchen sinks: An algorithm for machine learning on near-term quantum computers. *arXiv:1806.08321*, 2018
12. S. A. Caldwell et al. Parametrically activated entangling gates using transmon qubits. *Physical Review Applied*, 10(3), September 2018
13. Matthew Reagor et al. Demonstration of universal parametric entangling gates on a multi-qubit lattice. *Science Advances*, 4(2):eaao3603, February 2018

## PATENTS

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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

## TECHNICAL EXPERTISE AND TOOLS

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*Development Languages & Frameworks:* Python, Java, Hadoop, Jax, TensorFlow, Pandas, NumPy, Scikit-Learn

*Database & Storage Technologies:* SQL, HDFS, PostgreSQL, Redis

*Data Pipeline & Workflow Management:* Luigi, SLURM

*High-performance & Parallel Computing:* MPI, OpenMP, AWS EC2

*Visualization Reporting Tools:* Matplotlib, Seaborn

*Code Versioning & Collaborative Tools:* Git, GitHub, GitLab, Bitbucket, JIRA, Confluence

*Data Manipulation Techniques:* ETL (Extract, Transform, Load) processes, data cleaning, data validation, batch processing

*Machine Learning & Statistical Analysis:* Regression Analysis, Classification, Clustering, Dimensionality Reduction