Anthony Polloreno, Ph.D.

Ph.D. Machine Learning & Physics
B.A. Computer Science, Math, Physics

Research engineer with 10+ years of experience building and deploying software in industry, academia and government

Website : https://www.ampolloreno.com

Email : ampolloreno [at] gmail [dot] com

Languages : Python, Julia, C++, Mathematica

Frameworks: NumPy, PyTorch, Jax pandas, SQLAlchemy

Education

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

2023 | Postdoctoral Associate at JILA
Machine Learning for Predictive Modeling and Analysis of Noise in Recurrent Neural Networks
Conducted research on the impact of noise on reservoir computers in predictive modeling, with a focus on echo state networks (ESNs) and their robustness in handling time series data and prediction tasks. Developed an ensemble approach to simulate various ESN configurations and assessed their performance in the presence of Gaussian noise. Analyzed the polynomial scaling of usable signals in noisy environments, challenging the assumption of exponential scaling and highlighting the network's resiliency to noise in real-world scenarios. Implemented and optimized ML algorithms and simulations in Python, using the Jax framework, and ran computations on Amazon EC2 instances with V100 tensor core GPUs, aiming for efficient hardware utilization and improved network training times. Contributed to the theoretical understanding of the limits of reservoir computing and explored their applications in reinforcement learning contexts.

2021 - 2023 | Graduate Student Intern at Sandia National Laboratories
Statistical Analysis and Characterization of Computational Errors
Built a theoretical framework for analyzing the impact of computational errors on a family of Markov processes inspired by quantum computation, with simulations in Python. Developed a cohesive theory of a general statistical techniques for characterization of computational errors that increases the size of the system that can be characterized by a factor of 10x and is 100x faster than state-of-the-art techniques. 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 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 by linearizing the problem, averaging over trajectories with Gaussian quadrature and using gradient descent.

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. 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

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