Anthony Polloreno, Ph.D.

Member of Technical Staff @ Essential.ai
Post-Doctoral Researcher @ CU Boulder
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Languages: Python, Julia, C++, Lisp, Mathematica
Frameworks: Jax, PyTorch, NumPy pandas, SciPy, SQLAlchemy, Slurm Docker, Kubernetes, MPI

Machine learning engineer and researcher with over a decade of experience in machine learning, software engineering and physics across industry, academia and government. Extensive expertise in scaling model training, optimization algorithms and development of machine learning systems. Seeking roles that involve cutting-edge machine learning research and engineering of intelligent systems.

Education

2019 - 2023	Ph.D. Physics, University of Colorado, Boulder
2012 - 2016	B.A., Computer Science, Mathematics, and Physics, University of California, Berkeley

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

2024 | Member of Technical Staff at Essential.ai: *Large-Scale Model Pretraining, Hyperparameter Optimization and Fine-Tuning for Enterprise AI*

- **Led large-scale model pretraining and inference optimization** for AI systems, focusing on training and deploying models on custom datasets across 1,000 chips, achieving full cluster utilization.
- **Designed and implemented hyperparameter optimization and transfer** through the maximal update parameterization (μP), enabling transfer of hyperparameters across model scaling dimensions.
- **Advanced model stability by developing and applying spectral analyses and**, increasing stability range metrics by a factor of two.
- **Optimized batch size scaling** and used second-order methods (Shampoo and KFAC) to facilitate stable, larger-than-standard batch sizes.
- **Created a custom Jax and Kubernetes-integrated database** for experiment tracking, replacing WandB, and enabling comprehensive, scalable monitoring of experimental data.
- **Conducted extensive Chinchilla-style scaling experiments** to determine optimal trade-offs between model size, token usage, and computational costs (FLOPS), maximizing performance within resource constraints.
- **Enhanced policy iteration workflows for in-house planning models** through behavior cloning from GPT-4, utilizing trajectory generation and LORA fine-tuning on LLaMA 8B and 70B models.
- **Spearheaded profiling and optimization of the compute stack** to accelerate inference execution by 4×, dramatically improving trajectory generation speed.
- **Operated in a cross-functional role reporting directly to the CEO**, independently managing key projects, collaborating across teams to drive consensus among stakeholders, and prioritizing high-impact technical solutions.

2023 - 2024 | Postdoctoral Associate at JILA: *Machine Learning for Predictive Modeling and Analysis of Noise in Recurrent Neural Networks*

- **Conducted research on the impact of noise in reservoir computing systems**, focusing on echo state networks (ESNs) and their robustness in handling time series data and prediction tasks.
- **Developed a novel ensemble approach** to simulate various ESN configurations and assessed their performance in the presence of Gaussian noise.
- **Extended the Information Processing Capacity (IPC) metric in a novel way** to measure the capacity of networks, providing a new form of evaluation for ESNs.
- **Orchestrated large-scale computations in Jax on Amazon EC2 instances equipped with V100 tensor core GPUs**, achieving efficient hardware utilization and significantly improved network training times.

2021 - 2023 | Graduate Student Intern at Sandia National Laboratories: *Scalable Error Propagation Analysis for Computational Systems*

- **Developed and implemented analytical and numerical frameworks** to model and analyze computational errors in circuits, creating scalable tools to assess how errors propagate, achieving a 100× increase in analysis speed and a 10× improvement in scalability over existing methods.
- **Employed statistical techniques to identify and quantify error dynamics**, advancing the understanding of error behavior in computational algorithms, with applications extending to quantum computational dynamics.

2019 - 2023 | Graduate Student at JILA and University of Colorado, Boulder: *Learning and Information Processing in Physical Systems*

- **Investigated the impact of noise on learnability within reservoir computing systems**, quantifying how stochastic physical dynamics affect learning performance.
- **Used natural evolutionary strategies** to achieve a 10,000× speed-up in the Quantum Approximate Optimization Algorithm (QAOA) by minimizing measurement overhead.
- **Theoretically and numerically analyzed the fundamental scaling of signal processing**, improving broadband detection speeds by 10×.
- **Conducted extensive numerical simulations using HPC clusters managed with Slurm**, applying information theory to model and analyze the dynamics of physical systems and enabling quantum computation on 10× more qubits than existing platforms.

2016 - 2019 | Full Stack Software Engineer at Rigetti Computing: *Scaling Quantum Computers*

- **Implemented novel quantum machine learning algorithms using implicit kernels on quantum processors**, achieving a 0.7% error rate improvement over linear classifiers on the MNIST dataset.
- **Developed machine learning models and simulations for device bring-up and characterization**, reducing the need for extensive calibration experiments.
- **Enhanced automated device calibration routines using a Python DSL**, increasing development speed by over 2×.
- **Utilized machine learning techniques for signal processing, including matched filtering of RF signals**, reducing data transfer overhead by more than 10×.

2015 - 2016 | Student Intern at Sandia National Laboratories: *Control Theory and Convex Optimization*

- **Applied backpropagation and optimal control theory** to significantly reduce errors on quantum gates by 10×.
- **Formulated the problem as an instance of convex optimization**, resulting in a 90% reduction in the number of required FPGA controls.
- **Improved the simulability of the controls by 10×** and demonstrated a 5× increase in gate performance over 87.5% of operating parameter values.

Publications and Patents

Anthony M. Polloreno et al. "Limits to Reservoir Learning," *arXiv preprint*, 2023; **Anthony M. Polloreno et al.** "Impact of Markovian Errors on Random Circuits," *in progress*, 2023; **Anthony M. Polloreno et al.** "Theory of Direct Randomized Benchmarking," *arXiv preprint*, 2023; **Anthony M. Polloreno et al.** "Noisy Reservoir Computation," *arXiv preprint*, 2023; **Anthony M. Polloreno et al.** "Opportunities and Limitations in Broadband Sensing," *Physical Review Applied*, 2023; **Anthony M. Polloreno et al.** "QAOA with Few Measurements," *arXiv preprint*, 2022; **Ariel Shlosberg et al.** "Fault Tolerance in Small Circuits Using Bacon-Shor Codes," *arXiv preprint*, 2021; **Anthony M. Polloreno et al.** "Individual Qubit Addressing in Ion Crystals," *Physical Review Research*, 2022; **Anthony M. Polloreno et al.** "Decorrelation of Errors in Quantum Gates," *Quantum Science and Technology*, 2021; **Sabrina S. Hong et al.** "Parametrically Activated Entangling Gate Protected from Flux Noise," *Physical Review A*, 2020; **C. M. Wilson et al.** "Quantum Kitchen Sinks: Algorithm for Machine Learning on Quantum Computers," *arXiv preprint*, 2018; **S. A. Caldwell et al.** "Entangling Gates Using Transmon Qubits," *Physical Review Applied*, 2018; **Matthew Reagor et al.** "Universal Parametric Entangling Gates on Multi-Qubit Lattice," *Science Advances*, 2018, **Michael Justin Gerchick Scheer et al.** "Modular Quantum Processor Architectures," *US Patent App. 17/119,089*, 2021; **Alexander Papageorge et al.** "Operating a Quantum Processor with 3D Device Topology," *Google Patents.*