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Training of Quantum Circuits on a Hybrid Quantum Computer[1]

DAIWEI ZHU, University of Maryland, College Park, NORBERT LINKE, University of Maryland, MARCELLO BENEDETTI, University College London, KEVIN LANDSMAN, NHUNG NGUYEN, CINTHIA ALDERETE, University of Maryland, College Park, ALEJANDRO PERDOMO-ORTIZ, University College London, NATHAN KORDA, ALISTAIR GARFOOD, CHARLES BRECQUE, Mind Foundry Limited, LAIRD EGAN, University of Maryland, College Park, OSCAR PERDOMO, Central Connecticut State University, CHRISTOPHER MONROE, University of Maryland, IonQ,Inc — Generative modeling is a flavor of machine learning with applications ranging from computer vision to chemical design. It is expected to be one of the techniques most suited to take advantage of the additional resources provided by near-term quantum computers. Here we implement a datadriven quantum circuit training algorithm on the canonical Bars-and-Stripes data set using a quantum-classical hybrid machine. The training proceeds by running parameterized circuits on a trapped ion quantum computer, and feeding the results to a classical optimizer. We apply two separate strategies, Particle Swarm and Bayesian optimization to this task. We show that the convergence of the quantum circuit to the target distribution depends critically on both the quantum hardware and classical optimization strategy. Our study represents the first successful training of a high-dimensional universal quantum circuit, and highlights the promise and challenges associated with hybrid learning schemes.

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