Qubit reset via adaptive thresholding: a scalable approach for large quantum processing devices

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Abstract

Quantum circuits require the ability to reset qubits to the ground state. Various approaches to resetting exist, such as thermal relaxation to the ground state or using active reset mechanisms. A more sophisticated method is the Repeat-Until-Success (RUS) approach, which offers high fidelity but is non-deterministic in time and may result in long waiting times for large quantum processing units (QPUs), where prepared qubits can spontaneously excite. Here we propose an alternative method, the adaptive threshold approach, in which qubits are prepared in a sequence of steps, each taking advantage of the biased distribution obtained throughout the process. This approach achieves a high ground-state population in deterministic time, particularly for weak measurements. In this work, we compare the resulting fidelities of reset methods with experimental evidence from a superconducting chip, showcasing the best performing and most scalable method for initializing large-scale quantum devices.