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New Error Correction Scheme Seeks to Advance Quantum Computing Capabilities

Bob Sorensen and Tom Sorensen
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RECENT DEVELOPMENT

Researchers at the US-based Lawrence Berkeley National Lab (LBNL) recently reported a new approach to error mitigation in a quantum computer (QC) that targets error-producing noise, a ubiquitous problem that can severely limit the performance and utility of existing and near-future quantum computers. The method developed at LBNL consists of taking an initial noisy target circuit and constructing an analogous estimation circuit that is configured specifically for accurate noise characterization. The information gathered from running the estimation circuit is then applied to correct the noise in the original target circuit.

To achieve this, the estimation circuit is a simplified version of the target circuit that consists of only single qubit and CNOT gates and that has a predetermined computational result. Key assumptions in the method are that the estimation and target circuits have similar errors rates and that CNOT gates are the major source of noise in the target circuit. The procedure was verified on IBM's Q Paris device using six qubits with 8192 shots for each circuit, and the longest circuit for 15 time steps contained a total of 210 CNOT gates.

- Researchers found this technique, when working in conjunction with other error correction techniques including readout-error correction, randomized compiling, and zero-noise extrapolation, produced results that were very close to expected results and suggested that the method can scale to any number of qubits and CNOT gates.

ANALYST COMMENT

For at least the next few years, the issue of noise within quantum computers will be one of the major limiting factors in the progress of the technology and a key determinant of how soon QC systems can scale up to sufficient error-corrected qubit counts necessary to demonstrate clear computational advantage over classical counterparts. QC researchers around the world are making continual progress in mitigating the impact of noise through a broad range of measures that include improving the noise characteristics of various qubit hardware designs, using multiple physical qubits to implement a single error corrected logical qubit, developing error-tolerant QC applications, and exploring QC system agnostic methods such as the one under development at LBNL.