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Exponential Error Suppression for Near-Term Quantum Devices

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***Abstract*:** Suppressing noise in physical systems is of fundamental importance. As quantum computers mature, quantum error correcting codes will be adopted in order to suppress errors to any desired level. However in the NISQ era, the complexity and scale required to adopt even the smallest QEC is prohibitive: a single logical qubit needs to be encoded into many thousands of physical qubits. Here we show that, for the crucial case of estimating expectation values of observables (key to almost all NISQ algorithms) one can indeed achieve an effective exponential suppression. We take n independently-prepared circuit outputs to create a state whose symmetries prevent errors from contributing bias to the expected value. The approach is very well suited for current and near-term quantum devices as it is modular in the main computation and requires only a shallow circuit that bridges the n copies immediately prior to measurement. Using no more than 4 circuit copies, we confirm error suppression below 10-6 for circuits consisting of several hundred noisy gates (two-qubit gate error 0.5%) in numerical simulations validating our approach.

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