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Quantum fault-tolerance and locality

Abstract

The design of error suppression mechanisms and associated fault-tolerance architectures is at the heart of quantum computation: Maintaining coherence is paramount if the goal is to realize a quantum advantage over classical information-processing. The theory of quantum error correction has recently seen significant developments with e.g., the discovery of good quantum low-density parity check codes. However, translating these theoretical advancements into practice necessitates addressing experimental constraints associated with current and future computational architectures. We discuss the particular challenges arising from the fact that available operations are typically local, acting only on adjacent qubits. This involves characterizing the potential of local operations for computation and the design of schemes for fault-tolerant quantum information-processing based on such operations.