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Quantum Error Correction: from theory to practice

The Achilles' heel of quantum information processors is the fragility of quantum states and processes. Without a method to control imperfection and imprecision of quantum devices, the probability that a quantum computation succeed will decrease exponentially in the number of gates it requires. In the last fifteen years, building on the discovery of quantum error correction, accuracy threshold theorems were proved showing that errors can be controlled using a reasonable amount of resources as long as the error rate is smaller than a certain threshold. We thus have a scalable theory describing how to control quantum systems. I will describe a variety of mathematical techniques that have been developed to turn this theorem into a useful tool in the laboratory and will sum up with a quick overview of where we are at controlling quantum systems in practice.