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What can I do with a quantum computer today?

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Quantum computers can offer dramatic speed-ups over their classical counterparts for certain problems. However, noise remains the biggest impediment to realizing the full potential of quantum computing. While the solution to this challenge has been known for almost 30 years with the theory of quantum error correction, a large scale realization of fault tolerance is still pending. What can one hope to do then, with existing noisy processors? Superconducting quantum processors now exist with over 1000 qubits, at a scale that is well beyond direct, brute-force classical simulation. In this talk, I will present methods to learn and manipulate noise in these devices to obtain noise-free computations. These methods, dubbed "error mitigation", do not require the large qubit overheads of quantum error correction, and are immediately accessible to current devices. I will then present experiments that demonstrate the accurate execution of quantum circuits at a scale that is only accessible with classical approximate methods. I shall argue that these experiments present the first evidence that useful information can be obtained from current quantum computers even before the advent of fault tolerance.

Theme

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