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Designing, programming, and optimizing a (small) quantum computer

KRYSTA SVORE, Microsoft Corp

In 1982, Richard Feynman proposed to use a computer founded on the laws of quantum physics to simulate physical systems. In the more than thirty years since, quantum computers have shown promise to solve problems in number theory, chemistry, and materials science that would otherwise take longer than the lifetime of the universe to solve on an exascale classical machine. The practical realization of a quantum computer requires understanding and manipulating subtle quantum states while experimentally controlling quantum interference. It also requires an end-to-end software architecture for programming, optimizing, and implementing a quantum algorithm on the quantum device hardware. In this talk, we will introduce recent advances in connecting abstract theory to present-day real-world applications through software. We will highlight recent advancement of quantum algorithms and the challenges in ultimately performing a scalable solution on a quantum device.