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Quantum Algorithmic Breakeven: on scaling up with noisy qubits

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As quantum computing proceeds from perfecting physical qubits towards testing logical qubits and small scale algorithms, an urgent question being confronted is how to decide that critical milestones and thresholds have been reached. Typical criteria are gates exceeding the accuracy threshold for fault tolerance, logical qubits with higher coherence than the constituent physical qubits, and logical gates with higher fidelity than the constituent physical gates. In this talk I will argue in favor of a different criterion I call "quantum algorithmic breakeven", which focuses on demonstrating an algorithmic scaling improvement in an error-corrected setting over the uncorrected setting. I will present evidence that current experiments with commercial quantum annealers have already crossed this threshold. Time permitting, I will also discuss our latest evidence for a scaling advantage for a quantum annealer over simulated annealing with such devices. The lessons we have learned from experimenting with commercial devices with many noisy qubits will hopefully inform other approaches to quantum computing.

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