Pedram Roushan

Staff Scientist, Google

Going beyond classical computation with superconducting qubits

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Abstract: The promise of quantum computers is that certain computational tasks might be executed exponentially faster on a quantum processor than on a classical processor. In 2019, we reported the use of a processor with programmable superconducting qubits to create quantum states on 53 qubits, corresponding to a computational state-space of dimension 2^{53} (about 10^{16}). Measurements from repeated experiments sample the resulting probability distribution, which we verify using classical simulations. Our Sycamore processor takes about 200 seconds to sample one instance of a quantum circuit a million times—our benchmarks indicate that the equivalent task for a classical supercomputer would take approximately 10,000 years. If time permitting, we take a closer look at how quantum information scrambling takes place and computational complexity grows. We image the dispersion of the scrambling wavefront as it changes from diffusive to ballistic propagation. Our work illustrates a tool to visualize scrambling and diagnose complexity in time and size scales that are challenging to access classically.

Bio: Pedram Roushan received his PhD in 2011 from Princeton University, performing the first scanning tunneling microscopy on the surface of topological insulators in the lab of A. Yazdani. After three years of post-doctoral studies in the J. Martinis lab at the University of California, Santa Barbara, in 2014 he joined the Google quantum hardware lab aiming on making a quantum computer. With the Google team in 2019, they performed the first computation on a quantum processor beyond the capability of a supercomputer. The current focus of his research is on simulating novel many-body physics with quantum processors.