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Scaling up with superconducting qubits

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There have been significant developments in the field of superconducting qubits since the first observation, almost 15 years ago, of coherent oscillations in a superconducting electrical circuit. One key number could summarize this progress: the coherence time. Indeed, this quantity has increased by about 5 orders of magnitude since the first experiments. Characterizing this progress with a single number is, however, too simplistic. It does not capture the many improvements that the field has witnessed and, in the same way, hides many of the challenges that lie ahead. Indeed, with many ingredients having to come together and work just right, quantum computation is about more than long coherence times. A much better (yet incomplete) measure is the error rate of single- and two-qubit logical gates. Recent experiments show this rate approaching the level required for fault-tolerant quantum computation, a requirement for a scalable quantum computer architecture. In parallel, much effort has been invested in using superconducting qubits as artificial atoms to explore quantum optics with microwaves and in unconventional parameter ranges. With an emphasis on theoretical work, in this talk I will present an overview of the recent achievements in the field and present some challenges that will have to be overcome.