The future of computing: Quantum

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The future of computing: Quantum

-Our world is quantum mechanical.

-Quantum computers enable novel computations.
Quantum effects for computing

-Superposition: a qubit can be both 0 and 1 simultaneously (with some amplitudes)

-Interference: computations in superposition can collectively contribute to the final result

-Entanglement: qubits can have stronger than classical correlations
Quantum supremacy

-Quantum computers have the potential to solve some problems exponentially more efficiently than classical computers.

-Google just reported passing the cross-over point, where a quantum chip can be much faster in practice than the best available supercomputer.
Boaz Barak’s analogy (quoted by Scott Aaronson) vs.
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“Deep Blue vs. Kasparov”
Main techniques for quantum algorithms

-Quantum Fourier transform: Shor’s algorithm for factoring, breaking RSA crypto-system, etc.

-Hamiltonian simulation: dynamical simulation of quantum systems for chemistry, material science, etc.

-Grover search: generic quadratic speed-up for unstructured search problems

-Large-dimensional regression (HHL algorithm): speeding-up various machine learning applications
Quantum Singular Value transformation

- A common unification / generalization of Hamiltonian simulation, Grover search and regression (HHL).

- Block-encodings: exponentially faster matrix operations

- Efficient circuits & near-term applicability
Some applications / other results

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- Efficiently working with the lowest-energy states of some structured Hamiltonians (quantum mechanical systems).

- Using quantum machine learning ideas to speed up classical machine learning tasks.
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