

Explorers

Quantum Computing

Skill Overview: How it works: Quantum Computing



Transcript

Quantum physics one of the most successful theories of modern science, describes the way our world works at the most fundamental level. Quantum computing has become one of the leading applications of quantum physics. Quantum computers have the potential to solve some of the world's most complex problems that are beyond the reach of even today's most powerful supercomputers.

Quantum computers are not going to replace classical computers, but they're radically different way of operating enables them to perform calculations that classical computing cannot. Let's see how they differ: Classical computers encode information in bits, and each bit can represent a 0 or a 1; these zeros and ones act as on-off switches that ultimately translate into compute functions, to perform a simple calculation like solving a maze.

A classical computer would test each possible route one at a time to find the correct one. Just as classical computers have bits, Quantum computers have qubits, qubits however make use of two key principles of quantum physics: superposition and entanglement. Superposition means that each qubit can represent a zero, a one, or both at the same time and entanglement happens when two qubits in a superposition are correlated with one another; meaning the state of one whether it's a 0, a 1 or both depends on the state of another.

Using these two principles qubits can act as a much more sophisticated version of switches, helping quantum computers solve difficult problems that are virtually impossible using classical computers.

To illustrate how this makes quantum computers more powerful; let's look at some numbers. Take a classical “n” bit computer, with “n” representing the number of bits. It can represent and examine only one system state at a time, an “n” qubit computer however would have the power to represent 2^n system states and perform parallel operations on all those states at once. This means that every time you add just one more qubit to a quantum computer, the number of states it can represent and examine doubles. So a 50 qubit quantum machine could examine 2^{50} states at once; this exponential increase in power together with the entanglement of qubits is what allows quantum computers to solve certain problems so much more efficiently.

While a classical computer solves a problem like the maze by testing each possible route one at a time, a quantum computer uses its entangled quantum states to find the correct route quicker, with far fewer calculations. Think of it this way; technologies that currently run on classical computers can expertly find patterns and insights buried in vast amounts of existing data, but quantum computers will deliver solutions where patterns cannot be seen, because sufficient data does not exist, or the possibilities for discovering an optimal answer are too enormous to ever be processed by a classical computer.

Quantum computers could lead to the discovery of new medicines and materials, by helping us untangle the complexities of molecular and chemical interactions. They could help the financial services industry make better investments by finding new ways to model financial data and isolate key global risk factors. They could even transform supply chain and logistics by finding the optimal routes across global systems; like optimizing fleet operations for deliveries during the holiday season.

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Quantum computing won't replace our everyday computers and smartphones, but its ability to solve complex problems will open up a new universe of information, transforming our view of the world and the way we navigate.