Could quantum computing help beat the next coronavirus?

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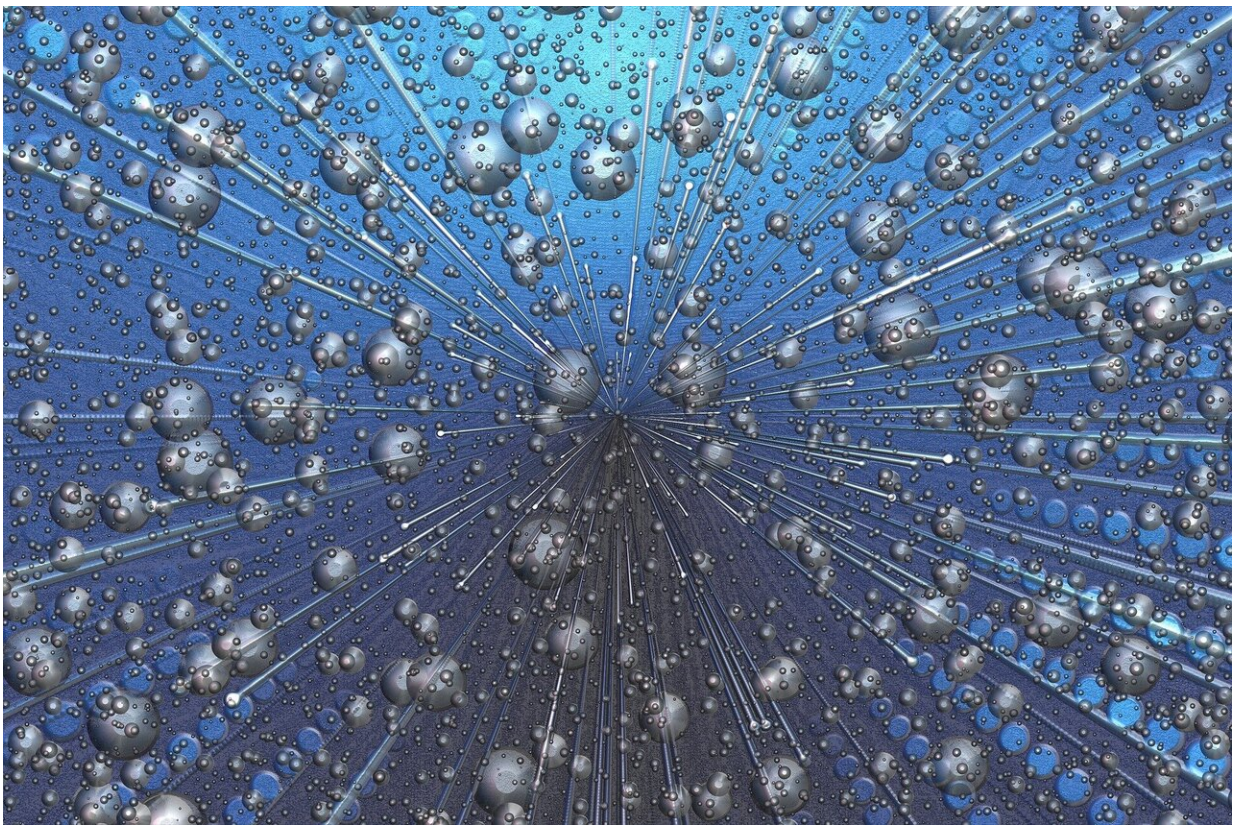

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Quantum computing isn't yet far enough along that it could have helped curb the spread of this coronavirus outbreak. But this emerging field of computing will almost certainly help scientists and researchers confront

future crises.

"Can we compress the rate at which we discover, for example, a treatment or an approach to this?" asks Dario Gil, the director of IBM Research. "The goal is to do everything that we are doing today in terms of discovery of materials, chemistry, things like that, (in) factors of 10 times better, 100 times better,"

And that, he says, "could be game-changing."

Quantum computing is the next big thing in computing, and it promises exponential advances in artificial intelligence and machine learning through the next decade and beyond, leading to potential breakthroughs in healthcare and pharmaceuticals, fertilizers, battery power, and financial services.

For a consumer with a retirement fund, "quantum computers over the next 10 to 15 years ... may help you make better personal financial decisions through the calculations that your broker is doing," says Bob Sutor, an IBM Research vice president tasked with driving the quantum computing ecosystem.

IBM, with 15 deployed quantum systems, is at the forefront of quantum computing. U.S. TODAY recently got to tour a quantum lab in Yorktown Heights, New York.

But Google, Amazon, Intel, Microsoft and Honeywell are among other tech stalwarts working in the field, as are several venture-backed global startups.

The U.S. government, which is in a quantum race against China, has also lent support. In late 2018, President Trump signed the National Quantum Initiative Act into law to fund quantum research to the tune of $1.2

billion over a five-year period.

Here is a guide to help demystify quantum computing, which you will almost certainly hear a lot more about in the years ahead.

What is quantum computing?

It isn't easy to get a grip around quantum computing or the field of physics it harnesses, quantum mechanics. But such machines—they cost millions—are designed to model nature.

In the simplest terms, they are exponentially more powerful than what we consider classical computers, whose basic fundamental units are expressed in 1s or 0s—or bits. Quantum computing takes a quantum leap with what are known as quantum bits or "qubits" for short.

Think about it this way: If you flip a coin, it will land as either heads or tails, or in those classical computer terms, 1s and 0s. But what's the state of that coin when it is still spinning? That's kind of where qubits are, not necessarily as a 1 or a 0, but as all the possibilities in between.

Now let's take the analogy further. If you flip two coins in the physical world, the heads or tails of one coin has no bearing on the other. Qubits, though, can be entangled in multiple states at the same time.

"This is one of those the "Earth is not flat' kind of moments," Gil says. "There is actually a revolution going on."

What quantum computers look like

A quantum computer chip is kept at a temperature that's colder than outer space in a cylinder that's part of an elaborate refrigerated

apparatus. The system has more than 2,000 components, including pulse tube coolers, superconducting coaxial lines, a mixing chamber and various circuits. It resembles a fancy chandelier.

How far along is quantum computing?

In May 2016, IBM became the first company to put a quantum computer on the cloud, where anyone with the computing know-how could run experiments.

Currently, more than 150 billion programs and executions have been run on IBM's quantum machines, by more than 200,000 registered users in over 140 countries. There are over 12,000 monthly active users, and, on a typical day, the machines on the cloud run over 400 million quantum circuits.

IBM says it has signed contracts around quantum with more than 100 universities, national laboratories and companies.

For example, quantum researchers at IBM are teaming up with counterparts at Mercedes-Benz parent Daimler to develop next-generation batteries for electric vehicles. IBM is also partnering with Delta Air Lines to explore quantum opportunities in the travel business.

This past October, Google said it achieved what's been described as "quantum supremacy." It was able to perform a calculation in 200 seconds that supposedly would take a classic state-of-the-art supercomputer about 10,000 years to handle.

IBM pushed back. The company argued at the time that an ideal simulation of the same task can be performed on a classical system in 2 1/2 days and with far greater fidelity, which at that it said was a conservative, worst-case estimate.

Gil told U.S. TODAY that "people are not making a distinction of what's a lab experiment, versus what is a real system."

The claims around quantum computing keep coming.

Just this week, Honeywell announced what it said is "the most powerful quantum computer yet," set for a mid-2020 release. Honeywell has formed a strategic partnership with JPMorgan Chase around financial solutions that exploit quantum. JPMorgan is also part of the IBM quantum ecosystem.

But these are still early days. Gil says quantum computing today is in roughly the same spot where artificial intelligence was in 2010.

His IBM colleague Sutor says, "Just to be clear, nobody on the planet has a quantum computer that can today do better that our classical computers."

But IBM says it can double the power of a quantum computer every year, and at some point cross a threshold at which the quantum machines might leap past classical computers, at least to address certain types of problems.

Are there security risks?

There could be. Large future "fault-tolerant" quantum computers—and such computers are not yet around the corner—have the potential to crack current encryption systems. IBM is working with the National Institute of Standards and Technology (NIST) on changing encryption standards that promise to keep quantum systems efficient while at the same time keeping them secure.

Though security threats might be years away, Gil stresses the urgency to

prepare now. "You cannot just sit and ignore the problem," Gil says.

Even years from now, you shouldn't expect to have a quantum computer sitting on your desk.

But the technology made possible by quantum computers will start to insert itself into supporting and making consumer apps more powerful. And society would benefit if quantum computers can stop a potential pandemic before it ever really gets started.

"Nature itself is one great big computer," Sutor says, in the way atoms and molecules and light interact. "Can we learn enough about how it really does it and harness it for our own computing needs with the toughest sort of problems we have?"

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