Why banks like Barclays are testing quantum computing

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Quantum computing — technology based on the principles of quantum theory — is increasingly attracting the interest of financial services firms that are seeking to process transactions, trades and other types of data as fast as possible.

Barclays and JPMorgan Chase have been experimenting with IBM's quantum computing technology since December, when they joined the tech company's Q network. Salvatore Cucchiara at Morgan Stanley last week articulated the bank's hope of speeding up portfolio optimizations like Monte Carlo simulations with the help of quantum computing.

True Positive Technologies, which creates investment strategies for institutional investors with the use of machine learning, has been working with quantum computers since 2014 for portfolio optimization and scenario simulations. Dr. Marcos Lopez de Prado, who founded Guggenheim Partners' Quantitative Investment Strategies business and is now CEO of True Positive, argues that quantum computing will solve financial firms' need for increased computing capacity in the future, while requiring less energy than traditional computers suck up.

"Quantum computing will become increasingly important over time," he said. "In 20 years, quantum computing will not be just an option. It may be our only option, from an energy perspective, let alone from a computational standpoint."

Quantum computing got its start in 1981, but it still feels like science fiction. Quantum chips have to be kept at subzero temperatures in an isolated environment. They promise performance gains of a billion times and more, through the processors' ability to exist in multiple states simultaneously, and therefore to perform tasks using all possible permutations in parallel.

Currently, the chief use case banks and other financial firms see for it relates to investments.

"Banks and financial institutions like hedge funds now appear to be mostly interested in quantum computing to help minimize risk and maximize gains from dynamic portfolios of instruments," said Dr. Bob Sutor, vice president, IBM Q Strategy and Ecosystem. "The most advanced organizations are looking at how early development of proprietary mixed classical-quantum algorithms will provide competitive advantage."

Barclays started getting involved with quantum computing last summer, according to Dr. Lee Braine, from the investment bank's chief technology office.

Lee Braine, Barclays' chief technology office

The bank has an internal working group for quantum computing that includes stakeholders, the CTO's office, statistical modeling teams and others. Some, like Braine, have Ph.D.s in mathematical subjects. They've been writing short quantum programs, uploading them to an IBM quantum computer running on IBM's cloud, and getting results back. Their programs have fallen mainly into two categories.

The first is optimization problems, where a problem faced by Barclays or the industry at large could be solved with the added computing power of quantum chips. For example, they might seek to optimize the settlement of a large batch of transactions that have varying credit, collateral and liquidity constraints.

When banks submit delivery-versus-payment securities transactions (where the buyer's payment for the securities is due at the time of delivery) to a clearinghouse, typically many of those trades can't be settled instantly. Some may not have sufficient credit to go through. Others are just complicated.

"Imagine a trade where the security is being passed from A to B and from B to C," Braine said. "So you've got two transactions: A to B and B to C. If you submit one of the trades first, it may sit there unable to settle until the second trade arrives, then the two of them could settle together because they net out."

A clearinghouse might have 50,000 such trades to consider at any given time.

"By choosing which ones you settle in this batch and which ones you defer the settlement to a subsequent batch, you can increase the efficiency, meaning the value settled," Braine said.

Optimizing that — making the best decisions about which trades to settle when — "is a tough problem and in many cases, because you have a large number of trades, there is no solution that gives you the absolute best answer," Braine said. "It requires more compute power than is available."

Enter quantum computing. A quantum processor with millions of qubits could explore all possible combinations of order settlements in parallel to find the best answer, Braine says. (A qubit, or quantum bit, is the basic unit of quantum information — the quantum version of the classical binary bit.)

enough to solve a problem of this magnitude.

"The types of problems we're looking at require many thousands or millions of qubits," Braine said. "So it's not something you can address practically with real-world data sets at the moment. But it is something where you can come up with a toy solution and you can consider, for example, how to represent a number accurately as a range."

If this use case for the technology gets worked out an adopted, clearinghouses will take advantage of quantum computing to optimize settlement efficiency for their bank members.

"The reason we're exploring this is to give some inspiration to some of the market infrastructure firms of areas they might want to explore," Braine said.

The other category of problems is those that could be modeled by something that happens in nature.

"There aren't many in that category in banking that have a nice, elegant mapping to the natural world of quantum behaviors," Braine said. "Effectively we're making hypotheses."

One example they've considered is that the volatility of a portfolio could be modeled similarly to the surface of the sun.

"People could challenge those assumptions, but if your goal is to conduct an experiment, you need to do something like make those types of assumptions to get the number of qubits you require down from the thousands or millions to the handful you have available," Braine said.

For Barclays, the point of all this work is to learn about what works and what doesn't in quantum computing, to be ready when the technology is ready for prime time.

"We would expect in the longer term as the number of qubits increases, so we can perform more operations during a given period, we will start to reach a sufficient degree of compute power in the quantum processor to start to be able to do practical things," Braine said.

How does he win the time and resources to experiment with technologies where the payoff is so far out? Braine noted that part of the job of a CTO office is spurring innovation. That covers the Barclays accelerator program in London, New York and Tel Aviv as well as Barclays' investment in R3 and blockchain work and these quantum computing experiments.

The payoff comes in being able to provide input and guidance to industry initiatives and help shape them.

Barclays also keeps an eye on the threat side of quantum computing. It's widely believed that when bad actors get their hands on quantum computers, they'll use them to crack existing encryption algorithms. Some, like NIST, say this could happen in the next few years. Others say it's not likely to happen for three decades.

"From a risk perspective, it's good for us to be able to understand that possible threat in the future," Braine said.

Overall, Braine suspects quantum computing might follow the adoption arc of blockchain.

"About four years ago banks started looking at blockchain technology, then the market infrastructure providers started looking at it," he noted.

DTCC is expected to go live next year with its distributed ledger upgrade to its Trade Information Warehouse. CLS, the foreign exchange clearing bank, is doing something similar.

"That started with the banks, and then banks being members of the market infrastructures encouraged them to explore it," Braine said. "Blockchain's time has come. For quantum computing, more research is required."

Quantum computing might be three to five years behind blockchain technology, he surmises.

In the broader world outside banking, Lopez de Prado says quantum computing will change society forever.

"Combined with AI, it will be the most disruptive technology since the invention of the wheel," he said. "Those who do not embrace this new paradigm today will be left behind."

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