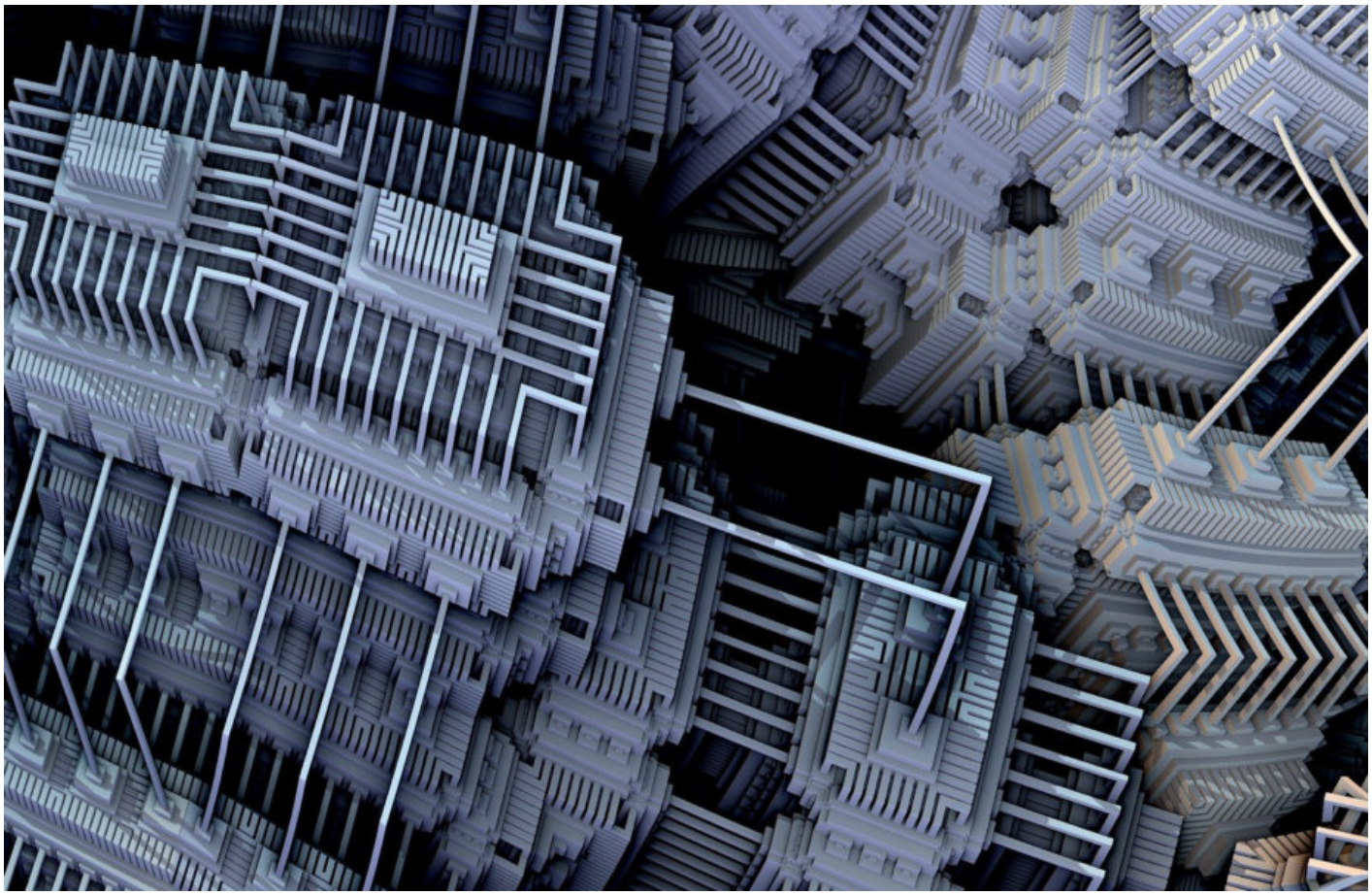
Business Brain: What is quantum supremacy and why should businesses care?



Business Brain is a think tank we've been running for the past three years where we discuss and explore topics on leadership, diversity, performance and neuroscience.

In late 2019, Google announced that it had demonstrated quantum supremacy in a paper published in *Nature magazine*. Google managed to do a computation that took 300 seconds on their quantum computer - the same computation would take 10,000 years on the most powerful supercomputer today.

The press reported that this was a major milestone in quantum computing and would ultimately impact many different aspects of life, from medicine to finance, internet security to artificial intelligence, and even climate change.

Public and the private sector organisations have started to pump money into quantum computing research, with the US and the EU both announcing billion dollar and billion euro funding in the last 18 months. China is reportedly planning a US$10-billion funding, while Japan, Israel, Australia and Singapore all have their own initiatives.

In order to help shed some light on this topic, Augustine Syn*, Senior VP for Europe for a Singapore-based engineering company gave a talk at our Business Brain breakfast roundtable in London.

He explained how quantum computers derive their computing power from the “superposition” and “entanglement” of tiny atoms and electrons, two very strange yet fundamental concepts at the heart of Schrodinger’s Cat paradox and Einstein’s uneasiness about “spooky action at a distance”.

With such power, come both threats and opportunities. While Shor’s quantum-based algorithm can be used to crack today’s internet encryption systems, new powerful quantum-based simulation and optimisation algorithms will revolutionise drug discovery, industrial chemical processes, logistics planning, financial asset management, etc. The following is an excerpt of the presentation which we hope will shed some light on this exciting new field.

So what is so special about a quantum computer?

In a normal classical computer (like your laptop), the 1s and 0s are stored in components called transistors. When the transistor is on, it represents a 1, when it is off, a 0.

In a quantum computer, the 1s and 0s are represented by spinning particles; it could be a single atom or single electron, for example. This is where the strange laws of quantum physics come into play and which make quantum computers so very powerful.

Quantum bits (or qubits for short) can be spinning up and down simultaneously at any one time, meaning they can be both 1 and 0 at the same time, much like a tossed coin spinning in the air.

And by stringing together (or entangling, in the technical jargon) 2 qubits, you effectively have 4 numbers existing at any one time (ie 00, 01, 10, 11). In other words, it is like doing 4 computations in parallel on 4 different computers. Google’s experiment used 53 entangled qubits, which represents 9 quadrillion different numbers (a 1 followed by 15 zeros).

In other words, it was like having 9 quadrillion computers working in parallel!

Implications for cybersecurity

While there are still major challenges in making a stable quantum computer, today's internet traffic can be easily decrypted the day a working quantum computer comes to market. This is because, in the 90s, Peter Shor developed a quantum computer-based algorithm that could break the RSA encryption system which is used to secure today's internet communications.

Researchers are therefore studying new ways to encrypt data that Shor's algorithm cannot crack. Businesses need to start understanding the research in these encryption methods. Rivals might already be intercepting your encrypted data today in the hope of decrypting them one day soon.

Major impact across diverse industries

While the power of quantum computing raises serious concerns about data protection, on the flip side, it is also set to revolutionise industries such as finance, medicine, agriculture, transport and logistics.

In finance

IBM has tested simple quantum computing algorithms to analyse and optimise a financial portfolio of finance assets. They have shown that it is possible to speed up tremendously the risk analysis of a portfolio of bonds and options.

This month, IDC Financial Insight published a two-part series that delves into the world of quantum computing in the context of banking looking at infrastructure and how it's being deployed.

In medicine

Quantum computing will be key to simulating how proteins fold up in living cells. Proteins folding wrongly can lead to diseases. Quantum computers will help pharmaceutical companies to properly simulate protein-folding and design the right medications.

In agriculture

Half the world’s food supply is sustained by ammonia-derived fertilizers produced in huge and expensive industrial plants using the Haber-Bosch process under extreme pressures and temperatures. Quantum computers can simulate how ammonia is produced under normal temperature and pressure conditions.

In transport and logistics

Quantum computers can help find the most efficient way to route people and goods. Using quantum computing techniques, Volkswagen has performed traffic optimisation trials in Beijing and Lisbon while the German Space Agency, DLR, has done work to optimise airport gate assignments.

THE RACE IS ON!

While there are still major challenges to overcome before a working quantum computer appears, researchers around the world are nevertheless making huge progress in terms of improving qubit stability and the number of qubits that can be made to work together.

Google’s recent announcement is giving new impetus and urgency to researchers and governments worldwide. We are witnessing the dawn of a very powerful new technology that will change our lives.

The race is now on!

*Augustine Syn *gave this talk in his personal capacity. Having obtained his Master’s degree in photonics engineering at a French Grande Ecole in the 80s, he has been actively following developments in quantum computing and successfully completed a 16-week online MIT quantum computing course for professionals in 2018.*