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SCL Tea & Tech: "Quantum computing: still waiting for the leap?" with Rebecca Keating

In this week's tea & tech session SCL welcomed Rebecca Keating to talk about quantum computing, what quantum technology can achieve and the legal challenges it poses.

What are quantum computers?

Quantum computers store and process data very differently from classic computers – they manipulate quantum entities such as electrons and harness power to greatly increase processing power.

Classic computers use bits which are either 1s or 0s. Quantum computers use a unit called a qubit which are both.

There are many different ways to build a qubit and they can for example be suspended in laser beams or trapped in a diamond. They use something called super-positioning – Rebecca used the analogy of a coin to explain how they work but effectively whereas a classic computer bit will either be heads or tails, a qubit spins and can be heads, tails or anywhere in between. This provides a wide range of possibilities.

The idea of entanglement is also important for stable quantum computing – if one particle comes up heads, the other one is heads, even if they are separated by thousands of miles. Therefore, you can scale exponentially.

Rebecca used the analogy of a maze to explain further: if you ask a classic computer to work out how to get out of a maze, it will try every single branch in turn, ruling them all out individually until it finds the right one. A quantum computer can go down every path of the maze at once. It can deal with uncertainty.

Therefore, it surpasses the limits of classic computers, can solve intractable problems and be used in areas such as machine learning, large databases, medicine, science and climate change.

Are there problems with qubits?

Yes, there are – the more qubits you add, the more delicate the quantum state becomes. The idea of coherence is key here – where you try to lengthen the timespan in which calculations can be performed – in effect you need to keep the coins spinning. Any heat, light or vibration can undermine the stability of the qubit.

Google has claimed quantum supremacy but what does it mean?

Quantum computers have been around for some years but have not had a great deal of utility during that time. Google uses a chip called Sycamore and claimed that it had made a breakthrough equivalent to the Wright brothers' first flight or the first Sputnik mission. It said that Sycamore had outperformed the most advanced supercomputer, effectively making it look like an

abacus. It did a calculation in three minutes which would have taken the supercomputer 10,000 years. IBM disputed this, and said it was a meaningless test anyway.

IBM is working towards "quantum advantage" where it wants to solve real world, rather than theoretical, problems.

However, regardless of the controversy, Rebecca said that it was a milestone.

She also talked about carbon nanotube chips which can conduct electricity at superfast speeds and could, in time, replace silicon chips.

Why does quantum computing matter for lawyers?

New technology leads to new ways of working which in turn lead to new legal issues in the regulatory sphere, with contracts, and then disputes. The themes are:

- cybersecurity
- data protection
- competition law
- blockchain
- liability.

One of the biggest issues is cybersecurity: quantum computers have the processing power to break codes, so systems could be vulnerable, but on the other hand they can be used for cryptography too, so promise improvements to cybersecurity, for classic computers too.

They could also pose a risk to the integrity of blockchain but on the other hand they are good at dealing with insecurity.

Rebecca also said that lawyers need to consider liability and where the risk falls because the error rate varies between one and ten per cent due to the instability of the technology.

She talked about regulatory activity – in the UK, in 2018, the Enterprise Act 2002 was amended so that the government can intervene in mergers related to quantum technology.

There is also a memorandum of understanding between the UK and Canada on emerging technologies including quantum technologies which allows for investment in those technologies. The EU, US and China are also investing heavily.

What may we see in this field in the next five years?

There is currently a project to build the "unhackable internet" by the University of Technology in Delft. They hope to have a network within four Dutch cities very soon which they say they may be able to scale globally within the next decade.

Some companies are allowing cloud access to their quantum technologies, which, for example, are currently being used for Covid-19 research.

Quantum technologies are unlikely to be used for day to day computing technologies but will be used to solve problems.

Rebecca also discussed ethics and environmental issues, eg the energy use of a quantum computer which is very high but probably comparable with a supercomputer. However, they could also lead to more efficient products to combat climate change.