Brain-like computer chips could address privacy concerns and greenhouse emissions

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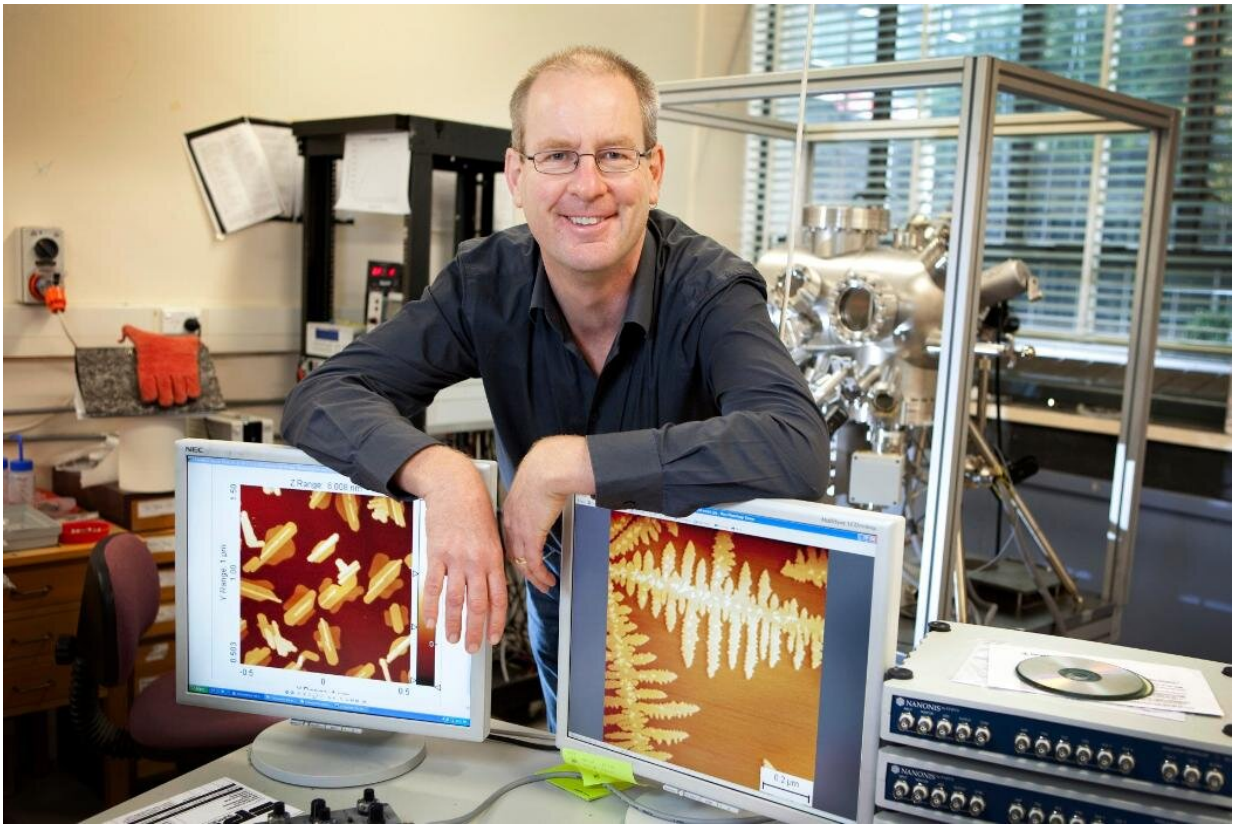

Professor Simon Brown's paper published in prestigious peer-reviewed journal *Science Advances* proves signals on the chips are remarkably like those that pass through the network of neurons in the brain. Credit: University of Canterbury

A team lead by Professor Simon Brown at the University of Canterbury

(UC) has developed computer chips with brain-like functionality, that could significantly reduce global carbon emissions from computing.

Published this week in prestigious peer-reviewed journal *Science Advances*, the paper proves signals on the chips are remarkably like those that pass through the network of neurons in the brain. This is important for building new kinds of computers because the brain is incredibly good at processing information using very small amounts of energy. Brain-like computing could enable "edge computing" and address the ever increasing energy consumption of computers. It would also significantly reduce the amount of data shared with companies like Google and Facebook, and reduce global carbon emissions from computing.

The chips are based on self-organisation of nanoparticles – taking advantage of physical principles at unimaginably small scales, a hundred thousand times smaller than the thickness of a human hair, to make brain-like networks.

The components of this new chip are at the atomic level and are so small they cannot be seen with the naked eye or conventional microscopes, and can only be seen in electron microscopes.

"The research shows that this type of chip really does mimic the signalling behaviour of the brain. We were surprised at the extent to which the avalanches or cascades of voltage pulses on our chips replicate the avalanches of 'action potentials' that are observed in the brain. These are the signals that pass instructions from one 'neuron' to another, and so replicating them is an important step towards being able to make computer chips with brain-like functionality," Professor Brown says.

"These chips might provide a different kind of artificial intelligence. By understanding the underlying fundamental physical processes, we believe

we can design these chips and control their behaviour to do things like pattern or image recognition," he says. "The key is that processing on-chip and with low power consumption opens up new applications that are not currently possible."

Potential applications of on-chip pattern recognition technology can be found in retinal scans on cell phones, robotics, autonomous vehicles and biomedical devices. The team is conscious of concerns about AI and works with social scientists to understand ethical considerations in tandem with the research. It is possible that by allowing more data processing to take place on cell phones, the technology might by-pass concerns about sharing data with big companies like Facebook and Google.

Avalanches and criticality in self-organised nanoscale networks is co-authored by doctoral students Josh Mallinson, Shota Shirai and Edoardo Galli, and postdoctoral fellows Susant Acharya and Saurabh Bose. The research shows the chips are based on self-organisation of nanoparticles – taking advantage of physical principles at unimaginably small scales, a hundred thousand times smaller than the thickness of a human hair, to make brain-like networks.

More information: J. B. Mallinson et al. Avalanches and criticality in self-organized nanoscale networks, *Science Advances* (2019). DOI: 10.1126/sciadv.aaw8438

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