

Machine learning is going on a diet

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Machine learning, a concept where computers learn to solve specific problems by themselves, has been an incredibly rapidly growing field for over a decade. While the achievements are great, the cost of the high-power consumption that goes hand in hand with it is often criticized. A research team at Lund University is working on computer memory technology which might reshape the way machine learning is seen today. The new devices, known as ferroelectric memory devices, are expected to drastically improve the speed of the learning process, while at the same time greatly cutting down the power that is consumed. Learning time and power consumption are the two main drawbacks hindering the development of machine learning. Thanks to the new devices, machine learning will go on a diet.

What's special about the new devices becomes more apparent when compared to the currently used common technology. Most common memory device, Dynamic Random Access Memory (DRAM), can be simplified to a capacitor connected to a transistor. The memory is stored in the capacitor in form of electric charge, while the transistor is used to control the charge flow. If there is charge in the capacitor, it is seen as being "on" and if there isn't, then it is "off". In other words, it is seen as 1 or 0. A problem with these devices is that the charge leaks from the capacitors. If the charge is lost so is the memory state. To combat this, the memory states are erased and refreshed periodically. This method works but it wastes a lot of energy. On top of that, all of the memory is lost the moment the system is powered off. The ferroelectric memory does not have such leaking problems because it does not use capacitors to store a "memory".

Ferroelectricity is a phenomenon where some material has electric polarization which can be changed. It's a rather exotic property so usually such materials have to be custom made. What it means is that the material adopts the properties of an electric field around it and keeps it even after the field is removed. Keeping the field properties is the key in the key in storing data. It was found that changes in polarization have measurable differences which is how the data is stored and retrieved. On top of that, the polarization state stays the same for a long time so there is no need to refresh the memory of the device, unlike DRAM.

We combined these ferroelectric devices with machine learning by using their behavior in machine learning simulations. We trained spiking neural networks (SNNs) to recognize handwritten numbers. Their success rate was only 77 %, however, considering we used very simple networks and we showed that probability-based machine learning is comparable to previous iterations which means this is only the start.

The future of machine learning is looking to be much greener than it currently is. Not only will this benefit the planet, but also might bring advanced technology to us which we are used to only seeing on TV.