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Neuromorphic computing in nanomagnetic arrays

Artificial intelligence is increasingly ubiquitous across tech and broader society. While incredibly powerful, the energy demands of operating deep-learning networks on traditional von Neumann computers are spiralling unsustainably - limiting scalability and presenting a barrier to zero-carbon futures[1]. A huge reason for this is that existing computing architectures look nothing like the brain, and as a result struggle to efficiently run 'neural network' style computing.

Directly implementing machine-learning in complex physical systems is emerging as an attractive low-energy solution to this issue[2]. So-called 'Neuromorphic Computing'[3] takes inspiration from the brain & migrates computing back to the complex physical systems which initially inspired AI[4]. Nanomagnetic arrays are ideal candidates for neuromorphic hardware. They passively store information, providing memory, and perform complex nonlinear processing via magnonics[5], their collective GHz dynamics. Remarkably, the maths powering modern software neural networks originate from theoretical frameworks developed by physicists in the 1970's to describe strongly-interacting magnetic networks[6], with great synergy between the nanomagnets and neural network architectures. The early machine learning community adopted these frameworks (originally termed Hopfield networks[7]) and adapted & refined them into the AI of today. My team at Imperial College London (especially Dr. Kilian Stenning & Dr. Will Branford) recently engineered the world-first example of a functioning neuromorphic computer built from a specific nanomagnetic network[8] termed 'Artificial Spin Ice'. In this talk I'll tell you about this system, our recent progress[9] and new developments.

Short Bio

Jack C. Gartside is a Royal Academy of Engineering Research Fellow in Engineering Magnonic Metamaterials for Low-Energy Neuromorphic Computing. Their team is currently hiring with 2 funded Postdoctoral Researcher positions available & PhD studentships. Email j.carter-gartside13@imperial.ac.uk for info.

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[7] Hopfield, John J. Proc. NAS 79.8 (1982): 2554-2558.
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