Replacing digital neural networks by physical learning machines

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Recent rapid progress in deep learning has coincided with an exponential explosion of the resource requirements. This has inspired the search for alternative so-called neuromorphic hardware architectures, which exploit physical effects to realize learning machines and potentially replace digital artificial neural networks. They promise to be much more energy-efficient and performant, exploiting massive parallelism and distributed computing. In this talk I will introduce the first general approach to training based on purely physical dynamics, a technique we labeled "Hamiltonian Echo Backpropagation". Furthermore, I will present a recent idea where we propose to use purely linear wave scattering to implement nonlinear learning machines.

[1] Lopez-Pastor and Marquardt, Phys. Rev. X 13, 031020 (2023)

[2] Wanjura and Marquardt, arXiv:2308.16181