Machines that Learn via Physical Dynamics

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Recent rapid progress in applications of machine learning has also illustrated that there is an exponential growth of required resources, especially for advanced applications like large-language models. This makes it all the more urgent to explore possible alternatives to current digital artificial neural networks. The field of neuromorphic computing sets itself the goal to identify suitable physical architectures that enable us to perform machine learning tasks in a highly parallel and much more energy-efficient manner. In this talk, I will present two examples from our research in this domain. One important goal is physics-based training. I will introduce the idea of Hamiltonian Echo Backpropagation, which allows to perform both a physics-based version of backpropagation and parameter updates purely via physical dynamics, making it unique among proposed physical learning techniques. In the second part, I will present our recent idea on implementing fully nonlinear neuromorphic computing based on any purely linear wave scattering platform.

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