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Machine learning for the design of magnonic computing devices - and some hints on experimental realization

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The development of magnonic neuromorphic computing devices is greatly hindered by the difficulty in engineering these devices. While it is possible to use wave optics as a starting point for a design [1], this approach is not always helpful as (1) nonlinearities are hard to account for (2) optical devices are generally large and hence may be unrealizable by magnonic devices with limited magnon propagation distances.

Inspired by recent developments in optical metamaterial design [2] we developed a machine learning tool to (almost) automatically design magnonic index of refraction profiles for realizing compact wave-based computing devices. The tool (which we named spintorch) integrates a custom-built micromagnetic simulator into a machine-learning framework [3]. The backpropagation algorithm essentially designs a magnon scatterer to satisfy prescribed design goals. We show how classifiers, linear signal processors can be designed and how magnonic reservoirs can be optimized using this method.

We also show that the design method is versatile and allows to design different variants of the device. For example, the scatterer can be defined by a magnetic dot array (that is placed in top of the film) as described in [2] but also one may use a gradient in the M_s saturation magnetization of the YIG film, which may be much more amenable to experimental realization.

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