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Neural Networks: from Imaging to Nanophotonics Inverse Design

In the last decade neural networks were introduced in many physics workflows with great promise, but after the initial enthusiasm, their limitations started to emerge. Now that the dust is settling, we aim to demonstrate their usefulness in a few specific applications. We explore the deployment of neural networks in two distinct domains: advanced imaging and inverse photonic design. In imaging, specifically ptychography and computer-generated holography, we show that deep learning architectures can dramatically enhance reconstruction quality and speed, even with incomplete data. Beyond imaging, we investigate their potential for inverse photonic design. Here, we demonstrate how neural networks serve not only as fast surrogate models but also as direct optimizers, leveraging automatic differentiation to discover non-intuitive geometries. We discuss the specific advantages and limitations of these optimization-driven strategies.

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