Optical Backpropagation: Training Neural Networks with Light

J Spall[1], X Guo[1], and A Lvovsky[1]

[1]*Department of Physics, University of Oxford, Clarendon Laboratory, Parks Road, Oxford, OX1 3PU, Oxford, UK. Contact Phone: +44 (0) 1865 272200*
Contact Email: alex.lvovksy@physics.ox.ac.uk

Backpropagation, one of the most celebrated algorithms in machine learning, enables neural networks to learn efficiently. Optical implementation of this algorithm allows neural networks to be optically trained with significant potential advantages of optical computing. However, backpropagation through a fully optical neural network remains an outstanding challenge to the field. In this work, we address this challenge for the first time with a surprisingly simple and generic scheme. This is achieved by designing both the optical linear and nonlinear layers properly, and optically backpropagate in a pump-probe process through saturable absorbers that work as optical activation units. Our approach is adaptable to various analog platforms, materials, and network structures, and it represents a significant step forward in the development of optical artificial intelligence for both training and inference tasks.