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Editorial: Editor's challenge in optics and photonics: Advancing electronics with photonics

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Editorial on the Research Topic
Editor' s challenge in optics and photonics: Advancing electronics with photonics

Photonics has the potential to significantly enhance electronics in various areas such as computing and communications [1]. By using photons as the information carrier rather than electrons, photonics can process more data at higher frequencies with less power consumption than conventional electronics [2]. This is particularly evident in the field of photonic computing or photonic neural network [3]. In fact, simple mathematical functions such as matrix multiplication can be performed in photonics quite easily while electronics are power-hungry [4]. As an example, photonic accelerators process TB of information at the speed of light diffusion from a scattering media even in living systems [5, 6]. This is also apparent in integrated photonics where the use of the different wavelengths generated by frequency combs allows the processing of data at TOPS (teraflops operation per second) speed [7–9]. Despite these achievements, there is ample space for improvements when using photonics to complement electronics. In this Research Topic, the different contributions aim at addressing a few of these aspects. In particular, the use of integrated photonics for neural network applications.

First, Xu et al. presented a review of the methods and applications of on-chip beam splitting [10]. These are fundamental components for any photonic integrated circuits since they allow the routing of the photons along different paths. The different principles and the properties of various designs are reviewed and compared.

Then, Mekemeza-Ona et al. introduce the use of Q switched laser to realize photonic spiking neural networks Mekemeza-Ona et al. The paper is a modeling paper where the behavior and design of a side injection laser are discussed to mimic the different statuses of a biological neuron with the advantage of speed (ps), low power, and cascadability.

Another modeling paper by Bauwens et al. proposes to use of photonic delay-based reservoirs as preprocessors for deep neural networks [11]. The idea is to map the input data into a hyperspace on which the following network can more efficiently perform the analysis. A photonic reservoir computing model is used to allow speed and low power in the preprocessor.

The limit of using thermally actuated weights in photonic feed-forward networks is discussed by Biasi et al. In the study, a two-layers network based on silicon photonics is demonstrated as being able to approximate non-linear surjective functions [12]. However, thermal cross-talk among the different network nodes has to be properly managed which might pose serious issues for large photonic integrated networks.

Finally, Ortín et al. get inspiration from the complex biological structures of neurons to implement plasticity in a photonic neural network Ortín et al. As in neurons, where different synapsis contact single dendrites, they have demonstrated a fiber-based optoelectronic dendritic unit where the signal from a superluminescent diode is split into different branches which are then weighted and summed up to yield a GHz plasticity of the network.

In conclusion, these works witness the potential of neuromorphic photonics which gets inspiration from how the brain works and seeks to reproduce the biological paradigm to enable photonics computation.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of interest

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