Intelligent Signal Processing by Neuromorphic Silicon Photonics

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Abstract— State-of-the-art AI algorithms, by and large, are implemented using neural networks, a computational architecture inspired by the neuro-synaptic architecture of the brain. Many new applications nowadays need neural networks to deliver gigahertz bandwidth and low-latency computing. These applications have tight requirements for high throughput, low energy, and low latency. There, the implementation of neural network algorithms in real-time remains a major challenge. Neuromorphic (i.e., neuron isomorphic) photonics [1] promises to tackle these challenges by developing radical new hardware platforms capable of emulating the neural structure of the brain using photonic devices and waveguides. Photonics has unrivaled capabilities for interconnects and communication that may overcome the bandwidth and interconnectivity tradeoffs that electronics essentially suffers from. As a consequence, algorithms operating on neuromorphic photonic hardware may be able to overcome electronic performance bottlenecks and gain advantages in terms of speed, latency, and power consumption while addressing intellectual tasks that are now unattainable by digital electronic platforms [2]. In this talk, we will discuss the applications of neuromorphic photonics in optical [3] and wireless communications [4, 5], an application domain where high speed, sub-nanosecond latencies, and energy efficiency requirements are critical. In these applications, the same operation must be performed repeatedly and rapidly, and the signals to be processed are already in the analog domain. We aim to provide an intuitive understanding of neuromorphic photonics of how it can play a unique role in advancing these applications.

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