Intelligent Optical Signal Processing for Optical Communications

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Abstract: Machine learning can solve many applications in optical communications, but its benefits are largely validated offline using conventional computers. We will introduce a radically new hardware platform, neuromorphic photonics, for machine learning, and review its applications in different optical communication systems.

1. Introduction

Machine learning algorithms, especially using neural network models, have been shown to outperform traditional DSP algorithms in performing many functions in optical communication systems [1]. To date, the benefits of machine learning algorithms are largely validated using conventional computers and conducted offline. Real-time implementation of machine learning algorithms on ASIC chips remains a grand challenge due to the high throughput, low energy, and low latency requirement in optical communication systems.

The emerging field of neuromorphic photonics promises to solve these challenges by creating radical new hardware platforms that emulate the underlying neural network model with photonic devices and circuits [2, 3]. Photonics has unmatched feats for interconnects and communications which can negate the bandwidth and interconnectivity trade-offs that electronic hardware fundamentally suffers. As a result, algorithms running on neuromorphic photonic hardware (i.e., photonic neural networks (PNNs)) could break performance limitations in electronics, and gain advantages in speed, latency, and power consumption in solving intellectual tasks that are unreachable by conventional digital electronic platforms. This could be a major benefit for optical communication systems [4]. This paper will provide a rationale for PNNs as a compelling alternative to process optical communication signals. We will review different PNN approaches, including recurrent PNN and photonic BSS [3–5], and their applications in long-haul and short-reach optical communication systems.

References

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