

Offset-Diagonal Computing for Scalable and Sparsity-Enabled Optical Processors

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Optical processors have emerged recently as attractive alternatives to digital processors because of their intrinsic advantages of large bandwidth, ultra-low loss propagation, and efficient data reuse. Optical processors including MZI meshes, cross-bar arrays, and diffractive neural networks are effective but are very difficult to scale to the large problem sizes in demand today. Time multiplexing approaches ease this challenge, but current systems still require many ($>10^6$) integrated electrical components such as balanced detectors, ADCs, and capacitive integrators. Here we describe the development of a novel optical computing paradigm based on offset-diagonal computations, which is fast, efficient, versatile, and scalable. By introducing a new degree of freedom in optical delay lines, large-scale models can be computed efficiently at high speeds with minimal components. In addition, this talk will describe how this platform is compatible with structured sparse matrices, enabling further reduced energy costs. Experimental demonstrations in agreement with predictions will be presented.