Variational Optical Processors

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Programmable arrays of Mach-Zehnder interferometers (MZI) are a versatile platform for integrated photonics processing. They have found numerous applications across classical and quantum photonics, including boson sampling, inference in deep neural networks, and automatic learning of communication channels. Self-configuring arrays of MZI are particularly convenient since they allow one to learn communication channels with a deterministic and finite set of measurements and reconfigurations. Here, I will review an emerging approach coined "variational optical processing" which consists in mapping modal representations of an incident light field onto a variational optimization of the network's output. Concretely, this means that one can automatically learn broadly defined "modes" of light by optimizing some function of the network's output. I will show how this approach can be used to decompose partially coherent light fields into mutually incoherent components, entangled photons into Schmidt modes, squeezed supermodes, and learn communication channels. Variational optical processing promises to be a versatile approach to analyze classical and quantum optical light fields in various physical settings.