Subwavelength metamaterial devices with optimization and machine learning

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ABSTRACT (250 words):
Subwavelength metamaterials are realized by structuring a dielectric material with a period much smaller than the wavelength. In this way, it is possible to frustrate diffraction and obtain an artificial material with synthesized optical properties tuned for each device of interest. The extensive use of this class of metamaterials especially in (but not limited to) silicon-based photonics allowed to demonstrate a broad range of devices including waveguide-to-fiber couplers, optical antennas, wavelength demultiplexers, mode controllers, and filters with ultra-low losses, large operational bandwidth, complex spectral responses, and compact footprint. While enabling high performance and enhanced scale of integration, the development of metamaterial-based devices with complex topologies often requires to control a large number of interrelated parameters whose manual design can be impractical or lead to suboptimal solutions. Likewise, multiple figures of merit are often involved in the evaluation of the performance of a device, e.g., losses, bandwidth, footprint, or tolerance to fabrication uncertainty, complicating the selection of optimal device design. In this invited talk, we will discuss the potentiality offered by multi-objective optimization and machine learning for the design of high-performance photonic devices based on non-trivial shapes and metamaterials. We will present both integrated devices for on-chip photonic systems as well as recent advances in the development of devices for free-space applications and optical beam control.

ABSTRACT (100 words):
Subwavelength metamaterials allow to synthesize tailored optical properties which enabled the demonstration of photonic devices with unprecedented performance and scale of integration. Yet, the development of metamaterial-based devices often involves a large number of interrelated parameters and figures of merit whose manual design can be impractical or lead to suboptimal solutions. In this invited talk, we will discuss the potentiality offered by multi-objective optimization and machine learning for the design of high-performance photonic devices based on metamaterials. We will present

both integrated devices for on-chip photonic systems as well as recent advances in the development of devices for free-space applications and optical beam control.