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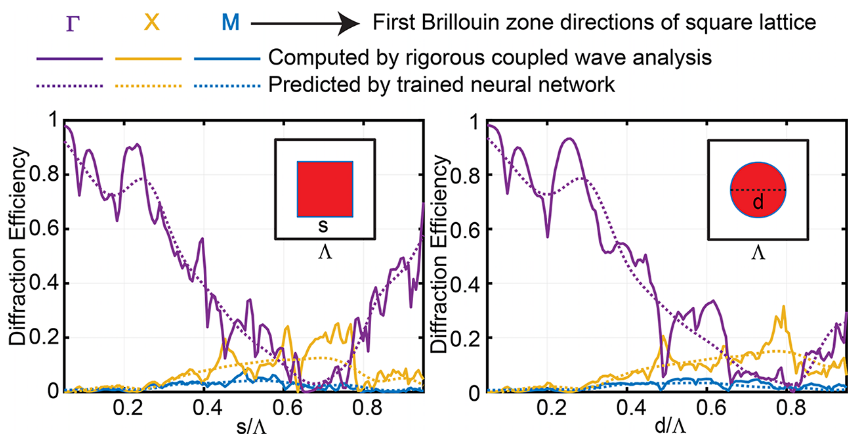
A novel use of neural nets assists in the development of a mathematical relationship between the structural and diffraction properties of metagratings.



Wave manipulation is a fundamental aspect of most optical applications. Optical elements called metagratings are among the newest candidates for tailored wave manipulation with broad applicability for integrated optical devices. Metagratings consisting of ultrathin, uniformly repeating, arbitrarily shaped units whose patterns determine its waveguide behavior. The computation difficulty involved in relating unit shape and far-field intensity patterns, however, still keeps them from broader use.

Research published in *Applied Physics Letters* demonstrates the successful application of neural net algorithms as a method for predicting the diffraction efficiency of a metagrating. Further, using the neural net's predictive abilities in place of full wave Maxwell's equation solvers, while optimizing the design of common optical test cases, reduced the processing time by orders of magnitude.

The authors created a large training set for their neural net algorithm by calculating the diffraction efficiencies of thousands of arbitrarily shaped metagratings, resulting in a collection of diffraction properties as a function of structural characteristics. The algorithm identified patterns in the training set and calculated the weights and biases needed to predict a mathematical relationship between diffraction properties and structural characteristics.

The researchers used this mathematical relationship to predict the diffraction properties of simple canonical and arbitrarily shaped units that were not a part of the training set. This enabled them to compare the neural net's resulting diffraction efficiencies to those generated by regular Maxwell's equations-based solutions. The similarity allowed the researchers to conclude that their interdisciplinary approach is capable of replacing complex differential equations solvers with simple mathematical functions in large multiphysics simulation domains.

Source: "Neural network based design of metagratings," by Sandeep Inampudi and Hossein Mosallaei, *Applied Physics Letters* (2018). The article can be accessed at https://doi.org/10.1063/1.5033327.