

Machine-Learning-Assisted Photonics

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Discovering unconventional optical designs via machine-learning promises to advance on-chip circuitry, imaging, sensing, energy, and quantum information technology. In this talk, we discuss photonic design approaches and emerging material platforms for showcasing machine-learning-assisted topology optimization for optical metasurface designs with applications in thermophotovoltaics, reflective optics, and lightsail technology. We demonstrate the effectiveness of autoencoders for compressing the vast design space of metasurfaces into a smaller search space. By employing global optimization via adjoint methods or quantum annealing, one can find the optimal metasurface designs within the smaller space constructed by the autoencoder. The quantum-assisted machine learning framework, named bVAE-QUBO, presented in this work is the first demonstration of a generic machine learning framework that compresses an arbitrary continuous optimization problem into an Ising-model formalism for quantum sampling. When compared to other global optimization techniques, bVAE-QUBO has the potential for quantum speedups and achieving higher quality designs than traditional adjoint optimization methods. The techniques employed in this work extend well beyond the metasurface optimization space and into many inverse design problems for engineering and physics.