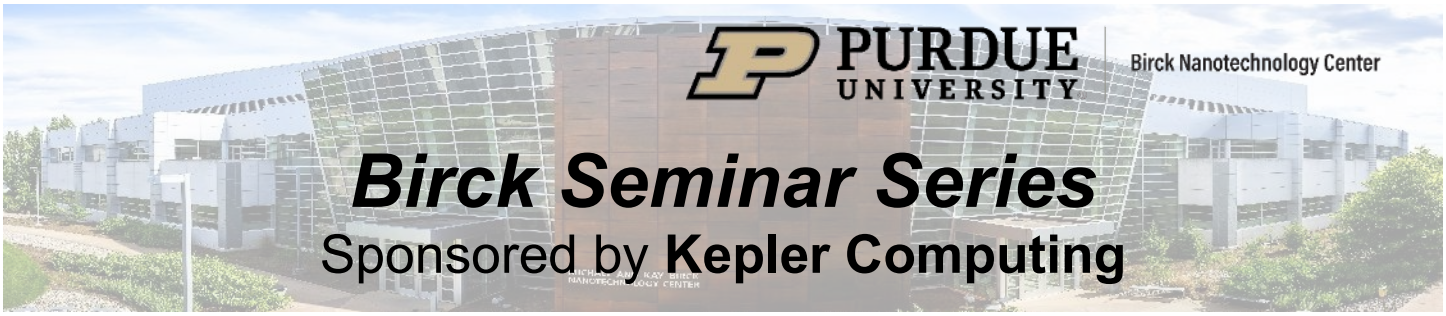

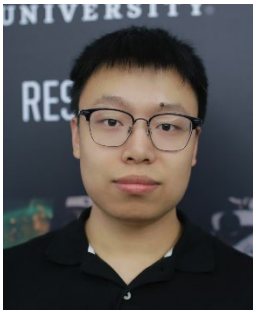

Machine Learning and Quantum-Assisted Inverse Design for Next-Generation Photonics

Yuheng Chen and Vaishnavi Venkatacha Iyer

Elmore Family School of Electrical and Computer Engineering

Wednesday, January 14th @ 2:00 pm in BRK 1001

Coffee and snacks served before seminar

also on MS Teams

Abstract: Machine learning (ML) offers a powerful framework for navigating the high-dimensional design spaces and physical constraints of photonics and quantum optics. We develop a unified set of ML-assisted inverse design approaches for next-generation photonics that integrate data-driven generative models, surrogate-based latent optimization, and solver-in-the-loop adjoint learning. For data-driven methods, a central component is a physics-conditioned multimodal model, where physical figures of merit (FOM) and fabrication constraints are embedded directly into the generative process. It enables prompt-conditioned, fabrication-aware device generation and outperforms prior generative methods significantly for thermophotovoltaic (TPV) metasurface design. In parallel, we introduce two complementary latent optimization frameworks for surrogate-based optimization: a quadratic unconstrained binary optimization (QUBO) approach using binary variational autoencoders and factorization machines to enable hybrid quantum-classical sampling beyond the training distribution, and PearSAN (Pearson Correlated Surrogate Annealing), which enforces monotonic surrogate-FOM correlations via PearSOL (Pearson Correlated Surrogate Optimization Loss) and delivers faster convergence. Alongside these approaches, we investigate reinforcement learning (RL)-based, solver-in-the-loop adjoint optimization for designing multilayer photonic structures incorporating epsilon-near-zero (ENZ) materials, enabling closed-loop, physics-resolved exploration of complex multilayer parameter spaces. Together, these methods form a cohesive toolkit for next-generation photonic and quantum device design.

Bios: Yuheng Chen (5th year Ph.D. candidate) and Vaishnavi Iyer (1st year Ph.D. student) are two rising stars in the nanophotonics research groups of Profs. Vladimir Shalaev and Alexandra Boltasseva at Birck Nanotechnology Center.

Host: Neil Dilley, Research Manager | Email: ndilley@purdue.edu