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AI-assisted experiment design and optimization at the frontiers of computation: new perspectives in fundamental and medical physics

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Designing the next generation colliders and detectors involves solving optimization problems in high-dimensional spaces where the optimal solutions may nest in regions that human experts would normally not explore. Meanwhile, the staggering simulation demands of existing and future high-energy physics facilities call for a new paradigm for event generation and reconstruction.

Differentiable programming offers a path forward. By integrating domain knowledge encoded in simulation software with gradient-based optimization and reinforcement learning, it enables end-to-end experimental design and inference in settings that are intractable with conventional methods.

In this talk I will describe recent results for the AI-assisted optimization of experimental design, with a focus on large-scale simulation software, touching on recent advances in calorimetry with neuromorphic hardware architectures, and on medical applications, paving the way to more complex challenges.

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