Abstract

The intersection of quantum science and AI holds transformative potential for tackling some of the most challenging problems in both fields. Quantum algorithms, particularly in quantum optimization and quantum machine learning, offer powerful solutions to problems that surpass the limits of classical computational methods. Conversely, AI techniques also provide innovative tools to address complex questions in quantum physics. In this talk, I will mainly focus on two key applications of quantum optimization and quantum machine learning: (1) detecting Bell-operator correlations and (2) quantum delegated learning, highlighting their implications for both fundamental physics and practical tasks. Additionally, I will explore how classical optimization and AI algorithms contribute to advancing quantum physics, such as by establishing optimizable mappings between Bell inequalities and Hamiltonians, and enabling efficient quantum circuit compilation for many-body experiments. Finally, I will outline future research directions in this exciting field, emphasizing the mutual enrichment of quantum science and AI.