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AI and ML at the future Electron Ion Collider

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The Electron Ion Collider (EIC) promises unprecedented insights into nuclear matter and quark-gluon interactions, with advances in artificial intelligence (AI) and machine learning (ML) playing a crucial role in unlocking its full potential. This talk will explore potential opportunities for AI/ML integration within the EIC program, drawn from broader discussions in the AI4EIC forum. I will begin by exploring the impact of AI-assisted detector design for future EIC experiments and its broader applications in future nuclear and high-energy physics experiments. These AI-driven methods have the potential to optimize detector performance and push experimental design beyond traditional limits. I will focus on how ML enhances event-level reconstruction and particle identification (PID), particularly for Cherenkov detectors, a key technology at EIC energy scales. I will demonstrate how ML models enable faster simulations and reconstruction, improving data analysis efficiency and expanding physics reach. I will also discuss the use of machine learning in kinematic reconstruction for key reaction mechanisms at the EIC, including deep learning to address uncertainty quantification, which is crucial for interpreting precise measurements. As an example, I will highlight its application in Deep Inelastic Scattering. If time permits, I will briefly mention the community's efforts in streaming readout and its potential for real-time AI/ML applications, therefore introducing the subsequent talk on real-time PID and tracking in nuclear physics. This talk highlights the transformative role of AI/ML at the EIC, addressing key computational challenges and emphasizing their broader scientific impact on nuclear and particle physics.

Focus areas

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