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Advanced Neural Network Applications in Heavy-Ion Physics: From Track Search to Quark-Gluon Plasma Analysis

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The rapid advancement of artificial intelligence (AI) in recent years has catalyzed its exploration for data processing and analysis in high-energy and heavy-ion physics. In this presentation we investigate the properties of various neural network architectures and their potential applicability in heavy-ion physics experiments. A critical aspect of this study is the compatibility and integration of AI methods with conventional approaches currently employed in ongoing and upcoming experiments.

Focusing on the CBM (FAIR/GSI) experiment, we demonstrate the feasibility of utilizing neural networks in three key areas of data processing and analysis:
1. Identifying particle tracks in detector systems with high track multiplicity,
2. Detecting rings in a RICH detector within regions of high ring density,
3. Analyzing properties of colliding matter and the formation of quark-gluon plasma.

In the first area, we explore how neural networks can efficiently process complex data from high-multiplicity events, improving the accuracy of particle track reconstruction. Traditional algorithms often struggle under these conditions, whereas neural networks offer additional solutions by learning from large datasets.

In the second area, we address the challenges of ring detection in RICH detectors, where high ring density can complicate accurate identification. Neural networks are trained to recognize intricate patterns within the data, enhancing the precision of ring detection and reducing false positives. This improvement is crucial for experiments where high-resolution imaging is essential for accurate data interpretation.

The third area involves the analysis of colliding matter properties and the formation of quark-gluon plasma, a state of matter created under extreme conditions. By applying neural networks to this domain, we can extract subtle features and correlations from experimental data, providing deeper insights into the dynamics of heavy-ion collisions and the behavior of quark-gluon plasma.

We will present and discuss the detailed results of applying neural networks to these areas, leveraging the PHSD model within the CBM experiment. The findings highlight the potential of neural networks to enhance data analysis capabilities in high-energy and heavy-ion physics. The integration of AI not only complements existing methodologies but also paves the way for new discoveries and more efficient data processing techniques, ultimately advancing our understanding of fundamental physics.

Internet talk

No

Is this an abstract from experimental collaboration?

Yes

Name of experiment and experimental site

CBM

Is the speaker for that presentation defined?

Yes

Details

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