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Deep learning methods for noise filtering in the NA61/SHINE experiment.

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The NA61/SHINE experiment is a prominent venture in high-energy physics, located at the SPS accelerator within CERN. Recently, the experiment's physics program has been extended, which necessitated the upgrade of detector hardware and software for new physics purposes.

The upgrade included a fundamental modification of the readout electronics (front-end) in the detecting system core of the NA61/SHINE, namely the time projection chambers (TPCs). This improvement increased data flow rates, raising them from 80 Hz to 1.7 kHz.

In light of the significant increase in the amount of data collected, it has become necessary to implement an online noise filtering tool.

Traditionally, this task has relied on the reconstruction of particle tracks and the subsequent removal of clusters that lack association with any discernible particle trajectory. However, it's important to acknowledge that this method consumes a noteworthy amount of time and computational resources.

In the year 2022, the initial dataset was collected through the utilization of the upgraded detector system. In relation to this data, a collection of machine learning models was developed, employing two distinct categories of neural networks: dense and convolutional networks (DNN, CNN). Of utmost significance is the seamless integration of these trained models into the existing NA61/SHINE C++ software framework, utilizing the capabilities of the TensorFlow C++ library. Furthermore, to facilitate easier deployment, containerization using Docker was applied. It is production ready.

This presentation aims to unveil the results attained through the application of these algorithms for noise reduction, encompassing training times for both CNN and DNN models, post-filtering data reconstruction duration, and the Receiver Operating Characteristic (ROC) analysis of the CNN-filtered data. During this presentation, we intend to unveil the outcomes yielded by the application of these algorithms for noise filtration. Additionally, we will delve into the time performance of these models, offering insights into various pertinent metrics.

We will compare the results of reference invariant mass spectra generated with and without the ML noise rejection and draw the conclusions on the influence of employed ML methods on the physical results.

Significance

The incremental updates of an important project are: integration of these trained models into the existing NA61/SHINE C++ software framework, utilizing the capabilities of the TensorFlow C++ library, test of the methods on new, 2022 data, comparison of the results of reference invariant mass spectra generated with and without the ML noise rejection.

References

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Experiment context, if any

NA61/SHINE CERN

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