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Deep learning the physics of heavy-ion collisions at the CBM experiment with PointNet

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Deep Learning methods are a popular tool for efficient and fast data analysis in high energy/ nuclear physics experiments. The upcoming Compressed Baryonic Matter (CBM) experiment will study nuclear-nuclear collisions in the range of 10- 40 AGeV at an unprecedented event rate of up to 10MHz, creating about 1TB/s of raw data. In order to run the experiment to its full potential, novel methods for event characterisation and subsequent data analysis are necessary. In this talk, we show that PointNet based DL models are an ideal candidate for such tasks on experimental data with minimal pre-processing. We demonstrate that PointNet based models can perform, event-by-event impact parameter reconstruction at CBM experiment using directly the hits/ tracks of particles from the detector planes [1, 2]. The models have their mean error varying from -0.33 to 0.22 fm for impact parameters 2-14 fm and outperform conventional methods based on a single observable such as track multiplicity. We also show that PointNet models can accurately identify the nature of QCD transition at the CBM experiment [3]. The DL models distinguish a first order phase transition from a crossover transition using the reconstructed tracks of charged particles with an accuracy of up to 99.8%. The models are also shown to outperform methods relying on conventional mean observables.

References

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[2] Omana Kuttan, M., Steinheimer, J., Zhou, K., Redelbach, A., & Stoecker, H. (2021). Deep Learning Based Impact Parameter Determination for the CBM Experiment. Particles, 4(1), 47-52.

[3] Omana Kuttan, M., Zhou, K., Steinheimer, J., Redelbach, A., & Stoecker, H. (2021). An equation-of-state-meter for CBM using PointNet. Journal of High Energy Physics, 2021(10), 1-25.

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