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PointNet for fast event characterisation in heavy-ion collision experiments

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A major challenge for the upcoming heavy-ion collision programmes around the world is to develop fast, accurate techniques to analyze the large amounts of data produced in the experiments. Novel data analysis techniques are necessary in the experiments to quickly identify events with interesting physics for further analyses and permanent storage. In this talk, we show that PointNet based Deep Learning (DL) models can be deployed for online event characterisation in heavy-ion collision experiments. In particular, 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
[1] Omana Kuttan, M., Steinheimer, J., Zhou, K., Redelbach, A., & Stoecker, H. (2020). A fast centrality-meter for heavy-ion collisions at the CBM experiment. Physics Letters B, 811, 135872

[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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