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Advances in developing deep neural networks for finding primary vertices in proton-proton collisions at the LHC

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We have been studying the use of deep neural networks (DNNs) to identify and locate primary vertices (PVs) in proton-proton collisions at the LHC. Earlier work focused on finding primary vertices in simulated LHCb data using a hybrid approach that started with kernel density estimators (KDEs) derived from the ensemble of charged track parameters and predicted "target histograms"from which the PV positions are extracted. We have recently demonstrated that using a UNet architecture performs indistinguishably from a "flat"convolutional neural network model and that "quantization", using FP16 rather than FP32 arithmetic, degrades its performance minimally. We have demonstrated that the KDE-to-hists algorithm developed for LHCb data can be adapted to ATLAS data. Finally, we have developed an "end-to-end"tracks-to-hists DNN that predcits target histograms directly from track parameters using simulated LHCb data that provides better performance (a lower false positive rate for the same high efficiency) than the best KDE-to-hists model studied.

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