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Harnessing the power of neural networks to identify and locate primary vertices in proton-proton collision data

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Extensive research has been conducted on deep neural networks (DNNs) for the identification and localization of primary vertices (PVs) in proton-proton collision data from ATLAS/ACTS. Previous studies focused on locating primary vertices in simulated ATLAS data using a hybrid methodology. This approach began with the derivation of kernel density estimators (KDEs) from the ensemble of charged track parameters, employing an analytical probability density estimation technique. These KDEs were subsequently utilized as input for two neural network (NN) architectures, namely UNet and UNet++, alongside the truth PV positions extracted in the form of target histograms from the simulated data. Through these investigations, a proof-of-concept was demonstrated, achieving performance comparable to the ATLAS Adaptive Multi-Vertex Finder (AMVF) algorithm, while also enhancing the vertex position resolution.

The current studies transition from analytical KDE computation to a fully NN-based implementation, presenting an end-to-end primary vertex finder algorithm driven by neural networks. A comprehensive analysis of this approach, including a comparative assessment of its performance against the AMVF algorithm, will be presented.

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