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Towards Novel Charged Particle Tracking Approaches with Transformer and U-Net Models

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Inspired by the recent successes of language modelling and computer vision machine learning techniques, we study the feasibility of repurposing these developments for particle track reconstruction in the context of high energy physics. In particular, drawing from developments in the field of language modelling we showcase the performance of multiple implementations of the transformer model, including an autoregressive transformer with the original encoder-decoder architecture, and encoder-only architectures for the purpose of track parameter classification and clustering. Furthermore, in the context of computer vision we study a U-net style model with submanifold convolutions, treating the event as an image and highlighting those pixels where a hit was detected.

We benchmark these models on simplified training data utilising a recently developed simulation framework, REDuced VIrtual Detector (REDVID). These data include noisy linear and helical track definitions, similar to those observed in particle detectors from major LHC collaborations such as ATLAS and CMS. We find that the proposed models can be used to effectively reconstruct particle tracks on this simplified dataset, and we compare their performances both in terms of reconstruction efficiency and runtime. As such, this work lays the necessary groundwork for developments in the near future towards such novel machine learning strategies for particle tracking on more realistic data.

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