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Graph Data Structures and Graph Neural Networks in High Energy Physics with the ExaTrkX Project

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We present a set of techniques studied by the ExaTrkX collaboration for classification and regression of large scale high energy physics data. Using graph structures and geometric machine learning, we observe excellent performance with particle tracking algorithms on silicon trackers and high-granularity calorimeters for HL-LHC, as well as LArTPCs for neutrino experiments. Promising future research directions include jet reconstruction, particle identification, and particle flow algorithms. We argue that these techniques are viable solutions to the scaling problem of traditional track finding algorithms in the era of experiments such as the HL-LHC, and present results of performance scaling against collision event size. We also argue for the use of heterogeneous solutions, such as distributing training and inference across CPUs, GPUs and TPUs.

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