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Self-supervised learning of jets using a realistic detector simulation

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Self-supervised learning (SSL) is a technique to obtain descriptive representations of data in a pretext task based on unlabeled input. Despite being well established in fields such as natural language processing and computer vision, SSL applications in high energy physics (HEP) have only just begun to be explored. Further research into SSL in the context of HEP is especially motivated given the potential to leverage enormous datasets collected by LHC experiments for training without labels. We demonstrate an SSL model of jet representations and its ability to express both global information and jet substructure. Furthermore, we investigate how SSL representations derived from low-level detector features can be used to search for exotic or anomalous jets in a largely unsupervised way. Going beyond the few existing studies in this direction, we conduct our studies using a realistic, state-of-the-art calorimeter simulation, such that our results are representative of possible future applications at collider experiments.

Brainstorming idea [title]

Connecting partons and particles with ML

Brainstorming idea [abstract]

Machine learning has been applied to most areas of the forward and inverse problem in collider physics (see [1]). Arguably the most nebulous region remains the string of processes connecting partons on one end and truth-level particles on the other. Recent ML models for hadronization, parton-level unfolding, and reconstructing event topology have shed light in this area, and prompt some intriguing questions: What exactly is possible to learn for fully-supervised models of these processes or their inverse? Which of the restrictions are imposed by truly physical principles and which of them simply reflect limitations in our theoretical calculations, e.g. of soft QCD? Can we make progress using unsupervised learning or other approaches learning directly from experimental data?

[1] Machine learning and LHC event generation, A. Butter et al. (2023) doi:10.21468/SciPostPhys.14.4.079

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