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Explainable machine learning of parton shower mechanisms

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A parton shower model is presented that is explainable and physics aware, and trainable solely based on the energy-momentum vectors of final state particles [1]. We show that it is possible to use such a white box AI approach to train a generative–adversarial network (GAN) from a DGLAP-based parton shower Monte Carlo, where the inferred mechanisms can be fully understood by a human physicist. For the first time, we demonstrate how the resulting network not only reproduces the final distribution of particles, but is also able to deduce the underlying branching mechanism, including the Altarelli–Parisi splitting function, the ordering of the shower, and the scaling behavior. While our proof-of-concept is focused on the perturbative physics of the parton shower, we see broad applicability of this approach to investigate areas of the QCD that are difficult to address from first principles. This includes nonperturbative and collective effects, factorization breaking and modification of the parton shower in heavy-ion settings, and electron–nucleus collisions.

[1] Y. Lai, D. Neill, M. Płoskoń, F. Ringer, arXiv:2012.06582 [hep-ph], accepted by Phys. Lett. B

In-person participation

No

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