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Encoding collider events with pre-trained jet models

Current physics measurements at the LHC rely on event selection based on modularized objects, such as jets and leptons. While modern deep learning algorithms have significantly improved jet tagging capabilities, their uses have been largely separated from event-level selections. Conversely, the holistic event-level neural networks employed in current analyses use less sophisticated jet information compared to what is available from advanced jet tagger models. These suggest the potential for further advancements in discriminating between signal and background events.

In this study, we demostrate a viable and promising approach that utilizes pre-trained jet models to encode collider events. Our methodology involves initially pre-training jet tagging models with the ParT architecture to capture a high-dimensional, comprehensive representation of jets, followed by the integration of these models into an event-level neural network. This network also incorporates inputs from other event objects. Through examples of searching for single and di-Higgs signatures, where the Higgs decays into $b\bar{b}$, we demonstrate our method's superior background rejection capabilities against other standard model processes. Importantly, we illustrate that the pre-trained model can be designed to adhere to infrared and collinear (IRC) safety, indicating a significant advancement over traditional methods that rely on theory-inspired jet substructure observables. Furthermore, our approach maintains the modularity of analysis strategies, ensuring the feasibility of per-object calibrations.

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