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Automated Collider Event Analysis, Plotting, and Machine Learning with AEACuS, RHADAManTHUS, and MInOS

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A trio of automated collider event analysis tools are described and demonstrated. **AEACuS** interfaces with the standard MadGraph/MadEvent, Pythia, and Delphes simulation chain, via the Root file output. An extensive algorithm library facilitates the computation of standard collider event variables and the transformation of object groups (including jet clustering and substructure analysis). Arbitrary user-defined variables and external function calls are also supported. An efficient mechanism is provided for sorting events into channels with distinct features. **RHADAManTHUS** generates publication-quality one- and two-dimensional histograms from event statistics computed by AEACuS, calling MatPlotLib on the back end. Large batches of simulation (representing either distinct final states and/or oversampling of a common phase space) are merged internally, and per-event weights are handled consistently throughout. Arbitrary bin-wise functional transformations are readily specified, e.g. for visualizing signal-to-background significance as a function of cut threshold. **MInOS** implements machine learning on computed event statistics with XGBoost. Ensemble training against distinct background components may be combined to generate composite classifications with enhanced discrimination. ROC curves, as well as score distribution, feature importance, and significance plots are generated on the fly. Each of these tools is controlled via instructions supplied in a reusable card file, employing a simple, compact, and powerful meta-language syntax.

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