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Exploring machine learning methods for unbinned data analysis of Drell-Yan phase space at CMS

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Analyses performed on data from high energy experiments aim to describe the nature of processes ruling high energy collisions and compare the results with theoretical predictions. To ensure reproducibility of results and reliable comparisons between different experiments, a common representation is needed where the real values of observables are determined with the least possible uncertainty. Such representation is often achieved by performing the unfolding of distributions obtained from experimental data using previous knowledge from Monte Carlo(MC) event generation and detector simulations. One of the most popular methods for unfolding is the Iterative Bayesian Unfolding (IBU) which uses prior weights to iterative improve the accuracy of "true"spectra. Along with corrections for detector effects, efficiency and acceptance corrections are also estimated from MC. Unfolding traditionally considers one binned observable at a time, and only those used later in the analysis, hence leaving out important information about detector effect such as extra observables or the relations between them. A method called OmniFold naturally incorporates information from the full phase space to iteratively reweight MC unbinned data into more realistic values by using machine learning to extract abstract relations from observables. This work exploits the advantages of OnmiFold method to generate an unbinned and unfolded phase space from which to calculate new observables of interest. Many new observables are proposed as more robust against statistical fluctuations and theoretical divergences, such as ϕ^* which is fully determined by angular measurements and its uncertainty is reduced at low p_T, where perturbative quantum chromo dynamics fails to accurately describe experimental data.

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