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Neural Empirical Bayes: Source Distribution Estimation and its Applications to Simulation-Based Inference

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We study the problem of retrieving a truth distribution from noisy observed data, often referred to as unfolding in High Energy Physics, which facilitates comparisons with theoretical predictions, and thus aids the process of scientific discovery. Our simulation-based inference technique, which we call Neural Empirical Bayes (NEB), combines Empirical Bayes, also known as maximum marginal likelihood, with deep generative modeling. This approach allows us to unfold continuous multidimensional distributions, in contrast to traditional approaches that treat unfolding as a discrete linear inverse problem. We show that domain knowledge can be easily introduced into our method, which is highly beneficial for efficiently finding solutions to these ill-posed inverse problems. We demonstrate the applicability of NEB in the absence of a tractable likelihood function, which is typical of scientific fields relying on computer simulations.

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