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Optimal dataset-wide inference in the presence of systematic uncertainties

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Real-world datasets often comprise sets of observations that collectively constrain the parameters of an underlying model of interest. Such models typically have a hierarchical structure, where "local" parameters impact individual observations and "global" parameters influence the entire dataset. In this talk we introduce Bayesian and Frequentist approaches for optimal dataset-wide probabilistic inference in cases where the likelihood is intractable, but simulations can be realized via forward modeling. We construct neural estimators for the likelihood(-ratio) or posterior and show that explicitly accounting for the model's hierarchical structure can lead to tighter parameter constraints. We illustrate our methods using case studies from particle physics and astrophysics.

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