Likelihood-Free Frequentist Inference — Constructing Confidence Sets with Correct Conditional Coverage

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Abstract
Many areas of science make extensive use of computer simulators that implicitly encode likelihood functions of complex systems. Classical statistical methods are poorly suited for these so-called likelihood-free inference (LFI) settings, outside the asymptotic and low-dimensional regimes. Although new machine learning methods, such as normalizing flows, have revolutionized the sample efficiency and capacity of LFI methods, it remains an open question whether they produce reliable measures of uncertainty. We present a statistical framework for LFI that unifies classical statistics with modern machine learning to: (1) efficiently construct frequentist confidence sets and hypothesis tests with finite-sample guarantees of nominal coverage (type I error control) and power; (2) provide practical diagnostics for assessing empirical coverage over the entire parameter space. We refer to our framework as likelihood-free frequentist inference (LF2I). Any method that estimates a test statistic, like the likelihood ratio, can be plugged into our framework to create valid confidence sets and compute diagnostics, without costly Monte Carlo samples at fixed parameter settings. In this work, we specifically study the power of two test statistics (ACORE and BFF), which, respectively, maximize versus integrate an odds function over the parameter space. Our study offers multifaceted perspectives on the challenges in LF2I. This is joint work with Niccolo Dalmasso, David Zhao and Ann B. Lee.

References

[1] N. Dalmasso, D. Zhao, R. Izbicki, A. B. Lee. *Likelihood-Free Frequentist Inference: Bridging Classical Statistics and Machine Learning in Simulation and Uncertainty Quantification*. Preprint at ArXiv: 2107.03920, 2021.