Bayesian score calibration for approximate models

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Abstract
Scientists continue to develop increasingly complex mechanistic models to reflect their knowledge more realistically. Statistical inference using these models can be challenging since the corresponding likelihood function is often intractable and model simulation may be computationally burdensome. Fortunately, in many of these situations, it is possible to adopt a surrogate model or approximate likelihood function. It may be convenient to conduct Bayesian inference directly with the surrogate, but this can result in bias and poor uncertainty quantification. In this paper we propose a new method for adjusting approximate posterior samples to reduce bias and produce more accurate uncertainty quantification. We do this by optimizing a transform of the approximate posterior that maximizes a scoring rule. Our approach requires only a (fixed) small number of complex model simulations and is numerically stable. We demonstrate good performance of the new method on several examples of increasing complexity.

References

[1] J. Bon, D.J. Warne, D. J. Nott, C. Drovandi. Bayesian score calibration for approximate models. Preprint at *ArXiv*: 2211.05357, 2023.