ID de Contribution: **3** Code de contribution: **Confirmed** Type: **Talk (submitted)**

Truncated Marginal Neural Ratio Estimation with swyft

jeudi 21 avril 2022 15:55 (15 minutes)

Parametric stochastic simulators are ubiquitous in science, often featuring high-dimensional input parameters and/or an intractable likelihood. Performing Bayesian parameter inference in this context can be challenging. We present a neural simulation-based inference algorithm which simultaneously offers simulation efficiency and fast empirical posterior testability, which is unique among modern algorithms. Our approach is simulation efficient by simultaneously estimating low-dimensional marginal posteriors instead of the joint posterior and by proposing simulations targeted to an observation of interest via a prior suitably truncated by an indicator function. Furthermore, by estimating a locally amortized posterior our algorithm enables efficient empirical tests of the robustness of the inference results. Since scientists cannot access the ground truth, these tests are necessary for trusting inference in real-world applications. We perform experiments on a marginalized version of the simulation-based inference benchmark and two complex and narrow posteriors, highlighting the simulator efficiency of our algorithm as well as the quality of the estimated marginal posteriors.

Our implementation of the above algorithm is called swyft. It accomplishes the following items: (a) estimates likelihood-to-evidence ratios for arbitrary marginal posteriors; they typically require fewer simulations than the corresponding joint. (b) performs targeted inference by prior truncation, combining simulation efficiency with empirical testability. (c) seamless reuses simulations drawn from previous analyses, even with different priors. (d) integrates dask and zarr to make complex simulation easy.

Relevant code and papers can be found online here:
https://github.com/undark-lab/swyft
https://arxiv.org/abs/2107.01214

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Classification de Session: Talks