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Fast nested sampling with deep neural network model emulators

Elaborate simulations of physical systems can be approximated by deep learning model emulators, aka surrogate models, based on training data generated from the full model. Because of powerful deep learning libraries and the enormous speed-up to compute model components or the full likelihood, model emulators becoming more common in astronomy. An interesting computational property of deep neural networks on GPU/CPU/TPUs is that the evaluation cost with one model instance is almost the same as the evaluation cost of hundreds of model instances. JAX-based models are limited to a fixed number of model instances. Tailored to this emulator computational model, I will present three new Bayesian inference algorithms based on nested sampling, implemented in UltraNest. Two enable rapid inference in physical systems with 100 or more parameters, currently powering inference on supernova explosions. The third provides robustness guarantees and is ideal low-dimensional inference of many data sets. This is common in large astronomical surveys, and in heavy use in systematic eROSITA and XMM X-ray data analyses.

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