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Learning Optimal and Interpretable Summary Statistics of Galaxy Catalogs with SBI

How much cosmological information can we reliably extract from existing and upcoming large-scale structure observations? Many summary statistics fall short in describing the non-Gaussian nature of the late-time Universe in comparison to existing and upcoming measurements. We demonstrate that we can identify optimal summary statistics and that we can link them with existing summary statistics. Using simulation based inference (SBI) with automatic data-compression, we learn summary statistics for galaxy catalogs in the context of cosmological parameter estimation. By construction these summary statistics do not require the ability to write down an explicit likelihood. We demonstrate that they can be used for efficient parameter inference. These summary statistics offer a new avenue for analyzing different simulation models for baryonic physics with respect to their relevance for the resulting cosmological features. The learned summary statistics are low-dimensional, feature the underlying simulation parameters, and are similar across different network architectures. To link our models, we identify the relevant scales associated to our summary statistics and we are able to match the summary statistics to underlying simulation parameters across various simulation models.

AI keywords

simulation-based inference; graph neural networks; informative summary statistics

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Track Classification: Inference & Uncertainty