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Unbiased likelihood-free inference of the Hubble constant from light standard sirens

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Late-time measurements of the Hubble Constant (H0) are in strong disagreement with estimates provided by early-time probes. As no consensus on an explanation for this tension has been reached, new independent measurements of H0 are needed to shed light on its nature. In this regard, multi-messenger observations of gravitational-wave standard sirens are very promising, as each siren provides a self-calibrated estimate of its luminosity distance. However, H0 estimates from such objects must be proven to be free from systematics, such as the Malmquist bias. In the traditional Bayesian framework, accounting for selection effects in the likelihood requires calculation of the fraction of detections as a function of the model parameters; a potentially costly and/or inaccurate process. This problem can be bypassed by performing a fully simulation-based and likelihood-free inference (LFI), training neural density estimators to approximate the likelihood-function instead. In this work, I have applied LFI, coupled to neural-network-based data compression, to a simplified light standard siren model for which the standard Bayesian analysis can also be performed. I have demonstrated that LFI provides statistically unbiased estimates of the Hubble constant even in presence of selection effects, and matches the standard analysis's uncertainty to 1-5%, depending on the training set size.

Auteur principal: GERARDI, Francesca (UCL)

Orateur: GERARDI, Francesca (UCL)

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