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Rapid parameter estimation of compact binary sources using a meshfree approach

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The LIGO community uses Bayesian inference extensively to estimate the parameters of gravitational wave (GW) signals recorded in the network of interferometric detectors. The enhanced sensitivities of the upcoming and future detectors would have two-fold consequences, the increased computational cost of parameter estimation (PE) and the large detection rate. Therefore, it becomes imperative to develop techniques to accelerate the PE to prioritize the limited observational resources for EM follow-ups. In this work, we demonstrate a computationally efficient method to rapidly estimate the posterior distribution of source parameters using mesh-free interpolation aided by dimensional reduction techniques. In our approach, we bypass the waveform generation at any sampling point and directly estimate the likelihood values via our interpolation scheme over the likelihood surface. We report a maximum speedup of ˜ 4000 at a negligible loss of accuracy ˜ $O(10^{-5})$ for a single detector and project a maximum speedup of ˜ 650 at a similar accuracy for a network of three detectors across the different compact binary systems in comparison to traditional techniques of PE. Moreover, our scheme is generic and can be applied across various fields wherever Bayesian inference is employed to reconstruct model parameters.

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