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Scalable Bayesian Inference for Third-Generation Gravitational Wave Data with Normalizing Flows

Third-generation (3G) gravitational wave (GW) observatories will unveil a cosmic orchestra, detecting thousands of sources annually. However, their increased detection rate poses a major challenge for data analysis. Existing, widely used techniques to obtain the source parameters are prohibitively expensive, creating a bottleneck for extracting scientific insights from 3G detector data. We present ongoing developments of an efficient data analysis pipeline that leverages normalizing flows and hardware accelerators. As an example, we demonstrate Bayesian inference of GW data from binary neutron star mergers, their electromagnetic counterparts, and their implications for nuclear physics, reducing the computational cost from months to a couple of hours. Moreover, our approach enables joint parameter estimation of overlapping GW signals within a few hours. Our methods hold strong promise in meeting the scalability demands of 3G GW detectors, enabling efficient and comprehensive data analysis for future observatories.

AI keywords

normalizing flows;generative AI;Bayesian inference;deep learning;automatic differentiation

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