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ML4GW: A Real-Time Framework for Machine-Learning Algorithms in Gravitational-Wave Data Analysis

Abstract

The field of multi-messenger astronomy (MMA) with gravitational waves (GWs) has seen steady growth in terms of infrastructure and automation since the joint observation of GWs and photons from GW170817. The subsequent lack of further success stories has shown the need for rapid inference and coordinated observations for the future success. Motivated by the need of real-time applications, machine learning (ML) algorithms using neural networks (NNs) bring a promise for future data pipelines. Though the development of these algorithms in GWs literature are becoming increasingly common, the infrastructure to validate them at scale or deploy them in real-time has largely been absent in the GW community. This is a gap, especially given that the detection rate in the current fourth observing run (O4) already exceeds that from previous runs combined, by almost twice. Subsequent observing runs through the next decade will exacerbate this further, and require efficient and robust real-time processing of GW data. On that note, I will be talking about ML4GW, an effort to build optimized training and ML inference for real-time GW data. I will also mention the use of this framework in applications like denoising, binary black detection, anomaly detection, and real-time parameter estimation. Our toolkit allows for the development of ML-powered GW algorithms leveraging the modeling techniques available in the GW literature, which are faster and allow deployment in heterogeneous compute environments. Finally, I will discuss the outlook for the future deployment of these in the online analysis of LIGO/Virgo/KAGRA data.