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Time series forecasting for fast waveform evaluation

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One of the primary challenges in analyzing gravitational wave data from future ground and space-based experiments is the need for rapid waveform and likelihood evaluation to expedite Bayesian analysis. Although surrogate models are commonly used to address this, they are limited to finite regions of the parameter space, and their computational cost can escalate significantly as higher precision is demanded. In this work, we leverage the efficiency and fast evaluation times of state-of-the-art time forecasting techniques and large language models, such as transformers, to tackle this challenge. Specifically, we design models capable of generating the latter part of a binary black hole merger waveform (merger and ringdown) based on information from the inspiralling phase, which can be analytically obtained using post-Newtonian methods. Our models can be trained using waveforms produced by traditional surrogates and numerical relativity, employing Monte Carlo dropout and active learning to dynamically select the most efficient training data.

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