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A Deep Learning Powered Numerical Relativity Surrogate for Binary Black Hole Waveforms

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Gravitational wave approximants are extremely useful tools in gravitational wave astronomy. By skipping the full evolution of numerical relativity waveforms, their usage allows for dense coverage of the parameter space of binary black hole (BBH) mergers for purposes of parameter inference, or, more generally, match filtering tasks. However, these benefits come at a slight cost to accuracy when compared to numerical relativity waveforms, depending on the approach. One way to minimize this is by constructing so-called \textit{surrogate models} which, instead of using approximate physics or phenomenological formulae, rather interpolate within the space of numerical relativity waveforms. In this work, we introduce NRSurNN3dq4, a surrogate model for non-precessing BBH merger waveforms powered by neural networks. This approximant is extremely fast and competitively accurate: it can generate to the order of tens of thousands of waveforms in a tenth of a second, and mismatches with numerical relativity waveforms are restrained below 10^{-3}. We implement this approximant within the \texttt{bilby} framework for gravitational wave parameter inference, and show that it obtains good performance for parameter estimation tasks.

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