Deep-Learning Continuous Gravitational Waves

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The search for continuous gravitational waves from unknown spinning neutron stars presents an open computational challenge: optimal fully-coherent matched filtering is computationally impossible, and empirical semi-coherent methods are the best current alternative known. There has been promising progress recently in applying Deep Convolutional Neural Networks as a detection method for binary black-hole coalescence signals (George & Huerta, Gabbard et al, Gebhard et al (2017)). We present results of our study on the feasibility and potential of using similar networks to search for continuous gravitational waves directly in the detector strain data.

We show with well-defined benchmark tests that deep learning can successfully be applied to the search for continuous gravitational waves: it comes close to the performance of coherent matched filtering for short observation times ($\sim 1\,\mathrm{day}$) and low signal frequencies ($\sim 20\,\mathrm{Hz}$) but increasingly falls short for larger values in either of those parameters.

We further discuss the advantages a deep learning algorithm has compared to matched filtering in terms of generalization and computational cost.