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GWAK: Gravitational-Wave Anomalous Knowledge with Recurrent Autoencoders

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Deep Learning assisted Anomaly detection is quickly becoming a powerful tool allowing for the rapid identification of new phenomena.
We present a method of anomaly detection techniques based on deep recurrent autoencoders to the problem of detecting gravitational wave signals in laser interferometers. This class of algorithm is trained via a semi-supervised strategy, i.e. with a weak distinction between classes at training time. While the semi-supervised nature of the problem comes with a cost in terms of accuracy as compared to supervised techniques, there is a qualitative advantage in generalizing experimental sensitivity beyond pre-computed signal templates.
We construct a low-dimensional embedded space GWAK (Gravitational-Wave Anomalous Knowledge) which captures the physical signatures of distinct signals on each axis of the space.
By introducing alternative signal priors that capture the salient features of gravitational-wave signatures, we allow for the recovery of sensitivity even when an unmodelled anomaly is encountered.
We show that regions of the embedded space can identify binaries, sine-Gaussian-like signals and detector glitches, and also search a variety of hypothesized astrophysical sources that may emit signals in the GW frequency band including core-collapse supernovae and other stochastic sources.
Proved to be efficient, we incorporate the GWAK search pipeline as a part of the ML4GW software stack. We show how the ML4GW stack is quickly becoming an effective toolkit for the fast and effective deployment of Machine Learning based gravitational algorithms.

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