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Anomaly detection for non-gaussian transient noise characterization in LIGO data using auxiliary channel information

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Gravitational-wave interferometers are able to detect a change in distance of ~ 1/10,000th the size of a proton. Such sensitivity leads to large rates of appearance of non-gaussian transient noise bursts in the main output of the detectors (the strain), also known as glitches. These glitches come in a wide range of frequency-amplitude-time morphologies and have unknown environmental and instrumental causes, hindering searches for gravitational wave transients. Current Machine Learning approaches for studying glitches use their strain morphologies to classify them but do not consider relevant information provided by auxiliary channels that are distributed through the detectors and monitor their state. In this proof-of-concept work, an unsupervised approach is taken by using the auxiliary channel data encoded in a fractal dimension measure to train an autoencoder with circular convolutions in an anomaly detection fashion. Basing the analysis on the autoencoder's embedded space, this methodology uncovers unknown glitch morphologies, overlaps between different glitches, and misclassifications by the current state of the art.

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