Self-Adaptive Multi-Transform Representation Learning with Dynamic Routing for Interpretable Time-Series Classification and Anomaly Detection

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ABSTRACT

Time-series classification methods increasingly use image-based representations such as Gramian Angular Summation Fields (GASF), Gramian Angular Difference Fields (GADF), and Continuous Wavelet Transforms (CWT) to capture different temporal patterns. Most existing approaches, however, generate these representations using the same fixed settings for every sample and only learn how to combine them afterwards. This study takes a different approach by making the representation stage itself adaptive.

On each input time series, we propose a self-adaptive multi-transform framework in which transformation choices are conditioned . The model adapts the construction of GASF and GADF representations, selects informative CWT scale bands, and uses a sparse dynamic router to determine which transformation branches are needed for each sample. Unlike dense gating, which assigns weights to all available representations after they have been generated, the proposed router can suppress unnecessary branches. This reduces redundant computation and provides interpretable, sample-specific routing decisions.

Using accuracy, precision, recall, F1-score, and macro-F1, the framework is evaluated on the UCI Epileptic Seizure Recognition dataset and compared with fixed-transform, concatenation, and dense-gating baselines .

Keywords: Time-series classification, GASF, GADF, continuous wavelet transform, adaptive representation learning, sparse routing, interpretability.