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Classification of ECG signals through persistent homology

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The algorithmic analysis of ECG signals is a non-trivial task due to the variety and complexity of cardiac abnormalities reflected in heart-rate dynamics. In this work, we investigate a topological approach to ECG classification. Topological Data Analysis (TDA) has recently emerged as a effective framework for problems in which the topology and geometric structure of the data serves as an descriptor of the underlying phenomenon. The main tool in TDA is persistent homology, which allows to capture spacial structure of the data, e.g. number of connected components, cycles, and n-dimensional voids across many scales. We propose an algorithmic pipeline for binary classification of ECG signals that incorporates Takens' embedding to encode time-series data as a point clouds in $\mathbb{R}^n$, followed by dimensionality reduction using PCA to enable efficient computation of persistence diagrams and their vectorizations. We evaluate the performance of random forest classifiers trained on: (i) raw ECG signals, (ii) TDA features, and (iii) raw signals augmented with TDA features. Our results demonstrate the potential of topological descriptors to enhance classification performance for certain types of time-series data.

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