

**Sparse-TDA: Sparse Realization of Topological Data Analysis for Multi-Way Classification**

**Abstract:**

Topological data analysis (TDA) has emerged as one of the most promising techniques to reconstruct the unknown shapes of high-dimensional spaces from observed data samples. TDA, thus, yields key shape descriptors in the form of persistent topological features that can be used for any supervised or unsupervised learning task, including multi-way classification. Sparse sampling, on the other hand, provides a highly efficient technique to reconstruct signals in the spatial-temporal domain from just a few carefully-chosen samples. Here, we present a new method, referred to as the Sparse-TDA algorithm, that combines favorable aspects of the two techniques. This combination is realized by selecting an optimal set of sparse pixel samples from the persistent features generated by a vector-based TDA algorithm. These sparse samples are selected from a low-rank matrix representation of persistent features using QR pivoting. We show that the Sparse-TDA method demonstrates promising performance on three benchmark problems related to human posture recognition and image texture classification.

**Existing System:**

We bring together the two research areas of TDA and sparse sampling in the context of multi-way classification. In particular, we leverage QR pivoting-based sparse sampling for optimal feature selection once the topological features are extracted using a state-of-the-art TDA method. We test our method on three challenging data sets pertaining to 3D meshes of synthetic and real human postures and textured images, respectively.

We call our new method the Sparse-TDA algorithm. We show that it achieves comparable accuracy as the kernel TDA method with substantially lower training times, and better accuracy with comparable or lower training times than widely-used L1-regularized classifiers. Thus, our method opens up a new direction in making online multi-way classification practically feasible.

**Proposed System:**

We present a new method, referred as the Sparse-TDA algorithm, that provides a sparse realization of a TDA algorithm. More specifically, we combine optimized sparse sampling based on pivoted QR factorization with a state-of-the-art TDA method. Instead of persistence diagrams, we use a vector-based representation of persistent homology, called persistence images, with two different weighting functions to extract the topological features.