Piecewise Aggregate Approximation and Symbolic Aggregate Approximation applied to the analysis of manual gestures

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Objective

Piecewise Aggregate Approximation (PAA) and Symbolic Aggregate Approximation (SAX) are methods for discretizing time series. The purpose of this paper is to apply these methods to the Libras Movement dataset to create a discrete representation of the data series, present the data in this representation to a classification algorithm, the K-nearest Neighbors (KNN), and analyze the results.

Materials and Methods

The dataset used is composed by time series that represent hand positioning at specific movements over 45 frames of video. In total, there are 15 movement classes, with 24 instances in each class, composing 360 instances of movement (data). Each of these is represented by 90 descriptive attributes (two coordinates per frame).

The K-nearest neighbors classifier, with $1 \leq K \leq 10$, was applied to the dataset with and without the use of discretization methods. Both PAA and SAX receive as a parameter the number of attributes that the new series will have. The SAX also receives the size of the alphabet used in the symbolic representation of the series.

The PAA tests were done in series with 30, 18, 10 and 6 attributes and in SAX tests, only 18 and 10, with an alphabet size varying from 3 to 10. The classification was evaluated in terms of accuracy and under the leave-one-out test strategy.

Results

Without discretizations, the accuracy was between 68.33% (K = 10) and 87.22% (K = 1). The best results obtained with PAA were in the tests with K = 1, on sets with 10 and 18 attributes, reaching 85.56% and 86.67%, respectively. In SAX, the best performance was about 76.39% for K = 1 and alphabet of size 10 in tests on the set with 18 attributes and 69.99% for K = 4 and alphabet of size 9, with 10 attributes.

Conclusions

The best accuracy rates were obtained with lower K, probably due to the low volume of data and the high similarity between certain classes of movements. For the PAA, many results were satisfactory, and the loss of precision (less than one percentage point) was considered particularly low due to the reduction of 80% of the attributes in the best result. The SAX performed poorly, in comparison, due to the over discretization of the values, increasing the similarity between the series.

References

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