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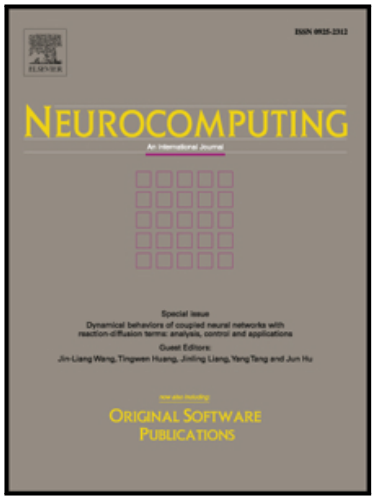

Concept drift robust adaptive novelty detection for data streams

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Concept drift robust adaptive novelty detection for data streams

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Abstract

In this paper we study the performance of two original adaptive unsupervised novelty detection methods (NDMs) on data with concept drift. Newly, the concept drift is considered as a challenging data imbalance that should be ignored by the NDMs, and only system changes and outliers represent novelty. The field of application for such NDMs is broad. For example, the method can be used as a supportive method for real-time system fault detection, for onset detection of events in biomedical signals, in monitoring of nonlinearly controlled processes, for event driven automated trading, etc.. The two newly studied methods are the error and learning based novelty detection (ELBND) and the learning entropy (LE) based detection. These methods use both the error and weight increments of a (supervised) learning model. Here, we study these methods with normalized least-mean squares (NLMS) adaptive filter, and while the NDMs were studied on various real life tasks, newly, we carry out the study on two types of data streams with concept drift to analyze the general ability for unsupervised novelty detection. The two data streams, one with system changes, second with outliers, represent different novelty scenarios to demonstrate the performance of the proposed NDMs with concept drifts in data. Both tested NDMs work as a feature extractor. Thus, a classification framework is used for the evaluation of the obtained features and NDM benchmarking, where two other NDMs, one based on the adaptive model plain error, second using the sample entropy (SE), are used as the reference for the comparison to the proposed methods. The results show that both newly studied NDMs are superior to the merely use of the plain error of adaptive model and also to the sample entropy based detection while they are robust against the concept drift occurrence.

Keywords: Novelty detection; System change; Outlier detection; Concept drift; Learning algorithms; Adaptive filter; Streaming data

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