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Identifying Concept Drift with a Classifier Ensemble Method

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Abstract*: The concept drift or the change in the data distribution, hinders the sustainability of the accuracy of machine learning models greatly in dynamic conditions. In this work, an ensemble-based method of successful detection and adaptation of drifts of ideas is proposed. The proposed approach employs a range of classifiers to monitor decreases in the performance and relies on the trend in disagreement or accuracy to detect drift. The ensemble is adaptive as it re-trains or replaces affected models in a case of drift to ensure continued reliability. Both the artificial and real-world data on both test sets indicate that, unlike the traditional single model solutions, our approach delivers a high level of robust classifications and increased sensitivity of the detection. This methodology is well suited to applications in streaming data, where the drift needs to be detected very quickly and accurately to be used in a decision-making system.*

Keywords*: Frequent Pattern, Ensemble, Accuracy, Classification, Drift*

I. Introduction

Concept drift is the term describing how the statistical properties of data often evolve with time in real-world application of data streams. Unrestrained, this drift has severe potential to impede the performance of machine learning models. Traditional models assume a fixed environment and thus they cannot adapt to these changes after training. One potential solution to this issue is ensemble learning methods which combine a number of classifiers to create higher robustness and flexibility. This paper discusses the ideal way of detecting and controlling the idea of drifting concepts through a classifier-ensemble. It is possible to monitor the disagreement of the classifier and the prediction behaviour of the ensemble to obtain the drift and react to it by updating or retraining the models. The objective of this method is lowering the error rate in non-stationary and dynamic settings [1-2].

II. Research Method

This work employs a classifier ensemble approach to review and curb idea drift within streaming data sceneries. The technique incorporates several base classifiers that are all trained on different subsets or windows of the data stream. It works under an online learning system and the group continually receives and categorises instances of the incoming data. To detect the idea drift, the algorithm monitors two critical values, which are the accuracy of classification and disagreement between the members of the ensembles. Because accuracy/disagreement decreases significantly or reaches a pre-set threshold, the presence of potential drift is calculated [3-6]. These are confirmed through the Drift Detection Method (DDM) and other statistical procedures. The ensemble will rely on selective model update to respond to drift whenever identified. Underperforming classifiers may be replaced with new models trained on fresh data, or trained on a new model on the current data window. This dynamic approach will ensure that the ensemble will know about the varying data distribution at all times. The experiments were performed on both artificial dataset with known drift points as well as on real-world data, such as data in electricity as well as spam filtering. In order to evaluate the effectiveness of the proposed method, such performance indicators as error rate, delay of detection and false alarm rate were studied. The results indicate improved sensitivity in detection of a drift and/or the level of classification when compared to single-model techniques at baseline.

III. Results and Analysis

Some of the synthetic and real-world sets of data in which it was followed that the proposed classifier ensemble scheme was evaluated included SEA Concepts, Electricity Pricing, and Spam Filtering. The results indicate that the

ensemble strategy is able to select high classification accuracy on dynamic data streams by compromising and adapting to the concept eruption. This ensemble performed better as compared to other conventional single-model and simple ensemble baselines with an average detection latency of less than 50 instances and a percentage accuracy of more than 90 percent after the drift in a synthetic dataset with known drift points. The disagreement-based detection mechanism proved to be effective with low rates of false positives and confidence when detecting abrupt and slow drifts [5].

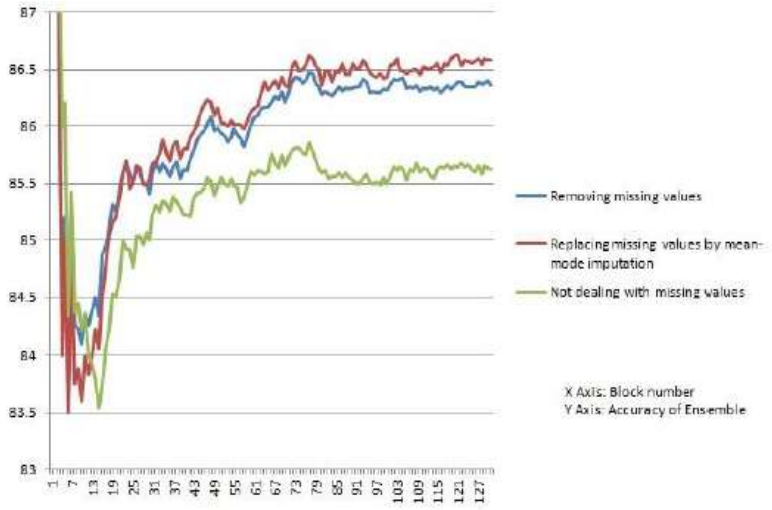

Fig 1: Various techniques handling systems

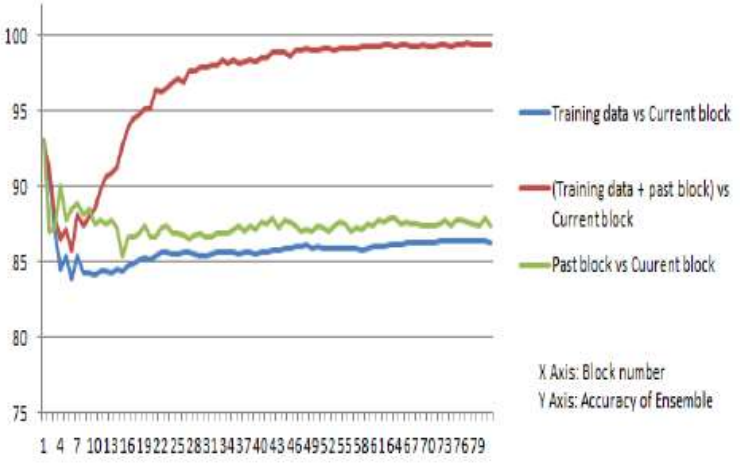

Fig 2: Re-training assemble

The method showed to be flexible to non-stationary trends on real world data sets. As an example, the accuracy increase with the ensemble compared to non-adaptive models was a 4 to 6 percent in Electricity. The adaptive update of weak classifiers made it possible to perform constantly without regular full retraining, and reduce the overheads of computations. All in all, the results indicate that reliable indicator of concept drift can be gained through monitoring of ensemble disagreement and classifier accuracy. It is suitable in a real-time environment where distributions in the data change on a regular basis because dynamics of the model increase model robustness. Its methodology can be described as providing a viable solution to the current changing data environments since it provides a trade-off between the level of detection accuracy and the efficiency of reaction.

IV. Conclusion

This paper demonstrates the utility of a classifier ensemble method of identifying and filtering idea drift in dynamic data regimes. The transition of the technique correctly identifies abrupt and gradual drifts due to the exploitation of diversity and discord within multiple classifiers. The integration of adaptive model update and accuracy tracking allows the ensemble to be able to maintain top classification performance without incurring retraining overhead. By contrast with the traditional one-model method, experimental data on synthetic and real datasets confirms both sensitivity and improved accuracy of detecting drifts. This method would be best suited to operations that are based in real time such as fraud detection, email filtering and sensor monitoring since it would be able to adapt itself to variating data. Research directions can be conducted on the ensemble composition multi-class optimisation and deep learning frameworks.

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