Long Short-Term Memory Stream Cruise Control Method for Automated Drift Detection and Adaptation

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Abstract : Adaptive learning, a commonly employed solution to drift, involves updating predictive models online during their operation to react to concept drifts, thereby serving as a critical component and natural extension for online learning systems that learn incrementally from each example. This paper introduces LSTM-SCCM "Long Short-Term Memory Stream Cruise Control Method", a drift adaptation-as-a-service framework for online learning. LSTM-SCCM automates drift adaptation through prompt detection, drift magnitude quantification, dynamic hyperparameter tuning, performing shortterm optimization and model recalibration for immediate adjustments, and, when necessary, conducting long-term model recalibration to ensure deeper enhancements in model performance. LSTM-SCCM is incorporated into a suite of cutting-edge online regression models, assessing their performance across various types of concept drift using diverse datasets with varying characteristics. The findings demonstrate that LSTM-SCCM represents a notable advancement in both model performance and efficacy in handling concept drift occurrences. LSTM-SCCM stands out as the sole framework adept at effectively tackling concept drifts within regression scenarios. Its proactive approach to drift adaptation distinguishes it from conventional reactive methods, which typically rely on retraining after significant degradation to model performance caused by drifts. Additionally, LSTM-SCCM employs an in-memory approach combined with the Self-Adjusting Memory (SAM) architecture to enhance real-time processing and adaptability. The framework incorporates variable thresholding techniques and does not assume any particular data distribution, making it an ideal choice for managing high-dimensional datasets and efficiently handling large-scale data. Our experiments, which include abrupt, incremental, and gradual drifts across both low- and high-dimensional datasets with varying noise levels, and applied to four state-of-the-art online regression models, demonstrate that LSTM-SCCM is versatile and effective, rendering it a valuable solution for online regression models to address concept drift.

Keywords : automated drift detection and adaptation, concept drift, hyperparameters optimization, online and adaptive learning, regression

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