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Enhancing Crash Prediction with T-SMOTE: A Comparative Study of LSTM, GRU, and BiLSTM on Imbalanced Financial Time Series

Communication Info

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Abstract

Financial crash prediction is a critical yet challenging task due to the rarity of such events [1], leading to severe class imbalance in time series data [2]. This study investigates the impact of T-SMOTE [3], a temporal-oriented oversampling technique, on the performance of deep learning models for crash forecasting. We compare three recurrent architectures—Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), and Bidirectional LSTM (BiLSTM) [4,5] —trained on a global stock indices dataset. Each model is evaluated both with and without T-SMOTE augmentation, using metrics such as F1-score, recall, precision, and area under the precision-recall curve (AUC-PR), which are particularly suited for imbalanced classification. Experimental results demonstrate that T-SMOTE significantly enhances the detection of minority crash events, improving recall and F1-score across all architectures, with BiLSTM achieving the highest performance. The findings highlight the effectiveness of temporal oversampling in addressing

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