A Global Framework for Multi-Horizon Crop Price Forecasting Using Gradient Boosting and Temporal Feature Engineering

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Abstract

Precise prediction of the prices of agricultural commodities is essential to good decision-making by farmers, policymakers, and the supply-chain stakeholders. The price series of agricultural products, however, are highly seasonal, non-stationary and volatile, and this would greatly reduce the efficacy of traditional statistical models of forecasting e.g., on ARIMA, SARIMA, and the use of VEC. To effectively overcome them, we propose a global machine learning-based framework to predict the price of crops as a multi-horizon in this paper that will share learning time series on a number of commodities. The proposed model utilizes a histogram-based gradient boosting regressor with time-enhanced rich feature engineering, such as lagged, rolling statistics, and calendar-based seasonal encodings. The expanding-window backtesting method is taken in such a strict manner that leaks are avoided to achieve leakage-free assessment, and the performance forecasting is evaluated based on MAE, sMAPE, and MASE measures against seasonal naive baselines. In addition, a direct multi-horizon forecasting strategy is presented that allows price forecasting over the long term without recursive error accumulation, and it also uses quantile regression to measure predictive uncertainty by using probabilistic forecast intervals. Experiments on a publicly available dataset of Indian crop prices are shown to yield improvements across all metrics of evaluation and generate reliable long-term predictions into the year December 2031. The proposed framework provides scalable, interpretable, and deployment-ready price forecasting under uncertainty in agriculture.

Keywords

Agricultural commodity price forecasting, time series analysis, gradient boosting regression, multi-horizon forecasting, global learning, quantile regression, uncertainty estimation.