DEVELOPMENT AND RESEARCH OF SOFTWARE COMPONENTS FOR DEMAND FORECASTING BASED ON ARTIFICIAL INTELLIGENCE

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This study introduces an intelligent demand forecasting solution based on deep learning and ensemble techniques, aimed at improving prediction accuracy across multiple markets [1]. A custom software platform was developed and tested using real-world sales data from a Ukrainian poultry producer exporting to Europe, MENA, Asia, and Canada. The forecasting pipeline included data preprocessing (outlier removal, normalization, encoding) and the training of several neural network models: RNN, GRU, Bidirectional LSTM, and CNN-GRU [2]. Their predictions were combined using XGBoost stacking, which served as a meta-learner.

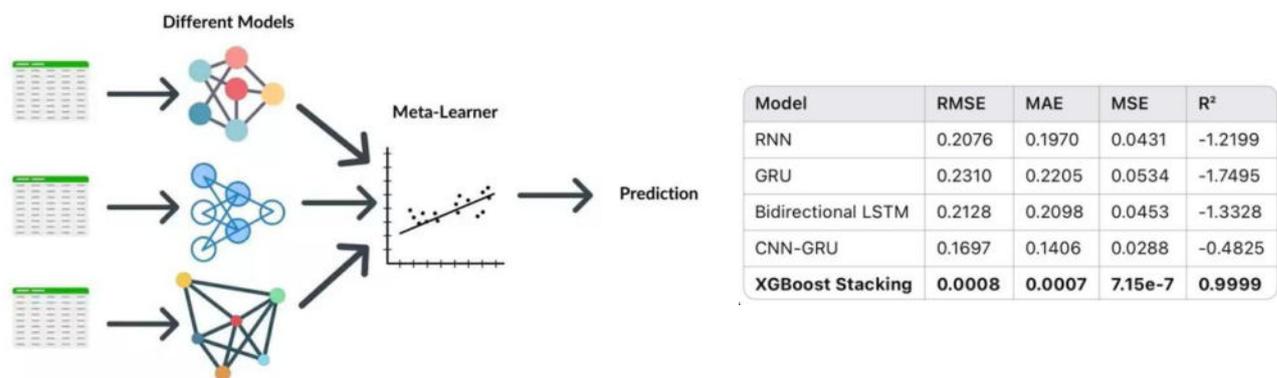| Model	RMSE	MAE	MSE	R^2
RNN	0.2076	0.1970	0.0431	-1.2199
GRU	0.2310	0.2205	0.0534	-1.7495
Bidirectional LSTM	0.2128	0.2098	0.0453	-1.3328
CNN-GRU	0.1697	0.1406	0.0288	-0.4825
XGBoost Stacking	**0.0008**	**0.0007**	**7.15e-7**	**0.9999**

Fig. 1. – Schematic representation of XGBoost stacking [3] and performance comparison of different neural network models

Forecast performance was evaluated using RMSE, MAE, MSE, and R^2 metrics. Among individual models, CNN-GRU demonstrated the best accuracy (RMSE = 0.1697, MAE = 0.1406), while RNN and GRU performed poorly due to issues with long-term dependency handling. The ensemble model outperformed all others, achieving near-perfect accuracy (R^2 = 0.9999, RMSE = 0.0008). These results confirm the effectiveness of ensemble learning in leveraging the strengths of multiple architectures to enhance forecast quality [3].

The proposed solution is well-suited for real-world demand environments and can be integrated into business planning systems to support decision-making, optimize resource allocation, and reduce waste. Future enhancements will explore the inclusion of macroeconomic indicators and the application of Transformer-based models.

References:

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3. Bagging, Boosting, and Stacking – What's the Difference? // https://spotintelligence.com/2024/03/18/bagging-boosting-stacking/, 18.03.2024