Joint Tech Internship Community Program

Generative AI Consortium (MSME)

SystimaNX IT Solutions Pvt Ltd.

AI/ML Internship - Deep Learning
Assignment 2

Demand Prediction
Report

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Report on Demand Prediction Model Performance and Inventory Management Optimization

1. Executive Summary

This report summarizes the findings from the demand prediction model developed for optimizing inventory management. It presents the model's performance metrics, insights derived from feature importance, and actionable recommendations aimed at enhancing inventory efficiency and reducing costs.

2. Introduction

Efficient inventory management is crucial for businesses to meet customer demand while minimizing holding costs. In this project, we developed a demand prediction model using historical sales data, aiming to achieve reduced Mean Absolute Error (MAE).

3. Data Overview

- **Dataset**: The dataset used comprised various features, including sales figures, prices, promotional activities, and time-related variables.
- **Data Preprocessing**: Steps included handling missing values, outlier treatment, feature engineering (lag features, moving averages, etc.), and encoding categorical variables.

4. Model Development

Three machine learning models were trained and evaluated for demand prediction:

1. **LightGBM**
2. **XGBoost**
3. **Random Forest**

4.1 Hyperparameter Tuning

- A randomized search was conducted to optimize hyperparameters for each model, ensuring the best performance based on cross-validation.

5. Model Performance

- **Best Performing Model**: The LightGBM model achieved the lowest MAE, indicating the best predictive performance among the tested models.
- **Feature Importance**: The analysis of feature importance showed that variables such as sales history, promotions, and pricing had the most significant impact on demand predictions. This information can guide inventory strategies.

5.1 Blended Model Performance

The blended model, combining predictions from the best individual models, further improved the MAE and efficiency, showcasing the benefit of ensemble methods.

6. Insights and Findings

- The temporal features (day of the week, holiday indicators) played a crucial role in predicting demand.
- Promotional activities were linked to spikes in demand, highlighting the importance of marketing strategies in inventory planning.
- Seasonal patterns were evident, necessitating adjustments in inventory levels according to seasonal trends.

7. Recommendations for Optimizing Inventory Management

Based on the findings from the demand prediction model, the following recommendations are made:

7.1 Demand Forecasting

- Implement regular updates of the demand prediction model with new data to maintain accuracy.
- Use blended model predictions for more reliable inventory planning.

7.2 Inventory Strategies

- **Safety Stock Adjustment**: Utilize the model's output to calculate appropriate safety stock levels based on predicted demand variability.
- **Dynamic Reordering**: Develop a dynamic reordering system that considers lead times and predicted demand, minimizing excess stock and stockouts.

7.3 Promotion Planning

- Leverage promotional insights to plan marketing campaigns and align inventory accordingly.
- Analyze past promotions' effectiveness to forecast future demand during similar campaigns.

7.4 Seasonal Adjustments

- Prepare for seasonal demand fluctuations by adjusting inventory levels in advance, based on historical data insights.

8. Conclusion

The demand prediction model has proven effective in forecasting product demand, offering valuable insights into inventory management strategies. By implementing the recommendations outlined in this report, businesses can optimize inventory levels, reduce costs, and enhance customer satisfaction through better availability of products.