DOMINOS - PREDICTIVE PURCHASE ORDER SYSTEM

Predicts future pizza sales and generates a purchase order to ensure optimal ingredient stock levels, helping to minimize waste, reduce costs, and streamline the supply chain

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ABSTRACT

Effective inventory management is crucial in the food service industry to balance supply and demand efficiently. Overstocking leads to ingredient wastage and financial losses, while under stocking results in stock outs and lost sales. This project addresses these challenges by leveraging machine learning to predict future pizza sales and generate an optimized purchase order for ingredients.

By analyzing historical sales data, a time-series forecasting model was developed to estimate demand for various pizza types over the next seven days. The forecasted sales were then mapped to ingredient usage data to calculate precise stock requirements. This ensures that Domino's maintains optimal ingredient levels, minimizing waste, reducing costs, and improving overall supply chain efficiency.

The automated purchase order system streamlines inventory planning, reducing manual effort and enhancing operational decision-making. This data-driven approach enables Domino's to optimize resource allocation, improve profitability, and maintain seamless kitchen operations while meeting customer demand efficiently.

INTRODUCTION

Efficient inventory management is a critical factor in the food service industry, where businesses must strike a balance between maintaining sufficient stock and minimizing waste. Overstocking ingredients leads to financial losses due to spoilage, while understocking can result in stockouts, delays in service, and lost revenue. Traditionally, businesses rely on manual estimation and past experience to place purchase orders, which often leads to inefficiencies. To overcome these challenges, this project utilizes machine learning to predict future pizza sales and generate an optimized ingredient purchase order, ensuring smooth kitchen operations while reducing waste and unnecessary costs.

By analyzing historical sales data, advanced time-series forecasting models are employed to estimate the demand for different pizza types over the next seven days. These predictions are then mapped to ingredient usage data to calculate the exact quantity of each ingredient required. This data-driven approach not only eliminates guesswork but also helps Domino's streamline its supply chain, improve resource allocation, and reduce manual effort in inventory planning. With an optimized purchase order system in place, the company can ensure consistent availability of ingredients, enhance profitability, and improve overall operational efficiency.

PROBLEM STATEMENT

Managing inventory efficiently is a major challenge in the food service industry, where fluctuating demand makes it difficult to maintain optimal stock levels. Overstocking ingredients leads to unnecessary waste and increased costs, while understocking results in shortages, disrupting operations and causing customer dissatisfaction. Domino's currently relies on manual estimation for ingredient ordering, which can be inaccurate and inefficient, leading to financial losses and operational inefficiencies.

To address these challenges, this project aims to develop a predictive purchase order system that leverages machine learning to forecast pizza sales. By accurately predicting demand, the system ensures that the right amount of ingredients is available, minimizing waste, preventing stockouts, and optimizing inventory management. This automation will enhance supply chain efficiency, reduce costs, and streamline the ordering process, allowing Domino's to meet customer demand more effectively while maximizing profitability.

DATASET OVERVIEW

The project utilizes two key datasets - **sales data** and **ingredient data** - to forecast pizza demand and optimize purchase orders.

1. Sales Data

- **Description**: Contains historical sales records, tracking pizza sales over time.
- **Key Features**:
    - order_date – Date of order placement.
    - pizza_name_id – Unique identifier for each pizza type.
    - quantity_sold – Number of pizzas sold per day.
    - pizza_category – Type of pizza (e.g., vegetarian, non-vegetarian).
    - unit_price and total_price – Pricing details.
- **Purpose**: Used to train the machine learning model for sales forecasting.

2. Ingredient Data

- **Description**: Specifies the quantity of ingredients required for each pizza type.
- **Key Features**:
    - pizza_name_id – Links with sales data.
    - pizza_ingredients – List of ingredients used in each pizza.
    - Items_Qty_In_Grams – Required quantity of each ingredient per pizza.
- **Purpose**: Helps in mapping predicted sales to ingredient requirements for purchase order generation.

METHODOLOGY

1. Data Preprocessing & Feature Engineering

- Handled missing values, removed duplicates, and standardized date formats.
- Created time-based features like **week number, month number, and day of the week**.
- Aggregated daily sales data for each pizza type.

2. Sales Forecasting Model

- **Model Selection**: Evaluated **six different models** to determine the best approach:
    1. **ARIMA** - Captures trends and seasonality in time-series data.
    2. **SARIMA** - An extension of ARIMA that accounts for seasonal patterns.
    3. **Prophet** - Facebook's time-series model that handles missing values and holidays.
    4. **Linear Regression** - A baseline model to capture linear trends.
    5. **Random Forest** - A tree-based model that captures non-linear relationships.
    6. **XGBoost** - A powerful boosting algorithm for time-series forecasting.
- **Final Model**: **XGBoost Regression** was selected due to its superior performance and ability to handle complex sales patterns.
- **Evaluation Metric**: **Mean Absolute Percentage Error (MAPE)** was used to measure model accuracy.

3. Purchase Order Generation

- Predicted pizza sales for the next **7 days** using the trained model.
- Mapped predicted sales to ingredient usage data to compute total ingredient requirements.
- Converted ingredient quantities to **grams and kilograms** for purchase order creation.

RESULTS AND DISCUSSION

1. Model Performance and Comparison

Six different machine learning models were tested to forecast pizza sales, with **XGBoost Regression emerging as the most accurate**. The models were evaluated using **Mean Absolute Percentage Error (MAPE)**, and the results showed that XGBoost consistently outperformed other models by capturing complex sales patterns effectively.

- **ARIMA** had moderate error and struggled with trend shifts.
- **SARIMA** improved over ARIMA but was less accurate than tree-based models.
- **Prophet** performed well but was sensitive to missing data.
- **Linear Regression** had high error and failed to capture non-linear trends.
- **Random Forest** showed good accuracy but occasionally over fitted.
- **XGBoost** delivered the **best performance** with the **lowest MAPE score**, making it the most reliable model for forecasting pizza sales.

2. Sales Forecasting Results

Using XGBoost, **pizza sales were forecasted for the next seven days**, ensuring better demand planning. The model effectively identified **weekly trends, peak sales periods, and fluctuations in demand**, helping to optimize ingredient procurement.

For example, the forecast predicted a steady demand for popular pizzas like BBQ Chicken, Pepperoni, Veggie, and Hawaiian, with sales fluctuating across the week. These insights allow for **precise ingredient planning**, ensuring that stock levels are maintained efficiently without overstocking or running out of essential items.

3. Ingredient Purchase Order Generation

The **forecasted sales were mapped to ingredient usage data** to calculate the exact stock requirements for the next seven days. This approach ensures that **Domino's maintains optimal inventory levels, reduces waste, and prevents stock shortages**.

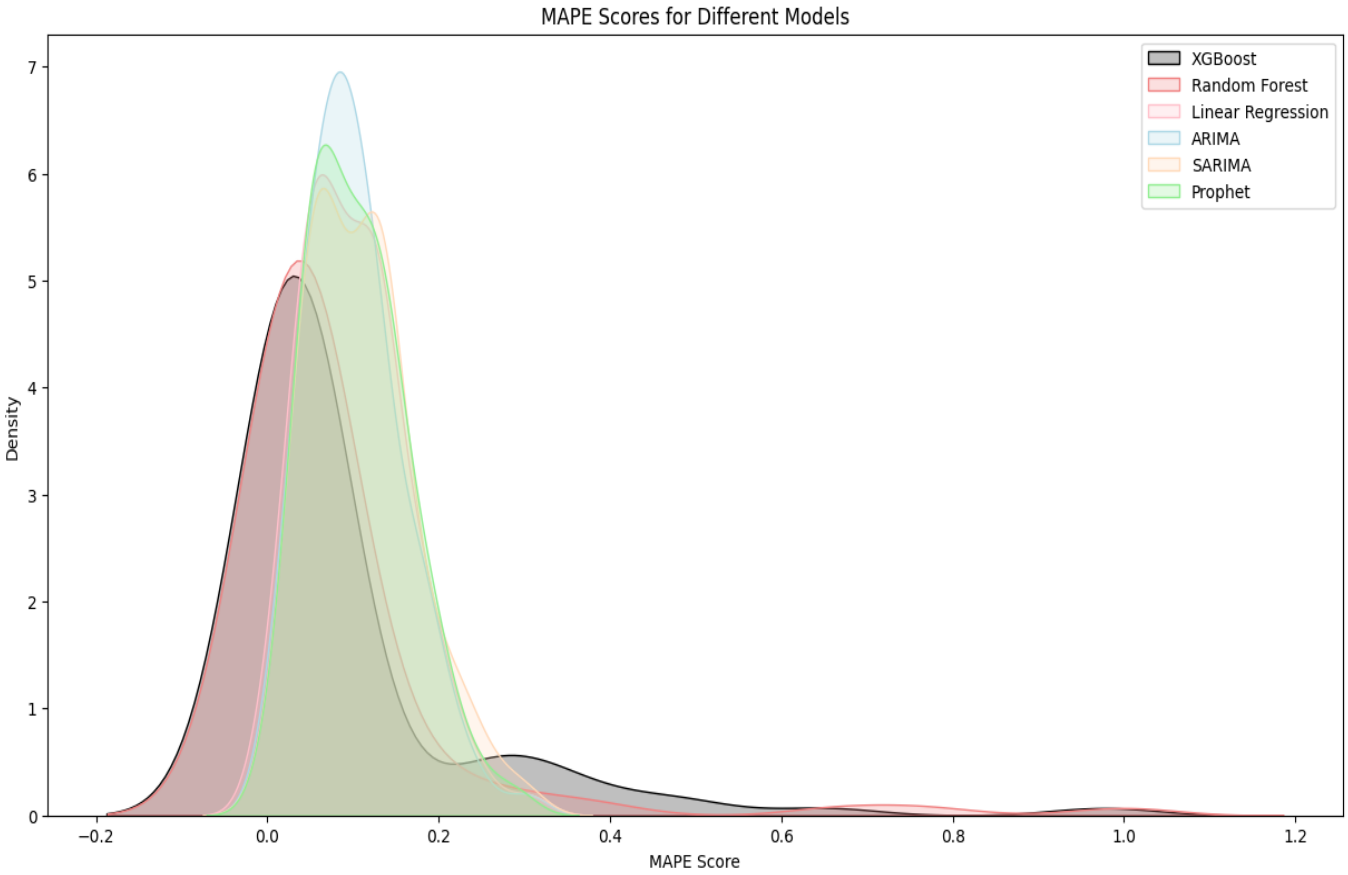
For instance, based on the predicted sales, ingredients such as Mozzarella Cheese, Tomato Sauce, Pepperoni, and Mushrooms were identified as high-demand items. Their required quantities were calculated accordingly, allowing for an **automated purchase order** to be generated. This eliminates manual estimation errors and ensures that the right amount of ingredients is ordered at the right time.

4. Business Impact and Benefits

The implementation of this predictive purchase order system offers multiple business advantages:

- **Reduced Waste** – Prevents overstocking and spoilage, leading to cost savings.
- **Optimized Inventory** – Ensures that ingredients are available when needed without excess stock.
- **Cost Reduction** – Lowers procurement costs by ordering the right quantity of ingredients.
- **Automated Ordering** – Reduces manual effort and improves operational efficiency.
- **Improved Decision-Making** – Provides data-driven insights for better supply chain management.

The results successfully demonstrate how **machine learning can optimize inventory planning**, helping **Domino's streamline operations, reduce costs, and improve overall profitability**.


MAPE Scores for Different Models
XGBoost
Random Forest
Linear Regression
ARIMA
SARIMA
Prophet
Density
MAPE Score
0
1
2
3
4
5
6
7
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2

CONCLUSION

This project successfully demonstrates the application of **machine learning for predictive inventory management** in the food service industry. By leveraging **historical sales data and time-series forecasting models**, an **optimized purchase order system** was developed to ensure **accurate ingredient procurement** based on predicted pizza sales.

Among the six models tested, **XGBoost Regression emerged as the most effective**, providing highly accurate sales forecasts. These predictions were then mapped to ingredient usage data, allowing for **precise stock planning**, minimizing **waste**, reducing **procurement costs**, and **preventing stockouts**. The **automated purchase order system** eliminates manual errors, enhances operational efficiency, and helps **Domino's maintain an uninterrupted supply chain**.

By implementing this solution, **Domino's can make data-driven decisions, streamline its inventory process, and improve overall profitability**. This project lays the foundation for future enhancements, such as incorporating **seasonal trends, promotions, and real-time inventory tracking**, to further refine sales predictions and optimize supply chain management.

REFERENCE

https://docs.google.com/document/d/1j9hJ4JEeIe3QJIl3dTwdxgSCn5e3VXoLd8Fgvr9VCno/edit?tab=t.0

DECLARATION

I declare that, this Documentation is prepared by Mirthu Baashini B, Data Science Student at Guvi Geek Network, Batch MDE95.