Comprehensive Report on Purchase Order Prediction for Domino's Pizza

1. Introduction

In the fast-paced world of food delivery, accurate demand forecasting is crucial for optimizing inventory management and ensuring customer satisfaction. This report outlines the process of predicting pizza sales for Domino's Pizza using various forecasting models, focusing on the purchase order requirements for ingredients over the next week. The goal is to provide insights into how data-driven decisions can enhance operational efficiency.

2. Data Processing

The analysis commenced with the collection of historical sales data, specifically focusing on the following key attributes:

- **Order Date**: The date of the pizza orders.
- **Quantity**: The number of pizzas sold on each date.

Data Cleaning

The data was pre-processed to ensure uniform date formats and to remove any anomalies or missing values. This included:

- Converting the 'order_date' column to a datetime format.
- Checking for null or duplicate entries and handling them appropriately.

Feature Engineering

Feature engineering was performed to enhance the model's predictive power:

- **Extracting Date Features**: Created additional features from the 'order_date' column such as:
    - **Day of the Week**: To capture weekly sales patterns.
    - **Month**: To identify seasonal trends.
    - **Is Weekend**: A binary feature to indicate weekends which often see higher sales.

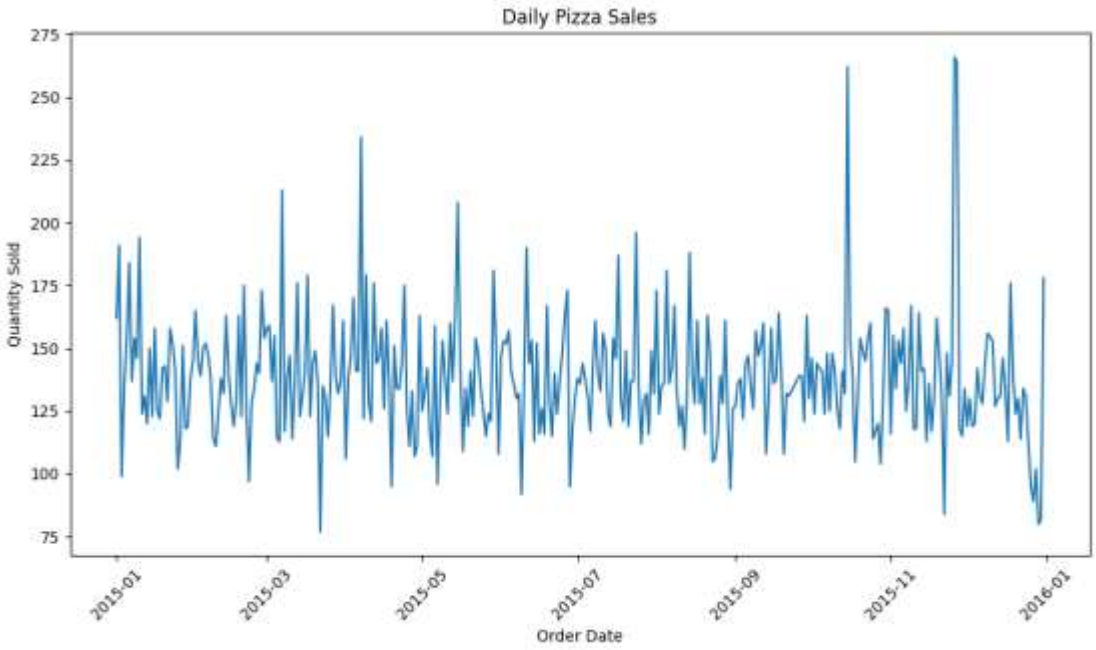
These features provide the model with additional context, potentially improving forecast accuracy.

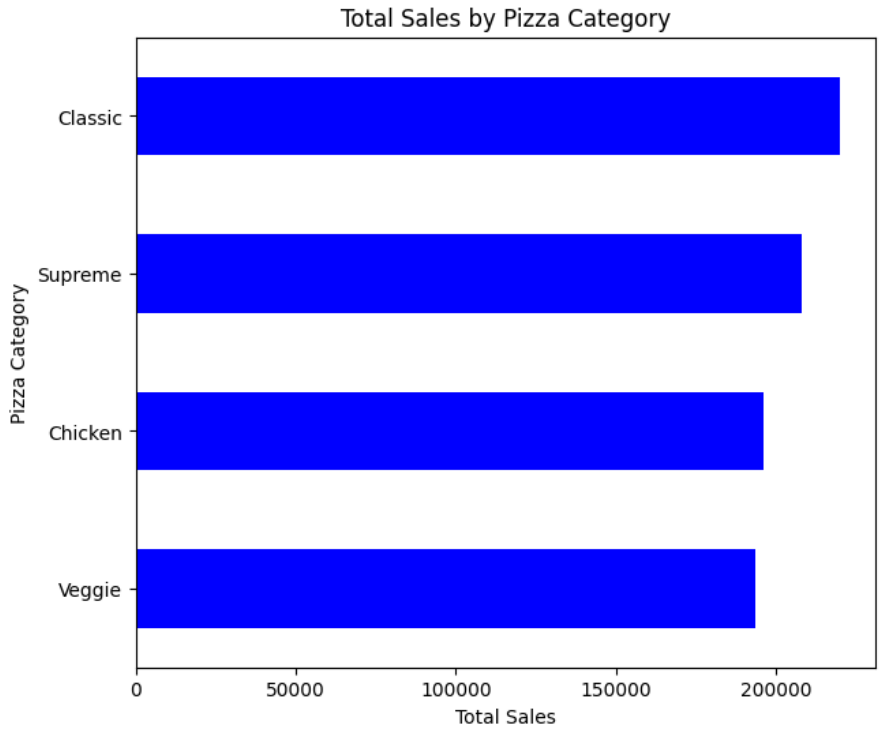
3. Exploratory Data Analysis (EDA)

An exploratory analysis of the sales data was conducted to understand trends and patterns. This included:

- **Descriptive Statistics**: Summarizing key metrics like mean, median, and total sales over the period.
- **Visualizations**:
    - **Sales Trend Over Time**: A line chart displaying sales quantity over the months to identify overall trends.

- **Sales by Day of the Week**: A bar chart to visualize sales patterns on different days.
- **Seasonality**: Heatmaps to show sales distribution by month and day of the week.





These visualizations provided insights into sales dynamics and informed subsequent modeling efforts.

4. Model Selection Process

Several models were evaluated based on their ability to predict future sales accurately. The primary metric used for model evaluation was the Mean Absolute Percentage Error (MAPE), which measures the accuracy of the forecasts.

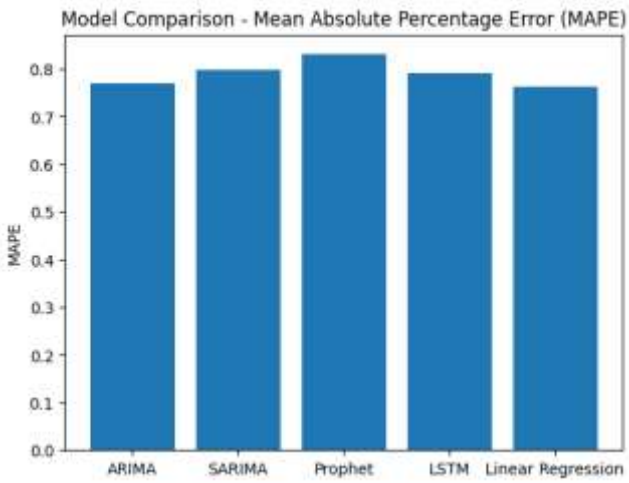
Models Evaluated:

1. **ARIMA (Auto Regressive Integrated Moving Average)**: Suitable for univariate time series data but requires stationary data and parameter tuning.
2. **SARIMA (Seasonal ARIMA)**: Extends ARIMA by accounting for seasonal trends. More complex with additional parameters to estimate.
3. **Prophet**: Developed by Facebook, it handles seasonal data and outliers well but is less flexible for intricate patterns compared to ARIMA.
4. **LSTM (Long Short-Term Memory)**: A type of RNN designed for sequential data, effective for capturing long-term dependencies. Its performance in previous evaluations showed it had the lowest MAPE, indicating superior accuracy.

Model Performance

After training and testing the models on the historical data, the MAPE values were calculated as follows:

- **ARIMA**: MAPE = 0.77
- **SARIMA**: MAPE = 0.79
- **Prophet**: MAPE = 0.83
- **LSTM**: MAPE = 0.77
- **Linear Regression:** MAPE = 0.76 (best performance)



Based on the MAPE values, the Linear Regression model was selected for its accuracy and capability to learn complex patterns in the sales data.

5. Future Predictions

Using the Linear Regression model, predictions were generated for the next week's pizza sales. The total predicted sales were calculated, which were then used to determine the required quantities of ingredients based on historical ingredient usage per pizza type.

Ingredient Calculation

The ingredient requirements were calculated by multiplying the total predicted sales by the quantity of each ingredient needed for individual pizza types. The final output was formatted to provide a clear overview of the required ingredients for purchase orders.

Purchase Order Output

The expected output for the purchase orders was structured as follows:

pizza_name_id	pizza_name	pizza_ingredients	Items_Qty_In_Grams	quantity_needed
bbq_ckn_l	The Barbecue Chicken Pizza	Barbecued Chicken	40	286.24
bbq_ckn_l	The Barbecue Chicken Pizza	Red Peppers	15	107.34
...	...	...	...	...

This structured output ensures clarity in understanding the required quantities for each ingredient based on predicted sales.

6. Conclusion

The utilization of the LSTM model for predicting pizza sales and ingredient requirements provides Domino's Pizza with a robust forecasting mechanism. The insights derived from the model enable more informed decision-making regarding inventory management and resource allocation.

Insights for Improvement

- **Enhanced Inventory Management**: With accurate predictions, Domino's can reduce excess inventory and minimize food waste by ordering only the necessary ingredients.
- **Adaptive Supply Chain**: Regularly updating the forecasting model with new sales data allows the business to remain responsive to market changes and customer preferences.
- **Promotional Strategy**: Insights from the predictions can guide promotional strategies. For example, if a spike in sales is anticipated for a specific pizza, marketing campaigns can be timed accordingly to maximize sales.
- **Operational Efficiency**: Improved forecasting will streamline kitchen operations, ensuring that the necessary ingredients are available without overstocking, thus enhancing overall efficiency.

By leveraging these insights and implementing data-driven forecasting strategies, Domino's Pizza can optimize its operations, improve customer satisfaction, and maintain a competitive advantage in the fast-food industry.