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Report On

Demand Forecasting and Inventory Optimization

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Abstract

Efficient inventory management is crucial for businesses to optimize operational costs while ensuring customer satisfaction. This project focuses on integrating demand forecasting with inventory optimization techniques to achieve this balance. Using historical demand data, a Seasonal Autoregressive Integrated Moving Average (SARIMA) model was developed to forecast future demand. These forecasts were then used to calculate key inventory metrics such as order quantity, reorder points, safety stock, and total cost. The methodology ensures an optimal balance between holding costs and stockout costs while maintaining a high service level. Python libraries such as Statsmodels, Pandas, and Plotly were employed for data analysis and visualization. The results demonstrate how predictive analytics can drive data-driven decisions in inventory management.

Contents

1 Introduction

Inventory management is a critical component of supply chain management, balancing the cost of holding inventory with the risk of stockouts. Accurate demand forecasting enables businesses to predict future demand and align inventory levels accordingly. This project employs a SARIMA model to forecast demand and derives inventory metrics to optimize operational costs.

2 Methodology

2.1 Data Preprocessing

The dataset comprises daily demand and inventory levels. Missing values were handled, and the `Date` column was converted into a datetime format for time series analysis. The dataset was then visualized to understand trends and seasonality.

2.2 Demand Forecasting

A SARIMA model was selected for its ability to model both seasonal and non-seasonal components. The model parameters were tuned to achieve the best fit:

- ARIMA Order: (1, 1, 1)
- Seasonal Order: (1, 1, 1, 2)

The model was trained on historical data, and future demand was forecasted for 10 days.

2.3 Inventory Optimization

The `InventoryManagement` class was implemented in Python to calculate:

- **Optimal Order Quantity**: Ideal inventory amount to minimize costs.
- **Reorder Point**: Trigger level for placing a new order.
- **Safety Stock**: Buffer stock for demand variability.
- **Total Cost**: Combined holding and stockout costs.

Key inputs:

- Initial Inventory: 5500 units
- Lead Time: 1 day
- Service Level: 0.95
- Holding Cost: 0.10/$unitStockoutCost$:10/unit

3 Results

3.1 Demand Forecasting

The SARIMA model predicted demand for the next 10 days as follows: 1200, 1180, 1215, 1198, 1205, 1187, 1210, 1203, 1195, and 1207 units.

3.2 Inventory Metrics

The calculated inventory metrics are:

- **Optimal Order Quantity**: 1245 units
- **Reorder Point**: 1217.5 units
- **Safety Stock**: 17.5 units

- **Total Cost**: 655.25

4 Discussion

The integration of demand forecasting with inventory optimization demonstrates significant cost savings and improved service levels. The SARIMA model effectively captured seasonal patterns, providing reliable forecasts for inventory planning. The calculated metrics enable proactive stock management, ensuring high service levels while minimizing costs.

5 Conclusion

This project highlights the importance of predictive analytics in inventory management. The methodology can be extended to different industries and adapted for more complex supply chain scenarios. Future work could incorporate dynamic pricing and supplier variability to enhance the model's robustness.