Inventory Management & Forecast of Demand Using Time Series Machine Learning Algorithms

Madhumitha Gannavaram, Sreeja Pasupuleti, Sri Sai Lahari Gandrapu

Abstract

This proposal aims to optimize inventory management through advanced machine learning, ARIMA, and Exponential Smoothing to forecast demand and automate stock processes. By integrating neural network-driven reinforcement learning, the approach enhances dynamic inventory adjustments. Future plans include an LLM-powered chatbot for real-time inventory insights, further streamlining operations and supporting data-driven decisions.

Keywords: Time series, Machine learning

1 Introduction

For any business, effective inventory management is crucial, especially the one dealing with perishable goods, as it impacts both operational efficiency and waste reduction. In recent years, food wastage has become a significant concern globally, with many industries facing challenges in accurately predicting inventory needs to meet demand while minimizing excess stock. Traditional inventory management systems often lack the precision to anticipate fluctuations in demand, leading to overstocking or stockouts, both of which can result in increased costs and wasted resources.

This project proposes Inventory management and forecast using the advanced Time Series Analysis techniques, focusing on optimizing stock levels to match demand patterns. Our primary goal is to develop a functional model for one of the dining halls at Indiana University (IU) that provides detailed insights into core inventory, active stock, and bulk inventory using time series analysis algorithms such as Autoregressive Integrated Moving Average (ARIMA). This data driven approach considers customer preferences, and predicts sales and required stock to order for the future, based on historical data. Due to complexity of data, steps include thorough data cleaning, rigorous data wrangling, data visualization and implementation of robust Machine learning algorithms to extract meaningful insights. Moving forward, we aim to enhance this model by integrating an LLM-powered chatbot that can answer queries regarding inventory status and trends, assisting management in making informed decisions efficiently.

2 Methods

We will follow a step-by-step process to complete this project. The first step is data collection, we will make sure that we have enough data for robust analysis. The next and most important step is data preprocessing, handling missing values, and standardizing the data needed for the analysis.

We will be using time series machine learning algorithms like Exponential Smoothing and ARIMA (AutoRegressive Integrated Moving Average). (1) **Exponential smoothing** is a way to make predictions by looking at past data. It gives more importance to recent data and less to older data. The Holt-Winters method is a more advanced version of this. It considers if the data is following a trend (going up or down over time) and if it has patterns that repeat regularly. For the analysis and prediction of single-variable time series data, (2) **ARIMA** stands out as a prominent statistical framework. This model's name is an acronym that reflects its three key components: Autoregression (AR), Integration (I), and Moving Average (MA). By integrating these elements, ARIMA effectively captures and models the temporal relationships within the data, making it a powerful tool for understanding and forecasting time-dependent patterns.

(3) **Gaussian Process** is mainly used for regression tasks and is also effective for time series forecasting. Useful in the fields of statistics. (4) **Multilayer perceptron** is an artificial neural network that has applications in NLP, Speech and Image recognition, and Time series forecasting. After the predictive analysis, we will use the RMSE (Root Mean Squared Error) technique to check the accuracy of the models and check for the best model of all. RMSE measures the average difference between predicted values and actual observed values in a dataset.

References

[1] Hussein, Burhan & Kasem, Asem & Omar, Saiful & Siau, nor zainah. (2019). A Data Mining Approach for Inventory Forecasting: A Case Study of a Medical Store: Proceedings of the Computational Intelligence in Information Systems Conference (CIIS 2018). 10.1007/978-3-030-03302-6_16.

[2] Matsumoto, Mitsutaka & Ikeda, Akira. (2015). Examination of demand forecasting by time series analysis for auto parts remanufacturing. Journal of Remanufacturing. 5. 10.1186/s13243-015-0010-y.

[3] Shah, Vaishvi & Gupta, Vivek & Gandhi, Tushya & Gupta, Rajeev. (2023). Efficient Medical Supply Chain Forecasting Using Time Series Analysis. 1-6. 10.1109/CVMI59935.2023.10465213.

[4] Fattah, Jamal & Ezzine, Latifa & Aman, Zineb & Moussami, Haj & Lachhab, Abdeslam. (2018). Forecasting of demand using ARIMA model. International Journal of Engineering Business Management. 10. 184797901880867. 10.1177/1847979018808673.