**Performance Assessment**

NLM3 — NLM3 Task 1: Time Series Modeling

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# Part I: Research Question

In the healthcare sector, understanding financial trends is crucial for long-term stability, particularly in response to readmission penalties imposed by the Centers for Medicare and Medicaid Services (CMS). Hospitals are continually working to optimize financial and operational strategies to mitigate penalties associated with excessive readmissions. This study examines revenue trends over the first two years of a hospital’s operation to identify significant patterns that may inform financial forecasting and strategic decision-making.

The research question guiding this analysis is: *What are the key trends and patterns in the hospital's revenue over the first two years of operation?* To address this, the objectives of the study include identifying long-term revenue trends, detecting seasonal variations, developing a robust time series model for predictive forecasting, and offering insights into the potential financial planning strategies that could be employed based on historical data patterns.

The main objective of this analysis is to understand how revenue patterns change over time and what factors contribute to these fluctuations. By identifying trends and seasonal variations, hospitals can make informed financial decisions that help mitigate potential risks. The study also aims to develop a reliable forecasting model to predict future revenue trends based on historical data. This predictive insight can assist hospital administrators in planning budgets, allocating resources effectively, and preparing for fluctuations in patient influx. Additionally, by examining financial trends, healthcare organizations can evaluate the impact of readmission penalties and assess the effectiveness of strategies implemented to reduce their occurrence.

# Part II: Method Justification

Time series modeling is an essential analytical technique when working with chronological data, such as daily revenue records. This type of modeling relies on key assumptions, including stationarity, where the statistical properties of the data remain stable over time; autocorrelation, where past values influence future values; and seasonality, where recurring patterns emerge at fixed intervals.

For this study, an Autoregressive Integrated Moving Average (ARIMA) model was selected due to its ability to accommodate trends, remove non-stationary patterns, and generate reliable forecasts. The ARIMA model combines three components: autoregression (AR), integration (I) to stabilize trends, and moving averages (MA) to smooth short-term fluctuations. This approach ensures that the model effectively captures both long-term trends and periodic variations in the hospital's revenue data.

# Part III: Data Preparation

The dataset used in this analysis consists of 731 daily revenue observations, measured in millions of dollars. Data cleaning was performed to ensure accuracy and consistency. The "Day" column was converted into a datetime format to provide a proper time index, and the dataset was reviewed for missing values. No data gaps were identified, confirming data completeness.

To facilitate analysis, the dataset was divided into training and testing subsets, with 80% of the data allocated for training and 20% reserved for validation. This ensures that the model learns from historical trends while being evaluated on unseen data to assess predictive accuracy. Additionally, the Augmented Dickey-Fuller (ADF) test was applied to evaluate stationarity, and necessary transformations, such as differencing, were implemented where needed.

# Part IV: Model Identification and Analysis

A comprehensive exploratory analysis was conducted to examine revenue trends over time. The time series decomposition process was employed to separate the data into three components: trend, seasonality, and residual fluctuations. Additionally, Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots were generated to determine the appropriate parameters for the ARIMA model.

To further understand the revenue fluctuations, spectral density analysis was performed using a periodogram, which highlighted key frequency components in the dataset. Based on the insights from these exploratory analyses, an ARIMA model was fitted to the data, with the optimal parameters determined based on model selection criteria such as the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC).

The finalized ARIMA model was then applied to generate revenue forecasts, providing valuable insights into expected financial trends for the hospital. Model accuracy was assessed using standard performance metrics, ensuring that the predictions align with observed patterns.

# Part V: Data Summary

The time series analysis of the hospital’s revenue data over the first two years revealed key insights. The overall revenue trend showed a steady increase, with identifiable seasonal fluctuations at regular intervals. These findings suggest that external factors, such as patient influx variations and policy changes, may be influencing revenue dynamics.

The **ARIMA model** was selected after rigorous evaluation, ensuring that it effectively captured both trend components and seasonal variations. The generated forecast provided an estimate of future revenue trends, offering valuable information for strategic planning. The prediction interval was carefully defined to account for uncertainty, ensuring realistic projections.

Based on the analysis, it is recommended that hospitals employ data-driven financial planning to anticipate revenue trends and mitigate potential risks. Adopting technology-driven solutions can enhance operational efficiency and reduce financial penalties associated with readmissions. Additionally, further exploration of external variables affecting revenue fluctuations could improve future forecasting accuracy.

Works Cited

**There are no sources in the current document.**