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**Forecasting Apple Stock Prices Using Exponential Smoothing and ARIMA Models**

**Methodology**

For this analysis, I explored two different time series forecasting models to predict Apple’s stock prices: **Holt-Winters Exponential Smoothing** and **ARIMA (Auto-Regressive Integrated Moving Average).** The dataset used contains monthly stock prices from January 2019 to December 2024.

**Data Collection & Preparation**

The historical stock price data was sourced from Yahoo Finance, focusing on the adjusted closing prices for each month. Once the data was collected, I transformed it into a time series format to ensure proper analysis. Any missing values were handled using interpolation techniques to maintain data continuity.

**Model Selection & Forecasting**

1. **Holt-Winters Exponential Smoothing:** This method is particularly useful when the data exhibits both trend and seasonality. It adjusts dynamically to changes over time, making it a suitable choice for stock price forecasting.
2. **ARIMA Model:** The ARIMA model was selected using the auto.arima() function, which automatically determines the best parameters based on statistical criteria. ARIMA is well suited for time series data with trends but does not explicitly model seasonality unless specified.

**Evaluation Metrics**

To assess the accuracy of both models, I used the following performance indicators:

* **Root Mean Squared Error (RMSE):** Measures the average magnitude of forecast errors. Lower values indicate better accuracy.
* **Mean Absolute Percentage Error (MAPE):** Evaluates the percentage deviation between predicted and actual values. A lower MAPE suggests a more reliable forecast.

To compare the models fairly, I tested them using stock prices from January 2024 to December 2024 as the test set.

**Results & Model Comparison**

**Holt-Winters Model:**

* **RMSE:** 13.03
* **MAPE:** 5.56%

The Holt-Winters model effectively captured both the trend and seasonality present in the stock prices, resulting in relatively accurate forecasts.

**ARIMA Model:**

* **RMSE:** 18.77
* **MAPE:** 8.34%

While the ARIMA model was able to capture the underlying trend, its performance was weaker compared to Holt-Winters. This could be because ARIMA does not explicitly account for seasonal patterns, which might have affected its forecasting accuracy.

**Interpretation & Conclusion**

The evaluation metrics clearly indicate that **Holt-Winters outperformed ARIMA** in this case. With a lower RMSE and MAPE, Holt-Winters provided more accurate and reliable predictions. The presence of seasonality in Apple’s stock prices likely gave Holt-Winters an advantage over ARIMA, which focuses more on trend-based patterns.

In summary, based on the results, **Holt-Winters Exponential Smoothing is the better choice for forecasting Apple’s stock prices in this scenario.** Its ability to incorporate both trend and seasonality made it more effective in predicting future prices compared to ARIMA.

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