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For my assignment, I applied four different forecasting models: Naive, ETS (Error, Trend, Seasonal), Moving Average (MA5), and Holt-Winters. Here's my detailed analysis of the model outputs, the accuracy measures, and which model performed the best.

**Naive Forecast**

The Naive model simply assumes that the forecast for the next period is the same as the last observed value. While this model is straightforward, it doesn't account for trends or seasonality, which are important factors in my dataset.

* RMSE: 1.15389
* MAE: 0.874063
* MAPE: 0.3274991

In this case, the errors are relatively high, indicating that the Naive model is not well-suited for my dataset. The lack of trend and seasonal adjustments means it doesn’t capture the underlying structure of the data, which leads to larger forecast errors. The plot for the Naive forecast confirms this, showing flat predictions that fail to reflect the fluctuations in my data.

**ETS (Error, Trend, Seasonal) Model**

The ETS model is more sophisticated, capturing error, trend, and seasonal components in the data. This model automatically selects the most appropriate combination of these factors.

* RMSE: 0.7028751
* MAE: 0.5309777
* MAPE: 0.200057

The ETS model performed the best, with the lowest errors across all measures. The low RMSE means that it has fewer large errors, and the MAE indicates smaller average errors. The MAPE shows that the forecast errors are small relative to the actual values. From the plot, the ETS model clearly adapts to the trends and seasonality in my data, making it a strong choice for forecasting.

**Moving Average (MA5)**

The Moving Average model averages the last five observations to smooth the data. While this method helps reduce noise, it isn’t a strong forecasting tool for future periods.

Although the plot shows a smoother series, the Moving Average model lacks predictive power. It’s mainly useful for smoothing the data rather than forecasting, and it doesn’t capture any trend or seasonal behavior.

**Holt-Winters Model**

The Holt-Winters model uses three smoothing parameters: alpha, beta, and gamma. These parameters control the level, trend, and seasonal components, respectively.

* Alpha (0.9597): This indicates that the model places significant weight on recent data, meaning it is highly reactive to changes in the dataset. Since alpha is close to 1, the model adapts quickly to new data points, giving more of a priority to the latest observations.
* Beta (0.2026): The moderate beta tells me that this model is adjusting for the trend but is not overly sensitive to small changes. The lower beta value indicates that the model smooths out the trend more slowly and avoids overreacting to short-term fluctuations.
* Gamma (1.0): Gamma controls seasonality, and a value of 1 indicates that the model fully emphasizes the seasonal pattern in the data.
* RMSE: 0.9475624
* MAE: 0.7201522
* MAPE: 0.2707807

The Holt-Winters model performed better than the Naive model but didn’t match the accuracy of the ETS model. While it does capture the seasonality well (as indicated by the gamma value), the slightly higher RMSE and MAE suggest that it doesn’t handle the trends as effectively as ETS. The plot for Holt-Winters shows the model adjusting for both seasonality and trend, but the errors are still larger than those for ETS.

**Choosing the Best Model**

After reviewing the accuracy metrics, the ETS model clearly stands out as the best performer. With the lowest RMSE, MAE, and MAPE values, ETS captures both the trend and seasonality in my data while minimizing forecast errors. The Naive and Holt-Winters models are less accurate, with larger errors, and the Moving Average model is more useful for smoothing rather than forecasting.

**Conclusion**

Based on the accuracy measures and model performance, the ETS model is the most appropriate for my dataset. It provides the best balance of accuracy, adapting to both the trend and seasonal components, making it the optimal choice for forecasting in this assignment.