Model Generalization for AAPL Stock Price Forecasting

This report compares how well two models- ARIMA (AutoRegressive Integrated Moving Average) and LSTM (Long Short-Term Memory neural network) predict Apple (AAPL) daily closing stock prices from January 1, 2015, to January 1, 2025. I assess generalization (accuracy on unseen data) using error metrics from a single test split and a rolling-window cross-validation (5 folds via TimeSeriesSplit). Lower errors indicate better generalization.

Performance Results

- **Single Test Split**:
  - ARIMA: RMSE = 2.55, MAPE = 1.02%
  - LSTM: RMSE = 34.69, MAPE = 14.01%
- **Rolling-Window Cross-Validation** (Mean RMSE, 5 folds):
  - ARIMA: 1.85
  - LSTM: 10.99
- **Key Observation**: ARIMA consistently shows lower errors, indicating better predictive accuracy.

Why ARIMA Generalizes Better

- **Matches Data Patterns**:
  - ARIMA handles non-stationary stock prices effectively by smoothing trends and capturing repeating patterns.
  - LSTM, designed for complex patterns, may struggle with noise in stock data and a limited dataset (~2,500 days).
- **Simpler and More Robust**:
  - ARIMA requires minimal tuning, reducing overfitting risk and delivering reliable results.
  - LSTM's complexity (e.g., multiple layers, 50 epochs) needs more data and careful tuning, leading to higher errors if not optimized.
- **Consistent Over Time**:
  - Rolling-window results show ARIMA's stable performance across different time periods.

    - LSTM's higher errors suggest it's less adaptable to changing market conditions, possibly due to overfitting.

Conclusion

- ARIMA is the better choice for forecasting AAPL stock prices, offering superior accuracy and stability.
- LSTM could improve with more data or additional features (trading volume, market sentiment), but ARIMA is recommended for reliable predictions in this scenario.