Model Prediction F1 racing

GOAL:

- Forecast 5 future lap times for a F1 driver for a specific race using data from 2014-2023

APPROACH:

- Statistical Learning
- Machine Learning

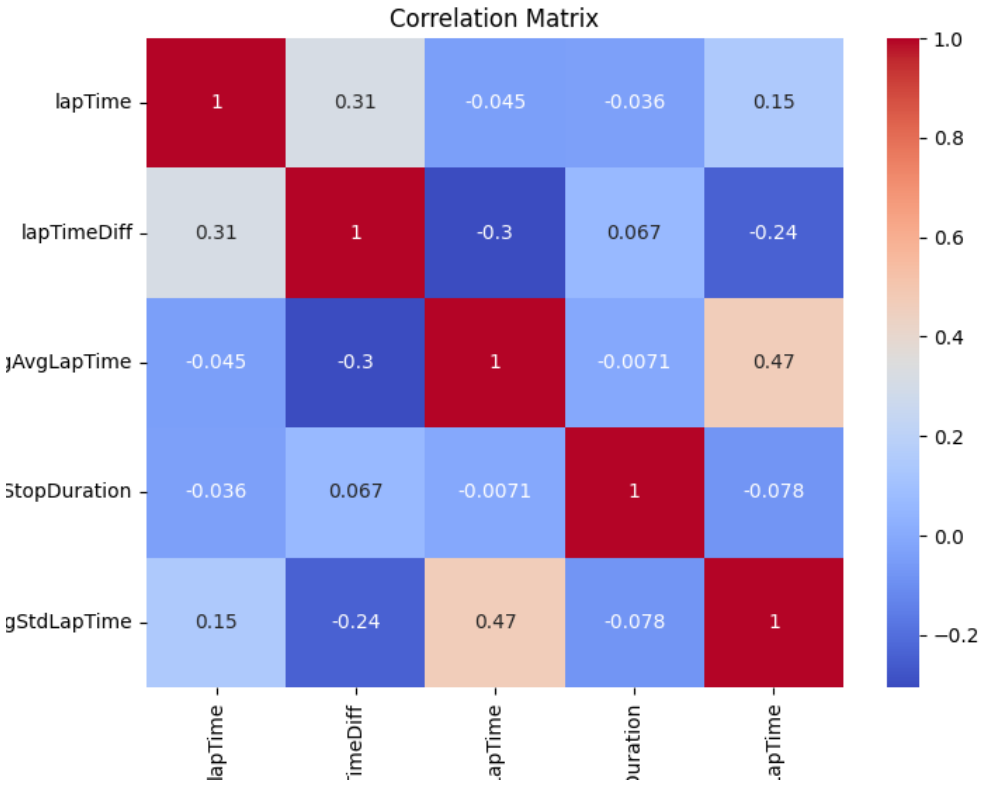
ERROR METRICS:

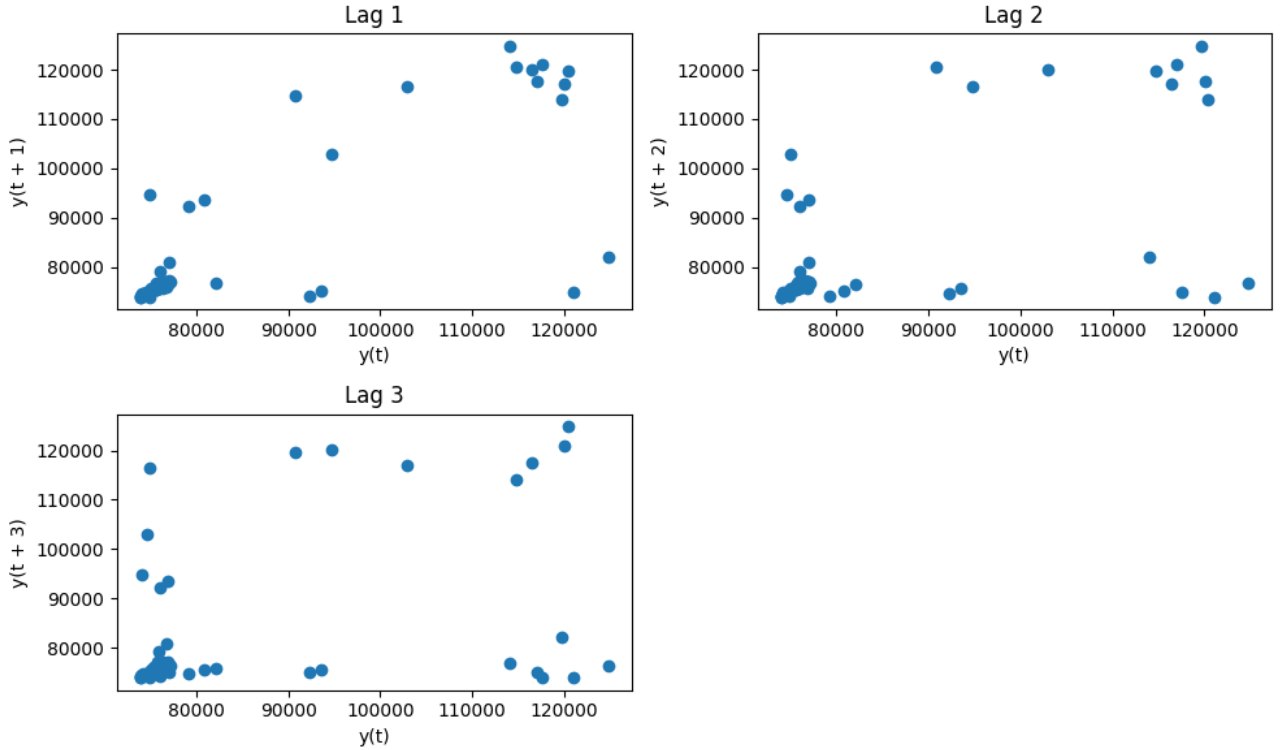
- RMSE (Root Mean Squared Error)
- MAE (Mean Absolute Error)

STEPS:

- Data Aggregation
- Data Visualization
- Model Selection
- Model Tuning
- Comparison of Models

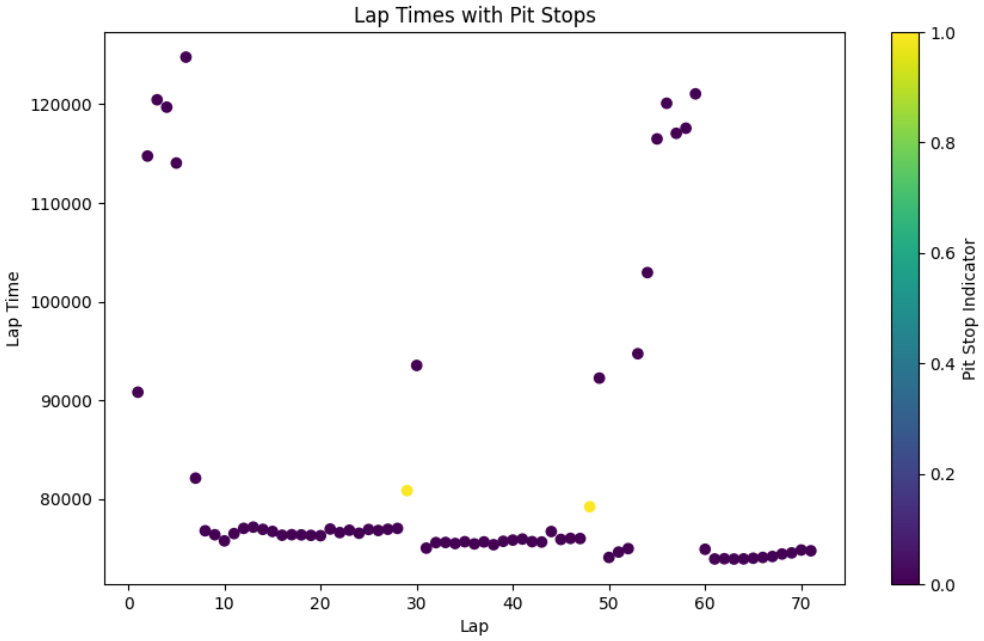
Data Visualization

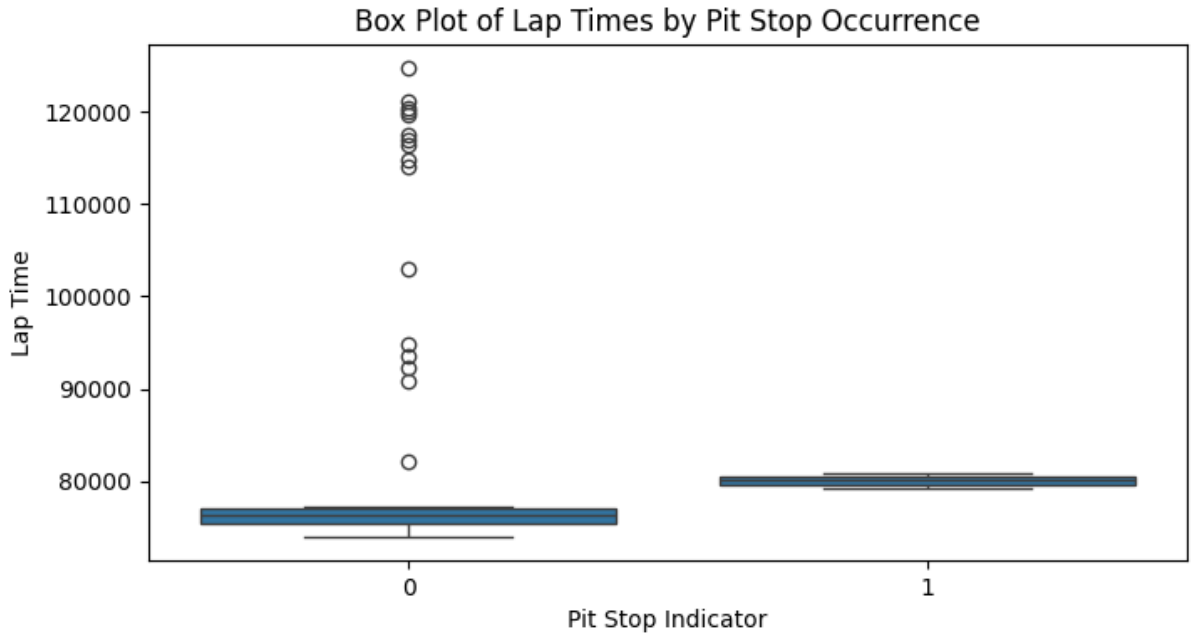




- Moderate positive and negative correlation among some variables
- If lag plot is linear, we can infer that the underlying structure is of the autoregressive model and autocorrelation is present
- If lag plot is of elliptical shape, we can say that the underlying structure represents some continuous periodic function
- Not clear from the lag plots the distribution of the data

Data Visualization





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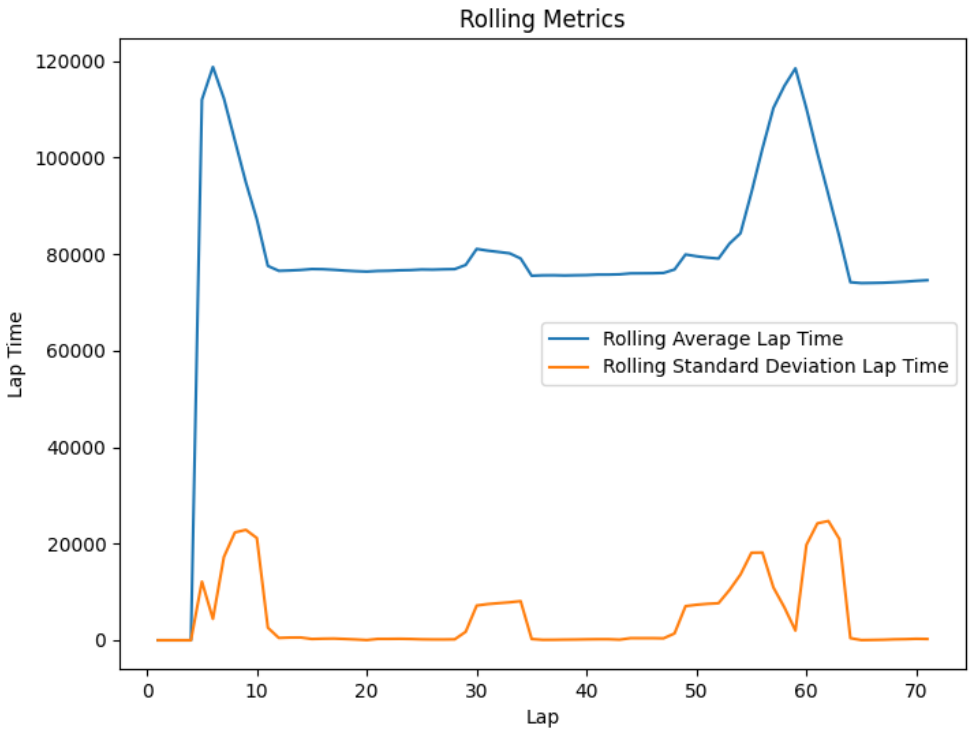

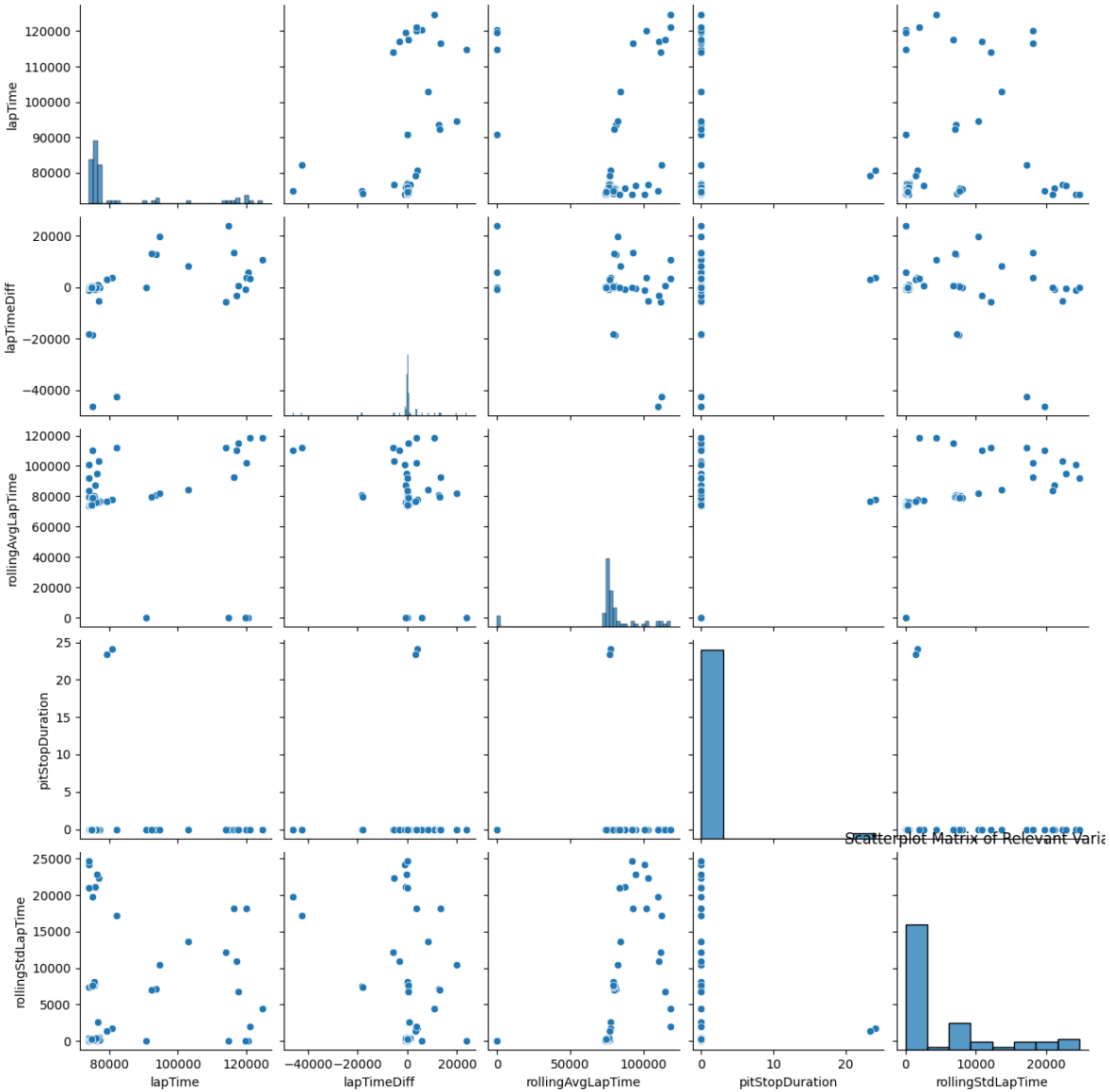

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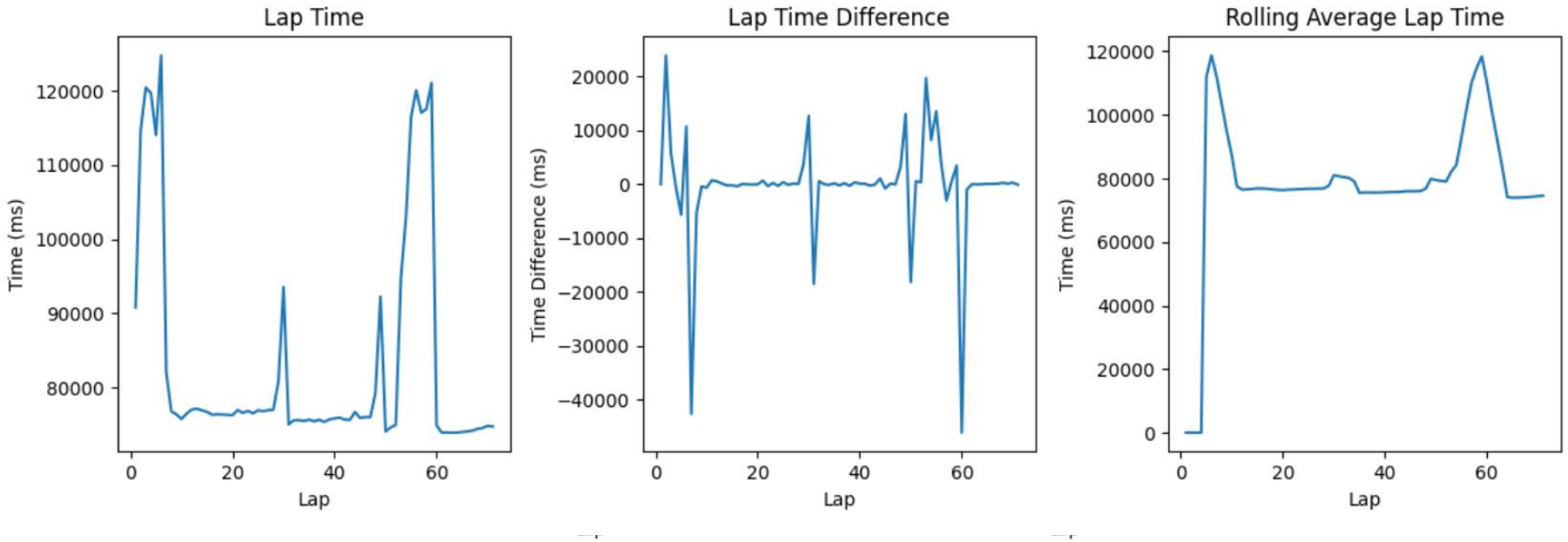

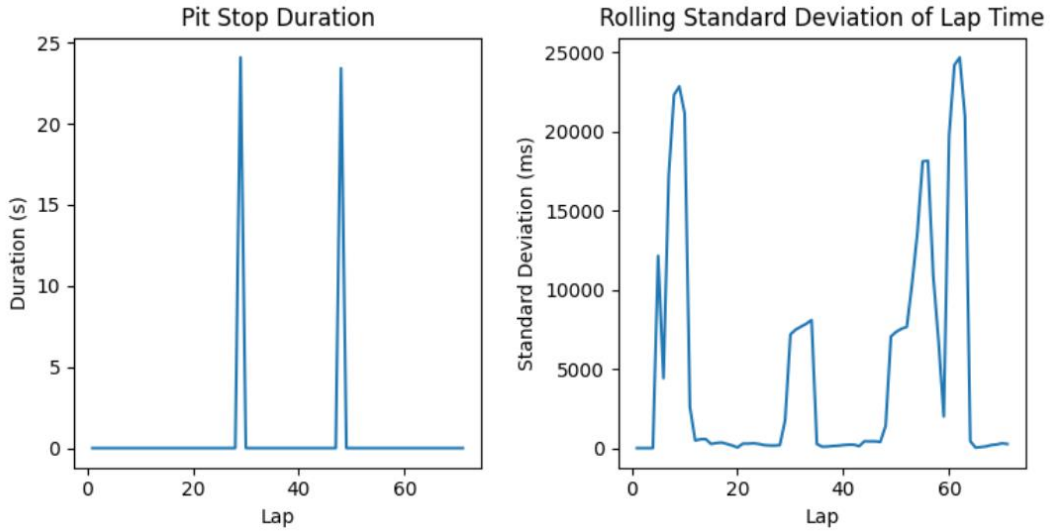

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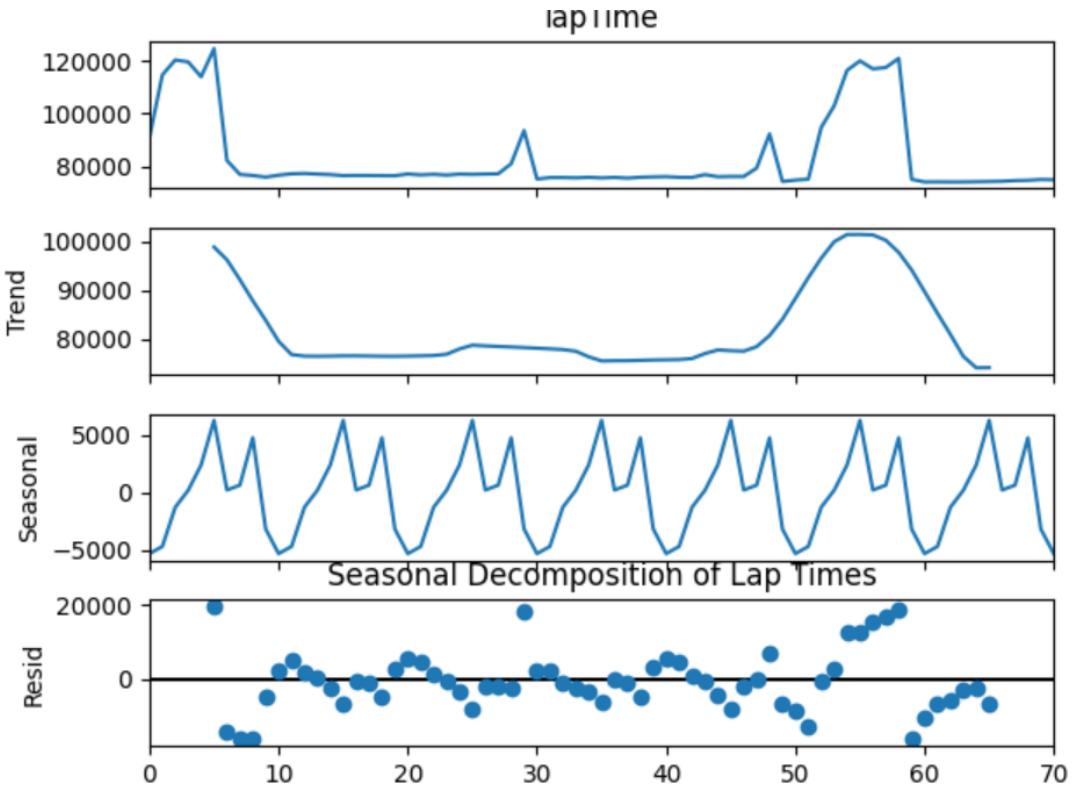
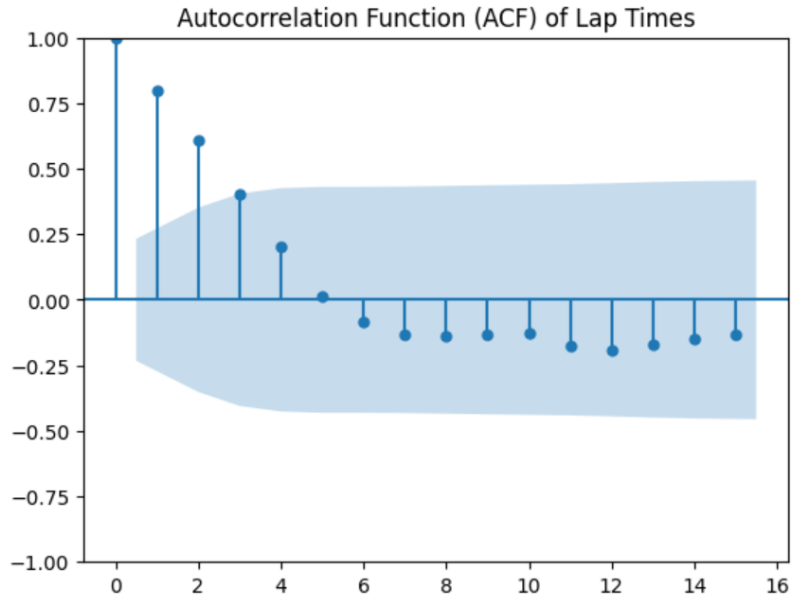
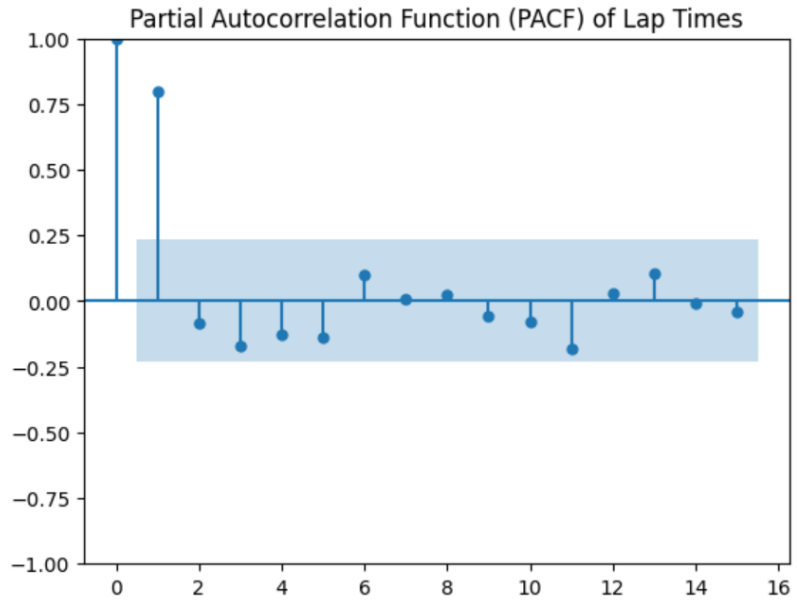






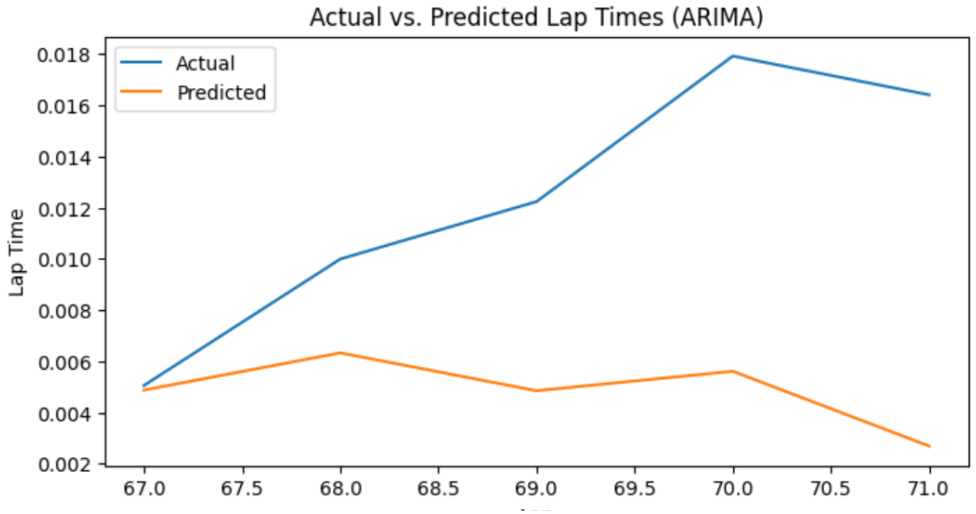
ARIMA Model Specification

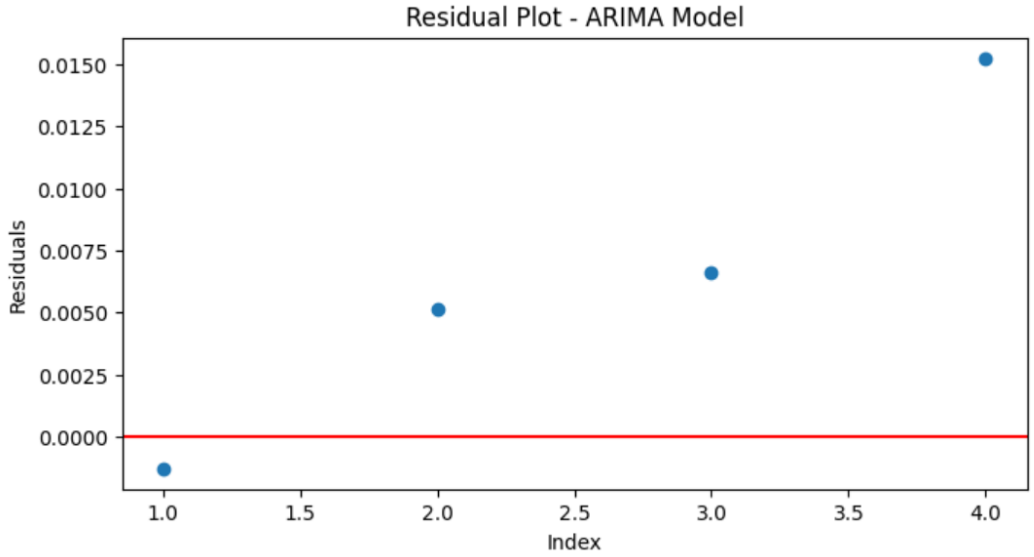
Best Hyperparameters with lowest RMSE in train set:

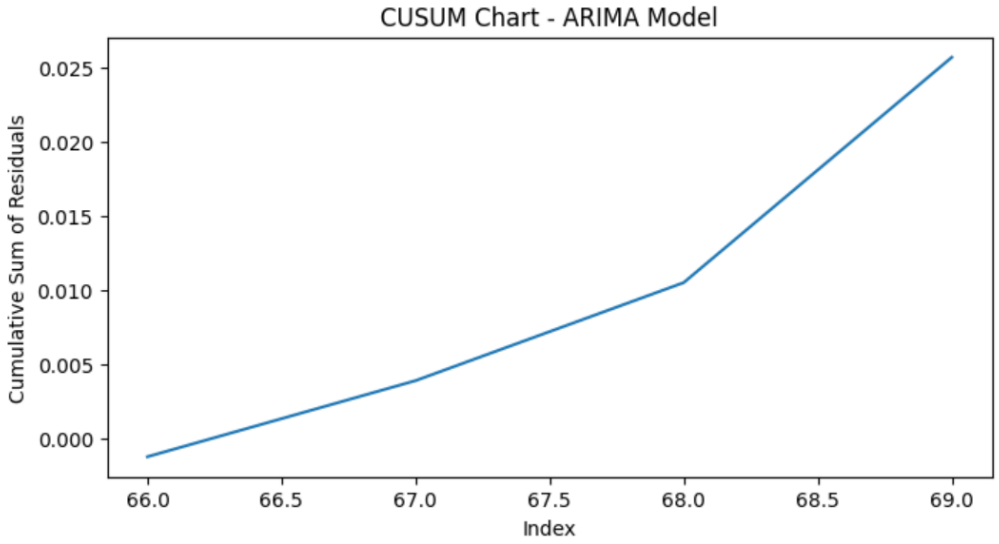
(p,d,q) = (2,1,0) ⟶ ARIMA(2, 1, 0) model

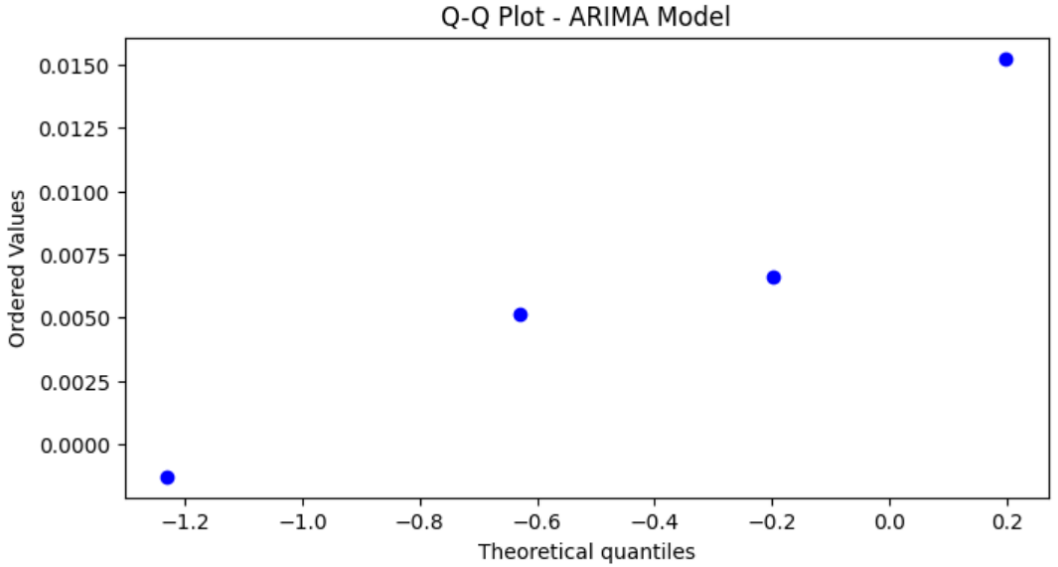
Test RMSE = 0.009
Test MAE = 0.007

ARIMA Model Results

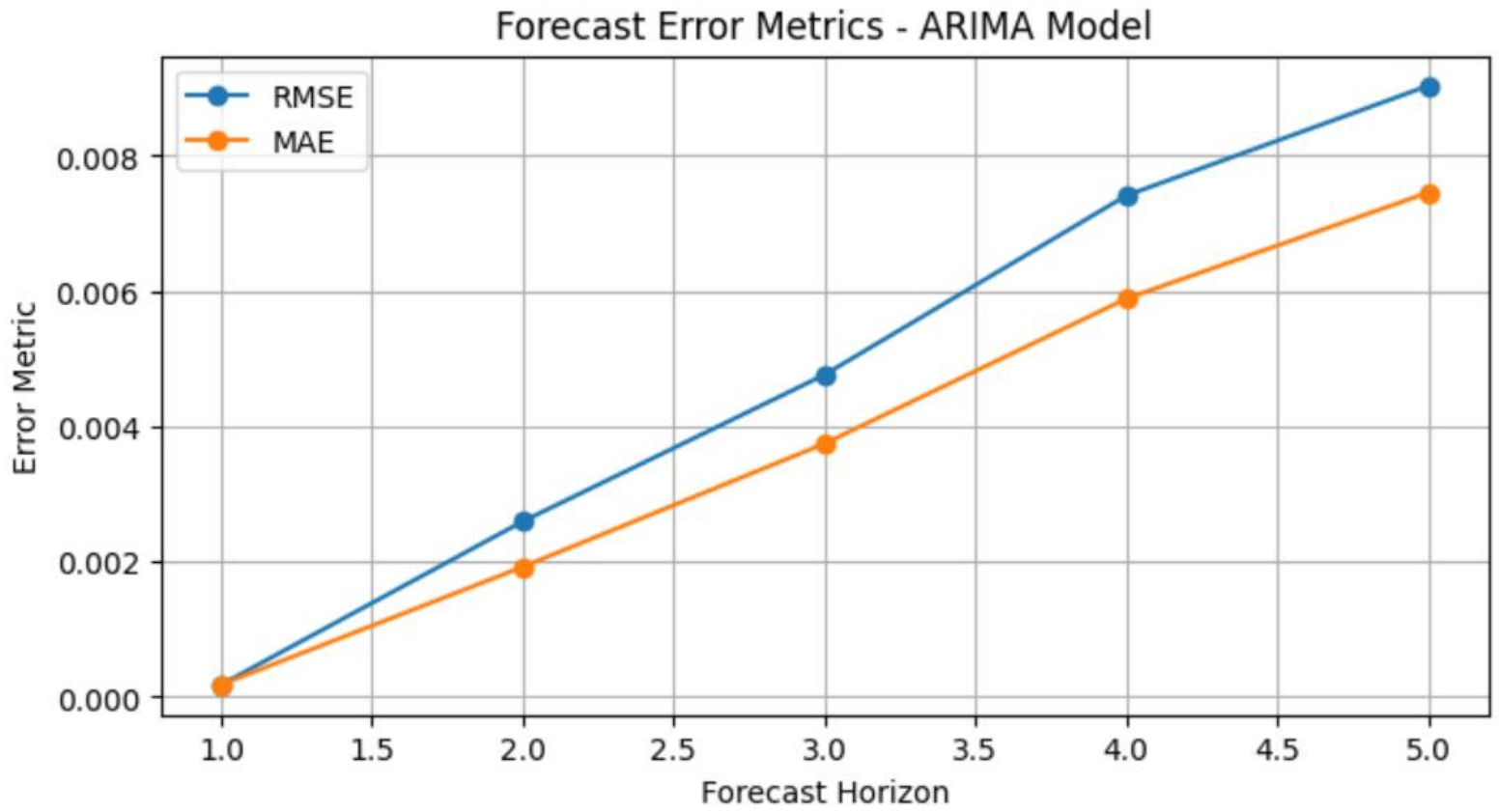








ARIMA Model Results



LSTM Model Specification

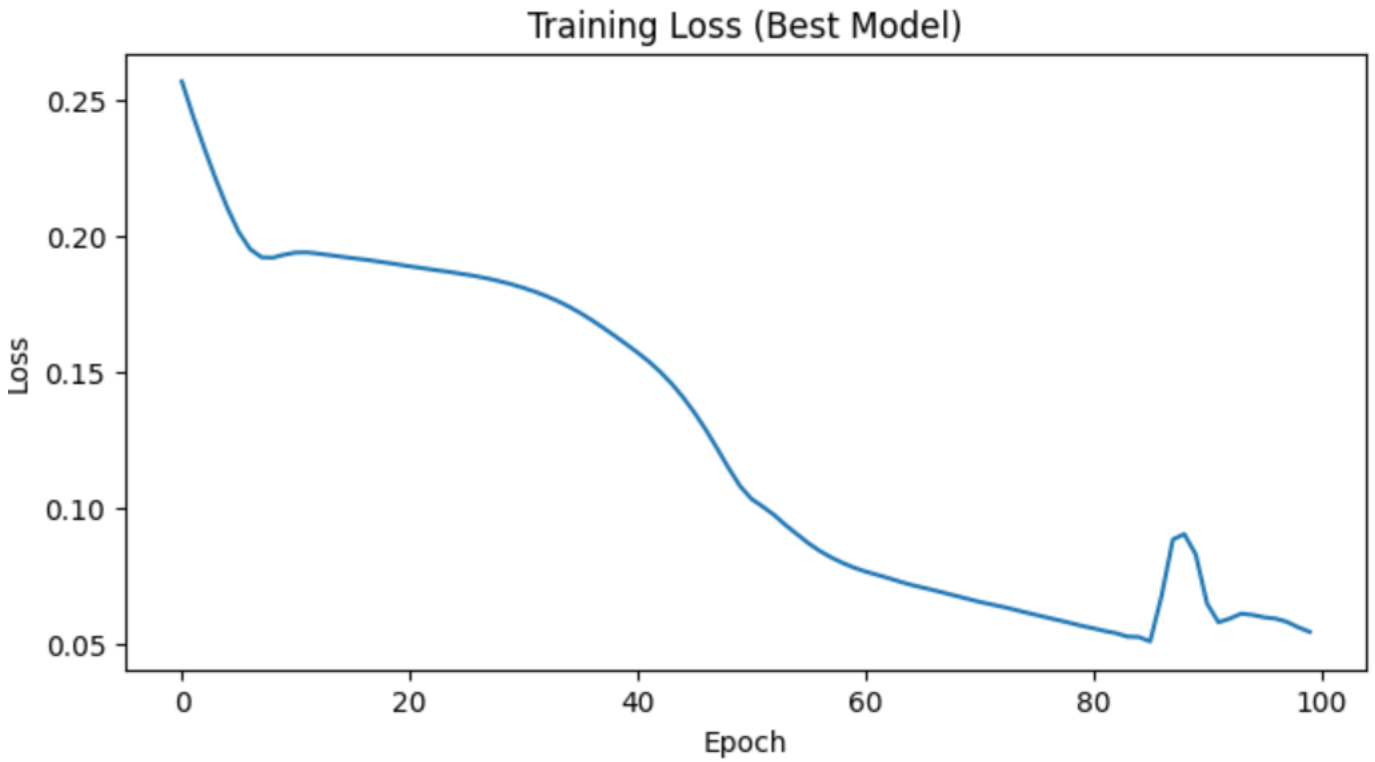
hidden_dim = 32
num_layers = 2

num_epochs = 100
batch_size = 16

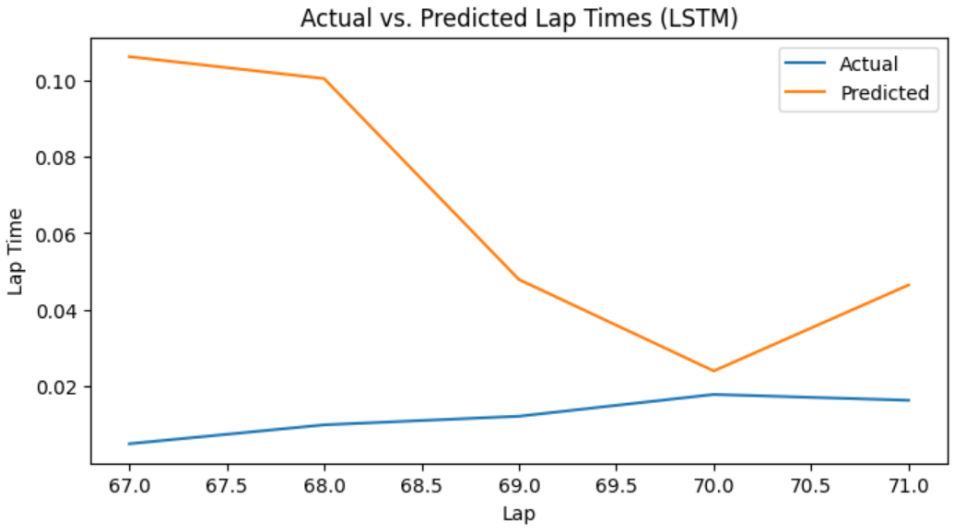
window_sizes = [5, 10, 15, 20]

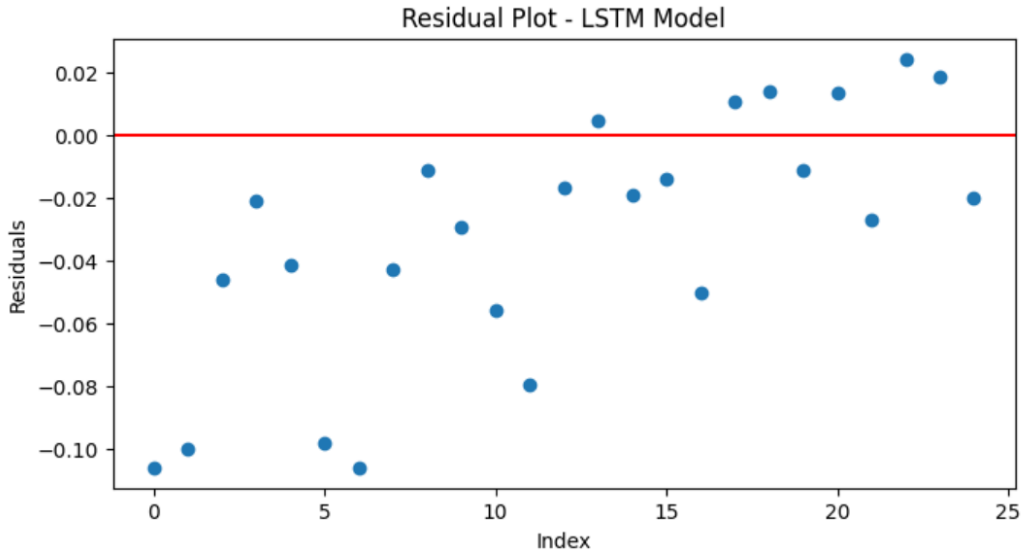
Best Window Size = 20
Best RMSE = 0.0393

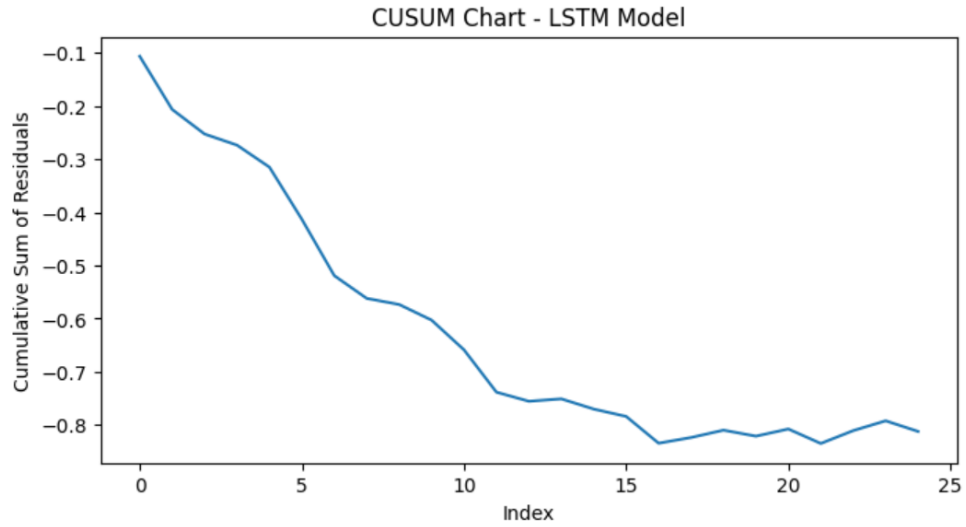
Test RMSE = 0.0641
Test MAE = 0.0526

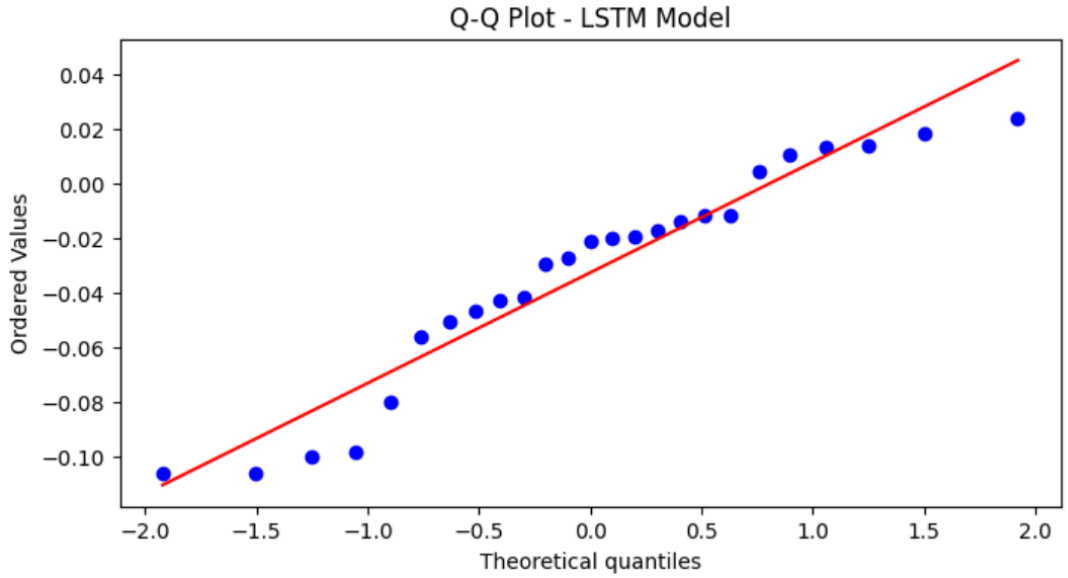


LSTM Model Results

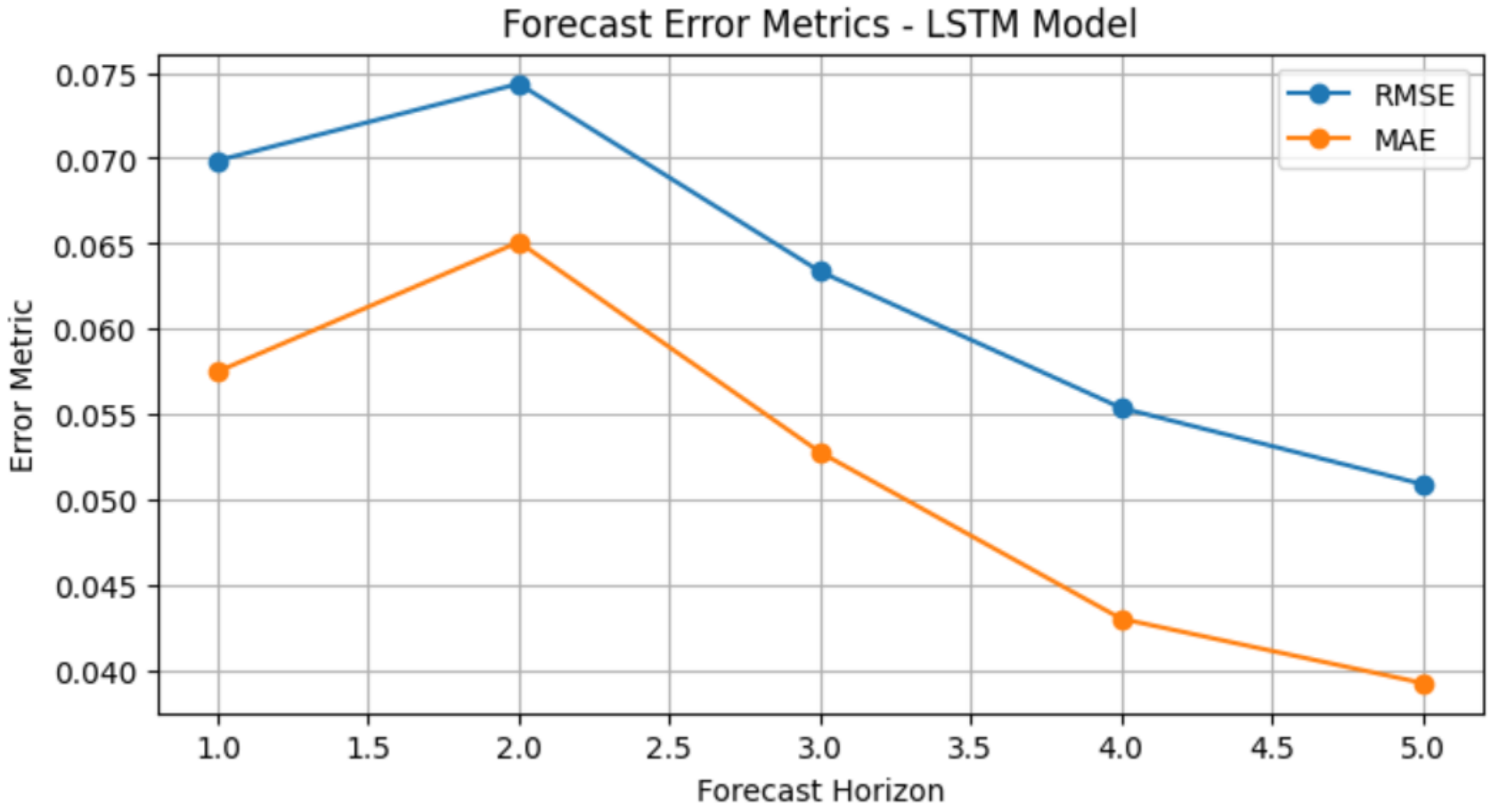








LSTM Model Results



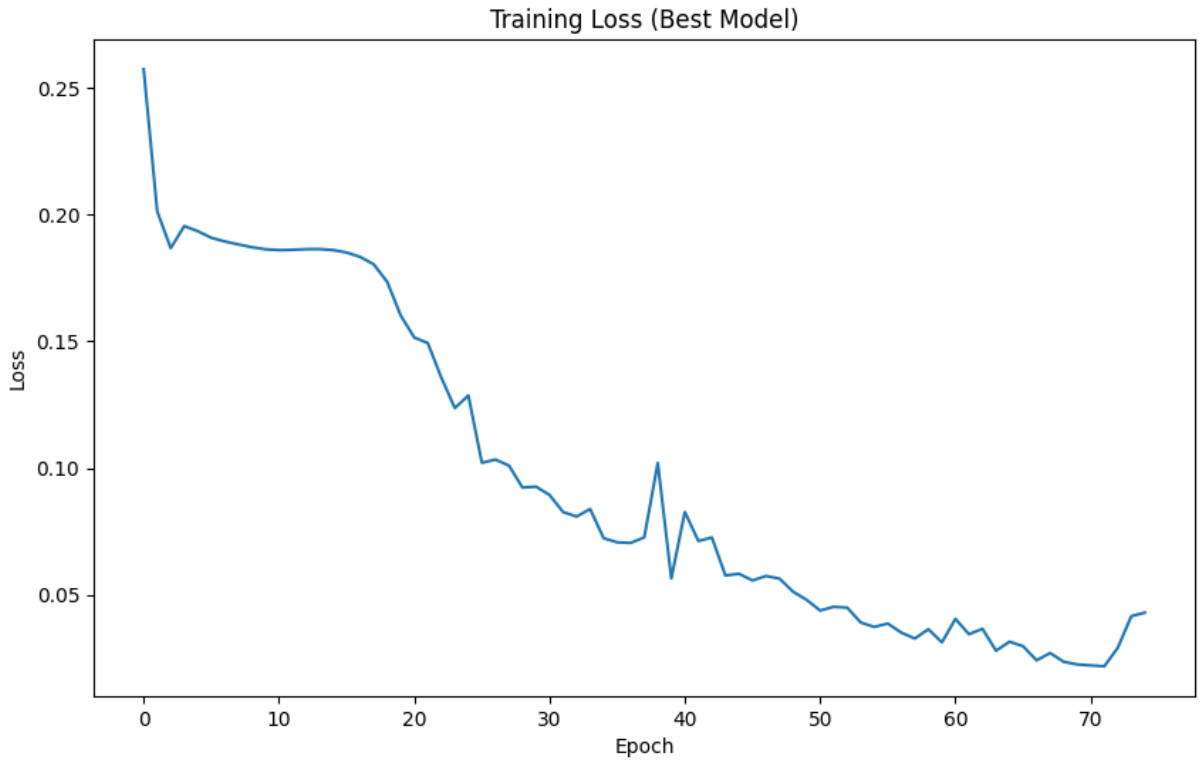
LSTM Model Tuning (Optuna)

hidden_dim = 52
num_layers = 4
learning rate = 0.003

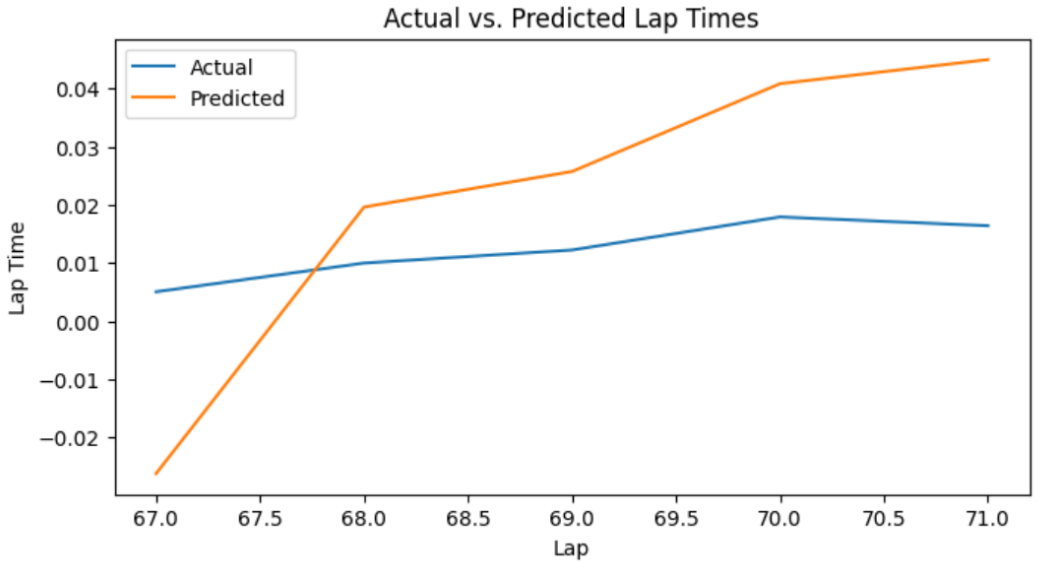
num_epochs = 100
batch_size = 16

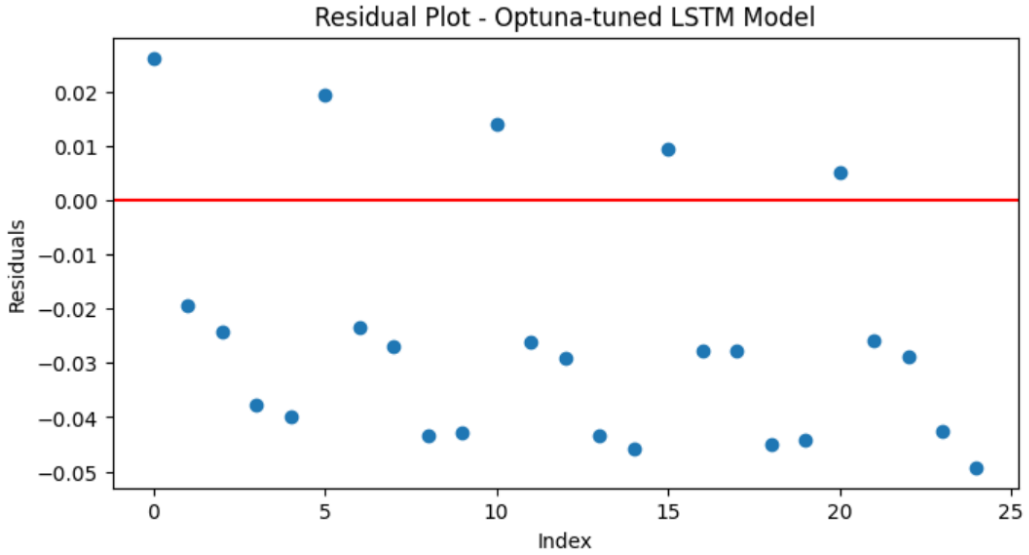
Best Window Size = 19
Best RMSE = 0.0167

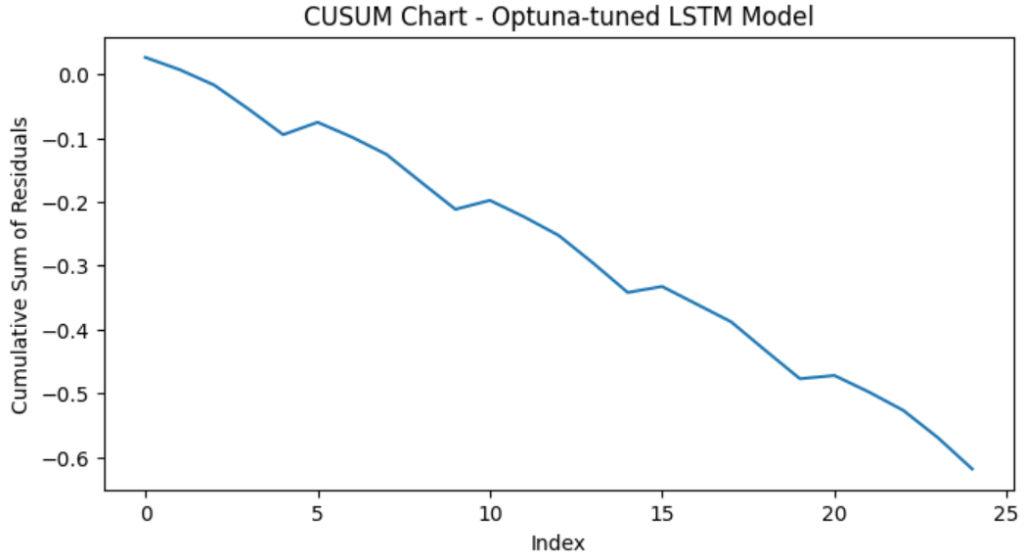
Test RMSE = 0.0227
Test MAE = 0.02117

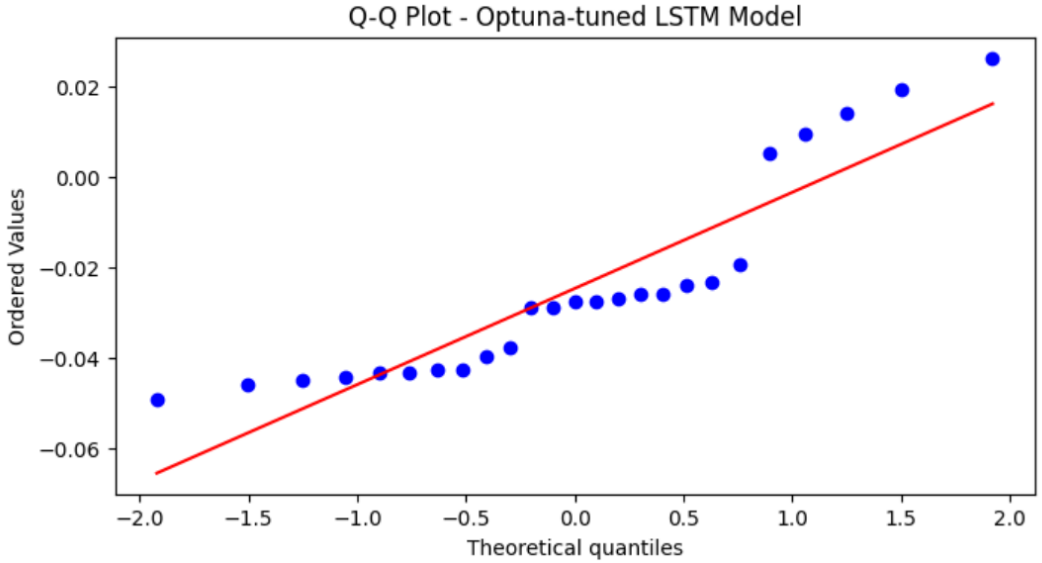


LSTM Model Results (with hyperparameter tuned - Optuna)

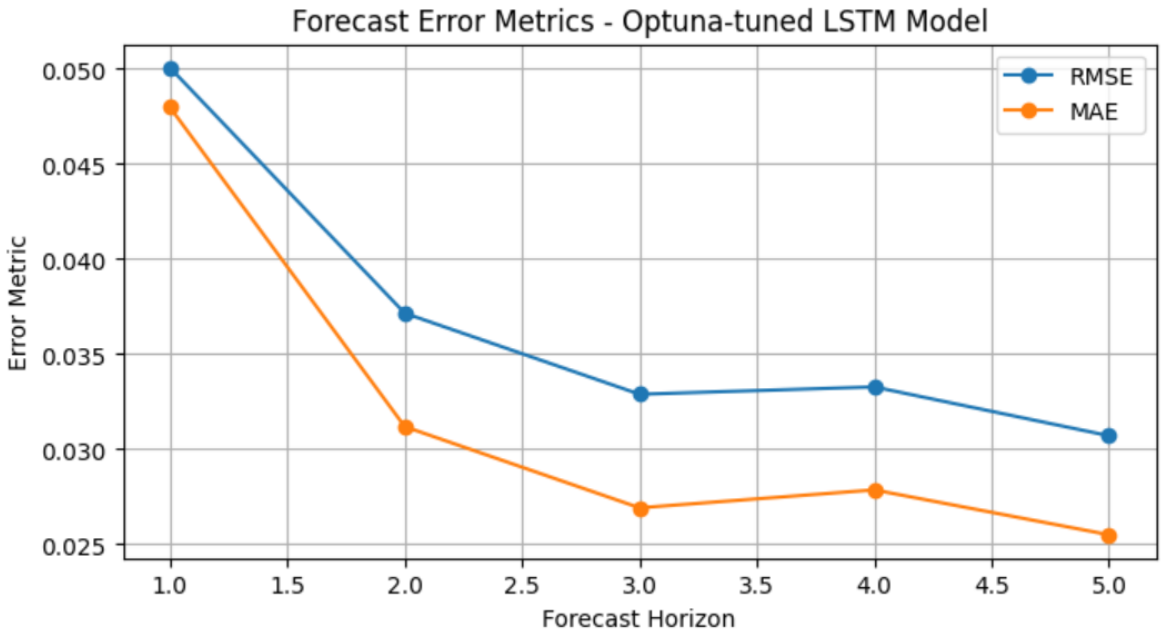


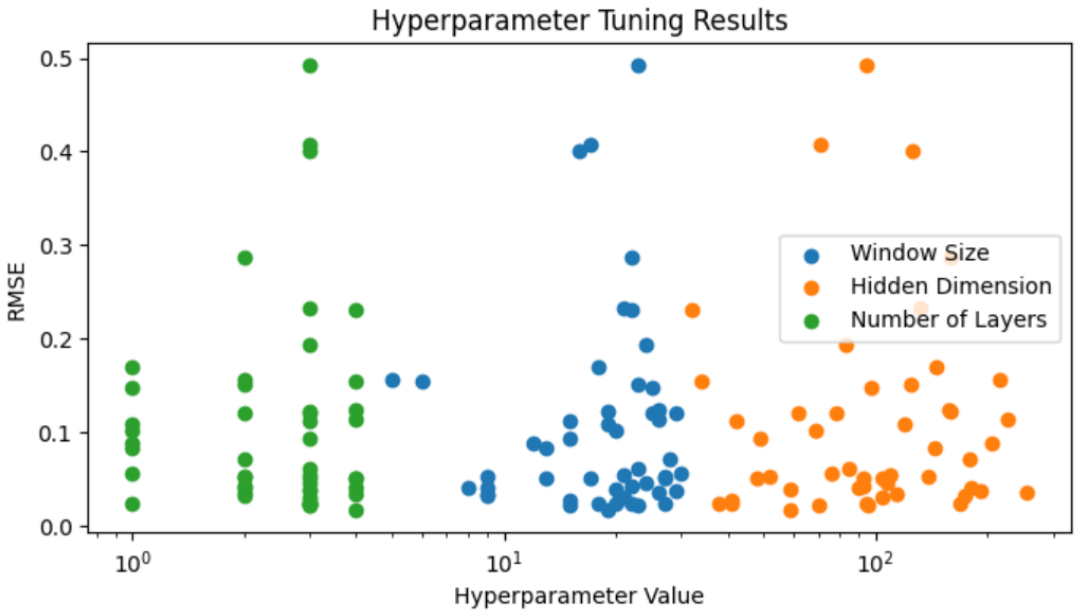




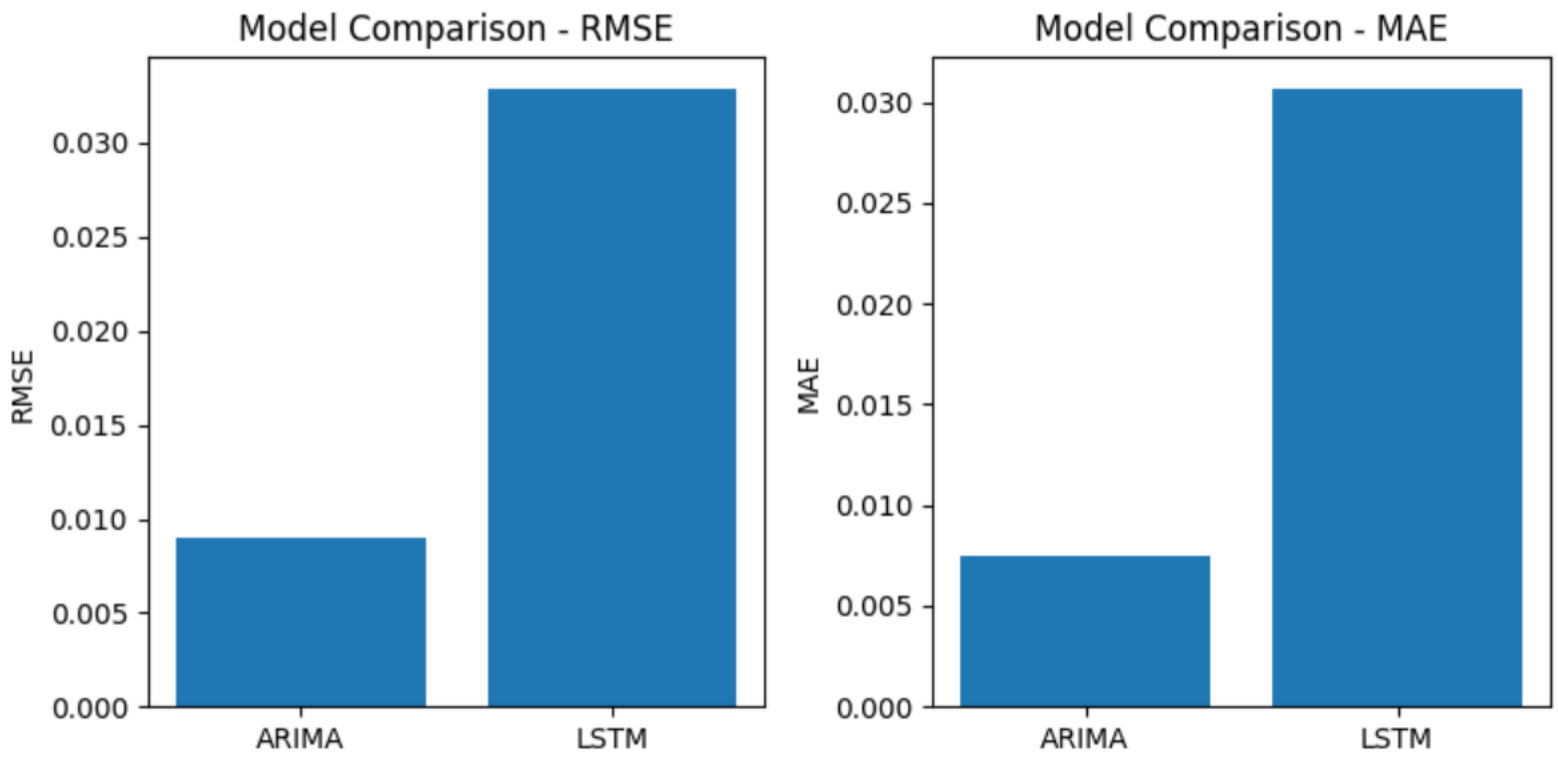


LSTM Model Results (with hyperparameter tuned)





Model Comparison



Thank You