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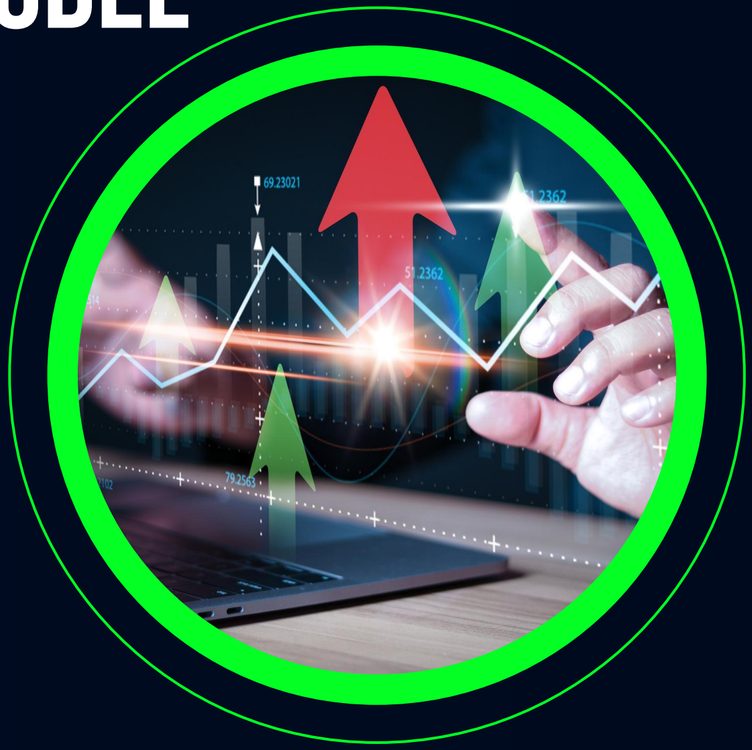
AN EXPERIMENT: OPTIMIZING LSTM MODEL FOR STOCK PRICE (TESLA) PREDICTION

Forecasting Tesla's next-day stock price using LSTM model



Team Members:

- BEN, BUT, CHARLES, HAZEL

Start Presentation

2025 Presentation

PROJECT OBJECTIVE

Objective:

To develop an LSTM model for predicting Tesla's next-day stock price by experimenting with input windows, epoch sizes, and LSTM layer configurations to determine the optimal setup for accurate prediction.

Key Questions:

- Can an LSTM model accurately forecast Tesla’s next-day stock price?
- What is the optimal combination of parameters for predicting Tesla's next-day stock price?
- Are there any overfitting risks with certain configurations? How can they be mitigated?
- Does the LSTM outperform a naive forecast?

DATASET OVERVIEW

- Stock: Tesla
- Data Source: Yahoo Finance
- Time Period: 2014 to 2024 (01/01 to 31/12)
- Features Used: Date, Close Prices (Daily(trading day))
- Target Variable: Closing price (next day)

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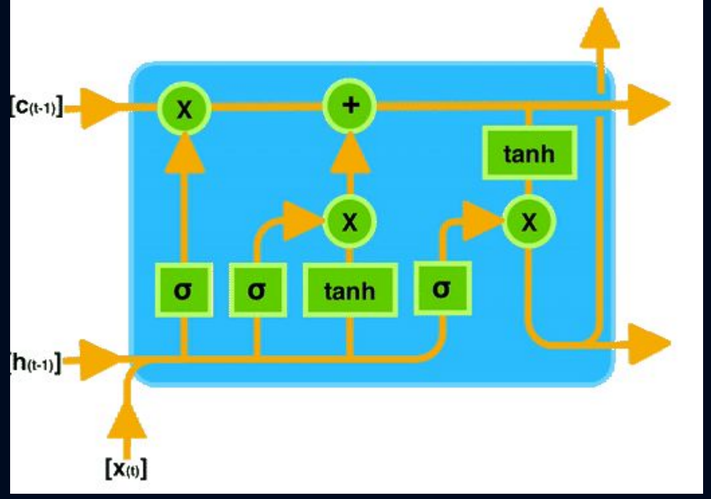
LSTM MODEL OVERVIEW



Why LSTM?

- Designed for sequential data (time series)
- Capture temporal dependencies across multiple time steps
- Suitable for stock price prediction due to its ability to model long-term trends

Model Architecture:

- Recurrent Neural Network(RNN) Model
  - Forget Gate, Input Gate, Output Gate
- Steps:

1. Looks at past info and new data (past stock price).
2. Forgets unimportant things.
3. Remembers useful new information.
4. Gives an output (predicting tomorrow's price).

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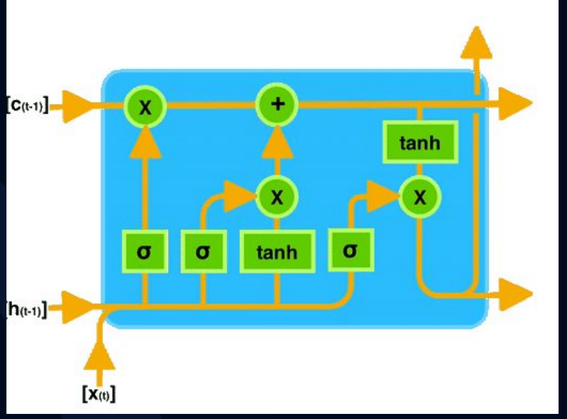
METHODOLOGY



Data Preparation:

- Extract and Peprocess Data from Yahoo Finance
- Missing & Null Value Checking
- Rescaling (min-max normalization): Rescaling the range of features to scale the range in [0, 1]
- 80%-Training, 20%-Validation

LSTM Settings:

- Input window size (60, 30, 10, 5), next day's price as the target
- Layer Setting:
  - 1st Layer: 128; 2nd layer: 64
  - 1st Layer: 256; 2nd layer: 128
  - 1st Layer: 512; 2nd layer: 256
- Epoch Setting:
  - 50, 1000 Epoch
- Batch Size: 32
- Dropout Layer: 20% dropout
- Dense Layer: 25 -> 1 units

Evaluation Metrics:

- R^2 Score
- Mean Absolute Error (MAE)
- Mean Squared Error (MSE)
- Root Mean Squared Error (RMSE)
- Comparison with naive forecast

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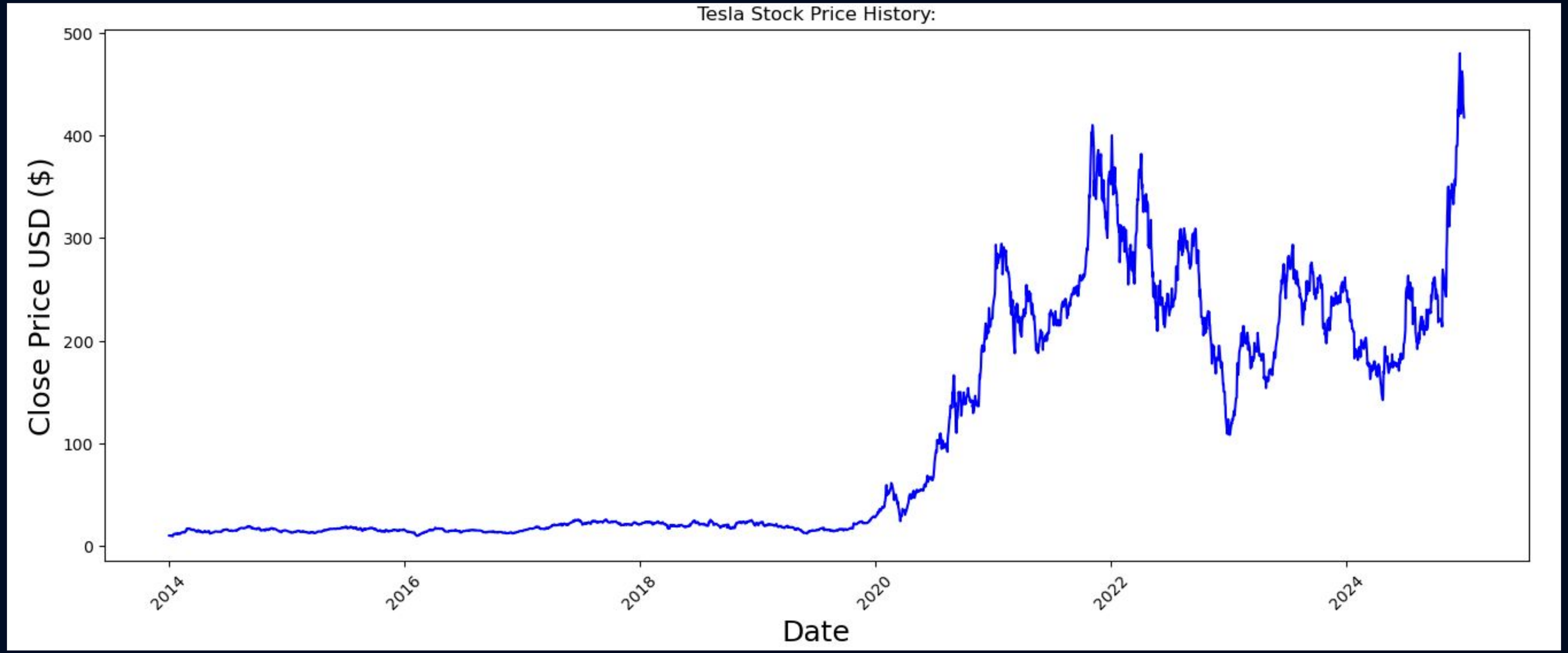
TESLA STOCK PRICE HISTORY



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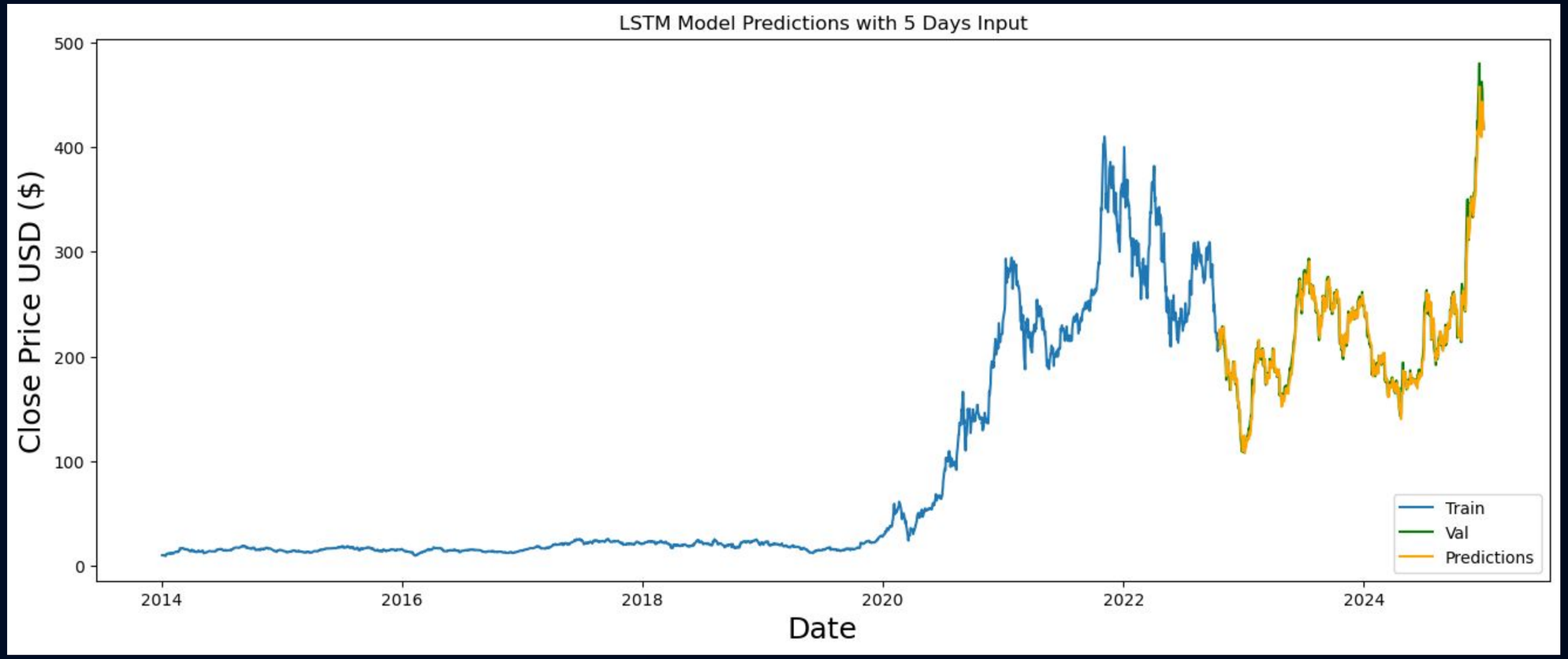
EXAMPLE

- LSTM: 512/256 Layer
- Epoch: 1000
- 5 Days Input



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EXAMPLE

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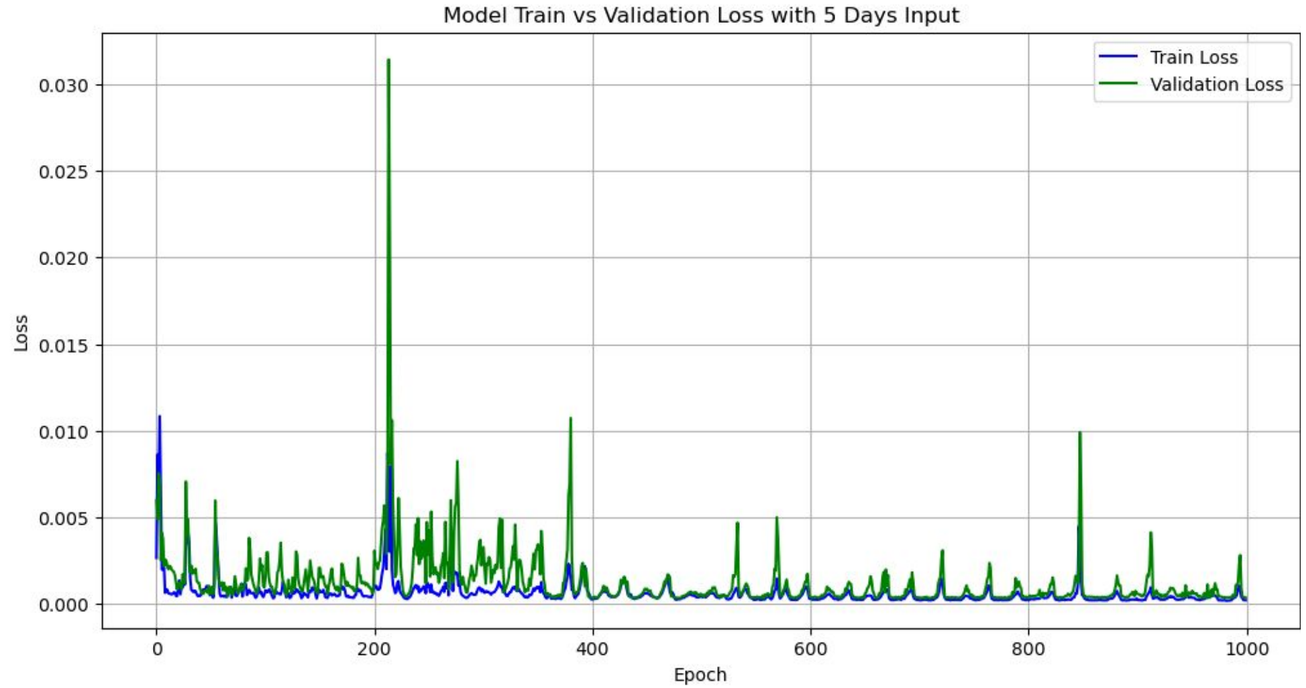
- Epoch: 1000
- 5 Days Input



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RESULT: LSTM 128/64

	Input Days				
Epoch : 50		60	30	10	5
	R^2 Score:	0.7428	0.7510	0.6488	0.7722
	Mean Absolute Error (MAE)	27.6385	26.0889	31.7359	25.3057
	Mean Squared Error (MSE)	851.0045	823.9134	162.1004	753.5819
	Root Mean Squared Error (RMSE)	29.1720	28.7039	34.0896	27.4514
	Predicted stock price for 2024-12-31	$399.24	$376.21	$377.24	$395.02

Epoch : 1000		60	30	10	5
	R^2 Score:	0.9750	0.9492	0.9635	0.9746
	Mean Absolute Error (MAE)	6.4624	10.8464	7.1809	6.7507
	Mean Squared Error (MSE)	82.7977	168.1439	120.7022	84.1947
	Root Mean Squared Error (RMSE)	9.0993	12.9670	10.9865	9.1758
	Predicted stock price for 2024-12-31	$420.24	$416.81	$388.79	$420.41

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RESULT: LSTM 256/128

	Input Days				
Epoch : 50		60	30	10	5
	R^2 Score:	0.7224	0.9512	0.9355	0.5301
	Mean Absolute Error (MAE)	28.4841	8.9993	12.1694	34.5408
	Mean Squared Error (MSE)	918.5099	161.4600	213.4480	1554.7187
	Root Mean Squared Error (RMSE)	30.3069	12.7067	14.6099	39.4299
	Predicted stock price for 2024-12-31	$379.85	$386.98	$404.27	$342.55

Epoch : 1000		60	30	10	5
	R^2 Score:	0.9661	0.9614	0.9679	0.9728
	Mean Absolute Error (MAE)	8.2405	8.5385	6.5828	7.1826
	Mean Squared Error (MSE)	112.0645	127.6787	106.3648	89.8919
	Root Mean Squared Error (RMSE)	10.5861	11.2995	10.3133	9.4811
	Predicted stock price for 2024-12-31	$426.67	$412.77	$290.08	$422.43

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RESULT: LSTM 512/256

	Input Days				
Epoch : 50		60	30	10	5
	R^2 Score:	0.8959	0.9491	0.9566	0.5883
	Mean Absolute Error (MAE)	12.3222	8.8290	7.7919	23.1218
	Mean Squared Error (MSE)	344.4414	168.3586	143.5481	1362.2894
	Root Mean Squared Error (RMSE)	18.5591	12.9753	11.9812	36.9092
	Predicted stock price for 2024-12-31	$353.41	$381.78	$383.74	$278.34

Epoch : 1000		60	30	10	5
	R^2 Score:	0.9502	0.9665	0.9205	0.9750
	Mean Absolute Error (MAE)	10.5560	8.0045	14.2956	6.3659
	Mean Squared Error (MSE)	164.9266	110.7121	262.9412	82.6635
	Root Mean Squared Error (RMSE)	12.8424	10.5220	16.2155	9.0919
	Predicted stock price for 2024-12-31	$423.15	$419.39	$409.13	$404.76

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SECTION SUMMARY

- Best Settings:
  - Use 1000 Epoch Instead of 50 Epoch
  - Use 5 Days or 60 Days for Prediction
  - No Obvious Difference in the Size of LSTM Layer
- Best Result in this Training:
  - LSTM 512/256
  - 5-Days

Predict Stock Price on 01/01/2024:	$404.76
Naive Forecast:	$417.41
Actual Stock Price:	$379.28

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FURTHER EXPLORATION

- Overfit Validation
  - Use RMSE from Performance Metric instead of Loss Function
  - Code:

```
if train_rmse < test_rmse * 0.8:
    print("⚠️ Overfitting detected! Consider adding dropout or reducing LSTM units.")
elif train_rmse > test_rmse * 1.2:
    print("⚠️ Underfitting detected! Consider increasing LSTM units or learning rate.")
else:
    print("✅ Model is well-fitted.")
```

  - All Result in Overfit by Adjusting:
    - No. of Units
    - Lookback Day
    - Dropout Rate
    - Learning Rate

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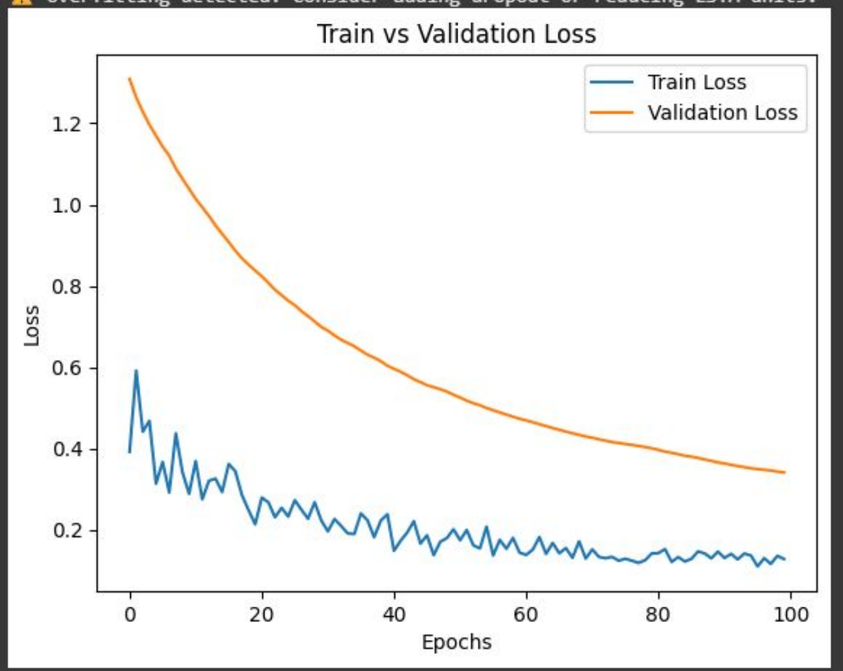
SUMMARY

- Good Model for Stock Price Prediction
  - Limited to Historical Data
- Overfitted Model
  - Room for Refinement to be Well-fitted

```
for lookback in lookback_periods:
        parallel_grid_search('TSLA', lookback, param_grid)
```

```
[**********100%**********]  1 of 1 completed
Training with units=1, dropout=0.9, lr=0.0001, batch=16
69/69 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step
18/18 ━━━━━━━━━━━━━━━━━━━━ 0s 11ms/step
✅ Train RMSE: 119.79 | Test RMSE: 206.52
⚠️ Overfitting detected! Consider adding dropout or reducing LSTM units.
```



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CHALLENGES & LIMITATIONS

Challenges Faced During the Project

- Time Constraints
- Limited LSTM Familiarity
- Overfitted Model
- Computing Power

Limitations of the Approach or Dataset

- Only based on historical data
- Simplified Assumptions
- Unverified by Different Stocks

Potential Areas for Future Improvement

- Incorporating External Factors (e.g. Economic Indicators)
- Adjust Parameters to Early Stop Before Overfit result
- Compare Result via Different ML Models

DISCLAIMER

Stocks, Futures and options trading involves substantial risk of loss and is not suitable for every investor. The valuation of futures, stocks and options may Fluctuate and as a result, clients may lose more than their original investment. The impact of seasonal and geopolitical events are already Factored into the market prices. The highly leveraged nature of futures trading means that small market movements will have a great impact on your trading account and this can work against you, leading to large losses or can work for you, leading to large gains. if the market moves against you, you may sustain a total loss greater than the amount you deposited into your account. You are responsible for all the risks and Financial resources you use and for the chosen trading system. You should not engage in trading unless you fully understand the nature of transactions you are entering into and the extent of your exposure to loss. IF you do not Fully understand these risks you must seek independent advice from your Financial advisor.

All trading strategies are used at your own risk.

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THANK YOU

FOR YOUR TIME & SPECIAL THANKS TO OUR DEAR TEAM!

By BEN, BUT, CHARLES, HAZEL

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