Forecasting Stock Prices Using Long Short-Term Memory (LSTM) Networks: A Comprehensive Analysis

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INTRODUCTION

- According to the World Federation of Exchanges (WFE) in June 2024, **India's stock market** is the **5th largest in the world** in terms of market capitalization. The National Stock Exchange (NSE) of India currently facilitates trading for **2,266 companies** [1].
- **Stock market forecasting**: Challenges exist due to market volatility and complex patterns.
- **Why Machine Learning using LSTM**: Enhanced capability in handling time-series data to handle stock prices.

[1] Reference : World Federation of Exchanges (WFE) in (June 2024)

PROBLEM STATEMENT

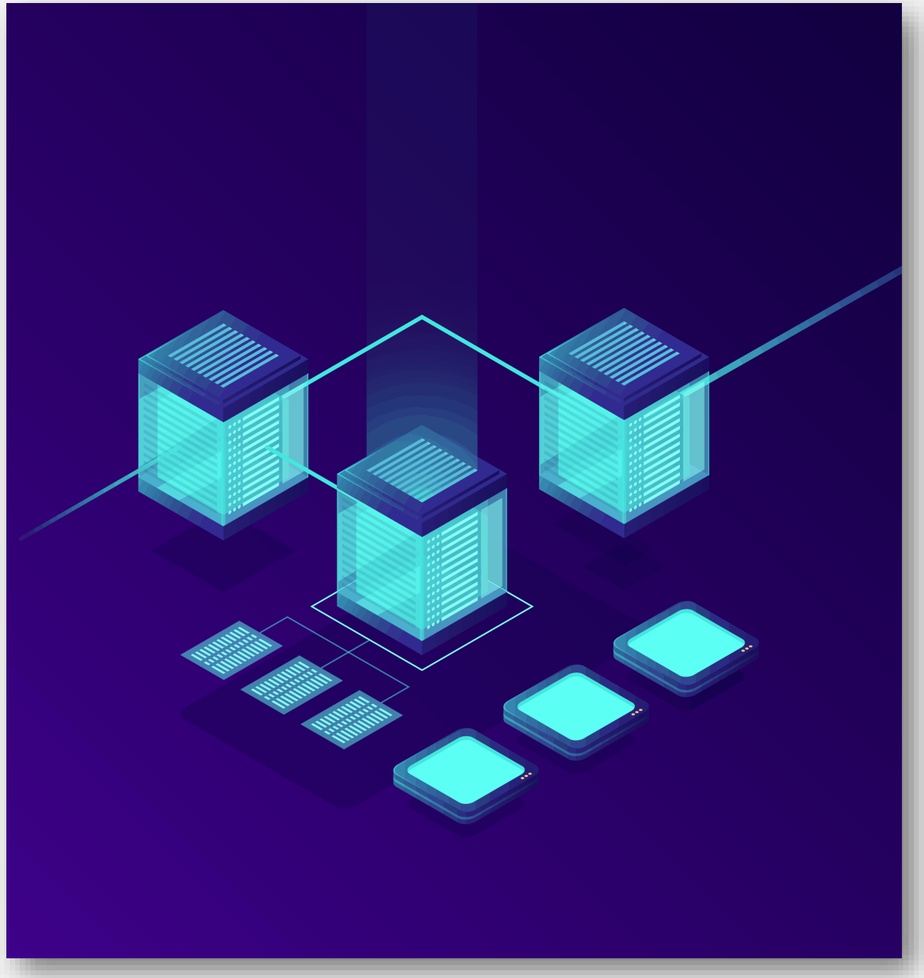
- **Who**: Financial analysts and investors.
- **What**: Need to accurately predict stock prices.
- **Why**: The stock market is inherently volatile, with complex, non-linear relationships influencing prices, making reliable predictions challenging.
- **Where**: This problem is particularly evident in rapidly changing and highly unpredictable markets, such as Indian Stock Market.

MOTIVATION

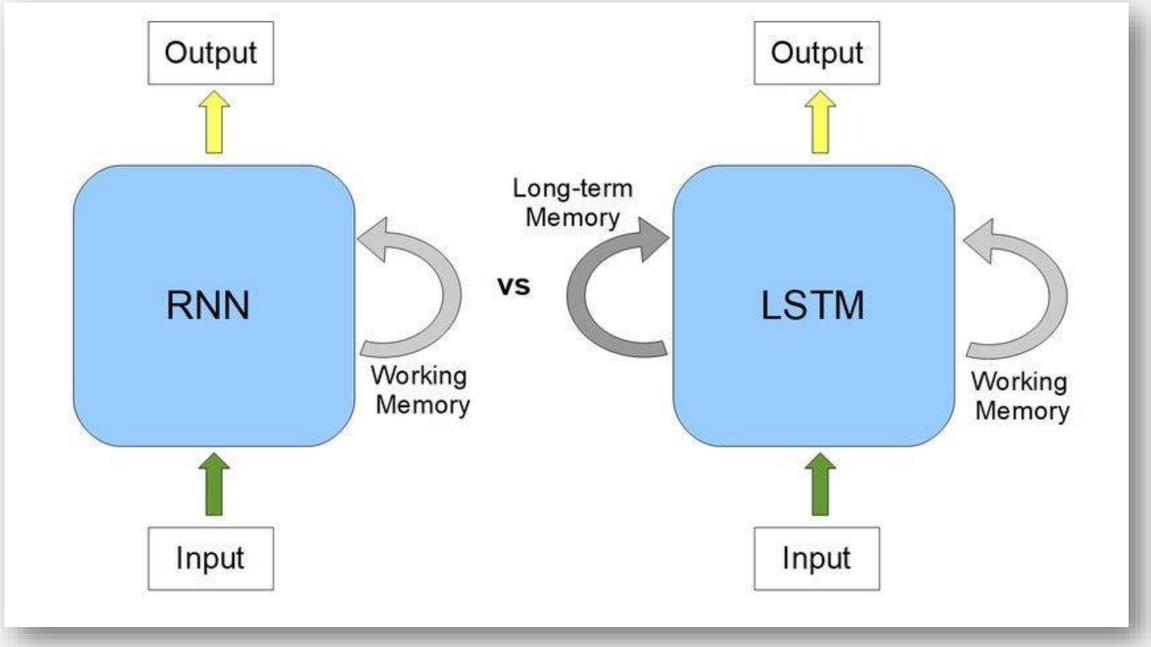
- Stock market's **volatility** creates challenges for traditional forecasting models.
- **LSTM**: Specialized for sequential data, capturing long-term dependencies.
- Financial decisions rely on **accurate predictions** to mitigate risk.

OBJECTIVES

- Develop a **LSTM model** for stock prediction.
- **Optimize** model performance with grid search.
- Compare with traditional methods like **Support Vector Regression (SVR)**.
- Provide investors with **reliable forecasting tools**.



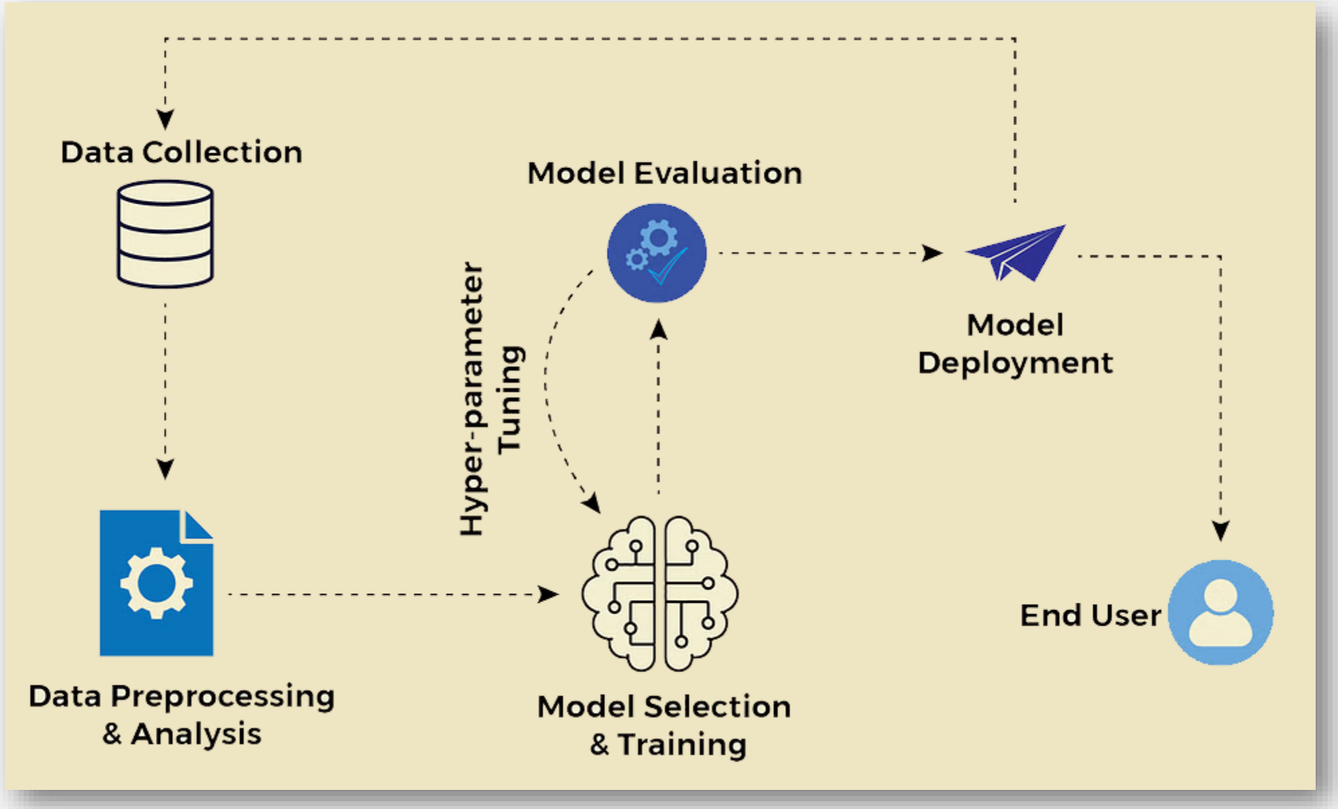
LITERATURE REVIEW



- **Traditional methods** (technical analysis, statistical models) fall short in prediction accuracy.
- Machine learning models, especially **LSTM**, outperform standard methods in time-series prediction.
- Previous studies show LSTM's effectiveness in **financial market forecasting.**
- LSTM is a type of RNN architecture designed to address the **vanishing gradient** problem in RNNs.

METHODOLOGY

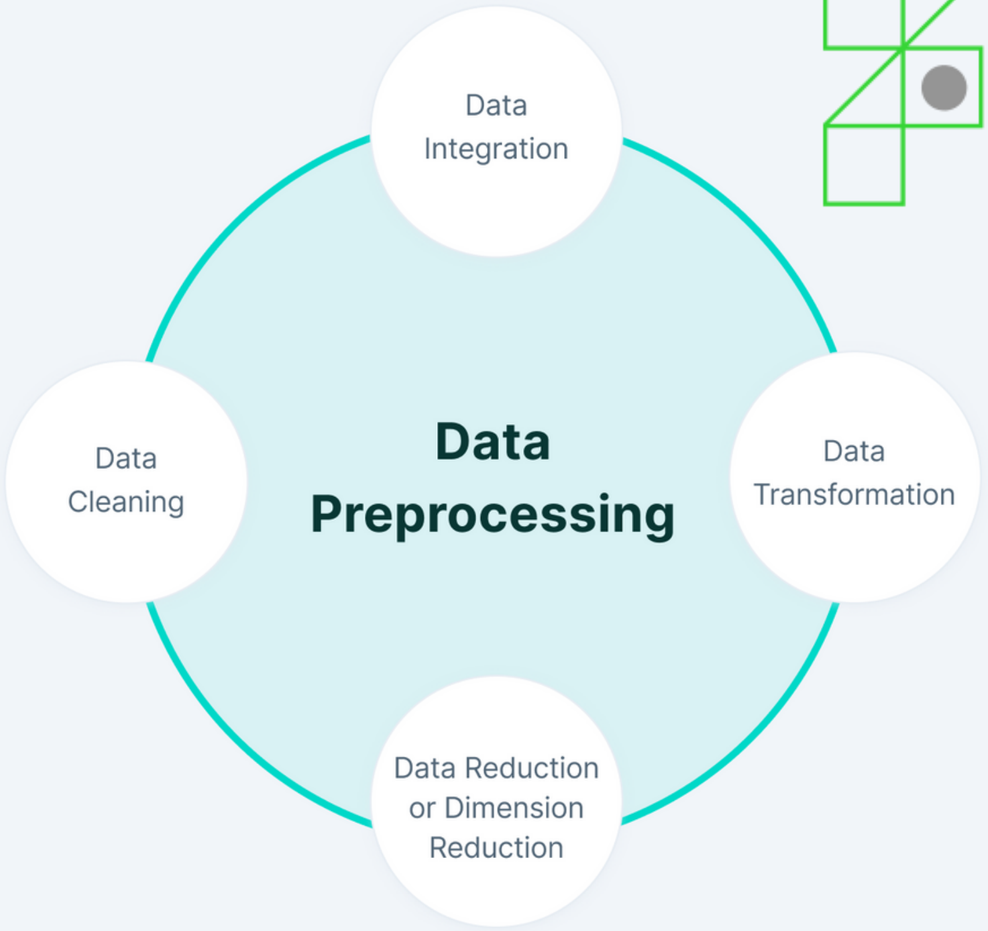
- **Data Collection**: Historical stock prices from APIs like NSE (National Stock Exchange of India Ltd) [2].
- **Data Preprocessing**: Normalize and split data.
- **Model Architecture**: Input layer, LSTM layers, Dense output layer.
- **Hyperparameter tuning**: Using grid search for optimal results.



[2] Reference : NSE - National Stock Exchange of India Ltd: Live Share/Stock Market News & Updates, Quotes- Nseindia.com (2024). Available at: https://www.nseindia.com/

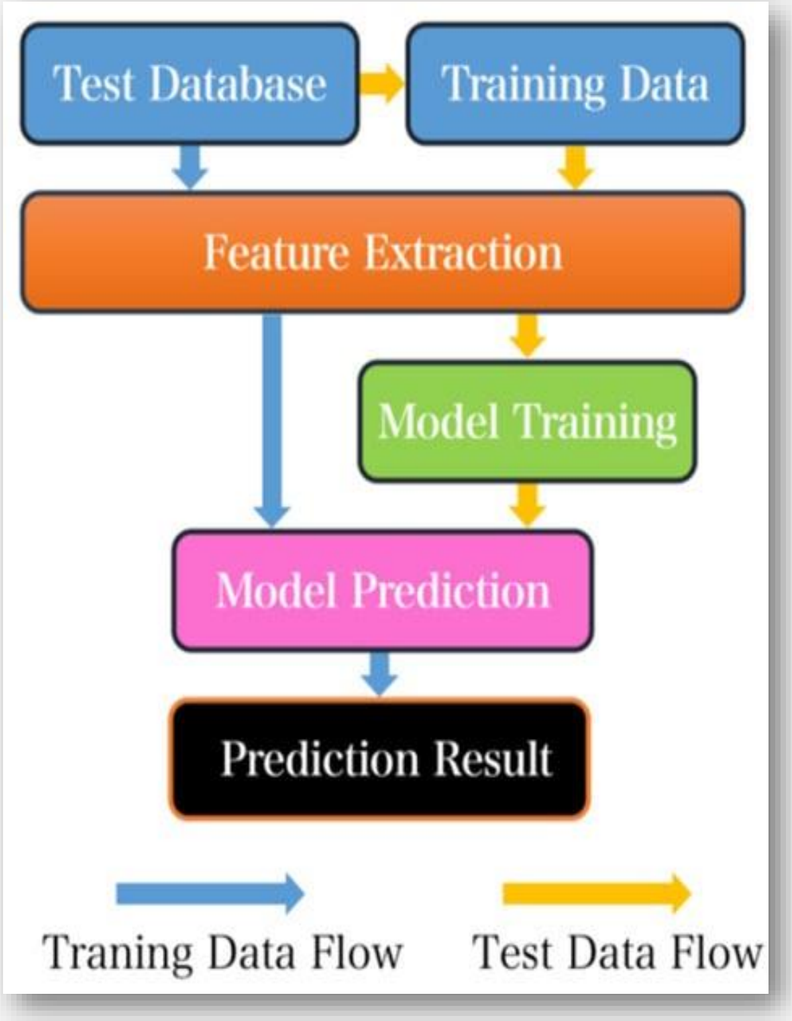
DATA PREPROCESSING TECHNIQUES

- Techniques used for effective data preprocessing :
  - **Feature Selection:** Focused on the closing price of stocks, extracting the Date and Close columns for trend analysis.
  - **Date Handling**: Converted string dates to datetime objects for accurate chronological sorting and indexing.
  - **Handling Missing Values**: Addressed missing data by using imputation techniques like forward/backward filling.

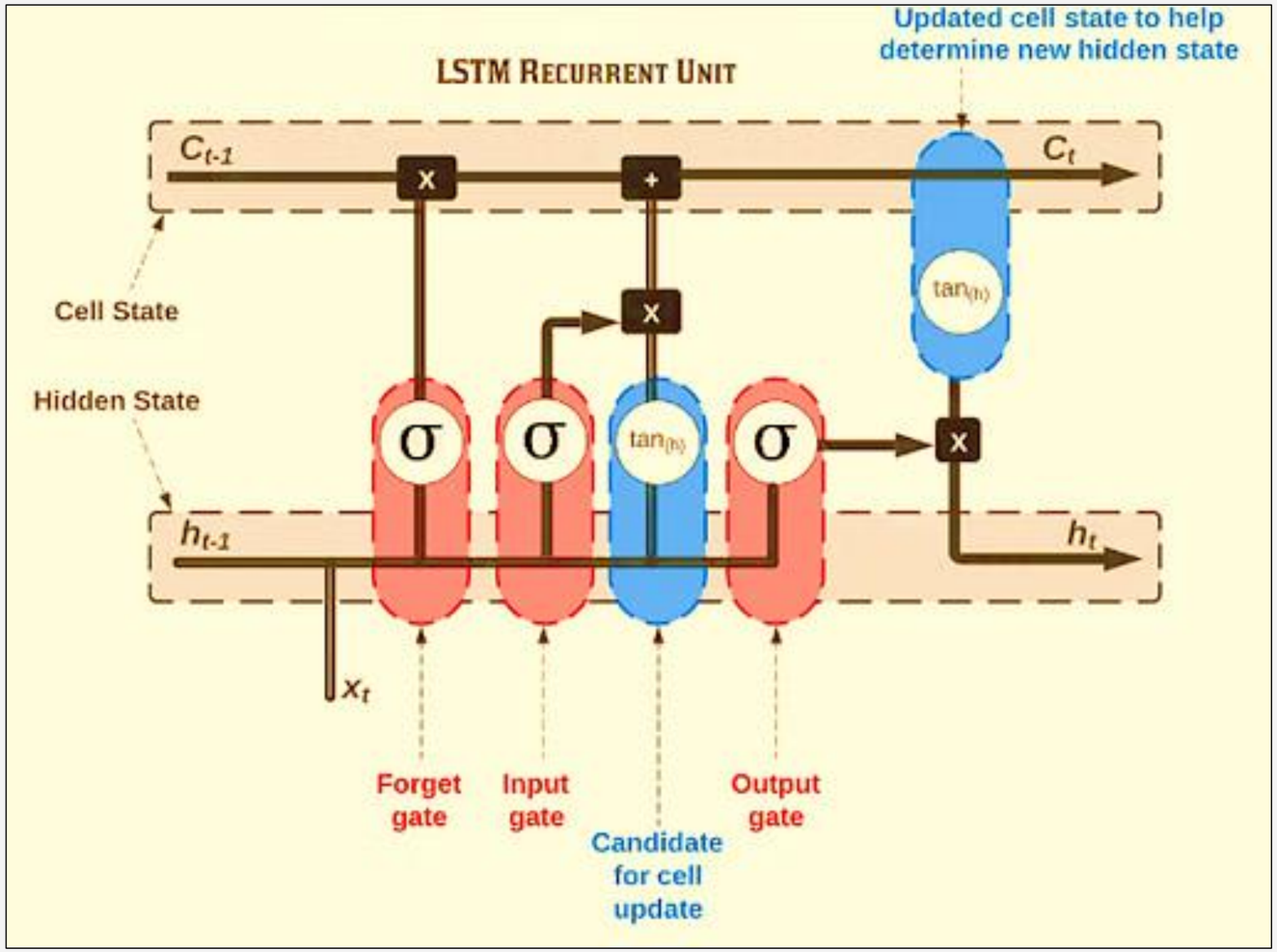


MODEL TRAINING AND VALIDATION

- **Training Process**: The LSTM model was trained using Backpropagation Through Time (BPTT). The data was split into **80% training**, **10% validation**, and **10% test sets** to ensure robust evaluation.
- **Optimization**: The model was optimized by tuning hyperparameters like the **learning rate (set to 0.001)**, batch size, and dropout rate. These adjustments resulted in significant improvements in the model's accuracy.
- **Performance Evaluation**: The model was trained for **100 epochs**. The validation and test sets were used to ensure generalization to unseen data.



LSTM ARCHITECTURE OVERVIEW



LSTM networks consist of **memory cells** that can maintain information over long periods. This architecture allows the model to learn from past data effectively, making it suitable for tasks like time series forecasting in volatile markets.

Figure Reference: https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/lstm

MODEL PERFORMANCE

- **Evaluation Metrics**: RMSE, MAE, and R-squared used to assess model accuracy.
- **LSTM** outperforms SVR, especially in capturing temporal dependencies.
- After training the LSTM model, the Mean Absolute Percentage Error (MAPE) was calculated, resulting in a **prediction accuracy of 98%.**

Model	RMSE	MAE	R^2
LSTM	1.23	0.87	0.92
SVR	2.45	1.76	0.78

RESULTS

- **Comparison**: LSTM achieves lower RMSE than traditional models.
- **Training vs. Testing**: Consistency in predictions across datasets.

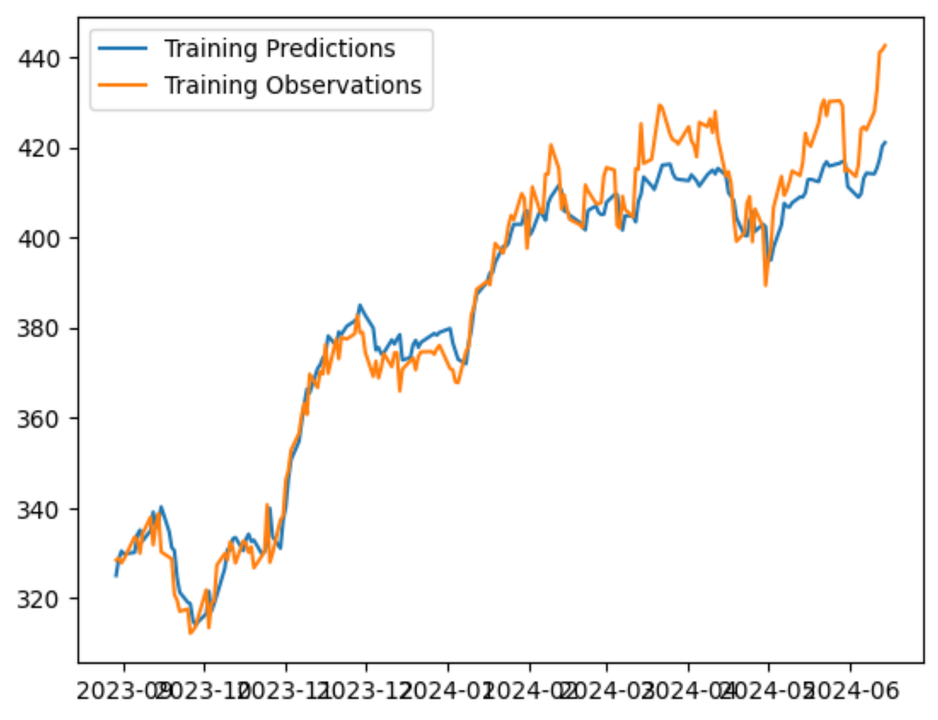


Figure: actual stock prices against the predicted prices using LSTM.

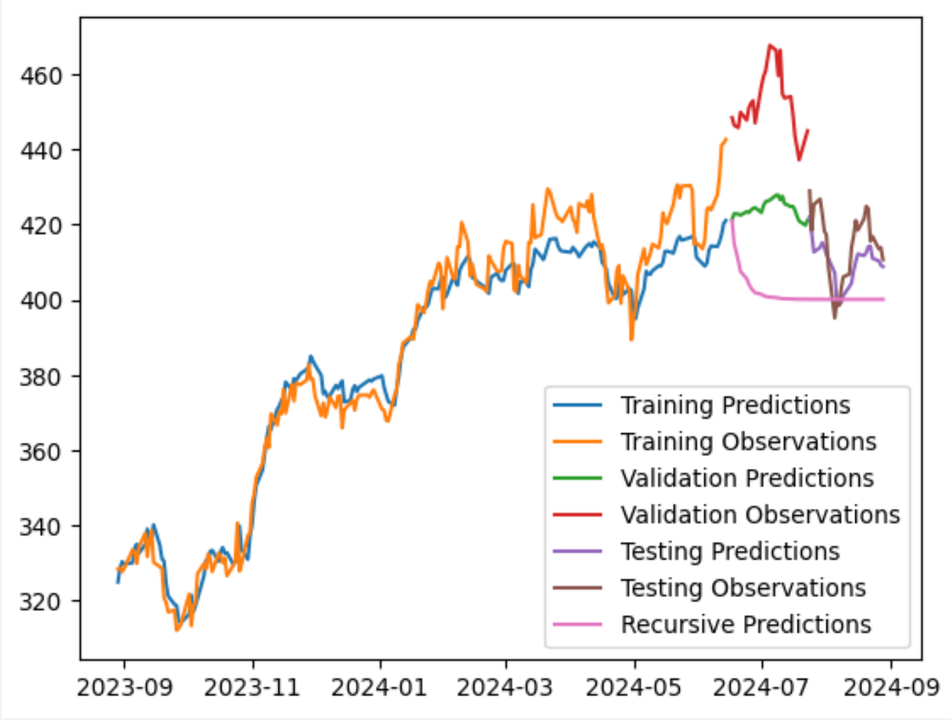


Figure: 30-day stock price predictions using LSTM.

IMPLICATIONS AND FUTURE SCOPE

- **Real-time predictions**: Enhance financial decision-making.
- **Expand model**: Include sentiment analysis, macroeconomic factors for improved accuracy.
- **Develop application**: Web or mobile app for real-time stock predictions

CONCLUSION

- **Key Findings**: LSTM outperforms traditional models in predicting stock prices.
- **Real-World Utility**: Improved accuracy can benefit financial analysts and investors.
- **Future Research**: Expand data sources and user-friendly applications.

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Thank you!