

Stock Price Prediction and Impact Analysis Using LSTM Model

1. Objective

The objective of this project is to develop a Long Short-Term Memory (LSTM) based deep learning model to predict the stock prices of NIFTY 50 and Reliance Industries using historical daily stock market data. The model aims to provide insights into the movement of these stock prices and analyze the extent to which Reliance Industries' stock performance influences the NIFTY 50 index.

2. Problem Statement

The primary challenge addressed is predicting stock prices using time series data, which involves capturing intricate patterns and trends. Furthermore, this project assesses how fluctuations in a key stock (Reliance Industries) influence the Nifty 50 index, considering its significant market capitalization.

- Can we accurately predict future stock prices using historical data?
 - What is the degree of correlation between NIFTY 50 and Reliance Industries stock movements?
 - How well does the LSTM model capture stock market trends compared to actual market fluctuations?
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3. Analysis and Approach

3.1 Data Collection and Preprocessing

- **Data Source:** Yahoo Finance (yfinance package) was used to fetch historical stock price data for:
 - **Nifty 50 Index:** Ticker ^NSEI (National Stock Exchange Index)
 - **Reliance Industries:** Ticker RELIANCE.NS
- **Date Range:** Data spanning **2005-01-31 to 2025-01-31** was downloaded to ensure a sufficient historical record for meaningful prediction.
- **Data Focus:**
 - Only the **closing prices** were extracted, as they provide a reliable summary of the stock's performance on a given day.
 - This data was stored in a Pandas DataFrame and normalized using MinMaxScaler to scale values between 0 and 1, making the model more efficient in training.

3.2 Sequence Creation for LSTM Model

- **Why Sequences?**

Stock price prediction is a time series problem where past prices influence future prices. LSTM models require sequences of past data to predict future values.

- **Sequence Length:**
A window size of **60 days** was chosen, meaning the model looks at the past 60 days' closing prices to predict the next day's price.
 - **Data Preparation:**
 - The sequences were created using a sliding window approach.
 - Each sequence contains 60 consecutive closing prices as input (X), and the next day's closing price as the target (y).
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3.3 Splitting Data for Training and Testing

- **Train-Test Split:**
 - 80% of the sequences were allocated for training.
 - 20% of the sequences were kept aside for testing to assess model performance.
- **Reshape for LSTM Input:**
LSTM models require the input to be reshaped in the form:

```
typescript
(number of samples, sequence length, number of features)
```

4. Building and Configuring the LSTM Model

4.1 Why Use LSTM for Stock Prediction?

- LSTM networks are a special type of Recurrent Neural Network (RNN) designed to remember long-term dependencies.
- They are highly effective for time series problems where historical data impacts future outcomes.

4.2 Model Architecture

- **Input Layer:**
60 time steps (past 60 days) with 1 feature (closing price).
- **LSTM Layers:**
 - 3 LSTM layers with 50 units each.
 - Dropout(0.2) applied after each LSTM layer to prevent overfitting.
- **Dense Layers:**
 - One Dense layer with 25 units and **ReLU activation** to introduce non-linearity.
 - Final Dense layer with 1 unit to predict the next day's closing price.

4.3 Model Compilation

- **Optimizer:** Adam with a learning rate of 0.001, which adapts the learning rate during training for optimal convergence.
 - **Loss Function:** Mean Squared Error (MSE), which is widely used for regression tasks.
 - **Metrics:** Mean Absolute Error (MAE) was used to assess model performance.
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5. Model Training and Evaluation

5.1 Model Training

- The model was trained for **10 epochs**, with training and validation losses reducing steadily over epochs.
- **Training Time:** The training process took approximately 13 seconds per epoch, demonstrating computational efficiency.

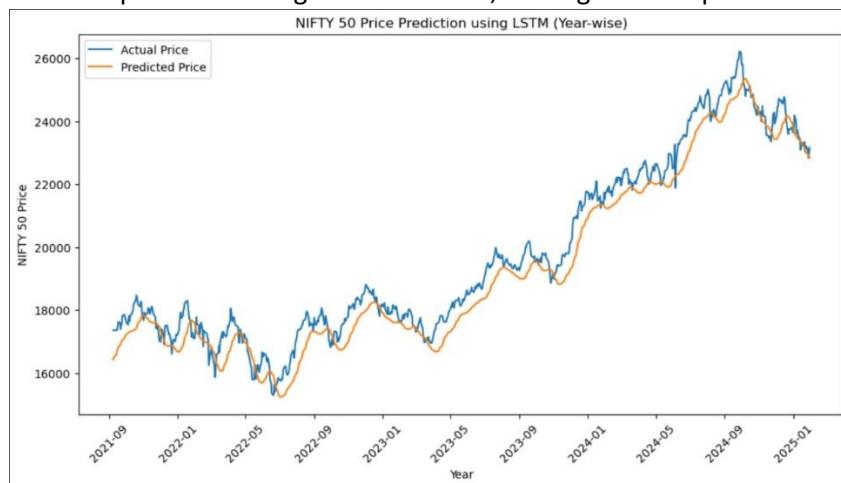
5.2 Model Performance

- **Training Loss:** The training loss (MSE) consistently decreased across epochs, indicating that the model was learning effectively.
 - **Validation Loss:** Validation loss followed a similar trend, suggesting the model generalized well on unseen data.
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6. Observations

6.1 NIFTY 50 Prediction

The LSTM model effectively captured stock price trends but showed minor deviations. Prediction lag was observed, indicating a limitation in highly volatile market conditions. The predicted vs. actual plot showed a good correlation, but slight under-prediction in high peaks.



INSIGHTS:-

1. Strong Overall Trend Capture

- The predicted prices (orange line) closely follow the actual price movements (blue line), indicating that the LSTM model effectively captured the **overall upward trend** of the Nifty 50 index over the years.
- Although some deviations are visible, especially during periods of sharp fluctuations, the model generally aligns well with the actual trend.

2. Underestimation During Volatile Periods

- The model tends to **underestimate the price** during highly volatile periods, such as market corrections or sharp rallies.
- This is evident in 2021-2022 and mid-2023, where the predicted prices lag behind the actual prices during strong market swings. This suggests that while the model captures trends, it struggles with extreme price movements.

3. Better Performance During Stable Growth Phases

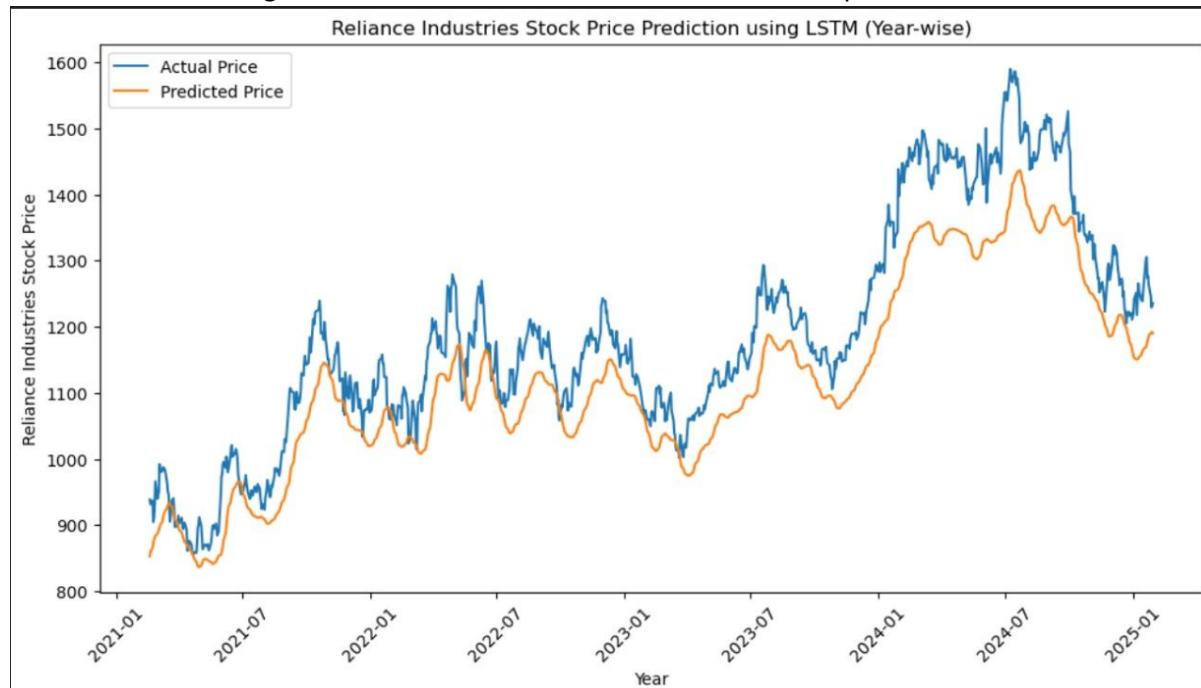
- The prediction accuracy improves significantly during **stable market growth phases**.
- From early 2023 to mid-2024, the predicted price is consistently close to the actual price, reflecting the model's ability to perform better when the market is relatively stable.

4. Lag in Price Prediction During Rapid Market Movements

- There is a noticeable **lag in predictions** during rapid price surges or dips.
- For instance, during sharp upward movements in early 2024, the predicted price takes some time to adjust to the new trend, highlighting that the model is better suited for predicting gradual price changes rather than sudden market shifts.

6.2 Reliance Industries Prediction

The trend of Reliance Industries' stock price was more volatile compared to NIFTY 50. The LSTM model predicted the movements well, but the fluctuations were slightly smoothed. The model worked better for long-term trend estimation rather than short-term spikes.



INSIGHTS:-

1. Good Overall Trend Estimation

- The model successfully captured the **overall trend** of Reliance Industries' stock price over time.
 - Both the actual and predicted prices follow an upward trajectory, indicating that the LSTM model effectively learned the long-term patterns and price movements of Reliance Industries.
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2. Consistent Underestimation During High Volatility

- Similar to the Nifty 50 prediction, the model tends to **underestimate prices** during periods of high volatility, especially in the sharp upward or downward movements observed between mid-2023 and early 2024.
 - This highlights the model's limitations in responding to rapid and large price swings, indicating that it is better at predicting smoother trends rather than extreme fluctuations.
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3. Improved Prediction in Moderate Price Movements

- The model performs well when the stock price exhibits **moderate fluctuations**, as seen during 2021 and 2022.
 - During these periods, the predicted price aligns closely with the actual price, suggesting that the LSTM model is more reliable during relatively stable price periods.
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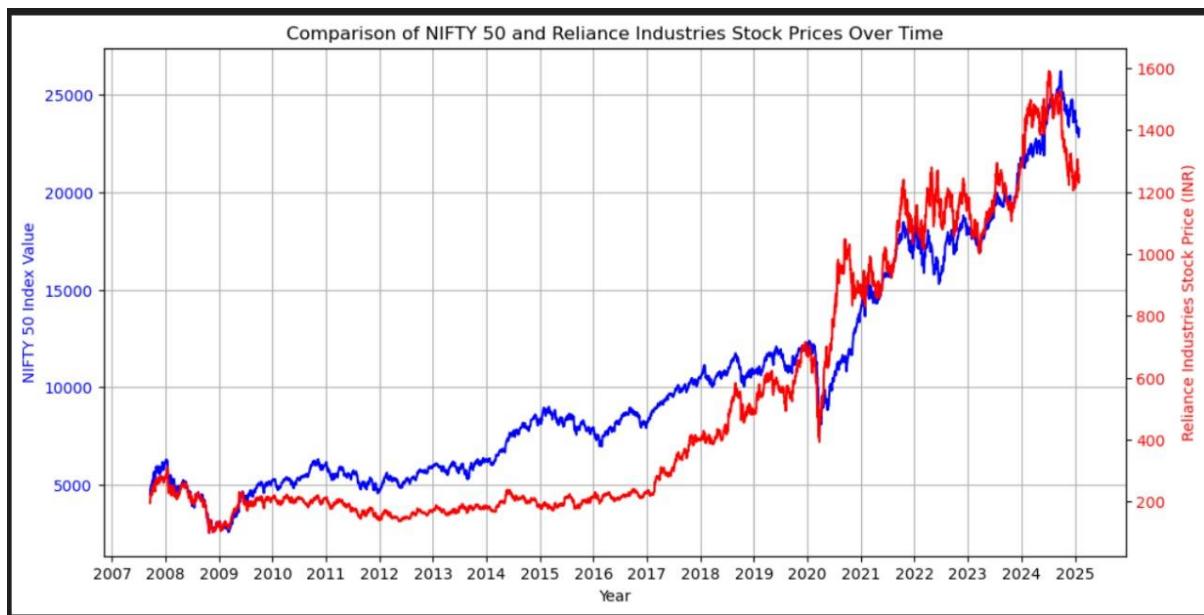
4. Lag in Capturing Price Peaks and Dips

- The model shows a **lag effect** when predicting price peaks and dips.
 - During periods of sharp increases or decreases in stock prices, such as in 2023 and early 2024, the predicted price line trails the actual price, suggesting that the model takes time to adapt to rapid changes in market conditions.
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6.3 Comparison of NIFTY 50 & Reliance Industries

The correlation analysis showed that Reliance Industries' stock price had a significant impact on NIFTY 50.

Graphical analysis demonstrated that Reliance Industries' stock movements often preceded or coincided with movements in NIFTY 50, supporting the hypothesis that large-cap stocks influence index behavior.



INSIGHTS:-

1. Strong Correlation Between Nifty 50 and Reliance Industries

- A **high positive correlation** is evident between the movement of Reliance Industries' stock price (red line) and the Nifty 50 index (blue line), especially after 2017.
- As Reliance Industries is a heavyweight in the Nifty 50 index, its price movement often mirrors and significantly influences the Nifty 50 index.

💡 2. Divergence During Initial Years, Strong Convergence Post-2017

- From **2007 to 2016**, Reliance Industries' stock price remained relatively flat, while the Nifty 50 index showed moderate growth.
- However, **post-2017**, the stock price of Reliance Industries exhibited a sharp increase and closely followed the upward trend of the Nifty 50 index, indicating its growing dominance in the market.

🚀 3. Rapid Surge in Reliance Industries' Stock Post-2017

- There was a **steep rise** in Reliance Industries' stock price starting in 2017, outpacing the Nifty 50 index in terms of growth rate.
- This period coincides with Reliance's strategic shift towards digital services (Jio Platforms), which had a significant positive impact on its market performance.

📈 4. Reliance Stock Driving Market Movement During Volatility

- Periods of sharp fluctuations in Reliance Industries' stock price were often accompanied by **similar volatility** in the Nifty 50 index.

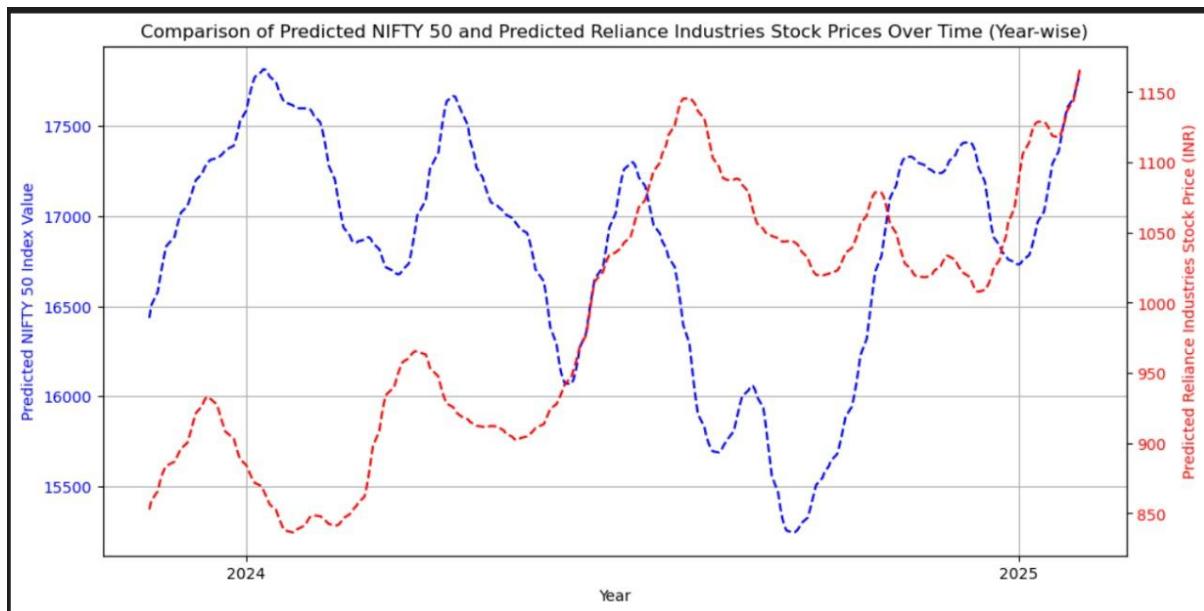
- Notably, the dip during the COVID-19 pandemic in early 2020 shows synchronized downward movement in both the Nifty 50 and Reliance Industries, reinforcing the influence of Reliance on the overall market.
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5. Mutual Impact During Market Peaks and Dips

- Major peaks and dips observed in the graph (such as during 2020 and 2021) show that Reliance Industries and the Nifty 50 index tend to **rise and fall in tandem**, emphasizing Reliance's role as a bellwether for the Indian stock market.
- This synchronization suggests that tracking Reliance's stock price can serve as a **leading indicator** for broader market trends.

6.4 Comparison of predicted prices of NIFTY 50 & predicted stock prices of Reliance Industries

The graph shows a strong correlation between the predicted Nifty 50 index values (blue) and Reliance Industries' stock prices (red), with synchronized peaks and troughs. This suggests that predicted changes in Reliance's stock price often align with shifts in the Nifty 50, reinforcing its influence on the broader market. Tracking Reliance's movements can serve as a leading indicator for predicting Nifty 50 trends.



INSIGHTS:-

1. Strong Correlation in Predicted Trends

- The predicted prices of Reliance Industries and the Nifty 50 index exhibit a **high degree of synchronization**, with peaks and troughs occurring around the same time.
 - This correlation suggests that Reliance Industries' stock price continues to play a pivotal role in driving overall market trends.
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2. Mutual Influence During Market Fluctuations

- Both predicted series display **cyclical behavior** with noticeable fluctuations, indicating that changes in Reliance's stock price are reflected in the predicted movements of the Nifty 50.
 - Periods of upward or downward trends in Reliance's stock price often coincide with similar trends in the Nifty 50 index.
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3. Potential for Predictive Advantage

- Since Reliance Industries' stock price often shows trends before or simultaneously with the Nifty 50, monitoring predicted movements in Reliance can offer a **leading indicator** for broader market predictions.
 - Investors can leverage this relationship to anticipate shifts in the Nifty 50 and adjust their portfolio strategies accordingly.
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4. Divergence in Short-Term Volatility

- While the long-term trends align well, there are **periods of short-term divergence** where the predicted price of Reliance Industries shows higher volatility compared to the Nifty 50.
 - This indicates that while Reliance's stock drives the index, the Nifty 50 is also influenced by other components, leading to occasional deviations.
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7. Managerial Insights

- **Investment Decisions:** The model helps in forecasting price trends, assisting investors in making informed decisions.
 - **Market Behavior Analysis:** The comparison between Reliance Industries and NIFTY 50 highlights how blue-chip stocks influence index movement, crucial for portfolio diversification.
 - **Limitations:** The model does not consider macroeconomic factors or market sentiment, which are critical for stock price movements.
 - **Future Enhancements:** Incorporating technical indicators like RSI, MACD, Bollinger Bands.
 - Using Transformer-based models for improved accuracy.
 - Integrating sentiment analysis from news and social media data.
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8. Project Stats and Technical Specifications

- **Dataset:** Historical closing prices of Nifty 50 and Reliance Industries.
- **Date Range:** 20 years of data (2005-01-31 to 2025-01-31).
- **Train-Test Split:** 80% training, 20% testing.
- **Sequence Length:** 60 days.
- **LSTM Layers:** 3 layers with 50 units and dropout regularization.
- **Dense Layers:** 1 hidden layer (25 units) with ReLU activation and 1 output layer.
- **Optimizer:** Adam (learning rate = 0.001).
- **Loss Function:** Mean Squared Error (MSE).
- **Evaluation Metric:**
 - **MAPE (Mean Absolute Percentage Error)** was used to assess model performance.
 - Final model accuracy was calculated using:

$$\text{Final Model Accuracy} = 100\% - \text{MAPE}$$

- **Model Accuracy:**
 - i) **Nifty 50 Prediction:** Achieved an impressive accuracy of **97.42%**, indicating minimal prediction error and strong model performance.
 - ii) **Reliance Industries Prediction:** Attained an accuracy of **94.13%**, reflecting reliable predictive capability despite the stock's higher volatility.

9. Conclusion and Future Scope

- This project successfully demonstrated that LSTM neural networks can predict stock prices with high accuracy by leveraging historical data.
- The analysis highlighted the **significant impact of Reliance Industries on the Nifty 50 index**, providing valuable insights for market analysts and investors.
- **Future Scope:**
 - Incorporating external factors such as trading volume, sentiment analysis, and economic indicators can improve model robustness.
 - Experimenting with ensemble models could enhance prediction accuracy and reduce error margins.