Real-Time Stock Market Prediction Using ML and DL

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***Abstract*— The goal of the project is to predict stock market prices in real-time using machine learning (ML) and deep learning (DL) algorithms. Two models were developed for this purpose, the first model being a combination of Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM), and the second model is a combination of Support Vector Machine (SVM) and LSTM. The datasets used for this research were the historical stock prices of various companies obtained from the Yahoo Finance website. The proposed models were trained, validated, and tested on these datasets. The result of the project concludes that the hybrid combination of CNN-LSTM gives more accuracy than a hybrid combination of SVM-LSTM.**

***Index Terms*—Stock prediction, ML, DL, CNN-LSTM, SVM-LSTM.**

I. INTRODUCTION

The stock market is an intricate and ever-changing ecosystem influenced by a myriad of factors posing significant challenges for investors and traders seeking accurate predictions. However recent strides in Deep Learning and Machine Learning techniques offer promising results for stock market prediction. This project aims to harness the power of these advanced techniques to develop a real-time stock market prediction system that can aid investors in making informed decisions.

The primary objective of this project is to leverage machine learning algorithms to analyze historical stock market data and forecast future price movements by integrating real-time data feeds and employing robust computational models. Our system strives to provide timely and precise predictions enabling investors to react swiftly to fluctuations taking place in the market and potentially optimize their investment returns

In this project, we focus on developing hybrid models that combine deep learning techniques to enhance prediction accuracy specifically. We explore the integration of LSTM long short-term memory networks CNN convolutional neural network and SVM support vector machine algorithms within our framework. These hybrid models capitalize on the strengths of each technique allowing for a comprehensive analysis of the stock market data. LSTM networks are known for capturing long-term dependencies and patterns in sequential data making them ideal for modeling the time-series nature of stock market data CNNs on the other hand excel at extracting spatial features and patterns which can be valuable in analyzing financial charts images and textual data. SVMs known for their ability to handle multi-dimensional data and nonlinear relationships offer a robust method for classification and regression tasks. The implementation of the project encompasses several key steps initially we will collect and preprocess historical stock market data ensuring its quality and compatibility with our models, subsequently, the hybrid models including LSTM-CNN and LSTM-SVM combinations will be trained and fine-tuned using a subset of the data we will employ techniques like cross-validation to evaluate and by comparing the accuracy and performance of these hybrid models. Additionally, real-time data feeds will be seamlessly integrated into the system allowing for continuous updates and evaluations of the predictions. We have developed a user-friendly interface that facilitates effective visualization and interpretation of the predictions from the hybrid models allowing investors to make well-informed decisions. The successful execution of this project holds immense potential for investors and financial institutions. Alike accurate real-time stock market predictions obtained from the hybrid models can help investors to plan their trading strategies mitigate risks and improve overall profits. Moreover, this project contributes to the broader field of financial forecasting by analyzing the capabilities of hybrid machine learning and deep learning models incorporating LSTM, CNN, and SVM algorithms in the context of stock market prediction.

II. RELATED WORK

Sean McNally, Jason Roche, Simon Caton," Predicting the Price of Bitcoin Using Machine Learning"2018. This study aims to determine how accurately the direction of the price of bitcoin in US dollars can be predicted. The Bitcoin Price Index is the source of the price information. Through the use of a Bayesian-optimized recurrent neural network (RNN) and a Long Short-Term Memory (LSTM) network, the goal is accomplished to variable degrees of success. As a comparison to the deep learning models, the well-known ARIMA model for time series forecasting is used. As indicated, the non-linear deep learning techniques better the poor-performing ARIMA forecast. Finally, the performance of both deep learning models are benchmarked on CPU and GPU, with the GPU training time exceeding CPU implementation by 67.7%.

Ming-Chi Lee, " Using support vector machine with a hybrid feature selection method to the stock trend prediction"2009. To forecast the trend of stock markets, they created a prediction model based on support vector machines (SVM) with a hybrid feature selection strategy in this study. The advantages of filter methods and wrapper methods are combined in this suggested hybrid feature

selection method, known as F-score and Supported Sequential Forward Search (F SSFS), to choose the best feature subset from the original feature set. Their test results show that the suggested SVM-based model with F SSFS has the best level of accuracy and beats BPN in terms of. These studies confirm their conclusion that the SVM-based model with F SSFS can be a promising complement to the current stock trend prediction techniques.

Soheila Abrishami, Michael Turek, Ahana Roy Choudhury, and Piyush Kumar," Enhancing Profit by Predicting Stock Prices using Deep Neural Networks"2020. In this study, they provide a deep learning system that forecasts stock prices using a variety of data for a sample of stocks listed on the NASDAQ exchange. The prediction model forecasts the closing price of a given stock ticker for multiple steps ahead using the minute data for that stock ticker. Their deep learning framework consists of a Variational Autoencoder for removing noise and uses time-series data engineering to combine the higher-level features with the original features. Their framework takes minute data for five different stock tickers and predicts the stock closing price 7 minutes ahead. Their findings demonstrate that the suggested model outperforms cutting-edge methods for time series forecasting.

M. Suresh Babu, Dr. N.Geethanjali, Prof B.Satyanarayana, "Clustering Approach to Stock Market Prediction"2011. This study compares the performance of the three main clustering methods, K-Means, Hierarchical clustering algorithm, and reverse K means, on the issue of accurately class-wise cluster formation. To predict the short-term stock price movements following the release of financial reports, HRK (Hierarchical Agglomerative and Recursive K-means Clustering) is offered as an efficient clustering technique. The outcomes demonstrate that HRK outperforms using the K-means clustering or the HAC approach by combining the benefits of two clustering techniques. Additionally, HRK (with ratio) leads SVM in terms of accuracy and average profits.

Md. Rafiul Hassan and Baikunth Nath, "StockMarket Forecasting Using Hidden Markov Model: A New Approach"2005. They only implement one HMM(Hidden Markov Model), which was trained using the historical data of the selected airlines. The trained HMM is used to search the previous dataset for the variable of interest behavioral data pattern. Forecasts are created by interpolating these datasets neighboring values. HMM offers a new paradigm for stock market forecasting, the results produced using HMM are positive. The result shows that the proposed method using HMM to forecast stock price is explainable and has a solid statistical foundation.

III. Problem Statement

The stock market is a complex and dynamic system affected by many factors of uncertainty. As a result, stock price movements are difficult to predict. Due to the globalization of technology and business and financial markets, faster and more accurate forecasting of stock prices is important. Based on Financial Prediction Indicators algorithms and machine learning techniques, an automated user-friendly trading application can be developed to predict stock returns. Stock market analysts usually don't understand how the market behaves. It is very difficult for them to trade because they aren't sure what stocks to buy and what stocks to sell for profit.

This market is affected by many uncertainties. Therefore, it is difficult to predict the movement of stock prices. Faster and more accurate forecasting of stock prices is important due to the globalization of technology and business and financial markets. In the ancient Stock Market, people could easily trade stocks and either profit from them or fall into a pitfall with huge amounts of money. It is a common misconception that the stock market is like gambling since all it offers is profit or loss. In other words, even if there is a lack of proper knowledge and analytical ability, people tend to think so, but with the revolution in data science, big data, and human awareness, businesses are learning proper lessons about the future and setting themselves up for success.

IV. Experiment

To evaluate the performance of our stock market prediction project we conducted experiments using two hybrid models, CNN-LSTM and SVM-LSTM. These models were implemented and trained using historical stock market data collected from Yahoo Finance through using API.

The CNN-LSTM model combines the power of Convolutional Neural Networks CNN and Long Short-Term Memory LSTM networks. The model takes advantage of the CNN layers for extracting meaningful features from the input data while the LSTM layers capture the temporal dependencies within the data. The SVM-LSTM model on the other hand merges the strength of support vector machines SVM with LSTM networks. This hybrid model begins with an SVM that classifies the data into buy or sell categories. The output of the SVM is then fed into an LSTM layer which leverages the temporal dependencies in the data to make predictions for our experiment.

We focused on predicting the closing price of stocks we selected a set of attributes from the Yahoo Finance dataset including high low open and close prices these attributes are commonly used in stock market analysis and have a significant impact on predicting future stock prices next we performed feature selection to identify the most relevant attributes for predicting the closing price this step helps to reduce dimensionality and improve the models' efficiency and accuracy by carefully selecting the attributes that are most likely to influence the closing price we aimed to enhance the predictive performance of both the CNN-LSTM and SVM-LSTM models

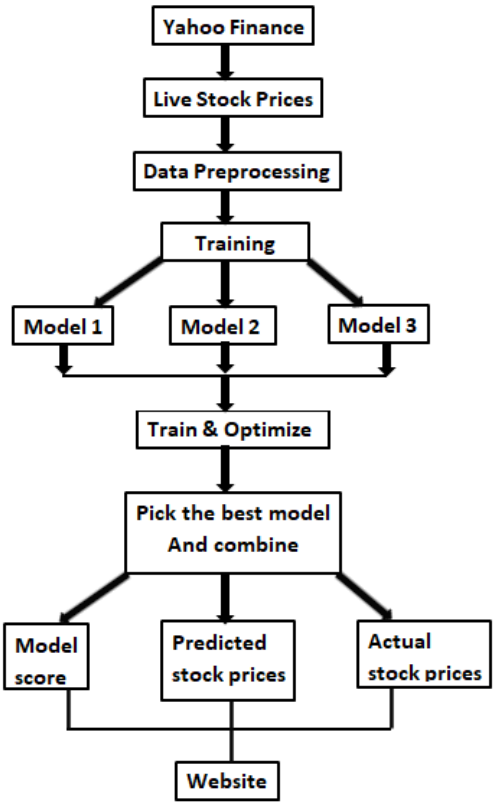
After feature selection we proceeded with the training phase of the models the historical stock market data including the selected attributes was divided into training and validation sets the models were trained using the training set and their performance was continuously monitored on the validation set during the training process the models adjusted their internal parameters based on the discrepancies between the predicted and actual closing prices this iterative adjustment allowed the models to improve their prediction capabilities and optimize their performance following the training phase we evaluated the performance of the CNN-LSTM and SVM-LSTM models using a separate test dataset this evaluation aimed to assess the models ability to predict future stock prices accurately we compared the predicted closing prices with the actual values to measure the models accuracy and effectiveness.

Based on the results of our experiment we found that the CNN-LSTM model outperformed the SVM-LSTM model in terms of accuracy in predicting the closing price of stocks the CNN-LSTM model demonstrated a higher level of accuracy indicating its superior predictive capabilities compared to the SVM-LSTM model, in conclusion, our experiments revealed that the CNN-LSTM model which combines the strengths of CNN and LSTM networks is more effective in predicting the closing price of stocks compared to the SVM-LSTM model this finding emphasizes the significance of leveraging both spatial and temporal dependencies in stock market data for accurate predictions.

Overall, the CNN-LSTM model is a powerful tool for stock market prediction, as it can capture both the spatial and temporal dependencies in the data. By combining the strengths of CNN and LSTM models, the CNN-LSTM model can provide accurate predictions about future stock prices, which can help investors and traders make more informed decisions

V. System Architecture

Yahoo Finance provides live stock prices which can be used by API provided by them. This livestock is formatted into training data which is used by different machine learning models like linear regression, SVM, and LSTM. The result obtained by the models will be compared and check which model has the best accuracy based on the input. All the Predicted stock prices and model scores with actual stock prices will be displayed on the website.



VI. Methodology

Collecting live stock market prices will be the first step. Data can be collected once a day at a pre-defined time or at the moment when the user enters the stock ticker. Then we will be loading all the gathered data into the database so that it can be used for predictions. We are using Python to implement this project. Python provides us with a large number of machine learning libraries helping us to deal with algorithms and mathematical and statistical formulas. Data pre-processing is done in the next step which includes removal of null values and extreme values that may cause errors while using it as input for prediction models. The data that is stored in the database from Yahoo! Finance is then divided into two parts. The first part is used to train the model and the other part is used to evaluate the performance of the model. The prediction system we have designed consists of three unique modern machine learning and deep learning techniques to predict stock maker prices in the coming future. Evaluation of the models we have trained we will test them on the Test Dataset. This will tell us whether the model is perfectly trained or has some overfitting or underfitting errors. The results from all the prediction models will be analyzed and compared. The model having the highest accuracy and negligible price difference between the predicted and the actual value will be selected, and its predicted value will be given as the predicted value for a stock to the user.

VII. Model Summary

1. LSTM-SVM Model

The necessary libraries are imported: pandas for data manipulation, Numpy for numerical operations, matplotlib.pyplot for plotting, MinMaxScaler from sklearn.preprocessing for scaling the data, SVR from sklearn.svm for the Support Vector Regression model, and Sequential and Dense from keras.models and keras.layers respectively for the LSTM model. The user is prompted to enter the ticker symbol of the company they want to predict. Historical stock price data is retrieved for the specified ticker symbol from Yahoo Finance using its API. The data is preprocessed by scaling the 'Open', 'Close', 'High', and 'Low' columns using MinMaxScaler. The

input features (X) are defined as a Numpy array consisting of the scaled 'Open', 'Close', 'High', and 'Low' values. The output target (y) is defined as the scaled 'Close' values. The data is split into training and test sets, with 80% of the data used for training. The LSTM model is defined using the Sequential class. It consists of an LSTM layer with 64 units, followed by a Dense layer with 1 unit. The model is compiled with the mean squared error loss function and the Adam optimizer. The LSTM model is trained using the training data. The input data is reshaped to be in the form of a 3D tensor as expected by the LSTM layer.
Predictions are made on the training and test data using the trained LSTM model. The SVM model is defined with a radial basis function (RBF) kernel and specific hyperparameters. The SVM model is trained using the LSTM predictions from the training data. Predictions are made on the training and test LSTM predictions using the combined LSTM-SVM model. The model is evaluated by calculating the root mean squared error (RMSE) between the actual and predicted values for both the training and test data. The RMSE scores are printed. Finally, the actual and predicted stock prices for the test data are plotted using matplotlib.

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 lstm (LSTM)                 (None, 64)                16896

 dense (Dense)               (None, 1)                 65

=================================================================
Total params: 16,961
Trainable params: 16,961
Non-trainable params: 0
_________________________________________________________________
```

2. CNN-LSTM Model

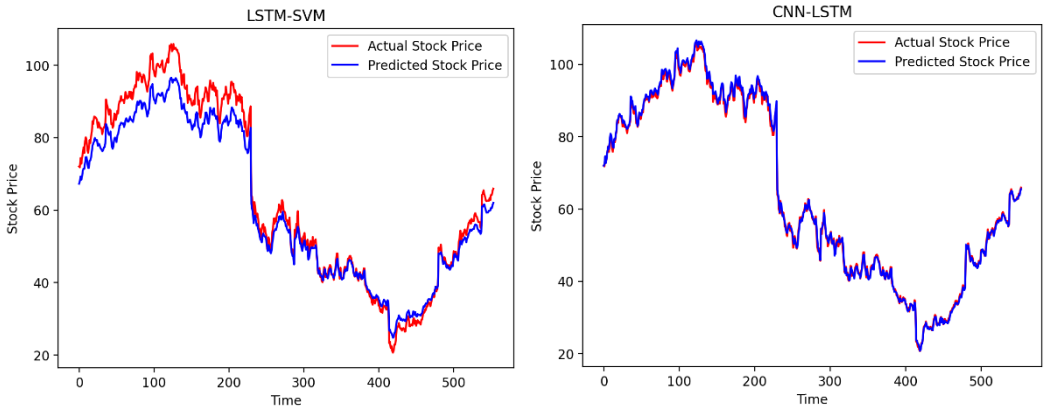
The model architecture is defined using the Sequential class. It consists of a Conv1D layer with 64 filters and a kernel size of 3, followed by a MaxPooling1D layer with a pool size of 2. The output of the pooling layer is passed to an LSTM layer with 64 units, and finally, a Dense layer with 1 unit. The model is compiled with the Adam optimizer and mean squared error loss function. The model is trained using the training data. The input data is reshaped to be in the form of a 3D tensor as expected by the Conv1D and LSTM layers. The validation data is specified using the test data. The model is evaluated by calculating the mean squared error (MSE) loss on the training and test data. The square root of the MSE is taken to get the RMSE (root mean squared error). The RMSE scores are printed. Predictions are made on the test data using the trained model. The actual and predicted stock prices for the test data are plotted using matplotlib.

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv1d_1 (Conv1D)           (None, 2, 64)             256

 max_pooling1d_1 (MaxPooling  (None, 1, 64)            0
 1D)

 lstm_1 (LSTM)               (None, 64)                33024

 dense_1 (Dense)             (None, 1)                 65

=================================================================
Total params: 33,345
Trainable params: 33,345
Non-trainable params: 0
_________________________________________________________________
```

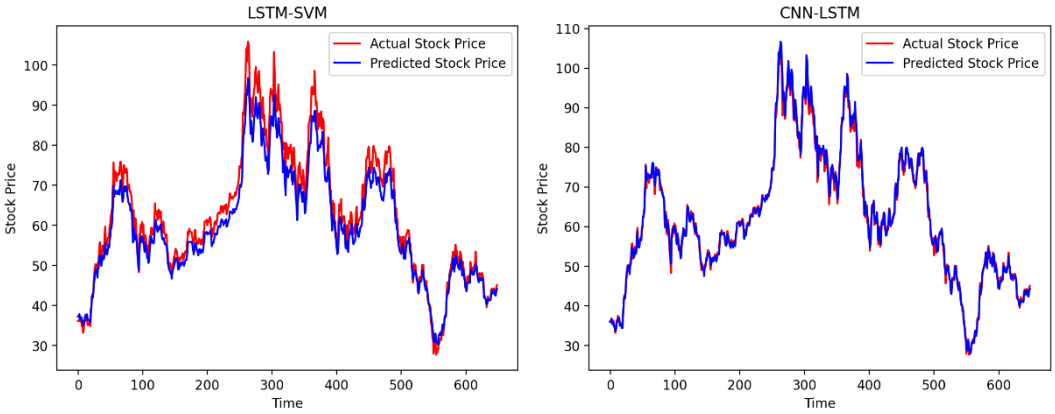
The architecture of this model combines the capability of Conv1D to capture local patterns in the data with the ability of LSTM to capture long-term dependencies. The model learns to extract relevant features from the input data and predict the stock prices based on those features.

VIII. COMPARING RESULTS

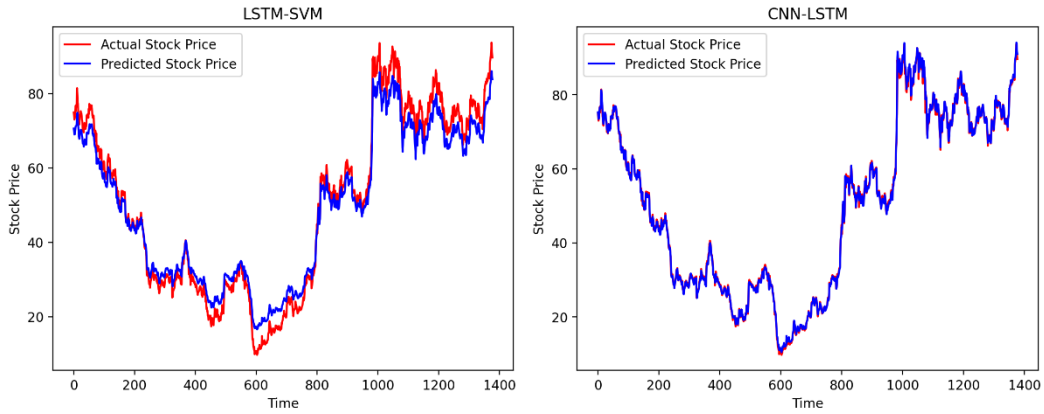
1. META - Meta



2. TSLA - Tesla



3. TATAMOTORS.NS – TATA Motors



IX. CONCLUSION

In conclusion the experiments conducted in our project demonstrate that the CNN-LSTM model is a powerful tool for predicting the closing price of stocks by combining CNN and LSTM networks the model effectively captures spatial and temporal dependencies in stock market data resulting in more accurate predictions the CNN-LSTM model can be utilized in various applications within the financial industry it can assist investors and traders in making informed decisions based on reliable price forecasts additionally the model can be integrated with sentiment analysis to incorporate market sentiment data further enhancing its predictive capabilities furthermore there is potential to update the model in real-time by incorporating streaming data this would enable users to obtain up-to-date predictions and react promptly to market changes overall the CNN-LSTM model offers promising prospects for stock market prediction providing valuable insights for financial professionals and supporting decision-making processes in the dynamic world of finance.

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