

A Hybrid Deep Learning Improved Method for Share Price Prediction

Rachana Kamble¹ and Amar Nayak²

¹⁻²Department Computer Science and Engineering, Technocrats Institute of Technology (Excellence), Bhopal, M.P. India

Email: rachanakamble@gmail.com, amar.n1975@gmail.com

Abstract— Share Market/ Equity Market are the most important current research topic. Machine learning is increasingly used in stock/index price prediction due to its ability to analyze large amounts of data and identify complex patterns that may not be immediately obvious to human analysts. There are several deep learning algorithms commonly used for stock price prediction, including RNN, CNN, LSTM, and DNN. In stock price prediction, hybrid models can be used to combine the predictions of multiple models to produce more accurate predictions. The paper proposed hybrid deep learning DNN-CNN based method to improve the prediction of NSE Bank i.e. Bank Nifty. The ensemble DNN-CNN technique consists of two main components a DNN for feature extraction and a CNN for regression or classification tasks. In DNN-CNN model DNN layer is used to extract features from input data related to an estimated future value and CNN layer is used to combine features learned from the DNN layers. The results represent that proposed method recall is 91.02, precision is 98.2 and accuracy is 97.4.

Index Terms— Share/Index price prediction, CNN, RNN, LSTM, DNN, Hybrid Model.

I. INTRODUCTION

Share Market/ Equity Market are the most important current research topic [1]. There are many research works of the last two decades available because since 2 decades investors and traders are using online platforms instead of paper-based physical forms of shares. Even in the last few years governing bodies are asked Investors/shareholders to demetallize their physical shares or can say paper-based shares into the online forms in DMAT account /depository services i.e., NSDL and CDSL. Across the world, thousands of companies/organizations, Business Channels, and Business Newspapers are involved in research about Equity Market to provide benefits to their viewers/users/clients this is one of the finest works across the financial industry. Even most of the share brokers also run their research vertical to provide good calls to their customers. Machine learning techniques are computational algorithms and statistical models that allow computers to learn from historical data and predict new, unseen data. In the context of stock/index price prediction, machine learning techniques can be applied to historical stock market data to identify patterns and relationships that can be used to predict future stock/index prices [2]. Machine learning can be used to identify the most relevant features that influence stock/index prices and construct new features that capture additional market information. This can improve the accuracy of forecasts and help identify the most important factors affecting stock/index prices. Machine learning can be used to analyze news articles, social media posts, and other sources of information to determine investor and public sentiment [3]. This can provide insight into market sentiment that can be used to predict future stock/index prices. Deep learning

techniques such as neural networks can be used to model complex relationships between various features and stock/index prices. These models can learn to identify non-linear relationships that may not be captured by traditional statistical models [4]. There are several deep learning algorithms commonly used for stock price prediction, including Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), and Deep Neural Networks (DNN) [5].

A hybrid index/stock price prediction model involves a combination of various deep learning algorithms such as Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), and Deep Neural Networks (DNN). With the help of hybrid models, researchers can give strengths to the deep learning algorithms to improve prediction accuracy [6]. For example, a hybrid model might use a CNN to extract features from raw data such as historical prices, news articles, and economic indicators, and then use an RNN or LSTM to model temporal dependencies in the data and make predictions based on the learned patterns. One example of a hybrid model for index/stock price prediction is to use a CNN to extract features from the input data, followed by an LSTM or RNN to model temporal dependencies in the data, and finally a DNN to combine the extracted features. CNN with other data sources and generate the final prediction. This type of hybrid model can improve forecast accuracy by leveraging the strengths of each component and combining multiple data sources to produce more accurate forecasts.

As everybody knows equity price is important for analyzing a company and Index price is important to know about the growth of a country or a sector in the case of sectorial Index i.e., NIFTY 50 and Banknifty in India. Prediction is always required for better planning for economic developments, and in the case of the investors for better returns. There are several motivations for doing stock / Index price prediction research such as investment decision making, risk management, financial analysis, economic planning, and market efficiency. The paper aims to contribute to the field of stock/ share market, and finance using machine learning by providing a comprehensive analysis of the factors that influence stock/index prices and developing and evaluating accurate and reliable prediction models with the help of a Hybrid Network of CNN, and DNN that can help investors and financial analysts make better investment decisions. The developed method evaluated using machine learning models for stock/index price prediction to identify the most accurate and efficient forecasting method for investors and financial analysts.

The contributions of the paper are:

1. The method identified the most significant financial and economic indicators that influence stock/index prices in the case of the Indian sectorial Index NSE BANK (BankNifty).
2. The developed CNN and DNN deep learning technique predicted the stock/index and improve the accuracy and performance of automatic prediction.
3. The proposed method provided insights and recommendations for investors and financial analysts, how to use predictive models to make informed investment decisions and analyze the impact of different time intervals and prediction horizons on model performance.

The paper is organized as follows, section 2 represents related work, section 3 represents proposed method, section 4 provides implementation details and result analysis, and section 5 provides conclusion and future research direction.

II. RELATED WORKS

In [7] predicted the Indian Index Nifty 50 on behalf of price data or can say trading data, through 3 different networks/models individually these used models are RNN, CNN, and LSTM. LSTM gives better performance than RNN and CNN. [8] present prediction of VIX i.e. Volatility Index every Index has VIX to predict its movement is different from stock and Index. The method chosen six algorithms including a few traditional methods such as Naïve Bayes (NB), Logistic Regression (LR), Classic ML such as Decision Tree (DT) and Random Forest (RF) along with some advanced methods such as Adaptive boosting (AB), Multi-Layer Perceptron (MLP), And an Ensemble model using all the above. The method provides good prediction as compared to traditional methods. In [9] discussed about all the ways of share price prediction on behalf of Market data and textual data. The author described Fundamental Analysis and Technical Analysis is the traditional Methods of Stock Price Prediction. Modern approaches are the Machine Learning approach and Sentiment Analysis approach. Apart from both these techniques, one more process is there called the Generic Process of Stock Market Prediction using Machine Learning in this all the technological algorithms are used as Artificial Neural Networks (ANN), Deep Neural Networks (DNN), regression on Algorithms (RA), Support Vector Machine (SVM), Naïve Bayes (NB), Generic Algorithms (GA), Fuzzy Logic Algorithms (FA) and Hybrid Approaches (HA). All these approaches are available still researchers are struggling with the accuracy sometimes in few researches 80% or 90% plus accuracy is showing but it is also in rare cases or sometimes for a particular script not for all the user scripts.

In [10] predicting Stock return of UAE listed companies using financial ratios, related to accounting and finance. This research was done for observing whether financial ratios can predict the equity return for 30 listed companies in the Abu Dhabi Stock Exchange and the Dubai Financial Market. In this technique, five independent features were used i.e. earnings per share, debt equity, price earnings ratio, dividend yield, and return on equity. They also used the dependent variable the stock return. In this research, the researchers have used Descriptive Analysis, Correlation Analysis, and Regression Analysis. The descriptive statistics, correlation analysis, and regression model have proven successful and their empirical value has proven strong. These models can also be used as a powerful tool to determine if a relationship or correlation exists between the two variables. This research also provides insight into the help of ratio investors predicting stock returns over the coming year.

In [11] analyzed the TUNINDEX, the benchmark of the Tunisian Stock Exchange. The researcher collected the data/events from electronic media such as space manager, web manager reports of the World Bank and leaders, etc. and they have also collected the past news of terrorist attacks in the past since 1970. After that, they used descriptive statistics to get the results. The descriptive analysis of a time series is based essentially on the analysis of flattening coefficients (kurtosis) and skewness asymmetry. The latter can be combined in a Jarque-Bera (JB) statistic to test the normality of distribution.

In the two similar research papers [12], [13] are based on Economics and it is the major arena to research for the purpose of share market future. In [14] is an informative journal for events based or can say to predict the stock market in case of crisis. In [15] worked on 10 years data of 4 Indian major banks as Kotak Bank, ICICI Bank, Axis Bank and Yes Bank this research is also beneficial to predict Banknifty.

A Deep LSTM Algorithm [16] has given 82.36% prediction results in the case of SBI. About NSE Nifty50 other companies for HDFC BANK 82.67%, Infosys 82.94%, BPCL 81.02%, TCS 81.63%, And ITC 82.59%, For L&T 82.59%, For UPL 81.66%, For CIPLA 81.71% and for Indian OIL 81.21%.

III. HYBRID DNN-CNN MODEL

The proposed deep learning method will be a hybrid DNN-CNN based method to improve Share market price prediction. The proposed model can predict the NSE Nifty Bank i.e. Stock Equity/ Market future movement/ price.

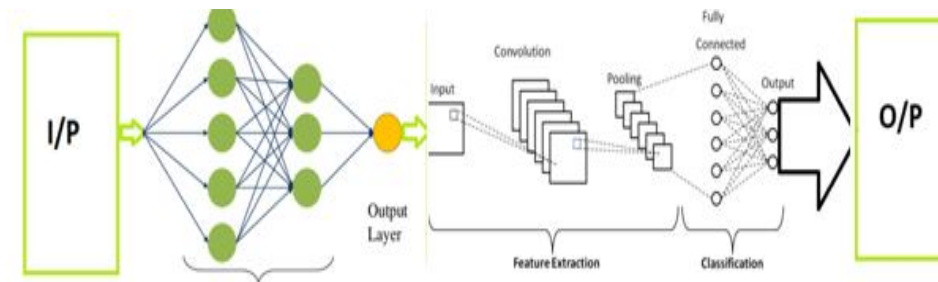


Figure 1 Proposed System Architecture

Fig. 1 represents the system architecture of proposed hybrid DNN-CNN model. The model consists of input layer, DNN layer, CNN layer, and output layer. The dataset from yfinance is input to the model using input layer. After processing from DNN and CNN layer we get the final results at output layer.

Figure 2 represents the flow diagram of proposed hybrid DNN-CNN based prediction model. The steps involved in proposed model is importing of stock/ index training data from yfinance dataset provided by Yahoo, data preprocessing, DNN layer, CNN layer, model training, testing and validation, model evaluation, and result analysis. DNN is a type of Neural Network that can understand the nonlinear relationships in data. In the context of stock prediction DNN is used to extract features from input data (such as stock prices and indicators) related to an estimated future value. The method is designed it to provide inputs from NSE Bank data from past trading days and predict future movements. CNN is a neural network that can learn features of data. In this work, CNN as the last/final layer of the model used for equity/stock price prediction on behalf of past data, a CNN layer can be used to combine features learned from the DNN layers. In this work, the CNN layer produces the final result

Fig.2 represents the flow diagram of proposed system. The model consists of importing stock data, data preprocessing, ensemble DNN-CNN model, training, testing and validation, evaluation and result analysis.

1. Importing the stock/ index trading data

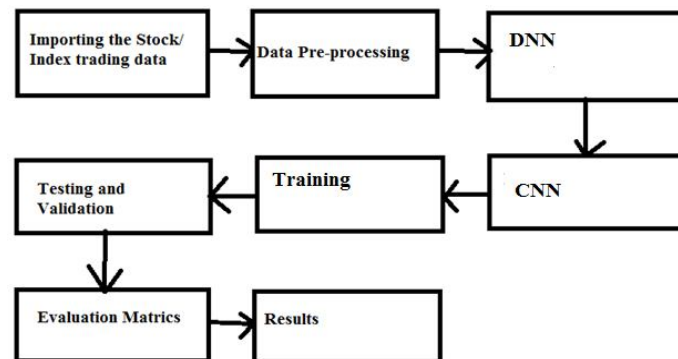
Yahoo Finance provides the stock/ index dataset in the form of yfinance library. For our model we have collected data for 15 years from 28th September 2007 to 4th May 2022.

2. Data Pre-processing

yfinance dataset consists of large amount of data which may have unused and unwanted data. In data pre-processing unwanted data is removed i.e. cleaned, normalized and also selection of most useful features for prediction. The splitting of data for training and testing purpose is also performed in data pre-processing. The yfinance dataset consists of stock data having 3301 rows, for training we have selected 2640 rows i.e. 80% of dataset and for testing 661 rows i.e. 20% of dataset. We have selected most required features from yfinance dataset such as low, date, economic factors, high, moving average, close, volume and open,

3. Model Development

This is the third phase of the work; it involves developing the model. We proposed hybrid DNN-CNN deep learning-based model. The proposed model has been trained and tested using training and testing dataset.



Ensemble DNN-CNN hybrid model algorithm

Input: BANKNIFTY and Output: Share/ Index price prediction

Where f is data features, C is output from DNN algorithm, P is output from CNN algorithm

HybridDnnCnn(data)

For f features in data do

$C = \text{Dnn}(f)$

$P = \text{Cnn}(C)$

End For

$\text{MSE}(P)$

Evaluate Precision, Accuracy, F-Score, Recall

End HybridDnnCnn

4. Model Evaluation

This is the fourth phase of the work; it involves evaluating the model on the performances of proposed model have been tested using evaluation metrics such as MAE, RMSE, MSE, F1-Score, precision, recall and accuracy.

5. Prediction

After training, validation and testing of proposed model we can predict the future stock market/ index.

IV. IMPLEMENTATION AND RESULT ANALYSIS

A. Implementation

The experiment is performed on Intel(R) Core(TM) i5-2.4 GHz CPU with 16GB RAM. Python language, Scikit-learn, NumPy, Pandas, Seaborn, and Matplotlib, libraries, with Keras and TensorFlow framework used for implementation of proposed technique.

The data set used for implementation if from Yfinannce data library. The attributes and values of data set are represented in table below.

The table 1 represents the 10 rows of the yfinance dataset. The dataset attributes are low, open, high, close, date and Adj close.

Table 2 describes the dataset attributes with their values. The dataset contains Banknifty Trading data from yfinance library having 3301 rows. The total 2640 rows i.e. 80% of data is used as training data and 661 rows i.e. 20% of data is used for testing. The start data (Training) is select as 28-09-2007 and end date (Training) is 04-05-

2022. Similarly start date (Validation) is select as 26-08-2019 and end date (Validation) is select as 02-05-2022. We get training accuracy (R-squared) is 0.9971777414652634 and validation accuracy (R-squared) is 0.9748483276160194.

TABLE 1: DATASET YFINANCE LIBRARY

Date	Open	High	Low	Close	Adj Close
25-04-2022	35792.351562	36270.148438	35511.398438	36082.351562	36082.354512
26-04-2022	36515.351562	36604.550781	36265.898438	36404.800781	36405.810882
27-04-2022	36067.550781	36175.898438	35747.148438	36028.851562	35928.841560
28-04-2022	36189.949219	36501.101562	35951.101562	36422.199219	36522.199210
29-04-2022	36474.050781	36718.800781	35978.949219	36088.148438	36089.148437
28-9-2007	7838.250000	8082.850098	7836.049805	8042.200195	8042.106934
01-10-2007	8008.549805	8085.149902	7913.299805	7987.500000	7987.407227
03-10-2007	8029.799805	8235.799805	7820.250000	8097.899902	8097.805664
04-10-2007	8083.299805	8086.700195	7828.649902	8035.899902	8085.806641
05-10-2007	8038.100098	8066.549805	7789700195	7845.250000	7845.158691

TABLE II: DATASET ATTRIBUTES

Total number of Rows	3301
Start date (Training)	28-09-2007
End date (Training)	04-05-2022
Number of Rows used for Training	2640
Start date (Validation)	26-08-2019
End date (Validation)	02-05-2022
Number of Rows used for Validation	661
Ratio of Rows used in Training	0.7997576491972129
Ratio of Rows used in Validation	0.20024235080278704
Training accuracy (R-squared)	0.9971777414652634
Validation accuracy (R-squared)	0.9748483276160194

```
Epoch 1/50
44/44 [=====] - 9s 93ms/step - loss: 0.0123 - val_loss: 0.0014
Epoch 2/50
44/44 [=====] - 3s 63ms/step - loss: 9.1255e-04 - val_loss: 0.0011
Epoch 3/50
44/44 [=====] - 2s 55ms/step - loss: 7.6129e-04 - val_loss: 8.4991e-04
Epoch 4/50
44/44 [=====] - 2s 51ms/step - loss: 6.7954e-04 - val_loss: 8.5456e-04
Epoch 5/50
44/44 [=====] - 2s 51ms/step - loss: 6.6628e-04 - val_loss: 9.9024e-04
Epoch 6/50
44/44 [=====] - 2s 51ms/step - loss: 5.8186e-04 - val_loss: 7.5233e-04
Epoch 7/50
44/44 [=====] - 2s 51ms/step - loss: 5.9139e-04 - val_loss: 7.2585e-04
Epoch 8/50
44/44 [=====] - 2s 54ms/step - loss: 5.6971e-04 - val_loss: 0.0013
Epoch 9/50
44/44 [=====] - 2s 54ms/step - loss: 5.1169e-04 - val_loss: 0.0016
Epoch 10/50
44/44 [=====] - 2s 54ms/step - loss: 5.2365e-04 - val_loss: 0.0011
Epoch 11/50
```

B. RESULT ANALYSIS

1. Actual V/S Training and Actual V/S Prediction

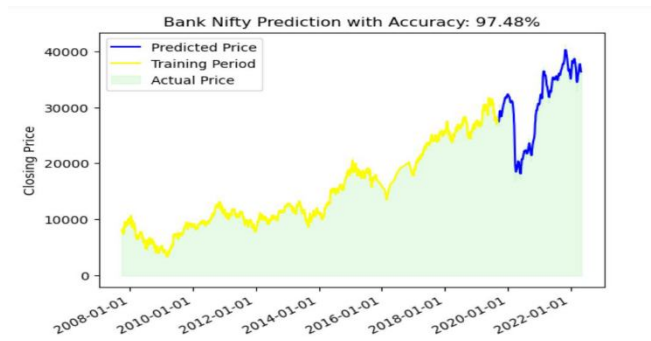


Figure 4: Actual V/S Training and Actual V/S Prediction

The fig. 4 represents the Actual V/S Training and Actual V/S Testing graph. The duration of the dataset is from 28th September 2007 to 4th May 2022 i.e., for 15 years. The proposed method achieved 97.4% prediction accuracy.

2. Bank Nifty Sensex, and Nifty Actual Movements

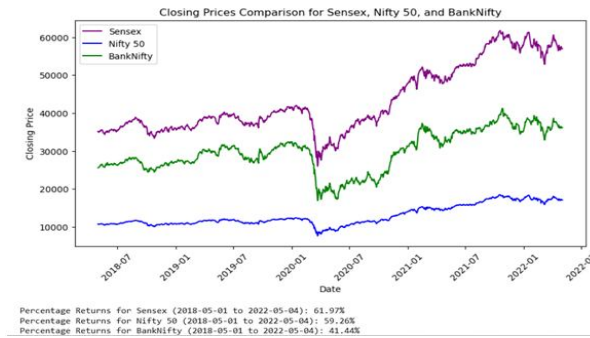


Figure 5: Years Movements and Returns of Sensex, Nifty and Bank Nifty

The figure5. represents the closing prices of Sensex, Nifty and Bank nifty for 4 years 2018 to 2022. Sensex percentage return from 2018-05-01 to 2022-05-04 is 61.9%. Nifty percentage return from 2018-05-01 to 2022-05-04 is 59.2%. Bank Nifty percentage return from 2018-05-01 to 2022-05-04 is 41.4%. The percentage returns represent the overall profitability and performance of each index over a 4-year period.

Validation Loss

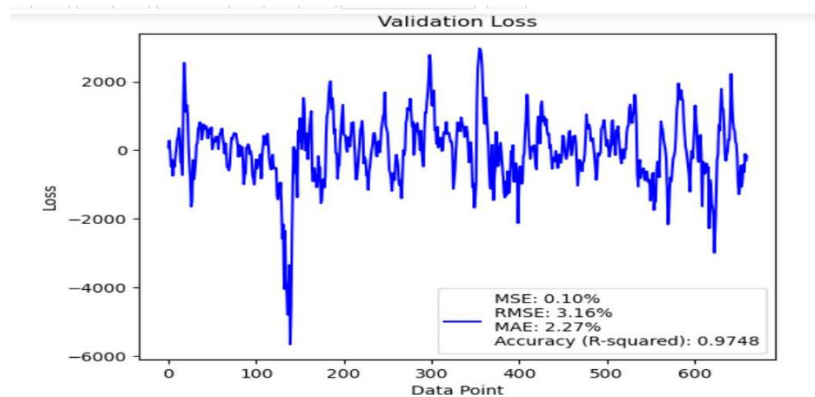


Figure 6: Validation Loss

Fig. 6 represents the testing period validation loss. As from results we get MSE of 0.10%, MAE of 2.27% and RMSE of 3.16%.

3. Testing- Actual V/S Predicted

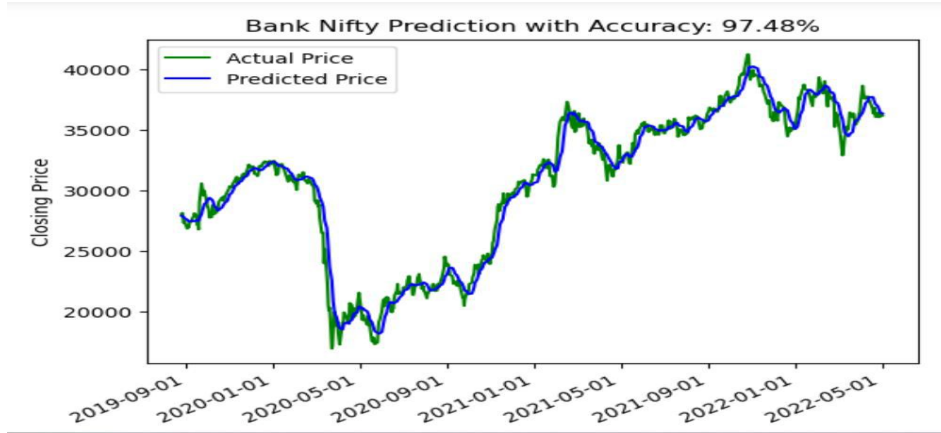


Figure 7: Testing- Actual V/S Predicted Line Graph

The fig. 7. represents the Testing- Actual V/S Predicted graph. The predicted accuracy is 97% using Bank Nifty for 15 years data from 28th September 2007 to 4th May 2022

C. Evaluation Metrics

The table 3 shows the statistics about Evaluation Metrics

TABLE III: EVALUATION METRICS

Training loss (MSE)	0.07068396332442098 %
Validation loss (RMSE)	0.0999814561486119 %
Training loss (RMSE)	2.6586455823298634 %
Validation loss (MSE)	3.1619844425393984 %
Training loss (MAE)	1.9755309561750818 %
Validation loss (MAE)	2.273714829994833 %
Training Accuracy (R-squared)	0.9971777414652634
Validation Accuracy (R-squared)	0.9748483276160194

The evaluation matrix represents the metrics with their values. As from the above results we can find the MSE Loss, RMSE Loss, MAE Loss in % during training and validation and the most important R-Squared Accuracy during the training and validation i.e. 99.71% (Traning Accuracy) and 97.4% (Testing Accuracy).

Closing Price V/S predicted Price: In the following figure/image we have shown the closing price V/S predicted price it has a large number of rows so we have shown the first 5 rows and the last 5 rows.

Comparison: In the following table shown parameter are using in prediction.

TABLE 4: PARAMETERS USED IN PREDICTION

1	Unit= 64	Drop out:0.3	Activation: Relu	Loss=binary_cross sentropy	Optimizer=adam	Epoch 50
2	Unit =64	Drop out:0.4	Sigmoid	Loss=binary_cross sentropy	Optimizer=adam	Epoch 60
3	Unit= 64	Drop out:0.2	Softmax	Loss=binary_cross sentropy	Optimizer=adam	Epoch 80

Table 4 represents parameters used in implementation for stock market prediction. The table 5 represents unit, drop out, activation function, loss, optimizer and epoch used in the implementation.

TABLE V: MODEL EVALUATION

Actual class	Predicted Class	
	Negative	Positive
Negative	TN (True Negative)	FP (False Positive)
Positive	FN (False Negative)	TP (True Positive)

Table 5 represents the actual class and predicted class with TN, TP, FN and FP classification method.

Accuracy: Proportion of correct classifications (true positives and true negatives) from overall number of cases.

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

Recall: Proportion of correct positive classifications (true positives) from cases that are actually positive.

$$\text{Recall} = \frac{TP}{TP + FN}$$

Precision: Proportion of correct positive classification (true positives) from cases that are predicted as positive.

$$\text{Precision} = \frac{TP}{TP + FP}$$

F-Score or F-Measure: is a single measure of classification procedures usefulness. The F-Score considers both precision and recall of the procedure to compute the score. The higher the F-Score, the better the predictive power of the classification procedure. A score of 1 means the classification procedure is perfect. The lowest possible F-Score is 0.

$$0 \leq F \leq 1$$

The F-Score is the Harmonic mean of Precision and recall.

$$F = 2 / \left(\frac{1}{\text{recall}} + \frac{1}{\text{precision}} \right)$$

$$F = 2 * (\text{precision} * \text{recall}) / (\text{Precision} + \text{recall})$$

TABLE VI: COMPARISON BETWEEN EXISTING MODEL AND PROPOSED MODEL

Method	Accuracy	Precision	Recall
LSTM	89.22	83.21	79.25
RNN	91.23	88.25	82.12
DNN	96.22	93.88	90.25
CNN	92.31	90.25	89.11
Proposed DNN-CNN	97.4	98.2	91.02

$$F1 \text{ score} = (2 * 98.2 * 91.0) / (98.2 + 91.0) = 94.4.$$

The table 6 represents the comparison between recall, accuracy and precision of proposed model and other methods. The table represents that proposed method recall is 91.02, precision is 98.2 and accuracy is 97.4.

V. CONCLUSIONS

The use of machine learning in stock/index price prediction involves building and training models that can learn from historical data and make predictions of future prices and potential to improve forecast accuracy and provide valuable insights into market trends and investor sentiment. Deep learning is a subset of machine learning that involves using artificial neural networks with multiple layers to analyze and learn from complex data such as stock price data. The hybrid model for index/stock price prediction involves the combination of various deep learning algorithms such as CNN and DNN or LSTM and DNN in a single model to improve the prediction accuracy. The paper presents DNN-CNN based hybrid model for share price prediction. The proposed model can predict the NSE

Nifty Bank i.e. Stock Equity/ Market future movement/ price. The results represent that proposed method recall is 91.02, precision is 98.2 and accuracy is 97.4 which is better as compared to another hybrid model.

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