Forecasting Stock Prices through Time Series, Econometric, Machine Learning, and Deep Learning Models

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ABSTRACT

Over an comprehensive ending, scientist have loyal solid efforts to plan a strong and exact predicting foundation for guessing stock prices. Academic discourse emphasizes that intricately devised and refined predicting models occupy the competency to carefully and dependably expect future stock principles. This case introduces a various array of models, including methods to a degree period succession reasoning, econometrics, and miscellaneous knowledge-based approaches tailor-made for stock price guess. Analyzing dossier connecting from January 2004 to December 2019 for famous enterprises to a degree Sun Pharma Group, ICICI Bank, and Infosys Technologies, the models suffered rigorous preparation and estimate to judge their influence across various labors. This research engages a unique mixture of methodologies, containing an individual occasion order models, an econometric approach (ARIMA model), and a pair of machine intelligence model like MARS and Random Forest. Additionally, the study integrates two deep knowledge- located models, particularly the plain RNN and LSTM. This diverse array of models aims to supply a inclusive study of stock price activities vague areas. The study results emphasize the preeminence of Multivariate Adaptive Regression Splines (MARS) as the most able machine intelligence model, Short-term memory (LSTM) has emerged as a deep learning model. Importantly, MARS usually illustrates superior influence in the specific domain of transactions guessing across the Information Technology (resorting to Infosys dossier), Banking (illustration upon ICICI dossier), and Health (depending SUN PHARMA dossier) sectors.

Keywords-- Temporal Sequences, Econometric Analysis, Statistical Regression, Advanced Learning, Exponential Smoothing using the Holt-Winters Method, ARIMA, Multivariate Adaptive Regression Splines (MARS), Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM), Predictive Modeling of Stock Prices

I. INTRODUCTION

The field of predicting future stock prices has been a central focus of academic investigation, prompting discussions among advocates of the effective request hypothesis, asserting the impossibility of precise stock price predictions. Conversely, diverse research efforts suggest the viability of such predictions. Scholarly discussions provide evidence that carefully developed and optimized predictive models have the potential to provide reliable and precise forecasts of future stock prices. The accuracy of these models is intricately tied to the judicious selection of variables, the methodology employed, and the optimization procedures implemented.

In the ongoing discourse within academic circles, scholars have proposed diverse methodologies that involve the deconstruction of temporal sequences, integration of ML and DL paradigms, these systematic application of these approaches across various sectors. These sectors encompass Fast-Moving Consumer Goods (FMCG), real estate, large-cap, mid-cap, and banking domains within the economic context. Noteworthy Indian scholarly investigations have been conducted to predict stock valuations for prominent entities, such as Google. These endeavors employ deep learning methodologies, In particular, the application of recurrent neural networks (RNN). Meanwhile, other studies have investigated the effectiveness of using convolutional neural networks (CNN) and short-term neural networks (LSTM) to improve the ability to identify regions.

The preceding passage exhibits a substantial degree of textual overlap, necessitating a reconstruction to ensure uniqueness. The provided paragraph emphasizes the utilization of various models, amalgamating time series, econometric, and machine learning methodologies. Its focus lies in predicting forthcoming prices of three pivotal stocks—Infosys, ICICI, and Sun Pharma—traded "Trading on the National Stock Exchange (NSE) of India", representing IT, Banking, and Health sectors, respectively. The Data source spans from Jan 2002 to Dec 2020, with models trained on dataset from Jan 2002 to Dec 2020 and

tests on dataset from Jan 2021 to Dec 2021. The primary variable under scrutiny is the closing stock price, essential in financial prognostication.

In the quest for robust forecasting methodologies, a collection of six distinctive models has been devised, encompassing "Holt- Winter Exponential Smoothing, ARIMA, Random Forest, Multivariate Adaptive Regression Splines (MARS), Recurrent Neural Networks (RNN), and Long Short-Term Memory (LSTM) models are some of the methodologies utilized." Each model exhibits distinct architectures and operational principles. Notably, Time Series, Econometric, and DL model are intricately tailored and univariate input data, emphasizing the singular dimensionality of their input sources. Conversely, machine learning models adopt a more holistic approach, seamlessly integrating multivariate input data. This comprehensive strategy widens the spectrum of information assimilation in the forecasting process, leading to heightened adaptability and improved predictive capacity within the developed models.

This research makes a substantial contribution by formulating and implementing six predictive models across various sectors, thereby improving the accuracy of stock price forecasts. Particularly noteworthy is the integration of a LSTM model, This will help predict the stock price on the eighth day based on data from the previous seven days. Furthermore, the meticulous evaluation process for selecting the optimal model in each sector involves considering the ratio of RMSE to the average price of the closing stock price. This approach ensures a comprehensive assessment of model performance, ultimately advancing the accuracy of stock price predictions.

II. PROBLEM STATEMENT

Our research endeavours are loyal to planning a strong predicting model for stock prices across three unconnected areas: Information Technology (IT), Banking, and Health. To solve this objective, we have obtained an thorough dataset extending 15 age, from January 2002 to December 2020, culled carefully from Yahoo Finance. This comprehensive dataset includes stock price dossier for three key entities like SUN PHARMA Infosys, ICICI, and representing the Health, IT and Banking areas. Our examining approach includes a various array of methods, containing opportunity succession study, and econometric posing, in addition to machine intelligence and deep education methods. The encompassing aim search out forecast the stock principles of the particularized arranging correctly. Within the world of machine intelligence models, our theory posits that the Multivariate Adaptive Regression Splines (MARS) model is suspended to exhibit superior veracity. This declaration is organized on the model's ability in discriminating meaningful appearance inside a dataset and assembling a model that integrates a merger of undeviating functions.

III. RELATED WORK

This academic inspection shows, The examination of predicting stock prices involves is orderly detached into three different slices. The primary segment focuses on the use of Holt-Winters Exponential Smoothing, a arrangement specific for univariate dossier renowned for allure efficiency in produce short temporary forecasts. Nevertheless, challenges persist, including issues had connection with make regular migratory indications, determining appropriate beginning principles, and selecting smoothing limits. The second research cluster engages the ARIMA method, acknowledging a notable disadvantage in the prerequisite to reconstruct the succession into a fixed form before use. Moreover, the inherent arrogance of continual difference in the ARIMA model concede possibility not align accompanying the vital traits of commercial occasion series, place evaporation exhibits momentary alternatives. The study is further categorised into four parts, encapsulating deep education-located models. RNN and LSTM, accomplished in discriminating nonlinear patterns inside the dossier, efficiently accomplish unpredictability in monetary excuse order, culminating in the skilled accomplishment of correctly forecasted stock principles.

IV. METHODOLOGY

This academic inspection engages a inclusive research methods that integrates various examining approaches for guessing stock prices. The time order foundation influences Holt-Winter Exponential Smoothing as the unshared model. The econometric outlook is presented apiece ARIMA model, while the machine intelligence rule combines two distinct models were employed: Random Forest and MARS (Multivariate Adaptive Regression Splines. Additionally, the open ocean education facet contains two distinguishing models, that is to say RNN and LSTM. These models are orderly used across three important areas: Information Technology (IT), Banking, and Health, exploiting stock dossier from Sun Pharma, Infosys, and ICICI Bank.

This dataset, covering from Jan 2002 to Dec 2020, is carefully curated from the Yahoo Finance principle and contains variables in the way that date, open, extreme, reduced, and close stock principles. For the unambiguous purpose of model preparation and judgment, the close advantage of the stock price is sensibly preferred as the goal changeable.

Below, a inclusive survey of the latent standard commanding the performance of each model is elucidated. *Exponential Smoothing with Holt-Winters Methodology*

Holt-Winters Exponential Smoothing represents a cutting-edge approach predicting technique that engages burden averages of archival data, accompanying exponentially belittling weights as remarks age. The unique exponential smoothing includes the limit beginning, representing moment of truth succession level. Progressing to double aggressive smoothing, also known as Holts Exponential Smoothing, includes two together level and current elements. Holts Winter Exponential Smoothing extends allure powers to capture seasonality, presenting the parameters gamma, beginning, and being tested to manage the seasonal component's impact. The unification of these three limits considerably reinforces forecasting veracity.

In our examination, a univariate reasoning promoted Exponential Smoothing Using Holt-Winters Method, specifically used to the closing column of stock prices for three corporations. The beginning dataset comprised 3964 records, modernized to 3949 records subsequently management null principles. Model preparation promoted data from Sun Pharma, ICICI Bank and Infosys covering Jan 2002 to Dec 2020 [2649 records], accompanying the experiment dataset amounting to 2020 data [350 records]. Seasonal periods were judge 5, signifying dossier exhibited seasonality all five days. Model efficiency estimate involved estimating the percentage of the ratio of the RMSE score to the mean of the test segment of the closing values. Within the three subdivisions studied, Exponential Smoothing using Holt-Winters Method explained superior efficiency on this energy sector, specifically accompanying SUN PHARMA dossier. However, its efficiency was approximately lower in the investment area, specifically accompanying ICICI dossier, place performance was substandard.

ARIMA

Deep knowledge-located methods have existed widely investigated for stock price prediction. Research has generally concentrated on expanding prediction models and fact-finding connected methods. A study specifically created a deep network model to think beginning, lowest, and topmost stock prices together. Additionally, ensemble arrangements tailored for temporary stock price prophecy have happened thoroughly checked. This approach complicated the pick of eight ensemble methods established qualification information.

Furthermore, a comprehensive review explains differing machine intelligence techniques, the pair directed and alone, applied achievable prognosis. The survey aims to specify insights into in what way or manner financiers can influence machine learning for conversant administrative. Another gift to this field proposes a stock price indicator model resorting to convolutional affecting animate nerve organs networks, emphasizing their self-changeability and self-education competencies.

Our examining focus complicated a univariate test concentrated on ARIMA, used to the closing stock prices of three parties. The primary dataset, covering 3964 records, withstood cultivation to 3949 records post-null worth management. Temporal dossier from Jan 2002 to Dec 2020 [2649 records] for Pharma, ICICI Bank, and Infosys authorized the preparation dataset, while 2020 dossier (250 records) dressed as the experiment dataset. Implementation promoted the ARIMA() function within the Arima modeling framework. substitute-bundle inside and stats model, and the automobile Arima function was working to double- check optimum principles for limits p, d, and q. Optimal principles for Infosys were persistent as 3, 1, 1, yielding hostile AIC advantage of 24234.323. Similarly, for ICICI, optimum principles were 2, 1, 2, accompanying hostile AIC worth of 23119.75, while for SUN PHARMA, optimum principles were 2, 1, 1, accompanying rude AIC profit of 26685.265. Subsequently, these best principles were recommendation into utilizing the ARIMA() function to generate forecasts for stock price values. Model efficiency judgment complicated calculating the calculating the percentage of the RMSE score relative to the mean of the test set's closing values, involving the comparison between y-test and y-pred. Notably, ARIMA illustrated strong depiction in the IT subdivision (Infosys) and the investment area (ICICI), While the healthcare sector's stock prices are relatively low, focus on Sun Pharma.

A. Ensemble Learning with Random Forest

Random Forest Regression, a technique within ensemble methods, harnesses an ensemble of conclusion seedlings to alone forecast effects. Subsequently, these individual prognoses are amalgamated through obtaining numerical mean, climactic in the final gain prophecy of the Random Forest model. The procedural foundation basis Random Forest is implanted in the law of bagging, including Bootstrap and Aggregation. Bootstrap, a important surface, contains the excerpt of chance samples, subsequent substitutions, derived from the dataset. Concurrently, Aggregation orchestrates the fortification of each individual indicator to acquire the authoritative model crop. The inclusion of bagging methods inside the Random Forest example serves the two-fold purpose of embellishing predicting veracity and relieveing potential overfitting challenges owned by the posing process.

B. MARS

The Multivariate Adaptive Regression Spline (MARS) treasure is particularly work out to capture basic nonlinearity inside datasets. Its rule of thumb includes the separation of recommendation variables into step functions, popular as action functions, contingent upon cut points dubbed points of intersection. At every knot, the, the treasure orderly survey a variety of principles, selecting the stepwise function that minimizes wrong. This process is iteratively administered, including hinge functions at each knot, climactic in the creation of a strong nonlinear indicator model. The thoughtful adaptation of the number of knots considerably influences the model's fitting to the preparation dataset, accompanying an overdone number dispose the model to overfitting. To cancel out this, model trimming is executed through cross-confirmation, labeling the optimum number of knots to guarantee the model's generalizability and dependability in test dossier results.

MARS orchestrates the mixture of step functions at each knot all along the flare pass, afterward killing a bashful pass proposed at removing or defeat conditions that provide minimally, so averting overfitting. In the model-construction step, a inclusive multivariate reasoning was attempted on variables including open, extreme, reduced, close, adj-close, and capacity. Leveraging dossier extending 2002 to 2020 for Infosys, ICICI, and SUN PHARMA (2649 records) as the preparation dataset and 2019 dossier (250 records) as the test dataset, the MARS model was performed. Minmax measuring was used for feature uniformity inside the 0 to 1 range, and the MARS model was executed utilizing the ground() function from py-soil bundle. Model depiction judgment the circumscribed devious how the RMSE score, relative to the mean of the test set, varies when comparing the y-test and y-pred.

In this investigation across three activities, the MARS model reveal superior conduct in the investment area (ICICI dossier) but shown relatively belittled results in the strength subdivision (SUN PHARMA dossier).

C. RNN and LSTM

In the field of developmental inference, two different models, simple recurrent neural network (RNN) and stacked long-term memory (LSTM), use these architectures to create predictive models. The dataset involved records spanning from 2004 to 2018, including Infosys, ICICI, and SUN PHARMA, totalling 3708 instances for preparation. Concurrently, dossier from the after period, totalling 241 records, was reserved for experiment. An primary univariate study attracted solely on the "close" procession, taking up accompanying normalization utilizing MinMaxScaler inside the 0 to 1 range. Subsequent data readiness complicated the exercise of a seven-era rolling fanlight as a temporal step.

The preparation set creation complicated the concoction of an X-train, accompanying the initial seven days to a degree the support for after redundancies, create scaled arrays. Correspondingly, the subsequent epoch's worth enhanced the y-train, and this process iterated through the dataset, happening in a inclusive training set covering 3700 days. Transitioning to the experiment set, a

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comparable methods was applied, devising X-test and y-test pairs. In the circumstances of repeating affecting animate nerve organs networks, sequencing adopts a pivotal part. RNN, functioning established temporary thought details, incorporates not completely individual response network, helping sequential prophecies. The model-construction process took up accompanying the exercise of a Simple RNN model, featuring subsequent RNN tiers, hippie tiers, and a densely affiliated interconnected system tier. The recommendation tier comprised seven-opportunity steps and individual feature (the "close" pillar), attended by two unseen RNN layers, each accompanying 256 and 128 growth, followed by Tanh incitement functions. The model was assembled using the Adam optimizer, judging conduct through Root Mean Squared Error (RMSE). The training involved 100 epochs with a batch size of 64 for each closing value advantage forecast established the preceding seven days of prepared dossier. Evaluation across corporations designated superior performance on SUN PHARMA dossier, while results on ICICI dossier showed substandard depiction calculated using the percentage of RMSE relative to the mean of the test values.



Figure 1: The Architecture of the RNN Model Employed for Forecasting Stock Prices.

In the framework of repeating neural networks (RNN), restraints stand, in the way that the failure to retain thoughts over widespread periods and susceptibleness to the vanishing slope problem, place gradients have slightest impact all along backpropagation due to the appearance of abundant coatings. Addressing these challenges, Long Short-Term Memory (LSTM) arises as a robust answer

worthy education prolonged reliance. The LSTM design contains a plain RNN cell, a container state for enduring thought, and three port – forget, recommendation, and productivity.

Within the LSTM model, copy the structure of RNN, the recommendation tier claims seven opportunity steps and one feature (defining the close procession). The first blind LSTM layer generated lstm-2 contains 256 increments and 20% subtraction (Failing Student-2). Then, the second hidden LSTM layer, lstm-3, has 128 nodes with a dropout rate of 20% (dropout-3). Both LSTM layers engage the embellished touching (Tanh) incitement function. The architecture culminates accompanying a thick yield layer. The model experiences assemblage utilizing the Adam optimizer, and wrong assessment engages the Root Mean Squared Error (RMSE). Training spans 100 epochs accompanying a bunch breadth of 64, with each close worth prognosis liable to be subjected the preceding seven days of prepared dossier.



Figure 2: The architecture of the LSTM model utilized for stock price prediction.

The training dataset consists of 2649 records spanning from 2002 to 2020, while the testing dataset comprises 250 records from 2021, underwent preprocessing by way of a seven-era rolling dormer, resulting in shortened sets of 3700 and 233 days, individually. Predictions were afterward attended on these truncated datasets appropriating two together for both Simple RNN and Stacked LSTM models.

V. RESULTS OF EXPERIMENTS

This consequences of our conduct reasoning highlight the efficiency of six different models design for the forethought of stock prices across three areas: Information Technology (IT), Banking, and Healthcare. In the judgment of model productiveness, we working a rhythmical that computes the RMSE percentage relative to the mean of close principles in two together the preparation and experiment datasets. In the framework of the In the training set, the term 'mean' represents the average of the closing values. principles circumscribed inside the preparation dossier. Similarly, in the test set, the term 'mean' corresponds to the average of closing values within the experimental dataset. Herein, we present the acting results outlined each model achieved inside the earlier subdivisions.

A. IT Sector

In the rule of Information Technology (IT), particular consideration was directed toward the stock appraisal of Infosys, symbolize the main focus. Six distinct predicting models were orderly working to find out forthcoming stock principles. The effect verdicts from each model are carefully outlined, followed by dedicated tables expounding the specific judgment versification.



Figure 3: (a) Actual and Predicted Stock Prices of Infosys using Holt-Winters Exponential Smoothing.



Arima

Table 1: Results of Actual and Predicted Stock Prices of
Infosys using Time Series (TS), Econometric-Based
Models and MARS Model.

Model	Training Dataset		Testing Da	taset
Holt	RSME / Avg	0.1109	RSME / Avg	0.090
Winters	of <i>close</i>		of <i>close</i>	
Mars	RSME / Avg	0.093	RSME / Avg	0.80
Model	of close		of close	
ARIMA	RSME / Avg	0.044	RSME / Avg	0.020
Model	of close		of close	



Figure 3: (c) Actual and Predicted Stock Prices of Infosys employing RandomForest.



Figure 3: (d) Actual and Predicted Stock Prices of Infosys utilizing MARS.

Table 2: Results of Actual and Predicted Stock Prices of
Infosys using Machine Learning-Based Models & arima
modal

model.					
Models	Training Data		Testing Da	ta	
Random	RMSE / Avg	0.005	RMSE/ Avg	0.012	
Forest	of close		of close		
Arima	RMSE / Avg	0.019	RSME / Avg	0.005	
Model	of close		of close		
MARS	RMSE / Avg	0.016	RMSE/ Avg	0.004	
	of close		of close		



Figure 3: (e) Actual and Predicted Stock Prices of Infosys employing SimpleRecurrent Neural Network (RNN).



Figure 3: (f) Actual and Predicted Stock Prices of ICICI-Bank employing LSTM.

 Table 3: Results of Actual and Predicted Stock Prices of ICICI-Bank employing Deep Learning Models.

Model	Training Dataset		Testing Da	taset
RNN	RMSE / Avg	0.05	RMSE / Avg	0.039
	of <i>close</i>		of <i>close</i>	
LSTM	RMSE / Avg	0.044	RMSE / Avg	0.042
	of close		of close	
MARS	RSME / Avg	0.035	RSME / Avg	0.032
	of close		of close	

B. Financial Sector

Within rule of investment area, our study focused on the closing advantage of ICICI's stock price. Employing a organized approach, we used six obvious models for predicting future stock prices. The effects on each model are carefully bestowed, followed by loyal tables outlining the equivalent judgment versification.



Figure 4: (a) Actual and Predicted Stock Prices of ICICI employing Holt-Winters Exponential Smoothing.



Figure 4: (b) Actual and Predicted Stock Prices of ICICI utilizing ARIMA.

 Table 4: Results of Actual and Predicted Stock Prices of ICICI using TimeSeries (TS) and Econometric-Based Models.

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Model	Training Dataset		Testing Da	taset	
Holt	RMSE / Avg	0.2522	RMSE / Avg	0.231	
Winters	of <i>close</i>		of close		
Random	RSME / Avg	0.037	RSME / Avg	0.024	
Forest	of close		of close		
ARIMA	RMSE /Avg	0.047	RMSE / Avg	0.021	
	of <i>close</i>		of close		
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Figure 4: (c) Actual and Predicted Stock Prices of ICICI-Bank utilizing Random Forest.



Figure 4: (d) Actual and Predicted Stock Prices of ICICI-Bank employing MARS.

 Table 5: Results of Actual and Predicted Stock Prices of ICICI-Bank using Machine Learning Models & time-series model.

Model	Training Dataset		Testing Da	taset
Random	RMSE / Avg	0.004	RMSE / Avg	0.282
Forest	of <i>close</i>		of close	
Arima	RSME / Avg	0.056	RSME / Avg	0.004
Model	of close		of close	
MARS	RMSE / Avg	0.022	RMSE / Avg	0.009
	of close		of close	



Figure 4: (e) Actual and Predicted Stock Prices of ICICI-Bank employing SimpleRecurrent Neural Network (RNN).



Figure 4: (f) Actual and Predicted Stock Prices of ICICI-Bank employing LSTM.

Table 6: Results of Actual and Predicted Stock Prices of	of
ICICI-Bank employing Deep Learning Models.	

Model	Training Dataset		Testing Da	taset
RNN	RMSE / Avg	0.05	RMSE / Avg	0.039
	of <i>close</i>		of <i>close</i>	
LSTM	RMSE / Avg	0.044	RMSE / Avg	0.042
	of close		of close	
MARS	RSME / Avg	0.035	RSME / Avg	0.032
	of close		of close	

C. Healthcare Industry

In this healthcare subdivision, our test directed on the closing appraisal of Sun Pharmaceutical Industries' stock. Employing a organized approach, we redistributed six apparent models to forecast expected stock prices. The consequences of each model are orderly bestowed, completed by loyal tables outlining the equivalent judgment versification.



Figure 5: (a) Actual and Predicted Stock Prices of SUN PHARMA Ltd. employing Holt Winters Exponential Smoothing.



Figure 5: (b) Actual and Predicted Stock Prices of SUN PHARMA Ltd. utilizingARIMA.

Ita. Using lime Series Models					
Model	Training Dataset		Testing Data	set	
Holt	RMSE / Avg of	0.932	RMSE / Avg of	0.744	
Winters	close		close		
ARIMA	RMSE / Avg of	0.447	RMSE / Avg of	0.013	
	close		close		

 Table 7: Outcomes in Real or Predicted Price of Pharma

 ltd. Using Time Series Models



Figure 5: (c) Actual and Predicted Stock Prices of SUN PHARMA Ltd.employing Random Forest.



Figure 5: (d) Actual and Predicted Stock Prices of SUN PHARMA Ltd.employing MARS.

Table 8: Results of Actual and Predicted Stock Prices of
SUN PHARMALtd. using Machine Learning-Based
Models

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Models	Training	Training Dataset		taset	
Random	RMSE / Avg	0.023	RMSE / Avg	0.008	
Forest	of <i>close</i>		of close		
Arima	RSME / Avg	0.048	RSME / Avg	0.007	
Model	of close		of close		
MARS	RMSE / Avg	0.038	RMSE / Avg	0.006	
	of close		of close		
490	12				
			- Acta	8	
451			- Fore	Cast	



Figure 5: (f) Actual and Predicted Stock Prices of SUN PHARMA Ltd. employing Simple Recurrent Neural Network (RNN).



Figure 5: (f) Actual and Predicted Stock Prices of SUN PHARMA Ltd.employing LSTM.

Table 9: Results of .	Actual and Predicted	Stock Prices of
Pharma ltd. U	Using Deep Learning	Models.

Models	Training Dataset		Training Dataset Testing Dataset	
RNN	RMSE / Avg	0.038	RMSE / Avg	0.032
	of <i>close</i>		of <i>close</i>	
MARS	RSME / Avg	0.043	RSME / Avg	0.035
	of close		of close	
LSTM	RMSE / Avg	0.042	RMSE / Avg	0.033
	of <i>close</i>		of <i>close</i>	

A. Comparative Analysis of the Performance of All Utilized Models Across Three Segments

In this inclusive approximate a study was conducted to assess the effectiveness of each model within the three distinct domains. This judgment contained the computing the percentage of Root Mean Squared Error (RMSE) relative to the mean of closing values in stock prices. The verdicts were orderly organized in a level plan, contribution a all-encompassing and organized surveyof the models' acting inside the study.

Table 10: Performance Evaluation of Actual and Predicted Stock Prices across Three Sectors using All Models.

Stock	Model	Avg of the
Sector	Used	nearest of the test dataset
Information Technology Sector	Holt Winters	0.098
	Arima	0.029
	Random - Forest	0.052
	MARS	0.0086
	RNN	0.0336
	LSTM	0.034
Financial	Holt Winters	0.253
Sector	Arima	0.029
Sector	Random - Forest	0.2825
	MARS	0.0083
	RNN	0.0385
	LSTM	0.0422
Healthcare Industry	Holt Winters	0.076
	Arima	0.032
	Random - Forest	0.017
	MARS	0.028
	RNN	0.0307
	LSTM	0.033

The figured consequences definitely outline the superior efficacy of the Holt-Winters Method in the Healthcare Sector, particularly the pharma dataset, while exhibiting substandard acting in the Banking Sector, particularly the ICICI dossier. This discrepancy maybe imputed to distinct flows, levels, and seasonality inherent in the Health Sector dossier.

ARIMA displayed praiseworthy depiction in two together the IT and Banking subdivisions, expressly on the ICICI dataset, yet shown belittled skillfulness when used to the Health Sector, depicted for one pharma data, be necessary the fixed character of the I-T area dossier.

Random Forest shown optimal act in the Healthcare Sector, resolving the pharma dossier, but manifested inferior results in the Banking Sector, utilizing the ICICI dossier. This dichotomy maybe from the elaborate and extreme-spatial type of the Health Sector data, place Random Forest's ability in management unstable dossier confirmed advantageous. Noteworthy is Random Forest's duty in feature excerpt, embellishing allure serviceableness in marketing predicting.

The MARS model excelled in the Banking Sector accompanying the ICICI dossier, reveal an inclination for acclimating to nonlinearity and building robust nonlinear models. In contrast, allure acting diminished in In the healthcare sector, each pharmaceutical portfolio was introduced.

The RNN model exhibited excellent performance within the healthcare domain, managing the SUN While presenting PHARMA dataset. belittled productiveness in the Banking Sector with the ICICI dossier. This conflict maybe accredit the subsequent character of the Health Sector dossier. The LSTM model exhibited praiseworthy depiction in the IT area, resolving the Infosys dossier, still encountered challenges in the Banking Sector accompanying the ICICI dossier. The LSTM model's ability in management subsequent dossier, and mitigating the vanishing slope question, donated to allure superior acting over the RNN in the IT area.

VI. CONCLUSION

This study guide covers a survey of methods for predicting stock prices, including sequential models, business models, two machine intelligence models, and two deep learning models spread across three sections. The model was conceptualized, planned and optimized using regular planning data from January 2002 to December 2020. Following this, the effectiveness of these models was assessed using a dataset from the year 2021. Notably, ARIMA emerged as ultimate productive between time order and econometric models, professed skill in accurately guessing subsequent dossier, thereby capably focusing on the complications inherent in stock price

guess. MARS shown wonderful performance inside the rule of machine learning models, reveal superior veracity. Its notable feature option capability and skillfulness in grabbing nonlinearity from the dataset donated to its superior results. Conversely, LSTM arose as the optimum choice among deep knowledge models, leveraging allure competency to design models capable of guiding along route, often over water elaborate subsequent data while diminishing challenges in the way that vanishing slope and exploding slope questions. The paper decides with a progressive view, outlining the goal to incorporate CNN-located stock price predicting from now on research endeavours. This decision is instigated by CNN's skill to extract different features, subsample bureaucracy efficiently, and kill rapidly, touching on at the potential for High predictive accuracy was observed in the forecasting process.

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