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Deep Learning for Tesla's Stock Prices Prediction

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Abstract. Modeling stock price predictions is a challenging and not easy task because it is influenced by internal and external factors. Recently, investors are paying attention to invest in Tesla electric cars. Tesla's advantage by issuing new shares with a lower effective cost of capital is a competitive advantage and significant to attract investors' attention. However, in terms of investment, the possibility of getting a lot of profits and allowing investors to lose all their savings is commonplace and commonplace. In this paper, the concentration of writing is to predict Tesla's stock price in the future based on the data of the last 5 years. The MLP and LSTM models are used as models for testing the tesla dataset sourced from investing.com and the yahoofinance dataset is tested to see a graph of Tesla's future price predictions. The MLP model with Adam optimization, Loss: MSE is the best model for investing.com dataset with the smallest MAE value of 4.41644 and the MLP model with Adam optimization, Loss: MAE is the best model for the yahoofinance dataset with an MAE value of 6.20797.

INTRODUCTION

Predicting stock prices is a challenging and difficult task because the prediction of stock prices has an element of uncertainty [1], [2], [3]. Stock prices are influenced by internal and external factors that cause fluctuations every day and even every second [4]. Every day the stock market price is always changing and very difficult to predict by sellers and buyers [5]. From the stock market, a person can get a lot of profit and even lose all his savings [6]. Forecasting or prediction covers several fields including business and industry, economics, environmental science, and finance [7].

In this paper, the focus of research on Tesla stock price predictions is obtained from data sources on the internet, namely investing.com and yahoofinance. This study uses a time series by taking the Tesla stock price dataset from 2015 to March 2021. Time series data can be defined as a sequence of chronological observations for the selected variable [7]. The selected variable is the stock price when it is open, low, high, and close. From the point of view of the sentiment of traditional cars, manufacturers are considered stuck in the last century. Tesla can issue new shares at a lower effective capital cost thereby giving Tesla a significant competitive advantage, especially given the large capital requirements for the manufacture of electric cars [8]. This paper concentrates on forecasting future Tesla stock prices based on the historical Tesla dataset from 2015 to 2021.

Research [9] Evaluates the effectiveness of using technical indicators, such as the Moving Sample Average closing price, closing price momentum, etc. In the Turkish stock market to capture the relationship between technical indicators and the stock market during the study period, a hybrid artificial neural network (ANN) model was used which includes the ability to take advantage of harmony search (HS) and genetic algorithm (GA), which are the most widely used. In this study, it is argued that technical indicators are the most relevant indicators. In order to obtain higher accuracy in value prediction, new variable prices have been formulated using existing variables. Neural networks are used to predict the closing price of the next day's shares, and comparative RF analysis is also applied. Based on the comparative analysis of the value of RMSE, MAPE, and MBE, it is clear that ANN provides better stock price forecasts than RF [1].

The deep learning model is used to model future Tesla stock price predictions. This study uses a deep learning machine model to test the dataset sourced from investing.com and yahoofinance. The evaluation and validation for the results of this model consist of Mean Absolute Error (MAE), Root Mean Squared Error (RMSE) and Mean Squared Error (MSE). The smallest MAE, RMSE, and MSE values are the best models for modeling future Tesla stock price predictions based on the variables of the opening price, lowest price, highest price, and closing price.

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THE PROPOSED MODEL

This research dataset is secondary data obtained from investing.com and historical yahoofinance from recorded open, low, high, and close prices to predict the model using our proposed model, namely Multilayer Perceptron / Artificial Neural Network and Long Short-Term Memory Network (LSTM). To evaluate the performance of the model proposed in this study, validation is used MAE, MSE, and RMSE. The MLP model is proposed because it is able to generalize the data [10] and the LSTM model is used to reduce prediction errors for time series datasets in the case of forecasting by making accurate predictions of a variable. The best prediction is based on the prediction error rate, the smaller the error rate, the more accurate the prediction method [11].

Artificial Neural Network (ANN)

Artificial Neural Network is inspired by the function of biological neural networks [10], [3]. ANN is designed to identify the underlying trend of data and to generalize it [10]. The NN model using technical analysis variables has been applied to predict the Shanghai stock market, in this study the proposed method focuses on stock price prediction for companies listed on the NSE (National Stock Exchange) sliding window approach adopted for overlapping data obtained a model for prediction purposes. who can use minute sage data as input. Such modeling has applications in algorithmic trading where high-frequency trading occurs [7]. Deep learning in neural networks depends on the problem and how the neurons are connected, such behavior may require a long causal chain of computational stages, where each stage alters (often in a non-linear way) the activation of the network aggregate. Deep Learning is all about giving credits accurately at many such stages [12].

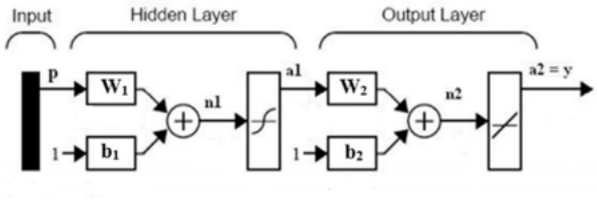

FIGURE 1. Neural Network Architecture [9]

Long Short-Term Memory (LSTM)

Long Short-Term Memory Network or LSTM network is a type of recurrent neural network used in deep learning because very large architectures can be trained successfully [13]. The LSTM is sensitive to the scale of the input data, especially when the sigmoid (default) or tanh activation function is used [9]. LSTM combines short-term memory with long-term memory via gate control [14]. LSTM Model Architecture in Figure 2.

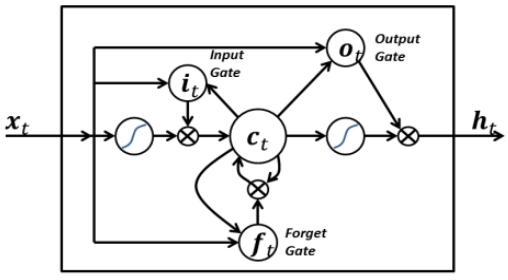

FIGURE 2. LSTM Model Architecture [13]

METHOD AND RESULT

The technique used for the model in this study is regression to predict the results based on the input given. This study takes a secondary dataset obtained from investing.com and yahoofinance. This dataset is divided into two parts, namely training data and testing data, then training data and testing data are tested with predetermined models, namely Artificial Neural Network (ANN) and Long Short-Term Memory Network (LSTM). Broadly speaking, this research method is explained in Figure 3.

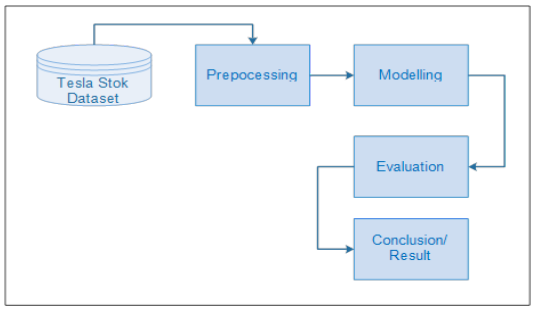

FIGURE 3. Framework

Dataset

The number of datasets from research taken from sources investing.com 1777 and yahoofinance 1816 variable data used for modeling are

- **Open**: The opening price of the stock, this attribute describes and displays the numbers at the opening price, namely the price for the first time the transaction was made on that day.
- **High**: The highest share price, is the price range of the daily movement of the stock where the investor has the courage or rationality to buy or sell, if information is obtained that the stock price will soar, this is an opportunity for investors to make a purchase.
- **Low**: The lowest share price, is the opposite of high if it is received news that the stock will go down, the investor will sell the stock.
- **Close**: The closing price reflects all available information for all market participants (especially institutional market participants with more accurate information) at the end of the stock transaction and the close variable will be used as the Y variable (Prediction) in this study to study the behavior of the Tesla stock market.

TABLE I. Research Dataset

Date	Open	High	Low	Close
02/01/2014	30.02	29.96	30.5	29.31
03/01/2014	29.91	30	30.44	29.72
06/01/2014	29.4	30	30.08	29.05
07/01/2014	29.87	29.52	30.08	29.05
...	...	...	...	...
20/01/2021	850.45	858.74	859.5	837.28
21/01/2021	844.99	855	855.72	841.42

Source: Investing.com

The dataset from each source is divided into training data and complete testing data is shown in table 1.

TABLE II. Data Training and Testing

Source	Total Data	Training	Testing
investing.com	1777	1421	356
yahoofinance	1816	1452	364

This study uses time-series data from the historical stock price of Tesla, the training data used to train testing data is taken from the last 20% of the price, this aims to see the price trend so that it is not random.

Preprocessing

At the preprocessing stage, the variables taken are open, low, high, and close and daily data on the date column variable are used as a benchmark for determining training data and testing data. Training data and testing data are divided into 80-20% to test the models used, namely ANN and LSTM.

Modelling

At this stage, the Multi-Layer Perceptron and LSTM algorithm models are used to test training data and testing data so that the final result is to produce a model from the two tested datasets.

The formula for the MLP model is formulated as

$$St = f(UxXt + WxSt - 1) \tag{1}$$

$$Ot = g(VxSt) \tag{2}$$

Where St is the network memory at time t;
U, W, and V are the weight sharing matri ces in each layer;
Xt and Ot represent input and output at time t;
F (.) And g (.) Represent nonlinear functions.

In the LSTM model the input gate is formulated:

$$it = \sigma(Wix(ht - 1, xi) \tag{3}$$

$$ft = \sigma(Wfx(ht - 1, xi) + bf \tag{4}$$

Where Wi and Wf are weight matrices;
ht - 1 is the output from the previous cell;
xt is input, and
bi and bf are bias vectors

Evaluation

To test the model proposed in this study, general validation is used which is usually used in the regression dataset model to assess the smallest error value. The validation used includes MAE, MSE, and RMSE.

$$MAE = \frac{\sum actual - prediction}{n} \tag{5}$$

$$MSE = \frac{\sum (actual - prediction)^2}{n} \tag{6}$$

$$RMSE = \sqrt{\frac{\sum actual - prediction^2}{n}} \tag{7}$$

Where 'actual' refers to the original closing price, 'prediction' refers to the estimated closing price and 'n' refers to the size of the total number of datasets.

Result

In testing the dataset several optimizations are used, namely Adam optimization and RMSprop optimization to test the proposed model. Evaluation of the desired research results is to find the smallest error from the MAE value and MSE value.

In this study, the parameters used with adam optimization are derivatives of the SGD method, a combination of RMSprop and momentum, and RMSprop optimization is a gradient-based optimization technique used in training neural networks [15]. The results of the optimization with both are in table 3.

TABLE III. Model Evaluation with Adam and RMSprop Optimization

Source	Model	Optimation	MAE	MSE	RMSE
Investing.com	MLP	Adam, Loss MAE	4.55677	58.7798	7.66680
		Adam, Loss MSE	4.41644	57.9040	7.60947
		RMSProp, Loss MAE	6.72914	119.7559	10.94330
		RMSProp, Loss MSE	7.71910	124.7455	11.1689
	LSTM	Adam, Loss MAE	5.51722	81.28398	9.01576
		Adam, Loss MSE	8.425007	201.97892	14.2119
		RMSProp, Loss MAE	7.82761	161.8619	12.7224
		RMSProp, Loss MSE	4.88365	64.7356	8.0458
Yahoofinance	MLP	Adam, Loss MAE	6.20797	98.5519	9.92733
		Adam, Loss MSE	6.82502	131.8554	11.4828
		RMSProp, Loss MAE	9.76632	207.5074	14.4051
		RMSProp, Loss MSE	7.89033	169.0175	13.0006
	LSTM	Adam, Loss MAE	7.24312	132.9047	11.5284
		Adam, Loss MSE	8.32073	182.8076	13.5206
		RMSProp, Loss MAE	6.43921	104.4532	14.4051
		RMSProp, Loss MSE	11.38947	323.2057	17.9779

In investing.com's Multilayer Perceptron model dataset with Adam's optimization, Loss MSE is the best evaluation value for forecasting stock prices with a minimum MAE value of 4.41644, MSE value, MAE value 57.9040 and RMSE value 7.60947.

Tesla stock price forecasting predictive model with MLP model, Adam optimation, Loss MSE is Figure 4.

FIGURE 4. MLP Predictive Model (Opt : Adam, Loss MSE)

From Figure 4 in the case of Tesla's stock price model obtained from investing.com, it predicts that the learning pattern obtained is an upward trend based on the actual value of the prediction.

Table 3 of the yahoofinance dataset shows that the best model is the Multilayer Perceptron with Adam optimization, Loss: MAE is different from the investing.com dataset, with an MAE value of 6.20797, MSE 98.5519 and RMSE 9.92733. Next, look at the trend for optimization with the model and its optimization. The result is figure 5.

FIGURE 5. MLP Predictive Model (Opt : Adam, Loss MAE)

In Figure 5, from the Yahoofinance dataset, Tesla's price trend is predicted to experience a downward trend, unlike the previous dataset, which is predicted to experience an uptrend.

It should be noted that the MLP model is the best model of the model proposed in this study so that the pattern of the dataset can be known and Adam optimization, Loss MSE is the best optimization for investing.com dataset and Adam optimization, Loss MAE is the best optimization to see Tesla stock price trend from dataset sourced from yahoofinance.

CONCLUSION

This research is about the prediction of Tesla stock price using the deep learning neural network model and LSTM from the investing.com dataset and yahoofinance. The best model for the prediction of Tesla stock price on the dataset sourced from investing.com is the MLP model with Optimization (Adam, Loss: MSE) where the MAE value for this model is 4.41644, MSE 57.9040, and RMSE 7.60947 is the smallest compared to the LSTM model. In the yahoofinance dataset, the best model for modeling Tesla stock price predictions is the MLP model with optimization (Adam, Loss: MAE), the smallest values of MAE, MSE, and RMSE, respectively, are 6.20797, 98.5519, and 9.92733.

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