

**T.R.**

**GEBZE TECHNICAL UNIVERSITY**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF COMPUTER ENGINEERING**

**FUTURE DATA PREDICTION WITH DEEP  
LEARNING MODELS**

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SUPERVISOR  
**DR. ÖĞR. BURCU YILMAZ**

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GRADUATION PROJECT  
JURY APPROVAL FORM

This study has been accepted as an Undergraduate Graduation Project in the Department of Computer Engineering on 31/08/2021 by the following jury.

**JURY**

Member

(Supervisor) : Dr. Öğr. Burcu YILMAZ

Member : Prof. Dr. Hasari ÇELEBİ

# ABSTRACT

In this project, it is aimed to predict future data with deep learning models, taking into account that time series data is affected by more than one time series data.

Crypto money data is used as time series data in this project. Cryptocurrencies are widely used both as a form of trade and investment nowadays. Investors' investment in Bitcoin and altcoins has increased the confidence in cryptocurrencies and increased their financial volume day by day. Predicting the future values of cryptocurrencies allows to prevent possible major financial losses. Consistent and accurate forecasts will increase the profits of investors investing in cryptocurrencies. This project aims to predict the future closing prices of cryptocurrencies.

Cryptocurrency data used in the project has been prepared with various features for 1-day, 12-hour, 4-hour, 1-hour and 15-minute timeframes. Deep learning methods are used to predict the closing price. After the data set was created, the target data to be predicted was determined. Indicators have been calculated to increase the accuracy of the prediction. Datasets have been visualized. Data has gone through the preprocessing stage. Data were created according to test data, train data, dependent and independent variables in the preprocessing stage. The specified LSTM model is trained with the train dataset. Some metrics are calculated to make comparisons with the test dataset and evaluate the performance of the model. The calculated metrics are R2, MSA, MEA and ACC.

Finally, the results of the metrics were reported and visualized to measure the closing prices of cryptocurrencies and the predictions of the models according to the given data sets of the model. According to these results, the closing price prediction made with the 1-day data of Bitcoin and the data set with the opening price, highest price, lowest price, volume, RSI and dominance was predicted most accurately with the highest  $R^2$  value and the lowest MSE value.

# ÖZET

Bu projede, zaman serisi verisinin birden fazla zaman serisi verisinden etkilenmesini dikkate alarak derin öğrenme modelleri ile gelecek veri tahmini amaçlanmıştır.

Projede zaman serisi verisi olarak kripto para verileri kullanılmıştır. Kripto paralar, günümüzde hem ticarete hemde yatırım şekli olarak çokça kullanılmaktadır. Gün geçtikçe yatırımcıların Bitcoin ve altcoinlere yatırım yapması, kripto paralara olan güveni artırıp, finansal hacmini de yükselmiştir. Kripto paraların gelecekteki değerlerinin tahmin edilmesi olası büyük finansal zararların engellemesini sağlar. Tutarlı ve doğru tahminler, kripto paralara yatırım yapan yatırımcıların karlarını artıracaktır. Bu projede kripto para birimlerinin gelecekteki kapanış fiyatlarının tahmin edilmesi amaçlanmaktadır.

Projede kullanılan kripto para verileri 1 günlük 12 saatlik 4 saatlik 1 saatlik ve 15 dakikalık zaman dilimleri için çeşitli özelliklere sahip olarak hazırlanmıştır. Kapanış fiyatı tahmin etmek için derin öğrenme yöntemleri kullanılmıştır. Veri kümesi oluşturulduktan sonra tahmin edilecek hedef veri belirlenmiştir. Tahminin doğruluğu artırmak için göstergeler hesaplanmıştır. Veri setleri görselleştirilmiştir. Veriler ön hazırlık aşamasından geçmiştir. Ön hazırlık aşamasında test verileri, train verileri, bağımlı ve bağımsız değişkenlere göre veriler oluşturulmuştur. Belirlenmiş LSTM modeli train veri kümesi ile eğitilmiştir. Test veri kümesi ile karşılaştırmalar yapmak ve modelin performansını ölçmek için bazı metrikler hesaplanmıştır. Hesaplanan metrikler R<sup>2</sup>, MSA, MEA ve ACC dir. Son olarak, modelin verilen veri setlerine göre kripto paraların kapanış fiyatları ve modellerin tahminlerinin ölçümlenmesi için metriklerin sonuçları raporlanmış ve görselleştirilmiştir.

Bu sonuçlara göre Bitcoinin 1 günlük verisi ve açılış fiyatı, en yüksek fiyatı, en düşük fiyatı, hacmi, RSI ve dominance verilene sahip veri seti ile yapılan kapanış fiyatı tahmini, en yüksek  $R^2$  değeri ve en düşük MSE değeri ile en doğru tahmin edilmiştir.

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# LIST OF SYMBOLS AND ABBREVIATIONS

<b>Symbol or Abbreviation</b>	<b>Explanation</b>
LSTM	: Long Short Term Memory
RNN	: Recurrent Neural Network
$R^2$	: R-Square Score
ACC	: Model Evaluate
MAE	: Mean Absolute Error
MSE	: Mean Squared Error
MA7	: Mean Average 7
MA21	: Mean Average 21
RSI	: Relative strength index
MACD	: Moving Average Convergence Divergence
DOM	: Dominance
BTC	: Bitcoin
ETH	: Ethereum
XRP	: Ripple
ADA	: Cardano
1d	: Daily
12h	: 12 Hours

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# 1. PROJECT GENERAL INFORMATION

My project was to predict future values using time series data and correlation of time series data. Here I used cryptocurrencies as time series.

Today, cryptocurrencies, which are a new generation investment tool with a large volume, have gained importance. Cryptocurrencies are digital assets that are used as virtual currency and do not exist in any physical form. They are secured by cryptography, that is, encryption. In this way, for example; The act of “double spending”, which means counterfeiting or making multiple transactions with the same cryptocurrency, has become almost impossible.

The world’s first cryptocurrency was Bitcoin, created in 2008. Bitcoin was followed by other types of cryptocurrencies, the number of which is in the hundreds today. Unlike currencies in the classical sense, cryptocurrencies are not issued by a central authority. This feature is perhaps the most attractive aspect of cryptocurrencies for investors. Because in this way, the majority of cryptocurrencies remain exempt from government regulation or manipulation.

These cryptocurrencies are based on a certain project on the back. And they are put on the stock market with a symbolic name. Estimating the prices of these coins can cause great financial losses.

After talking about what a cryptocurrency is and how important it is to predict its future price. A deep learning model has been designed to predict, visualize and report prices with historical crypto prices, indicators and the relationship of cryptocurrencies to each other.



Figure 1.1: This is cryptocurrency coins.

## 1.1. Project Schema and Description

In this project, closing values of cryptocurrencies were estimated by applying deep learning techniques. I used historical crypto money data as dataset. LSTM was

determined as a deep learning model and training was carried out with this model. The metrics ( $R^2$ , MEA, MSA and ACC) of the model were calculated according to the datasets. Estimated and actual price values are reported and visualized.

The steps are for the project :

1. After the dataset is received, it is determined and visualized which attributes will be sent to the dataset to estimate the close price.
2. The dataset is pre-processed. Test, Train data are determined.
3. The LSTM model is run.
4. R2, MSA, MEA and ACC values of the model are calculated to measure the success of the model.
5. Estimated value visualization and reporting is done.

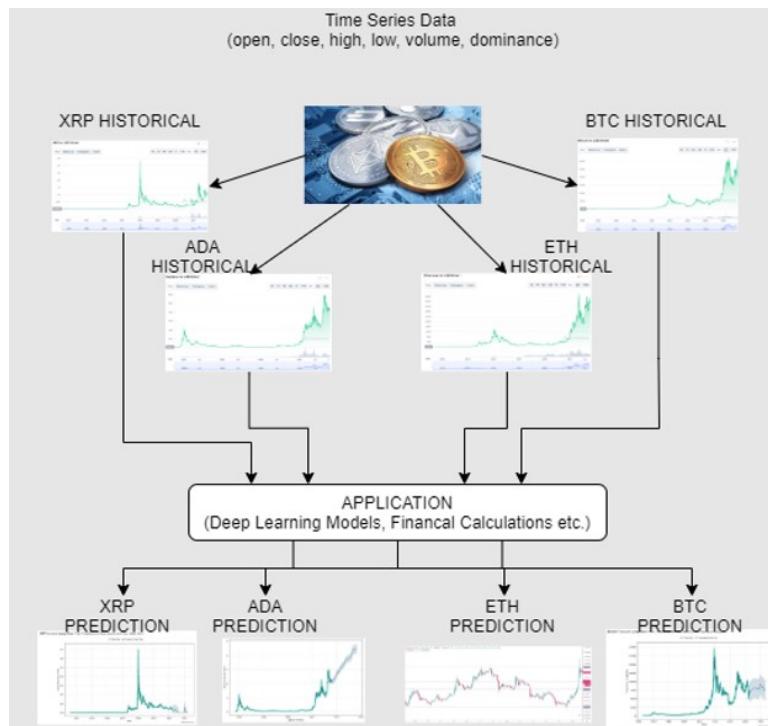


Figure 1.2: This is project schema.

## 1.2. Literature Research

In the literature research section, which deep learning models are used to predict time series data and cryptocurrencies, how the data is prepared and which indicators are used.

I observed that the deep learning model is using LSTM.

I observed that the data needs to be cleaned during data preparation. While

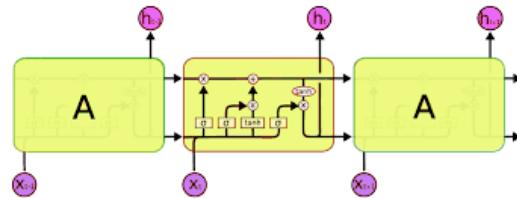


Figure 1.3: This is LSTM Structure.

cleaning the data, I observed that there are many steps and that the average of that column is placed in the empty data places in the time series data, the reason for this is not to lose valuable data.

Indicators determine patterns in cryptocurrency closing price prediction. These patterns are determined by some indicators. I have observed that these indicators are MA7, MA21, RSI, MACD, Upper Band, Lower Band, EMA, Momentum, Log Momentum.

MA7 : 7-day average

MA21 : 21-day average

RSI : The relative strength index (RSI) is an indicator used in technical analysis that measures the magnitude of recent price changes to assess overbought or oversold conditions in the price of a financial asset.

MACD : Moving average convergence divergence (MACD) is an indicator that shows the relationship between two moving averages of a financial asset's price. The MACD is calculated by subtracting the 26-period exponential moving average (EMA) from the 12-period EMA.

Upper Band and Lower Band : The price range the issuer and underwriter agree upon is referred to as the price band. The bottom band is the lower limit and the top band is known as the upper limit

EMA : An exponential moving average (EMA) is a type of moving average (MA) that places a greater weight and significance on the most recent data points.

Momentum: Momentum indicators are technical analysis tools used to determine the strength or weakness of a financial asset's price. Momentum measures the rate at which the price of a financial asset rises or falls. Common momentum indicators include the relative strength index (RSI) and the moving average convergence divergence (MACD).

Log Momentum :Just like regular momentum indicator except calculated in log space and with a horizontal line centered at zero for easier analysis

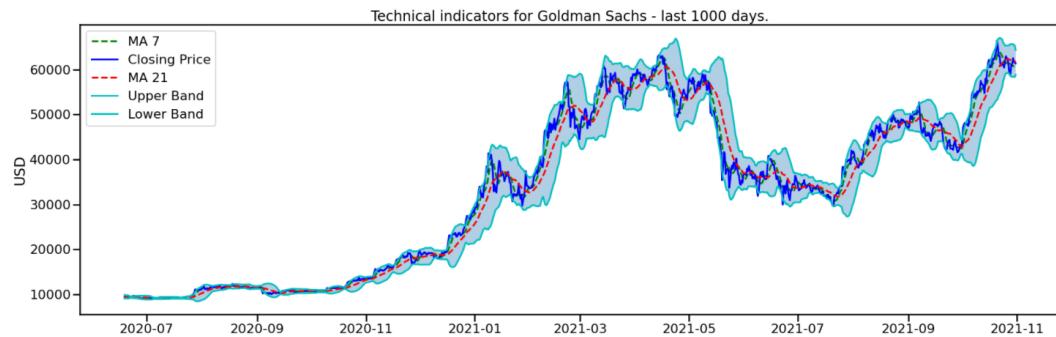


Figure 1.4: This is Indicator.

### 1.3. Project Design Plan

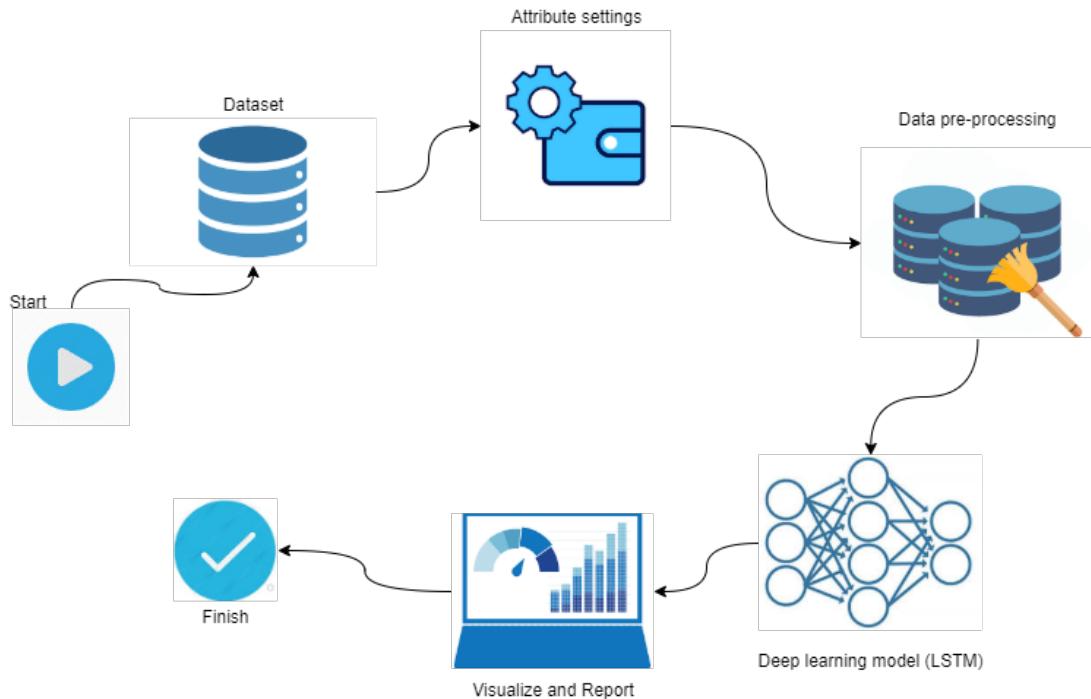


Figure 1.5: This is Project Design.

## 1.4. Project Requirements and Libraries

Datasets are imported, attributes of datasets are edited, data preprocessing is done. The LSTM model runs and predictions are made. How good the model is tested. Finally, the final state of the forecast and model is reported.

Necessary needs are;

- Cryptocurrency price time series data (BTC, ETH, XRP vs.)
- Jupyter or Colab (run python code)
- IDE or terminal (run python code)

Used libraries:

- pandas \item command.
- time
- matplotlib
- seaborn
- datetime
- numpy
- keras
- sklearn

## 2. DATA OPERATION

In this project, we worked with minute crypto money datasets and by doing some operations on these datasets, they were parsed as daily, 12 hour, 4 hour, 1 hour, 15 minutes. These data were between 2016-2021. A more limited data set was obtained for the dominance data of coins 2016-2019. In the rest of the report, it will be explained how the datasets are decided and what they add.

### 2.1. Dataset Construction

The data used in this project are selected from the historical time series data of the closing prices to be estimated. The data of BTC, ETH, XRP, ADA, XMR coins between 2016-2021 on the Kaggle site have been parsed as 1 day, 12 hours, 4 hours, 1 hour and 15 minutes with a script I wrote. Thus, I have time series data in 5 time periods for 5 coins.

However, I had access to 2016 - 2019 daily dominance data of BTC, ETH and XRP cryptocurrencies. Since I wanted to test the Dominance data in predicting the closing price, I decided to forecast these 3 coins in my project. My datasets were data fed by Binance API in CSV format, so my datasets were validated.

### 2.2. Dataset Attribute Setting

There are indicators used to predict the prices of cryptocurrencies, adding these indicators to a few types in my tests and added to see the contribution of the indicators to the forecast. In my project, tests were made on my model without these indicators and indicators. The indicators used in the project are MA7, MA21, RSI, MACD, EMA, 26EMA, 12EMA, 20SD, UPPER BAND, LOWER BAND, MOMENTUM and LOG MOMENTUM. You can get detailed information about the indicators used in Literature Research.

### 2.3. Dataset Pre-Processing

In this project, my datasets were preprocessed so that the model could make better predictions. These pre-processes are removing blank lines. Correlation of parameters.

Afterwards, the data were separated as train and test. Train and test data are set to 80% train 20% test. Dependent arguments such as X\_train, x\_test, y\_train, y\_test

were set. Data was taken from the dataset with the window method. Bitcoin, Etherium, Ripple, Cordano, Monero data were used between 2016-2019 and 2016-2021. In order to give more accurate results in the project, scaling was done during the data pre-processing phase.

Scaling is one of the most important preprocessing steps for the dataset. Whether the data is normally distributed or not is a factor that affects the operation of some algorithms. More accurate results can be obtained by pulling the data into a common data range. There are many methods for scaling. I did it with the normalise function I wrote. The scaler is a method where the mean value is 0 and the standard deviation is 1, and the distribution approaches normal. The mean value is subtracted from the known value and divided by the variance value.

Thus, the dataset is ready to be sent to the LSTM model.

## 2.4. Dataset Visualization

It was decided to estimate the price forecast closing value in the datasets. Before the preprocessing, the closing values of some data to be used are shown.

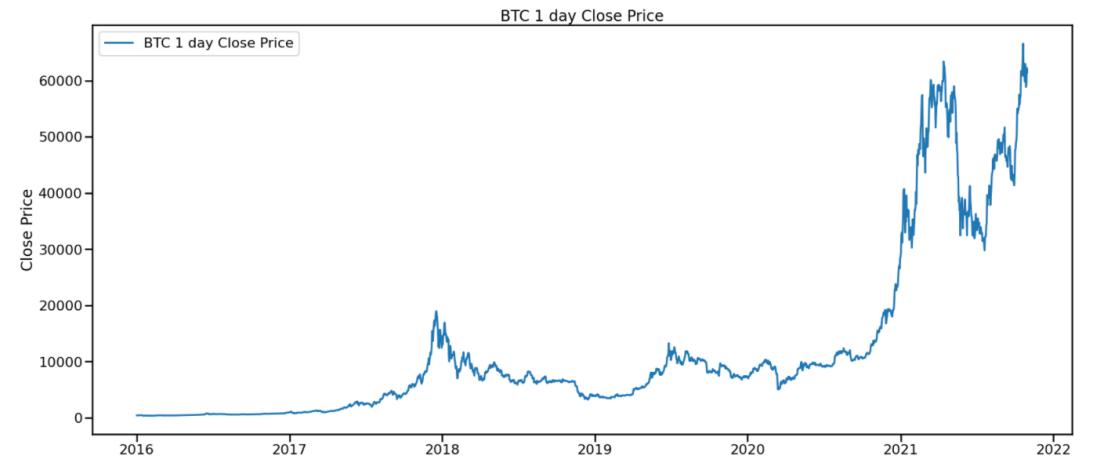


Figure 2.1: BTC Graphic(2016 - 2021).

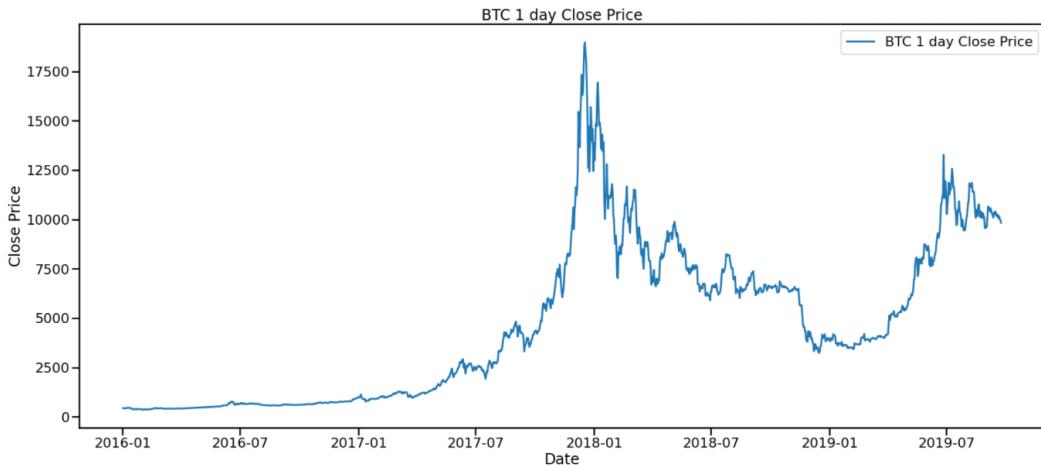


Figure 2.2: BTC Graphic(2017 - 2019).

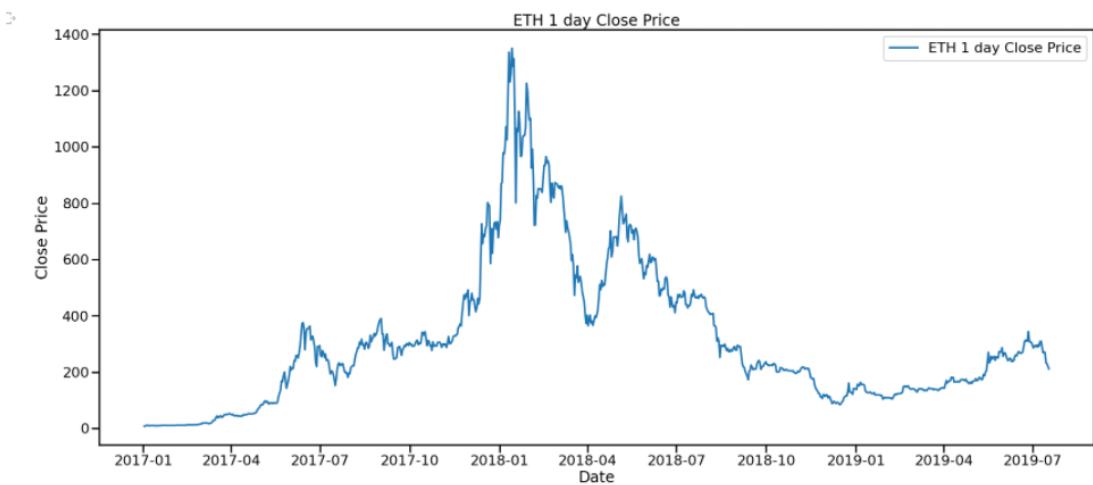


Figure 2.3: ETH Graphic(2017 - 2019).

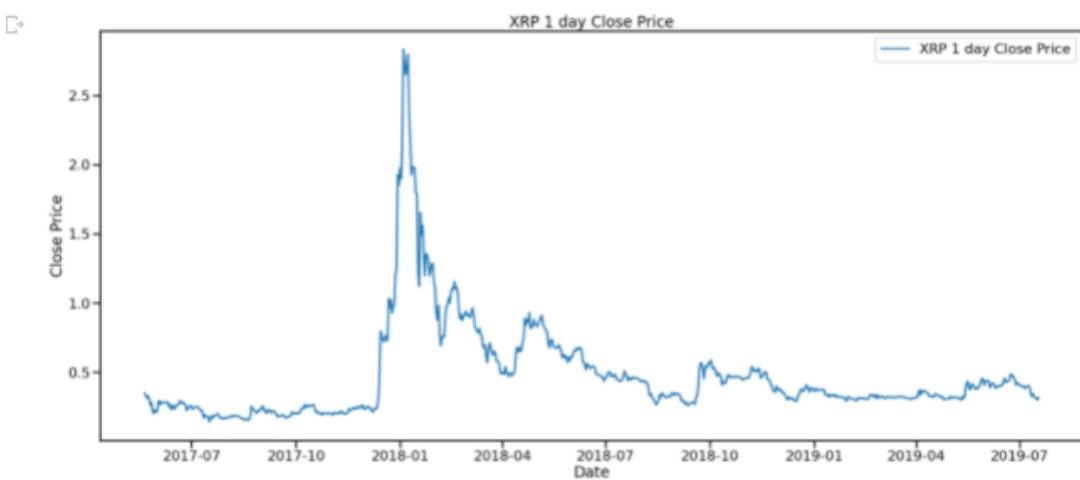


Figure 2.4: XRP Graphic(2017 - 2019).

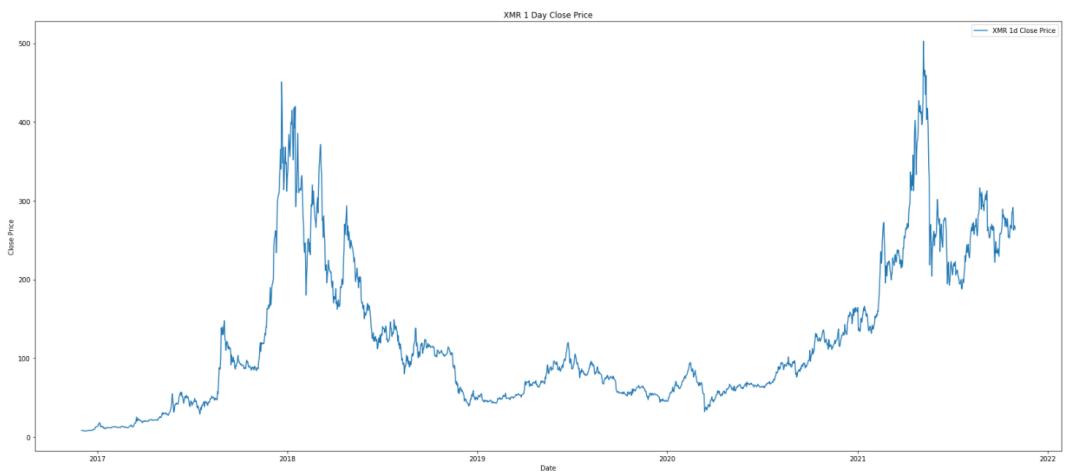


Figure 2.5: XMR Graphic(2017 - 2019).

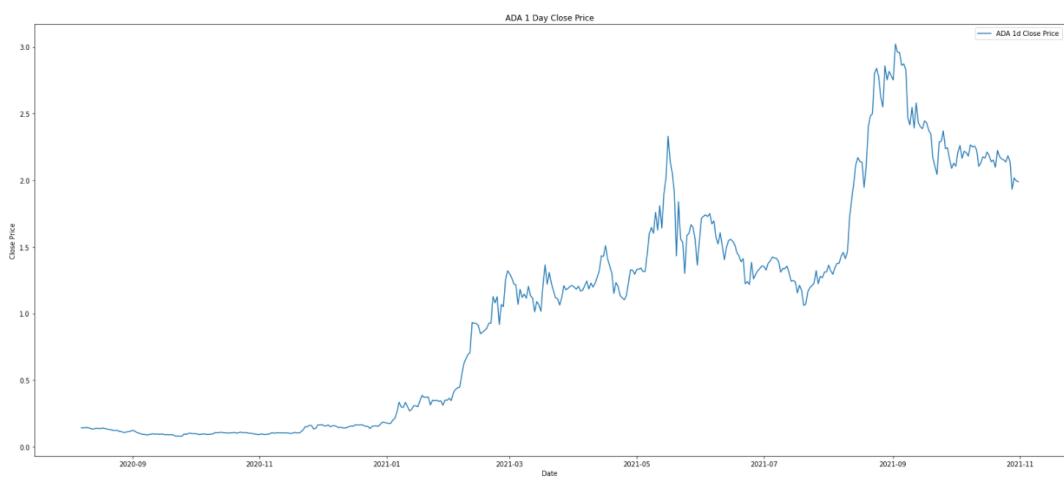


Figure 2.6: ADA Graphic(2020 - 2021).

## 3. MODEL CREATION

In this project, cryptocurrency price prediction was made using the Deep Learning model, LSTM. While determining the LSTM model, the optimum parameters were determined by testing with different parameters.

### 3.1. Deep Learning Model Creation

LSTM (Long Short-Term Memory) is a Recurrent Neural Network (RNN) based architecture widely used in time series estimation. The LSTM solves a major problem of recurrent neural networks that is short-memory. Using a series of 'gates', each with its own RNN, LSTM manages to retain, forget or ignore data points based on a probabilistic model. LSTMs also help solve vanishing gradient problems. More specifically, these problems are a result of repeated weight adjustments as a neural network. Repeated epochs change the gradients, and with each adjustment it is easier for the network's gradients to converge in both directions. This compounding affects the values of the gradients, making them either too high or too low. It's these gradients that are a big problem with traditional RNNs. The LSTM architecture also solves this problem. After a prediction is made, the sequence is fed back to the model to predict the next value. With each prediction, some error is added to the model. To prevent gradients from bursting, the values sigmoid are "crushed" before the gate input, output, via the tanh activation functions.

As a result, it is a successful deep learning model in time series data. Therefore, it was decided to use the LSTM model in this project.

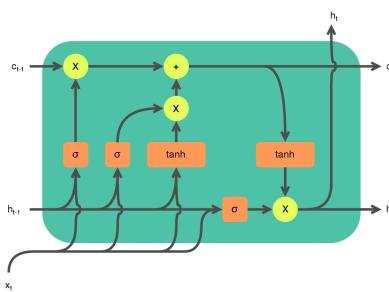


Figure 3.1: LSTM Architecture.

## 3.2. Metrics

In this project, 4 metrics were used to evaluate the LSTM model. With these metrics, the most optimal model for the project was selected.

### R<sup>2</sup>

R<sup>2</sup> is a mathematical measure of how close the data are to the regression line. R-Square is a performance measure for linear regression models. Within a data set, higher R-squared values represent smaller differences between observed data and predicted values. It is not a sufficient metric on its own. In some cases it can be misleading.

$$R^2 = 1 - \frac{\text{Explained Variation}}{\text{Total Variation}}$$

Figure 3.2: R2 formula.

### Mean Absolute Error(MAE)

Absolute error is the difference between the predicted values and the actual values. It is the mean of the absolute value of each difference between the actual value and the predicted value for that sample across the entire sample of the dataset.

A lower value indicates better accuracy.

$$\text{Mean Absolute Error} = \frac{1}{N} \sum_{i=0}^n |y_i - \hat{y}_i|$$

Figure 3.3: MAE formula.

### Mean Squared Error(MSE)

Mean Squared Error is the most commonly used regression loss function. MSE is the most widely used regression loss function. MSE is the average frame loss per sample over the entire dataset. To calculate the MSE, add up all the squared losses for individual samples and then divide by the number of samples. A lower value indicates better accuracy. Because of the square, large errors have a greater impact on the MSE than small errors. MSE is an indicator that is more resistant to outlier data.

$$\text{Mean Absolute Error} = \frac{1}{N} \sum_{i=0}^n |y_i - \hat{y}_i|$$

Figure 3.4: MSE formula.

### Model Evaluate(ACC)

It is for evaluating the pre-trained model. Returns the loss value and measurement values for the model.

## 3.3. LSTM Parameter determination

The LSTM model I use has hyperparameters. These parameters have been decided. There are scenarios that I test at the decision stage.

- One of these parameters is the input parameter, which is given to my model by giving more than 30 different datasets.
- The epoch (cycle) number is the number of times all training data is exposed to the network during training.
- Batch size is the number of subsamples given to the network where the parameter update takes place.
- The model will be suitable using efficient ADAM optimization algorithm and mean square error loss function.

### **Dropout**

Dropout is a threshold value. It does not use nodes below the threshold value in fully connected layers. This ensures that weak information is forgotten. Forgetting weak information increases learning.

### **Epoch**

Epoch is the number of turns. While the model is being trained, not all data are included in the training at once. It is included in the training by dividing along the epoch number.

### **Batch Size**

Batch size is required for batch processing. The dataset is divided into parts according to the batch size and the model is trained on this part at each step. The important point here is the random data selection of the part selection.

### **Optimazsyon**

In deep learning applications, there is an optimization problem at the root of the learning process. Some methods are used to find the optimum value in the solution of nonlinear problems. These methods are called optimization methods.

### **Dense layer**

Each node at the input is connected to each node at the output.

### **Activation layer**

It contains activation functions, it determines the output value according to the activation function.

## Model Test

### Test 1

Table 3.1: 1-day BTC Dataset LSTM Model Test 1

Parameters	Quantity
Training Shape	1590
Testing Shape	352
Epoch	20
Neurons	100
Dropout	0.2
Batch Size	32

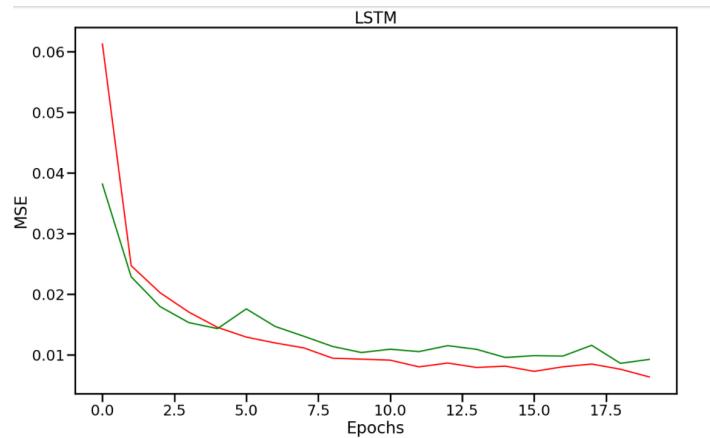


Figure 3.5: 1-day BTC Dataset LSTM Model Test 1 Result(Epoch).

Table 3.2: 1-day BTC Dataset LSTM Model Test 1 Result

Parameters	Quantity
Model Evaluate	0.008603265
Mean Absolute Error	0.058854312
Mean Squared Error	0.008603265
$R^2$	0.935141435

## Test 2 Increase Epoch

Table 3.3: 1-day BTC Dataset LSTM Model Test 2

Parameters	Quantity
Training Shape	1590
Testing Shape	352
Epoch	40
Neurons	100
Dropout	0.2
Batch Size	32

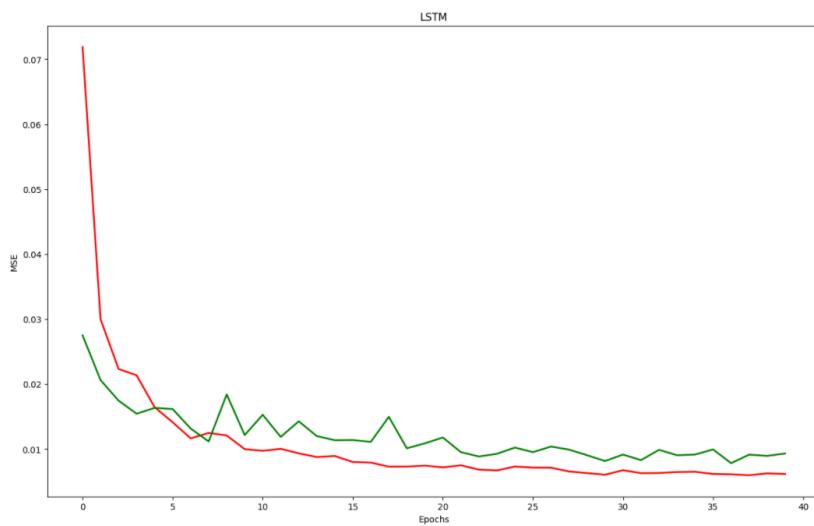


Figure 3.6: 1-day BTC Dataset LSTM Model Test 2 Result(Epoch).

Table 3.4: 1-day BTC Dataset LSTM Model Test 2 Result

Parameters	Quantity
Model Evaluate	0.0093142827
Mean Absolute Error	0.064359458
Mean Squared Error	0.009314283
$R^2$	0.923269044

### Test 3 Increase Batch Size

Table 3.5: 1-day BTC Dataset LSTM Model Test 3

Parameters	Quantity
Training Shape	1590
Testing Shape	352
Epoch	20
Neurons	100
Dropout	0.2
Batch Size	60

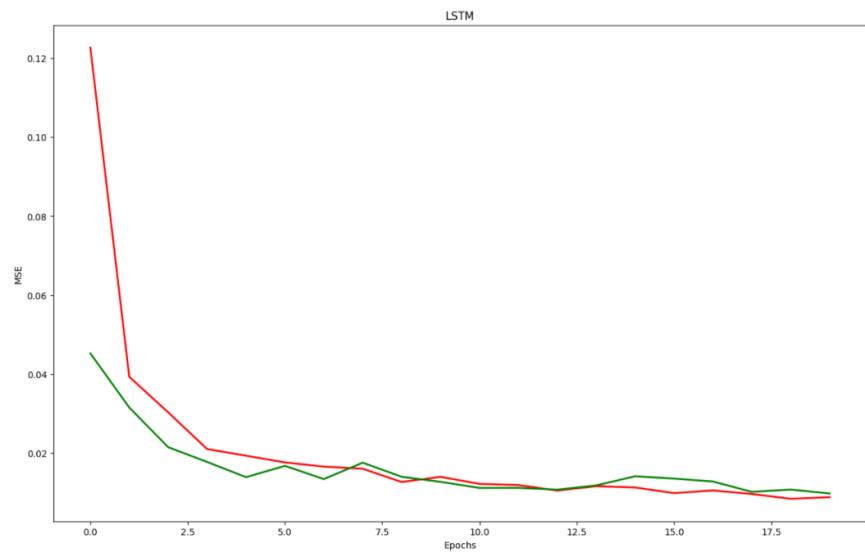


Figure 3.7: 3-day BTC Dataset LSTM Model Test 3 Result(Epoch).

Table 3.6: 1-day BTC Dataset LSTM Model Test 3 Result

Parameters	Quantity
Model Evaluate	0.009551188
Mean Absolute Error	0.062123495
Mean Squared Error	0.008851189
$R^2$	0.931151751

#### Test 4 Increase Neurons number

Table 3.7: 1-day BTC Dataset LSTM Model Test 4

Parameters	Quantity
Training Shape	1590
Testing Shape	352
Epoch	20
Neurons	150
Dropout	0.2
Batch Size	32

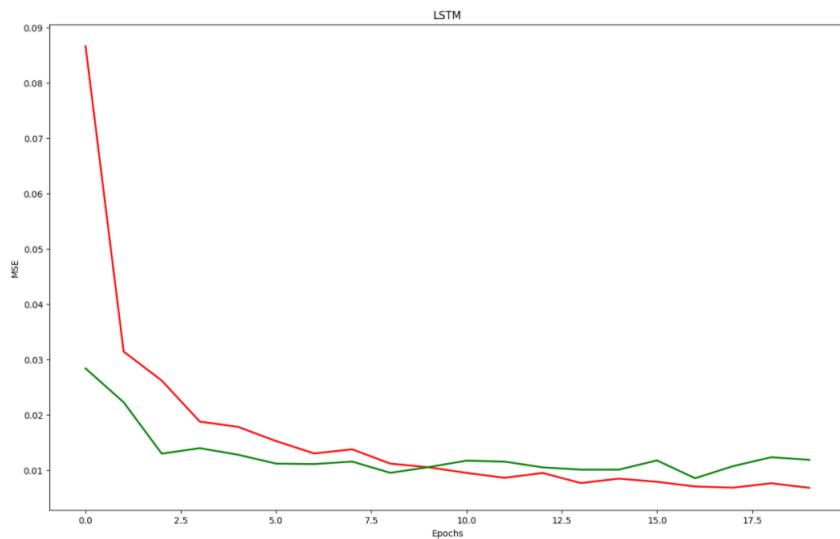


Figure 3.8: 3-day BTC Dataset LSTM Model Test 4 Result(Epoch).

Table 3.8: 1-day BTC Dataset LSTM Model Test 4 Result

Parameters	Quantity
Model Evaluate	0.0118995030
Mean Absolute Error	0.0769441904
Mean Squared Error	0.0118995020
$R^2$	0.9253074211

## Test 5 Decrease Epoch number

Table 3.9: 1-day BTC Dataset LSTM Model Test 5

Parameters	Quantity
Training Shape	1590
Testing Shape	352
Epoch	10
Neurons	100
Dropout	0.2
Batch Size	32

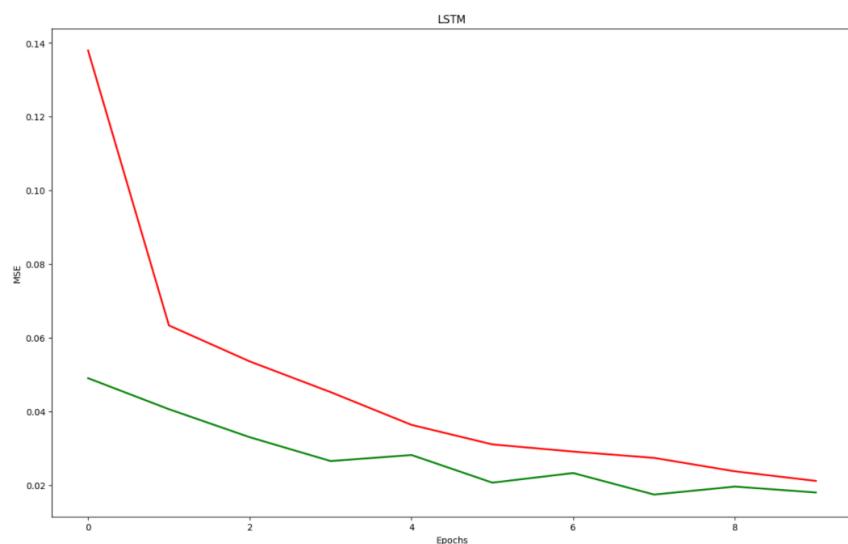


Figure 3.9: 3-day BTC Dataset LSTM Model Test 5 Result(Epoch).

Table 3.10: 1-day BTC Dataset LSTM Model Test 5 Result

Parameters	Quantity
Model Evaluate	0.018018998
Mean Absolute Error	0.084016929
Mean Squared Error	0.0180189993
$R^2$	0.8995226050

## Test 6 Decrease Batch Size number

Table 3.11: 1-day BTC Dataset LSTM Model Test 6

Parameters	Quantity
Training Shape	1590
Testing Shape	352
Epoch	20
Neurons	100
Dropout	0.2
Batch Size	10

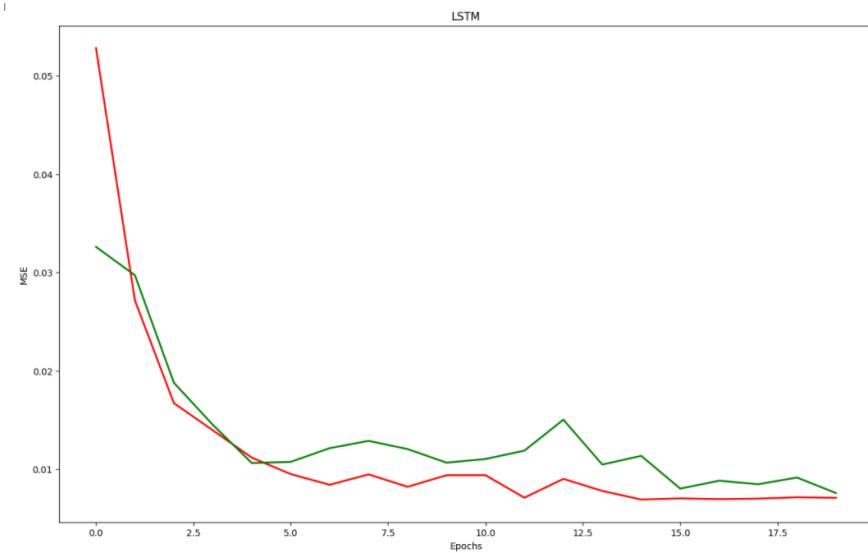


Figure 3.10: 3-day BTC Dataset LSTM Model Test 6 Result(Epoch).

Table 3.12: 1-day BTC Dataset LSTM Model Test 6 Result

Parameters	Quantity
Model Evaluate	0.007582314
Mean Absolute Error	0.059663224
Mean Squared Error	0.0075823139
$R^2$	0.9400990790

## Result

Since the most optimal metrics are in Test 1 after the tests here, the parameters in Test 1 were chosen as the hyper parameters of the LSTM model in the project.

## 4. CRYPTOCURRENCY CLOSING PRICE PREDICTION

In this project, predictions were made using 12 hour, 1-day data of BTC, ETH and XRP. Since ADA and XMR dominance data could not be found, estimations were not made. More have been made than the estimates below, but those that give the most accurate results are reported.

**Dataset Graphic:** It allows us to examine the closing values of the dataset that we will use in the model, according to date, before preprocessing.

**Dataset Correlation:** It is the heatmap table that I use to observe the correlations between the parameters of the dataset we will give to the model. Through this table, we can examine the relationship of the parameters with each other.

**Dataset LSTM Model Result:** This table lists the Model's performance metrics and helps us understand how well our model is performing.

**Dataset Model Epoch Graphic:** It is the graph that shows the Loss and Value Loss values during the epoch rounds of the model while it is running. In this chart, two lines continue on top of each other after a certain point. This point indicates the optimum epoch value.

### 4.1. Closing price prediction with Bitcoin 1-day data

5 datasets have been prepared for BTC 1-day dataset.

These datasets are:

- BTC : Open Price, Close Price, High Price, Low Price, Volume
- BTC : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD
- BTC : Open Price, Close Price, High Price, Low Price, Volume, RSI, Dominace
- BTC : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD ,Dominance
- BTC : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD ,Dominance, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

#### 4.1.1. BTC(1d) : Open Price, Close Price, High Price, Low Price, Volume

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

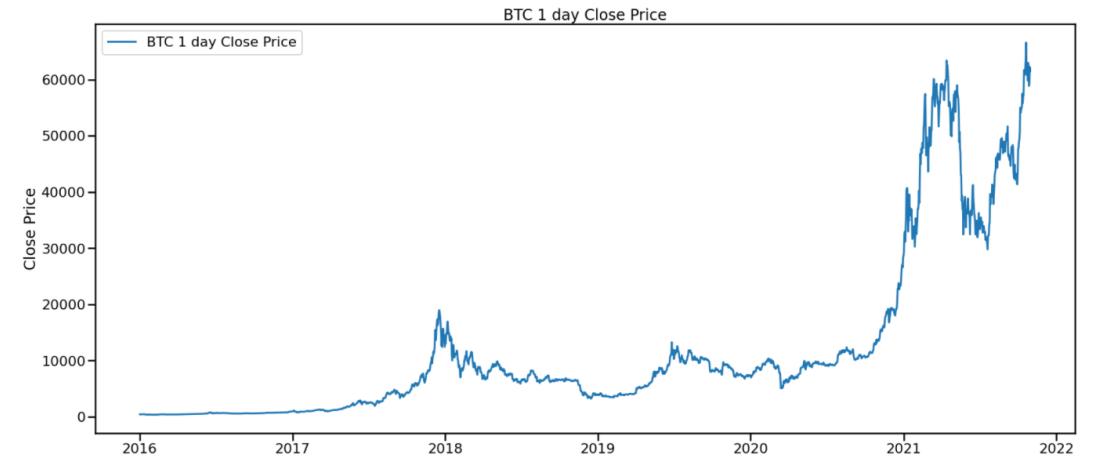


Figure 4.1: BTC dataset graphic 1.

Correlation of parameters used for closing price prediction

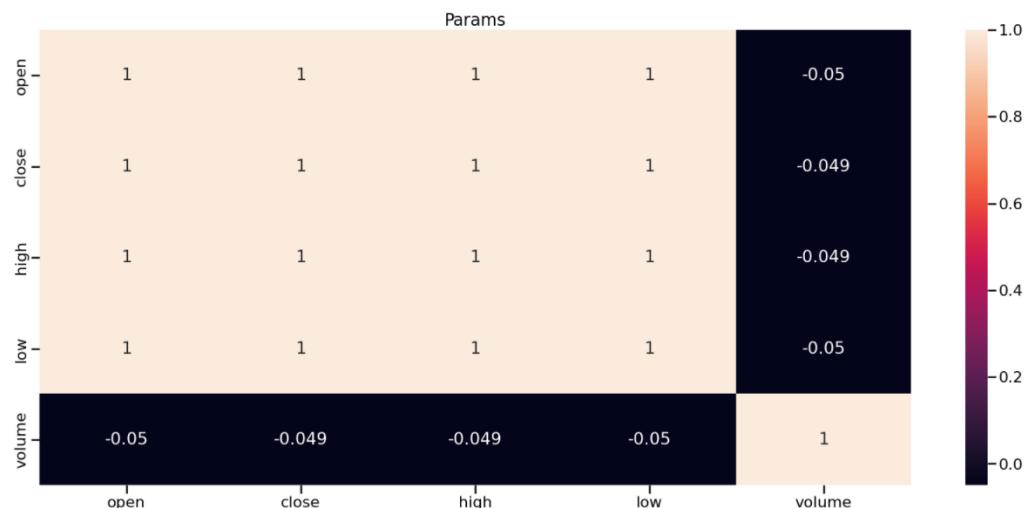


Figure 4.2: BTC dataset correlation 1.

Performance measurements of the model used for closing price prediction

Table 4.1: 1-day BTC Dataset LSTM Model Result 1

Parameters	Quantity
Model Evaluate	0.93%
Mean Absolute Error	6.31%
Mean Squared Error	0.93%
$R^2$	96.34%

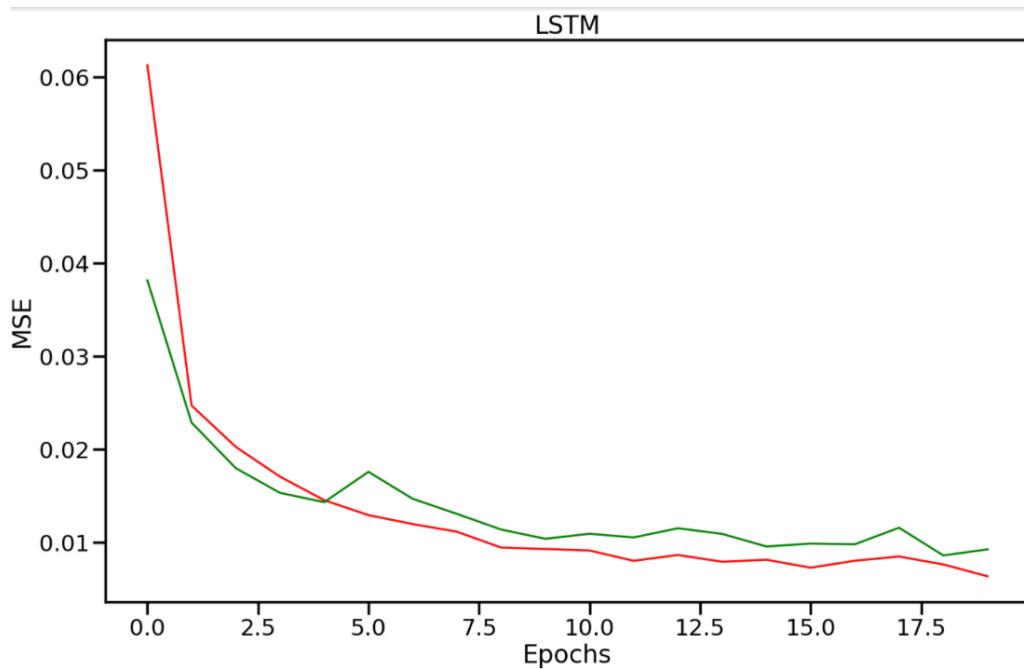


Figure 4.3: BTC(1d) dataset model epoch graphic 1.

## Closing price estimation and test data display

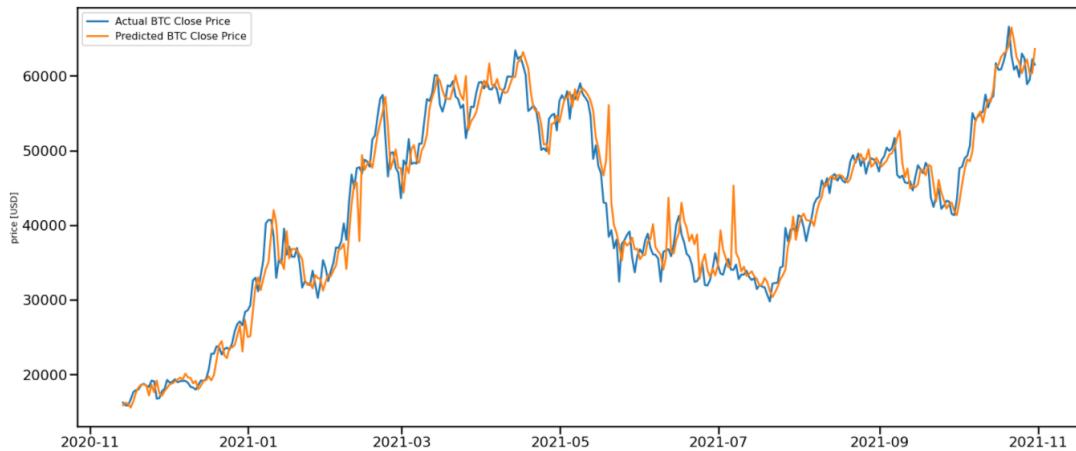


Figure 4.4: BTC(1d) dataset predition graphic 1.

time	open	close	high	low	volume	Classic_Prediction
1/1/2016 23:13	433.79	433.8	433.8	433.79	5.7574	
1/2/2016 21:26	433.73	433.7	433.73	433.7	1.780218	
1/3/2016 22:26	426.31	426.3	426.31	426.3	4.5	
1/4/2016 20:40	434.22	434.2	434.22	434.2	0.071477	
1/5/2016 21:40	431.81	432.07	432.07	431.81	8.209369	
1/6/2016 22:40	430.57	430.56	430.57	430.56	4.134743	
9/17/2019 17:06	10252.99	10250	10253	10250	2.268402	10328.75
9/18/2019 18:06	10234	10227	10234.9	10224	12.00242	10158.66
9/19/2019 19:06	10056	10059	10059	10054	0.315802	10116.94
9/20/2019 17:20	10168	10168	10168	10168	0.031689	9888.681
9/21/2019 18:20	10004	10005	10005	10004	3.025	10173.43
9/22/2019 19:20	9987.8	9987.2	9988.5	9987	1.58775	9833.036
9/23/2019 17:33	9835	9836.2	9837.6	9834.9	0.259004	9750.525

Figure 4.5: BTC(1d) dataset predition data table 1.

#### 4.1.2. BTC(1d) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD

The predictions came true with the above-mentioned attributes.

Data graphic and data table used for closing price prediction

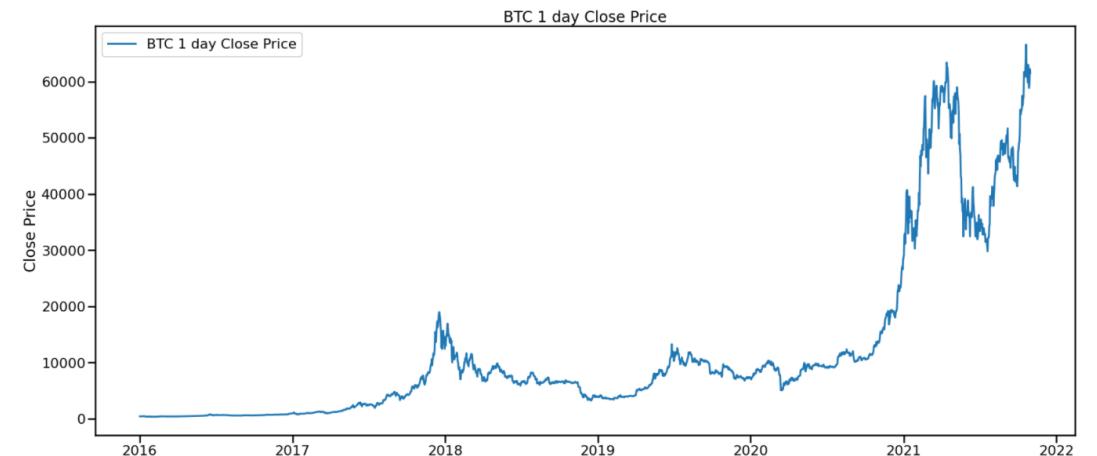


Figure 4.6: BTC dataset graphic 2.

	open	close	high	low	volume	RSI	MACD
time							
2016-01-15 22:06:00	388.290000	388.690000	388.770000	388.290000	24.931849	31.440797	-2.795834
2016-01-16 22:06:00	383.680000	383.490000	383.690000	383.490000	3.572000	30.055848	-6.409506
2016-01-17 22:06:00	388.290000	388.290000	388.290000	388.290000	1.741386	32.990127	-8.784783
2016-01-18 22:08:00	385.980000	385.980000	385.980000	385.980000	0.230000	32.288109	-10.729916
2016-01-19 22:09:00	380.230000	380.240000	380.240000	380.230000	4.615000	30.548550	-12.589494
...	...	...	...	...	...	...	...
2021-10-26 18:41:00	62335.824833	62335.824833	62335.824833	62335.824833	0.001111	61.678587	3313.613067
2021-10-27 18:41:00	58906.000000	58869.000000	58906.000000	58869.000000	0.277594	52.879738	2898.640538
2021-10-28 18:41:00	58932.000000	59463.000000	59505.000000	58830.000000	171.731072	54.088260	2587.871285
2021-10-29 18:41:00	62278.000000	62227.000000	62286.000000	62225.000000	0.380565	59.316988	2535.389719
2021-10-30 18:41:00	61512.000000	61489.000000	61516.000000	61489.000000	0.740997	57.436111	2406.506559

2048 rows × 7 columns

Figure 4.7: BTC dataset table 2.

### Correlation of parameters used for closing price prediction

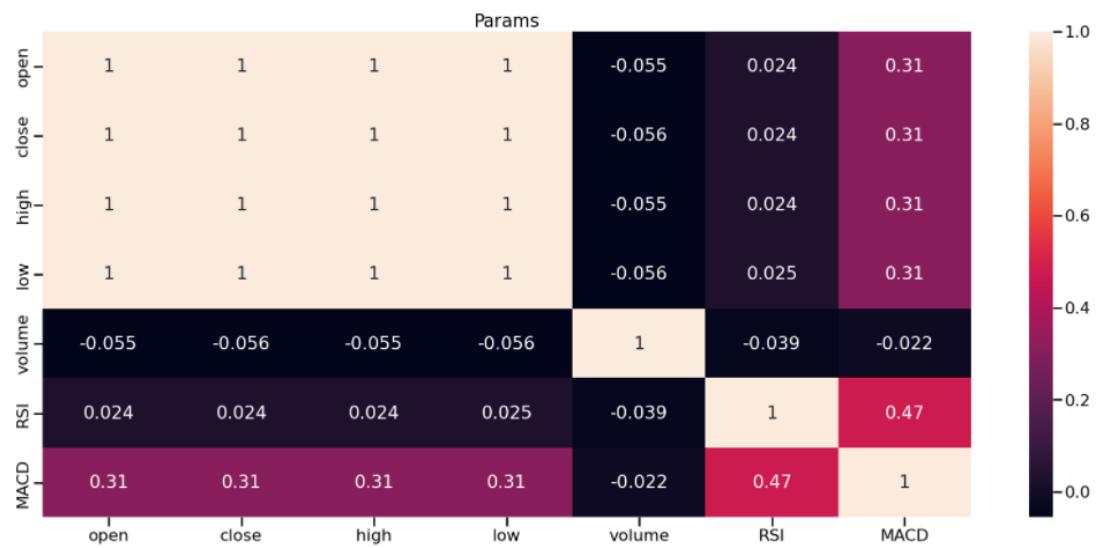


Figure 4.8: BTC dataset correlation 2.

## Performance measurements of the model used for closing price prediction

Table 4.2: 1-day BTC Dataset LSTM Model Result 2

Parameters	Quantity
Model Evaluate	0.55%
Mean Absolute Error	3.90%
Mean Squared Error	0.55%
$R^2$	93.09%

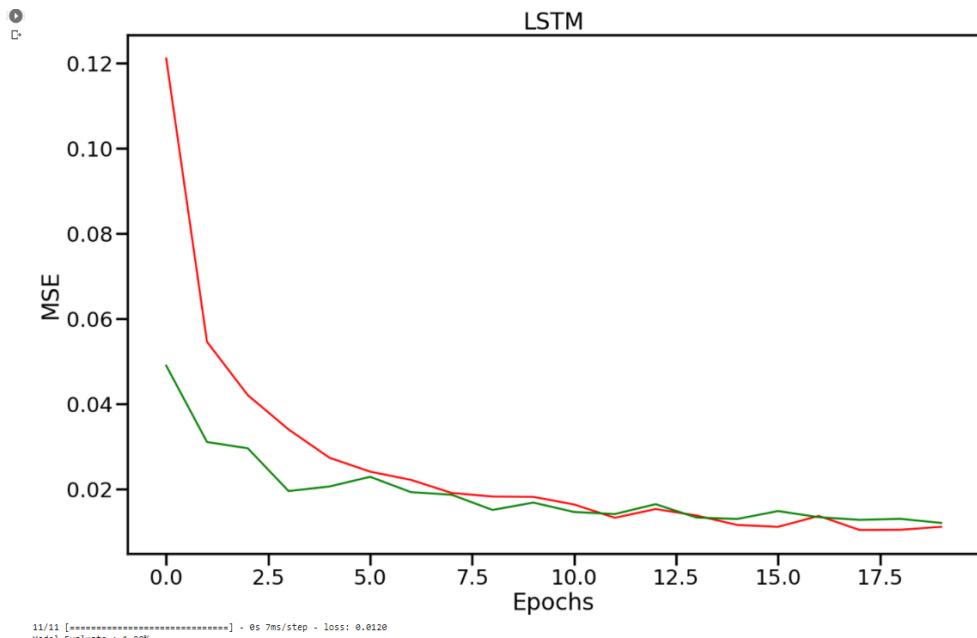


Figure 4.9: BTC(1d) dataset model epoch graphic 2.

## Closing price estimation and test data display

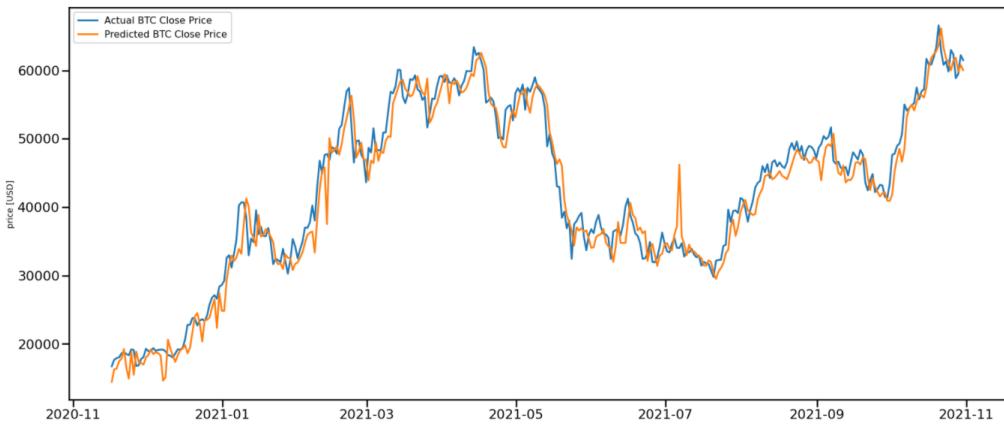


Figure 4.10: BTC(1d) dataset predition graphic 2.

time	open	close	high	low	volume	RSI	MACD	RSI_MACD_Prediction
1/15/2016 23:20	388.29	388.69	388.77	388.29	24.93185	31.4408	-2.79583	
1/16/2016 21:33	383.68	383.49	383.69	383.49	3.572	30.05585	-6.40951	
1/17/2016 22:33	388.29	388.29	388.29	388.29	1.741386	32.99013	-8.78478	
1/18/2016 20:46	385.98	385.98	385.98	385.98	0.23	32.28811	-10.7299	
1/19/2016 21:46	380.23	380.24	380.24	380.23	4.615	30.54855	-12.5895	
1/20/2016 22:46	408.09	408.09	408.09	408.09	0.0716	45.80501	-11.6813	
9/17/2019 17:06	10252.99	10250	10253	10250	2.268402	48.77109	-24.3236	9926.881
9/18/2019 18:06	10234	10227	10234.9	10224	12.00242	48.26386	-26.4858	10442.97
9/19/2019 19:06	10056	10059	10059	10054	0.315802	44.61399	-41.2797	9810.789
9/20/2019 17:20	10168	10168	10168	10168	0.031689	47.39367	-43.7048	10186.06
9/21/2019 18:20	10004	10005	10005	10004	3.025	43.84957	-58.1096	10326.19
9/22/2019 19:20	9987.8	9987.2	9988.5	9987	1.58775	43.4673	-70.1531	10117.66
9/23/2019 17:33	9835	9836.2	9837.6	9834.9	0.259004	40.26085	-90.8351	11684.51

Figure 4.11: BTC(1d) dataset predition data table 2.

### 4.1.3. BTC(1d) : Open Price, Close Price, High Price, Low Price, Volume, RSI, Dominace

The predictions came true with the above-mentioned attributes.

Data graphic and data table used for closing price prediction

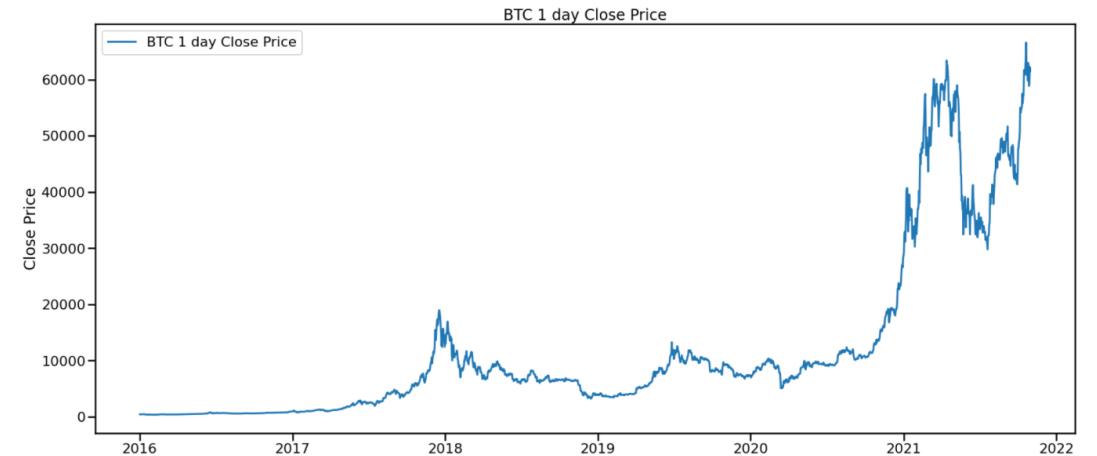


Figure 4.12: BTC dataset graphic 3.

	open	close	high	low	volume	RSI	Dom	🔗
time								
2016-01-15 23:20:00	388.29	388.69	388.77	388.29	24.931849	31.440797	90.99	
2016-01-16 21:33:20	383.68	383.49	383.69	383.49	3.572000	30.055848	90.48	
2016-01-17 22:33:20	388.29	388.29	388.29	388.29	1.741386	32.990127	90.29	
2016-01-18 20:46:40	385.98	385.98	385.98	385.98	0.230000	32.288109	90.53	
2016-01-19 21:46:40	380.23	380.24	380.24	380.23	4.615000	30.548550	90.30	
...	...	...	...	...	...	...	...	...
2019-09-19 19:06:40	10056.00	10059.00	10059.00	10054.00	0.315802	44.613989	65.06	
2019-09-20 17:20:00	10168.00	10168.00	10168.00	10168.00	0.031689	47.393674	64.84	
2019-09-21 18:20:00	10004.00	10005.00	10005.00	10004.00	3.025000	43.849569	65.44	
2019-09-22 19:20:00	9987.80	9987.20	9988.50	9987.00	1.587750	43.467302	66.31	
2019-09-23 17:33:20	9835.00	9836.20	9837.60	9834.90	0.259004	40.260847	66.55	

1280 rows × 7 columns

Figure 4.13: BTC dataset table 3.

### Correlation of parameters used for closing price prediction



Figure 4.14: BTC dataset correlation 3.

## Performance measurements of the model used for closing price prediction

Table 4.3: 1-day BTC Dataset LSTM Model Result 3

Parameters	Quantity
Model Evaluate	0.52%
Mean Absolute Error	4.74%
Mean Squared Error	0.52%
$R^2$	96.04%

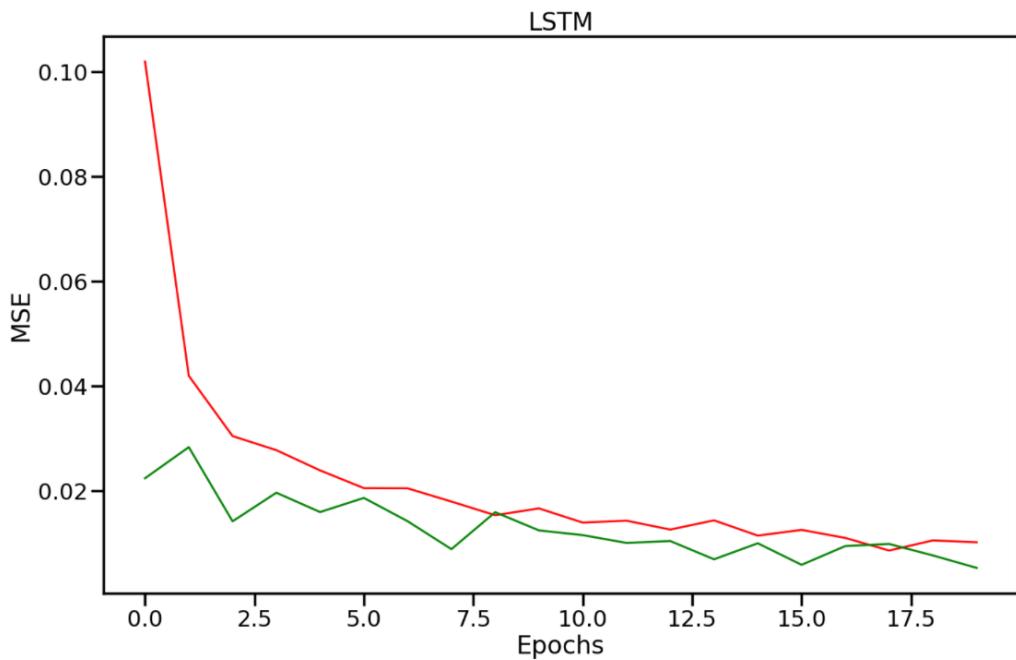


Figure 4.15: BTC(1d) dataset model epoch graphic 3.

## Closing price estimation and test data display



Figure 4.16: BTC(1d) dataset predition graphic 3.

time	open	close	high	low	volume	RSI	Dom	RSI_DOM_Prediction
1/15/2016 23:20	388.29	388.69	388.77	388.29	24.93185	31.4408	90.99	
1/16/2016 21:33	383.68	383.49	383.69	383.49	3.572	30.05585	90.48	
1/17/2016 22:33	388.29	388.29	388.29	388.29	1.741386	32.99013	90.29	
1/18/2016 20:46	385.98	385.98	385.98	385.98	0.23	32.28811	90.53	
1/19/2016 21:46	380.23	380.24	380.24	380.23	4.615	30.54855	90.3	
9/20/2019 17:20	10168	10168	10168	10168	0.031689	47.39367	64.84	10053.09597
9/21/2019 18:20	10004	10005	10005	10004	3.025	43.84957	65.44	10050.39746
9/22/2019 19:20	9987.8	9987.2	9988.5	9987	1.58775	43.4673	66.31	9801.955401
9/23/2019 17:33	9835	9836.2	9837.6	9834.9	0.259004	40.26085	66.55	8892.422915

Figure 4.17: BTC(1d) dataset predition data table 3.

#### 4.1.4. BTC(1d) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD ,Dominance

The predictions came true with the above-mentioned attributes.

Data graphic and data table used for closing price prediction

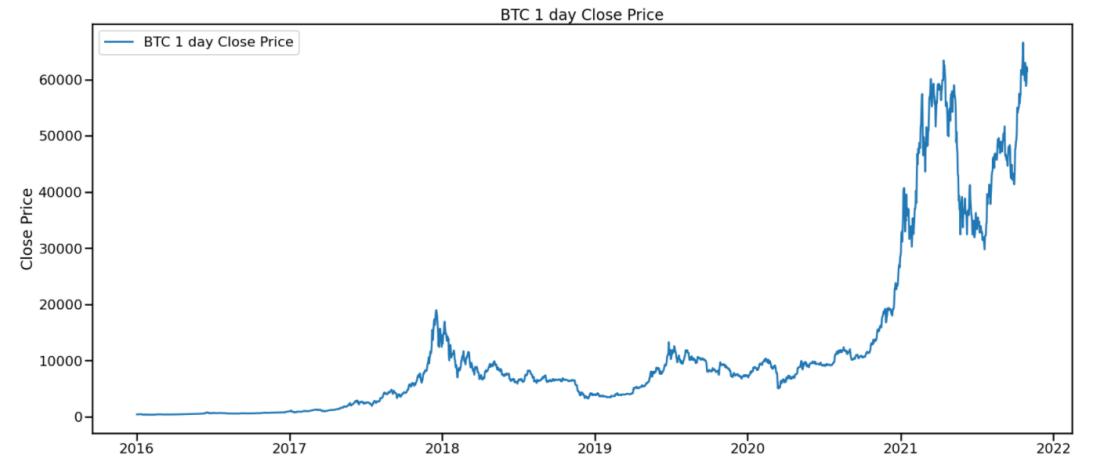


Figure 4.18: BTC dataset graphic 4.

	open	close	high	low	volume	RSI	Dom	🔗
time								
2016-01-15 23:20:00	388.29	388.69	388.77	388.29	24.931849	31.440797	90.99	
2016-01-16 21:33:20	383.68	383.49	383.69	383.49	3.572000	30.055848	90.48	
2016-01-17 22:33:20	388.29	388.29	388.29	388.29	1.741386	32.990127	90.29	
2016-01-18 20:46:40	385.98	385.98	385.98	385.98	0.230000	32.288109	90.53	
2016-01-19 21:46:40	380.23	380.24	380.24	380.23	4.615000	30.548550	90.30	
...	...	...	...	...	...	...	...	...
2019-09-19 19:06:40	10056.00	10059.00	10059.00	10054.00	0.315802	44.613989	65.06	
2019-09-20 17:20:00	10168.00	10168.00	10168.00	10168.00	0.031689	47.393674	64.84	
2019-09-21 18:20:00	10004.00	10005.00	10005.00	10004.00	3.025000	43.849569	65.44	
2019-09-22 19:20:00	9987.80	9987.20	9988.50	9987.00	1.587750	43.467302	66.31	
2019-09-23 17:33:20	9835.00	9836.20	9837.60	9834.90	0.259004	40.260847	66.55	

1280 rows × 7 columns

Figure 4.19: BTC dataset table 4.

## Correlation of parameters used for closing price prediction

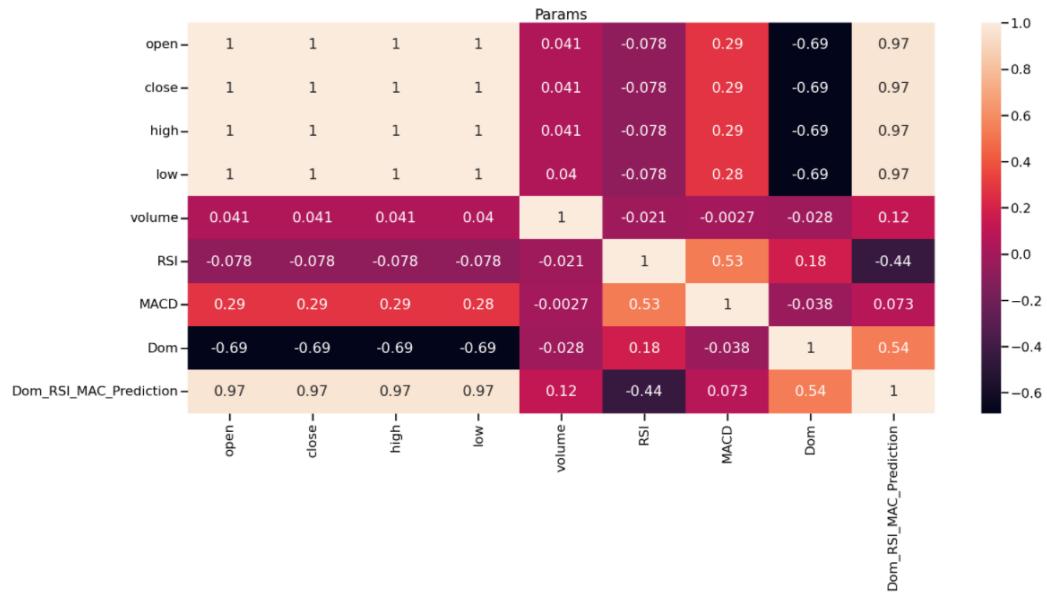


Figure 4.20: BTC dataset correlation 4.

Performance measurements of the model used for closing price prediction

Table 4.4: 1-day BTC Dataset LSTM Model Result 4

Parameters	Quantity
Model Evaluate	1.42%
Mean Absolute Error	7.70%
Mean Squared Error	1.42%
$R^2$	89.29%

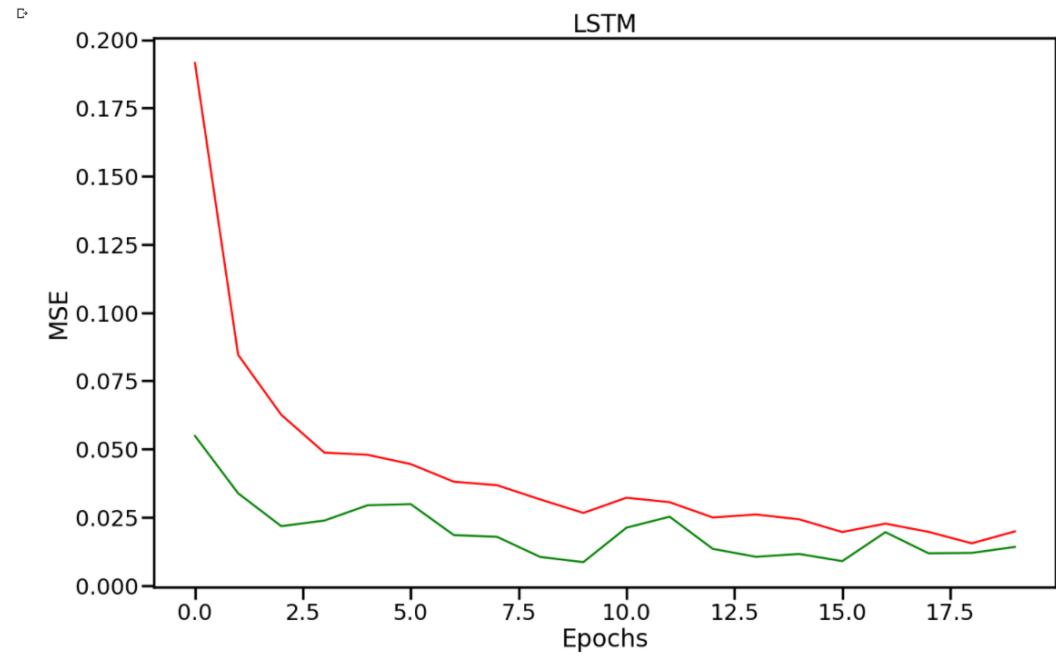


Figure 4.21: BTC(1d) dataset model epoch graphic 4.

#### Closing price estimation and test data display

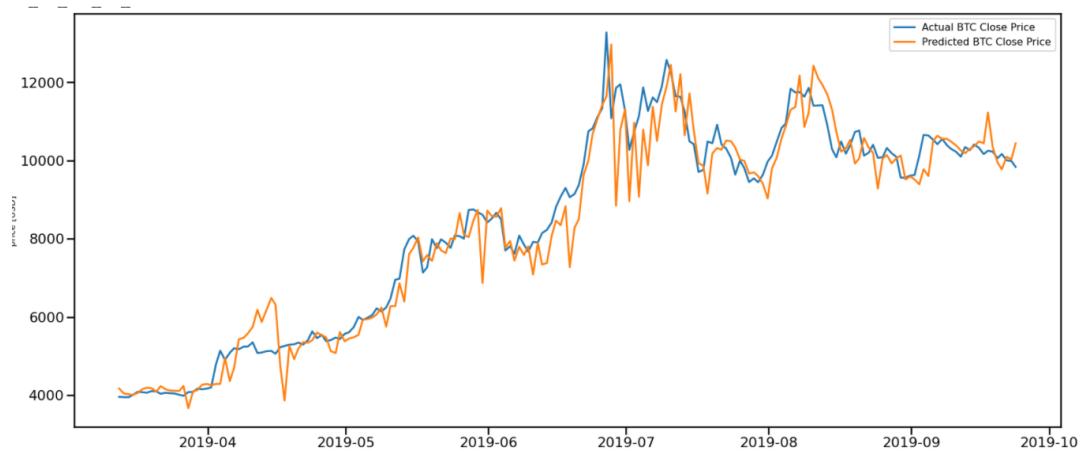


Figure 4.22: BTC(1d) dataset predition graphic 4.

time	open	close	high	low	volume	RSI	MACD	Dom	RSI_MACD_DOM_Prediction
1/15/2016 23:20	388.29	388.69	388.77	388.29	24,93185	31.4408	-2.79583	90.99	
1/16/2016 21:33	383.68	383.49	383.69	383.49	3,572	30.05585	-6.40951	90.48	
1/17/2016 22:33	388.29	388.29	388.29	388.29	1,741386	32.99013	-8.78478	90.29	
1/18/2016 20:46	385.98	385.98	385.98	385.98	0.23	32.28811	-10.7299	90.53	
1/19/2016 21:46	380.23	380.24	380.24	380.23	4,615	30.54855	-12.5895	90.3	
9/18/2019 18:06	10234	10227	10234.9	10224	12,00242	48.26386	-26.4858	65.57	10194.47256
9/19/2019 19:06	10056	10059	10059	10054	0.315802	44.61399	-41.2797	65.06	10029.20213
9/20/2019 17:20	10168	10168	10168	10168	0.031689	47.39367	-43.7048	64.84	10328.71124
9/21/2019 18:20	10004	10005	10005	10004	3,025	43.84957	-58.1096	65.44	10143.07664
9/22/2019 19:20	9987.8	9987.2	9988.5	9987	1.58775	43.4673	-70.1531	66.31	10048.68481
9/23/2019 17:33	9835	9836.2	9837.6	9834.9	0.259004	40.26085	-90.8351	66.55	9677.271843

Figure 4.23: BTC(1d) dataset prediction data table 4.

#### 4.1.5. BTC(1d) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD ,Dominance, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

The predictions came true with the above-mentioned attributes.

Data graphic and data table used for closing price prediction

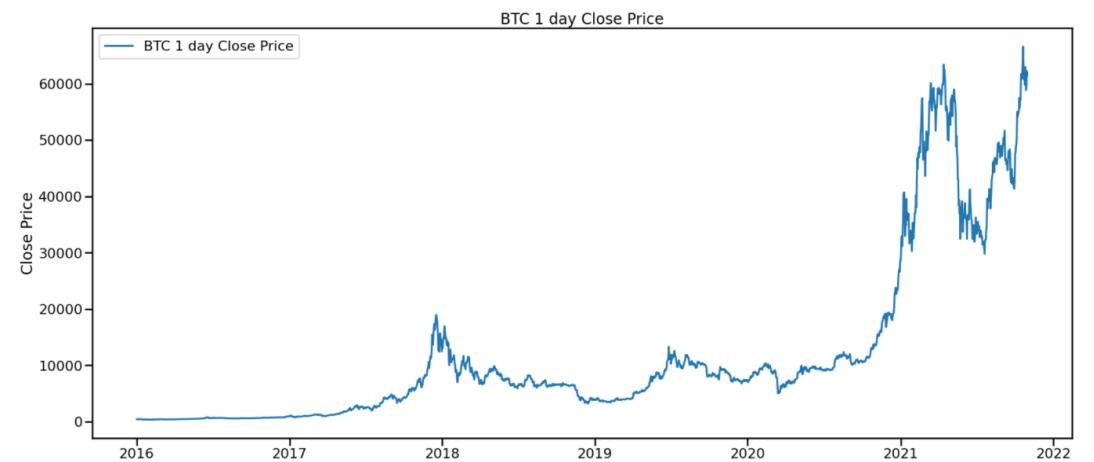


Figure 4.24: BTC dataset graphic 5.

time	open	close	high	low	volume	RSI	Dom	ma7	ma21	26ema	12ema	MACD	20sd	upper_band	lower_band	ema	momentum	log_momentum
2016-01-21 21:00:00	407.89	407.56	407.89	407.56	0.200000	45.599710	90.41	391.762857	423.509045	415.463420	407.437538	-0.025882	25.343508	474.196063	372.822032	404.889949	406.58	6.007732
2016-01-22 22:00:00	377.13	376.66	377.13	376.66	11.964121	35.555355	90.44	390.044286	420.788095	411.941217	402.579405	-9.361612	27.183931	475.155957	366.420234	388.699893	375.66	5.928684
2016-01-23 23:00:00	387.58	387.20	387.58	387.14	10.211809	40.394192	90.07	390.574286	418.573810	409.732326	400.161489	-9.570637	27.962296	474.498402	362.649217	388.823328	388.20	5.956355
2016-01-24 21:13:20	401.20	401.21	401.21	401.20	0.140000	46.148506	89.79	392.420000	417.379048	408.902051	400.325780	-8.657071	28.151050	473.681147	361.078949	398.414443	400.21	5.991989
2016-01-25 22:13:20	391.61	391.61	391.61	391.61	0.537650	43.079528	89.61	393.224286	415.350952	407.475937	398.963981	-8.511956	28.411577	472.174107	358.527798	393.211481	390.61	5.987710
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2019-09-19 19:06:40	10056.00	10059.00	10059.00	10054.00	0.315802	44.613989	65.06	10243.142857	10227.781542	10278.011104	10236.731380	-41.279724	309.025966	10845.813474	9609.709809	10116.524965	10058.00	9.216124
2019-09-20 17:20:00	10168.00	10168.00	10168.00	10168.00	0.031689	47.393974	64.84	10229.142857	10256.623328	10269.862133	10228.157322	-43.704812	268.504271	10795.631071	9717.614783	10150.841655	10167.00	9.226902
2019-09-21 18:20:00	10004.00	10005.00	10005.00	10004.00	3.025000	43.849589	65.44	10171.285714	10275.142378	10250.422716	10192.133118	-58.109598	234.380103	10743.862581	9806.422171	10053.813685	10004.00	9.210740
2019-09-22 19:20:00	9987.80	9987.20	9988.50	9987.00	1.587750	43.467302	66.31	10122.885714	10292.209927	10230.758070	10160.604948	-70.15124	194.615539	10681.441005	9902.978850	10009.337962	9806.20	9.208959
2019-09-23 17:33:20	9835.00	9838.20	9837.60	9834.90	0.259004	40.286847	66.55	10076.057143	10278.287574	10201.531547	10110.696493	-80.835054	216.171289	10710.630152	9845.944996	9893.912654	9835.20	9.193723

1274 rows × 18 columns

Figure 4.25: BTC dataset table 5.

### Correlation of parameters used for closing price prediction

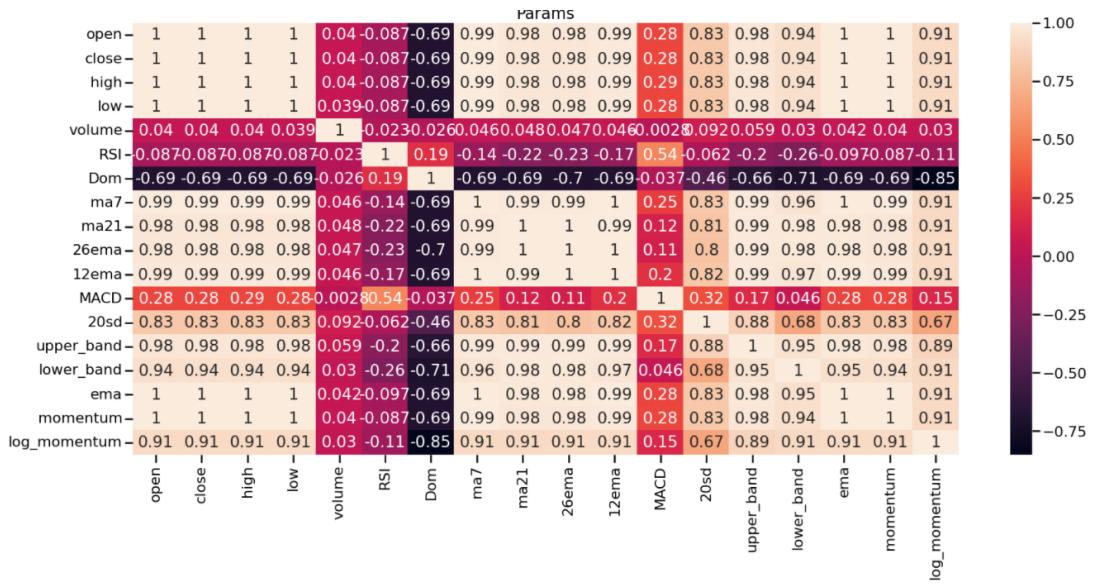


Figure 4.26: BTC dataset correlation 5.

### Performance measurements of the model used for closing price prediction

Table 4.5: 1-day BTC Dataset LSTM Model Result 5.

Parameters	Quantity
Model Evaluate	1.43%
Mean Absolute Error	7.32%
Mean Squared Error	1.43%
$R^2$	89.22%

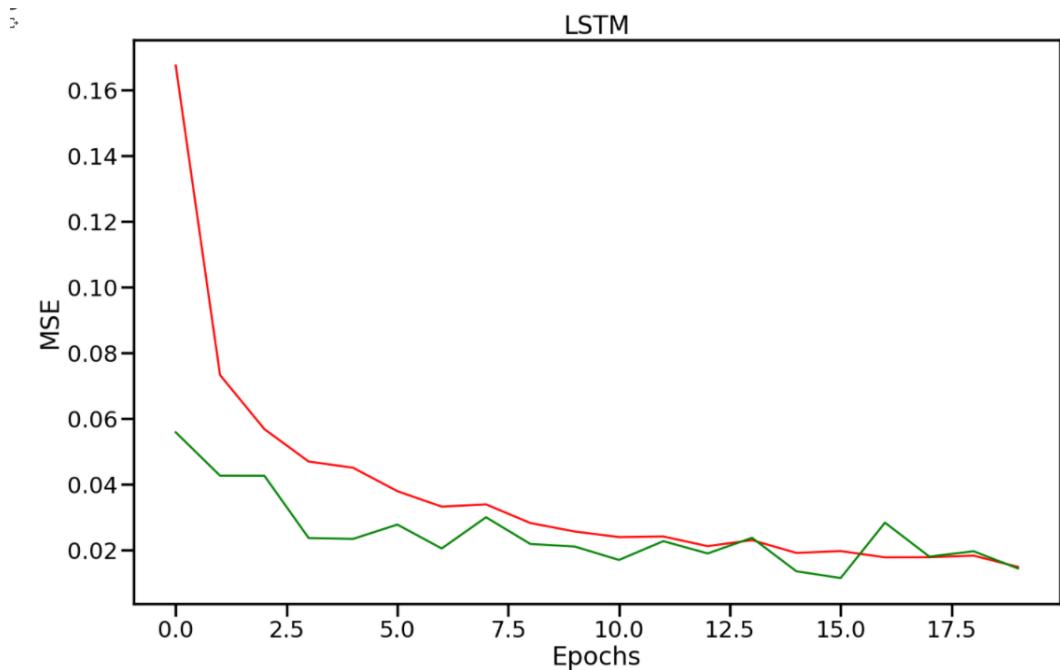


Figure 4.27: BTC(1d) dataset model epoch graphic 5.

#### Closing price estimation and test data display

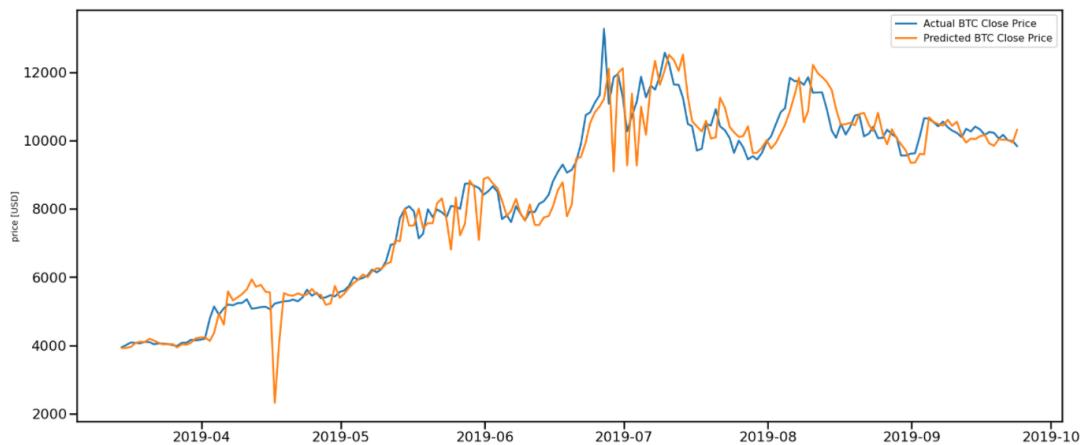


Figure 4.28: BTC(1d) dataset predition graphic 5.

time	open	close	high	low	volume	RSI	Dom	ma7	ma21	26ema	12ema	MACD	20sd	upper_band	lower_band	ema	momentum	log_momentum	All_Prediction
1/21/2016 21:00	407.89	407.56	407.89	407.56	0.2	45.59972	90.41	391.7629	423.509	415.4634	407.4375	-8.02588	25.34350763	474.1960629	372.8220324	404.8899	406.56	6.00773152	
1/22/2016 22:00	377.13	376.6	377.13	376.6	11.98412	35.58585	90.44	390.0443	420.7881	411.9412	402.5794	-9.36181	27.18393036	475.1559569	366.4202335	386.07	375.66	5.928684479	
1/23/2016 23:00	387.58	387.2	387.58	387.14	10.21181	40.39419	90.07	390.5743	418.5738	409.7323	400.1615	-9.57084	27.96229649	474.4984025	362.649216	386.8233	386.2	5.95635537	
1/24/2016 21:13	401.2	401.2	401.21	401.2	0.1401	46.14851	89.79	392.42	417.379	408.9829	400.3258	-8.65707	15104952	473.6811467	361.079480	396.4144	400.21	5.99198409	
1/25/2016 22:13	391.61	391.61	391.61	391.61	0.53768	43.07953	89.61	393.2243	415.351	407.4759	398.964	-8.51196	28.41157738	472.1741071	358.5277976	393.2115	390.61	5.96770962	
1/26/2016 23:13	392.86	392.82	393.11	392.82	42.77785	43.58874	88.92	395.0214	413.819	406.2206	398.0063	-8.21428	28.54742626	470.5767587	356.3870509	392.9505	391.82	5.970802551	
9/17/2019 17:00	10252.99	10250	10253	10250	2.268402	48.77109	65.21	10265.48	10197.62	10301.0	10276.69	-24.2336	340.9825243	10679.58373	9515.65363	10240.72	10249	9.234935419	9637.627763
9/18/2019 18:00	10234	10227	10234.9	10224	12.00242	48.26386	65.57	10283.76	10024.05	10295.53	10269.05	-26.8585	340.1633237	10884.3739	9523.720609	10231.57	10226	9.232688776	10344.31854
9/19/2019 19:06	10056	10055	10059	10054	0.315802	44.61399	65.06	10243.14	10227.76	10278.1	10236.73	-41.797	309.0259661	10845.81347	9609.709609	10116.52	10058	9.216123617	10011.01121
9/20/2019 19:20	10168	10168	10168	10168	0.031689	47.39367	64.84	10229.14	10256.62	10226.16	-43.7048	269.5042714	10795.63187	9717.164785	10150.84	10167	9.22690246	10154.87978	
9/21/2019 18:20	10004	10005	10005	10004	3.025	43.84957	65.44	10171.29	10275.14	10250.24	10192.13	-58.1096	234.3601026	10743.86258	9806.422171	10053.61	10004	9.210740292	10190.46271
9/22/2019 19:20	9987.8	9987.2	9988.5	9987	1.58775	43.4673	66.31	10122.89	10292.21	10230.76	10160.6	-70.1531	194.6155387	10681.441	9902.57885	10009.34	9986.2	9.208959419	9999.125654
9/23/2019 17:33	9835	9836.2	9837.6	9834.9	0.259004	40.26085	66.55	10076.06	10278.29	10201.53	10110.7	-90.8351	216.1712889	10710.63015	9845.944996	9839.913	9835.2	9.193723066	9429.253936

Figure 4.29: BTC(1d) dataset prediction data table 5.

## 4.2. Closing price prediction with BTC 12-hour data

3 datasets have been prepared for the BTC 12-hour dataset.

- BTC(12h): Open Price, Close Price, High Price, Low Price, Volume
- BTC(12h) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD
- BTC(12h) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD ,Dominance, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

### 4.2.1. BTC(12h) : Open Price, Close Price, High Price, Low Price, Volume

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

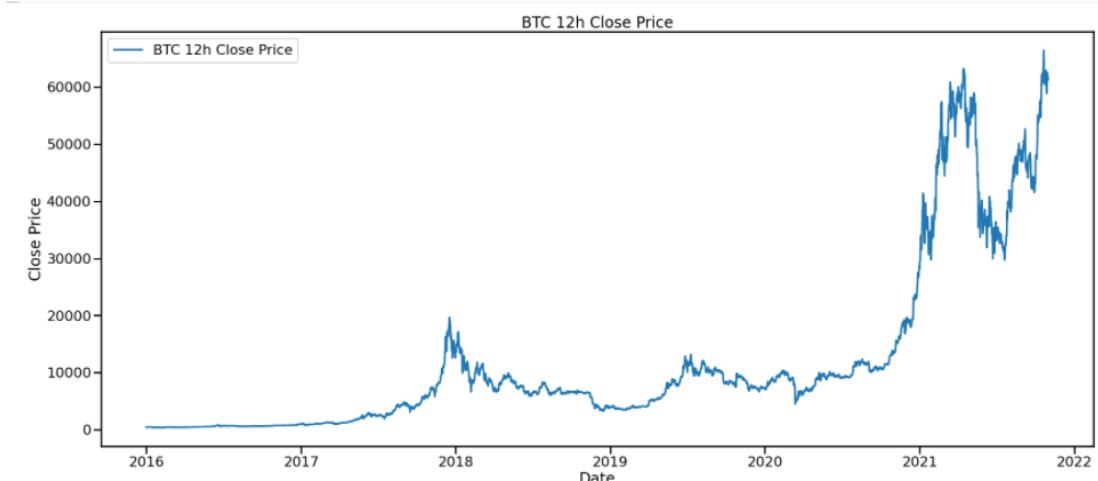


Figure 4.30: BTC(12h) dataset graphic 1.

	open	close	high	low	volume	
time						
2016-01-01 10:00:00	431.39000	431.390000	431.390000	431.390000	0.070000	
2016-01-01 22:01:00	433.79000	433.800000	433.800000	433.790000	5.757400	
2016-01-02 10:01:00	433.30000	433.410000	433.410000	433.300000	10.196000	
2016-01-02 22:01:00	433.73000	433.700000	433.730000	433.700000	1.780218	
2016-01-03 10:04:00	429.16000	429.090000	429.160000	429.090000	0.020868	
...	...	...	...	...	...	...
2021-10-29 05:36:00	61087.00000	61072.000000	61087.000000	61072.000000	1.458732	
2021-10-29 17:36:00	62556.00000	62527.000000	62564.081504	62496.000000	2.060607	
2021-10-30 05:36:00	61615.28625	61672.000000	61672.000000	61615.000000	6.153162	
2021-10-30 17:36:00	61556.00000	61511.604382	61558.000000	61511.604382	1.210133	
2021-10-31 05:36:00	61351.00000	61335.876759	61351.995564	61327.421767	0.337975	

4123 rows × 5 columns

Figure 4.31: BTC(12h) dataset table 1.

### Correlation of parameters used for closing price prediction

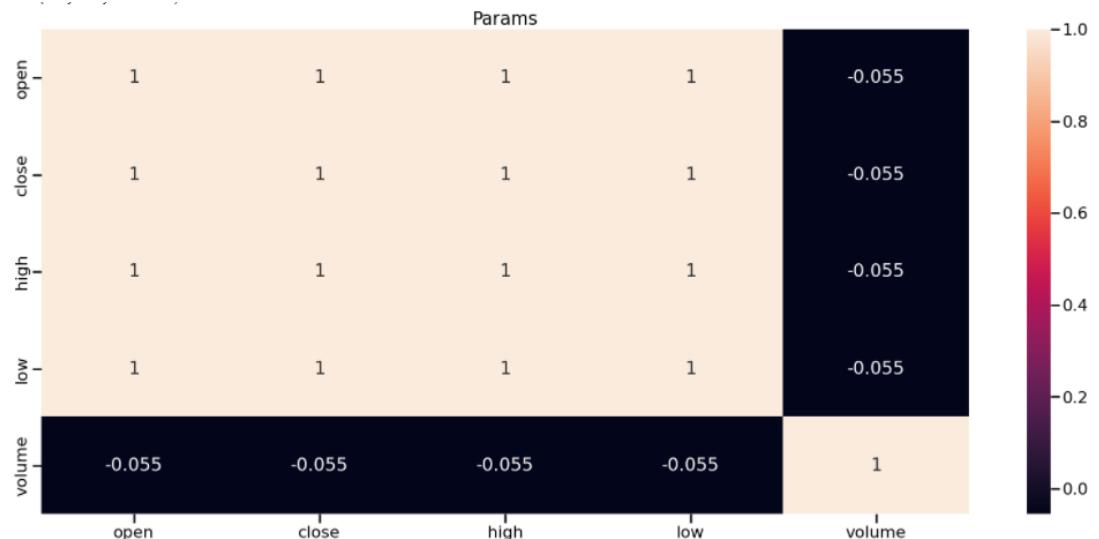


Figure 4.32: BTC(12h) dataset correlation 1.

Performance measurements of the model used for closing price prediction

Table 4.6: BTC(12h) Dataset LSTM Model Result 1

Parameters	Quantity
Model Evaluate	0.24%
Mean Absolute Error	3.03%
Mean Squared Error	0.24%
$R^2$	97.00%

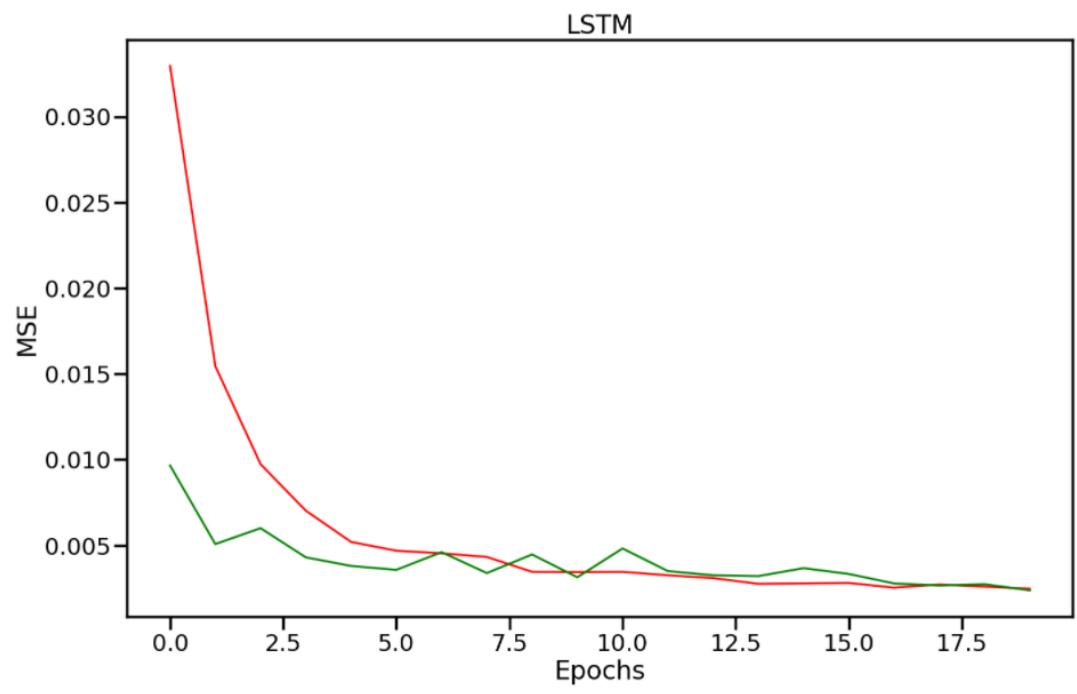


Figure 4.33: BTC(12h) dataset model epoch graphic 1.

## Closing price estimation and test data display

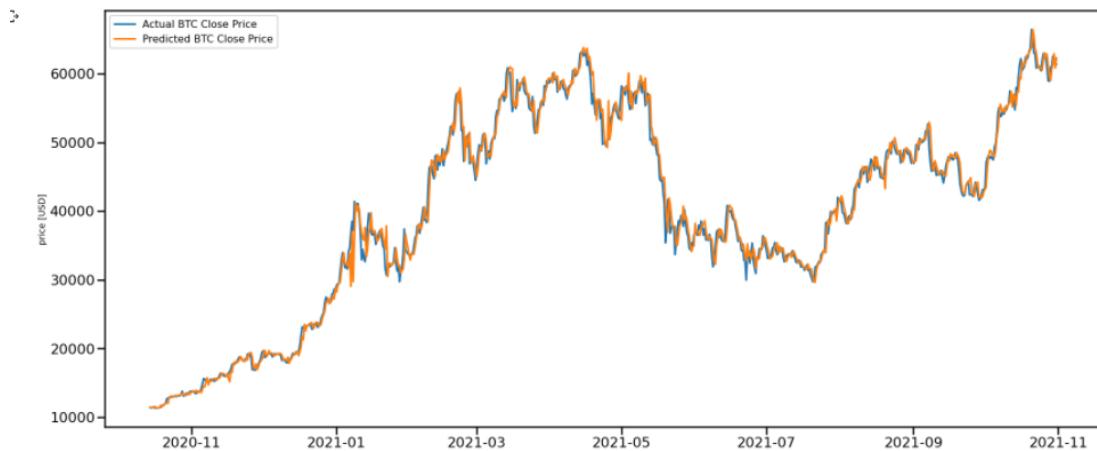


Figure 4.34: BTC(12h) dataset predition graphic 1.

time	open	close	high	low	volume	Classic_Prediction
1/1/2016 10:00	431.39	431.39	431.39	431.39	0.07	
1/1/2016 22:01	433.79	433.8	433.8	433.79	5.7574	
1/2/2016 10:01	433.3	433.41	433.41	433.3	10.196	
1/2/2016 22:01	433.73	433.7	433.73	433.7	1.780218	
1/3/2016 10:04	429.16	429.09	429.16	429.09	0.020868	
10/29/2021 5:36	61087	61072	61087	61072	1.458732	60575.82
10/29/2021 17:36	62556	62527	62564.08	62496	2.060607	61333.85
10/30/2021 5:36	61615.29	61672	61672	61615	6.153162	62915.27
10/30/2021 17:36	61556	61511.6	61558	61511.6	1.210133	60800.17
10/31/2021 5:36	61351	61335.88	61352	61327.42	0.337975	62277.72

Figure 4.35: BTC(12h) dataset predition data table 1.

#### 4.2.2. BTC(12h) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

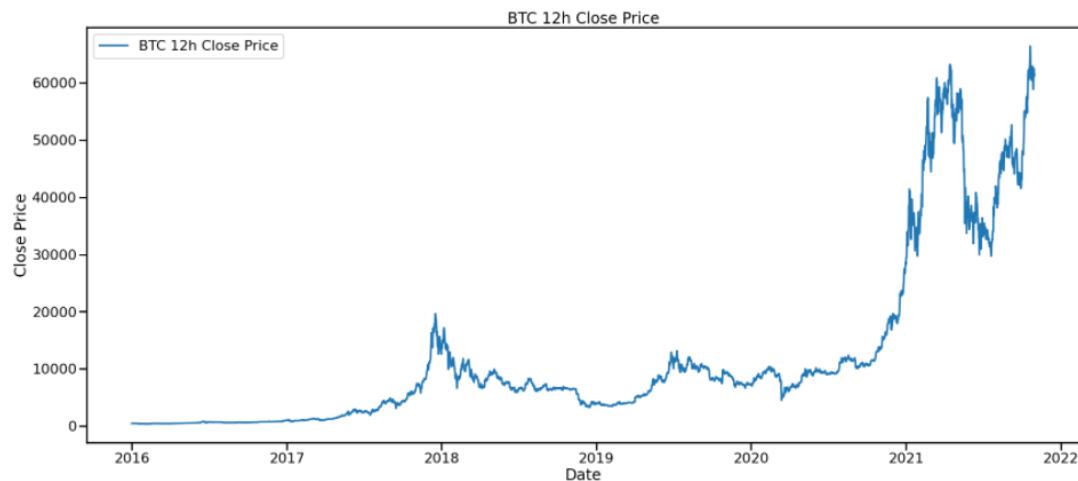


Figure 4.36: BTC(12h) dataset graphic 2.

time	open	close	high	low	volume	RSI	MACD
2016-01-08 10:08:00	457.71000	457.720000	457.720000	457.71000	0.223835	73.230986	4.375540
2016-01-08 22:08:00	453.72000	453.720000	453.720000	453.72000	0.060000	68.057676	5.115601
2016-01-09 10:08:00	451.02000	451.020000	451.020000	451.02000	1.000000	64.733447	5.421739
2016-01-09 22:08:00	451.32000	451.320000	451.320000	451.32000	0.041218	64.938369	5.623736
2016-01-10 10:08:00	443.58000	443.590000	443.590000	443.58000	12.073450	55.921660	5.101270
...	...	...	...	...	...	...	...
2021-10-29 05:36:00	61087.00000	61072.000000	61087.000000	61072.00000	1.458732	52.353479	426.694170
2021-10-29 17:36:00	62556.00000	62527.000000	62564.081504	62496.00000	2.060607	57.462445	516.180161
2021-10-30 05:36:00	61615.28625	61672.000000	61672.000000	61615.00000	6.153162	53.811032	512.202745
2021-10-30 17:36:00	61556.00000	61511.604382	61558.000000	61511.604382	1.210133	53.128977	490.454375
2021-10-31 05:36:00	61351.00000	61335.876759	61351.995564	61327.421767	0.337975	52.346152	453.807672
...	...	...	...	...	...	...	...

Figure 4.37: BTC(12h) dataset table 2.

Correlation of parameters used for closing price prediction

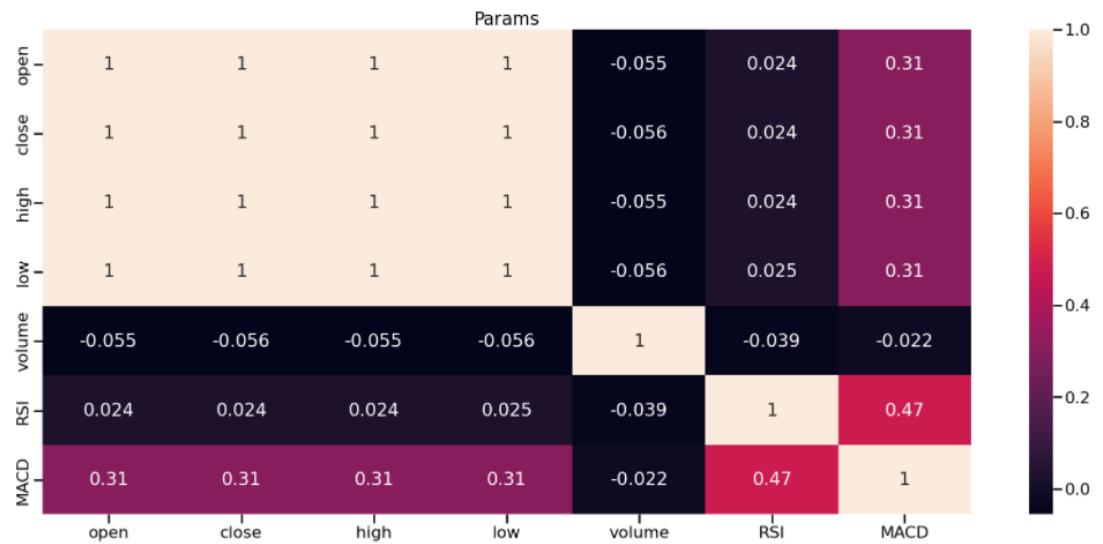


Figure 4.38: BTC(12h) dataset correlation 2.

Performance measurements of the model used for closing price prediction

Table 4.7: BTC(12h) Dataset LSTM Model Result 2.

Parameters	Quantity
Model Evaluate	0.55%
Mean Absolute Error	3.90%
Mean Squared Error	0.55%
$R^2$	93.09%

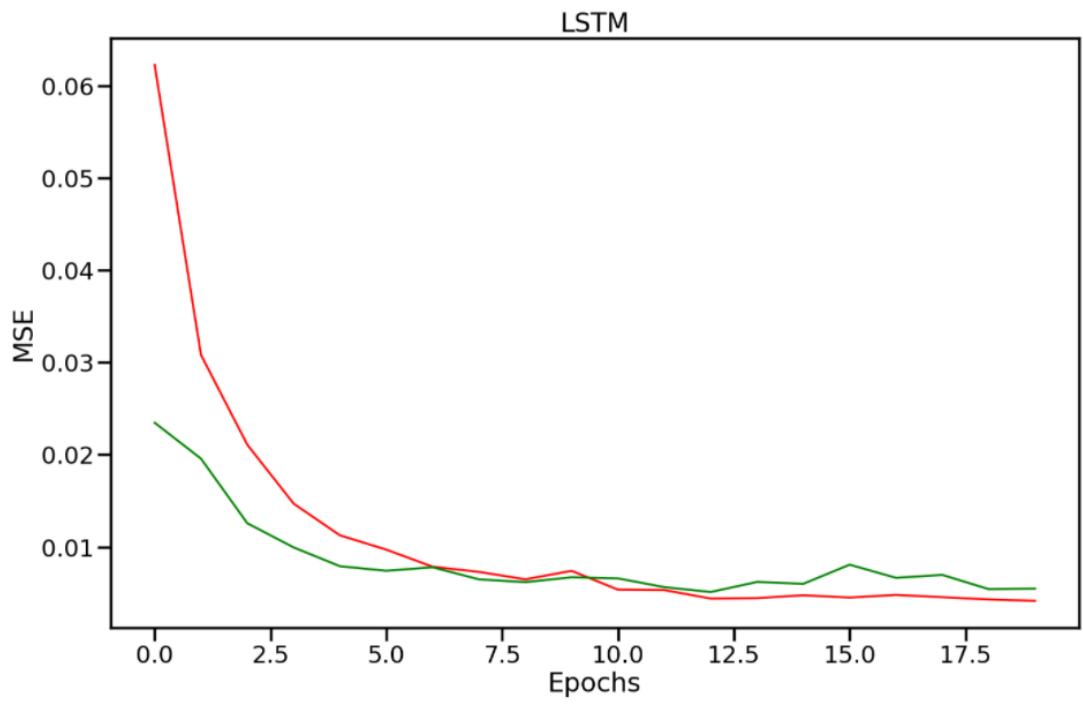


Figure 4.39: BTC(12h) dataset model epoch graphic 2.

#### Closing price estimation and test data display



Figure 4.40: BTC(12h) dataset predition graphic 2.

time	open	close	high	low	volume	RSI	MACD	RSI_Macd_Prediction
1/8/2016 10:08	457.71	457.72	457.72	457.71	0.223835	73.23099	4.37554	
1/8/2016 22:08	453.72	453.72	453.72	453.72	0.06	68.05768	5.115601	
1/9/2016 10:08	451.02	451.02	451.02	451.02	1	64.73345	5.421739	
1/9/2016 22:08	451.32	451.32	451.32	451.32	0.041218	64.93837	5.623736	
1/10/2016 10:08	443.58	443.59	443.59	443.58	12.07345	55.92166	5.10127	
10/29/2021 5:36	61087	61072	61087	61072	1.458732	52.35348	426.6942	60486.17955
10/29/2021 17:36	62556	62527	62564.08	62496	2.060607	57.46244	516.1802	61182.98429
10/30/2021 5:36	61615.29	61672	61672	61615	6.153162	53.81103	512.2027	60492.68136
10/30/2021 17:36	61556	61511.6	61558	61511.6	1.210133	53.12898	490.4544	61123.66955
10/31/2021 5:36	61351	61335.88	61352	61327.42	0.337975	52.34615	453.8077	62030.2903

Figure 4.41: BTC(12h) dataset prediction data table 2.

#### 4.2.3. BTC(12h) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD ,Dominance, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

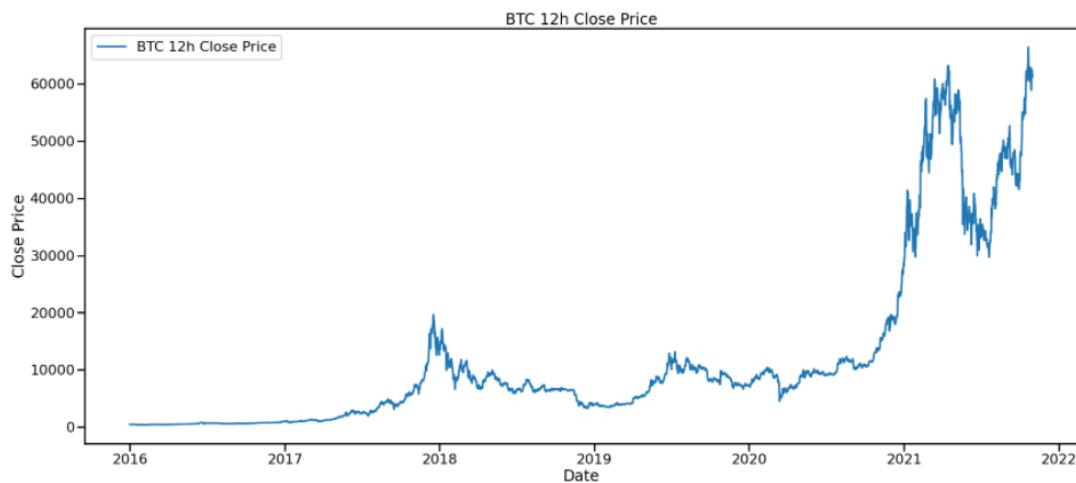


Figure 4.42: BTC(12h) dataset graphic 3.

Correlation of parameters used for closing price prediction

time	open	close	high	low	volume	RSI	ma7	ma21	26ema	12ema	MACD	20sd	upper_band	lower_band	ema	momentum	log_momentum
2016-01-11 10:00:00	445.980000	445.980000	445.980000	0.050000	57.548205	450.031429	439.523810	442.860065	445.614953	2.754888	10.530627	460.550563	418.462556	446.208805	444.980000	6.098029	
2016-01-11 22:10:00	449.150000	449.150000	449.150000	449.150000	0.050000	60.166427	448.807143	440.369524	443.431006	446.172949	2.741943	10.557857	461.485237	419.253811	448.169602	448.150000	6.105128
2016-01-12 00:12:00	446.830000	446.830000	446.830000	0.100000	57.577327	447.822857	440.990000	443.734467	446.276249	2.541782	10.535324	462.060648	419.919352	447.278534	445.830000	6.099938	
2016-01-12 22:12:00	446.990000	446.990000	446.990000	446.990000	2.356068	57.523568	447.247143	441.836867	444.020767	446.388088	2.367319	10.483324	462.563314	420.710019	447.085511	445.990000	6.100297
2016-01-13 10:12:00	428.720000	428.790000	428.720000	428.720000	5.495377	40.500705	444.028571	441.402857	442.699656	443.638470	0.938813	10.701685	462.006226	419.999488	434.888504	427.790000	6.050832
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2021-10-29 05:36:00	61087.000000	61072.000000	61084.000000	61072.000000	1.458732	52.353478	60798.570085	61979.968918	60582.319002	61009.013173	426.694170	1808.612517	65597.191952	58382.741884	60825.177928	61076.000000	11.019792
2021-10-29 17:36:00	62556.000000	62527.000000	62564.061504	62496.000000	2.060607	57.462445	60798.427228	61984.728823	60726.369447	61242.549698	516.180161	1809.975491	65604.687895	53364.769841	61959.725975	62526.000000	11.043338
2021-10-30 05:36:00	61615.28625	61672.000000	61672.000000	61615.000000	6.153162	53.811032	60700.574485	61910.241078	60796.416154	61308.610899	512.202745	1787.952890	65406.146858	58334.335298	61767.908658	61671.000000	11.029569
2021-10-30 17:36:00	61556.000000	61511.604382	61558.000000	61511.604382	1.210133	53.126997	60791.608025	61802.641287	60849.393068	61339.847435	490.454375	1737.881458	65276.684203	58327.678371	61597.039141	61510.604382	11.028695
2021-10-31 05:36:00	61351.000000	61335.876759	61351.995564	61327.421767	0.337975	52.346152	61130.786076	61560.792757	60885.428899	61339.236562	453.807672	1380.620061	64322.218398	58799.738153	61422.930886	61334.878759	11.024104

4103 rows × 17 columns

Figure 4.43: BTC(12h) dataset table 3.

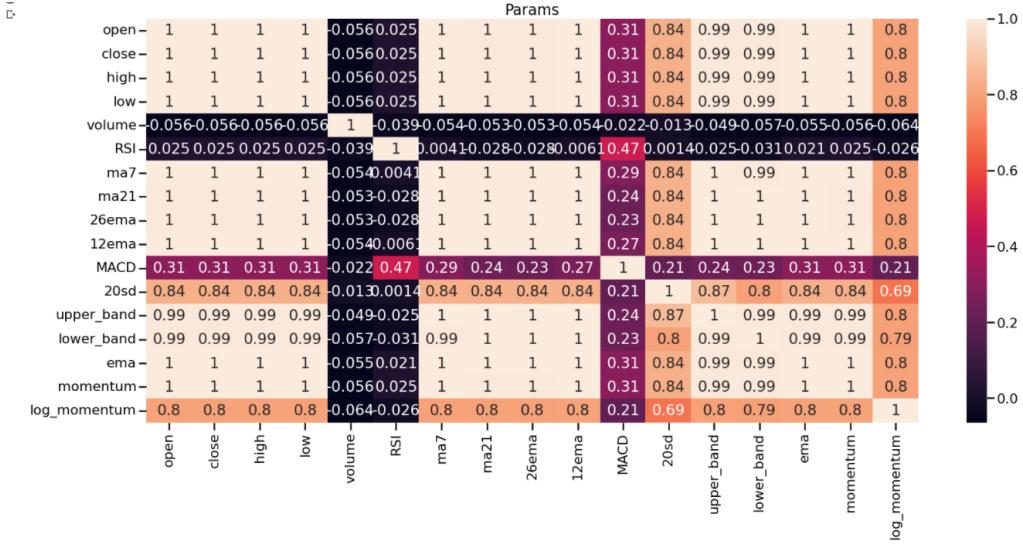


Figure 4.44: BTC(12h) dataset correlation 3.

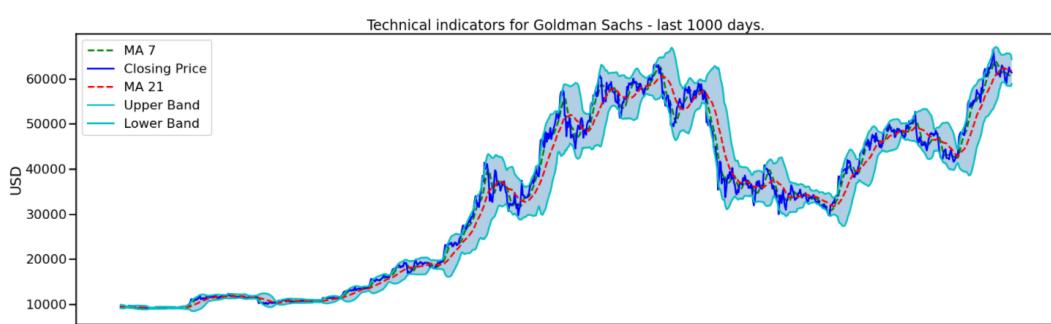


Figure 4.45: BTC(12h) dataset indicator1 3.

Performance measurements of the model used for closing price prediction

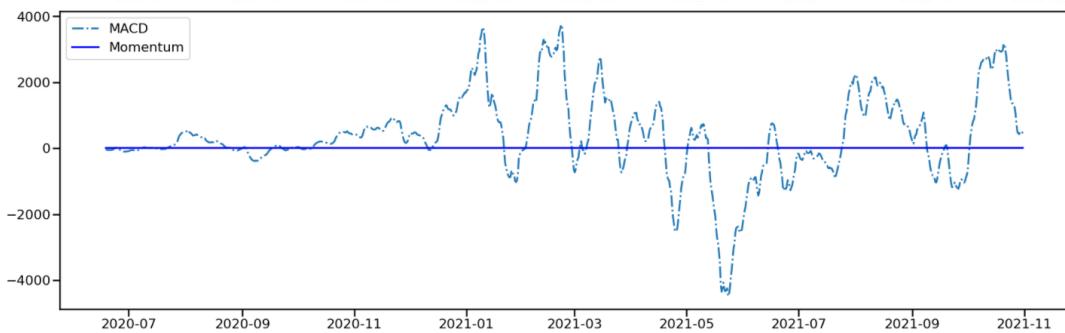


Figure 4.46: BTC(12h) dataset indicator2 3.

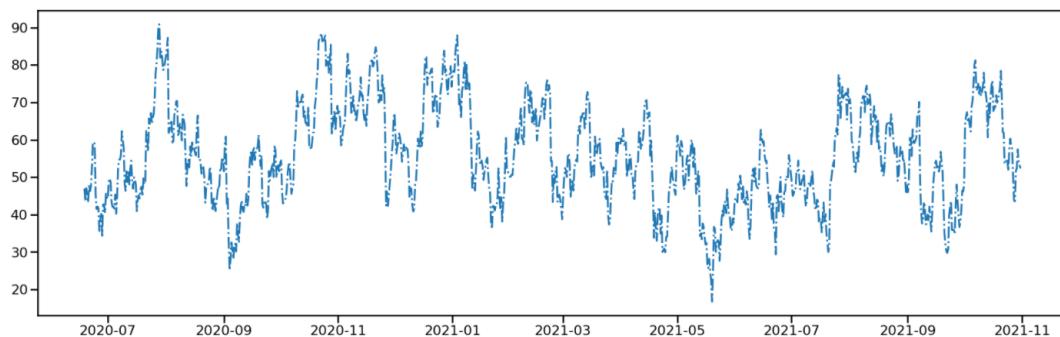


Figure 4.47: BTC(12h) dataset indicator3 3.

Table 4.8: BTC(12h) Dataset LSTM Model Result 3.

Parameters	Quantity
Model Evaluate	0.43%
Mean Absolute Error	3.92%
Mean Squared Error	0.43%
$R^2$	94.57%

Closing price estimation and test data display

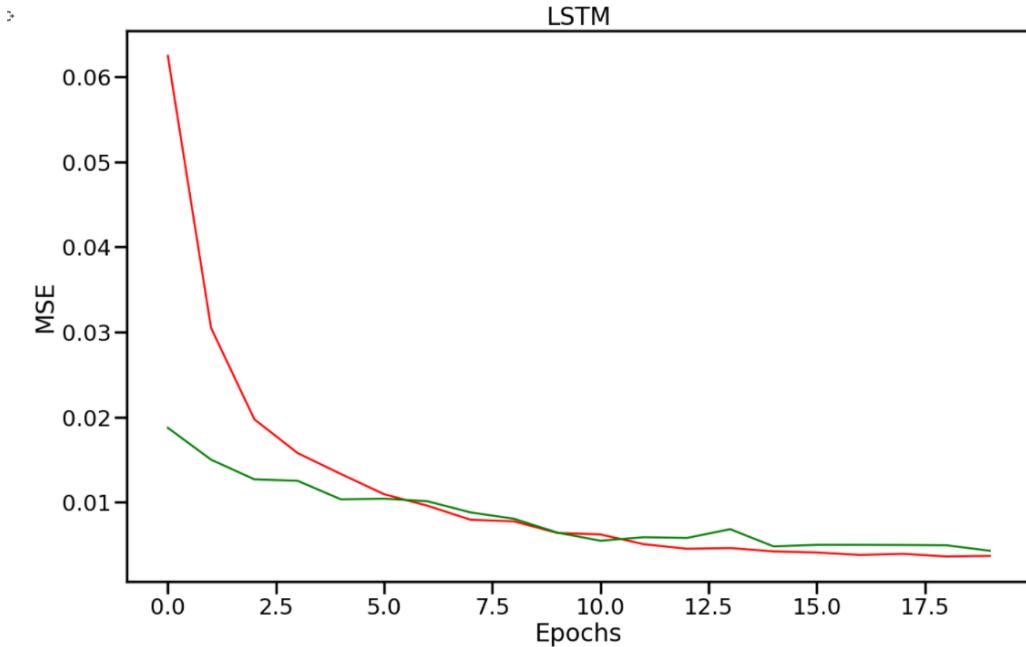


Figure 4.48: BTC(12h) dataset model epoch graphic 3.

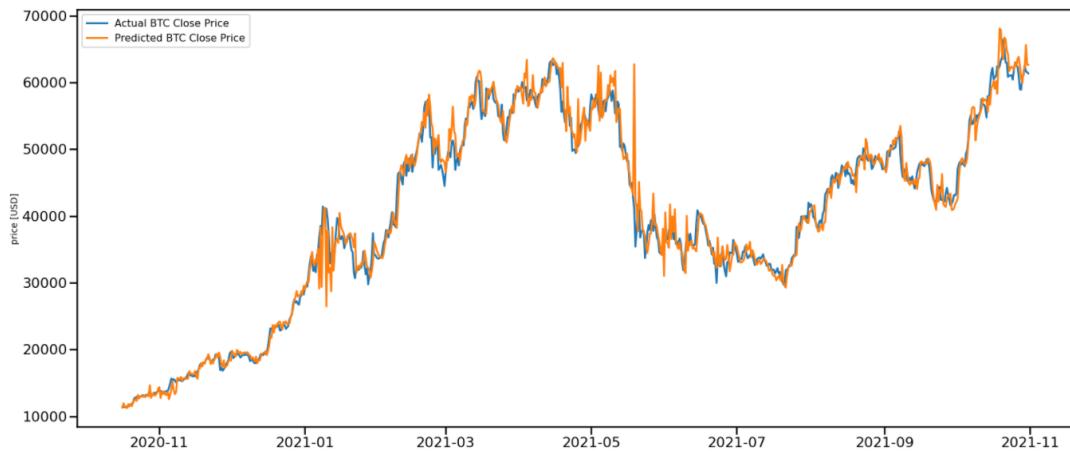


Figure 4.49: BTC(12h) dataset prediction graphic 3.

time	open	close	high	low	volume	RSI	ma7	ma21	26ema	12ema	MACD	20sd	upper_band	lower_band	ema	momentu	log_mom	All_Indicator_Prediction
1/11/2016 10:10	445.98	445.98	445.98	445.98	0.05	57.5482	450.0314	439.5238	442.8601	445.615	2.754888	10.53063	460.5850626	418.4625565	446.2088	444.98	6.098029	
1/11/2016 22:10	449.15	449.15	449.15	449.15	0.05	60.16643	448.8071	440.3695	443.431	446.1729	2.741943	10.55786	461.4852369	419.2538107	448.1696	448.15	6.105128	
1/12/2016 10:12	446.83	446.83	446.83	446.83	0.1	57.37733	447.8229	440.99	443.7345	446.2762	2.541782	10.53532	462.066478	419.9193522	447.2765	445.83	6.099938	
1/12/2016 22:12	446.99	446.99	446.99	446.81	2.356068	57.52357	447.2471	441.6367	444.0208	446.3881	2.367319	10.46932	462.5633141	420.7100192	447.0855	445.99	6.100297	
1/13/2016 10:12	428.72	428.79	428.79	428.72	5.495377	40.5007	444.0286	441.4024	442.6997	443.6385	0.938818	10.70168	462.8062262	419.9994881	434.8885	427.79	6.058632	
10/29/2021 5:36	61087	61087	61087	61072	1.458732	52.3534	60794.57	61979.97	60582.32	61009.01	426.6942	1808.613	65597.1919	58362.74188	60825.18	61071	11.01979	61653.39138
10/29/2021 17:36	62552	62527	62564.08	62496	2.060607	57.4624	60798.43	61984.73	60726.37	61242.55	516.1802	1809.579	65604.6879	58364.76984	61595.73	62526	11.04334	62316.61046
10/30/2021 5:36	61615.29	61672	61672	61615	6.153162	53.8110	60700.57	61910.24	60796.42	61308.62	512.2027	1787.953	65486.14682	58334.3353	61767.91	61671	11.02957	65608.31705
10/30/2021 17:36	61558	61511.6	61558	61511.6	1.210133	53.12899	60791.66	61802.84	60849.39	61339.85	490.4544	1737.881	65278.6042	58327.07837	61597.04	61510.6	11.02696	62606.37386
10/31/2021 5:36	61351	61335.88	61352	61327.42	0.337975	52.34615	61130.79	61560.98	60885.43	61339.24	453.8077	1380.62	64322.2184	58799.73815	61422.93	61334.88	11.0241	62646.4804

Figure 4.50: BTC(12h) dataset prediction data table 3.

## 4.3. Closing price prediction with Ethereum 1-day data

5 datasets have been prepared for the Etherium 1-day dataset.

These datasets are:

- ETH : Open Price, Close Price, High Price, Low Price, Volume
- ETH : Open Price, Close Price, High Price, Low Price, Volume, Dominance
- ETH : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance ,RSI
- ETH : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance ,RSI, MACD
- ETH : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance, RSI, MACD, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

### 4.3.1. ETH(1d) : Open Price, Close Price, High Price, Low Price, Volume

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

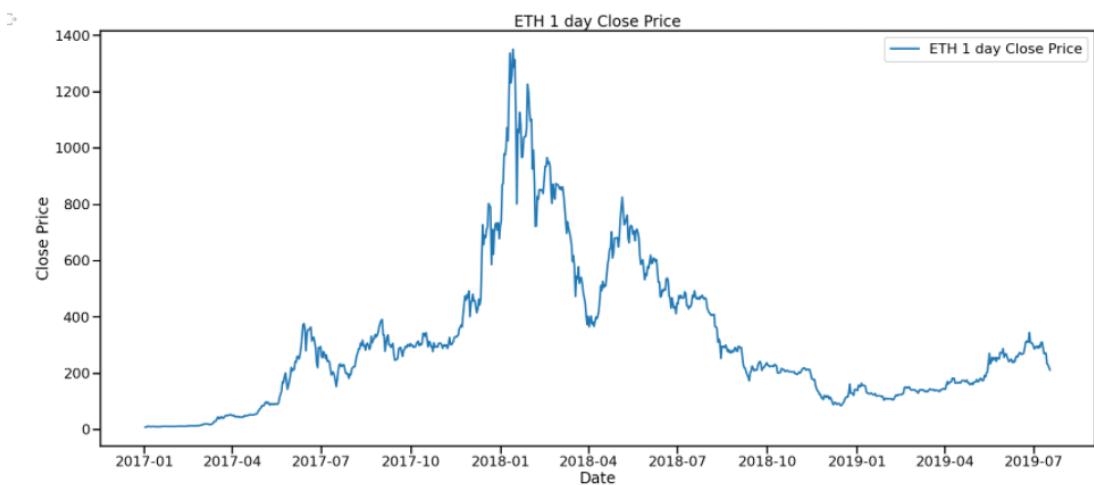


Figure 4.51: ETH dataset graphic 1.

Correlation of parameters used for closing price prediction

	open	close	high	low	volume	🔗
time						
2017-01-02 04:06:40	8.1921	8.1991	8.1991	8.192100	0.400000	
2017-01-03 02:20:00	8.3211	8.3211	8.3211	8.321100	0.757400	
2017-01-04 03:20:00	10.4000	10.4000	10.4000	10.391000	266.558580	
2017-01-05 04:20:00	11.4300	11.4300	11.4300	11.430000	28.677101	
2017-01-06 02:33:20	9.9599	9.9599	9.9599	9.959900	0.100000	
...	...	...	...	...	...	...
2019-07-13 15:00:00	269.6700	269.7200	269.7200	269.670000	16.843020	
2019-07-14 16:00:00	233.0900	233.0200	233.2000	232.340000	229.364460	
2019-07-15 17:00:00	229.2100	229.2000	229.4500	229.130000	27.586758	
2019-07-16 15:13:20	220.9900	220.9700	221.1000	220.970000	39.743973	
2019-07-17 16:13:20	212.0100	211.5000	212.0400	211.456104	194.600405	

927 rows × 5 columns

Figure 4.52: ETH dataset data table 1.

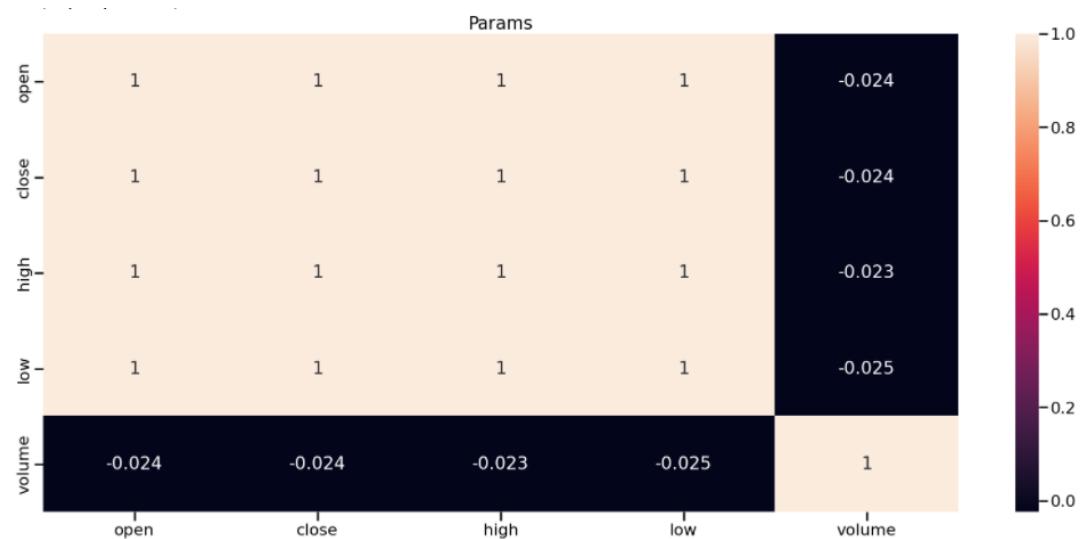


Figure 4.53: ETH dataset correlation 1.

Performance measurements of the model used for closing price prediction

Table 4.9: 1-day ETH Dataset LSTM Model Result 1.

Parameters	Quantity
Model Evaluate	1.27%
Mean Absolute Error	7.44%
Mean Squared Error	1.27%
$R^2$	83.04%

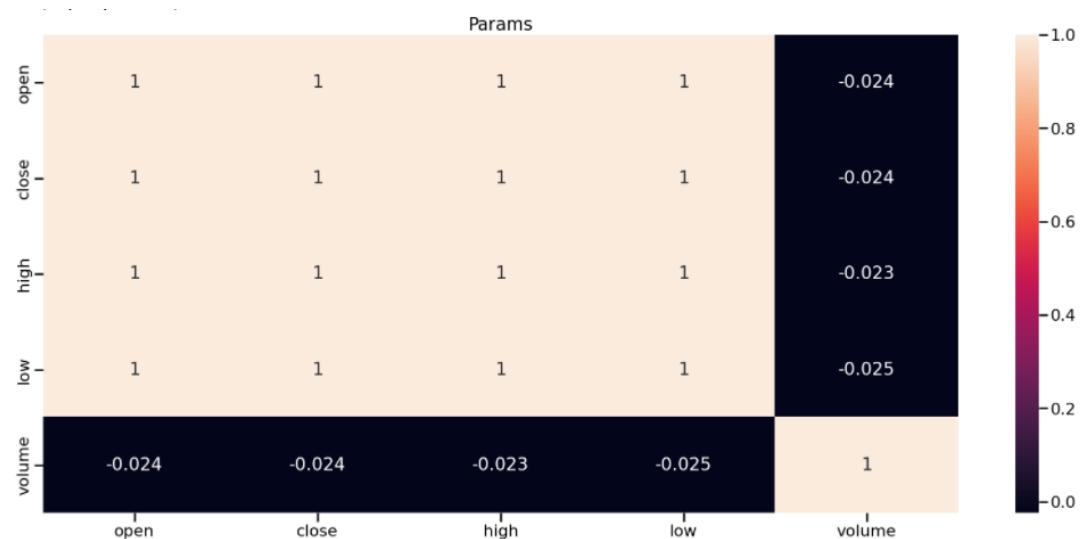


Figure 4.54: ETH(1d) dataset model epoch graphic 1.

## Closing price estimation and test data display

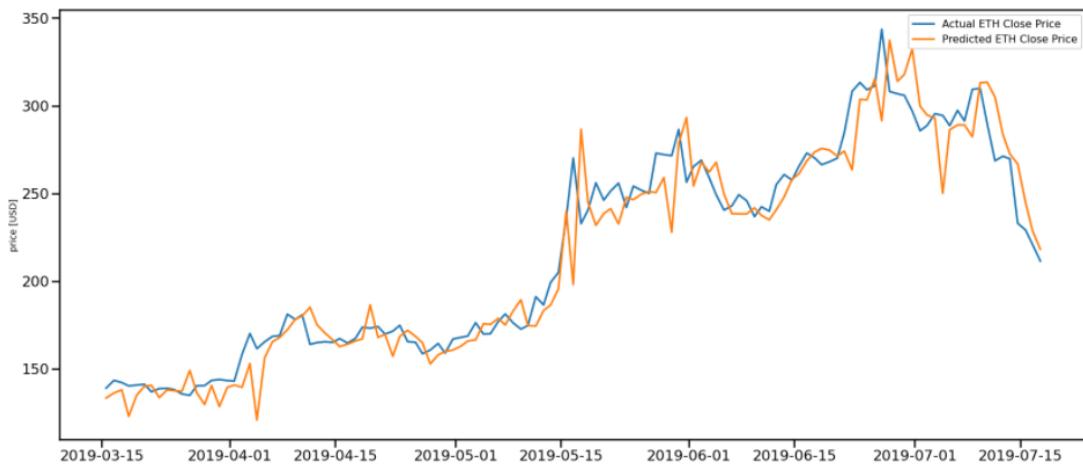


Figure 4.55: ETH(1d) dataset predition graphic 1.

time	open	close	high	low	volume	Dom	Dom_Predict
1/2/2017 4:06	8.1921	8.1991	8.1991	8.1921	0.4	3.96	
1/3/2017 2:20	8.3211	8.3211	8.3211	8.3211	0.7574	3.9	
1/4/2017 3:20	10.4	10.4	10.4	10.391	266.5586	4.45	
1/5/2017 4:20	11.43	11.43	11.43	11.43	28.6771	4.52	
1/6/2017 2:33	9.9599	9.9599	9.9599	9.9599	0.1	4.89	
7/13/2019 15:00	269.67	269.72	269.72	269.67	16.84302	9.21	269.3909
7/14/2019 16:00	233.09	233.02	233.2	232.34	229.3645	9.31	263.1323
7/15/2019 17:00	229.21	229.2	229.45	229.13	27.58676	8.85	246.2328
7/16/2019 15:13	220.99	220.97	221.1	220.97	39.74397	8.6	235.0515
7/17/2019 16:13	212.01	211.5	212.04	211.4561	194.6004	8.25	220.8453

Figure 4.56: ETH(1d) dataset predition data table 1.

### 4.3.2. ETH(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction



Figure 4.57: ETH(1d) dataset graphic 2.

	open	close	high	low	volume	Dom
time						
2017-01-02 04:06:40	8.1921	8.1991	8.1991	8.192100	0.400000	3.96
2017-01-03 02:20:00	8.3211	8.3211	8.3211	8.321100	0.757400	3.90
2017-01-04 03:20:00	10.4000	10.4000	10.4000	10.391000	266.558580	4.45
2017-01-05 04:20:00	11.4300	11.4300	11.4300	11.430000	28.677101	4.52
2017-01-06 02:33:20	9.9599	9.9599	9.9599	9.959900	0.100000	4.89
...	...	...	...	...	...	...
2019-07-13 15:00:00	269.6700	269.7200	269.7200	269.670000	16.843020	9.21
2019-07-14 16:00:00	233.0900	233.0200	233.2000	232.340000	229.364460	9.31
2019-07-15 17:00:00	229.2100	229.2000	229.4500	229.130000	27.586758	8.85
2019-07-16 15:13:20	220.9900	220.9700	221.1000	220.970000	39.743973	8.60
2019-07-17 16:13:20	212.0100	211.5000	212.0400	211.456104	194.600405	8.25

927 rows × 6 columns

Figure 4.58: ETH(1d) dataset data table 2.

### Correlation of parameters used for closing price prediction

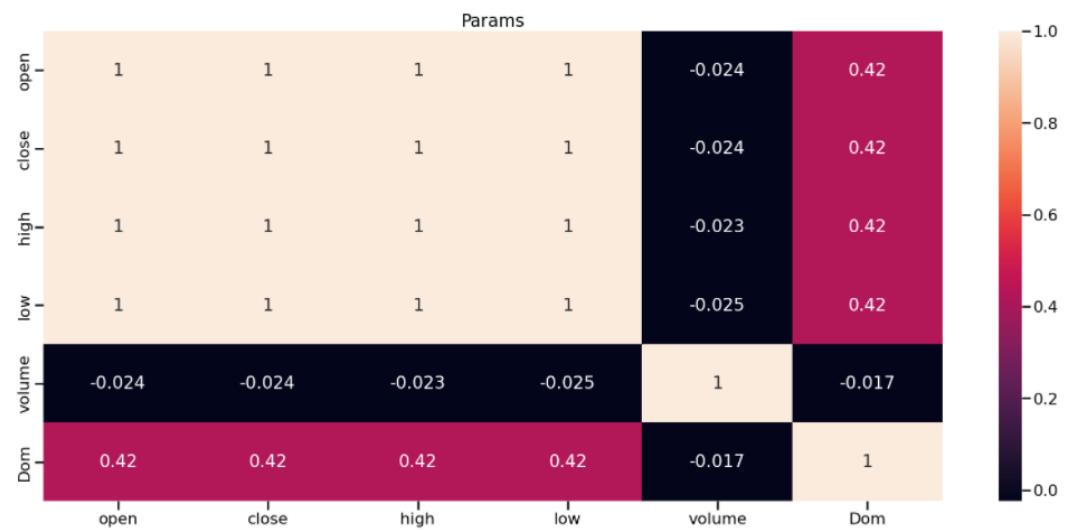


Figure 4.59: ETH(1d) dataset correlation 2.

Performance measurements of the model used for closing price prediction

Table 4.10: 1-day ETH Dataset LSTM Model Result 2.

Parameters	Quantity
Model Evaluate	1.75%
Mean Absolute Error	8.40%
Mean Squared Error	1.75%
$R^2$	76.72%

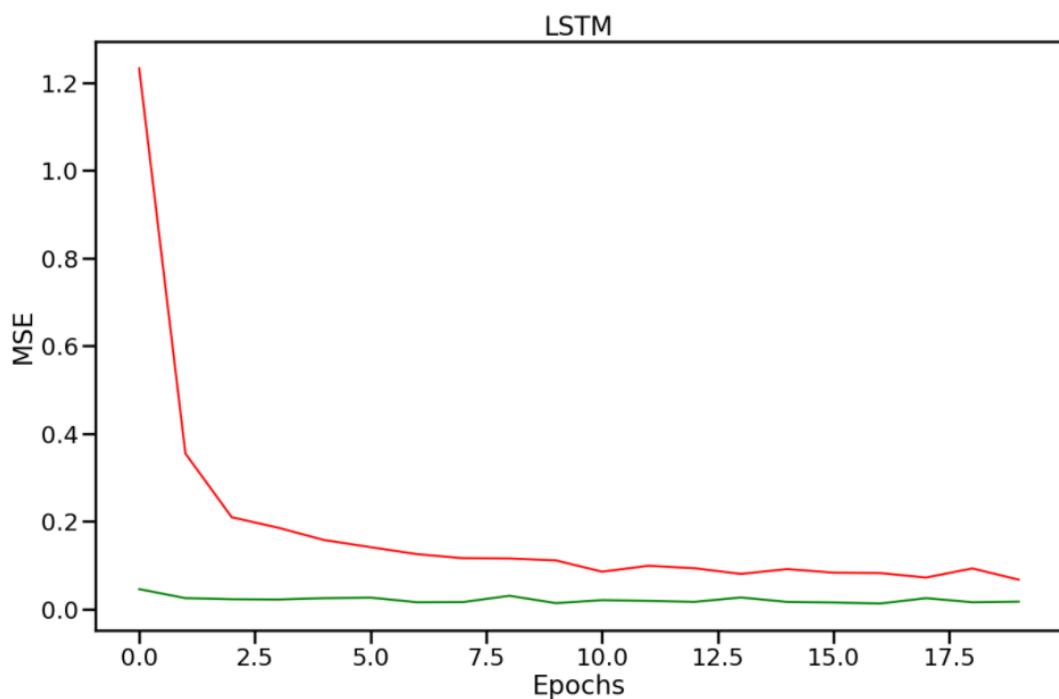


Figure 4.60: ETH(1d) dataset model epoch graphic 2.

## Closing price estimation and test data display

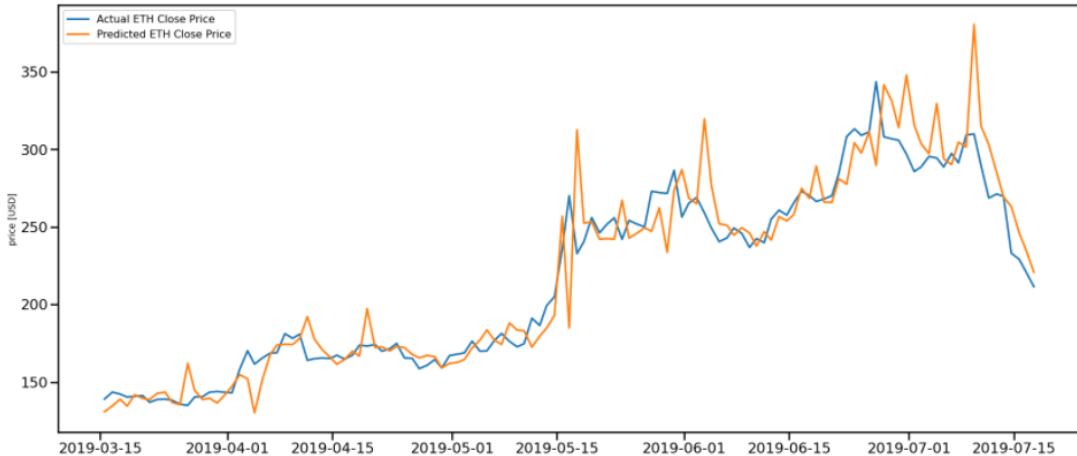


Figure 4.61: ETH(1d) dataset predition graphic 2.

	open	close	high	low	volume	Dom
time						
2017-01-02 04:06:40	8.1921	8.1991	8.1991	8.192100	0.400000	3.96
2017-01-03 02:20:00	8.3211	8.3211	8.3211	8.321100	0.757400	3.90
2017-01-04 03:20:00	10.4000	10.4000	10.4000	10.391000	266.558580	4.45
2017-01-05 04:20:00	11.4300	11.4300	11.4300	11.430000	28.677101	4.52
2017-01-06 02:33:20	9.9599	9.9599	9.9599	9.959900	0.100000	4.89
...	...	...	...	...	...	...
2019-07-13 15:00:00	269.6700	269.7200	269.7200	269.670000	16.843020	9.21
2019-07-14 16:00:00	233.0900	233.0200	233.2000	232.340000	229.364460	9.31
2019-07-15 17:00:00	229.2100	229.2000	229.4500	229.130000	27.586758	8.85
2019-07-16 15:13:20	220.9900	220.9700	221.1000	220.970000	39.743973	8.60
2019-07-17 16:13:20	212.0100	211.5000	212.0400	211.456104	194.600405	8.25

Figure 4.62: ETH(1d) dataset predition data table 2.

### 4.3.3. ETH(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance ,RSI

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

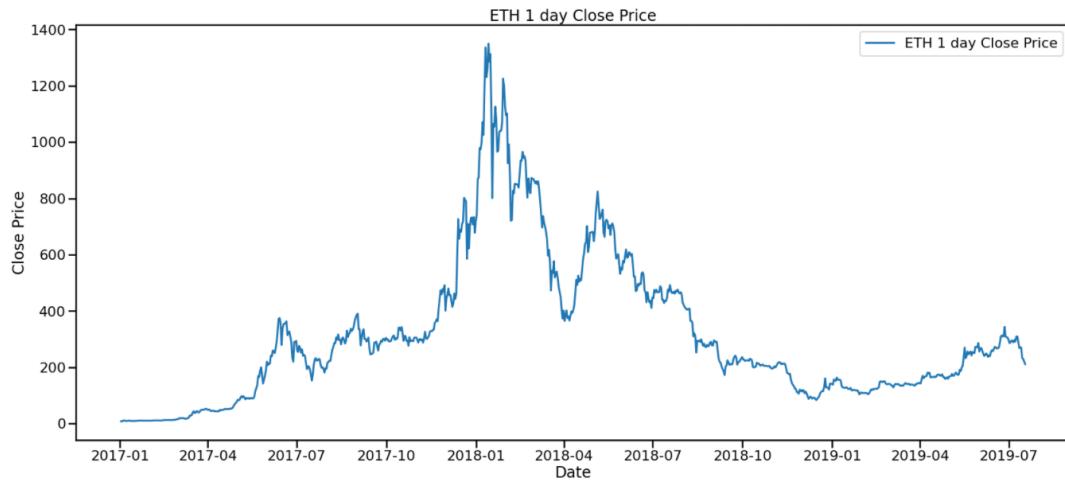


Figure 4.63: ETH(1d) dataset graphic 3.

	open	close	high	low	volume	RSI	Dom	BTC_Dom	edit
time									
2017-01-16 07:00:00	9.630	9.620	9.630	9.620000	32.177800	59.040990	5.60	83.23	
2017-01-17 08:00:00	9.704	9.704	9.704	9.704000	0.500000	59.507139	5.44	83.75	
2017-01-18 09:00:00	10.267	10.254	10.267	10.254000	9.443000	62.515277	5.40	83.50	
2017-01-19 07:13:20	10.266	10.266	10.266	10.266000	164.195000	62.580593	5.44	83.57	
2017-01-20 08:13:20	10.650	10.650	10.650	10.650000	18.000000	64.700277	5.38	83.63	
...	...	...	...	...	...	...	...	...	
2019-07-13 15:00:00	269.670	269.720	269.720	269.670000	16.843020	43.118146	9.21	55.83	
2019-07-14 16:00:00	233.090	233.020	233.200	232.340000	229.364460	32.730219	9.31	55.30	
2019-07-15 17:00:00	229.210	229.200	229.450	229.130000	27.586758	31.869568	8.85	56.07	
2019-07-16 15:13:20	220.990	220.970	221.100	220.970000	39.743973	30.037017	8.60	56.47	
2019-07-17 16:13:20	212.010	211.500	212.040	211.456104	194.600405	28.039095	8.25	57.79	

913 rows × 8 columns

Figure 4.64: ETH(1d) dataset data table 3.

Correlation of parameters used for closing price prediction

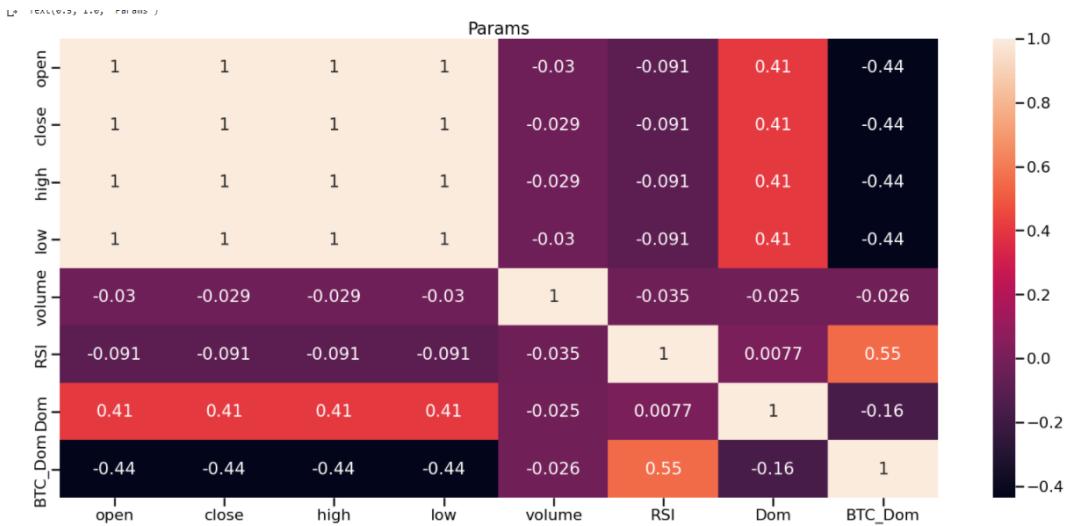


Figure 4.65: ETH(1d) dataset correlation 3.

Performance measurements of the model used for closing price prediction

Table 4.11: 1-day ETH Dataset LSTM Model Result 3.

Parameters	Quantity
Model Evaluate	2.08%
Mean Absolute Error	8.83%
Mean Squared Error	2.08%
$R^2$	71.78%

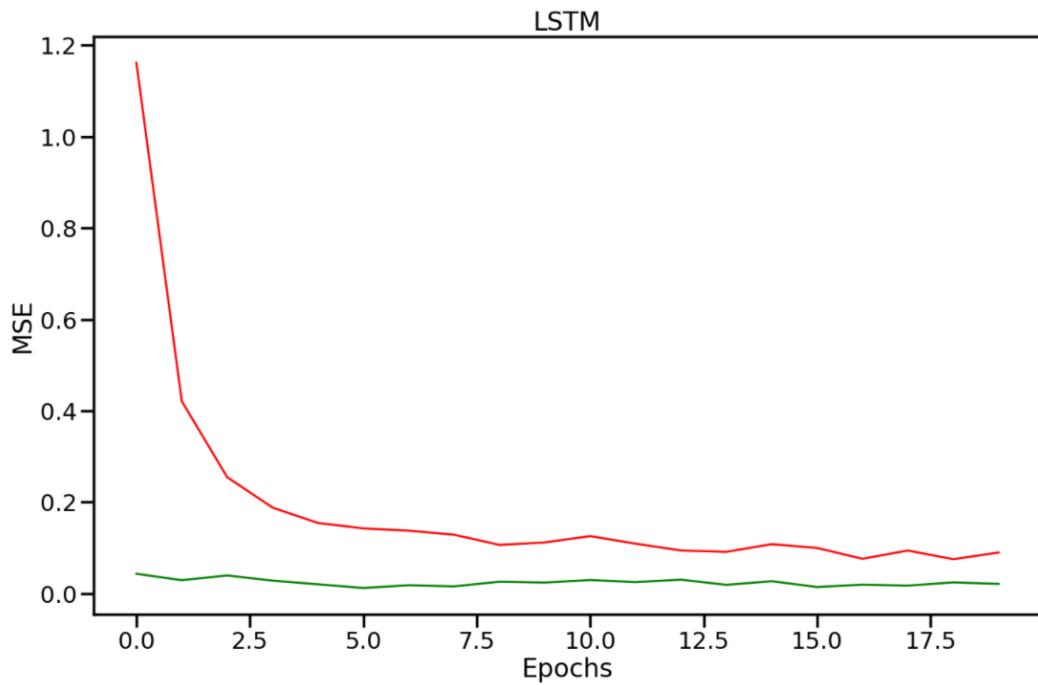


Figure 4.66: ETH(1d) dataset model epoch graphic 3.

#### Closing price estimation and test data display

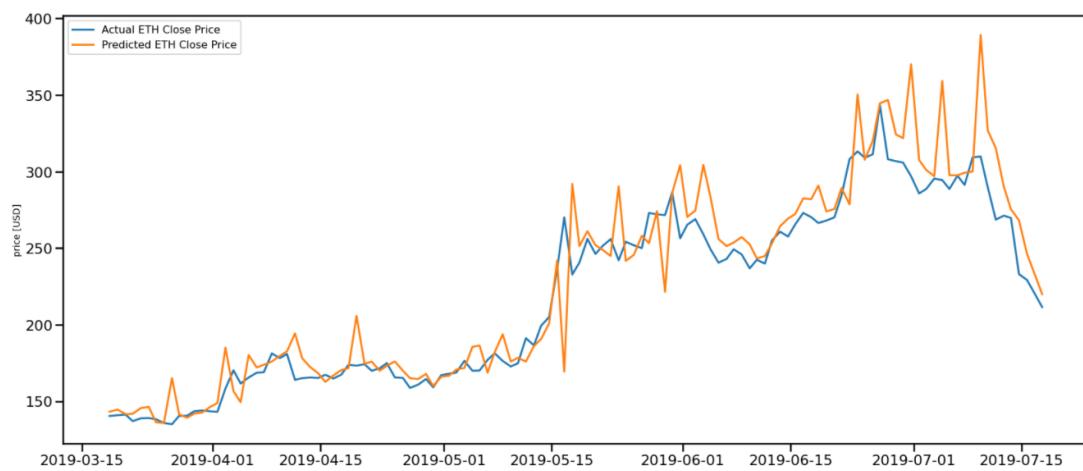


Figure 4.67: ETH(1d) dataset predition graphic 3.

#### 4.3.4. ETH(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance ,RSI, MACD

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

time	open	close	high	low	volume	RSI	Dom	BTC_Dom	Dom,RSI,BTC_dom
1/16/2017 7:00	9.63	9.62	9.63	9.62	32.1778	59.04099	5.6	83.23	
1/17/2017 8:00	9.704	9.704	9.704	9.704	0.5	59.50714	5.44	83.75	
1/18/2017 9:00	10.267	10.254	10.267	10.254	9.443	62.51528	5.4	83.5	
1/19/2017 7:13	10.266	10.266	10.266	10.266	164.195	62.58059	5.44	83.57	
7/13/2019 15:00	269.67	269.72	269.72	269.67	16.84302	43.11815	9.21	55.83	275.3353924
7/14/2019 16:00	233.09	233.02	233.2	232.34	229.3645	32.73022	9.31	55.3	268.2257727
7/15/2019 17:00	229.21	229.2	229.45	229.13	27.58676	31.86957	8.85	56.07	246.3146313
7/16/2019 15:13	220.99	220.97	221.1	220.97	39.74397	30.03702	8.6	56.47	233.9688118
7/17/2019 16:13	212.01	211.5	212.04	211.4561	194.6004	28.03909	8.25	57.79	219.9750576

Figure 4.68: ETH(1d) dataset predition data table 3.

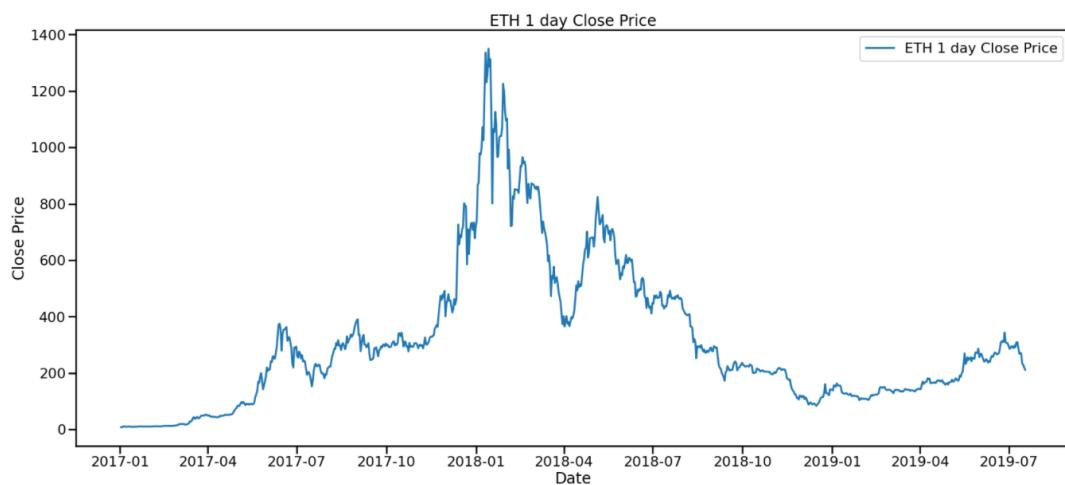


Figure 4.69: ETH(1d) dataset graphic 4.

time	open	close	high	low	volume	RSI	MACD	Dom	BTC_Dom	Dom,RSI,BTC_dom
2017-01-16 07:00:00	9.630	9.620	9.630	9.620000	32.177800	59.040990	0.365451	5.60	83.23	
2017-01-17 08:00:00	9.704	9.704	9.704	9.704000	0.500000	59.507139	0.340874	5.44	83.75	
2017-01-18 09:00:00	10.267	10.254	10.267	10.254000	9.443000	62.515277	0.361608	5.40	83.50	
2017-01-19 07:13:20	10.266	10.266	10.266	10.266000	164.195000	62.580593	0.374689	5.44	83.57	
2017-01-20 08:13:20	10.650	10.650	10.650	10.650000	18.000000	64.700277	0.411300	5.38	83.63	
...	...	...	...	...	...	...	...	...	...	...
2019-07-13 15:00:00	269.670	269.720	269.720	269.670000	16.843020	43.118146	0.541124	9.21	55.83	
2019-07-14 16:00:00	233.090	233.020	233.200	232.340000	229.364460	32.730219	-3.771899	9.31	55.30	
2019-07-15 17:00:00	229.210	229.200	229.450	229.130000	27.586758	31.869568	-7.412792	8.85	56.07	
2019-07-16 15:13:20	220.990	220.970	221.100	220.970000	39.743973	30.037017	-10.837392	8.60	56.47	
2019-07-17 16:13:20	212.010	211.500	212.040	211.456104	194.600405	28.039095	-14.152422	8.25	57.79	
...	...	...	...	...	...	...	...	...	...	...

Figure 4.70: ETH(1d) dataset data table 4.

### Correlation of parameters used for closing price prediction

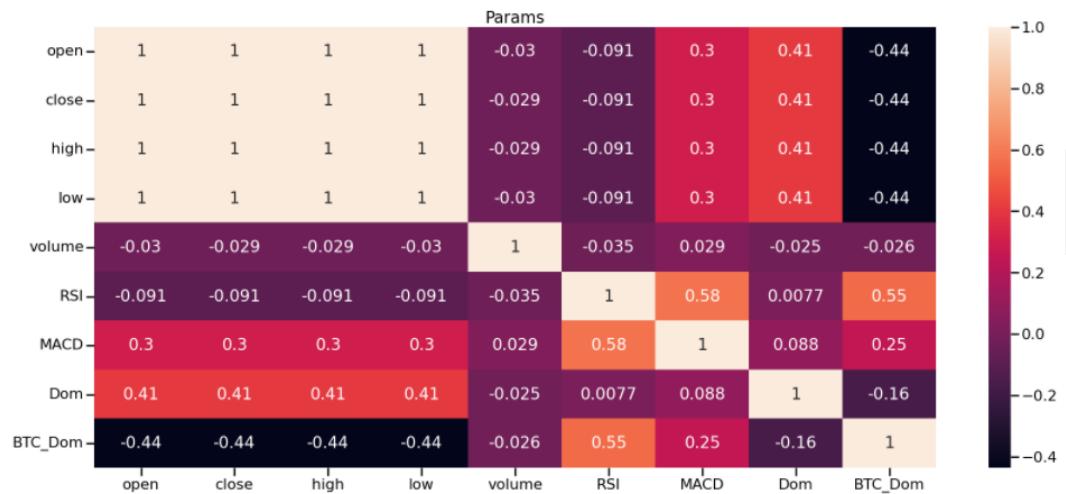


Figure 4.71: ETH(1d) dataset correlation 4.

Performance measurements of the model used for closing price prediction

Table 4.12: 1-day ETH Dataset LSTM Model Result 4.

Parameters	Quantity
Model Evaluate	4.62%
Mean Absolute Error	12.38%
Mean Squared Error	4.62%
$R^2$	37.34%

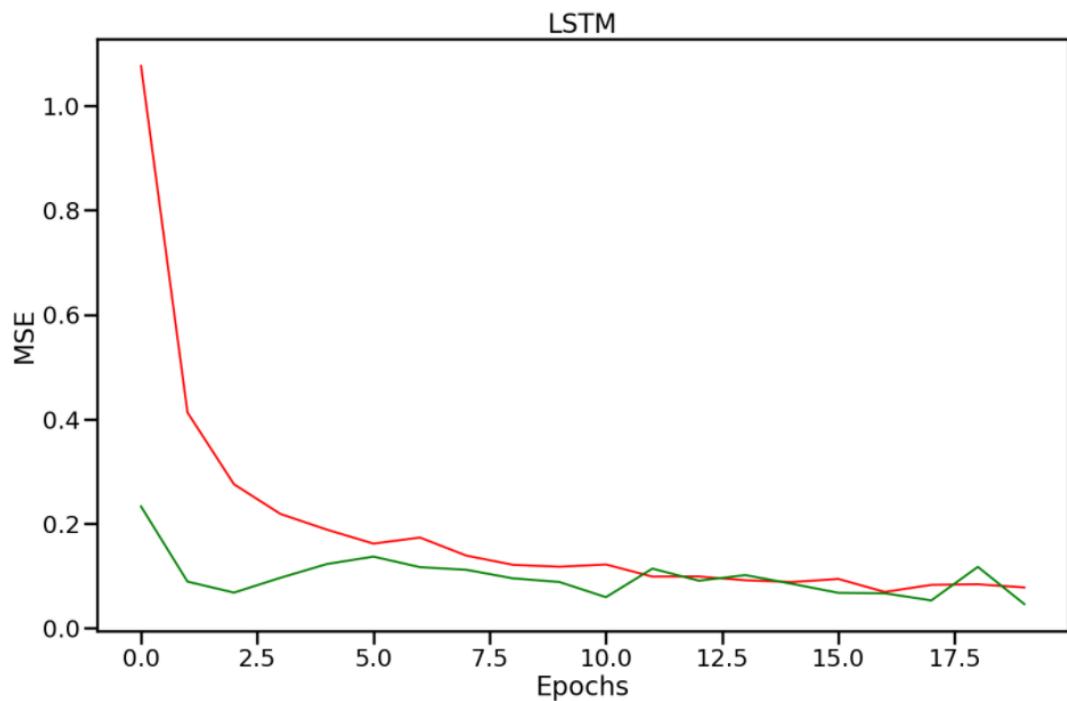


Figure 4.72: ETH(1d) dataset model epoch graphic 4.

### Closing price estimation and test data display

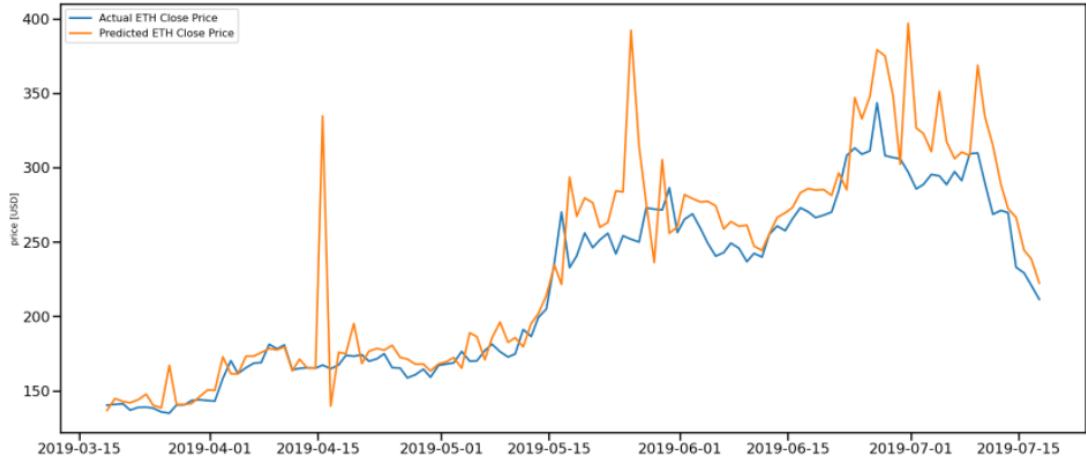


Figure 4.73: ETH(1d) dataset predition graphic 4.

time	open	close	high	low	volume	RSI	MACD	Dom	BTC_Dom	Dom_BTC_Dom_RSI_MACD_Predict
1/16/2017 7:00	9.63	9.62	9.63	9.62	32.1778	59.04099	0.365451	5.6	83.23	
1/17/2017 8:00	9.704	9.704	9.704	9.704	0.5	59.50714	0.340874	5.44	83.75	
1/18/2017 9:00	10.267	10.254	10.267	10.254	9.443	62.51528	0.361608	5.4	83.5	
1/19/2017 7:13	10.266	10.266	10.266	10.266	164.195	62.58059	0.374689	5.44	83.57	
1/20/2017 8:13	10.65	10.65	10.65	10.65	18	64.70028	0.4113	5.38	83.63	
7/13/2019 15:00	269.67	269.72	269.72	269.67	16.84302	43.11815	0.541124	9.21	55.83	272.4832201
7/14/2019 16:00	233.09	233.02	233.2	232.34	229.3645	32.73022	-3.7719	9.31	55.3	266.6057073
7/15/2019 17:00	229.21	229.2	229.45	229.13	27.58676	31.86957	-7.41279	8.85	56.07	244.4504484
7/16/2019 15:13	220.99	220.97	221.1	220.97	39.74397	30.03702	-10.8374	8.6	56.47	238.714223
7/17/2019 16:13	212.01	211.5	212.04	211.4561	194.6004	28.03909	-14.1524	8.25	57.79	222.4347063

Figure 4.74: ETH(1d) dataset predition data table 4.

### 4.3.5. ETH(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance, RSI, MACD, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

Correlation of parameters used for closing price prediction

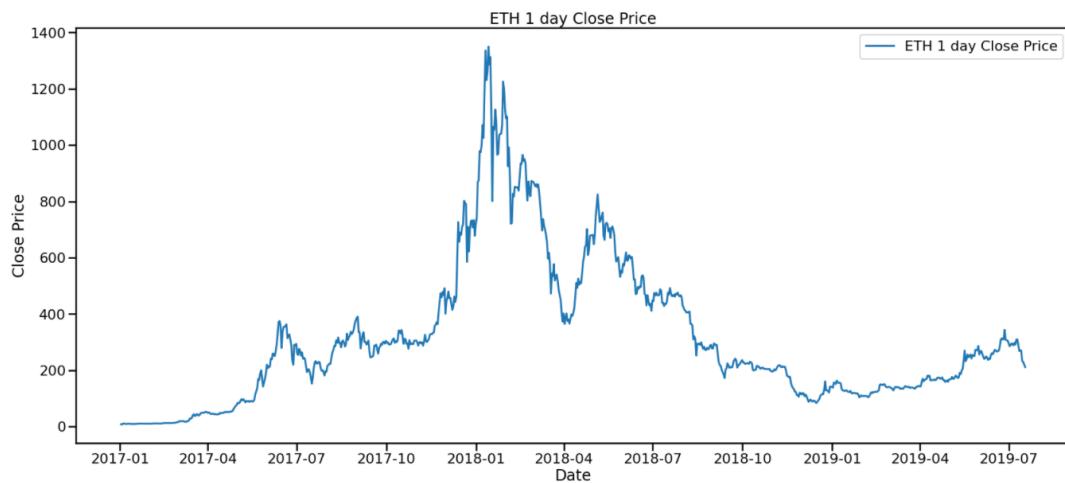


Figure 4.75: ETH(1d) dataset graphic 5.

time	open	close	high	low	volume	RSI	MACD	DOM	BTG_DOM	ma7	ma21	26ema	12ema	28sd	upper_band	lower_band	ema	momentum	log_momentum
2017-01-22 10:13:20	10.914	10.914	10.914	10.914000	18.444568	65.954171	0.149160	5.51	83.42	10.285286	9.967452	10.106283	10.255443	0.768338	11.500129	0.434776	10.795745	9.914	2.293948
2017-01-23 08:26:40	10.726	10.726	10.726	10.726000	1.000000	63.877195	0.167184	5.47	83.60	10.443286	10.087781	10.182535	10.329719	0.666699	11.421179	8.754383	10.748248	9.726	2.274803
2017-01-24 09:26:40	10.631	10.631	10.631	10.631000	2.981180	62.800963	0.172728	5.43	84.34	10.575714	10.197776	10.204559	10.377086	0.538962	11.275700	9.119853	10.670416	9.631	2.264987
2017-01-25 10:26:40	10.433	10.433	10.433	10.433000	79.722800	60.512563	0.161380	5.44	84.53	10.601236	10.199348	10.224466	10.38547	0.539629	11.278605	9.120091	10.512139	9.433	2.244214
2017-01-26 08:40:00	10.511	10.511	10.511	10.511000	467.037556	61.113704	0.156081	5.47	84.75	10.636266	10.155586	10.249320	10.405401	0.467246	11.090079	9.221093	10.511380	9.511	2.252449
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2019-07-13 15:00:00	269.670	269.720	269.720	269.670000	16.843020	43.110146	0.541124	9.21	55.83	207.103122	297.831436	266.043225	266.584349	17.240986	332.313408	263.349464	270.934758	268.720	5.593670
2019-07-14 16:00:00	233.090	233.020	233.200	232.340000	229.364468	32.730219	-3.771899	9.31	55.30	278.781694	294.014293	282.115579	278.343680	21.913459	337.841211	250.187375	245.682533	232.020	5.446824
2019-07-15 17:00:00	229.210	229.200	229.450	229.130000	27.586758	31.869568	-7.412792	8.85	56.07	267.337408	290.212684	278.195906	270.783114	25.764265	341.741394	236.684335	234.686084	228.200	5.430222
2019-07-16 15:13:20	220.990	220.970	221.100	220.970000	39.743973	30.037017	-10.837392	8.60	56.47	254.644551	285.913541	273.956950	263.119558	29.359270	344.631881	227.194800	225.542028	219.970	5.393491
2019-07-17 16:13:20	212.010	211.500	212.040	211.456104	194.600405	28.039095	-14.152422	8.25	57.79	243.463122	279.628103	269.330509	255.178087	30.522140	340.672382	218.583823	216.180676	210.500	5.349486

Figure 4.76: ETH(1d) dataset table 5.

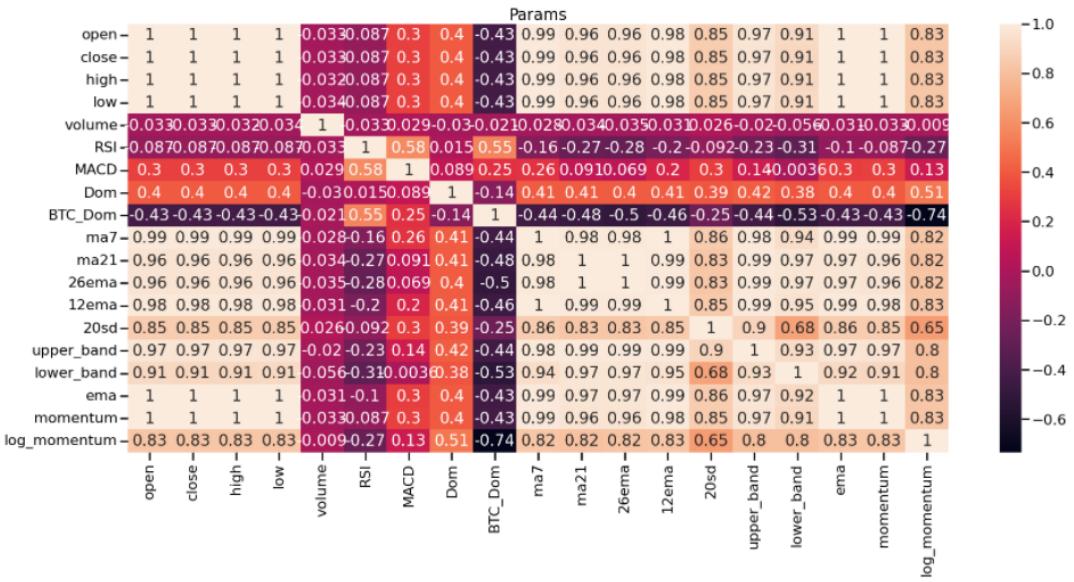


Figure 4.77: ETH(1d) dataset correlation 5.

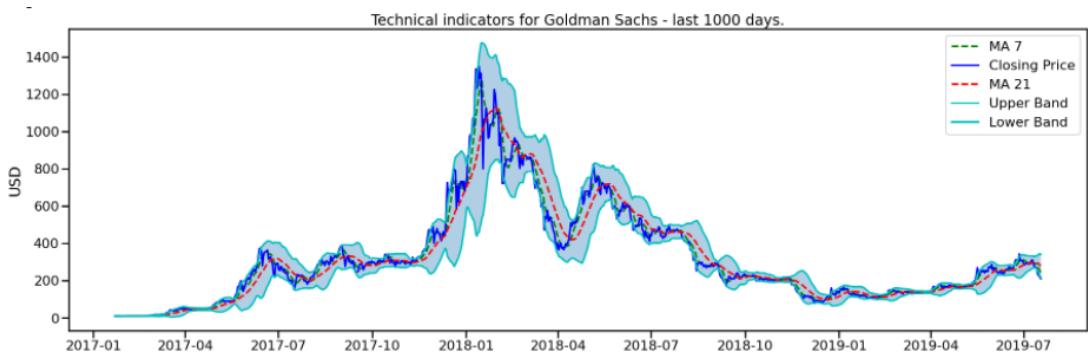


Figure 4.78: ETH(1d) dataset indicator1 5.

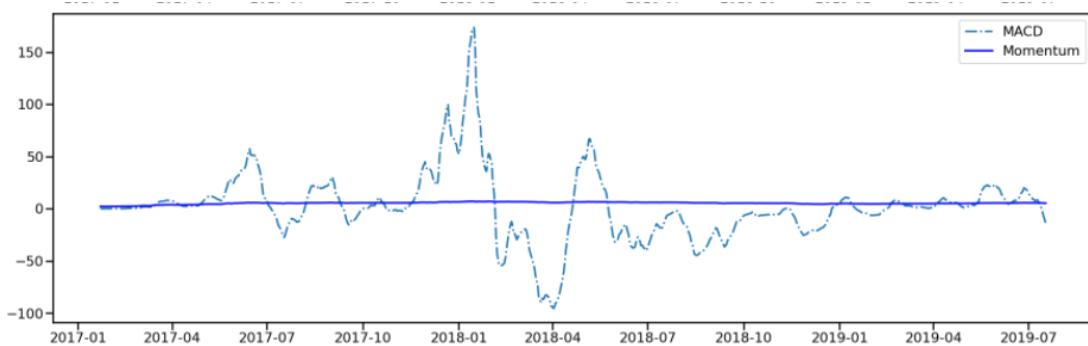


Figure 4.79: ETH(1d) dataset indicator2 5.

Performance measurements of the model used for closing price prediction

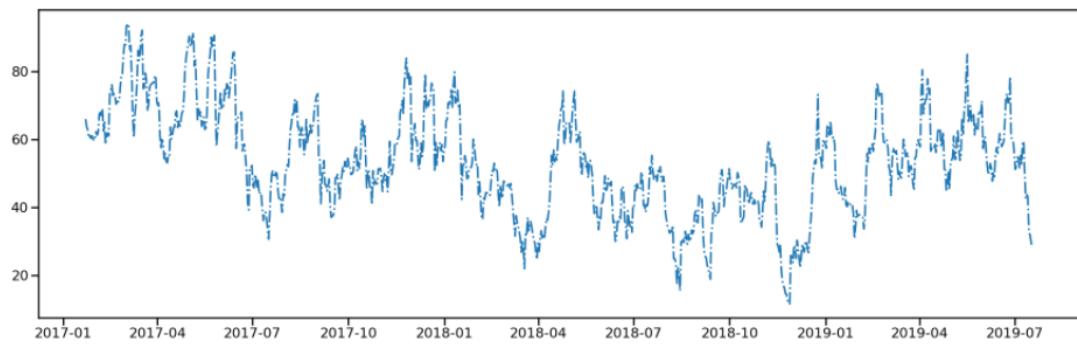


Figure 4.80: ETH(1d) dataset indicator3 5.

Table 4.13: ETH(1d) Dataset LSTM Model Result 5.

Parameters	Quantity
Model Evaluate	7.97%
Mean Absolute Error	15.53%
Mean Squared Error	7.97%
$R^2$	8.49%

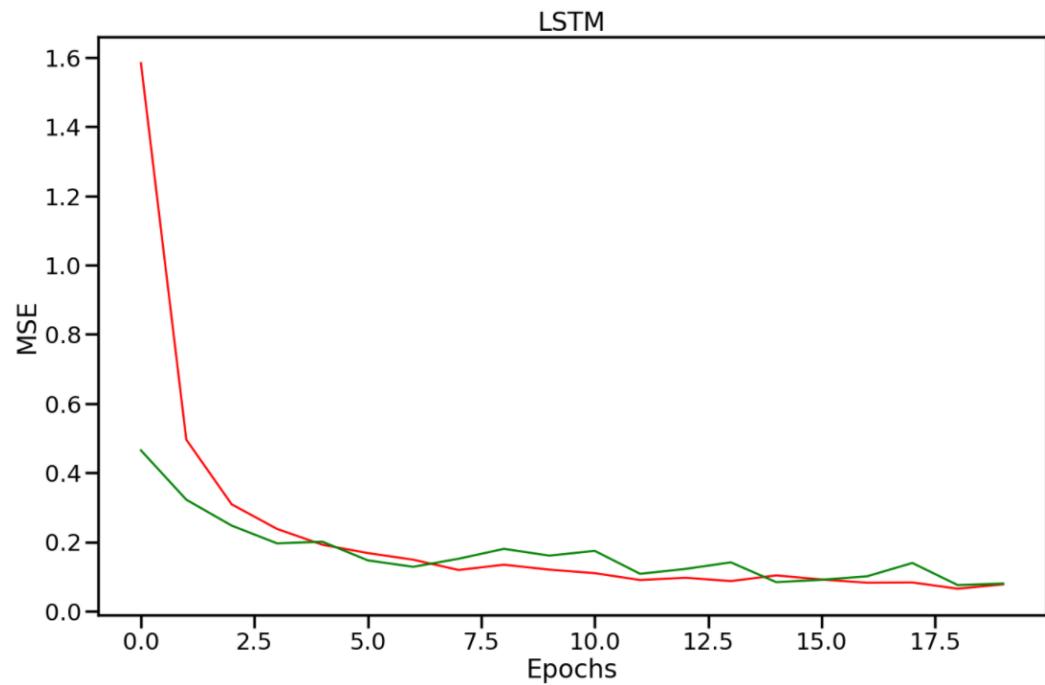


Figure 4.81: ETH(1d) dataset model epoch graphic 5.

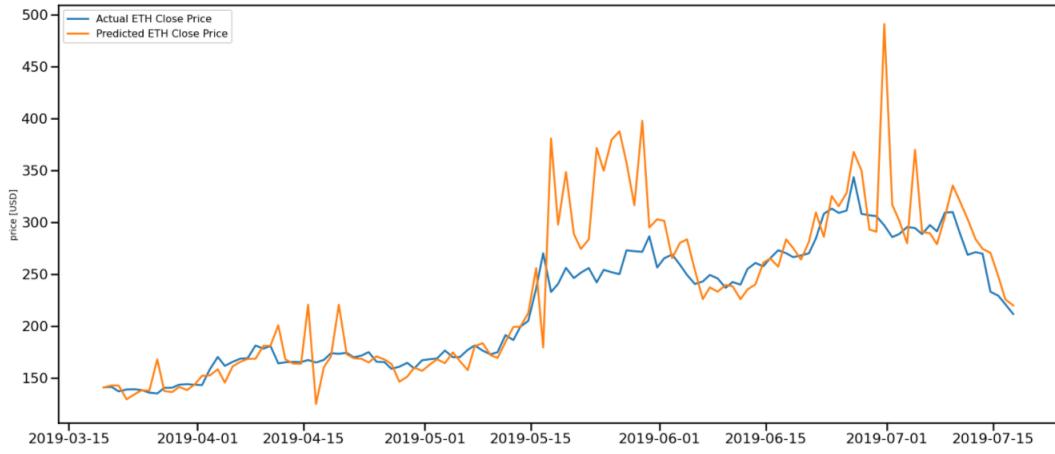


Figure 4.82: ETH(1d) dataset predition graphic 5.

time	open	close	high	low	volume	RSI	MACD	Dom	BTC_Dom	ma7	ma21	26ema	12ema	20sd	upper_band	lower_band	ema	momentum	log_momentum	ALL_Indicators_Predict
1/22/2017 10:13	10.914	10.914	10.914	10.914	18,4457	65.95417	0.14916	5.51	83.42	10.28529	9.967452	10.10628	10.25544	0.766338	11.15001286	8.434776166	10.79574	9.914	2.2939479	
1/23/2017 8:26	10.726	10.726	10.726	10.726	1	63.87719	0.167184	5.47	83.6	10.44329	10.08778	10.16253	10.32972	0.666699	11.4211782	8.754383181	10.7925	9.726	2.274802712	
1/24/2017 9:26	10.631	10.631	10.631	10.631	2,98118	62.80096	0.172726	5.43	84.34	10.57571	10.19778	10.20436	10.37709	0.538962	11.27869969	9.119852694	10.67042	9.631	2.264987063	
1/25/2017 10:26	10.433	10.433	10.433	10.433	79.7228	60.51256	0.16138	5.44	84.53	10.60129	10.19935	10.22447	10.38585	0.539629	11.2786047	9.120090538	10.51214	9.433	2.24421418	
1/26/2017 8:40	10.511	10.511	10.511	10.511	467.0376	61.1137	0.156081	5.47	84.75	10.63629	10.15559	10.24932	10.4054	0.467246	11.09007851	9.221092914	10.51138	9.511	2.252449024	
7/12/2019 16:46	271.2	271.21	271.21	271.2	1,514188	43.64031	2.301512	9.2	55.4	291.0431	299.6614	287.3491	289.6506	16.11044	331.8823146	267.4405572	273.3643	270.21	5.599199434	283.7339
7/13/2019 15:00	269.67	269.72	269.72	269.67	16.84302	43.11815	0.541124	9.21	55.83	287.1031	297.8314	286.0432	286.5843	17.24099	332.3134082	263.3494635	270.9348	268.72	5.593669945	274.389
7/14/2019 16:00	233.09	233.02	233.2	232.34	229.3645	32.73022	-3.7719	9.31	55.3	278.7817	294.0143	282.1156	278.3437	21.91346	337.841211	250.187375	245.6583	232.02	5.446823575	270.5433
7/15/2019 17:00	229.21	229.2	229.45	229.13	27.58676	31.86957	-7.41279	8.85	56.07	267.3374	290.2129	278.1959	270.7831	25.76426	341.741394	238.6843349	234.6861	228.2	5.430222437	247.7958
7/16/2019 15:13	220.99	220.97	221.1	220.97	39.74397	30.03702	-10.8374	8.6	56.47	254.6446	285.9133	273.957	263.1196	29.35927	344.6118814	227.1947999	225.542	219.97	5.393491173	225.6796
7/17/2019 16:13	212.01	211.5	212.04	211.4561	194.6004	28.03909	-14.1524	8.25	57.79	243.4631	279.6281	269.3305	255.1781	30.52214	340.6723817	218.5838233	216.1807	210.5	5.349485653	219.7791

Figure 4.83: ETH(1d) dataset predition data table 5.

## 4.4. Closing price prediction with Ethereum 12-hour data

4 datasets were created for the Etherium 12-hour dataset.

These datasets are:

- ETH : Open Price, Close Price, High Price, Low Price, Volume
- ETH : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD
- ETH : Open Price, Close Price, High Price, Low Price, Volume, BTC Close Price, RSI, MACD
- ETH : Open Price, Close Price, High Price, Low Price, Volume, BTC Close Price, RSI, MACD, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

#### 4.4.1. ETH(12h) : Open Price, Close Price, High Price, Low Price, Volume

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

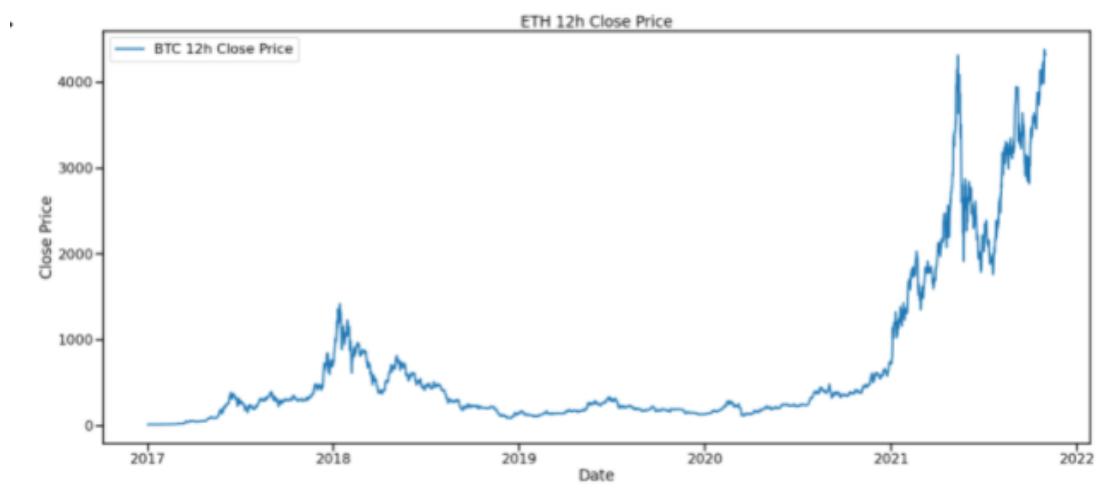


Figure 4.84: ETH(12h) dataset graphic 1.

	time	open	close	high	low	volume	edit
2017-01-01 17:00:00	8.315000	8.3493	8.349300	8.3150	56.016253		
2017-01-02 04:06:40	8.243800	8.2438	8.243800	8.2438	50.000000		
2017-01-02 15:13:20	8.306000	8.2867	8.306000	8.2867	22.281001		
2017-01-03 05:06:40	8.384200	8.3853	8.385300	8.3842	50.000000		
2017-01-03 16:13:20	9.360000	9.3700	9.370000	9.3540	8.633489		
...	...	...	...	...	...	...	
2021-10-29 06:46:40	4351.400000	4351.0000	4352.400000	4350.4000	20.273773		
2021-10-29 17:53:20	4384.100000	4377.2000	4384.853941	4377.2000	20.760971		
2021-10-30 07:46:40	4367.000000	4366.1000	4367.000000	4365.5000	2.715031		
2021-10-30 18:53:20	4312.262613	4311.9000	4312.300000	4311.5000	0.258500		
2021-10-31 06:00:00	4312.700000	4316.3000	4316.300000	4312.7000	11.230354		

Figure 4.85: ETH(12h) dataset table 1.

### Correlation of parameters used for closing price prediction

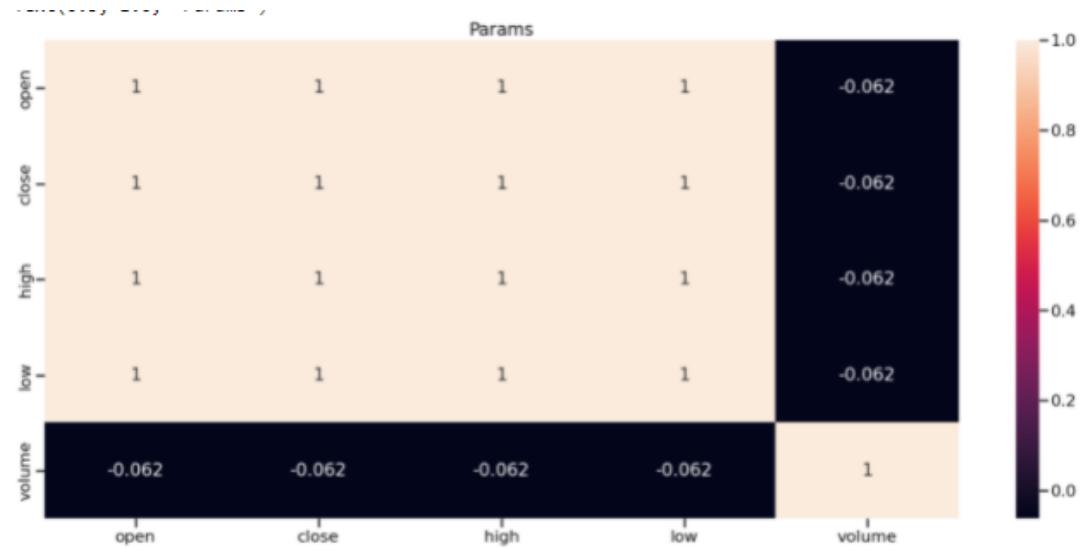


Figure 4.86: ETH(12h) dataset correlation 1.

Performance measurements of the model used for closing price prediction

Table 4.14: ETH(12h) Dataset LSTM Model Result 1.

Parameters	Quantity
Model Evaluate	0.84%
Mean Absolute Error	5.05%
Mean Squared Error	0.84%
$R^2$	93.49%

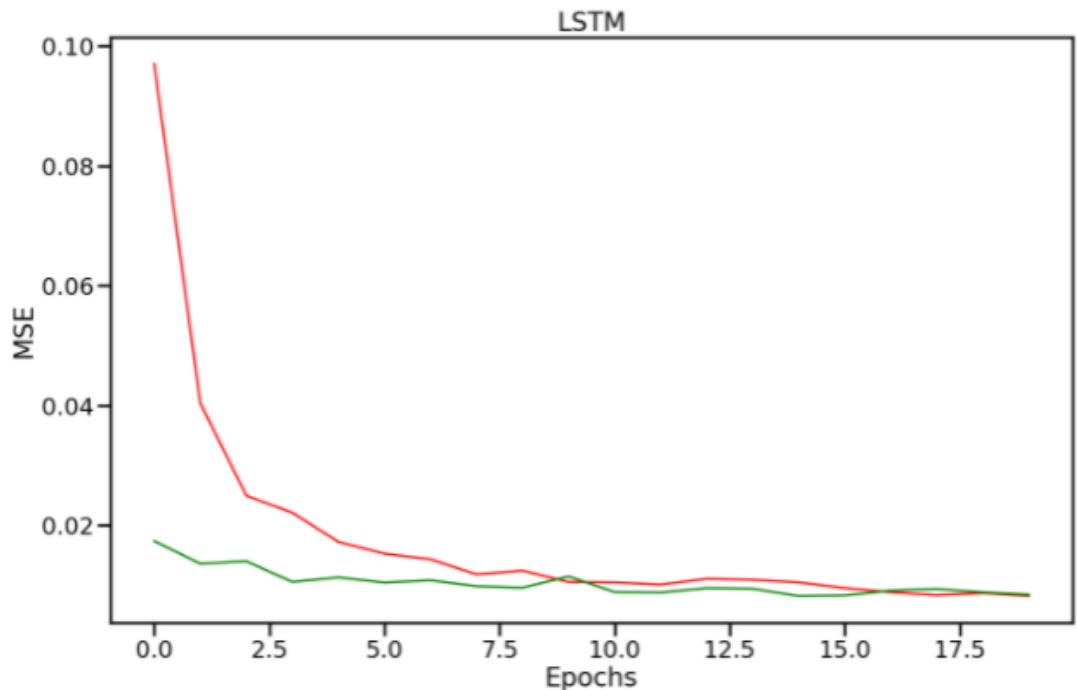


Figure 4.87: ETH(12h) dataset model epoch graphic 1.

#### 4.4.2. ETH(12h) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

Correlation of parameters used for closing price prediction

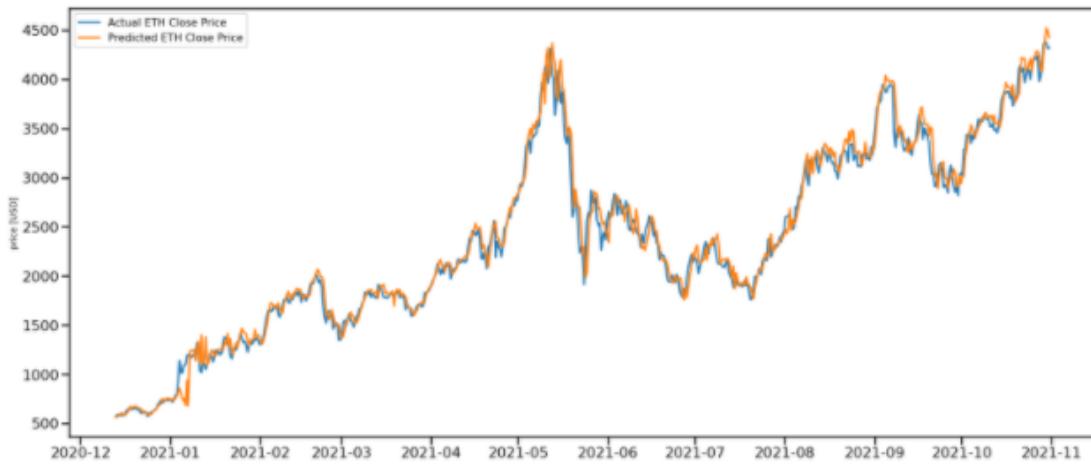


Figure 4.88: ETH(12h) dataset predition graphic 1.

time	open	close	high	low	volume	Classic_prediction
1/1/2017 17:00	8.315	8.3493	8.3493	8.315	56.01625	
1/2/2017 4:06	8.2438	8.2438	8.2438	8.2438	50	
1/2/2017 15:13	8.306	8.2867	8.306	8.2867	22.281	
1/3/2017 5:06	8.3842	8.3853	8.3853	8.3842	50	
10/28/2021 19:40	4172.8	4167.7	4173.9	4161.851	32.05534	4076.592024
10/29/2021 6:46	4351.4	4351	4352.4	4350.4	20.27377	4253.925564
10/29/2021 17:53	4384.1	4377.2	4384.854	4377.2	20.76097	4415.02266
10/30/2021 7:46	4367	4366.1	4367	4365.5	2.715031	4520.789743
10/30/2021 18:53	4312.263	4311.9	4312.3	4311.5	0.2585	4484.133721
10/31/2021 6:00	4312.7	4316.3	4316.3	4312.7	11.23035	4423.535338

Figure 4.89: ETH(12h) dataset predition data table 1.

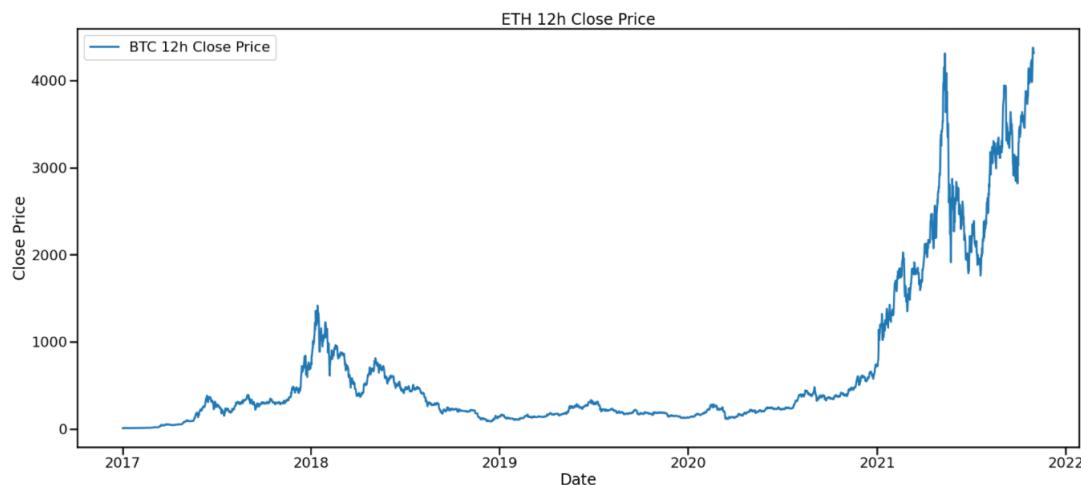


Figure 4.90: ETH(12h) dataset graphic 2.

		open	close	high	low	volume	RSI	MACD
	time							
	2017-01-08 15:40:00	10.222000	10.230	10.230000	10.222	29.612959	65.110636	0.468941
	2017-01-09 05:33:20	10.306000	10.306	10.306000	10.306	32.386800	65.563544	0.470187
	2017-01-09 16:40:00	10.729000	10.661	10.729000	10.661	280.358650	67.674420	0.494125
	2017-01-10 03:46:40	10.450000	10.450	10.450000	10.450	133.157114	65.119405	0.490416
	2017-01-10 17:40:00	10.577000	10.577	10.577000	10.577	0.856963	65.952623	0.492053
	...	...	...	...	...	...	...	...
	2021-10-29 06:46:40	4351.400000	4351.000	4352.400000	4350.400	20.273773	65.187391	114.683966
	2021-10-29 17:53:20	4384.100000	4377.200	4384.853941	4377.200	20.760971	65.986587	125.489797
	2021-10-30 07:46:40	4367.000000	4366.100	4367.000000	4365.500	2.715031	65.302591	131.640350
	2021-10-30 18:53:20	4312.262613	4311.900	4312.300000	4311.500	0.258500	61.927081	130.635338
	2021-10-31 06:00:00	4312.700000	4316.300	4316.300000	4312.700	11.230354	62.098361	128.710211

3512 rows × 7 columns

Figure 4.91: ETH(12h) dataset table 2.



Figure 4.92: ETH(12h) dataset correlation 2.

Performance measurements of the model used for closing price prediction

Table 4.15: ETH(12h) Dataset LSTM Model Result 2.

Parameters	Quantity
Model Evaluate	1.17%
Mean Absolute Error	5.59%
Mean Squared Error	1.17%
$R^2$	90.96%

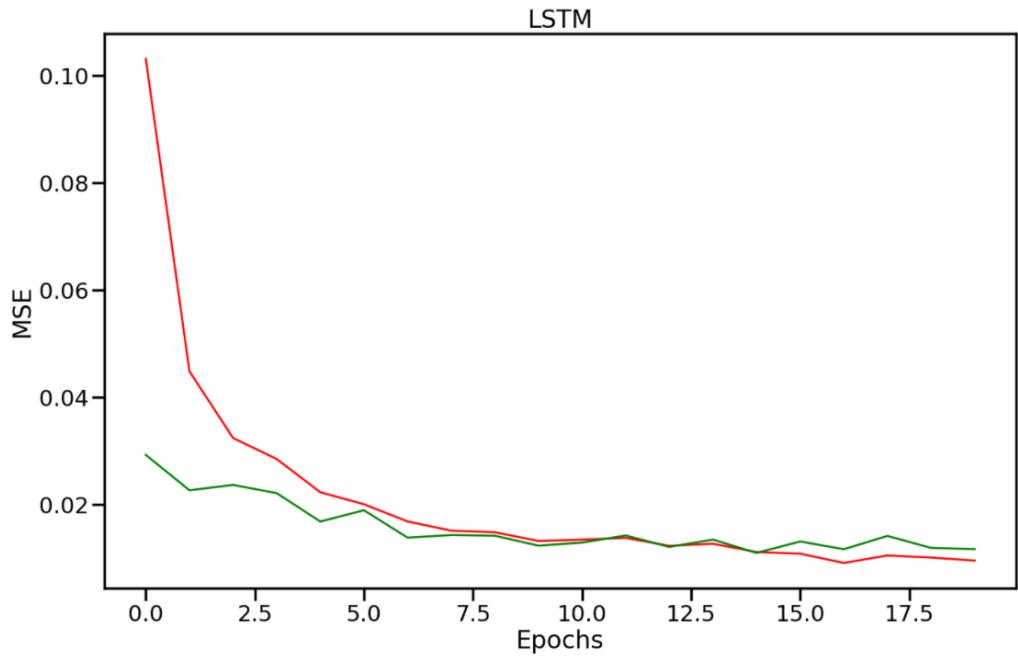


Figure 4.93: ETH(12h) dataset model epoch graphic 2.



Figure 4.94: ETH(12h) dataset prediction graphic 2.

#### 4.4.3. ETH(12h) : Open Price, Close Price, High Price, Low Price, Volume, BTC Close Price, RSI, MACD

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

Correlation of parameters used for closing price prediction

time	open	close	high	low	volume	RSI	MACD	RSI_MACD_prediction
1/8/2017 15:40	10.222	10.23	10.23	10.222	29.61296	65.11064	0.468941	
1/9/2017 5:33	10.306	10.306	10.306	10.306	32.3868	65.56354	0.470187	
1/9/2017 16:40	10.729	10.661	10.729	10.661	280.3587	67.67442	0.494125	
1/10/2017 3:46	10.45	10.45	10.45	10.45	133.1571	65.11941	0.490416	
10/29/2021 6:46	4351.4	4351	4352.4	4350.4	20.27377	65.18739	114.684	4121.907488
10/29/2021 17:53	4384.1	4377.2	4384.854	4377.2	20.76097	65.98659	125.4898	4270.801407
10/30/2021 7:46	4367	4366.1	4367	4365.5	2.715031	65.30259	131.6404	4410.436215
10/30/2021 18:53	4312.263	4311.9	4312.3	4311.5	0.2585	61.92708	130.6353	4345.918929
10/31/2021 6:00	4312.7	4316.3	4316.3	4312.7	11.23035	62.09836	128.7102	4277.911709

Figure 4.95: ETH(12h) dataset predition data table 2.

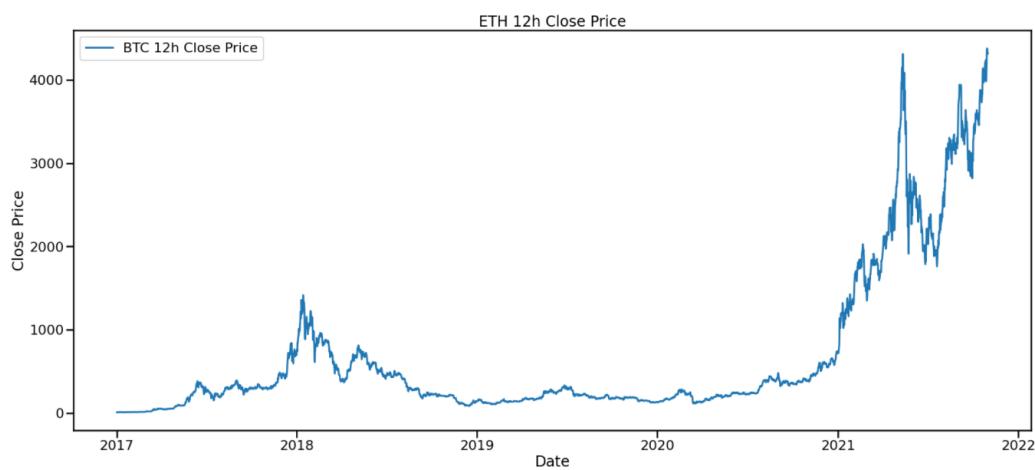


Figure 4.96: ETH(12h) dataset graphic 3.

time	open	close	high	low	volume	RSI	MACD	BTC_Close
2017-01-08 15:40:00	10.222000	10.230	10.230000	10.222	29.612959	65.110636	0.468941	934.80000
2017-01-09 05:33:20	10.306000	10.306	10.306000	10.306	32.386800	65.563544	0.470187	909.90000
2017-01-09 16:40:00	10.729000	10.661	10.729000	10.661	280.358650	67.674420	0.494125	886.13000
2017-01-10 03:46:40	10.450000	10.450	10.450000	10.450	133.157114	65.119405	0.490416	900.35000
2017-01-10 17:40:00	10.577000	10.577	10.577000	10.577	0.856963	65.952623	0.492053	913.21000
...	...	...	...	...	...	...	...	...
2021-10-29 06:46:40	4351.400000	4351.000	4352.400000	4350.400	20.273773	65.187391	114.683966	58882.00000
2021-10-29 17:53:20	4384.100000	4377.200	4384.853941	4377.200	20.760971	65.986587	125.489797	60905.00000
2021-10-30 07:46:40	4367.000000	4366.100	4367.000000	4365.500	2.715031	65.302591	131.640350	61087.00000
2021-10-30 18:53:20	4312.262613	4311.900	4312.300000	4311.500	0.258500	61.927081	130.635338	62556.00000
2021-10-31 06:00:00	4312.700000	4316.300	4316.300000	4312.700	11.230354	62.098361	128.710211	61615.28625

3512 rows × 8 columns

Figure 4.97: ETH(12h) dataset table 3.

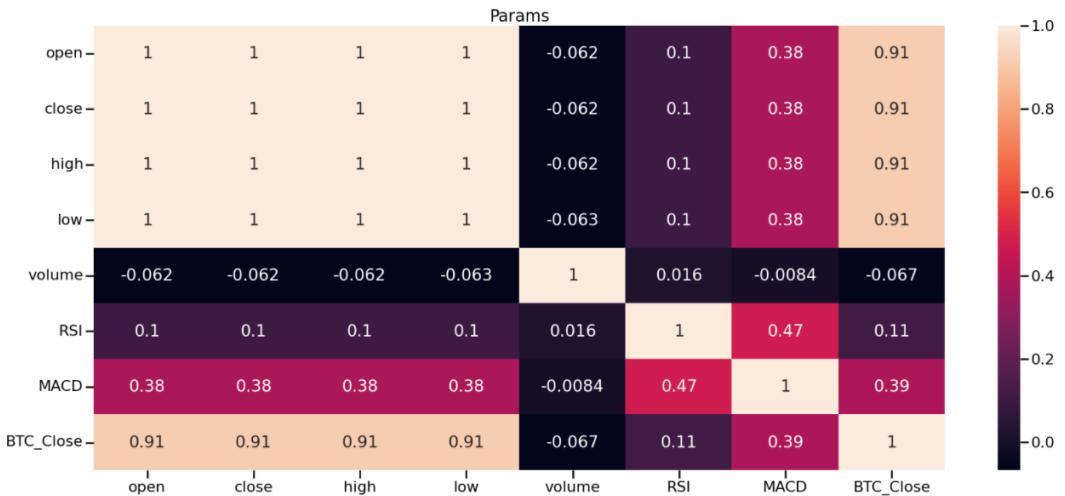


Figure 4.98: ETH(12h) dataset correlation 3.

Performance measurements of the model used for closing price prediction

Table 4.16: ETH(12h) Dataset LSTM Model Result 3.

Parameters	Quantity
Model Evaluate	1.22%
Mean Absolute Error	5.42%
Mean Squared Error	1.22%
$R^2$	90.54%

#### 4.4.4. ETH(12h) : Open Price, Close Price, High Price, Low Price, Volume, BTC Close Price, RSI, MACD, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

Correlation of parameters used for closing price prediction

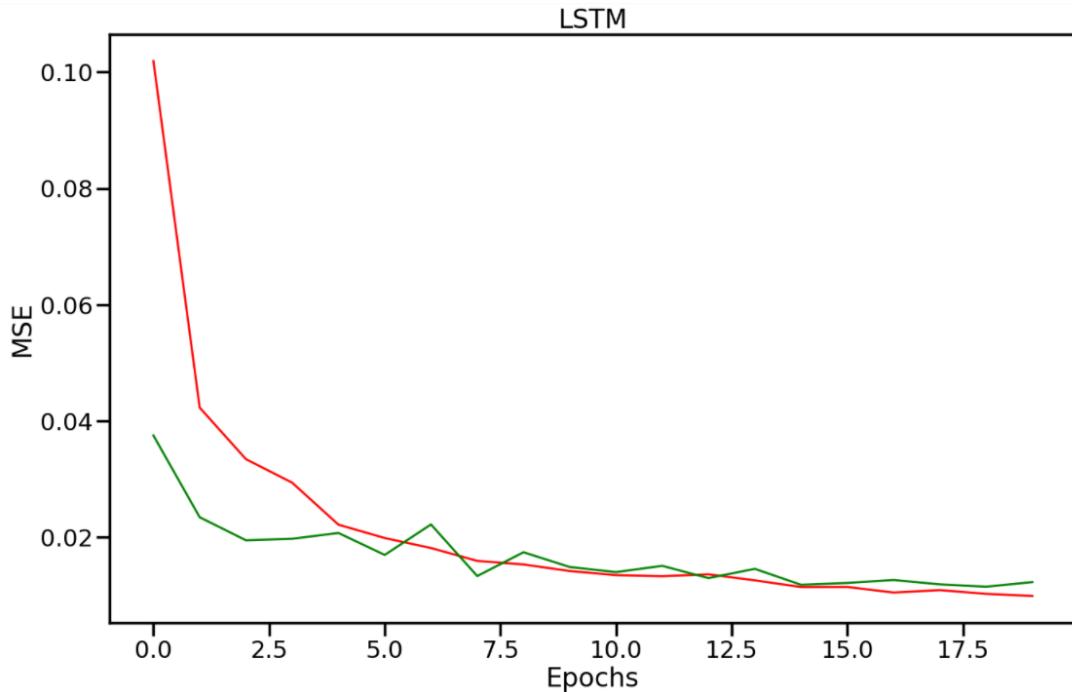


Figure 4.99: ETH(12h) dataset model epoch graphic 3.



Figure 4.100: ETH(12h) dataset prediction graphic 3.

time	open	close	high	low	volume	RSI	MACD	BTC_Close	RSI_MACD_BTC_Close_prediction
1/8/2017 15:40	10.222	10.23	10.23	10.222	29.61296	65.11064	0.468941	934.8	
1/9/2017 5:33	10.306	10.306	10.306	10.306	32.3868	65.56354	0.470187	909.9	
1/9/2017 16:40	10.729	10.661	10.729	10.661	280.3587	67.67442	0.494125	886.13	
1/10/2017 3:46	10.45	10.45	10.45	10.45	133.1571	65.11941	0.490416	900.35	
1/10/2017 17:40	10.577	10.577	10.577	10.577	0.856963	65.95262	0.492053	913.21	
10/29/2021 6:46	4351.4	4351	4352.4	4350.4	20.27377	65.18739	114.684	58882	4083.914917
10/29/2021 17:53	4384.1	4377.2	4384.854	4377.2	20.76097	65.98659	125.4898	60905	4276.857209
10/30/2021 7:46	4367	4366.1	4367	4365.5	2.715031	65.30259	131.6404	61087	4401.559649
10/30/2021 18:53	4312.263	4311.9	4312.3	4311.5	0.2585	61.92708	130.6353	62556	4382.167175
10/31/2021 6:00	4312.7	4316.3	4316.3	4312.7	11.23035	62.09836	128.7102	61615.28625	4311.290251

Figure 4.101: ETH(12h) dataset prediction data table 3.

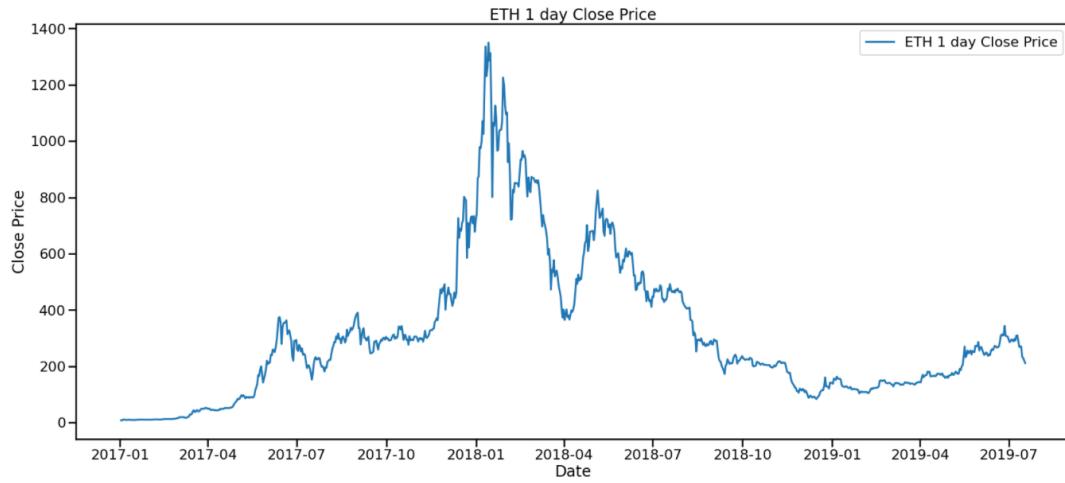


Figure 4.102: ETH(12h) dataset graphic 4.

time	open	close	high	low	volume	RSI	BTC_Clos	ma7	ma21	26ema	12ema	MACD	20sd	upper_band	lower_band	em	momentum	log_momentum
2017-01-11 15:53:20	9.888100	9.8508	9.888100	9.8508	37.450436	56.709630	856.00000	10.389114	9.898962	10.111027	10.243058	0.132031	0.897969	11.694900	8.103024	10.105084	8.8508	2.180508
2017-01-12 05:46:40	9.413000	9.4130	9.413000	9.4130	120.108262	52.193726	788.23000	10.272400	9.949614	10.047666	10.112036	0.064369	0.833900	11.617415	8.251813	9.643695	8.4130	2.129778
2017-01-12 16:53:20	9.750000	9.7431	9.750000	9.7431	25.000523	55.097186	764.37000	10.191986	10.021010	10.024975	10.054033	0.033558	0.739378	11.499766	8.542253	9.709965	8.7431	2.168285
2017-01-13 04:00:00	9.471000	9.5300	9.530000	9.4710	27.282000	52.865043	826.60000	10.030414	10.080214	9.977341	9.971922	-0.05419	0.636131	11.352476	8.807952	9.599988	8.5300	2.143589
2017-01-13 17:53:20	9.600000	9.60000	9.600000	9.6000	1.000000	53.531013	803.84000	9.908986	10.138057	9.944611	9.913811	-0.030800	0.518894	11.175445	9.100670	9.596663	8.6000	2.151762
...																		
2021-10-29 06:46:40	4351.400000	4351.00000	4352.400000	4350.4000	20.273773	65.187391	58882.00000	4167.94277	4074.145947	4020.564972	4135.248938	114.683966	144.107705	4362.361357	3785.930536	4275.594727	4350.0000	8.377931
2021-10-29 17:53:20	4384.100000	4377.2000	4384.853941	4377.2000	20.760971	65.986587	60905.00000	4193.372848	4102.293328	4046.982382	4172.472179	125.489797	142.742881	4387.774049	3816.812594	4343.315197	4376.2000	8.383936
2021-10-30 07:46:40	4367.000000	4368.1000	4367.000000	4365.5000	2.715031	65.302591	61087.00000	4215.415706	4128.794512	4070.620724	4202.261074	131.640350	137.246765	4403.288050	3854.300973	4355.510552	4365.1000	8.381396
2021-10-30 18:53:20	4312.262613	4311.9000	4312.30000	4311.5000	0.258600	61.927081	62556.00000	4225.887403	4151.432607	4088.493263	4218.128601	130.635338	125.312160	4402.056988	3900.0080226	4227.496842	4310.9000	8.368902
2021-10-31 06:00:00	4312.700000	4316.30000	4316.300000	4312.7000	11.230354	62.098361	61615.28625	4273.915974	4161.257039	4105.367836	4234.078047	128.710211	129.903715	4421.064470	3901.449608	4320.012281	4315.3000	8.369922

Figure 4.103: ETH(12h) dataset table 4.

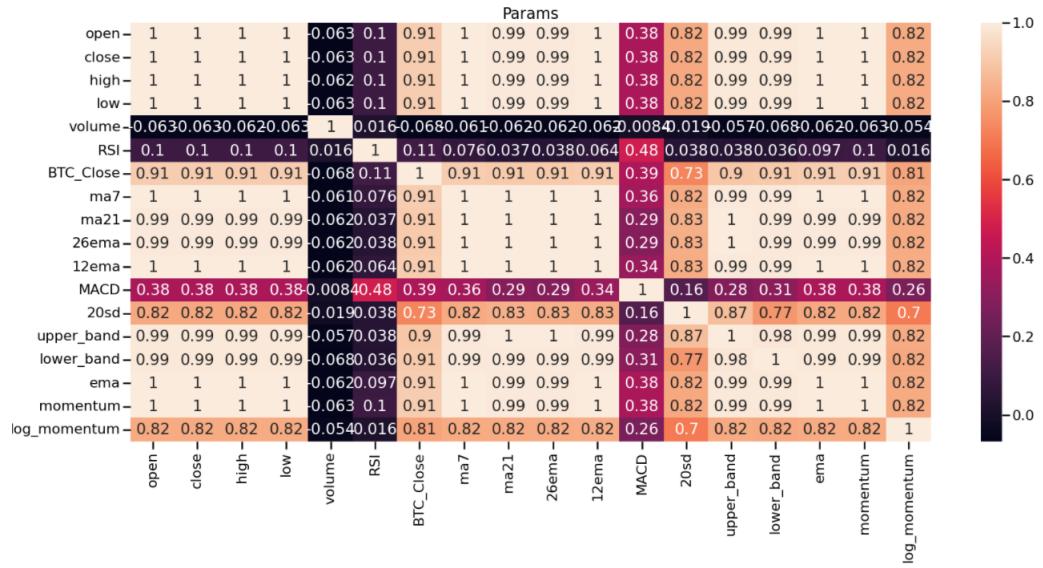


Figure 4.104: ETH(12h) dataset correlation 4.

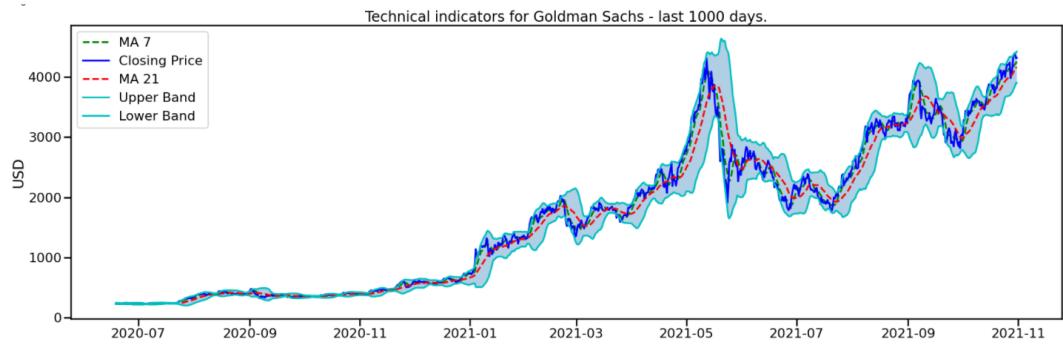


Figure 4.105: ETH(12h) dataset indicator1 4.

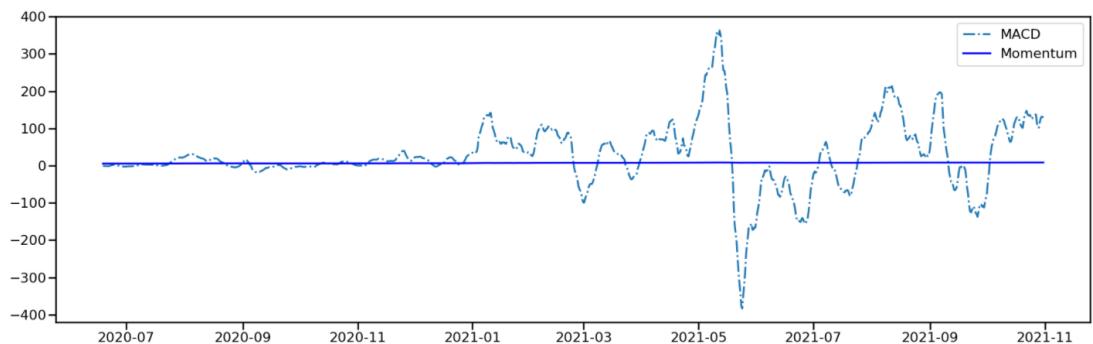


Figure 4.106: ETH(12h) dataset indicator2 4.

Performance measurements of the model used for closing price prediction

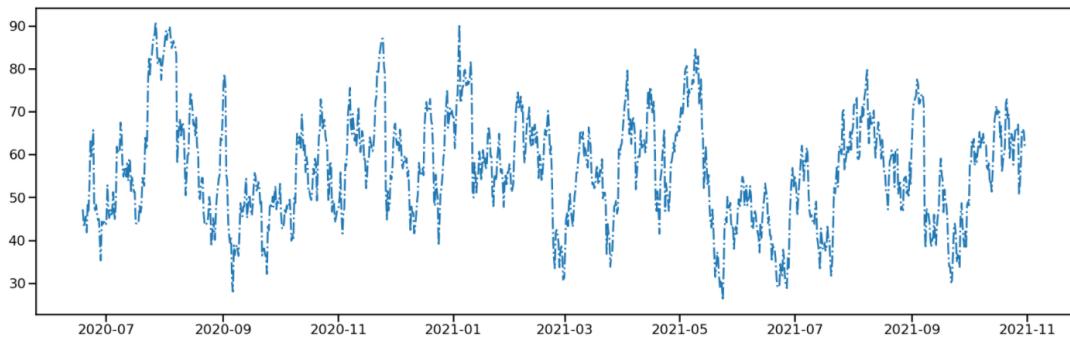


Figure 4.107: ETH(12h) dataset indicator 3.

Table 4.17: ETH(12h) Dataset LSTM Model Result 4.

Parameters	Quantity
Model Evaluate	1.40%
Mean Absolute Error	5.36%
Mean Squared Error	1.40%
$R^2$	89.23%

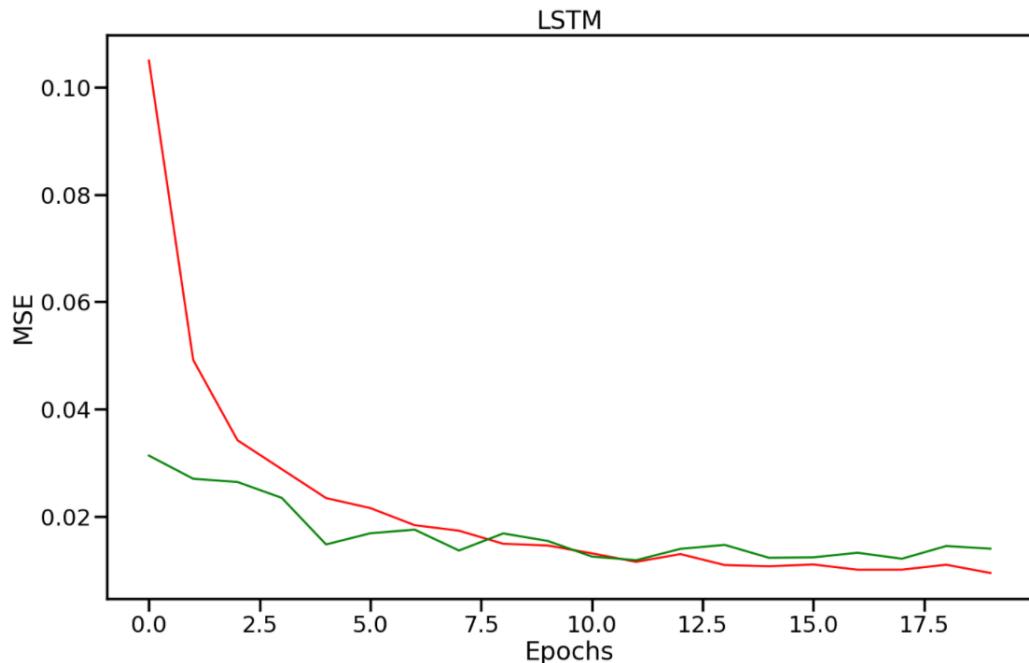


Figure 4.108: ETH(12h) dataset model epoch graphic 4.

## 4.5. Closing price prediction with Ripple 1-day data

7 datasets have been prepared for the Ripple 1-day dataset.

These datasets are:

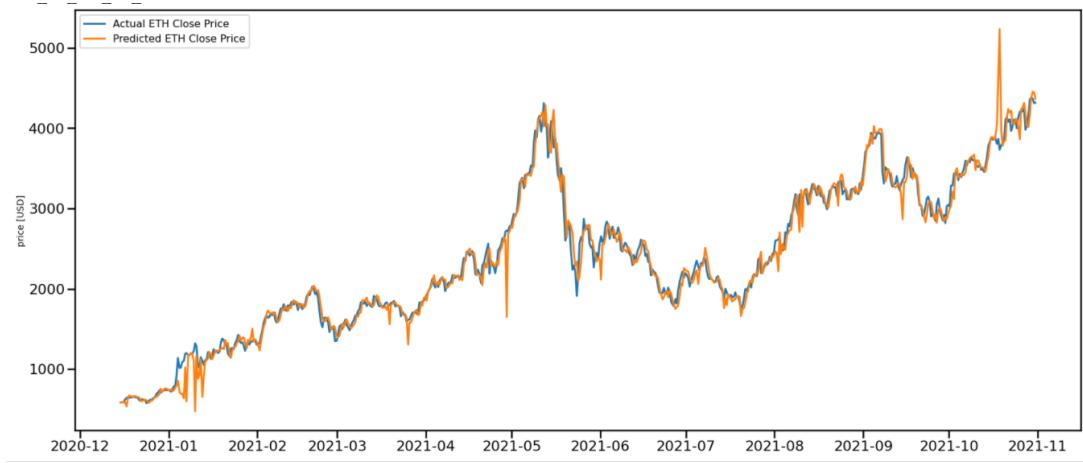


Figure 4.109: ETH(12h) dataset prediction graphic 4.

time	open	close	high	low	volume	RSI	BTC_Close_ma7	ma21	26ema	12ema	MACD	20d	upper_band	lower_band	ema	momentum	log_momentum	BTC_Close_All_Indicator_prediction
1/1/2017 15:53	9.8881	9.8508	9.8881	9.8508	37.45044	56.70963	856	10.38911	9.898962	10.11103	10.24306	0.132031	0.897969	11.65490206	8.103023551	10.10508	8.8508	2.18050785
1/12/2017 5:46	9.413	9.413	9.413	9.413	120.1083	52.19373	786.23	10.2724	9.949614	10.04767	10.11204	0.064389	0.8339	11.61741528	8.281812889	9.643695	8.413	2.129778129
1/12/2017 16:53	9.75	9.7431	9.75	9.7431	25.00052	55.09719	764.37	10.19199	10.02101	10.20247	10.05403	0.033558	0.7939378	11.49976061	8.542253038	9.709965	8.7431	2.168264818
1/13/2017 4:00	9.471	9.53	9.53	9.471	27.282	52.86504	826.6	10.03941	10.08021	9.977341	9.971922	-0.00542	0.636131	11.35247647	8.807952106	9.589988	8.53	2.143589362
1/13/2017 17:53	9.6	9.6	9.6	9.6	1	53.53101	803.84	9.905986	10.13806	9.944611	9.913811	-0.03108	0.518694	11.17544471	9.596663	8.6	2.15176203	
10/29/2021 6:46	4351.4	4351	4352.4	4350.4	20.27777	65.18739	58882	4167.944	4074.146	4020.568	4135.249	114.684	144.1077	4362.361357	3785.930536	4275.595	4350	8.377931124
10/29/2021 17:53	4384.1	4377.2	4384.854	4377.2	20.76097	65.98659	60905	4193.373	4102.298	4046.982	4172.472	125.4898	142.7429	4387.784089	3816.812566	4343.332	4376.2	8.383936047
10/30/2021 7:46	4367	4366.1	4367	4365.5	2.715031	65.30259	61087	4215.416	4128.795	4070.621	4202.261	131.6404	137.2468	4403.28805	3854.300973	4358.511	4365.1	8.381396378
10/30/2021 18:53	4312.263	4311.9	4312.3	4311.5	0.2585	61.92708	62556	4225.887	4151.433	4088.493	4219.129	130.6353	125.3122	4402.05988	3900.808226	4327.437	4310.9	8.368801978
10/31/2021 6:00	4312.7	4316.3	4316.3	4312.7	11.23035	62.09836	61615.29	4273.916	4161.257	4105.368	4234.078	128.7102	129.9037	4421.06447	3901.449608	4320.012	4315.3	8.369922126

Figure 4.110: ETH(12h) dataset prediction data table 5.

- XRP : Open Price, Close Price, High Price, Low Price, Volume
- XRP : Open Price, Close Price, High Price, Low Price, Volume, Dominance
- XRP : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD
- XRP : Open Price, Close Price, High Price, Low Price, Volume, Dominance, RSI
- XRP : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance
- XRP : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance, RSI
- XRP : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance, RSI, MACD, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

#### 4.5.1. XRP(1d) : Open Price, Close Price, High Price, Low Price, Volume

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction



Figure 4.111: XRP(1d) dataset graphic 1.

Correlation of parameters used for closing price prediction

time

	open	close	high	low	volume
<b>time</b>					
2017-05-20 17:06:40	0.34864	0.34864	0.34864	0.34864	55.000000
2017-05-21 18:06:40	0.32800	0.32800	0.32800	0.32800	252.730548
2017-05-22 19:06:40	0.31150	0.31299	0.31299	0.31150	1300.000000
2017-05-23 17:20:00	0.33699	0.32802	0.33699	0.32802	199.800000
2017-05-24 18:20:00	0.30291	0.30291	0.30291	0.30291	700.000000
...					
2019-07-13 20:33:20	0.32435	0.32455	0.32455	0.32435	12203.370000
2019-07-14 21:33:20	0.31567	0.31585	0.31598	0.31567	64287.577850
2019-07-15 22:33:20	0.31334	0.31342	0.31342	0.31334	16343.663140
2019-07-16 20:46:40	0.29937	0.29888	0.29937	0.29878	5028.857825
2019-07-17 21:46:40	0.31742	0.31685	0.31742	0.31685	671.000000

789 rows × 5 columns

Figure 4.112: XRP(1d) dataset table 1.

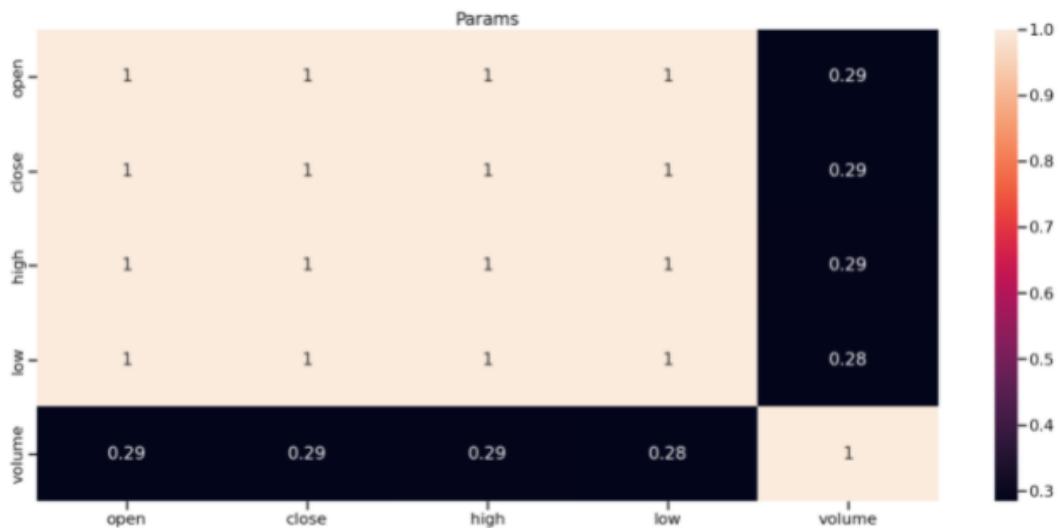


Figure 4.113: XRP(1d) dataset correlation 1.

Performance measurements of the model used for closing price prediction

Table 4.18: XRP(1d) Dataset LSTM Model Result 1.

Parameters	Quantity
Model Evaluate	1.95%
Mean Absolute Error	10.53%
Mean Squared Error	1.95%
$R^2$	40.04%

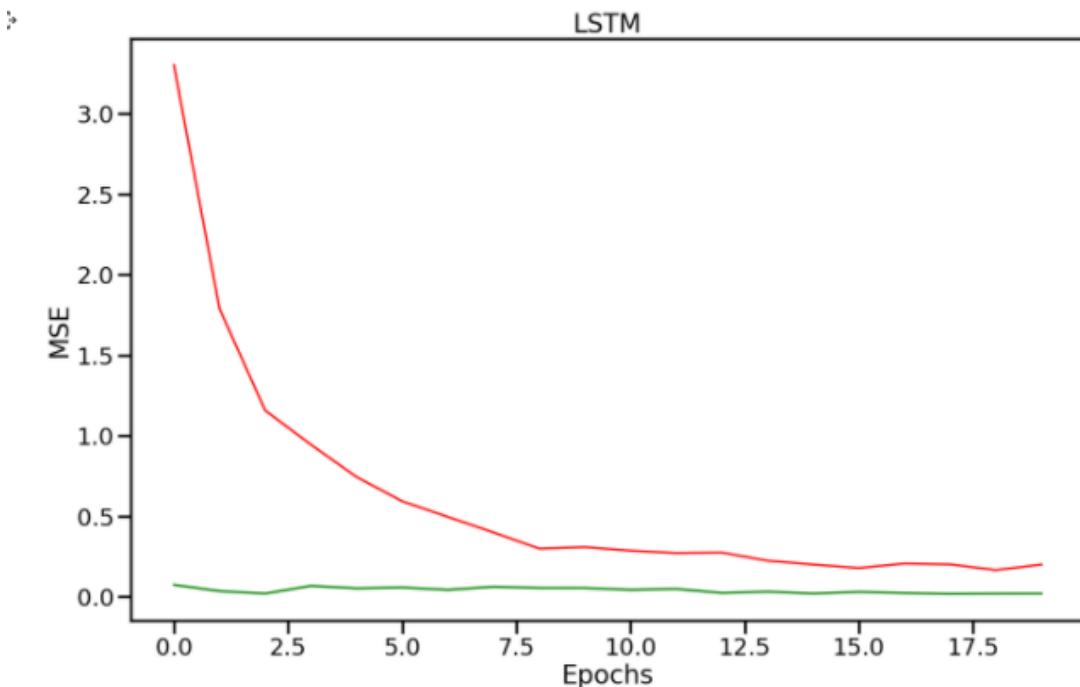


Figure 4.114: XRP(1d) dataset model epoch graphic 1.

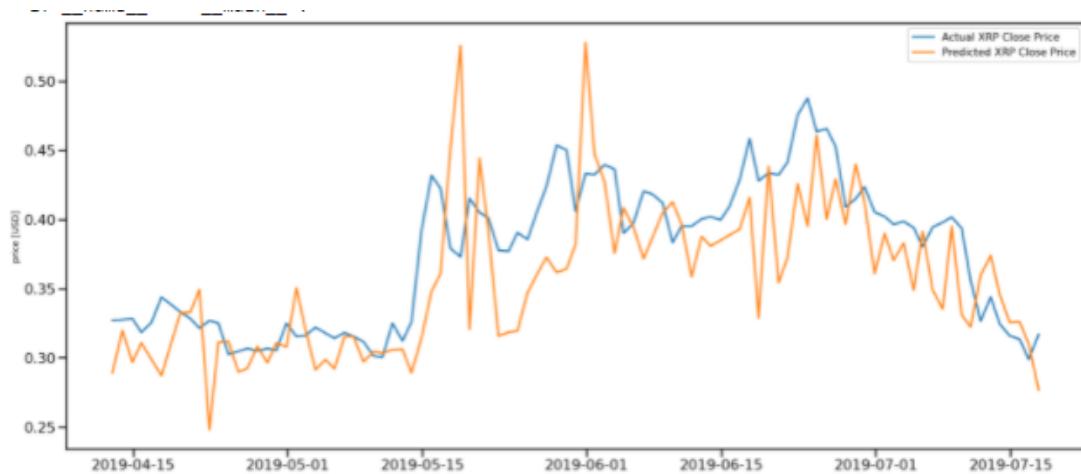


Figure 4.115: XRP(1d) dataset predition graphic 1.

time	open	close	high	low	volume	Classic_Prediction
5/20/2017 17:06	0.34864	0.34864	0.34864	0.34864	55	
5/21/2017 18:06	0.328	0.328	0.328	0.328	252.7305	
5/22/2017 19:06	0.3115	0.31299	0.31299	0.3115	1300	
5/23/2017 17:20	0.33699	0.32802	0.33699	0.32802	199.8	
5/24/2017 18:20	0.30291	0.30291	0.30291	0.30291	700	
7/13/2019 20:33	0.32435	0.32455	0.32455	0.32435	12203.37	0.346020298
7/14/2019 21:33	0.31567	0.31585	0.31598	0.31567	64287.58	0.325613216
7/15/2019 22:33	0.31334	0.31342	0.31342	0.31334	16343.66	0.32597674
7/16/2019 20:46	0.29937	0.29888	0.29937	0.29878	5028.858	0.310028265
7/17/2019 21:46	0.31742	0.31685	0.31742	0.31685	671	0.276765438

Figure 4.116: XRP(1d) dataset prediction data table 1.

#### 4.5.2. XRP(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction



Figure 4.117: XRP(1d) dataset graphic 2.

Correlation of parameters used for closing price prediction

	open	close	high	low	volume	Dom
time						
2017-05-20 17:06:40	0.34864	0.34864	0.34864	0.34864	55.000000	19.75
2017-05-21 18:06:40	0.32800	0.32800	0.32800	0.32800	252.730548	19.21
2017-05-22 19:06:40	0.31150	0.31299	0.31299	0.31150	1300.000000	17.92
2017-05-23 17:20:00	0.33699	0.32802	0.33699	0.32802	199.800000	14.80
2017-05-24 18:20:00	0.30291	0.30291	0.30291	0.30291	700.000000	15.77
...	...	...	...	...	...	...
2019-07-13 20:33:20	0.32435	0.32455	0.32455	0.32435	12203.370000	4.61
2019-07-14 21:33:20	0.31567	0.31585	0.31598	0.31567	64287.577850	4.58
2019-07-15 22:33:20	0.31334	0.31342	0.31342	0.31334	16343.663140	4.65
2019-07-16 20:46:40	0.29937	0.29888	0.29937	0.29878	5028.857825	4.64
2019-07-17 21:46:40	0.31742	0.31685	0.31742	0.31685	671.000000	4.85

789 rows × 6 columns

Figure 4.118: XRP(1d) dataset table 2.



Figure 4.119: XRP(1d) dataset correlation 2.

Performance measurements of the model used for closing price prediction

Table 4.19: XRP(1d) Dataset LSTM Model Result 2.

Parameters	Quantity
Model Evaluate	2.27%
Mean Absolute Error	9.86%
Mean Squared Error	2.27%
$R^2$	30.13%

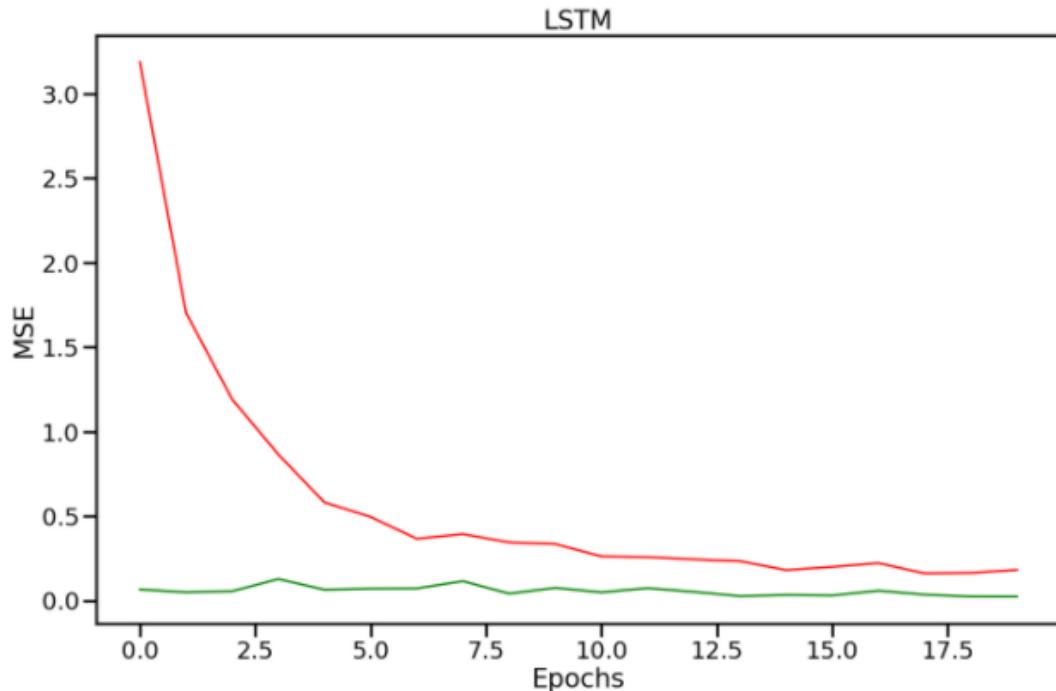


Figure 4.120: XRP(1d) dataset model epoch graphic 2.

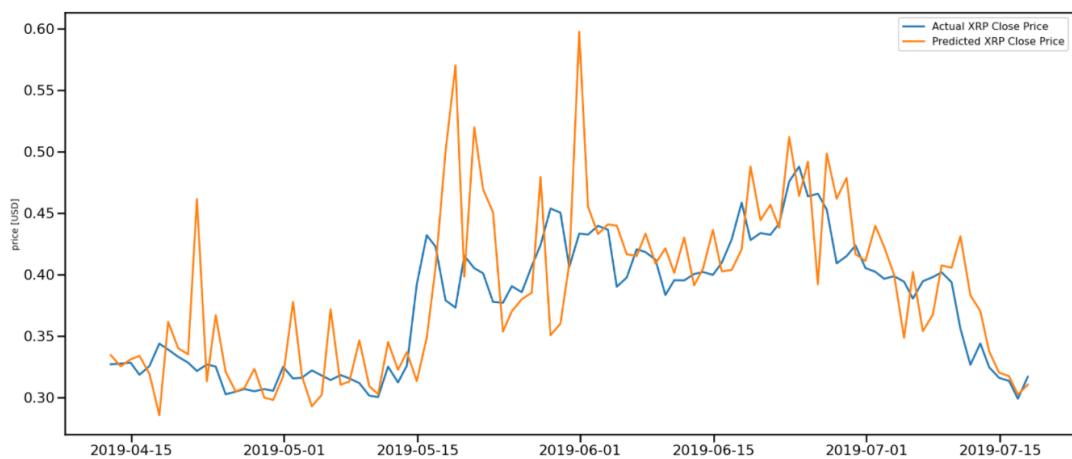


Figure 4.121: XRP(1d) dataset predition graphic 2.

time	open	close	high	low	volume	Dom	Dom_Prediction
5/20/2017 17:06	0.34864	0.34864	0.34864	0.34864	55	19.75	
5/21/2017 18:06	0.328	0.328	0.328	0.328	252.7305	19.21	
5/22/2017 19:06	0.3115	0.31299	0.31299	0.3115	1300	17.92	
5/23/2017 17:20	0.33699	0.32802	0.33699	0.32802	199.8	14.8	
5/24/2017 18:20	0.30291	0.30291	0.30291	0.30291	700	15.77	
7/12/2019 22:20	0.34399	0.34386	0.34399	0.34386	150	4.41	0.370192703
7/13/2019 20:33	0.32435	0.32455	0.32455	0.32435	12203.37	4.61	0.33741127
7/14/2019 21:33	0.31567	0.31585	0.31598	0.31567	64287.58	4.58	0.320091342
7/15/2019 22:33	0.31334	0.31342	0.31342	0.31334	16343.66	4.65	0.317226548
7/16/2019 20:46	0.29937	0.29888	0.29937	0.29878	5028.858	4.64	0.302264207
7/17/2019 21:46	0.31742	0.31685	0.31742	0.31685	671	4.85	0.310404861

Figure 4.122: XRP(1d) dataset predition data table 2.

#### 4.5.3. XRP(1d) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

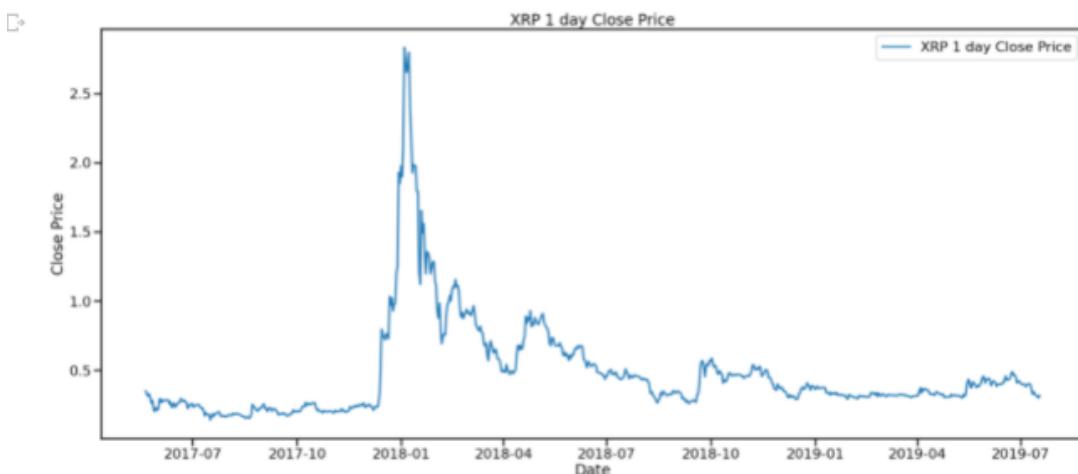


Figure 4.123: XRP(1d) dataset graphic 3.

Correlation of parameters used for closing price prediction

	open	close	high	low	volume	RSI	MACD	edit
time								
2017-06-03 17:13:20	0.26607	0.26607	0.26690	0.26607	6006.028880	38.657655	-0.023724	
2017-06-04 18:13:20	0.28252	0.28252	0.28252	0.28252	30.818855	41.504624	-0.020745	
2017-06-05 19:13:20	0.28400	0.28400	0.28400	0.28400	3.603100	41.766488	-0.018057	
2017-06-06 17:26:40	0.27902	0.27902	0.27902	0.27902	1579.166892	41.099764	-0.016142	
2017-06-07 18:26:40	0.28260	0.28251	0.28260	0.28251	0.540000	41.800921	-0.014180	
...	...	...	...	...	...	...	...	...
2019-07-13 20:33:20	0.32435	0.32455	0.32455	0.32435	12203.370000	32.437777	-0.020705	
2019-07-14 21:33:20	0.31567	0.31585	0.31598	0.31567	64287.577850	31.031687	-0.023539	
2019-07-15 22:33:20	0.31334	0.31342	0.31342	0.31334	16343.663140	30.632282	-0.025684	
2019-07-16 20:46:40	0.29937	0.29888	0.29937	0.29878	5028.857825	28.286290	-0.028233	
2019-07-17 21:46:40	0.31742	0.31685	0.31742	0.31685	671.000000	34.920092	-0.028474	

775 rows x 7 columns

Figure 4.124: XRP(1d) dataset table 3.



Figure 4.125: XRP(1d) dataset correlation 3.

Performance measurements of the model used for closing price prediction

Table 4.20: XRP(1d) Dataset LSTM Model Result 3.

Parameters	Quantity
Model Evaluate	38.04%
Mean Absolute Error	28.14%
Mean Squared Error	38.04%
$R^2$	-1052.73%

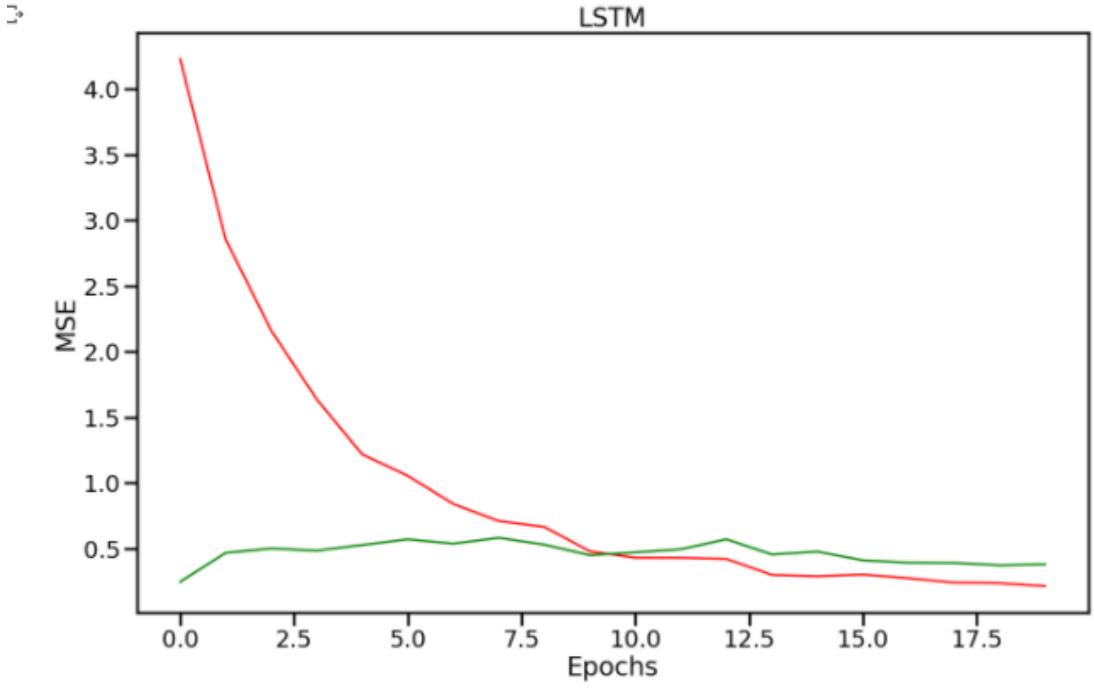


Figure 4.126: XRP(1d) dataset model epoch graphic 3.

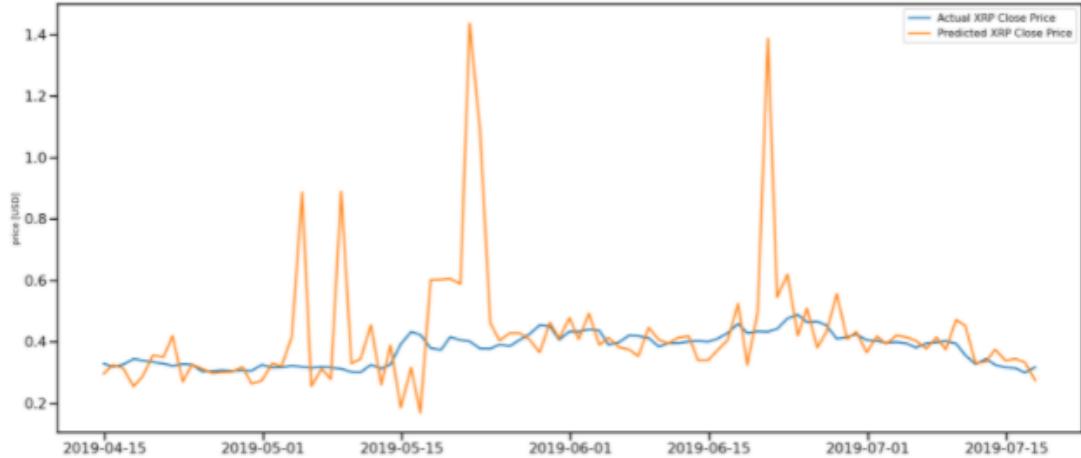


Figure 4.127: XRP(1d) dataset predition graphic 3.

#### 4.5.4. XRP(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance, RSI

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

time	open	close	high	low	volume	RSI	MACD	RSI_MACD_Prediction
6/3/2017 17:13	0.26607	0.26607	0.2669	0.26607	6006.029	38.65766	-0.02372	
6/4/2017 18:13	0.28252	0.28252	0.28252	0.28252	30.81886	41.50462	-0.02075	
6/5/2017 19:13	0.284	0.284	0.284	0.284	3.6031	41.76649	-0.01806	
6/6/2017 17:26	0.27902	0.27902	0.27902	0.27902	1579.167	41.09976	-0.01614	
6/7/2017 18:26	0.2826	0.28251	0.2826	0.28251	0.54	41.80092	-0.01418	
7/12/2019 22:20	0.34399	0.34386	0.34399	0.34386	150	35.77908	-0.01767	0.334650025
7/13/2019 20:33	0.32435	0.32455	0.32455	0.32435	12203.37	32.43778	-0.0207	0.374687531
7/14/2019 21:33	0.31567	0.31585	0.31598	0.31567	64287.58	31.03169	-0.02354	0.338656624
7/15/2019 22:33	0.31334	0.31342	0.31342	0.31334	16343.66	30.63228	-0.02568	0.343875318
7/16/2019 20:46	0.29937	0.29888	0.29937	0.29878	5028.858	28.28629	-0.02823	0.332664622
7/17/2019 21:46	0.31742	0.31685	0.31742	0.31685	671	34.92009	-0.02847	0.273763535

Figure 4.128: XRP(1d) dataset predition data table 3.



Figure 4.129: XRP(1d) dataset graphic 4.

	open	close	high	low	volume	RSI	Dom	
time								
2017-06-03 17:13:20	0.26607	0.26607	0.26690	0.26607	6006.028880	38.657655	13.55	
2017-06-04 18:13:20	0.28252	0.28252	0.28252	0.28252	30.818855	41.504624	12.12	
2017-06-05 19:13:20	0.28400	0.28400	0.28400	0.28400	3.603100	41.766488	12.22	
2017-06-06 17:26:40	0.27902	0.27902	0.27902	0.27902	1579.166892	41.099764	11.86	
2017-06-07 18:26:40	0.28260	0.28251	0.28260	0.28251	0.540000	41.800921	10.94	
...	...	...	...	...	...	...	...	...
2019-07-13 20:33:20	0.32435	0.32455	0.32455	0.32435	12203.370000	32.437777	4.61	
2019-07-14 21:33:20	0.31567	0.31585	0.31598	0.31567	64287.577850	31.031687	4.58	
2019-07-15 22:33:20	0.31334	0.31342	0.31342	0.31334	16343.663140	30.632282	4.65	
2019-07-16 20:46:40	0.29937	0.29888	0.29937	0.29878	5028.857825	28.286290	4.64	
2019-07-17 21:46:40	0.31742	0.31685	0.31742	0.31685	671.000000	34.920092	4.85	

Figure 4.130: XRP(1d) dataset table 4.

#### Correlation of parameters used for closing price prediction



Figure 4.131: XRP(1d) dataset correlation 4.

Performance measurements of the model used for closing price prediction

Table 4.21: XRP(1d) Dataset LSTM Model Result 4.

Parameters	Quantity
Model Evaluate	2.16%
Mean Absolute Error	11.26%
Mean Squared Error	2.16%
$R^2$	34.57%

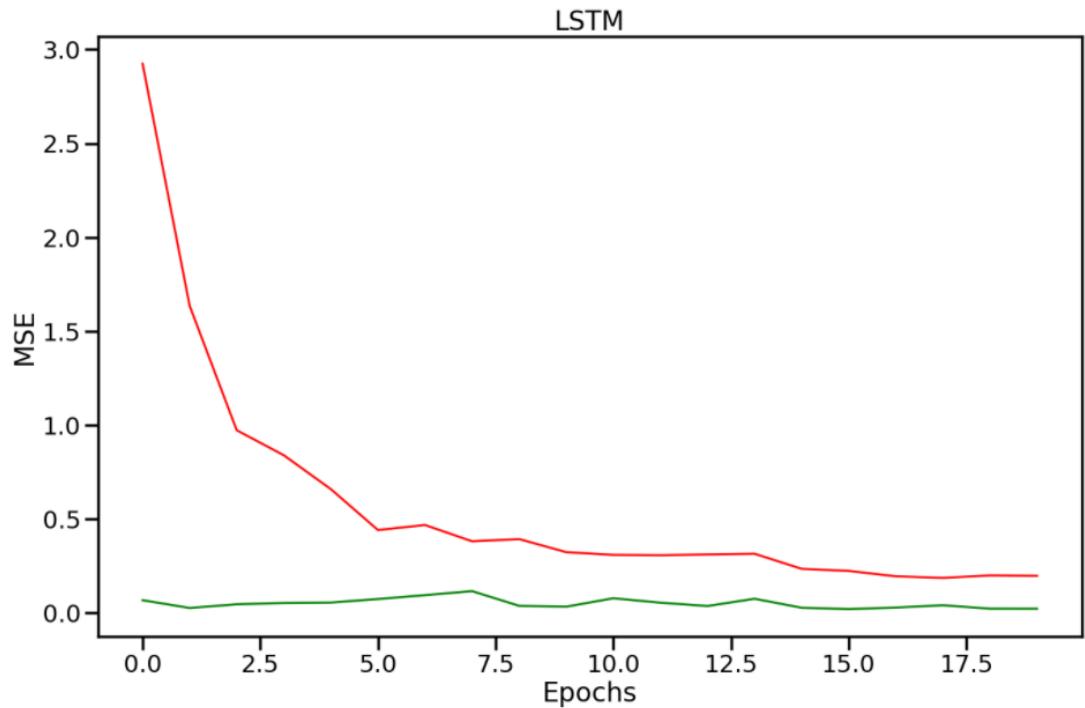


Figure 4.132: XRP(1d) dataset model epoch graphic 4.

#### 4.5.5. XRP(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction  
Correlation of parameters used for closing price prediction

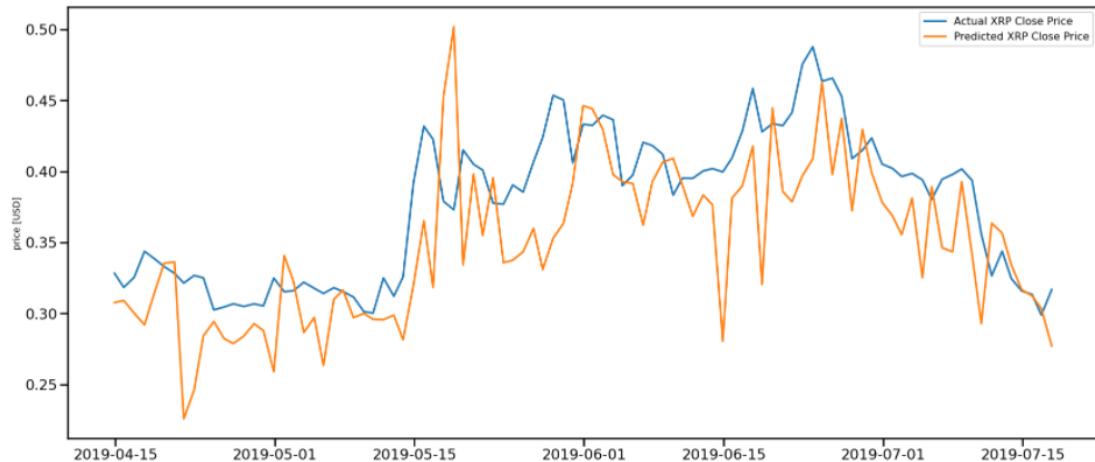


Figure 4.133: XRP(1d) dataset predition graphic 4.

time	open	close	high	low	volume	RSI	Dom	Dom_RSI_Prediction
6/3/2017 17:13	0.26607	0.26607	0.2669	0.26607	6006.029	38.65766	13.55	
6/4/2017 18:13	0.28252	0.28252	0.28252	0.28252	30.81886	41.50462	12.12	
6/5/2017 19:13	0.284	0.284	0.284	0.284	3.6031	41.76649	12.22	
6/6/2017 17:26	0.27902	0.27902	0.27902	0.27902	1579.167	41.09976	11.86	
6/7/2017 18:26	0.2826	0.28251	0.2826	0.28251	0.54	41.80092	10.94	
7/13/2019 20:33	0.32435	0.32455	0.32455	0.32435	12203.37	32.43778	4.61	0.334165021
7/14/2019 21:33	0.31567	0.31585	0.31598	0.31567	64287.58	31.03169	4.58	0.316775251
7/15/2019 22:33	0.31334	0.31342	0.31342	0.31334	16343.66	30.63228	4.65	0.312453498
7/16/2019 20:46	0.29937	0.29888	0.29937	0.29878	5028.858	28.28629	4.64	0.303412917
7/17/2019 21:46	0.31742	0.31685	0.31742	0.31685	671	34.92009	4.85	0.277151995

Figure 4.134: XRP(1d) dataset predition data table 4.



Figure 4.135: XRP(1d) dataset graphic 5.

	open	close	high	low	volume	Dom	BTC_Dom
time							
2017-05-20 17:06:40	0.34864	0.34864	0.34864	0.34864	55.000000	19.75	47.24
2017-05-21 18:06:40	0.32800	0.32800	0.32800	0.32800	252.730548	19.21	46.97
2017-05-22 19:06:40	0.31150	0.31299	0.31299	0.31150	1300.000000	17.92	45.94
2017-05-23 17:20:00	0.33699	0.32802	0.33699	0.32802	199.800000	14.80	46.63
2017-05-24 18:20:00	0.30291	0.30291	0.30291	0.30291	700.000000	15.77	45.95
...	...	...	...	...	...	...	...
2019-07-13 20:33:20	0.32435	0.32455	0.32455	0.32435	12203.370000	4.61	65.06
2019-07-14 21:33:20	0.31567	0.31585	0.31598	0.31567	64287.577850	4.58	64.84
2019-07-15 22:33:20	0.31334	0.31342	0.31342	0.31334	16343.663140	4.65	65.44
2019-07-16 20:46:40	0.29937	0.29888	0.29937	0.29878	5028.857825	4.64	66.31
2019-07-17 21:46:40	0.31742	0.31685	0.31742	0.31685	671.000000	4.85	66.55

Figure 4.136: XRP(1d) dataset table 5.



Figure 4.137: XRP(1d) dataset correlation 5.

Performance measurements of the model used for closing price prediction

#### 4.5.6. XRP(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance, RSI

The predictions came true with the above-mentioned attributes.

Table 4.22: XRP(1d) Dataset LSTM Model Result 5.

Parameters	Quantity
Model Evaluate	3.63%
Mean Absolute Error	12.10%
Mean Squared Error	3.63%
$R^2$	-11.42%

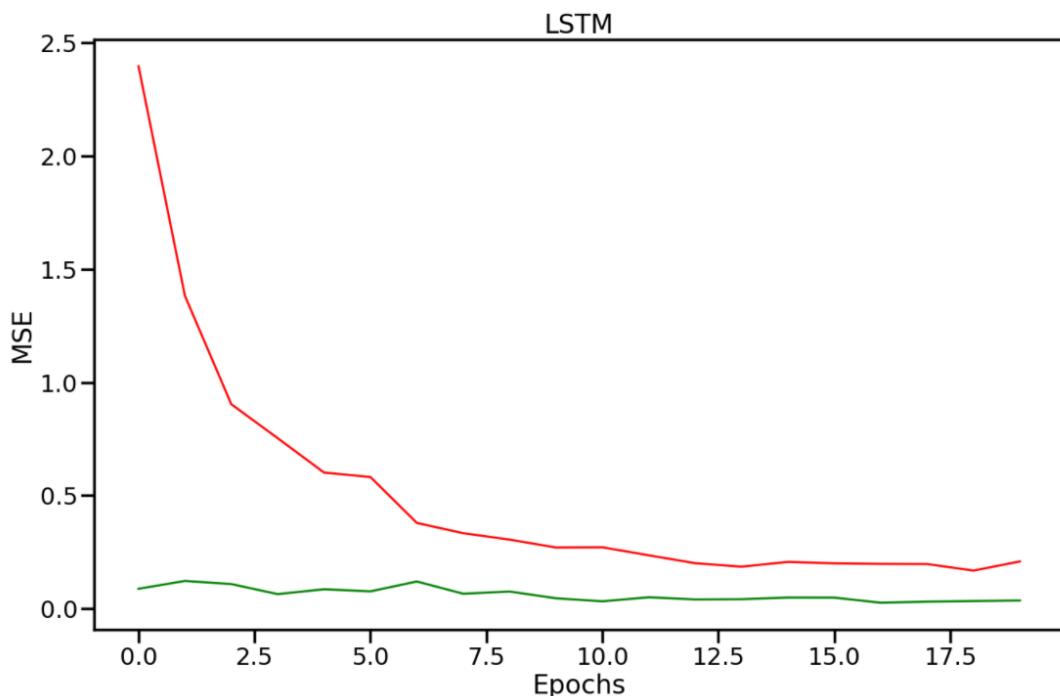


Figure 4.138: XRP(1d) dataset model epoch graphic 5.

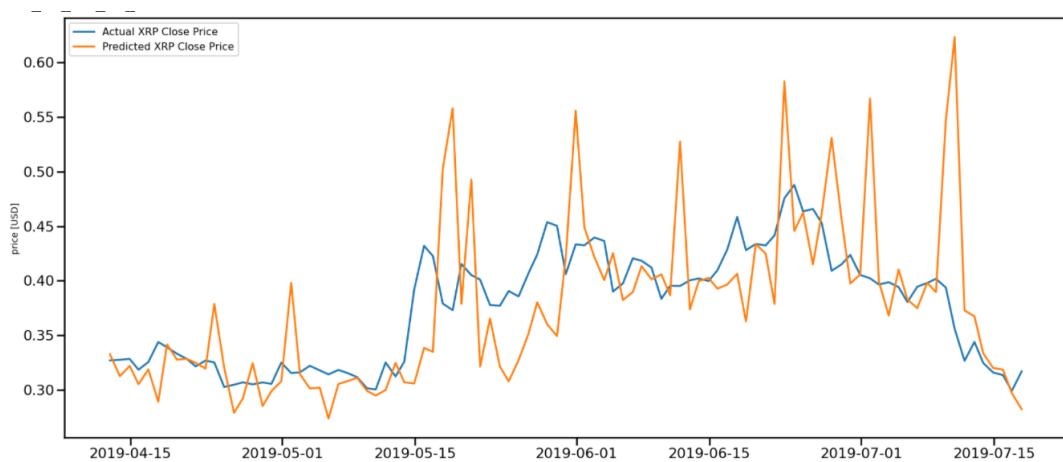


Figure 4.139: XRP(1d) dataset prediction graphic 5.

time	open	close	high	low	volume	Dom	BTC_Dom	Dom_BTCDom_Prediction
5/20/2017 17:06	0.34864	0.34864	0.34864	0.34864	55	19.75	47.24	
5/21/2017 18:06	0.328	0.328	0.328	0.328	252.7305	19.21	46.97	
5/22/2017 19:06	0.3115	0.31299	0.31299	0.3115	1300	17.92	45.94	
5/23/2017 17:20	0.33699	0.32802	0.33699	0.32802	199.8	14.8	46.63	
5/24/2017 18:20	0.30291	0.30291	0.30291	0.30291	700	15.77	45.95	
7/11/2019 21:20	0.32541	0.32651	0.32651	0.3254	56058.71	4.61	65.21	0.372706421
7/12/2019 22:20	0.34399	0.34386	0.34399	0.34386	150	4.41	65.57	0.367316721
7/13/2019 20:33	0.32435	0.32455	0.32455	0.32435	12203.37	4.61	65.06	0.33344589
7/14/2019 21:33	0.31567	0.31585	0.31598	0.31567	64287.58	4.58	64.84	0.320023045
7/15/2019 22:33	0.31334	0.31342	0.31342	0.31334	16343.66	4.65	65.44	0.318434123
7/16/2019 20:46	0.29937	0.29888	0.29937	0.29878	5028.858	4.64	66.31	0.297097205
7/17/2019 21:46	0.31742	0.31685	0.31742	0.31685	671	4.85	66.55	0.282105826

Figure 4.140: XRP(1d) dataset prediction data table 5.

data table used for closing price prediction

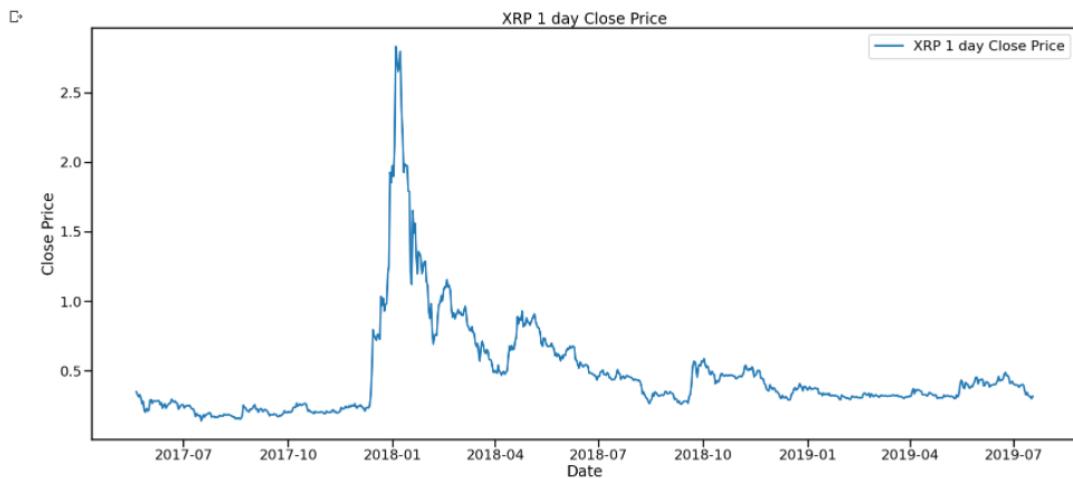


Figure 4.141: XRP(1d) dataset graphic 6.

Correlation of parameters used for closing price prediction

	open	close	high	low	volume	RSI	Dom	BTC_Dom
time								
2017-06-03 17:13:20	0.26607	0.26607	0.26690	0.26607	6006.028880	38.657655	13.55	44.98
2017-06-04 18:13:20	0.28252	0.28252	0.28252	0.28252	30.818855	41.504624	12.12	46.11
2017-06-05 19:13:20	0.28400	0.28400	0.28400	0.28400	3.603100	41.766488	12.22	44.43
2017-06-06 17:26:40	0.27902	0.27902	0.27902	0.27902	1579.166892	41.099764	11.86	44.56
2017-06-07 18:26:40	0.28260	0.28251	0.28260	0.28251	0.540000	41.800921	10.94	45.82
...	...	...	...	...	...	...	...	...
2019-07-13 20:33:20	0.32435	0.32455	0.32455	0.32435	12203.370000	32.437777	4.61	65.06
2019-07-14 21:33:20	0.31567	0.31585	0.31598	0.31567	64287.577850	31.031687	4.58	64.84
2019-07-15 22:33:20	0.31334	0.31342	0.31342	0.31334	16343.663140	30.632282	4.65	65.44
2019-07-16 20:46:40	0.29937	0.29888	0.29937	0.29878	5028.857825	28.286290	4.64	66.31
2019-07-17 21:46:40	0.31742	0.31685	0.31742	0.31685	671.000000	34.920092	4.85	66.55

Figure 4.142: XRP(1d) dataset table 6.

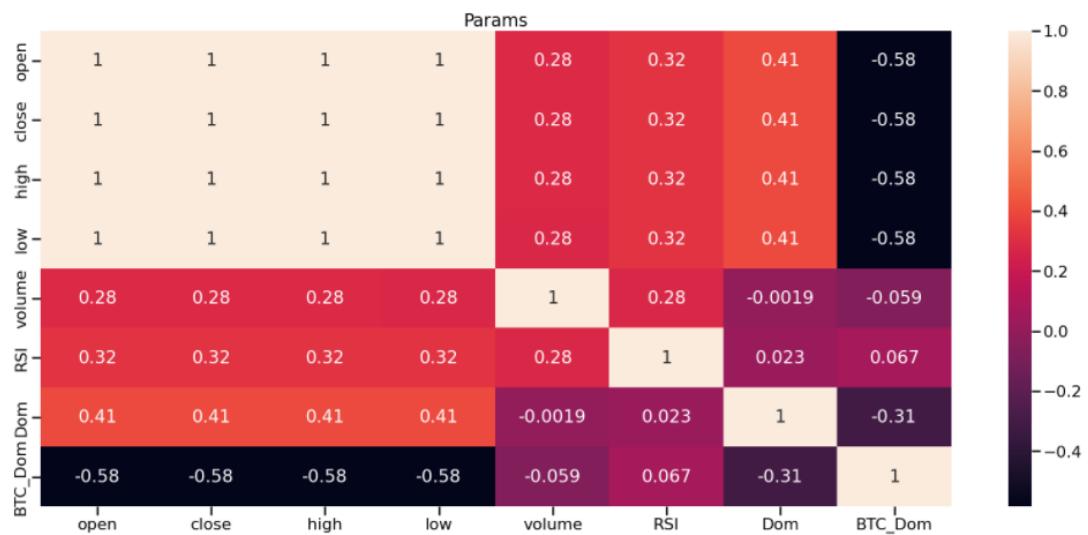


Figure 4.143: XRP(1d) dataset correlation 6.

Performance measurements of the model used for closing price prediction

Table 4.23: XRP(1d) Dataset LSTM Model Result 6.

Parameters	Quantity
Model Evaluate	4.28%
Mean Absolute Error	15.17%
Mean Squared Error	4.28%
$R^2$	-29.54%

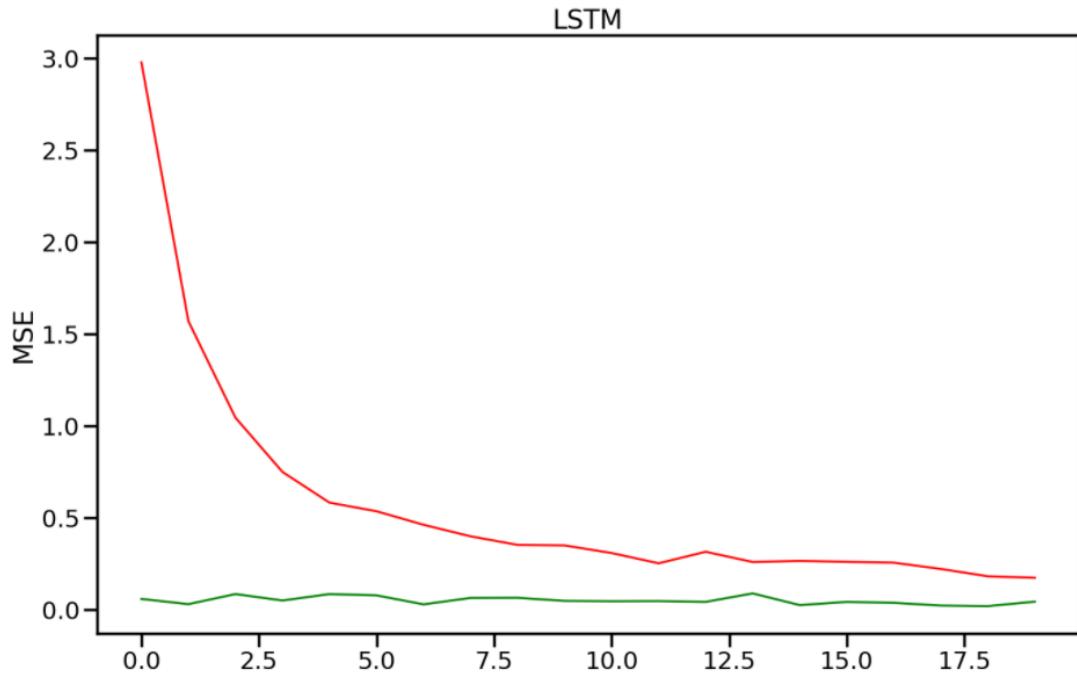


Figure 4.144: XRP(1d) dataset model epoch graphic 6.

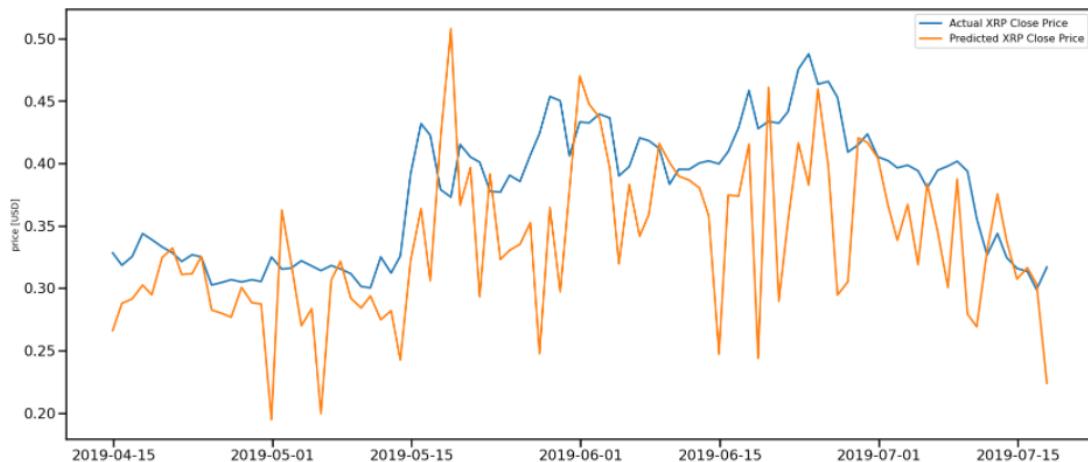


Figure 4.145: XRP(1d) dataset prediction graphic 6.

time	open	close	high	low	volume	RSI	Dom	BTC_Dom	Dom_RSI_BTCDom_Prediction
6/3/2017 17:13	0.26607	0.26607	0.2669	0.26607	6006.029	38.65766	13.55	44.98	
6/4/2017 18:13	0.28252	0.28252	0.28252	0.28252	30.81886	41.50462	12.12	46.11	
6/5/2017 19:13	0.284	0.284	0.284	0.284	3.6031	41.76649	12.22	44.43	
6/6/2017 17:26	0.27902	0.27902	0.27902	0.27902	1579.167	41.09976	11.86	44.56	
6/7/2017 18:26	0.2826	0.28251	0.2826	0.28251	0.54	41.80092	10.94	45.82	
7/13/2019 20:33	0.32435	0.32455	0.32455	0.32435	12203.37	32.43778	4.61	65.06	0.338029897
7/14/2019 21:33	0.31567	0.31585	0.31598	0.31567	64287.58	31.03169	4.58	64.84	0.307367047
7/15/2019 22:33	0.31334	0.31342	0.31342	0.31334	16343.66	30.63228	4.65	65.44	0.316379762
7/16/2019 20:46	0.29937	0.29888	0.29937	0.29878	5028.858	28.28629	4.64	66.31	0.303354996
7/17/2019 21:46	0.31742	0.31685	0.31742	0.31685	671	34.92009	4.85	66.55	0.223840383

Figure 4.146: XRP(1d) dataset prediction data table 6.

#### 4.5.7. XRP(1d) : Open Price, Close Price, High Price, Low Price, Volume, Dominance, BTC Dominance, RSI, MACD, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

The predictions came true with the above-mentioned attributes.  
data table used for closing price prediction

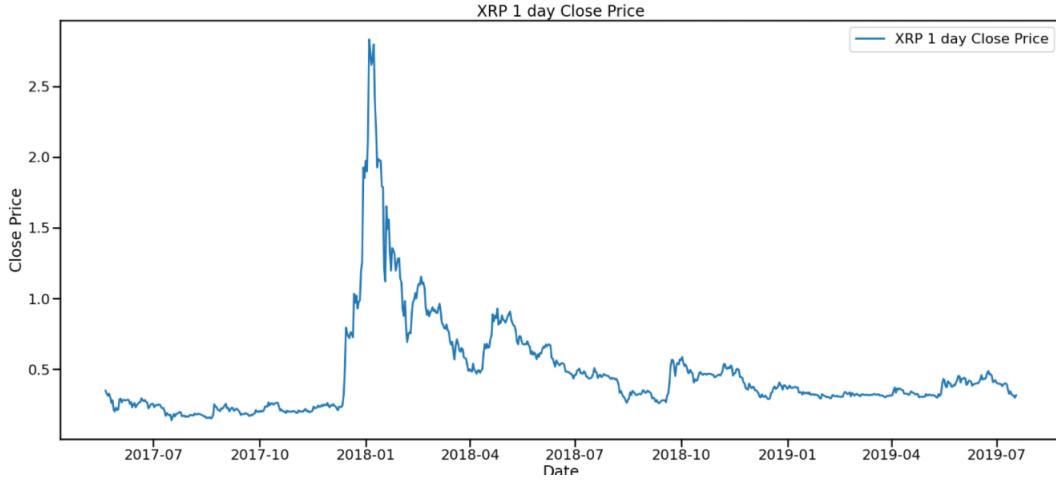


Figure 4.147: XRP(1d) dataset graphic 7.

time	open	close	high	low	volume	RSI	Dom	BTC_Dom	ma7	ma21	26ema	12ema	MACD	20sd	upper_band	lower_band	ema	momentum	log_momentum	X
2017-12-23 21:00:00	1.0359	1.0346	1.0357	1.0281	127865.182900	85.920466	4.77	45.38	0.783297	0.462289	0.505102	0.669850	0.164749	0.272980	1.008249	-0.083672	0.934833	0.0346	-3.363902	
2017-12-23 20:13:20	1.0220	1.0220	1.0224	1.0184	36462.436110	80.434380	8.38	44.58	0.855884	0.533807	0.572277	0.763100	0.187824	0.304928	1.143662	-0.076049	1.000759	0.0220	-3.816713	
2017-12-27 21:26:40	1.1972	1.1996	1.2024	1.1943	402176.065800	79.612426	7.17	45.56	1.016837	0.683181	0.689577	0.598233	0.202259	0.319519	1.322219	0.044144	1.126414	0.1996	-1.611440	
2017-12-28 19:40:00	1.2500	1.2539	1.2553	1.2500	179759.663200	80.812633	8.77	44.03	1.048166	0.732855	0.737304	0.952951	0.215647	0.323462	1.379779	0.085931	1.211405	0.2539	-1.370015	
2017-12-29 20:40:00	1.9277	1.9280	1.9413	1.9237	791706.569700	89.263079	10.18	43.04	1.185023	0.813484	0.825504	1.047455	0.386002	1.605487	0.021481	1.689135	0.9280	-0.074724		
2017-12-30 21:00:00	1.8401	1.8530	1.8559	1.8300	490491.643100	84.788787	12.42	40.99	1.303737	0.890474	0.901615	1.218350	0.316735	0.433545	1.757563	0.023385	1.785378	0.8530	-0.153996	
2017-12-31 19:53:20	1.9710	1.9750	1.9750	1.9703	42629.195640	86.016642	16.03	37.94	1.452967	0.973459	0.981125	1.334757	0.353832	0.466792	1.907034	0.039866	1.916126	0.9750	-0.025318	
2018-01-01 20:53:20	1.9020	1.8895	1.9020	1.8951	32720.626380	81.625467	14.22	38.76	1.585000	1.052192	1.049153	1.421641	0.372488	0.477281	2.006755	0.097630	1.905042	0.8995	-0.105916	
2018-01-02 19:06:40	2.1055	2.1107	2.1150	2.1041	36811.687920	84.074639	14.31	37.61	1.745671	1.137498	1.127786	1.527650	0.399864	0.499321	2.136139	0.138856	2.042147	1.1107	0.104990	
2018-01-20 06:40	2.8179	2.8337	2.8486	2.8134	189383.251700	89.321846	13.93	37.38	1.979114	1.248334	1.254159	1.728581	0.474433	0.600283	2.448960	0.047772	2.568849	1.8337	0.806338	
2018-01-04 21:06:40	2.7220	2.7443	2.7682	2.7220	188632.819500	85.567522	16.59	35.12	2.192029	1.341164	1.364531	1.884845	0.520314	0.672986	2.667136	-0.004908	2.686150	1.7443	0.556353	
2018-01-08 19:20:00	2.6419	2.8529	2.6535	2.8402	199155.032700	81.782838	17.62	33.34	2.295586	1.451636	1.459966	2.003007	0.543041	0.716276	2.864187	-0.000916	2.663983	1.6529	0.502531	
2018-01-06 20:00	2.6950	2.6896	2.6970	2.6880	20610.520040	82.124721	15.34	37.09	2.415100	1.524840	1.551050	2.108637	0.557587	0.747395	3.019631	0.030050	2.681061	1.6896	0.524492	
2018-01-07 21:20:00	2.7980	2.7980	2.7988	2.7949	16610.595100	83.131692	14.89	36.00	2.532671	1.623793	1.643417	2.214693	0.571276	0.772642	3.169078	0.076509	2.759020	1.7980	0.586675	
2018-01-08 19:33:20	2.4017	2.4036	2.4175	2.3962	272530.226900	68.100129	16.01	33.30	2.604688	1.701910	1.699727	2.243756	0.544029	0.764158	3.230226	0.173595	2.522073	1.4036	0.339040	
2018-01-09 20:33:20	2.1927	2.1997	2.2000	2.1908	29287.512670	61.871490	13.15	34.28	2.617400	1.770794	1.736762	2.236978	0.500216	0.739146	3.249087	0.292501	2.307158	1.1997	0.182072	

Figure 4.148: XRP(1d) dataset table 7.

Correlation of parameters used for closing price prediction

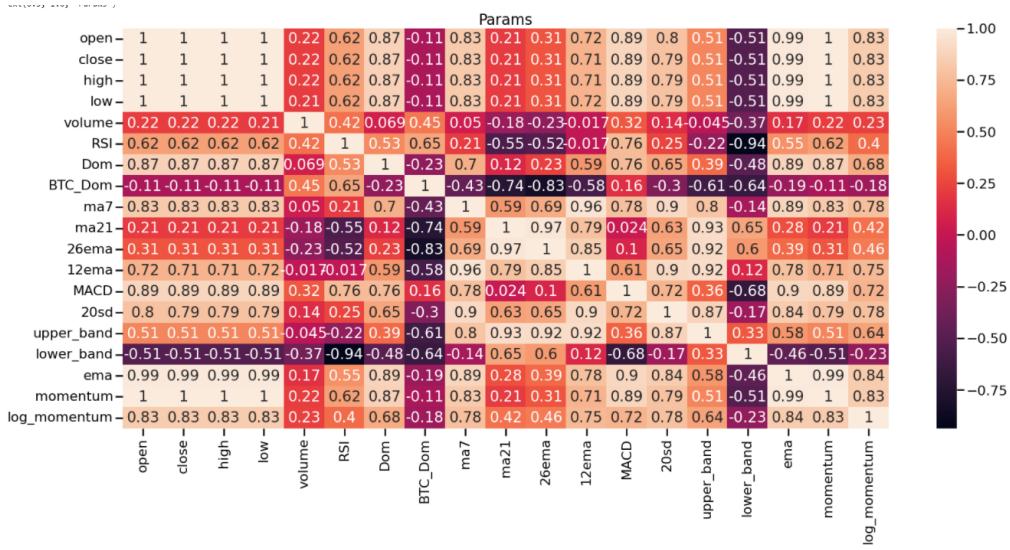


Figure 4.149: XRP(1d) dataset correlation 7.

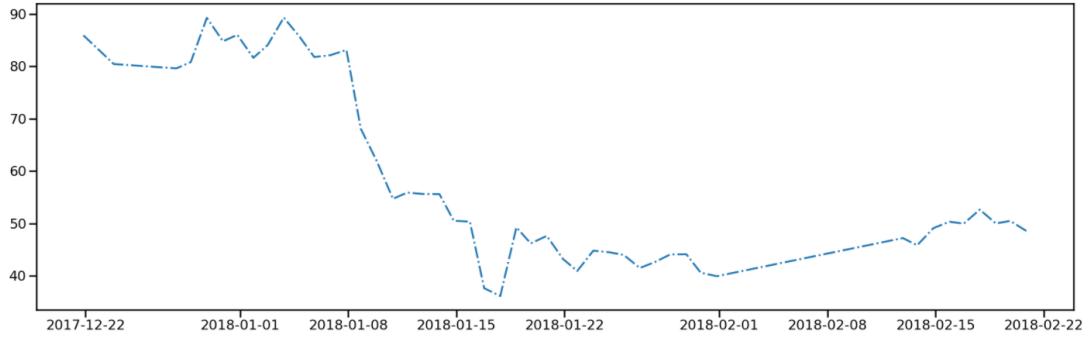


Figure 4.150: XRP(1d) dataset indicator1 7.

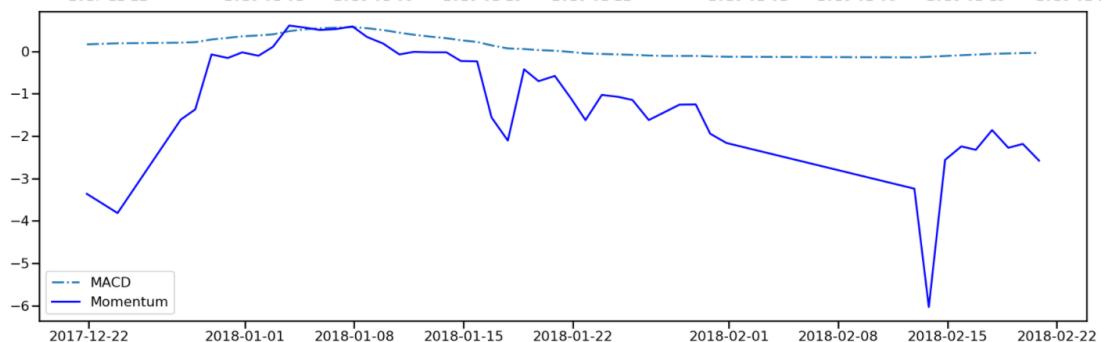


Figure 4.151: XRP(1d) dataset indicator2 7.

Performance measurements of the model used for closing price prediction

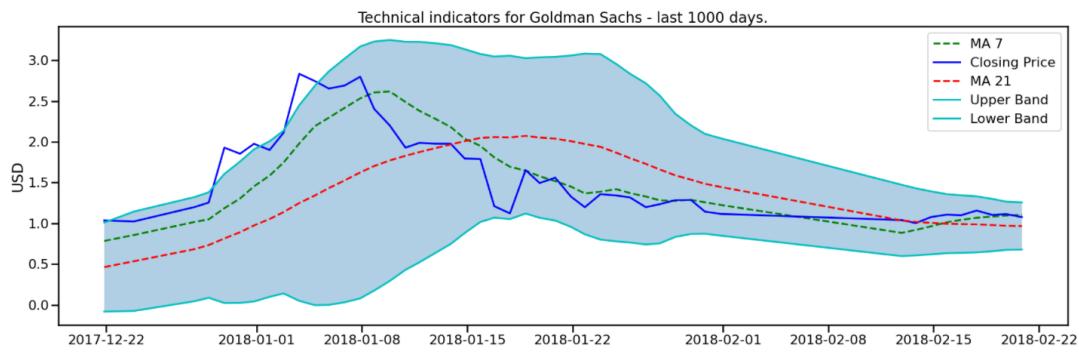


Figure 4.152: XRP(1d) dataset indicator3 7.

Table 4.24: XRP(1d) Dataset LSTM Model Result 7.

Parameters	Quantity
Model Evaluate	5.99%
Mean Absolute Error	17.46%
Mean Squared Error	5.99%
$R^2$	-1806.00%

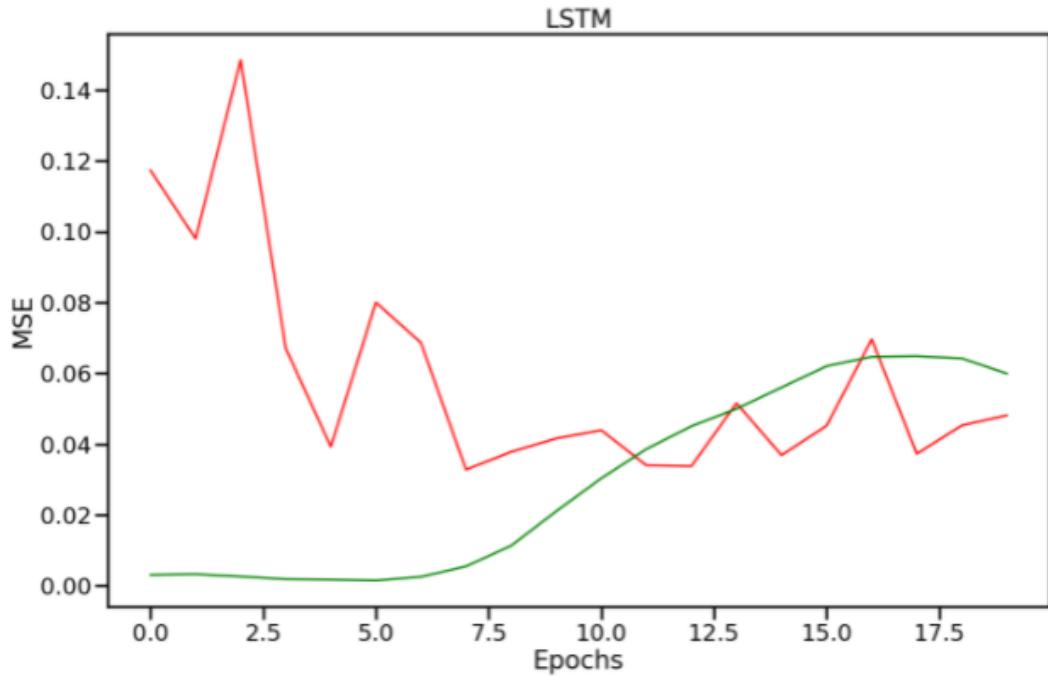


Figure 4.153: XRP(1d) dataset model epoch graphic 7.

## 4.6. Closing price prediction with Ripple 12-hour data

4 datasets have been prepared for the Ripple 12-hour dataset.

These datasets are:

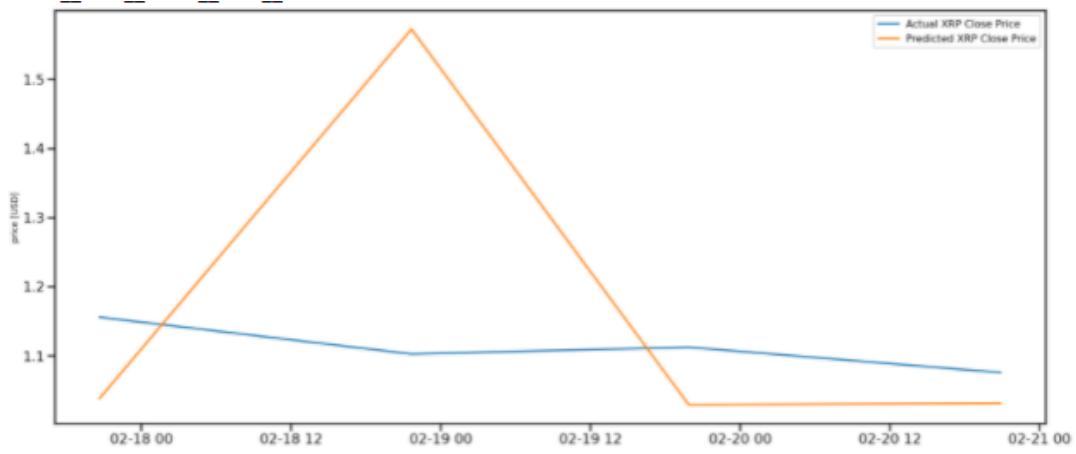


Figure 4.154: XRP(1d) dataset predition graphic 7.

time	open	close	high	low	volume	RSI	Dom	BTC_Dom	ma7	ma21	26ema	12ema	MACD	20sd	upper_band	lower_band	ema	momentu	log_momentum	RSI_MACD_Prediction
12/21/2017 21:00	1.035	1.0346	1.0357	1.0281	127865.2	85.92047	4.77	45.38	0.783297	0.462289	0.505102	0.66985	0.164749	0.27298	1.008249375	-0.083672232	0.934833	0.0346	-3.863901597	
12/23/2017 20:13	1.022	1.0224	1.0184	36462.44	80.43438	8.38	44.58	0.855664	0.533807	0.575277	0.7631	0.187824	0.304928	1.143662207	-0.076048874	1.000759	0.022	-3.816712826		
12/27/2017 21:26	1.1972	1.1996	1.2028	1.1943	402176.1	79.61243	7.17	45.56	1.016887	0.683181	0.695977	0.898233	0.202256	0.319519	1.322218627	0.04141423	1.126414	0.1996	-1.611439915	
12/28/2017 19:40	1.25	1.2539	1.2553	1.25	179759.7	80.81263	8.77	44.03	1.048164	0.732855	0.737304	0.852951	0.215647	0.323462	1.379779299	0.085931177	1.211405	0.2539	-1.37081479	
12/29/2017 20:40	1.9277	1.928	1.9413	1.9237	791706.6	89.26308	10.18	43.04	1.185023	0.813484	0.825504	1.102599	0.277455	0.396002	1.605487015	0.021480604	1.689135	0.928	-0.074723346	
2/17/2018 20:40	1.1563	1.1558	1.1565	1.1557	3907.885	52.6249	9.21	35.37	1.06682	0.986541	1.097444	1.036308	-0.06114	0.172042	1.330625595	0.642457262	1.135443	0.1558	-1.859182146	1.038544132
2/18/2018 21:40	1.1024	1.1026	1.1024	4887.154	49.58448	9.16	36.16	1.082971	0.977903	1.097826	1.046506	-0.05132	0.160529	1.29896115	0.656645517	1.113548	0.1026	-2.276917346	1.57205413	
2/19/2018 19:53	1.1107	1.1124	1.1124	1.1101	16179.84	50.47741	9.02	37	1.093443	0.96967	1.098905	1.056644	-0.04226	0.147913	1.265495525	0.67384475	1.112783	0.1124	-2.185691342	1.029285452
2/20/2018 20:53	1.0762	1.0758	1.0762	2550.72	48.55284	8.92	37.4	1.103929	0.96647	1.097194	1.059591	-0.0376	0.144667	1.255803356	0.677136644	1.088128	0.0758	-2.579656986	1.031366364	

Figure 4.155: XRP(1d) dataset predition data table 7.

- XRP : Open Price, Close Price, High Price, Low Price, Volume
- XRP : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD
- XRP : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD, BTC Close Price
- XRP : Open Price, Close Price, High Price, Low Price, Volume, BTC Close Price, RSI, MACD, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

#### 4.6.1. XRP(12h) : Open Price, Close Price, High Price, Low Price, Volume

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

Correlation of parameters used for closing price prediction



Figure 4.156: XRP(12h) dataset graphic 1.

	open	close	high	low	volume	edit
time						
2017-05-20 06:00:00	0.32108	0.32080	0.32108	0.32080	32.009009	
2017-05-20 17:06:40	0.34864	0.34864	0.34864	0.34864	55.000000	
2017-05-21 07:00:00	0.36100	0.36100	0.36100	0.36100	1.184000	
2017-05-21 18:06:40	0.33559	0.33559	0.33559	0.33559	181.000000	
2017-05-22 05:13:20	0.31761	0.31755	0.31761	0.31755	3011.576218	
...	...	...	...	...	...	...
2021-10-29 06:46:40	1.06780	1.06790	1.06790	1.06780	6285.247346	
2021-10-29 17:53:20	1.07710	1.07670	1.07730	1.07570	202188.000000	
2021-10-30 07:46:40	1.10600	1.10600	1.10600	1.10600	944.850270	
2021-10-30 18:53:20	1.07640	1.07640	1.07640	1.07640	443.480000	
2021-10-31 06:00:00	1.12090	1.11920	1.12100	1.11920	13903.848190	

3249 rows × 5 columns

Figure 4.157: XRP(12h) dataset table 1.

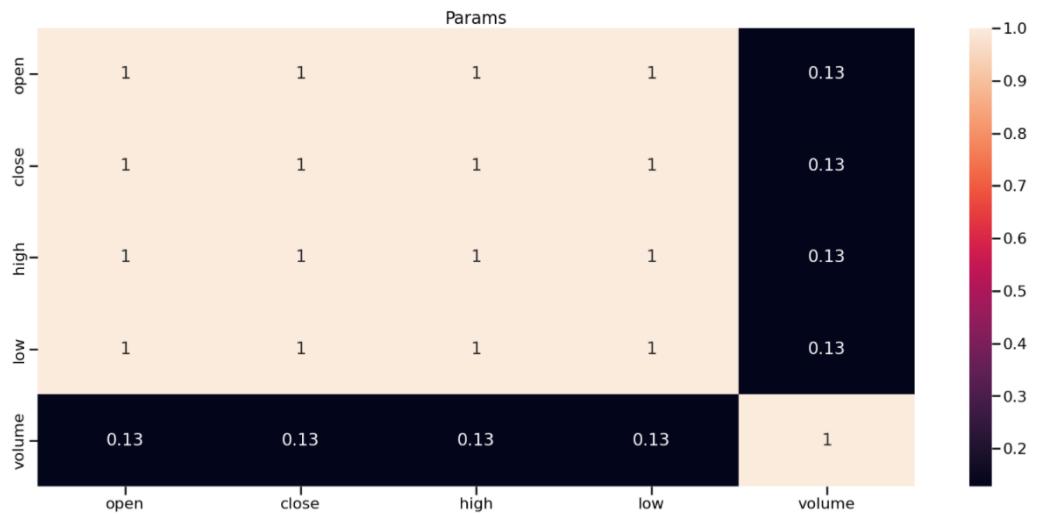


Figure 4.158: XRP(12h) dataset correlation 1.

Performance measurements of the model used for closing price prediction

Table 4.25: XRP(12h) Dataset LSTM Model Result 1.

Parameters	Quantity
Model Evaluate	2.21%
Mean Absolute Error	7.33%
Mean Squared Error	2.21%
$R^2$	94.81%

#### 4.6.2. XRP(12h) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

Correlation of parameters used for closing price prediction

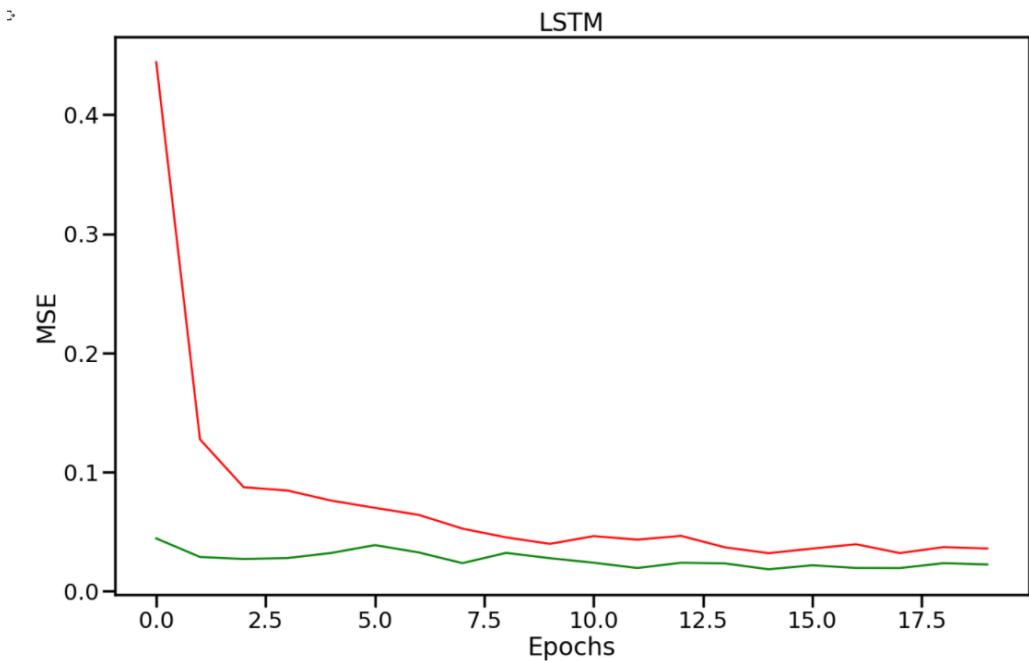


Figure 4.159: XRP(12h) dataset model epoch graphic 1.

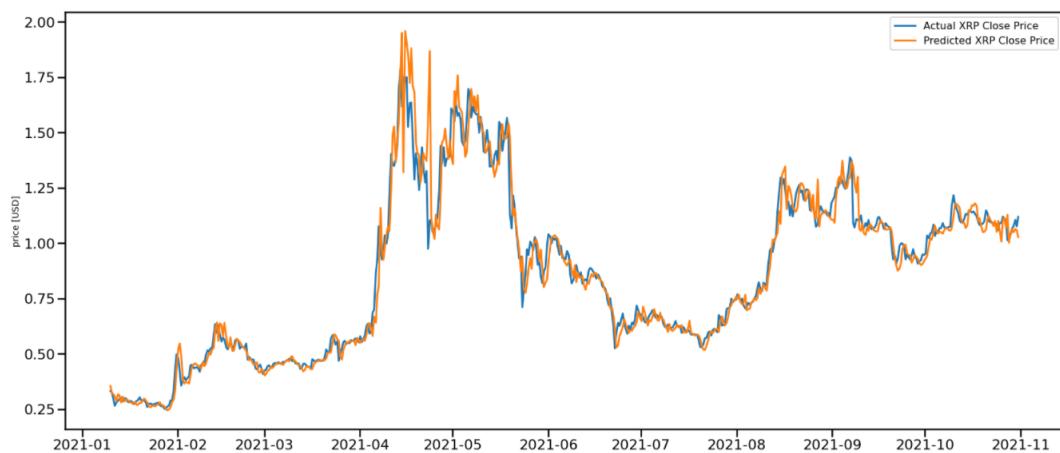


Figure 4.160: XRP(12h) dataset predition graphic 1.

time	open	close	high	low	volume	Classic_prediction
1/1/2017 17:00	8.315	8.3493	8.3493	8.315	56.01625	
1/2/2017 4:06	8.2438	8.2438	8.2438	8.2438	50	
1/2/2017 15:13	8.306	8.2867	8.306	8.2867	22.281	
1/3/2017 5:06	8.3842	8.3853	8.3853	8.3842	50	
10/28/2021 19:40	4172.8	4167.7	4173.9	4161.851	32.05534	4076.592024
10/29/2021 6:46	4351.4	4351	4352.4	4350.4	20.27377	4253.925564
10/29/2021 17:53	4384.1	4377.2	4384.854	4377.2	20.76097	4415.02266
10/30/2021 7:46	4367	4366.1	4367	4365.5	2.715031	4520.789743
10/30/2021 18:53	4312.263	4311.9	4312.3	4311.5	0.2585	4484.133721
10/31/2021 6:00	4312.7	4316.3	4316.3	4312.7	11.23035	4423.535338

Figure 4.161: XRP(12h) dataset predition data table 1.



Figure 4.162: XRP(12h) dataset graphic 2.

	open	close	high	low	volume	RSI	MACD	time
2017-05-27 07:26:40	0.19992	0.19983	0.19992	0.19983	1300.000000	34.437154	-0.016978	
2017-05-27 18:33:20	0.21842	0.21843	0.21843	0.21842	454.766803	37.650602	-0.021026	
2017-05-28 05:40:00	0.21921	0.21921	0.21921	0.21921	2.710000	37.788308	-0.023895	
2017-05-28 19:33:20	0.20407	0.20408	0.20408	0.20407	600.000000	36.121761	-0.027078	
2017-05-29 06:40:00	0.20700	0.20700	0.20700	0.20700	59.726210	36.701962	-0.029030	
...								
2021-10-29 06:46:40	1.06780	1.06790	1.06790	1.06780	6285.247346	46.631276	-0.012788	
2021-10-29 17:53:20	1.07710	1.07670	1.07730	1.07570	202188.000000	48.422953	-0.011454	
2021-10-30 07:46:40	1.10600	1.10600	1.10600	1.10600	944.850270	53.964548	-0.007941	
2021-10-30 18:53:20	1.07640	1.07640	1.07640	1.07640	443.480000	48.316684	-0.007459	
2021-10-31 06:00:00	1.12090	1.11920	1.12100	1.11920	13903.848190	55.559269	-0.003583	

3235 rows × 7 columns

Figure 4.163: XRP(12h) dataset table 2.

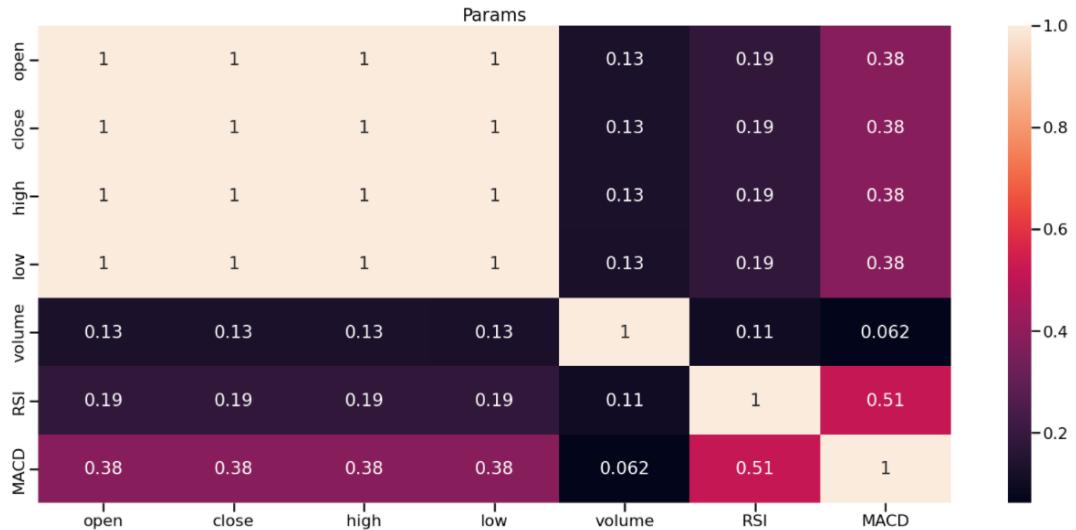


Figure 4.164: XRP(12h) dataset correlation 2.

Performance measurements of the model used for closing price prediction

Table 4.26: XRP(12h) Dataset LSTM Model Result 2.

Parameters	Quantity
Model Evaluate	4.17%
Mean Absolute Error	9.67%
Mean Squared Error	4.17%
$R^2$	90.23%

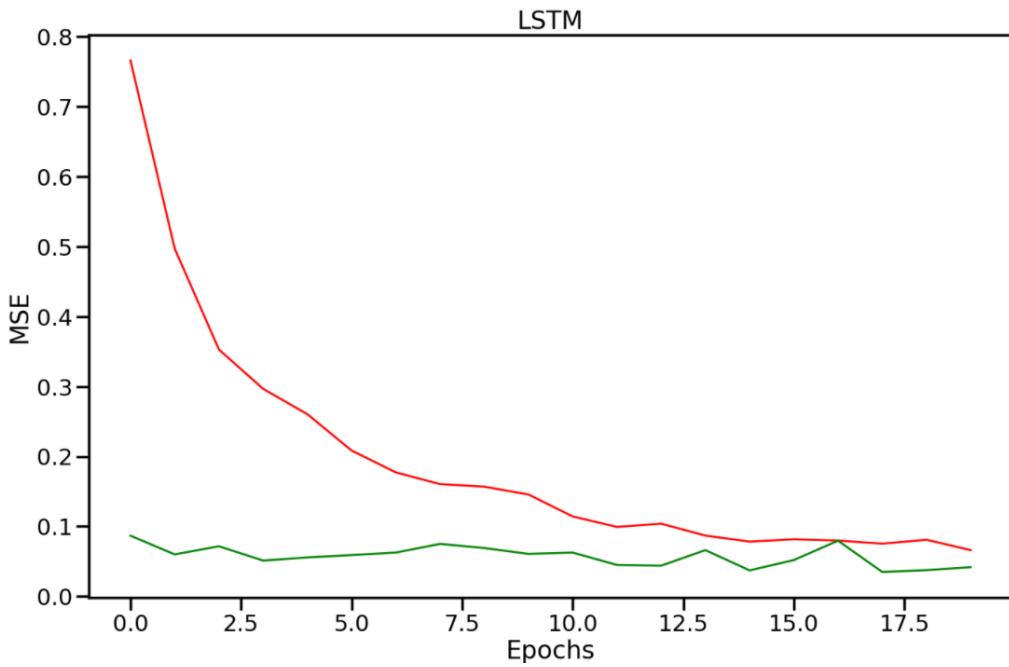


Figure 4.165: XRP(12h) dataset model epoch graphic 2.

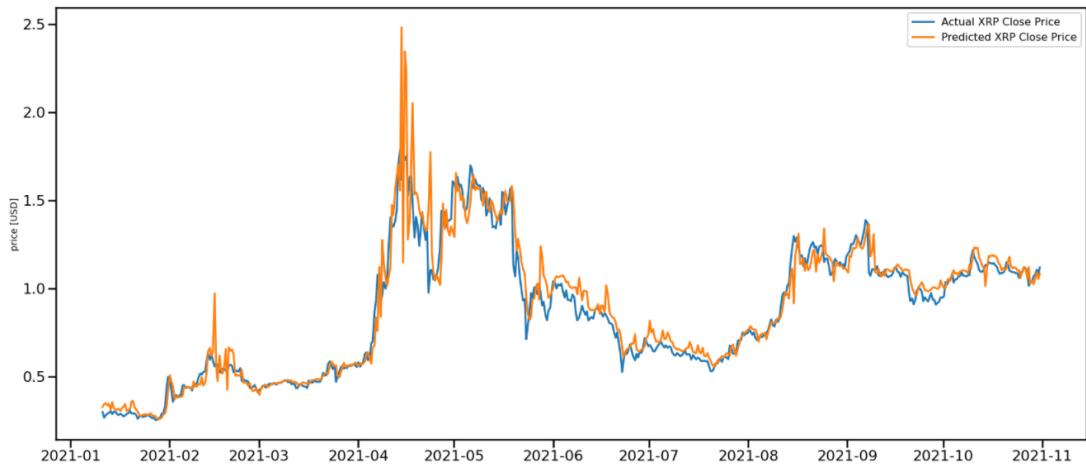


Figure 4.166: XRP(12h) dataset prediction graphic 2.

#### 4.6.3. XRP(12h) : Open Price, Close Price, High Price, Low Price, Volume, RSI, MACD, BTC Close Price

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

Correlation of parameters used for closing price prediction

time	open	close	high	low	volume	RSI	MACD	RSI_MACD_prediction
5/27/2017 7:26	0.19992	0.19983	0.19992	0.19983	1300	34.43715	-0.01698	
5/27/2017 18:33	0.21842	0.21843	0.21843	0.21842	454.7668	37.6506	-0.02103	
5/28/2017 5:40	0.21921	0.21921	0.21921	0.21921	2.71	37.78831	-0.0239	
5/28/2017 19:33	0.20407	0.20408	0.20408	0.20407	600	36.12176	-0.02708	
5/29/2017 6:40	0.207	0.207	0.207	0.207	59.72621	36.70196	-0.02903	
10/29/2021 6:46	1.0678	1.0679	1.0679	1.0678	6285.247	46.63128	-0.01279	1.02263051
10/29/2021 17:53	1.0771	1.0767	1.0773	1.0757	202188	48.42295	-0.01145	1.049927038
10/30/2021 7:46	1.106	1.106	1.106	1.106	944.8503	53.96455	-0.00794	1.090970569
10/30/2021 18:53	1.0764	1.0764	1.0764	1.0764	443.48	48.31668	-0.00746	1.053266006
10/31/2021 6:00	1.1209	1.1192	1.121	1.1192	13903.85	55.55927	-0.00358	1.083612395

Figure 4.167: XRP(12h) dataset prediction data table 2.



Figure 4.168: XRP(12h) dataset graphic 3.

time	open	close	high	low	volume	RSI	MACD	BTC_Close
2017-05-27 07:26:40	0.19992	0.19983	0.19992	0.19983	1300.000000	34.437154	-0.016978	1924.10000
2017-05-27 18:33:20	0.21842	0.21843	0.21843	0.21842	454.766803	37.650602	-0.021026	1936.80000
2017-05-28 05:40:00	0.21921	0.21921	0.21921	0.21921	2.710000	37.788308	-0.023895	2177.00000
2017-05-28 19:33:20	0.20407	0.20408	0.20408	0.20407	600.000000	36.121761	-0.027078	2042.40000
2017-05-29 06:40:00	0.20700	0.20700	0.20700	0.20700	59.726210	36.701962	-0.029030	2108.90000
...	...	...	...	...	...	...	...	...
2021-10-29 06:46:40	1.06780	1.06790	1.06790	1.06780	6285.247346	46.631276	-0.012788	60905.22958
2021-10-29 17:53:20	1.07710	1.07670	1.07730	1.07570	202188.000000	48.422953	-0.011454	61072.00000
2021-10-30 07:46:40	1.10600	1.10600	1.10600	1.10600	944.850270	53.964548	-0.007941	62527.00000
2021-10-30 18:53:20	1.07640	1.07640	1.07640	1.07640	443.480000	48.316684	-0.007459	61672.00000
2021-10-31 06:00:00	1.12090	1.11920	1.12100	1.11920	13903.848190	55.559269	-0.003583	61511.60438

3235 rows x 8 columns

Figure 4.169: XRP(12h) dataset table 3.



Figure 4.170: XRP(12h) dataset correlation 3.

Performance measurements of the model used for closing price prediction

Table 4.27: XRP(12h) Dataset LSTM Model Result 3.

Parameters	Quantity
Model Evaluate	4.86%
Mean Absolute Error	9.75%
Mean Squared Error	4.86%
$R^2$	88.60%

#### 4.6.4. XRP(12h) : Open Price, Close Price, High Price, Low Price, Volume, BTC Close Price, RSI, MACD, MA7, MA21, 26EMA, 12EMA, 20SD, Upper Band, Lower Band, EMA, Momentum, Log Momentum

The predictions came true with the above-mentioned attributes.

data table used for closing price prediction

Correlation of parameters used for closing price prediction

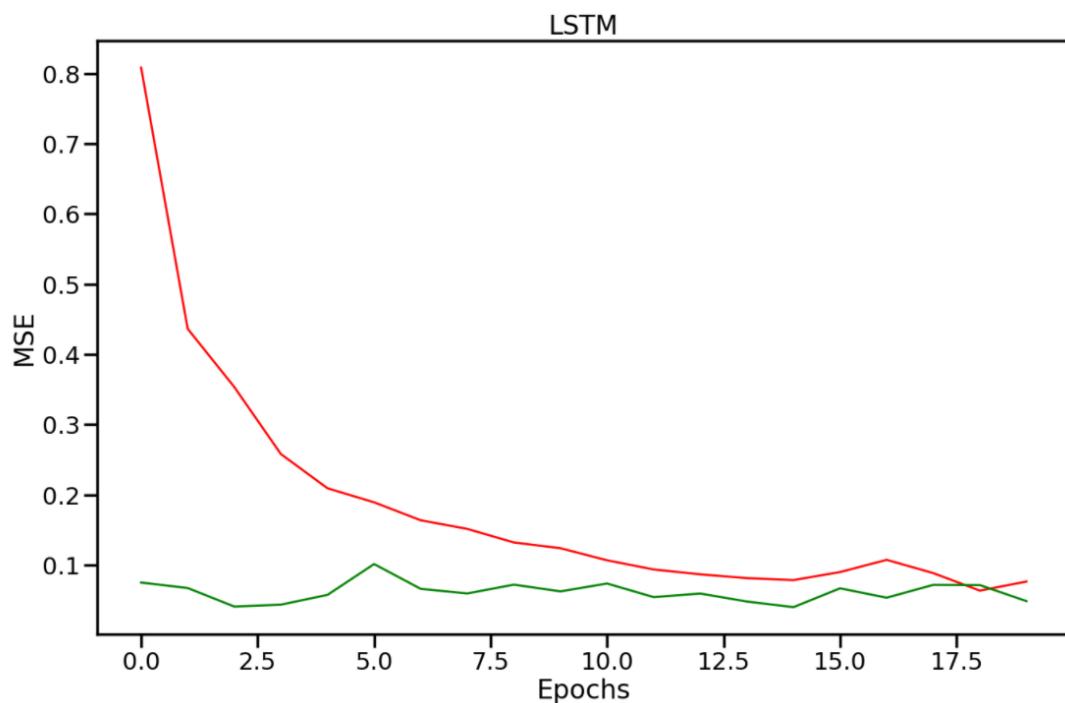


Figure 4.171: XRP(12h) dataset model epoch graphic 3.

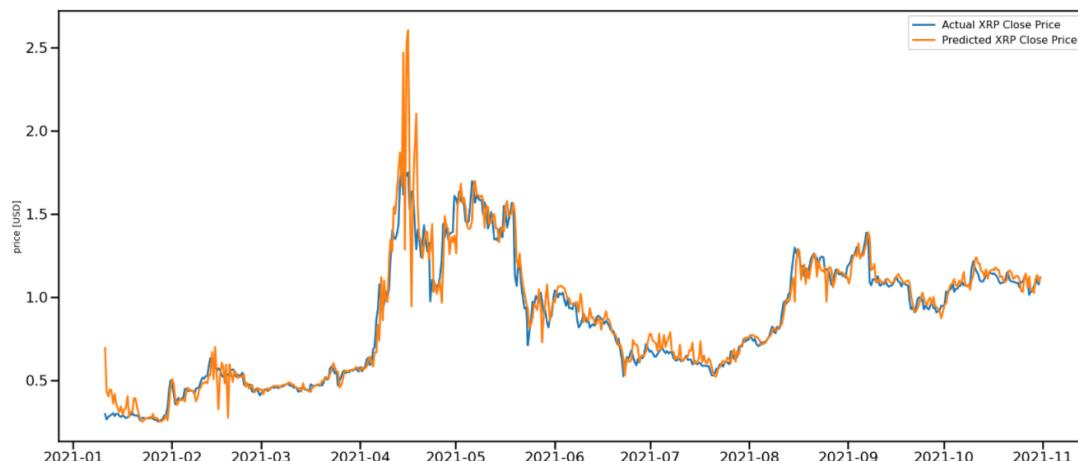


Figure 4.172: XRP(12h) dataset prediction graphic 3.

time	open	close	high	low	volume	RSI	MACD	BTC_Close	RSI_MACD_BTC_Close_prediction
5/27/2017 7:26	0.19992	0.19983	0.19992	0.19983	1300	34.43715	-0.01698	1924.1	
5/27/2017 18:33	0.21842	0.21843	0.21843	0.21842	454.7668	37.6506	-0.02103	1936.8	
5/28/2017 5:40	0.21921	0.21921	0.21921	0.21921	2.71	37.78831	-0.0239	2177	
5/28/2017 19:33	0.20407	0.20408	0.20408	0.20407	600	36.12176	-0.02708	2042.4	
5/29/2017 6:40	0.207	0.207	0.207	0.207	59.72621	36.70196	-0.02903	2108.9	
10/28/2021 19:40	1.0414	1.0399	1.0436	1.0385	46595.76	40.52732	-0.01341	58891.79	1.049622254
10/29/2021 6:46	1.0678	1.0679	1.0679	1.0678	6285.247	46.63128	-0.01279	60905.23	1.024919367
10/29/2021 17:53	1.0771	1.0767	1.0773	1.0757	202188	48.42295	-0.01145	61072	1.108935951
10/30/2021 7:46	1.106	1.106	1.106	1.106	944.8503	53.96455	-0.00794	62527	1.13397154
10/30/2021 18:53	1.0764	1.0764	1.0764	1.0764	443.48	48.31668	-0.00746	61672	1.092777201
10/31/2021 6:00	1.1209	1.1192	1.121	1.1192	13903.85	55.55927	-0.00358	61511.6	1.115080673

Figure 4.173: XRP(12h) dataset prediction data table 3.



Figure 4.174: XRP(12h) dataset graphic 4.

	open	close	high	low	volume	RSI	MACD	?
time								
2017-05-27 07:26:40	0.19992	0.19983	0.19992	0.19983	1300.000000	34.437154	-0.016978	
2017-05-27 18:33:20	0.21842	0.21843	0.21843	0.21842	454.766803	37.650602	-0.021026	
2017-05-28 05:40:00	0.21921	0.21921	0.21921	0.21921	2.710000	37.788308	-0.023895	
2017-05-28 19:33:20	0.20407	0.20408	0.20408	0.20407	600.000000	36.121761	-0.027078	
2017-05-29 06:40:00	0.20700	0.20700	0.20700	0.20700	59.726210	36.701962	-0.029030	
...	...	...	...	...	...	...	...	...
2021-10-29 06:46:40	1.06780	1.06790	1.06790	1.06780	6285.247346	46.631276	-0.012788	
2021-10-29 17:53:20	1.07710	1.07670	1.07730	1.07570	202188.000000	48.422953	-0.011454	
2021-10-30 07:46:40	1.10600	1.10600	1.10600	1.10600	944.850270	53.964548	-0.007941	
2021-10-30 18:53:20	1.07640	1.07640	1.07640	1.07640	443.480000	48.316684	-0.007459	
2021-10-31 06:00:00	1.12090	1.11920	1.12100	1.11920	13903.848190	55.559269	-0.003583	

3235 rows × 7 columns

Figure 4.175: XRP(12h) dataset table 4.

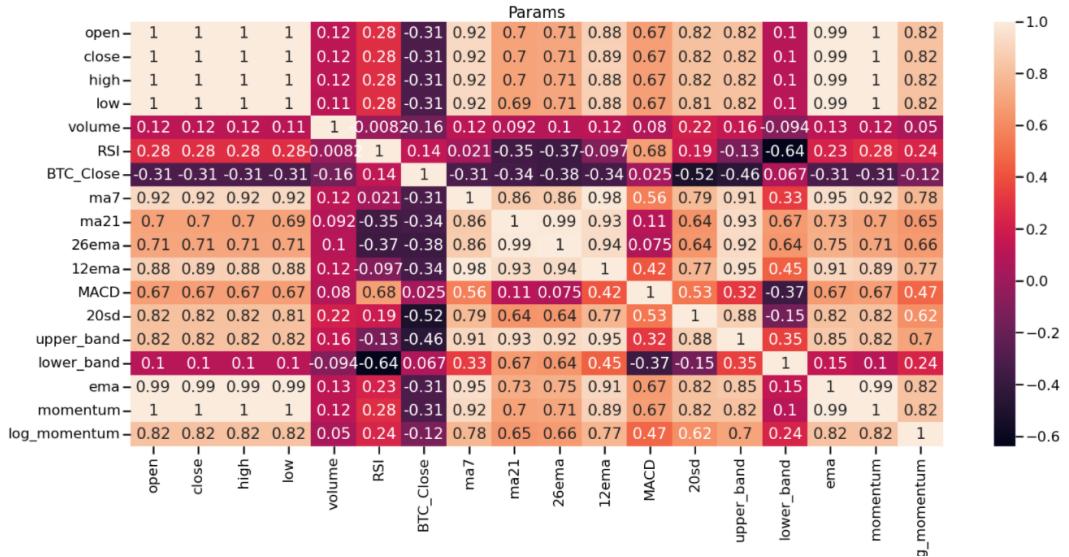


Figure 4.176: XRP(12h) dataset correlation 4.

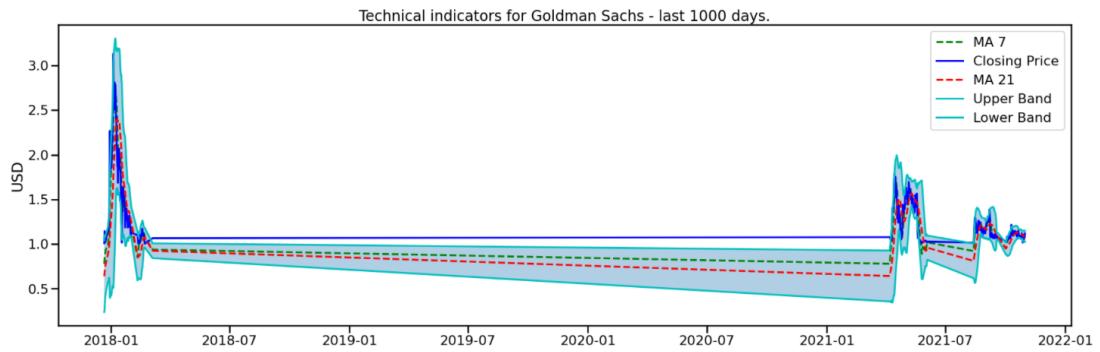


Figure 4.177: XRP(12h) dataset indicator1 4.

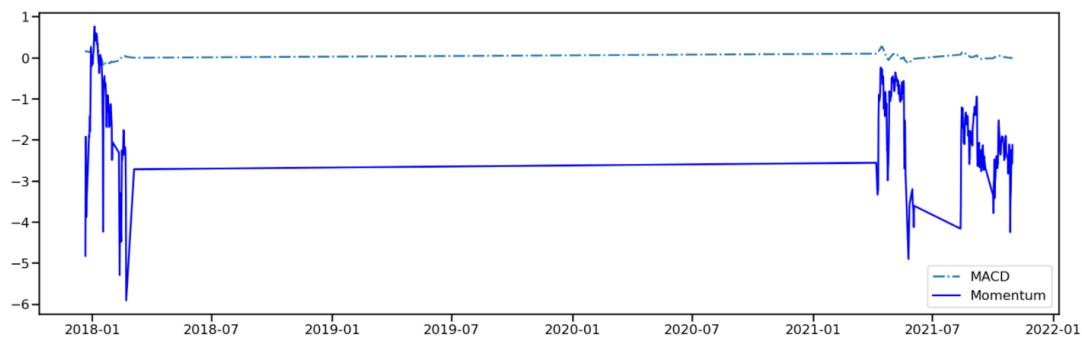


Figure 4.178: XRP(12h) dataset indicator2 4.

Performance measurements of the model used for closing price prediction

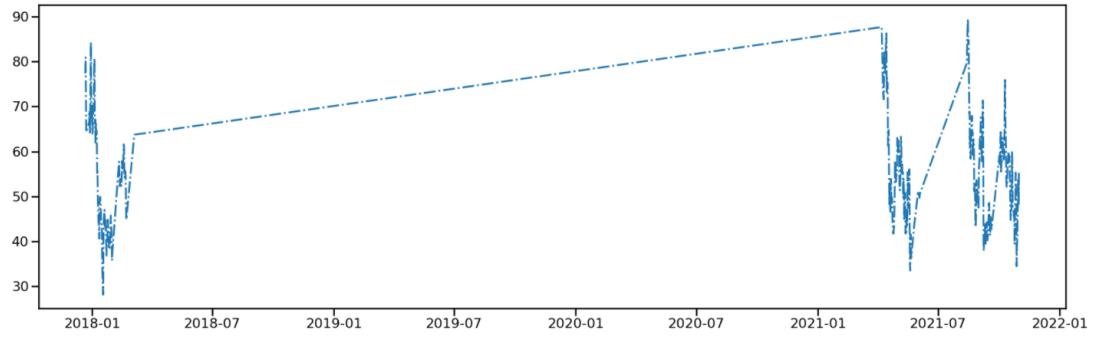


Figure 4.179: XRP(12h) dataset indicator3 4.

Table 4.28: XRP(12h) Dataset LSTM Model Result 4.

Parameters	Quantity
Model Evaluate	3.59%
Mean Absolute Error	15.78%
Mean Squared Error	3.59%
$R^2$	-8235.10%

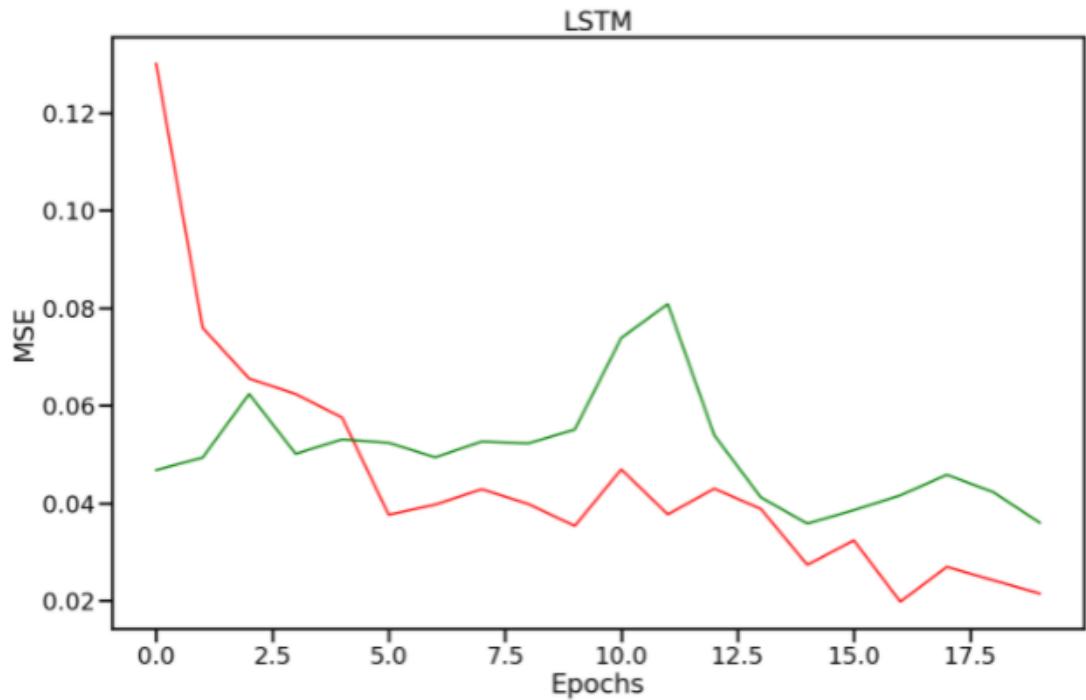


Figure 4.180: XRP(12h) dataset model epoch graphic 4.

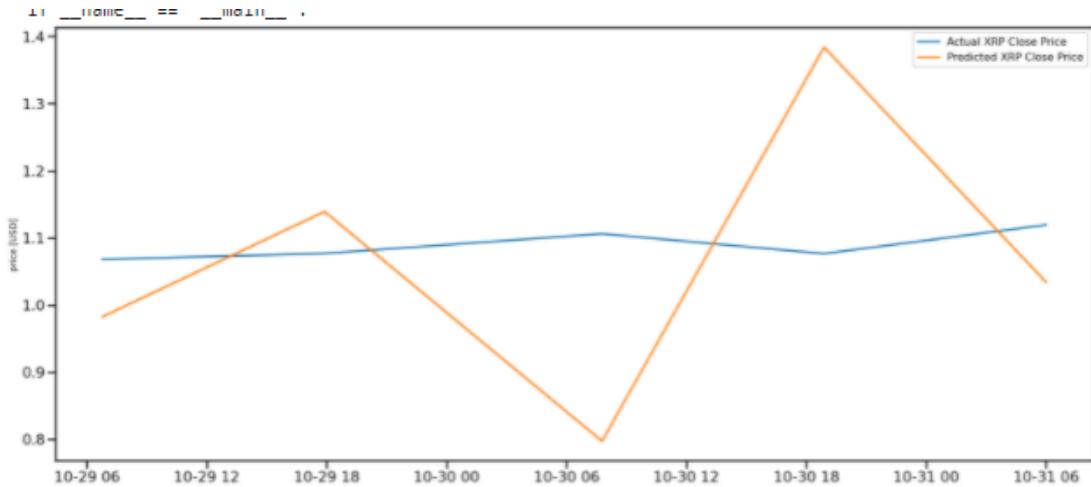


Figure 4.181: XRP(12h) dataset predition graphic 4.

time	open	close	high	low	volume	RSI	BTC_Close	ma7	ma21	26ema	12ema	MACD	20sd	upper_band	lower_band	ema	momentum	log_momentum
2017-10-21 12:40:00	1.0117	1.0080	1.0136	1.0080	296229.634000	77.344274	16471.000000	0.777809	0.638681	0.613088	0.745153	0.132064	0.200350	1.039380	0.237982	0.928785	0.0080	-4.828314
2017-10-22 02:33:20	1.1581	1.1460	1.1602	1.1402	320537.767800	80.922358	15609.000000	0.839249	0.681745	0.652563	0.606822	0.154258	0.207797	1.097340	0.286151	1.073588	0.1460	-1.924149
2017-10-23 00:46:40	1.0188	1.0205	1.0205	1.0177	52480.803950	64.281876	13879.000000	0.879570	0.743960	0.690616	0.840109	0.149493	0.167459	1.078877	0.409042	0.979621	0.0205	-3.887330
2017-10-23 14:40:00	1.0322	1.0330	1.0359	1.0281	43240.668640	64.654784	13840.000000	0.932440	0.7191670	0.715978	0.869785	0.153807	0.164695	1.101061	0.442279	1.015207	0.0330	-3.411248
2017-10-27 02:00:00	1.1428	1.1500	1.1500	1.1428	109973.270500	66.346170	15685.000000	0.980610	0.879361	0.830353	0.951450	0.131097	0.152412	1.184186	0.574537	1.095581	0.1500	-1.897120
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2021-10-29 06:46:40	1.0678	1.0679	1.0679	1.0678	6285.247346	46.631276	60905.22958	1.068929	1.087710	1.084639	1.071850	-0.012768	0.031923	1.151555	1.023684	1.058147	0.0679	-2.689719
2021-10-29 17:53:20	1.0771	1.0767	1.0773	1.0757	202188.000000	48.422953	61072.000000	1.063671	1.087210	1.084051	1.072598	-0.011454	0.032013	1.151236	1.023183	1.070516	0.0767	-2.567854
2021-10-30 07:46:40	1.1060	1.1060	1.1060	1.1060	944.850270	53.96454	62527.000000	1.062629	1.088643	1.085677	1.077735	-0.007941	0.032275	1.152593	1.023493	1.094172	0.1060	-2.244316
2021-10-30 18:53:20	1.0764	1.0764	1.0764	1.0764	443.480000	48.316684	61672.000000	1.059000	1.086952	1.084989	1.077530	-0.007459	0.032263	1.151477	1.022427	1.082324	0.0764	-2.571773
2021-10-31 06:00:00	1.1209	1.1192	1.1210	1.1192	13903.848190	55.559269	61511.60438	1.074000	1.085548	1.087523	1.083941	-0.003583	0.030003	1.145553	1.025542	1.106908	0.1192	-2.126953

Figure 4.182: XRP(12h) dataset predition data table 4.

## 4.7. Conclusion

The datasets used for prediction in the project were compared.

Data Type	Model Evaluate	Mean Absolute Error	Mean Squared Error	R2 Score
BTC:open,close,low,high,volume	0.008603265	0.058854312	0.008603265	0.935141435
BTC:open,close,low,high,volume,Dom	0.006908506	0.055472953	0.006908505	0.947917948
BTC:open,close,low,high,volume,Dom,RSI	0.007281584	0.060292361	0.007281584	0.945011528
BTC:open,close,low,high,volume,Dom,RSI,MACD	0.014176468	0.076972543	0.014176468	0.892943302
BTC:open,close,low,high,volume,Dom,All_Indicator	0.014285025	0.073218391	0.014285023	0.892187408
ETH:open,close,low,high,volume	0.01272659	0.074361631	0.01272659	0.830416082
ETH:open,close,low,high,volume,Dom	0.017473988	0.084033873	0.017473985	0.767156271
ETH:open,close,low,high,volume,Dom,BTC_Dom,RSI	0.020814842	0.088305319	0.020814838	0.717803776
ETH:open,close,low,high,volume,Dom,BTC_Dom,RSI,MACD	0.046221569	0.123798717	0.046221572	0.373353139
ETH:open,close,low,high,volume,Dom,BTC_Dom,All_Indicator	0.079702519	0.155273084	0.07970253	-0.08489185
XRP:open,close,low,high,volume	0.019520205	0.105292966	0.019520206	0.400446307
XRP:open,close,low,high,volume,Dom	0.022748362	0.098643635	0.022748362	0.301295069
XRP:open,close,low,high,volume,Dom,BTC_Dom	0.036276754	0.121025848	0.036276752	-0.114222896
XRP:open,close,low,high,volume,Dom,RSI	0.021593606	0.11264496	0.021593604	0.345730145
XRP:open,close,low,high,volume,Dom,BTC_Dom,RSI	0.042754486	0.151710934	0.042754484	-0.295428505
XRP:open,close,low,high,volume,BTC_Dom,MACD,RSI	0.380449891	0.281444193	0.380449841	-10.52734213
XRP:open,close,low,high,volume,MACD,RSI	0.374919891	0.273479686	0.374919863	-10.35978798
XRP:open,close,low,high,volume,Dom,BTC_Dom,All_Indicator	0.05990883	0.17462849	0.059908813	-18.06002259
BTC12h:open,close,low,high,volume	0.002374454	0.030349371	0.002374454	0.969974925
BTC12h:open,close,low,high,volume,rsi,macd	0.005485649	0.038960814	0.005485649	0.930859172
BTC12h:open,close,low,high,volume,all_indicator	0.004312093	0.039230388	0.004312094	0.94571319
ETH12h:open,close,low,high,volume	0.008380042	0.050530839	0.008380044	0.934912548
ETH12h:open,close,low,high,volume,RSI,MACD	0.01168881	0.055859157	0.011688811	0.909635456
ETH12h:open,close,low,high,volume,RSI,MACD,BTC_Close	0.012236139	0.054162681	0.012236139	0.905404136
ETH12h:open,close,low,high,volume,BTC_Close,All_Indicator	0.013951727	0.053649127	0.013951727	0.892308435
XRP12h:open,close,low,high,volume	0.02212389	0.07326876	0.022123891	0.948128432
XRP12h:open,close,low,high,volume,RSI,MACD	0.041656245	0.096721583	0.041656244	0.902319736
XRP12h:open,close,low,high,volume,RSI,MACD,BTC_Close	0.04862852	0.09749599	0.048628524	0.885970345
XRP12h:open,close,low,high,volume,BTC_Close,All_Indicator	0.014798624	0.113535489	0.014798622	-33.32192904

Figure 4.183: Performance Metrics result of models.

#### 4.7.1. Bitcoin closing price prediction(1d)

The most accurate prediction was "open price, close price, low price, high price, volume, Dominance" given the database with these attributes.

time	open	close	high	low	volume	Classic_Prediction	RSI_MACD_Prediction	RSI_DOM_Prediction	RSI_MACD_DOM_Prediction	All_Prediction
1/1/2016 23:13	433.79	433.8	433.8	433.79	5.7574					
1/2/2016 21:26	433.73	433.7	433.73	433.7	1.780218					
1/3/2016 22:26	426.31	426.3	426.31	426.3	4.5					
1/4/2016 20:40	434.22	434.2	434.22	434.2	0.071477					
1/5/2016 21:40	431.81	432.07	432.07	431.81	8.209369					
1/6/2016 22:40	430.57	430.56	430.57	430.56	4.134743					
1/7/2016 20:53	456.2	456.2	456.2	456.2	0.22					
1/8/2016 21:53	452.47	453.8	454	452.47	138.1117					
9/4/2019 18:00	10640	10640.1	10640.68	10640	0.668207	9826.797959	11191.21341	10860.04263	10509.52309	10290.87659
9/5/2019 19:00	10530.93	10530.94	10530.94	10530.05	0.959072	10412.55439	10759.43607	10789.21421	10565.18129	10576.39612
9/6/2019 17:13	10400.06	10416.94	10426.77	10380.09	11.41827	10535.0633	10824.52089	10790.55004	10667.68021	10639.03019
9/7/2019 18:13	10549	10553	10556	10543	0.62739	10503.66396	10687.96982	10732.03107	10542.69298	10597.49305
9/8/2019 19:13	10390	10389.19	10390	10389.19	0.065	10454.63446	10709.17421	10692.88885	10443.46416	10731.6894
9/9/2019 17:26	10295	10294.12	10295	10294.12	0.2	10557.66752	10716.67866	10559.91095	10443.75337	10615.98988
9/10/2019 18:26	10225	10224	10225	10224	0.294467	10136.71322	10739.50645	10428.05494	10468.69807	10263.53661
9/11/2019 19:26	10099	10099	10099	10098	0.4961	10431.26573	10418.51409	10306.00939	10257.63161	10392.04204
9/12/2019 17:40	10343.89	10343.34	10343.89	10343	0.1655	10358.55431	10237.81464	10155.8604	10138.76003	10203.01066
9/13/2019 18:40	10263	10266	10268	10261	3.065	10383.61672	10355.86765	10263.97147	10257.69668	10313.61898
9/14/2019 16:53	10410	10410	10410.34	10410	0.075	10404.98925	10373.5859	10253.28352	10297.3216	10304.48439
9/15/2019 17:53	10326	10326	10326	10326	0.115	10354.06849	10502.1901	10307.34597	10388.0722	10457.68764
9/16/2019 18:53	10164	10164	10164	10164	0.06161	10434.18381	10523.24335	10416.50591	10368.74857	10374.77745
9/17/2019 17:06	10252.99	10250	10253	10250	2.268402	10328.74996	9926.880876	10217.52926	8349.285815	9637.627763
9/18/2019 18:06	10234	10227	10234.9	10224	12.00242	10158.65524	10442.97053	10213.93398	10194.47256	10344.31854
9/19/2019 19:06	10056	10059	10059	10054	0.315802	10116.94136	9810.789369	9990.811212	10029.20213	10011.01121
9/20/2019 17:20	10168	10168	10168	10168	0.031689	9888.680781	10186.06159	10053.09597	10328.71124	10154.87978
9/21/2019 18:20	10004	10005	10005	10004	3.025	10173.4333	10326.18898	10050.39746	10143.07664	10190.46271
9/22/2019 19:20	9987.8	9987.2	9988.5	9987	1.58775	9833.035594	10117.65602	9801.955401	10048.68481	9999.125654
9/23/2019 17:33	9835	9836.2	9837.6	9834.9	0.259004	9750.525355	11684.50952	8892.422915	9677.271843	9429.253936

Figure 4.184: BTC(1d) combining forecasts.

#### 4.7.2. Bitcoin closing price prediction(12h)

The most accurate prediction was "open price, close price,low price, high price, volume" by the database with attributeerror.

time	open	close	high	low	volume	Classic_Prediction	RSI_Macd_Prediction	All_Indicator_Prediction
1/1/2016 10:00	431.39	431.39	431.39	431.39	0.07			
1/1/2016 22:01	433.79	433.8	433.8	433.79	5.7574			
1/2/2016 10:01	433.3	433.41	433.41	433.3	10.196			
1/2/2016 22:01	433.73	433.7	433.73	433.7	1.780218			
1/3/2016 10:04	429.16	429.09	429.16	429.09	0.020868			
1/3/2016 22:04	426.48	426.57	426.57	426.48	17.02			
1/4/2016 10:04	430.67	430.67	430.67	430.67	2			
10/19/2021 17:36	63250	63236.24	63257	63219	2.444457	62995.64329	63970.74592	67839.48654
10/20/2021 5:36	63815.84	63767	63815.84	63731	7.847585	63466.49531	66081.67978	64277.4284
10/20/2021 17:36	66419	66415	66420	66415	2.874375	63860.40741	64279.18185	63469.67024
10/21/2021 5:36	64992	65020	65036.77	64973.87	8.042261	66434.22076	66209.68738	66710.19935
10/21/2021 17:36	62980	62985	63020	62968	9.681952	65581.11789	65393.2855	66437.52235
10/22/2021 5:36	62897	62930	62930	62897	0.279803	63589.76136	63605.4847	64709.12978
10/22/2021 17:36	60814	60811	60814	60772	0.746239	63168.58108	62895.21107	64260.25502
10/23/2021 5:36	61016	61033	61033	61016	0.038156	61526.25371	61206.8041	61682.95126
10/23/2021 17:36	61035	61031	61035	61030	0.039928	60750.95472	60647.49694	62228.66996
10/24/2021 5:36	61057.25	61058.07	61058.07	61057.25	0.005478	60955.13499	60734.37602	62333.43362
10/24/2021 17:36	60403	60407	60440.23	60403	1.638387	60820.79167	60722.33203	62138.26687
10/25/2021 5:36	61978	61980	61999	61975	0.200138	60526.9769	60436.28215	61837.75006
10/25/2021 17:36	62903	62917	62950	62900	2.615663	61997.37569	61633.52739	63022.60782
10/26/2021 5:36	62514	62500	62514.37	62500	6.173248	63024.88826	60861.45511	62457.42256
10/26/2021 17:36	62348	62356.97	62374	62342.95	1.411722	62440.41666	61428.45794	63521.37067
10/27/2021 5:36	60960	60874	60961	60874	3.738136	62840.95259	62795.69144	63807.46508
10/27/2021 17:36	59001	58962	59001	58961	0.591123	61188.2966	61224.42917	62454.462
10/28/2021 5:36	58882	58891.79	58937	58871	2.477215	59580.73416	59121.45089	60653.00471
10/28/2021 17:36	60905	60905.23	60930	60905	3.00887	58998.95902	58912.09001	59900.77366
10/29/2021 5:36	61087	61072	61087	61072	1.458732	60575.81712	60486.17955	61653.39138
10/29/2021 17:36	62556	62527	62564.08	62496	2.060607	61333.85038	61182.98429	62316.61046
10/30/2021 5:36	61615.29	61672	61672	61615	6.153162	62915.27477	60492.68136	65608.31705
10/30/2021 17:36	61556	61511.6	61558	61511.6	1.210133	60800.16829	61123.66955	62606.37386
10/31/2021 5:36	61351	61335.88	61352	61327.42	0.337975	62277.7177	62030.2903	62646.4804

Figure 4.185: BTC(12d) combining forecasts.

### 4.7.3. Ethereum closing price prediction(1d)

The most accurate prediction was "open price, close price,low price, high price, volume" by the database with attributeerror.

time	open	close	high	low	volume	Classic_Predict	Dom_Predict	Dom,RSI,BTC_dom	Dom_BTC_Dom_RSI_MACD_Predict	All_Indicator_Predict
1/2/2017 4:06	8.1921	8.1991	8.1991	8.1921	0.4					
1/3/2017 2:20	8.3211	8.3211	8.3211	8.3211	0.7574					
1/4/2017 3:20	10.4	10.4	10.4	10.391	266.5586					
1/5/2017 4:20	11.43	11.43	11.43	11.43	28.6771					
1/6/2017 2:33	9.9599	9.9599	9.9599	9.9599	0.1					
1/7/2017 3:33	9.581	9.5554	9.581	9.5554	39.6					
6/28/2019 16:40	307.21	306.78	307.21	306.78	4.172572	313.833087	331.2614249	324.2783526	348.2580437	293.0315131
6/29/2019 14:53	305.41	305.85	305.85	305.33	147.2026	317.8519392	314.0045776	321.8168139	302.2893501	290.8466337
6/30/2019 15:53	297.02	296.94	297.02	296.9	88.84308	332.3507257	347.7788061	370.0672383	396.9400002	491.0175792
7/1/2019 16:53	286.29	285.71	286.29	285.52	174.9976	299.7691728	315.7420324	307.5262494	326.615381	316.8687869
7/2/2019 15:06	288.56	288.6683	288.6683	288.56	1.119174	294.6638423	303.5546579	301.0154643	322.9699528	301.5167421
7/3/2019 16:06	295.42	295.41	295.42	295.41	2.25	292.8599746	297.1294907	297.0045643	310.7346343	279.7367304
7/4/2019 17:06	294.5061	294.42	294.5061	294.39	18.22084	250.0376164	329.4746218	359.1666003	351.2338395	369.8796903
7/5/2019 15:20	289.34	288.63	289.34	288.63	165.7662	286.2748168	293.9298489	297.6218615	317.4510993	290.8088692
7/6/2019 16:20	296.96	297.3	297.3	296.96	15.82745	289.0091983	290.1636546	297.5513188	306.0234638	289.3359887
7/7/2019 14:33	291.25	291.27	291.42	291.17	99.83826	289.0194538	304.6165643	299.2550621	310.4452235	278.8589794
7/8/2019 15:33	309.3	309.31	309.31	309.3	14.45138	282.2347771	301.5183091	300.0042719	308.0963577	305.0876801
7/9/2019 16:33	309.89	309.82	309.89	309.5823	212.343	313.0314096	380.4659966	389.1856935	368.8008807	335.4973811
7/10/2019 14:46	289.78	289.77	289.86	289.77	38.05952	313.3560925	315.214801	326.8625683	334.3449256	320.562178
7/11/2019 15:46	267.82	268.6219	268.6219	266.79	458.535	304.8110573	302.8971971	315.2929056	314.8963865	302.9257184
7/12/2019 16:46	271.2	271.21	271.21	271.2	1.514188	283.6112845	285.2126252	290.1749258	288.6837291	283.7339254
7/13/2019 15:00	269.67	269.72	269.72	269.67	16.84302	272.5089777	269.3909454	275.3353924	272.4832201	274.3889856
7/14/2019 16:00	233.09	233.02	233.2	232.34	229.3645	266.8090917	263.1322688	268.2257727	266.6057073	270.5432563
7/15/2019 17:00	229.21	229.2	229.45	229.13	27.58676	244.9593684	246.2328357	246.3146313	244.4504484	247.7957918
7/16/2019 15:13	220.99	220.97	221.1	220.97	39.74397	228.7985873	235.0514968	233.9688118	238.714223	225.6796038
7/17/2019 16:13	212.01	211.5	212.04	211.4561	194.6004	218.2276494	220.8452552	219.9750576	222.4347063	219.7791387

Figure 4.186: ETH(1d) combining forecasts.

#### 4.7.4. Ethereum closing price prediction(12h)

The most accurate prediction was "open price, close price,low price, high price, volume" by the database with attributeerror.

time	open	close	high	low	volume	Classic_prediction	RSI_MACD_prediction	RSI_MACD_BTC_Close_prediction	BTC_Close_All_Indicator_prediction
1/1/2017 17:00	8.315	8.3493	8.3493	8.315	56.01625				
1/2/2017 4:06	8.2438	8.2438	8.2438	8.2438	50				
1/2/2017 15:13	8.306	8.2867	8.306	8.2867	22.281				
1/3/2017 5:06	8.3842	8.3853	8.3853	8.3842	50				
1/3/2017 16:13	9.36	9.37	9.37	9.354	8.633489				
10/21/2021 18:13	4087.1	4078.9	4087.1	4078.9	6.272032	4221.019114	4117.439542	4127.867546	4237.188208
10/22/2021 8:06	4110.8	4109	4111.9	4105.9	32.62103	4203.740752	4075.625224	4091.769845	4192.252218
10/22/2021 19:13	3966.3	3966.2	3966.3	3966.169	0.17031	4207.641675	4101.304596	4114.471075	4216.286329
10/23/2021 6:20	4020.8	4024.1	4024.46	4020.8	5.111764	4088.420615	3975.509199	3988.961329	4062.96908
10/23/2021 20:13	4106.5	4104.588	4106.5	4104.588	0.670122	4107.574009	3989.269905	3994.881564	4052.865959
10/24/2021 7:20	4091.176	4087.9	4091.176	4087.9	3.525043	4161.156237	4039.208559	4051.898661	4115.959762
10/24/2021 18:26	3990.7	3997.4	3997.4	3990.2	9.969818	4208.825841	4094.815062	4090.582172	4103.672154
10/25/2021 5:33	4127.4	4127.2	4127.4	4127.2	6.822	4072.389826	3922.580954	3950.639754	4029.756782
10/25/2021 19:26	4202.8	4204.9	4204.9	4202.8	3.664798	4201.078809	4013.656584	4603.914899	3860.784582
10/26/2021 6:33	4199.2	4199.2	4199.2	4199.2	0.074512	4238.85393	4090.741835	4121.55283	4236.397205
10/26/2021 17:40	4207.3	4211.8	4211.8	4207.3	18.78532	4281.883512	4168.164631	4208.991945	4253.010352
10/27/2021 7:33	4237.5	4238.598	4238.598	4237.4	16.61554	4283.240392	4190.040622	4195.610135	4313.042165
10/27/2021 18:40	3977.105	3980.1	3980.1	3977.105	12.4866	4235.159686	4153.043184	4445.830912	4192.608359
10/28/2021 5:46	4028.8	4027.212	4028.8	4024.326	59.811	4110.588633	3930.374428	3973.822706	4029.382399
10/28/2021 19:40	4172.8	4167.7	4173.9	4161.851	32.05534	4076.592024	3901.665875	3933.726765	4014.587948
10/29/2021 6:46	4351.4	4351	4352.4	4350.4	20.27377	4253.925564	4121.907488	4083.914917	4158.660422
10/29/2021 17:53	4384.1	4377.2	4384.854	4377.2	20.76097	4415.02266	4270.801407	4276.857209	4364.317743
10/30/2021 7:46	4367	4366.1	4367	4365.5	2.715031	4520.789743	4410.436215	4401.559649	4454.398529
10/30/2021 18:53	4312.263	4311.9	4312.3	4311.5	0.2585	4484.133721	4345.918929	4382.167175	4443.641709
10/31/2021 6:00	4312.7	4316.3	4316.3	4312.7	11.23035	4423.535338	4277.911709	4311.290251	4366.373805

Figure 4.187: ETH(12d) combining forecasts.

#### 4.7.5. Ripple closing price prediction(1d)

The most accurate prediction was "open price, close price,low price, high price, volume" by the database with attributeerror.

time	open	close	high	low	volume	Classic_Prediction	Dom_Prediction	Dom_BTCDom_Prediction	Dom_RSI_Prediction	Dom_RSI_BTCDom_Prediction	RSI_MACD_Prediction
5/20/2017 17:00	0.34864	0.34864	0.34864	0.34864	55						
5/21/2017 18:00	0.328	0.328	0.328	0.328	252.7305						
5/22/2017 19:00	0.3115	0.31299	0.31299	0.3115	1300						
5/23/2017 17:20	0.33699	0.32802	0.33699	0.32802	199.8						
5/24/2017 18:20	0.30291	0.30291	0.30291	0.30291	700						
5/25/2017 19:20	0.26213	0.26214	0.26219	0.26023	10324.06						
6/27/2019 21:13	0.40809	0.40904	0.40918	0.40809	57155.01	0.396656816	0.461609346	0.530936147	0.37235866	0.305096219	0.555482048
6/28/2019 22:13	0.41496	0.41494	0.41496	0.41494	459.884	0.439909135	0.478479783	0.456989359	0.429529844	0.42043309	0.408460801
6/29/2019 20:26	0.42393	0.42358	0.42393	0.42358	2040.929	0.412147626	0.416534873	0.397372477	0.399117337	0.416793007	0.432430091
6/30/2019 21:26	0.40526	0.40525	0.40526	0.40525	3709.38	0.360863051	0.411024365	0.405676285	0.378351809	0.404266838	0.364550167
7/1/2019 22:26	0.40152	0.40214	0.40214	0.40152	11211	0.389915778	0.439512177	0.566689035	0.368722197	0.365989395	0.417872554
7/2/2019 20:40	0.39569	0.39646	0.39646	0.39569	85	0.370466268	0.422348541	0.399242918	0.355481508	0.338369513	0.392339104
7/3/2019 21:40	0.3986	0.3986	0.3986	0.39851	3886.308	0.382922898	0.399613559	0.367982517	0.381232467	0.367076846	0.420160701
7/4/2019 22:40	0.39404	0.39407	0.39407	0.39404	4899.184	0.348917765	0.348414613	0.410240066	0.325210556	0.318909854	0.414169277
7/5/2019 20:53	0.38038	0.38038	0.38038	0.38038	350	0.391374341	0.402091063	0.382643031	0.389221106	0.383563847	0.402870147
7/6/2019 21:53	0.39358	0.39448	0.39462	0.39358	4098.316	0.349026877	0.353891283	0.374745117	0.346349262	0.34557274	0.377442773
7/7/2019 22:53	0.39787	0.39787	0.39788	0.39787	2611.383	0.335124818	0.367232085	0.398013482	0.343466601	0.300495815	0.413809891
7/8/2019 21:00	0.40174	0.40173	0.40174	0.40174	6098.593	0.394999934	0.407369528	0.389495735	0.392738246	0.3874138521	0.373800608
7/9/2019 22:06	0.39367	0.39366	0.39368	0.39366	3400	0.330995473	0.405464204	0.547244618	0.341268507	0.279250827	0.471322741
7/10/2019 20:20	0.35498	0.35587	0.35587	0.3549	6660	0.322329424	0.431070031	0.623355846	0.292873963	0.269057392	0.451800276
7/11/2019 21:20	0.32541	0.32651	0.32651	0.3254	56058.71	0.359722773	0.383103072	0.372706421	0.365544627	0.329687839	0.329384846
7/12/2019 22:20	0.34399	0.34386	0.34399	0.34386	150	0.37383687	0.370192703	0.367316721	0.356635349	0.375487113	0.334650025
7/13/2019 20:33	0.32435	0.32455	0.32455	0.32435	12203.37	0.346020298	0.337471127	0.33344589	0.334165021	0.338029897	0.374687531
7/14/2019 21:33	0.31567	0.31585	0.31598	0.31567	64287.58	0.325613216	0.320091342	0.320023045	0.316775251	0.307367047	0.338656624
7/15/2019 22:33	0.31334	0.31342	0.31342	0.31334	16343.66	0.32597674	0.317226548	0.318434123	0.312453498	0.316379762	0.343875318
7/16/2019 20:46	0.29937	0.29888	0.29937	0.29878	5028.858	0.310028265	0.302264207	0.297097205	0.303412917	0.303354996	0.332664622
7/17/2019 21:40	0.31742	0.31685	0.31742	0.31685	671	0.276765438	0.310404861	0.282105826	0.277151995	0.223840383	0.273763535

Figure 4.188: XRP(1d) combining forecasts.

#### 4.7.6. Ripple closing price prediction(12h)

The most accurate prediction was "open price, close price,low price, high price, volume" by the database with attributeerror.

time	open	close	high	low	volume	Classic_prediction	RSI_MACD_prediction	RSI_MACD_BTC_Close_prediction	All_Indicator_prediction
5/20/2017 6:00	0.32108	0.3208	0.32108	0.3208	32.00901				
5/20/2017 17:06	0.34864	0.34864	0.34864	0.34864	55				
5/21/2017 7:00	0.361	0.361	0.361	0.361	1.184				
5/21/2017 18:06	0.33559	0.33559	0.33559	0.33559	181				
5/22/2017 5:13	0.31761	0.31755	0.31761	0.31755	3011.576				
10/22/2021 19:13	1.0911	1.0925	1.0925	1.0911	78022.34	1.093540761	1.113287913	1.110107829	
10/23/2021 6:20	1.0901	1.091	1.091	1.0901	100	1.077285992	1.120475729	1.117433117	
10/23/2021 17:26	1.0859	1.0859	1.086	1.0859	500	1.100683485	1.115548875	1.128887256	
10/24/2021 7:20	1.0852	1.0852	1.0852	1.0852	150	1.051898401	1.100158564	1.125974343	
10/24/2021 18:26	1.0602	1.0592	1.0602	1.0483	480467.4	1.100998289	1.103588475	1.103565922	
10/25/2021 5:33	1.0911	1.0911	1.0911	1.0911	738.8806	1.059240658	1.059264429	1.03928831	
10/25/2021 19:26	1.0927	1.0925	1.0927	1.0925	2199.994	1.00774985	1.100938348	1.030928585	
10/26/2021 6:33	1.1206	1.1205	1.1206	1.1202	167.6021	1.105848425	1.120819206	1.116379274	
10/26/2021 17:40	1.1137	1.1133	1.1146	1.1127	102234.3	1.115344101	1.118055817	1.143239978	
10/27/2021 7:33	1.1017	1.1018	1.1018	1.1011	2515.457	1.071046037	1.057235878	1.057127847	
10/27/2021 18:40	1.0148	1.0142	1.0148	1.0142	351	1.128400238	1.121012419	1.125371499	
10/28/2021 5:46	1.0333	1.0319	1.0333	1.0311	1800.885	1.002141685	1.027121056	1.047653301	
10/28/2021 19:40	1.0414	1.0399	1.0436	1.0385	46595.76	1.048640445	1.044195189	1.049622254	
10/29/2021 6:46	1.0678	1.0679	1.0678	1.0678	6285.247	1.063680149	1.02263051	1.024919367	0.90188097
10/29/2021 17:53	1.0771	1.0767	1.0773	1.0757	202188	1.049818754	1.049927038	1.108933951	1.150482041
10/30/2021 7:46	1.106	1.106	1.106	1.106	944.8503	1.065113461	1.090970569	1.133597154	1.295808837
10/30/2021 18:53	1.0764	1.0764	1.0764	1.0764	443.48	1.058363722	1.053266006	1.092777201	0.981089738
10/31/2021 6:00	1.1209	1.1192	1.121	1.1192	13903.85	1.027965981	1.083612395	1.115080673	1.034042337

Figure 4.189: XRP(12d) combining forecasts.

## 5. SUCCESS CRITERIA

There were 2 success criteria that I set at the beginning of this project. These success criteria are:

- Must know the price of Cryptocurrency with 60 percent accuracy.
- Processing of 100 thousand lines of details in a maximum of 10 minutes

These success criteria have been completed. "Must know the price of Cryptocurrency with 60 percent accuracy." As seen in the report, there have been estimates of over 60 percent according to model performance metrics calculated for many data sets. The highest success was achieved by the closing price prediction made with the 1-day data of Bitcoin and the data set with the opening price, highest price, lowest price, volume, RSI and dominance.

Table 5.1: 1-day BTC Dataset LSTM Model Result

Parameters	Quantity
Model Evaluate	0.52%
Mean Absolute Error	4.74%
Mean Squared Error	0.52%
$R^2$	96.04%

The second success criterion is a success criterion given in relation to the effective work of the project. This criterion was carried out with the 15-minute data set of Bitcoin in the data sets.

```
Epoch 1/20
2499/2499 [=====] - 23s 7ms/step - loss: 0.0015 - val_loss: 7.0901e-05
Epoch 2/20
2499/2499 [=====] - 16s 7ms/step - loss: 9.0045e-05 - val_loss: 5.6597e-05
Epoch 3/20
2499/2499 [=====] - 17s 7ms/step - loss: 7.1719e-05 - val_loss: 7.3151e-05
Epoch 4/20
2499/2499 [=====] - 16s 7ms/step - loss: 6.1829e-05 - val_loss: 4.7182e-05
Epoch 5/20
2499/2499 [=====] - 16s 7ms/step - loss: 5.6283e-05 - val_loss: 3.8004e-05
Epoch 6/20
2499/2499 [=====] - 17s 7ms/step - loss: 5.3559e-05 - val_loss: 3.8475e-05
Epoch 7/20
2499/2499 [=====] - 16s 6ms/step - loss: 5.1248e-05 - val_loss: 3.4390e-05
Epoch 8/20
2499/2499 [=====] - 17s 7ms/step - loss: 5.1482e-05 - val_loss: 3.5384e-05
Epoch 9/20
2499/2499 [=====] - 16s 7ms/step - loss: 4.9416e-05 - val_loss: 3.9144e-05
Epoch 10/20
2499/2499 [=====] - 16s 6ms/step - loss: 4.8947e-05 - val_loss: 3.2595e-05
Epoch 11/20
2499/2499 [=====] - 16s 6ms/step - loss: 4.7786e-05 - val_loss: 3.1484e-05
Epoch 12/20
2499/2499 [=====] - 16s 7ms/step - loss: 4.7729e-05 - val_loss: 3.1750e-05
Epoch 13/20
2499/2499 [=====] - 16s 6ms/step - loss: 4.7376e-05 - val_loss: 4.6286e-05
Epoch 14/20
2499/2499 [=====] - 16s 7ms/step - loss: 4.7897e-05 - val_loss: 4.0863e-05
Epoch 15/20
2499/2499 [=====] - 16s 6ms/step - loss: 4.6678e-05 - val_loss: 3.2991e-05
Epoch 16/20
2499/2499 [=====] - 16s 6ms/step - loss: 4.5002e-05 - val_loss: 3.3274e-05
Epoch 17/20
2499/2499 [=====] - 16s 6ms/step - loss: 4.5152e-05 - val_loss: 3.3492e-05
Epoch 18/20
2499/2499 [=====] - 16s 6ms/step - loss: 4.5202e-05 - val_loss: 3.5842e-05
Epoch 19/20
2499/2499 [=====] - 16s 7ms/step - loss: 4.4507e-05 - val_loss: 3.1408e-05
Epoch 20/20
2499/2499 [=====] - 16s 6ms/step - loss: 4.5619e-05 - val_loss: 3.6206e-05
Duration: 0:06:23.806453
```

Figure 5.1: Running time for BTC-15 minutes dataset

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