# INTRODUCTION

Novelty of this study can be listed as follows:

1. Comparing DoE method with Hyperband Tuner in hyperparameter optimization.
2. Using hyperparameter optimizations in multistep time series prediction problems.
3. Defining custom loss and metric functions complying with portfolio optimization problem.

# METHODOLOGY

As it is illustrated in Business Process Modelling Notation (BPMN) diagram in Fig. 1.1, firstly the exchange rates are imported.

Diagram

Description automatically generated

* 1. BPMN Graph of Applied Method

## Full Factorial Design

## Response Surface Methodology

## Hyperband Tuner

## Prediction Models

### Multi-Layer Perceptron (MLP)

### Long-Short Term Memory (LSTM)

### Convolutional Encoder Decoder (Conv-EncDec)

### Luong’s Attention Mechanism (Luong-Att)

## Portfolio Optimization Model

Portfolio optimization problem is a special type of investment problem to select the optimal mix of opportunities that will maximize return while meeting requirements set by the investor and the market [1]. In this study, the decision variables of the optimization problem are and representing the amounts of the positions and types of the positions respectively, for the exchange rate to open the position on future time step and to close the position on future time step . There are 3 types of positions: Buy, Sell or Do nothing. In this context, objective function of the mathematical model is maximizing the total return of investments calculated in Formula (##):

|  |  |
| --- | --- |
|  |  |

where – return of investment.

Formula (##) demonstrates the calculation of return of investment (). Return of investment is the difference between the return gained from price difference and loss due to spread.

|  |  |
| --- | --- |
|  |  |

where – price difference that is calculated with the Formula (##);

– the ratio of spread at the time step when the position is opened. It is calculated with Formula (##).

|  |  |
| --- | --- |
|  |  |
|  |  |

where – closing price at the time step when the position is closed;

– opening price at the time step when the position is opened;

– spread at the time step when the position is opened.

Both and are the ratios respective to in order to eliminate the impacts that can occur due to different scales of exchange rates.

The constraint that is calculated with Formula (##) ensures that investment amount is set to zero in case type of investment is “Do nothing”.

|  |  |
| --- | --- |
|  |  |

where – is a very big number.

Balances in each time step with the Formula (##):

|  |  |
| --- | --- |
|  |  |

where – the balance on time step ;

– the balance of previous time step.

Constraints that imply the nonnegativity of returns and balances are represented with the Formula (##) and Formula (##) respectively:

|  |  |
| --- | --- |
|  |  |
|  |  |

Constraints that represent the borders of the decision variables are shown in Figure (##) and Figure (##). Amounts of the investments are nonnegative values. Types of the investment are -1, 0 and 1 that denote respectively to sell, to do nothing and to buy.

|  |  |
| --- | --- |
|  |  |
|  |  |

## Evolutionary Algorithms

### Genetic Algorithm (GA)

### Particle Swarm Optimization (PSO)

# APPLICATION

## Description of Data

As an application, 5 symbols of cryptocurrencies are taken into consideration: BCHUSD, BTCUSD, ETHUSD, LTCUSD and RPLUSD. The frequency of the data that is imported is 30 mins. Market data is imported for the date interval 2021-09-01 and 2022-03-10. In order to import market dataset, MetaTrader 5 [2] platform’s API [3] is used. First Prudential Markets (FP Markets) [4] is used as broker to fetch market data. Descriptive statistics of closing prices of imported datasets are demonstrated in Table 1.1.



Descriptive Statistics of Closing Prices

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | BCHUSD | BTCUSD | ETHUSD | LTCUSD | RPLUSD |
| count | 6516.00 | 6516.00 | 6516.00 | 6516.00 | 6516.00 |
| mean | 481.58 | 49089.19 | 3563.92 | 161.14 | 0.93 |
| std | 132.84 | 8509.96 | 649.56 | 39.90 | 0.18 |
| min | 259.73 | 33098.05 | 2181.45 | 90.39 | 0.56 |
| 25% | 355.08 | 42633.72 | 3053.48 | 131.84 | 0.78 |
| 50% | 478.23 | 47299.22 | 3548.43 | 154.77 | 0.93 |
| 75% | 599.14 | 56888.63 | 4096.23 | 187.79 | 1.09 |
| max | 68609.11 | 4845.78 | 794.64 | 288.53 | 1.41 |

Each symbol is trained with 4 prediction models: Multi-layer perceptron (MLP), Long-short term memory (LSTM), Convolutional encoder-decoder model (Conv-EncDec) and Luong’s Attention (Luong-Att).

## Full Factorial Experiments

In each prediction model, hyperparameters that are considered in DOE are given in Table 1.2 with the levels of them. For each cryptocurrency symbol & predictive model types a full factorial design of the above-mentioned hyperparameters is created. Full factorial design consists of 16 runs with 4 repetitions to minimize the impact of random weight initializations of the predictive models.



Levels of Factors

|  |  |  |
| --- | --- | --- |
| Hyperparameter | Lower Level | Upper Level |
| Batch size | 60 | 70 |
| Number of hidden neurons | 10 | 14 |

Full factorial design is executed for each symbol and predictive models and response values of experiments are calculated based on custom metric function. Experimental results of full factorial design for each symbol and predictive model is presented in Appendix 1. After completing all runs of full factorial design, a 1st order mathematical model is created. Coefficient of determination scores of 1st order mathematical models are summarized in Table 1.3.



Coefficient of Determination of 1st Order Models

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | MLP | LSTM | Conv-EncDec | Luongs-Att |
| BCHUSD | 0.14 | 0.3 | 0.43 | 0.34 |
| BTCUSD | 0.04 | 0.07 | 0.14 | 0.02 |
| ETHUSD | 0.05 | 0.04 | 0.13 | 0.23 |
| LTCUSD | 0.27 | 0.16 | 0.14 | 0.13 |
| RPLUSD | 0.09 | 0.36 | 0.1 | 0.12 |

Based on the first order model, steepest descent process is executed until the custom metric value starts to increase. Iterations of steepest descent process for each model type and exchange rate pair is shown as a bubble plot in Fig. 1.2.

Calendar

Description automatically generated

* 1. Bubbe Plot of Steepest Descent Process

## Response Surface Methodology

Factor levels identified by steepest descent process are considered as central point of central composite inscribed (CCI) design. CCI design consists of 8 central points. Experiment results of CCI designs are shown in Appendix 2.

After execution of CCI design, a 2nd order mathematical model is created. 2nd order mathematical model consists of interaction and square effects of the factors as well as linear affects. Coefficient of determination of 2nd order models are shown in Table 1.4.



Coefficient of Determination of 2nd Order Models

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | MLP | LSTM | Conv-EncDec | Luongs-Att |
| BCHUSD | 0.08 | 0.42 | 0.18 | 0.25 |
| BTCUSD | 0.36 | 0.77 | 0.29 | 0.4 |
| ETHUSD | 0.45 | 0.36 | 0.3 | 0.31 |
| LTCUSD | 0.15 | 0.44 | 0.84 | 0.19 |
| RPLUSD | 0.33 | 0.26 | 0.15 | 0.3 |

Based on the 2nd order mathematical model, a grid search algorithm is applied to find the optimum hyperparameter configuration within the defined interval of CCI design. Surface plots of 2nd order models are given in Fig. 1.3.

Shape, arrow

Description automatically generated

* 1. Surface Plot of Grid Search

Optimum configurations that are identified via RSM are given in Table 1.5.



Optimum Configurations via RSM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | MLP | LSTM | Conv-EncDec | Luongs-Att |
| BCHUSD | [60, 10] | [55, 4] | [60, 13] | [85, 14] |
| BTCUSD | [64, 11] | [62, 8] | [62, 12] | [66, 6] |
| ETHUSD | [60, 10] | [60, 10] | [68, 13] | [67, 6] |
| LTCUSD | [60, 13] | [69, 10] | [66, 15] | [60, 10] |
| RPLUSD | [67, 8] | [56, 8] | [68, 10] | [70, 15] |

Values are presented in [Batch Size, Number of Hidden Neurons] format.

Predictive models are created for each optimum configuration. Results for test dataset is demonstrated in Table 1.6. The configuration that has the minimum custom metric value is selected for simulation.



Test Results of Optimum Configurations via RSM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | MLP | LSTM | Conv-EncDec | Luongs-Att |
| BCHUSD | 47.825834 | 55.075167 | 68.721883 | 80.61469 |
| BTCUSD | 36.158233 | 46.668726 | 43.685923 | 1838.94727 |
| ETHUSD | 51.776433 | 52.527063 | 51.703628 | 71.787779 |
| LTCUSD | 52.566987 | 61.888913 | 110.833586 | 127.491509 |
| RPLUSD | 69.440883 | 68.174606 | 71.67011 | 89.41441 |

## Hyperband

Optimum configurations handled via Keras Tuner are shown in Table 1.7.



Optimum Configurations via Hyperband

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | BCHUSD | BTCUSD | ETHUSD | LTCUSD | RPLUSD |
| MLP |  |  |  |  |  |
| LSTM |  |  |  |  |  |
| Conv-EncDec |  |  |  |  |  |
| Luong-Att |  |  |  |  |  |

## Simulation

Optimum models are used to predict each exchange rate for the simulation time interval. The average custom metrics of predictions are shown in Fig. 1.4.

Chart, bar chart

Description automatically generated

* 1. Average Custom Metrics of Simulation Predictions via DOE

It is assumed that closing price of a time step is opening price of a previous time step.

A picture containing building, window, surrounded

Description automatically generated

* 1. Multi-Step Comparison of BCHUSD Simulation

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* 1. Multi-Step Comparison of BTCUSD Simulation

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Description automatically generated

* 1. Multi-Step Comparison of ETHUSD Simulation

A picture containing window, building, surrounded

Description automatically generated

* 1. Multi-Step Comparison of LTCUSD Simulation

A picture containing building, window, light, surrounded

Description automatically generated

* 1. Multi-Step Comparison of RPLUSD Simulation

## Portfolio Optimization

# RESULTS AND CONCLUSION

Following steps can be considered as further research areas:

1. Social media and financial news dataset can be processed via using natural language processing techniques.
2. There were not many resources where more valuable financial indicators such as open interest are shared by brokers. In the future, it is expected that open interest indicator will be shared more commonly by brokers. In future studies, this indicator would be included as future step to predict features financial instruments.
3. Statistical process control of prediction results can be applied to monitor the performance of prediction. In case the model starts to predict with error higher than a threshold, alerts can be generated to perform whole processes.
4. A strategy should be built on during the prediction and optimization durations.
5. A separate prediction algorithm for spread values could be used.

appendixes

[Appendix 1](#_Toc101537834)

[Experiments of Full Factorial Design](#_Toc101537835)

[Appendix 2](#_Toc101537836)

[Experiments of Central Composite Design](#_Toc101537837)



Experiments of Full Factorial Design

| Run ID | Model Type | Exchange Rate | Batch Size | Number of Hidden Neurons | Response |
| --- | --- | --- | --- | --- | --- |
| 0 | MLP | BCHUSD | 70 | 10 | 49.80 |
| 1 | MLP | BCHUSD | 70 | 10 | 49.64 |
| 2 | MLP | BCHUSD | 60 | 10 | 51.48 |
| 3 | MLP | BCHUSD | 70 | 14 | 55.60 |
| 4 | MLP | BCHUSD | 70 | 10 | 58.16 |
| 5 | MLP | BCHUSD | 60 | 14 | 65.69 |
| 6 | MLP | BCHUSD | 70 | 10 | 46.71 |
| 7 | MLP | BCHUSD | 60 | 14 | 51.77 |
| 8 | MLP | BCHUSD | 70 | 14 | 46.64 |
| 9 | MLP | BCHUSD | 70 | 14 | 46.47 |
| 10 | MLP | BCHUSD | 60 | 10 | 49.39 |
| 11 | MLP | BCHUSD | 60 | 10 | 50.85 |
| 12 | MLP | BCHUSD | 60 | 14 | 54.72 |
| 13 | MLP | BCHUSD | 60 | 10 | 51.80 |
| 14 | MLP | BCHUSD | 60 | 14 | 56.78 |
| 15 | MLP | BCHUSD | 70 | 14 | 79.79 |
| 0 | MLP | BTCUSD | 60 | 10 | 37.21 |
| 1 | MLP | BTCUSD | 60 | 10 | 36.38 |
| 2 | MLP | BTCUSD | 60 | 14 | 36.78 |
| 3 | MLP | BTCUSD | 60 | 14 | 39.93 |
| 4 | MLP | BTCUSD | 70 | 14 | 34.49 |
| 5 | MLP | BTCUSD | 70 | 10 | 37.44 |
| 6 | MLP | BTCUSD | 60 | 10 | 37.62 |
| 7 | MLP | BTCUSD | 70 | 10 | 36.60 |
| 8 | MLP | BTCUSD | 70 | 10 | 38.52 |
| 9 | MLP | BTCUSD | 60 | 14 | 39.14 |
| 10 | MLP | BTCUSD | 70 | 14 | 47.53 |
| 11 | MLP | BTCUSD | 60 | 14 | 35.73 |
| 12 | MLP | BTCUSD | 60 | 10 | 34.71 |
| 13 | MLP | BTCUSD | 70 | 14 | 37.35 |
| 14 | MLP | BTCUSD | 70 | 14 | 32.94 |
| 15 | MLP | BTCUSD | 70 | 10 | 37.05 |
| 0 | MLP | ETHUSD | 70 | 10 | 59.46 |
| 1 | MLP | ETHUSD | 60 | 14 | 51.09 |
| 2 | MLP | ETHUSD | 60 | 14 | 50.18 |
| 3 | MLP | ETHUSD | 60 | 10 | 50.78 |
| 4 | MLP | ETHUSD | 60 | 10 | 50.33 |
| 5 | MLP | ETHUSD | 60 | 14 | 52.79 |
| 6 | MLP | ETHUSD | 70 | 14 | 57.30 |
| 7 | MLP | ETHUSD | 70 | 14 | 53.00 |
| 8 | MLP | ETHUSD | 60 | 14 | 74.00 |
| 9 | MLP | ETHUSD | 70 | 14 | 54.40 |
| 10 | MLP | ETHUSD | 70 | 10 | 51.59 |
| 11 | MLP | ETHUSD | 70 | 14 | 49.84 |
| 12 | MLP | ETHUSD | 60 | 10 | 54.10 |
| 13 | MLP | ETHUSD | 60 | 10 | 52.31 |
| 14 | MLP | ETHUSD | 70 | 10 | 61.27 |
| 15 | MLP | ETHUSD | 70 | 10 | 74.27 |
| 0 | MLP | LTCUSD | 60 | 14 | 52.05 |
| 1 | MLP | LTCUSD | 70 | 14 | 62.38 |
| 2 | MLP | LTCUSD | 60 | 10 | 54.12 |
| 3 | MLP | LTCUSD | 60 | 14 | 52.66 |
| 4 | MLP | LTCUSD | 60 | 10 | 55.70 |
| 5 | MLP | LTCUSD | 70 | 10 | 54.60 |
| 6 | MLP | LTCUSD | 70 | 14 | 63.03 |
| 7 | MLP | LTCUSD | 70 | 10 | 56.58 |
| 8 | MLP | LTCUSD | 60 | 10 | 53.29 |
| 9 | MLP | LTCUSD | 70 | 14 | 67.83 |
| 10 | MLP | LTCUSD | 70 | 10 | 61.66 |
| 11 | MLP | LTCUSD | 60 | 14 | 59.15 |
| 12 | MLP | LTCUSD | 70 | 14 | 51.65 |
| 13 | MLP | LTCUSD | 60 | 10 | 57.48 |
| 14 | MLP | LTCUSD | 70 | 10 | 55.13 |
| 15 | MLP | LTCUSD | 60 | 14 | 53.76 |
| 0 | MLP | RPLUSD | 60 | 14 | 60.48 |
| 1 | MLP | RPLUSD | 60 | 14 | 65.67 |
| 2 | MLP | RPLUSD | 60 | 10 | 56.66 |
| 3 | MLP | RPLUSD | 60 | 10 | 61.38 |
| 4 | MLP | RPLUSD | 70 | 10 | 57.79 |
| 5 | MLP | RPLUSD | 60 | 14 | 62.86 |
| 6 | MLP | RPLUSD | 70 | 14 | 85.28 |
| 7 | MLP | RPLUSD | 70 | 10 | 70.15 |
| 8 | MLP | RPLUSD | 70 | 14 | 53.86 |
| 9 | MLP | RPLUSD | 60 | 14 | 71.20 |
| 10 | MLP | RPLUSD | 60 | 10 | 61.32 |
| 11 | MLP | RPLUSD | 70 | 10 | 61.94 |
| 12 | MLP | RPLUSD | 70 | 14 | 60.07 |
| 13 | MLP | RPLUSD | 70 | 14 | 63.39 |
| 14 | MLP | RPLUSD | 60 | 10 | 61.99 |
| 15 | MLP | RPLUSD | 70 | 10 | 57.24 |
| 0 | LSTM | BCHUSD | 60 | 10 | 55.84 |
| 1 | LSTM | BCHUSD | 70 | 10 | 65.21 |
| 2 | LSTM | BCHUSD | 60 | 14 | 66.06 |
| 3 | LSTM | BCHUSD | 70 | 10 | 55.40 |
| 4 | LSTM | BCHUSD | 60 | 10 | 62.96 |
| 5 | LSTM | BCHUSD | 70 | 14 | 67.74 |
| 6 | LSTM | BCHUSD | 60 | 10 | 62.73 |
| 7 | LSTM | BCHUSD | 60 | 10 | 69.37 |
| 8 | LSTM | BCHUSD | 70 | 14 | 70.99 |
| 9 | LSTM | BCHUSD | 60 | 14 | 81.50 |
| 10 | LSTM | BCHUSD | 60 | 14 | 64.38 |
| 11 | LSTM | BCHUSD | 60 | 14 | 72.28 |
| 12 | LSTM | BCHUSD | 70 | 14 | 63.81 |
| 13 | LSTM | BCHUSD | 70 | 10 | 69.57 |
| 14 | LSTM | BCHUSD | 70 | 10 | 54.94 |
| 15 | LSTM | BCHUSD | 70 | 14 | 61.41 |
| 0 | LSTM | BTCUSD | 70 | 10 | 53.60 |
| 1 | LSTM | BTCUSD | 60 | 14 | 58.19 |
| 2 | LSTM | BTCUSD | 60 | 10 | 41.53 |
| 3 | LSTM | BTCUSD | 70 | 10 | 48.05 |
| 4 | LSTM | BTCUSD | 60 | 14 | 53.14 |
| 5 | LSTM | BTCUSD | 60 | 14 | 42.74 |
| 6 | LSTM | BTCUSD | 70 | 10 | 50.53 |
| 7 | LSTM | BTCUSD | 70 | 14 | 43.78 |
| 8 | LSTM | BTCUSD | 60 | 14 | 55.33 |
| 9 | LSTM | BTCUSD | 70 | 14 | 54.18 |
| 10 | LSTM | BTCUSD | 70 | 14 | 58.17 |
| 11 | LSTM | BTCUSD | 70 | 10 | 45.41 |
| 12 | LSTM | BTCUSD | 70 | 14 | 60.50 |
| 13 | LSTM | BTCUSD | 60 | 10 | 60.28 |
| 14 | LSTM | BTCUSD | 60 | 10 | 47.17 |
| 15 | LSTM | BTCUSD | 60 | 10 | 54.24 |
| 0 | LSTM | ETHUSD | 70 | 14 | 55.07 |
| 1 | LSTM | ETHUSD | 70 | 10 | 64.56 |
| 2 | LSTM | ETHUSD | 60 | 14 | 47.88 |
| 3 | LSTM | ETHUSD | 60 | 10 | 51.60 |
| 4 | LSTM | ETHUSD | 70 | 14 | 59.49 |
| 5 | LSTM | ETHUSD | 70 | 14 | 60.34 |
| 6 | LSTM | ETHUSD | 60 | 14 | 93.40 |
| 7 | LSTM | ETHUSD | 70 | 10 | 54.73 |
| 8 | LSTM | ETHUSD | 60 | 10 | 47.01 |
| 9 | LSTM | ETHUSD | 60 | 14 | 59.18 |
| 10 | LSTM | ETHUSD | 70 | 14 | 60.43 |
| 11 | LSTM | ETHUSD | 60 | 10 | 58.87 |
| 12 | LSTM | ETHUSD | 70 | 10 | 57.68 |
| 13 | LSTM | ETHUSD | 70 | 10 | 76.65 |
| 14 | LSTM | ETHUSD | 60 | 14 | 60.66 |
| 15 | LSTM | ETHUSD | 60 | 10 | 53.68 |
| 0 | LSTM | LTCUSD | 70 | 10 | 89.65 |
| 1 | LSTM | LTCUSD | 60 | 10 | 72.34 |
| 2 | LSTM | LTCUSD | 60 | 14 | 73.49 |
| 3 | LSTM | LTCUSD | 70 | 14 | 70.39 |
| 4 | LSTM | LTCUSD | 60 | 14 | 80.12 |
| 5 | LSTM | LTCUSD | 60 | 10 | 57.04 |
| 6 | LSTM | LTCUSD | 60 | 14 | 75.32 |
| 7 | LSTM | LTCUSD | 70 | 14 | 66.32 |
| 8 | LSTM | LTCUSD | 70 | 10 | 69.06 |
| 9 | LSTM | LTCUSD | 60 | 14 | 66.67 |
| 10 | LSTM | LTCUSD | 70 | 10 | 67.71 |
| 11 | LSTM | LTCUSD | 60 | 10 | 68.05 |
| 12 | LSTM | LTCUSD | 60 | 10 | 62.51 |
| 13 | LSTM | LTCUSD | 70 | 14 | 79.15 |
| 14 | LSTM | LTCUSD | 70 | 10 | 62.76 |
| 15 | LSTM | LTCUSD | 70 | 14 | 78.56 |
| 0 | LSTM | RPLUSD | 70 | 14 | 73.34 |
| 1 | LSTM | RPLUSD | 70 | 10 | 63.09 |
| 2 | LSTM | RPLUSD | 70 | 14 | 73.99 |
| 3 | LSTM | RPLUSD | 70 | 10 | 73.41 |
| 4 | LSTM | RPLUSD | 60 | 14 | 74.70 |
| 5 | LSTM | RPLUSD | 60 | 10 | 67.47 |
| 6 | LSTM | RPLUSD | 60 | 14 | 93.48 |
| 7 | LSTM | RPLUSD | 70 | 14 | 77.23 |
| 8 | LSTM | RPLUSD | 60 | 10 | 65.75 |
| 9 | LSTM | RPLUSD | 70 | 14 | 63.78 |
| 10 | LSTM | RPLUSD | 70 | 10 | 66.66 |
| 11 | LSTM | RPLUSD | 60 | 10 | 72.97 |
| 12 | LSTM | RPLUSD | 60 | 14 | 67.48 |
| 13 | LSTM | RPLUSD | 70 | 10 | 65.49 |
| 14 | LSTM | RPLUSD | 60 | 14 | 104.88 |
| 15 | LSTM | RPLUSD | 60 | 10 | 68.78 |
| 0 | Conv-EncDec | BCHUSD | 60 | 14 | 86.19 |
| 1 | Conv-EncDec | BCHUSD | 60 | 10 | 61.29 |
| 2 | Conv-EncDec | BCHUSD | 70 | 14 | 1193.05 |
| 3 | Conv-EncDec | BCHUSD | 60 | 10 | 710.94 |
| 4 | Conv-EncDec | BCHUSD | 70 | 10 | 1615.13 |
| 5 | Conv-EncDec | BCHUSD | 70 | 10 | 1522.69 |
| 6 | Conv-EncDec | BCHUSD | 70 | 10 | 2095.63 |
| 7 | Conv-EncDec | BCHUSD | 60 | 10 | 64.62 |
| 8 | Conv-EncDec | BCHUSD | 70 | 14 | 109.57 |
| 9 | Conv-EncDec | BCHUSD | 60 | 10 | 72.60 |
| 10 | Conv-EncDec | BCHUSD | 70 | 14 | 69.57 |
| 11 | Conv-EncDec | BCHUSD | 70 | 14 | 98.51 |
| 12 | Conv-EncDec | BCHUSD | 70 | 10 | 72.00 |
| 13 | Conv-EncDec | BCHUSD | 60 | 14 | 72.26 |
| 14 | Conv-EncDec | BCHUSD | 60 | 14 | 69.44 |
| 15 | Conv-EncDec | BCHUSD | 60 | 14 | 74.72 |
| 0 | Conv-EncDec | BTCUSD | 60 | 10 | 967.90 |
| 1 | Conv-EncDec | BTCUSD | 60 | 10 | 51.77 |
| 2 | Conv-EncDec | BTCUSD | 70 | 14 | 49.40 |
| 3 | Conv-EncDec | BTCUSD | 60 | 14 | 64.74 |
| 4 | Conv-EncDec | BTCUSD | 70 | 10 | 65.94 |
| 5 | Conv-EncDec | BTCUSD | 70 | 10 | 1480.43 |
| 6 | Conv-EncDec | BTCUSD | 60 | 10 | 43.11 |
| 7 | Conv-EncDec | BTCUSD | 60 | 14 | 77.60 |
| 8 | Conv-EncDec | BTCUSD | 70 | 14 | 83.55 |
| 9 | Conv-EncDec | BTCUSD | 70 | 10 | 56.04 |
| 10 | Conv-EncDec | BTCUSD | 60 | 14 | 54.24 |
| 11 | Conv-EncDec | BTCUSD | 60 | 10 | 53.60 |
| 12 | Conv-EncDec | BTCUSD | 70 | 10 | 53.51 |
| 13 | Conv-EncDec | BTCUSD | 70 | 14 | 51.59 |
| 14 | Conv-EncDec | BTCUSD | 60 | 14 | 49.28 |
| 15 | Conv-EncDec | BTCUSD | 70 | 14 | 81.20 |
| 0 | Conv-EncDec | ETHUSD | 70 | 10 | 95.55 |
| 1 | Conv-EncDec | ETHUSD | 60 | 10 | 89.98 |
| 2 | Conv-EncDec | ETHUSD | 70 | 14 | 71.12 |
| 3 | Conv-EncDec | ETHUSD | 70 | 10 | 105.48 |
| 4 | Conv-EncDec | ETHUSD | 60 | 14 | 73.49 |
| 5 | Conv-EncDec | ETHUSD | 60 | 14 | 86.16 |
| 6 | Conv-EncDec | ETHUSD | 70 | 10 | 55.65 |
| 7 | Conv-EncDec | ETHUSD | 70 | 14 | 64.51 |
| 8 | Conv-EncDec | ETHUSD | 60 | 14 | 82.69 |
| 9 | Conv-EncDec | ETHUSD | 60 | 10 | 2122.17 |
| 10 | Conv-EncDec | ETHUSD | 60 | 10 | 82.94 |
| 11 | Conv-EncDec | ETHUSD | 70 | 14 | 134.93 |
| 12 | Conv-EncDec | ETHUSD | 70 | 10 | 65.43 |
| 13 | Conv-EncDec | ETHUSD | 60 | 14 | 150.38 |
| 14 | Conv-EncDec | ETHUSD | 60 | 10 | 52.31 |
| 15 | Conv-EncDec | ETHUSD | 70 | 14 | 83.04 |
| 0 | Conv-EncDec | LTCUSD | 60 | 10 | 1388.15 |
| 1 | Conv-EncDec | LTCUSD | 70 | 10 | 108.45 |
| 2 | Conv-EncDec | LTCUSD | 70 | 10 | 68.27 |
| 3 | Conv-EncDec | LTCUSD | 70 | 14 | 99.25 |
| 4 | Conv-EncDec | LTCUSD | 60 | 14 | 124.12 |
| 5 | Conv-EncDec | LTCUSD | 70 | 14 | 70.48 |
| 6 | Conv-EncDec | LTCUSD | 60 | 14 | 71.96 |
| 7 | Conv-EncDec | LTCUSD | 60 | 10 | 123.77 |
| 8 | Conv-EncDec | LTCUSD | 70 | 14 | 106.62 |
| 9 | Conv-EncDec | LTCUSD | 70 | 14 | 132.35 |
| 10 | Conv-EncDec | LTCUSD | 60 | 10 | 75.93 |
| 11 | Conv-EncDec | LTCUSD | 60 | 10 | 76.19 |
| 12 | Conv-EncDec | LTCUSD | 70 | 10 | 106.39 |
| 13 | Conv-EncDec | LTCUSD | 70 | 10 | 2295.53 |
| 14 | Conv-EncDec | LTCUSD | 60 | 14 | 104.75 |
| 15 | Conv-EncDec | LTCUSD | 60 | 14 | 96.66 |
| 0 | Conv-EncDec | RPLUSD | 60 | 14 | 89.44 |
| 1 | Conv-EncDec | RPLUSD | 70 | 10 | 101.70 |
| 2 | Conv-EncDec | RPLUSD | 60 | 14 | 86.69 |
| 3 | Conv-EncDec | RPLUSD | 60 | 14 | 92.57 |
| 4 | Conv-EncDec | RPLUSD | 70 | 10 | 968.53 |
| 5 | Conv-EncDec | RPLUSD | 60 | 14 | 2589.58 |
| 6 | Conv-EncDec | RPLUSD | 70 | 14 | 99.30 |
| 7 | Conv-EncDec | RPLUSD | 70 | 14 | 94.57 |
| 8 | Conv-EncDec | RPLUSD | 60 | 10 | 68.19 |
| 9 | Conv-EncDec | RPLUSD | 70 | 14 | 89.41 |
| 10 | Conv-EncDec | RPLUSD | 70 | 10 | 2477.97 |
| 11 | Conv-EncDec | RPLUSD | 60 | 10 | 108.50 |
| 12 | Conv-EncDec | RPLUSD | 70 | 10 | 2280.59 |
| 13 | Conv-EncDec | RPLUSD | 60 | 10 | 1743.82 |
| 14 | Conv-EncDec | RPLUSD | 70 | 14 | 161.40 |
| 15 | Conv-EncDec | RPLUSD | 60 | 10 | 99.68 |
| 0 | Luongs-Att | BCHUSD | 70 | 10 | 2119.84 |
| 1 | Luongs-Att | BCHUSD | 60 | 14 | 3641.46 |
| 2 | Luongs-Att | BCHUSD | 70 | 14 | 1597.49 |
| 3 | Luongs-Att | BCHUSD | 60 | 14 | 2077.13 |
| 4 | Luongs-Att | BCHUSD | 60 | 14 | 1871.12 |
| 5 | Luongs-Att | BCHUSD | 60 | 10 | 3314.37 |
| 6 | Luongs-Att | BCHUSD | 60 | 10 | 2294.92 |
| 7 | Luongs-Att | BCHUSD | 70 | 14 | 2315.11 |
| 8 | Luongs-Att | BCHUSD | 70 | 10 | 1394.12 |
| 9 | Luongs-Att | BCHUSD | 60 | 10 | 4590.75 |
| 10 | Luongs-Att | BCHUSD | 70 | 10 | 2549.35 |
| 11 | Luongs-Att | BCHUSD | 60 | 14 | 2771.10 |
| 12 | Luongs-Att | BCHUSD | 70 | 10 | 1664.33 |
| 13 | Luongs-Att | BCHUSD | 60 | 10 | 2767.74 |
| 14 | Luongs-Att | BCHUSD | 70 | 14 | 2143.89 |
| 15 | Luongs-Att | BCHUSD | 70 | 14 | 2378.40 |
| 0 | Luongs-Att | BTCUSD | 60 | 14 | 2613.32 |
| 1 | Luongs-Att | BTCUSD | 70 | 10 | 1874.85 |
| 2 | Luongs-Att | BTCUSD | 70 | 10 | 2172.32 |
| 3 | Luongs-Att | BTCUSD | 60 | 10 | 1871.26 |
| 4 | Luongs-Att | BTCUSD | 70 | 10 | 1376.09 |
| 5 | Luongs-Att | BTCUSD | 70 | 14 | 1898.95 |
| 6 | Luongs-Att | BTCUSD | 70 | 14 | 2947.59 |
| 7 | Luongs-Att | BTCUSD | 60 | 10 | 3051.66 |
| 8 | Luongs-Att | BTCUSD | 60 | 10 | 1322.59 |
| 9 | Luongs-Att | BTCUSD | 70 | 14 | 1648.22 |
| 10 | Luongs-Att | BTCUSD | 70 | 14 | 3229.98 |
| 11 | Luongs-Att | BTCUSD | 60 | 10 | 2757.64 |
| 12 | Luongs-Att | BTCUSD | 60 | 14 | 1320.74 |
| 13 | Luongs-Att | BTCUSD | 70 | 10 | 2651.43 |
| 14 | Luongs-Att | BTCUSD | 60 | 14 | 2802.98 |
| 15 | Luongs-Att | BTCUSD | 60 | 14 | 1978.63 |
| 0 | Luongs-Att | ETHUSD | 60 | 10 | 1124.48 |
| 1 | Luongs-Att | ETHUSD | 70 | 10 | 1497.09 |
| 2 | Luongs-Att | ETHUSD | 60 | 10 | 1175.01 |
| 3 | Luongs-Att | ETHUSD | 60 | 14 | 2242.49 |
| 4 | Luongs-Att | ETHUSD | 70 | 14 | 3435.31 |
| 5 | Luongs-Att | ETHUSD | 70 | 14 | 1767.03 |
| 6 | Luongs-Att | ETHUSD | 60 | 14 | 2388.34 |
| 7 | Luongs-Att | ETHUSD | 60 | 14 | 1542.55 |
| 8 | Luongs-Att | ETHUSD | 70 | 10 | 1928.47 |
| 9 | Luongs-Att | ETHUSD | 70 | 10 | 1364.50 |
| 10 | Luongs-Att | ETHUSD | 60 | 10 | 2103.26 |
| 11 | Luongs-Att | ETHUSD | 70 | 14 | 2188.88 |
| 12 | Luongs-Att | ETHUSD | 60 | 14 | 2190.56 |
| 13 | Luongs-Att | ETHUSD | 70 | 14 | 1337.35 |
| 14 | Luongs-Att | ETHUSD | 70 | 10 | 1892.08 |
| 15 | Luongs-Att | ETHUSD | 60 | 10 | 1831.76 |
| 0 | Luongs-Att | LTCUSD | 60 | 14 | 4241.93 |
| 1 | Luongs-Att | LTCUSD | 70 | 10 | 2121.48 |
| 2 | Luongs-Att | LTCUSD | 60 | 10 | 2450.71 |
| 3 | Luongs-Att | LTCUSD | 60 | 10 | 3014.16 |
| 4 | Luongs-Att | LTCUSD | 70 | 14 | 3899.71 |
| 5 | Luongs-Att | LTCUSD | 60 | 10 | 4343.53 |
| 6 | Luongs-Att | LTCUSD | 70 | 14 | 2455.04 |
| 7 | Luongs-Att | LTCUSD | 70 | 10 | 2144.33 |
| 8 | Luongs-Att | LTCUSD | 70 | 10 | 1125.04 |
| 9 | Luongs-Att | LTCUSD | 60 | 10 | 1855.93 |
| 10 | Luongs-Att | LTCUSD | 70 | 10 | 2141.81 |
| 11 | Luongs-Att | LTCUSD | 60 | 14 | 2045.03 |
| 12 | Luongs-Att | LTCUSD | 60 | 14 | 2458.57 |
| 13 | Luongs-Att | LTCUSD | 70 | 14 | 1620.66 |
| 14 | Luongs-Att | LTCUSD | 70 | 14 | 2591.70 |
| 15 | Luongs-Att | LTCUSD | 60 | 14 | 2229.91 |
| 0 | Luongs-Att | RPLUSD | 70 | 10 | 2022.25 |
| 1 | Luongs-Att | RPLUSD | 60 | 14 | 1708.17 |
| 2 | Luongs-Att | RPLUSD | 70 | 10 | 1281.39 |
| 3 | Luongs-Att | RPLUSD | 70 | 14 | 2029.52 |
| 4 | Luongs-Att | RPLUSD | 70 | 10 | 2673.07 |
| 5 | Luongs-Att | RPLUSD | 60 | 10 | 4399.37 |
| 6 | Luongs-Att | RPLUSD | 60 | 14 | 1801.69 |
| 7 | Luongs-Att | RPLUSD | 60 | 10 | 2778.40 |
| 8 | Luongs-Att | RPLUSD | 60 | 14 | 2282.05 |
| 9 | Luongs-Att | RPLUSD | 70 | 10 | 1308.04 |
| 10 | Luongs-Att | RPLUSD | 70 | 14 | 2144.27 |
| 11 | Luongs-Att | RPLUSD | 70 | 14 | 1649.16 |
| 12 | Luongs-Att | RPLUSD | 70 | 14 | 2658.75 |
| 13 | Luongs-Att | RPLUSD | 60 | 14 | 1751.76 |
| 14 | Luongs-Att | RPLUSD | 60 | 10 | 1759.37 |
| 15 | Luongs-Att | RPLUSD | 60 | 10 | 2328.33 |



Experiments of Central Composite Design

| Run ID | Model Type | Exchange Rate | Batch Size | Number of Hidden Neurons | Response |
| --- | --- | --- | --- | --- | --- |
| 0 | MLP | BCHUSD | 61 | 10 | 46.88 |
| 1 | MLP | BCHUSD | 68 | 10 | 53.02 |
| 2 | MLP | BCHUSD | 61 | 13 | 49.97 |
| 3 | MLP | BCHUSD | 68 | 13 | 54.42 |
| 4 | MLP | BCHUSD | 65 | 12 | 50.97 |
| 5 | MLP | BCHUSD | 65 | 12 | 69.18 |
| 6 | MLP | BCHUSD | 65 | 12 | 49.30 |
| 7 | MLP | BCHUSD | 65 | 12 | 53.57 |
| 8 | MLP | BCHUSD | 60 | 12 | 52.80 |
| 9 | MLP | BCHUSD | 70 | 12 | 49.32 |
| 10 | MLP | BCHUSD | 65 | 10 | 49.97 |
| 11 | MLP | BCHUSD | 65 | 14 | 47.77 |
| 12 | MLP | BCHUSD | 65 | 12 | 49.42 |
| 13 | MLP | BCHUSD | 65 | 12 | 50.78 |
| 14 | MLP | BCHUSD | 65 | 12 | 47.90 |
| 15 | MLP | BCHUSD | 65 | 12 | 48.27 |
| 0 | MLP | BTCUSD | 58 | 8 | 37.58 |
| 1 | MLP | BTCUSD | 65 | 8 | 38.93 |
| 2 | MLP | BTCUSD | 58 | 11 | 35.78 |
| 3 | MLP | BTCUSD | 65 | 11 | 36.83 |
| 4 | MLP | BTCUSD | 62 | 10 | 38.44 |
| 5 | MLP | BTCUSD | 62 | 10 | 35.72 |
| 6 | MLP | BTCUSD | 62 | 10 | 35.25 |
| 7 | MLP | BTCUSD | 62 | 10 | 33.85 |
| 8 | MLP | BTCUSD | 57 | 10 | 43.76 |
| 9 | MLP | BTCUSD | 67 | 10 | 36.06 |
| 10 | MLP | BTCUSD | 62 | 8 | 37.14 |
| 11 | MLP | BTCUSD | 62 | 12 | 37.14 |
| 12 | MLP | BTCUSD | 62 | 10 | 36.06 |
| 13 | MLP | BTCUSD | 62 | 10 | 37.81 |
| 14 | MLP | BTCUSD | 62 | 10 | 36.25 |
| 15 | MLP | BTCUSD | 62 | 10 | 35.73 |
| 0 | MLP | ETHUSD | 61 | 10 | 48.64 |
| 1 | MLP | ETHUSD | 68 | 10 | 59.40 |
| 2 | MLP | ETHUSD | 61 | 13 | 49.43 |
| 3 | MLP | ETHUSD | 68 | 13 | 48.77 |
| 4 | MLP | ETHUSD | 65 | 12 | 58.56 |
| 5 | MLP | ETHUSD | 65 | 12 | 56.35 |
| 6 | MLP | ETHUSD | 65 | 12 | 64.64 |
| 7 | MLP | ETHUSD | 65 | 12 | 65.69 |
| 8 | MLP | ETHUSD | 60 | 12 | 47.64 |
| 9 | MLP | ETHUSD | 70 | 12 | 51.09 |
| 10 | MLP | ETHUSD | 65 | 10 | 63.62 |
| 11 | MLP | ETHUSD | 65 | 14 | 52.15 |
| 12 | MLP | ETHUSD | 65 | 12 | 47.87 |
| 13 | MLP | ETHUSD | 65 | 12 | 51.16 |
| 14 | MLP | ETHUSD | 65 | 12 | 69.30 |
| 15 | MLP | ETHUSD | 65 | 12 | 52.99 |
| 0 | MLP | LTCUSD | 61 | 10 | 61.53 |
| 1 | MLP | LTCUSD | 68 | 10 | 59.77 |
| 2 | MLP | LTCUSD | 61 | 13 | 55.71 |
| 3 | MLP | LTCUSD | 68 | 13 | 57.12 |
| 4 | MLP | LTCUSD | 65 | 12 | 54.74 |
| 5 | MLP | LTCUSD | 65 | 12 | 48.66 |
| 6 | MLP | LTCUSD | 65 | 12 | 53.01 |
| 7 | MLP | LTCUSD | 65 | 12 | 59.39 |
| 8 | MLP | LTCUSD | 60 | 12 | 51.71 |
| 9 | MLP | LTCUSD | 70 | 12 | 57.13 |
| 10 | MLP | LTCUSD | 65 | 10 | 58.25 |
| 11 | MLP | LTCUSD | 65 | 14 | 50.43 |
| 12 | MLP | LTCUSD | 65 | 12 | 57.45 |
| 13 | MLP | LTCUSD | 65 | 12 | 55.49 |
| 14 | MLP | LTCUSD | 65 | 12 | 53.11 |
| 15 | MLP | LTCUSD | 65 | 12 | 73.07 |
| 0 | MLP | RPLUSD | 59 | 8 | 58.43 |
| 1 | MLP | RPLUSD | 66 | 8 | 55.44 |
| 2 | MLP | RPLUSD | 59 | 11 | 60.53 |
| 3 | MLP | RPLUSD | 66 | 11 | 55.24 |
| 4 | MLP | RPLUSD | 63 | 10 | 78.06 |
| 5 | MLP | RPLUSD | 63 | 10 | 58.58 |
| 6 | MLP | RPLUSD | 63 | 10 | 64.08 |
| 7 | MLP | RPLUSD | 63 | 10 | 61.24 |
| 8 | MLP | RPLUSD | 58 | 10 | 58.34 |
| 9 | MLP | RPLUSD | 68 | 10 | 61.74 |
| 10 | MLP | RPLUSD | 63 | 8 | 60.77 |
| 11 | MLP | RPLUSD | 63 | 12 | 79.69 |
| 12 | MLP | RPLUSD | 63 | 10 | 64.35 |
| 13 | MLP | RPLUSD | 63 | 10 | 77.09 |
| 14 | MLP | RPLUSD | 63 | 10 | 57.76 |
| 15 | MLP | RPLUSD | 63 | 10 | 62.75 |
| 0 | LSTM | BCHUSD | 53 | 4 | 50.79 |
| 1 | LSTM | BCHUSD | 60 | 4 | 56.71 |
| 2 | LSTM | BCHUSD | 53 | 7 | 62.61 |
| 3 | LSTM | BCHUSD | 60 | 7 | 61.38 |
| 4 | LSTM | BCHUSD | 57 | 6 | 70.92 |
| 5 | LSTM | BCHUSD | 57 | 6 | 68.20 |
| 6 | LSTM | BCHUSD | 57 | 6 | 46.45 |
| 7 | LSTM | BCHUSD | 57 | 6 | 58.10 |
| 8 | LSTM | BCHUSD | 52 | 6 | 61.28 |
| 9 | LSTM | BCHUSD | 62 | 6 | 75.75 |
| 10 | LSTM | BCHUSD | 57 | 4 | 56.29 |
| 11 | LSTM | BCHUSD | 57 | 8 | 51.79 |
| 12 | LSTM | BCHUSD | 57 | 6 | 51.96 |
| 13 | LSTM | BCHUSD | 57 | 6 | 59.07 |
| 14 | LSTM | BCHUSD | 57 | 6 | 57.56 |
| 15 | LSTM | BCHUSD | 57 | 6 | 66.80 |
| 0 | LSTM | BTCUSD | 60 | 8 | 33.42 |
| 1 | LSTM | BTCUSD | 67 | 8 | 45.26 |
| 2 | LSTM | BTCUSD | 60 | 11 | 67.88 |
| 3 | LSTM | BTCUSD | 67 | 11 | 41.61 |
| 4 | LSTM | BTCUSD | 64 | 10 | 49.47 |
| 5 | LSTM | BTCUSD | 64 | 10 | 50.21 |
| 6 | LSTM | BTCUSD | 64 | 10 | 47.51 |
| 7 | LSTM | BTCUSD | 64 | 10 | 38.49 |
| 8 | LSTM | BTCUSD | 59 | 10 | 73.17 |
| 9 | LSTM | BTCUSD | 69 | 10 | 51.10 |
| 10 | LSTM | BTCUSD | 64 | 8 | 37.08 |
| 11 | LSTM | BTCUSD | 64 | 12 | 59.86 |
| 12 | LSTM | BTCUSD | 64 | 10 | 57.35 |
| 13 | LSTM | BTCUSD | 64 | 10 | 41.75 |
| 14 | LSTM | BTCUSD | 64 | 10 | 36.62 |
| 15 | LSTM | BTCUSD | 64 | 10 | 40.25 |
| 0 | LSTM | ETHUSD | 61 | 10 | 50.79 |
| 1 | LSTM | ETHUSD | 68 | 10 | 65.98 |
| 2 | LSTM | ETHUSD | 61 | 13 | 75.79 |
| 3 | LSTM | ETHUSD | 68 | 13 | 57.65 |
| 4 | LSTM | ETHUSD | 65 | 12 | 59.41 |
| 5 | LSTM | ETHUSD | 65 | 12 | 56.94 |
| 6 | LSTM | ETHUSD | 65 | 12 | 57.87 |
| 7 | LSTM | ETHUSD | 65 | 12 | 75.49 |
| 8 | LSTM | ETHUSD | 60 | 12 | 53.77 |
| 9 | LSTM | ETHUSD | 70 | 12 | 56.08 |
| 10 | LSTM | ETHUSD | 65 | 10 | 55.82 |
| 11 | LSTM | ETHUSD | 65 | 14 | 52.73 |
| 12 | LSTM | ETHUSD | 65 | 12 | 53.11 |
| 13 | LSTM | ETHUSD | 65 | 12 | 59.73 |
| 14 | LSTM | ETHUSD | 65 | 12 | 58.05 |
| 15 | LSTM | ETHUSD | 65 | 12 | 66.61 |
| 0 | LSTM | LTCUSD | 61 | 10 | 73.95 |
| 1 | LSTM | LTCUSD | 68 | 10 | 69.75 |
| 2 | LSTM | LTCUSD | 61 | 13 | 69.11 |
| 3 | LSTM | LTCUSD | 68 | 13 | 99.37 |
| 4 | LSTM | LTCUSD | 65 | 12 | 86.43 |
| 5 | LSTM | LTCUSD | 65 | 12 | 102.00 |
| 6 | LSTM | LTCUSD | 65 | 12 | 105.78 |
| 7 | LSTM | LTCUSD | 65 | 12 | 92.36 |
| 8 | LSTM | LTCUSD | 60 | 12 | 89.22 |
| 9 | LSTM | LTCUSD | 70 | 12 | 70.04 |
| 10 | LSTM | LTCUSD | 65 | 10 | 54.29 |
| 11 | LSTM | LTCUSD | 65 | 14 | 64.71 |
| 12 | LSTM | LTCUSD | 65 | 12 | 79.19 |
| 13 | LSTM | LTCUSD | 65 | 12 | 67.46 |
| 14 | LSTM | LTCUSD | 65 | 12 | 81.62 |
| 15 | LSTM | LTCUSD | 65 | 12 | 88.88 |
| 0 | LSTM | RPLUSD | 57 | 8 | 62.04 |
| 1 | LSTM | RPLUSD | 64 | 8 | 77.09 |
| 2 | LSTM | RPLUSD | 57 | 11 | 74.86 |
| 3 | LSTM | RPLUSD | 64 | 11 | 84.65 |
| 4 | LSTM | RPLUSD | 61 | 10 | 68.68 |
| 5 | LSTM | RPLUSD | 61 | 10 | 87.02 |
| 6 | LSTM | RPLUSD | 61 | 10 | 98.56 |
| 7 | LSTM | RPLUSD | 61 | 10 | 69.95 |
| 8 | LSTM | RPLUSD | 56 | 10 | 66.25 |
| 9 | LSTM | RPLUSD | 66 | 10 | 77.39 |
| 10 | LSTM | RPLUSD | 61 | 8 | 72.97 |
| 11 | LSTM | RPLUSD | 61 | 12 | 65.33 |
| 12 | LSTM | RPLUSD | 61 | 10 | 79.22 |
| 13 | LSTM | RPLUSD | 61 | 10 | 65.96 |
| 14 | LSTM | RPLUSD | 61 | 10 | 72.67 |
| 15 | LSTM | RPLUSD | 61 | 10 | 72.10 |
| 0 | Conv-EncDec | BCHUSD | 61 | 10 | 1304.54 |
| 1 | Conv-EncDec | BCHUSD | 68 | 10 | 62.64 |
| 2 | Conv-EncDec | BCHUSD | 61 | 13 | 72.80 |
| 3 | Conv-EncDec | BCHUSD | 68 | 13 | 88.57 |
| 4 | Conv-EncDec | BCHUSD | 65 | 12 | 3806.89 |
| 5 | Conv-EncDec | BCHUSD | 65 | 12 | 84.46 |
| 6 | Conv-EncDec | BCHUSD | 65 | 12 | 76.49 |
| 7 | Conv-EncDec | BCHUSD | 65 | 12 | 92.70 |
| 8 | Conv-EncDec | BCHUSD | 60 | 12 | 68.15 |
| 9 | Conv-EncDec | BCHUSD | 70 | 12 | 70.07 |
| 10 | Conv-EncDec | BCHUSD | 65 | 10 | 1739.16 |
| 11 | Conv-EncDec | BCHUSD | 65 | 14 | 79.39 |
| 12 | Conv-EncDec | BCHUSD | 65 | 12 | 69.30 |
| 13 | Conv-EncDec | BCHUSD | 65 | 12 | 1618.63 |
| 14 | Conv-EncDec | BCHUSD | 65 | 12 | 66.44 |
| 15 | Conv-EncDec | BCHUSD | 65 | 12 | 93.64 |
| 0 | Conv-EncDec | BTCUSD | 62 | 12 | 47.94 |
| 1 | Conv-EncDec | BTCUSD | 69 | 12 | 59.09 |
| 2 | Conv-EncDec | BTCUSD | 62 | 15 | 51.76 |
| 3 | Conv-EncDec | BTCUSD | 69 | 15 | 70.21 |
| 4 | Conv-EncDec | BTCUSD | 66 | 14 | 74.23 |
| 5 | Conv-EncDec | BTCUSD | 66 | 14 | 1371.41 |
| 6 | Conv-EncDec | BTCUSD | 66 | 14 | 79.97 |
| 7 | Conv-EncDec | BTCUSD | 66 | 14 | 1392.34 |
| 8 | Conv-EncDec | BTCUSD | 61 | 14 | 67.94 |
| 9 | Conv-EncDec | BTCUSD | 71 | 14 | 1335.30 |
| 10 | Conv-EncDec | BTCUSD | 66 | 12 | 46.01 |
| 11 | Conv-EncDec | BTCUSD | 66 | 16 | 50.14 |
| 12 | Conv-EncDec | BTCUSD | 66 | 14 | 184.88 |
| 13 | Conv-EncDec | BTCUSD | 66 | 14 | 71.49 |
| 14 | Conv-EncDec | BTCUSD | 66 | 14 | 81.80 |
| 15 | Conv-EncDec | BTCUSD | 66 | 14 | 818.14 |
| 0 | Conv-EncDec | ETHUSD | 61 | 10 | 967.55 |
| 1 | Conv-EncDec | ETHUSD | 68 | 10 | 1115.45 |
| 2 | Conv-EncDec | ETHUSD | 61 | 13 | 108.07 |
| 3 | Conv-EncDec | ETHUSD | 68 | 13 | 69.76 |
| 4 | Conv-EncDec | ETHUSD | 65 | 12 | 68.28 |
| 5 | Conv-EncDec | ETHUSD | 65 | 12 | 88.80 |
| 6 | Conv-EncDec | ETHUSD | 65 | 12 | 2232.33 |
| 7 | Conv-EncDec | ETHUSD | 65 | 12 | 63.59 |
| 8 | Conv-EncDec | ETHUSD | 60 | 12 | 2301.60 |
| 9 | Conv-EncDec | ETHUSD | 70 | 12 | 68.86 |
| 10 | Conv-EncDec | ETHUSD | 65 | 10 | 64.48 |
| 11 | Conv-EncDec | ETHUSD | 65 | 14 | 73.82 |
| 12 | Conv-EncDec | ETHUSD | 65 | 12 | 69.10 |
| 13 | Conv-EncDec | ETHUSD | 65 | 12 | 66.32 |
| 14 | Conv-EncDec | ETHUSD | 65 | 12 | 92.33 |
| 15 | Conv-EncDec | ETHUSD | 65 | 12 | 97.57 |
| 0 | Conv-EncDec | LTCUSD | 62 | 12 | 152.87 |
| 1 | Conv-EncDec | LTCUSD | 69 | 12 | 1838.76 |
| 2 | Conv-EncDec | LTCUSD | 62 | 15 | 95.16 |
| 3 | Conv-EncDec | LTCUSD | 69 | 15 | 105.69 |
| 4 | Conv-EncDec | LTCUSD | 66 | 14 | 103.56 |
| 5 | Conv-EncDec | LTCUSD | 66 | 14 | 103.46 |
| 6 | Conv-EncDec | LTCUSD | 66 | 14 | 74.64 |
| 7 | Conv-EncDec | LTCUSD | 66 | 14 | 123.77 |
| 8 | Conv-EncDec | LTCUSD | 61 | 14 | 1174.17 |
| 9 | Conv-EncDec | LTCUSD | 71 | 14 | 1481.58 |
| 10 | Conv-EncDec | LTCUSD | 66 | 12 | 120.16 |
| 11 | Conv-EncDec | LTCUSD | 66 | 16 | 150.67 |
| 12 | Conv-EncDec | LTCUSD | 66 | 14 | 104.12 |
| 13 | Conv-EncDec | LTCUSD | 66 | 14 | 100.63 |
| 14 | Conv-EncDec | LTCUSD | 66 | 14 | 99.98 |
| 15 | Conv-EncDec | LTCUSD | 66 | 14 | 90.16 |
| 0 | Conv-EncDec | RPLUSD | 61 | 10 | 107.52 |
| 1 | Conv-EncDec | RPLUSD | 68 | 10 | 74.85 |
| 2 | Conv-EncDec | RPLUSD | 61 | 13 | 1581.34 |
| 3 | Conv-EncDec | RPLUSD | 68 | 13 | 1880.18 |
| 4 | Conv-EncDec | RPLUSD | 65 | 12 | 125.45 |
| 5 | Conv-EncDec | RPLUSD | 65 | 12 | 91.25 |
| 6 | Conv-EncDec | RPLUSD | 65 | 12 | 81.48 |
| 7 | Conv-EncDec | RPLUSD | 65 | 12 | 1524.04 |
| 8 | Conv-EncDec | RPLUSD | 60 | 12 | 65.17 |
| 9 | Conv-EncDec | RPLUSD | 70 | 12 | 69.82 |
| 10 | Conv-EncDec | RPLUSD | 65 | 10 | 77.73 |
| 11 | Conv-EncDec | RPLUSD | 65 | 14 | 86.24 |
| 12 | Conv-EncDec | RPLUSD | 65 | 12 | 1019.14 |
| 13 | Conv-EncDec | RPLUSD | 65 | 12 | 76.80 |
| 14 | Conv-EncDec | RPLUSD | 65 | 12 | 83.65 |
| 15 | Conv-EncDec | RPLUSD | 65 | 12 | 966.91 |
| 0 | Luongs-Att | BCHUSD | 79 | 12 | 2718.14 |
| 1 | Luongs-Att | BCHUSD | 86 | 12 | 2983.96 |
| 2 | Luongs-Att | BCHUSD | 79 | 15 | 3654.70 |
| 3 | Luongs-Att | BCHUSD | 86 | 15 | 3263.69 |
| 4 | Luongs-Att | BCHUSD | 83 | 14 | 1354.86 |
| 5 | Luongs-Att | BCHUSD | 83 | 14 | 1774.67 |
| 6 | Luongs-Att | BCHUSD | 83 | 14 | 2769.67 |
| 7 | Luongs-Att | BCHUSD | 83 | 14 | 2394.84 |
| 8 | Luongs-Att | BCHUSD | 78 | 14 | 2700.81 |
| 9 | Luongs-Att | BCHUSD | 88 | 14 | 1816.15 |
| 10 | Luongs-Att | BCHUSD | 83 | 12 | 2266.59 |
| 11 | Luongs-Att | BCHUSD | 83 | 16 | 2390.58 |
| 12 | Luongs-Att | BCHUSD | 83 | 14 | 3024.11 |
| 13 | Luongs-Att | BCHUSD | 83 | 14 | 1969.77 |
| 14 | Luongs-Att | BCHUSD | 83 | 14 | 1860.38 |
| 15 | Luongs-Att | BCHUSD | 83 | 14 | 2651.12 |
| 0 | Luongs-Att | BTCUSD | 60 | 6 | 2307.01 |
| 1 | Luongs-Att | BTCUSD | 67 | 6 | 1594.08 |
| 2 | Luongs-Att | BTCUSD | 60 | 9 | 2708.04 |
| 3 | Luongs-Att | BTCUSD | 67 | 9 | 1763.24 |
| 4 | Luongs-Att | BTCUSD | 64 | 8 | 2998.55 |
| 5 | Luongs-Att | BTCUSD | 64 | 8 | 2282.10 |
| 6 | Luongs-Att | BTCUSD | 64 | 8 | 1770.15 |
| 7 | Luongs-Att | BTCUSD | 64 | 8 | 2576.21 |
| 8 | Luongs-Att | BTCUSD | 59 | 8 | 3229.83 |
| 9 | Luongs-Att | BTCUSD | 69 | 8 | 3059.65 |
| 10 | Luongs-Att | BTCUSD | 64 | 6 | 1452.97 |
| 11 | Luongs-Att | BTCUSD | 64 | 10 | 2880.45 |
| 12 | Luongs-Att | BTCUSD | 64 | 8 | 3472.27 |
| 13 | Luongs-Att | BTCUSD | 64 | 8 | 2482.05 |
| 14 | Luongs-Att | BTCUSD | 64 | 8 | 2270.64 |
| 15 | Luongs-Att | BTCUSD | 64 | 8 | 3197.49 |
| 0 | Luongs-Att | ETHUSD | 59 | 6 | 3904.74 |
| 1 | Luongs-Att | ETHUSD | 66 | 6 | 2252.92 |
| 2 | Luongs-Att | ETHUSD | 59 | 9 | 1927.03 |
| 3 | Luongs-Att | ETHUSD | 66 | 9 | 2047.52 |
| 4 | Luongs-Att | ETHUSD | 63 | 8 | 1376.96 |
| 5 | Luongs-Att | ETHUSD | 63 | 8 | 1970.10 |
| 6 | Luongs-Att | ETHUSD | 63 | 8 | 3197.37 |
| 7 | Luongs-Att | ETHUSD | 63 | 8 | 2367.79 |
| 8 | Luongs-Att | ETHUSD | 58 | 8 | 3767.60 |
| 9 | Luongs-Att | ETHUSD | 68 | 8 | 2335.50 |
| 10 | Luongs-Att | ETHUSD | 63 | 6 | 2454.19 |
| 11 | Luongs-Att | ETHUSD | 63 | 10 | 1989.47 |
| 12 | Luongs-Att | ETHUSD | 63 | 8 | 4540.11 |
| 13 | Luongs-Att | ETHUSD | 63 | 8 | 3926.70 |
| 14 | Luongs-Att | ETHUSD | 63 | 8 | 3913.23 |
| 15 | Luongs-Att | ETHUSD | 63 | 8 | 2678.82 |
| 0 | Luongs-Att | LTCUSD | 61 | 10 | 2646.76 |
| 1 | Luongs-Att | LTCUSD | 68 | 10 | 3452.01 |
| 2 | Luongs-Att | LTCUSD | 61 | 13 | 4277.59 |
| 3 | Luongs-Att | LTCUSD | 68 | 13 | 2229.90 |
| 4 | Luongs-Att | LTCUSD | 65 | 12 | 3219.88 |
| 5 | Luongs-Att | LTCUSD | 65 | 12 | 3174.92 |
| 6 | Luongs-Att | LTCUSD | 65 | 12 | 2184.20 |
| 7 | Luongs-Att | LTCUSD | 65 | 12 | 2706.51 |
| 8 | Luongs-Att | LTCUSD | 60 | 12 | 1742.69 |
| 9 | Luongs-Att | LTCUSD | 70 | 12 | 2808.09 |
| 10 | Luongs-Att | LTCUSD | 65 | 10 | 1740.09 |
| 11 | Luongs-Att | LTCUSD | 65 | 14 | 1936.19 |
| 12 | Luongs-Att | LTCUSD | 65 | 12 | 908.86 |
| 13 | Luongs-Att | LTCUSD | 65 | 12 | 2040.90 |
| 14 | Luongs-Att | LTCUSD | 65 | 12 | 2373.17 |
| 15 | Luongs-Att | LTCUSD | 65 | 12 | 2990.87 |
| 0 | Luongs-Att | RPLUSD | 67 | 12 | 3001.72 |
| 1 | Luongs-Att | RPLUSD | 74 | 12 | 2478.59 |
| 2 | Luongs-Att | RPLUSD | 67 | 15 | 2608.97 |
| 3 | Luongs-Att | RPLUSD | 74 | 15 | 2601.61 |
| 4 | Luongs-Att | RPLUSD | 71 | 14 | 2761.52 |
| 5 | Luongs-Att | RPLUSD | 71 | 14 | 2299.03 |
| 6 | Luongs-Att | RPLUSD | 71 | 14 | 1308.57 |
| 7 | Luongs-Att | RPLUSD | 71 | 14 | 2440.74 |
| 8 | Luongs-Att | RPLUSD | 66 | 14 | 2109.07 |
| 9 | Luongs-Att | RPLUSD | 76 | 14 | 2924.22 |
| 10 | Luongs-Att | RPLUSD | 71 | 12 | 1446.06 |
| 11 | Luongs-Att | RPLUSD | 71 | 16 | 1702.60 |
| 12 | Luongs-Att | RPLUSD | 71 | 14 | 1947.35 |
| 13 | Luongs-Att | RPLUSD | 71 | 14 | 1947.79 |
| 14 | Luongs-Att | RPLUSD | 71 | 14 | 1719.75 |
| 15 | Luongs-Att | RPLUSD | 71 | 14 | 2849.37 |