# INTRODUCTION

Novelty of this study can be listed as follows:

1. Development of methodology for application of DOE for hyperparameter optimization in financial time series multi-step prediction.
2. Analysis of efficiency of DoE method comparing with Hyperband Tuner in hyperparameter optimization for financial data analysis.
3. Development of 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

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* 1. BPMN Graph of Applied Method

# NEURAL NETWORKS

## Multi-Layer Perceptron (MLP)

In this section, we summarize description from the book chapter (Goodfellow, Bengio, & Courville, 2016). Multilayer perceptrons (MLP) are called also as “feedforward neural networks” because information flows from inputs through some intermediate computations and finally to the output. The output of the system is not considered as an input to system. If output is returned to neural network as input, it would be called as “recurrent neural network”. MLPs use chain structure where a set of functions are connected like a chain. For example, let’s consider 3 functions , and that are connected in a chain. If the input of the chain is demonstrated with , then we can form the function as . In this case, we can say that is the “first layer" of the neural network, is the “second layer” of the neural network and so on so forth. First layer of the network is called as “input layer” and final layer of the network as called as “output layer”. Learning algorithm is used to decide the correct output of the neural network. Input and output layers should represent the inputs and outputs of the training data respectively. However, there are layers in the neural networks that don’t represent the training data directly. These layers are called as “hidden layers”. Each neuron in the layers is called as “unit”. Each unit receives input from many other units and computes their own value with “activation functions”.

### Activation Functions of Hidden Units

It is recommended to use “Rectified Linear Unit (ReLU)” functions are activation functions (Glorot & Antoine Bordes, 2011) of hidden layers of MLPs. ReLU function is easy to optimize because half of the space of ReLU function is linear and the other half is zero. There are variations of the ReLU function considering with a non-zero slope: “absolute value rectification” (Jarrett, 2009) is with the slope of -1, “leaky ReLU” (Andrew L Maas, 2013) is with the slope of small value like 0.01 or “parameteric ReLU” (He, Zhang, Ren, & Sun, 2015) is with learnable slope parameter and so on so forth. It is also an option to use linear activation function in all layers of MLP. However, then MLP will be a linear form. That’s why, it is recommended to use non-linear activation functions in at least some of the hidden layers of MLP. In addition, softmax activation function also can be considered if the architecture of MLP requires a memory that represent a probability distribution.

It is not recommended to use the functions that saturate in hidden layers of MLP. Gradient-based learning is not very easy for the activation functions that saturate. Activation functions such as sigmoid function, hyperbolic tangent function or radial basis function are not suggested to use in hidden layers of MLPs. However, in recurrent neural networks, these functions can be considered. Please note that if an activation function saturates and if it is differentiable, it doesn’t mean that it will give better results. Authors of (Goodfellow, Bengio, & Courville, 2016) gives softplus function as an example to this statement. They state that softplus function demonstrates performance of hidden units very counterintuitive. The researchers of (Xavier Glorot, 2011) found better results with rectifier than softplus function.

### Architecture

Architecture of an MLP refers to the number of the layers and units that are connected to each other. The length of the chain is called as “depth” of the model. Dimensions of hidden layers are the “width” of the model. To sum up, length and width are the main architectural considerations of MLPs. Most of the time, MLPs with single hidden layer are sufficient to generalize training dataset. According to “universal approximation theorem” (Hornik, Stinchcombe, & White, 1989), we know that a large MLP has ability to represent the function between input and output of MLP. However, we don’t know if the training algorithm is able to learn this function due to lack of convergence and overfitting. Deeper networks are harder to optimize. In the book that is written by (Goodfellow, Bengio, & Courville, 2016), it is recommended to follow an experimentation process to identify the optimum network architecture. Experimenting the depth and width of MLPs in different applications demonstrated that there is a clear improvement between experiments. They are recommending that in the worst-case scenario, an exponential number of hidden units based on number of inputs can be used. However, please note that there is still not a clear suggestion about what should be the correct width and depth of MLP in the literature.

There are also several architectural considerations about how to connect the hidden layers with each other. Default way of connecting the hidden layer is to connect each hidden layer with the subsequent. However, it could be considered to skip connections from layer to or higher orders instead of subsequent layer . In addition to the way of skipping connections, the way how to connect hidden units with subsequent layer can be considered. By default, each hidden unit in a layer is connected with each hidden unit in subsequent layer. This way of connection is called as “dense” connection. However, it can also be a case to connect a layer with subsequent layer partially instead of fully.

### Weight Initialization

In MLPs, all weights are initialized to small random values. Biases can be initialized to zero or small positive random values.

## Long-Short Term Memory (LSTM)

## Convolutional Encoder Decoder (Conv-EncDec)

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

# TRAINING NEURAL NETWORKS

## Cost Function

## Back-Propagation Algorithm

When a neural network is fed with input and propagates based on architecture, and finally produces an output , this process is called as “forward propagation”. As a result of forward propagation, a scalar cost value is calculated. The information is flowed backwards starting from the cost value. This flow operation is called as “back-propagation” (Rumelhart, Hinton, & Williams, 1986). Output of back-propagation process is called as “gradient”. A learning algorithm uses this gradient to perform learning. Learning algorithms are described in subsequent section 4.3. In this section, gradient computation is described. Mostly gradient of cost function with respect to parameters is calculated.

In order to describe the back-propagation algorithm in more simple way, “computational graphs” are used in libraries specified for deep learning such as TensorFlow (Abadi, et al., 2015), Torch (Collobert, Kavukcuoglu, & Farabet, 2011), Theano (Theano Development Team, 2016) etc. Computational graphs are directed graphs where “nodes” represent the mathematical “operations” while “edges” correspond to scalar data, vectors, tensors etc. An example of computational graph in Fig. 1.2 demonstrates that result of forward propagation is . Back-propagation algorithm calculates the gradient of output based on each edge of ,, and . In order to calculate the gradients that are backward multiple times, chain rule of calculus is used. As shown in Equation (##), gradient of based on can be calculated as follows:

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

where – is the derivative of based on for the equation ,

– is the derivative of based on for the equation .

**WRITE ADVANTAGES OF COMPUTATIONAL GRAPHS**

Diagram

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* 1. Example of Computational Graph

## Gradient Descent Algorithm

Adam optimization (Kingma & Ba, 2014) is a commonly used learning algorithm to identify optimum weights of neural networks.

# HYPERPARAMETER OPTIMIZATION

## Design of Experiments (DoE)

### Full Factorial Design

### Steepest Descent

### Response Surface Methodology

## Hyperband Tuner

# Portfolio Optimization

## Mathematical 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 (Taha, 1997). 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.

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

## Genetic Algorithm (GA)

# literature review

# APPLICATION

## Exploratory Data Analysis

As an application, 5 symbols of cryptocurrencies are taken into consideration: BCHUSD, BTCUSD, ETHUSD, LTCUSD and RPLUSD. The frequency of the data 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 (MetaQuotes, 2000) platform’s API (Ltd, 2022) is used. First Prudential Markets (FP Markets) (Markets, 2005) is used as broker to fetch market data. Descriptive statistics of closing prices of imported datasets are demonstrated in Table 1.1.



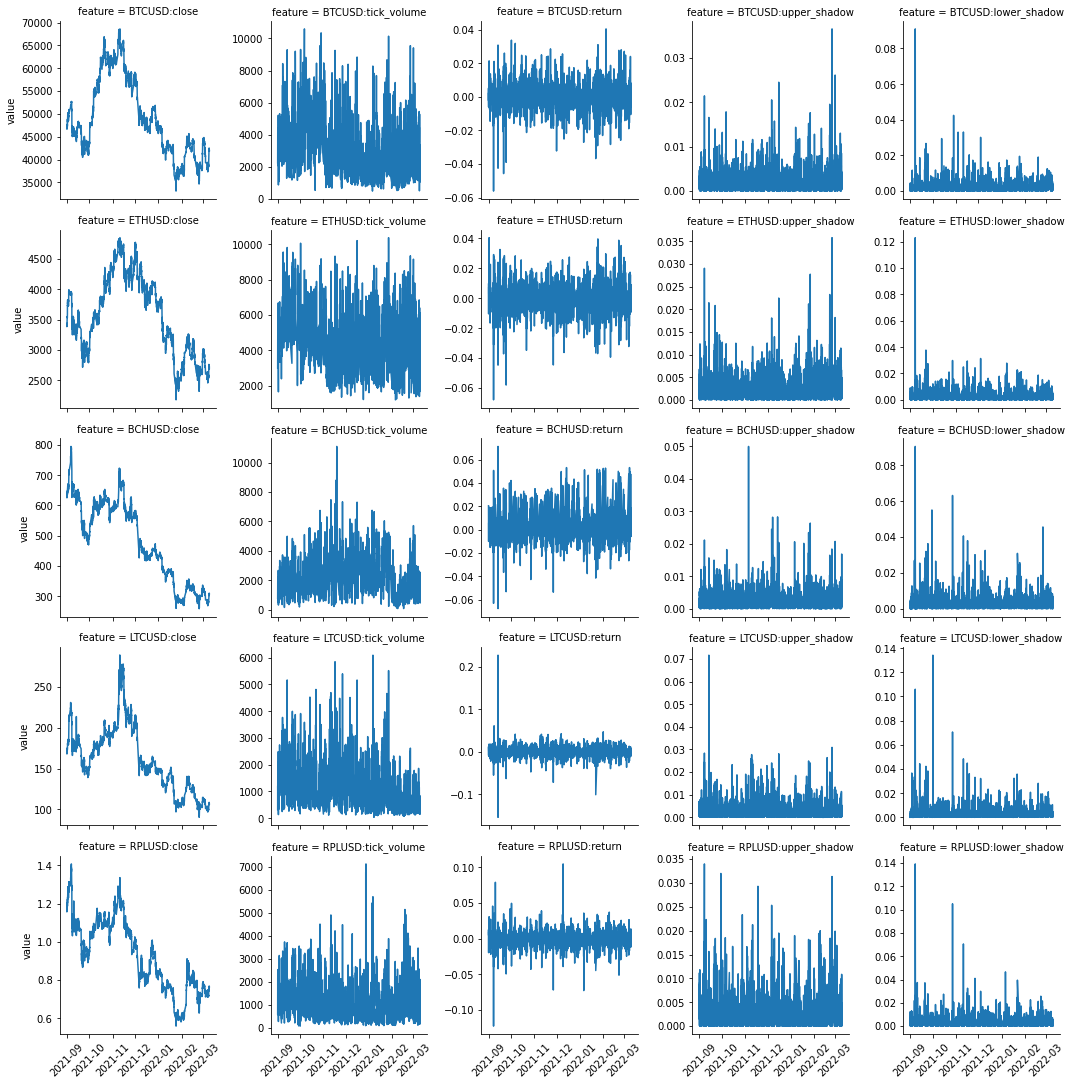
Descriptive Statistics of Closing Prices

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

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* 1. Data Distributions for Some Features



* 1. Trends of Some Features

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* 1. Corralation Analysis

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* 1. Scatter Plot for BTCUSD Features with Other Currencies

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 | 0.10 | 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. 1.6.

Calendar

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* 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. 1.7.

Shape, arrow

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* 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. 1.8.

Chart, bar chart

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* 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.

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* 1. Multi-Step Comparison of BCHUSD Simulation

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* 1. Multi-Step Comparison of BTCUSD Simulation

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* 1. Multi-Step Comparison of ETHUSD Simulation

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* 1. Multi-Step Comparison of LTCUSD Simulation

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* 1. Multi-Step Comparison of RPLUSD Simulation

## Portfolio Optimization

# RESULTS AND CONCLUSION

Following steps can be considered as further research areas:

1. Defining new types of activation functions can be still an interest for future studies. A special activation function for exchange rate prediction can be considered.
2. Social media and financial news dataset can be processed via using natural language processing techniques.
3. 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.
4. Cloud based cluster systems can be used to run the experiments.
5. 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.
6. A strategy should be built on during the prediction and optimization durations.
7. A separate prediction algorithm for spread values could be used.
8. In portfolio optimization algorithm, swap prices could be considered.
9. Pending orders could be considered in optimization. Also, stop loss and take profit options also could be considered.
10. Additional features can be predicted such as highest price, lowest price, spread etc.

appendixes

[Appendix 1](#_Toc106924211)

[Experiments of Full Factorial Design](#_Toc106924212)

[Appendix 2](#_Toc106924213)

[Experiments of Central Composite Design](#_Toc106924214)



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 |