A proposed method using neural network for electricity price prediction base on genetic algorithm

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Abstract. In predicting the electricity price, neural network is used as an applied model. To implement the neural network there are several parameters that we must determine such as learning rate and momentum, the problem is there is no standard guideline in determining the parameters to be used in this method, so that the experimental method is used. Therefore, we need method that can solve these problems, so parameters determination can be more optimal. The solution that can be applied is using genetic algorithm on neural network by optimizing the value of learning rate, momentum and training cycles parameter. The expected result is it can accelerate the process in getting the appropriate and optimal parameter values on neural network, so it can increase the accuracy of the prediction in predicting electricity price.

1. Introduction

Estimates of electricity price are one of the important factor in electricity market. Accuracy in forecasting and predicting electricity price is so useful for market participants in decision making and risk management in predicting electricity price. In addition for electricity suppliers, electricity price prediction is a basic reference for building optimal electricity bargaining strategy, while for customers, it help them to get a schedule in getting electricity purchases with maximum electricity power with minimum expenditure cost [1]. One example in Spain, electricity companies and wholesale electric buyers meet every day in an electricity market to offer electricity for 24 hours the next day [2].

Several research and method already done for electricity prediction for the last 15 years with various success level [3]. In 2012 chan et al, conduct research related electricity price prediction where Neural Network, Support Vector Machine, model time series using (ARMA, ARMAX, GARCH), and functional Principal component Analysis (FPCA) [4]. Madani et al, (2011) said that Artificial Neural Network, fuzzy system, support vector machines (SVM) and evolutionary computation (evolutionary Programming, Swarm Intelligence) is one of technique that used for computational intelligence (CI), it also can be associated with soft computing, machine learning, data mining dan cybernetics. The CI model is very flexible and it can handle complexity and nonlinear data, so it can be used for short term predictions and has excellent performance in predicting electricity prices [5]. The advantage of Neural Network is its ability to be able to do learning based on data used for training, it also can do self-
organization or make representation of the information it receives and it has a real time operation in the sense that Artificial Neural Networks can perform calculation in parallel and it has high tolerant fault [6], besides the advantages in modeling for pattern recognition [7] and one of them is backpropagation algorithm [8]. The disadvantage of backpropagation is to find the optimal solution in the selection of features on the weight of the attributes used and the need for large training data and the optimization used is less efficient [9]. In implementing Neural Network, there are several parameters that we have to determine. So far there are no standard guidelines in determining the Neural Network parameters. so the method used is an experimental method [10]. Therefore we need a method that can solve these problems, so that the implementation of the Neural Network can be more efficient.

The study was conducted by C,Luo et all (2011), using Neural Networks (NN) and Genetic Algorithm (GA) for prediction of vegetable prices in the Beijing wholesale market. The problem that arises is that the price of vegetables was previously stable and rapidly changing. This prediction is difficult for everyone because it is constrained in promoting sustainable development and production of stable vegetables. Using the four algorithm models presented which show that the BP Neural Network shows the worst results in the prediction of vegetable prices, while Algorithm Genetics and Neural Networks show the best results in terms of prediction of vegetable prices [11]. The research was conducted by Davor, Z.A (2013), using Artificial Neural Networks and Genetic Algorithms in predicting Particulate matter 10 emission. The fact that the emission factor has not been used to make the ANN model significantly in reducing the number of input parameters required, the time required for data preparation and uncertainty when the model is used to predict future emissions with the estimated input variables. Also, the comparison of the ANN model optimized using the Genetic Algorithm has an approximate performance far better than just the ANN model [12].

Research conducted by Liu in 2009, using genetic algorithms to operate the parameters of the BP Neural Network in predicting future gold prices. Neural Networks have several problems including pickling connection weights, fluctuations in the process of deciding the network structure, and networks easily trapped into local optimal solutions. To overcome these deficiencies, genetic algorithms can improve generalization capabilities of the BP Neural Network. This study compares the traditional BP Neural Network model with BP Neural Network based on Genetic Algorithms to predict future gold price models. The result of this study indicates that BP Neural Network based on Genetic Algorithm has better global convergence and high learning efficiency and precision compared to traditional BP Neural Network models [13].

From several studies that have been mentioned the main difficulties faced are determining the parameters of the model used so that the resulting predictions are still less than optimal based on several studies above in this study are different, to improve accuracy of data forecasting in predicting electricity prices. Models used by researchers is a hybrid model that uses Genetic Algorithms and Neural Networks (GA-NN). In this study Genetic Algorithm (GA) is used to obtain the optimal parameter values on the neural network, namely the value of learning rate, momentum and Training Cycles so that the result of the accuracy rate of electricity price prediction can be more accurate. The purpose of this study is that the implementation of genetic algorithms on Neural Networks is expected to accelerate the process of obtaining the appropriate and optimal parameter values so as to increase the level of predictive accuracy in predicting electricity prices.

2. Method
2.1. Dataset
The dataset that used in this research is time series data of electricity prices that taken in 2015 from www.nyiso.com. Electricity price dataset from NYISO that was taken is electricity price in the united states in the NewYork region in three of month period, from January 1, 2015 to March 31, 2015 consisting 4 attributes, TimeStamp (date and name), Name (service provider/ NYISO), PTID (code PT NYISO) LBMP (electricity price) with total 2160 data records. The method proposed in this study is using Neural Network (NN) for electricity price prediction and Genetic Algorithm (GA) for
determining parameter values, namely learning rate, momentum and Training Cycles that are on NN so it more optimal.

2.2. Preprocessing Dataset

for experiment and testing on proposed method use Rapid Miner5. Data has been prepared in advance and then enter into model that already created and modified to get expected result.

Table 1. Dataset real electricity price New York Region

| Time Stamp   | Name                        | PTID | LBMP |
|--------------|-----------------------------|------|------|
| 1/1/2015 0:00| NYISO_LBMP_REFERENCE        | 24008| 17.99|
| 1/1/2015 1:00| NYISO_LBMP_REFERENCE        | 24008| 4.25 |
| 1/1/2015 2:00| NYISO_LBMP_REFERENCE        | 24008| 10.53|
| 1/1/2015 3:00| NYISO_LBMP_REFERENCE        | 24008| 8.89 |
| 1/1/2015 4:00| NYISO_LBMP_REFERENCE        | 24008| 8.96 |
| 1/1/2015 5:00| NYISO_LBMP_REFERENCE        | 24008| 8.53 |
| 1/1/2015 6:00| NYISO_LBMP_REFERENCE        | 24008| 9.6  |
| 1/1/2015 7:00| NYISO_LBMP_REFERENCE        | 24008| 7.65 |
| 1/1/2015 8:00| NYISO_LBMP_REFERENCE        | 24008| 15.09|
| 1/1/2015 9:00| NYISO_LBMP_REFERENCE        | 24008| 13.21|
| 1/1/2015 10:00| NYISO_LBMP_REFERENCE       | 24008| 8.59 |
| 1/1/2015 11:00| NYISO_LBMP_REFERENCE       | 24008| 7.36 |
| 1/1/2015 0:00| NYISO_LBMP_REFERENCE        | 24008| 17.99|

| ...           | ...                         | ...  | ...  |
| ...           | ...                         | ...  | ...  |
| 3/31/2015 23:00| NYISO_LBMP_REFERENCE      | 24008| 17.71|

2.3. Proposed Method

Proposed Method in this research is use Neural Network (NN) for electricity price prediction and Genetic Algorithm (GA) for determine parameter values, namely learning rate, momentum and Training Cycles yang ada pada NN so it more optimal. Forecasting Performance Accuract used for accuracy level that produce from proposed method, in this research is use Split Validation method for searching Root Mean Squared Error (RMSE) values and Prediction trend accuracy and then te result of that accuracy is evaluated with comparing accuracy level that produce by NN traditional and proposed NN-GA.

3. Result and Discussion

3.1. Experiment Result and Model Testing

To test how closed the estimate is to the actual value, the general steps estimate the error, then the root mean squared error (RMSE) is used using the equation:

\[
\text{RMSE} = \sqrt{ \frac{1}{n} \sum_{i=1}^{n} (Y_i - O_i)^2 }
\]

Equation:
From the experiments that have been done as in the table above, the best RMSE (Root Mean Squared Error) value is 22,228 +/- 11,051, resulting in 1 (one) hidden layer with 4 (Four) neurons, 4 (Four) input layer attributes and 1 (one) output layer as shown in Figure 1.

**Table 2. Experiment Result**

| learning rate | momentum | RMSE   |
|---------------|----------|--------|
| 0.1           | 0.1      | 22.228 |
| 0.1           | 0.2      | 22.375 |
| 0.1           | 0.3      | 22.590 |
| 0.1           | 0.4      | 22.923 |
| 0.1           | 0.5      | 23.423 |
| 0.1           | 0.6      | 23.967 |
| 0.1           | 0.7      | 24.244 |
| 0.1           | 0.8      | 27.041 |
| 0.1           | 0.9      | 32.649 |
4. Evaluation Model
Based on the analysis result in experiment, it can be seen in Figure 2 that optimalization parameter determination of Neural Network (NN) using Genetics Algorithm (AG) it can make RMSE forecast value better which is decreasing RMSE (Root Mean Squared Error) value is 1.013 from 22.375 to be 21.362.

![Comparison Chart of RMSE NN and NN-GA for Training Data](image1)

![Comparison Chart of RMSE NN and NN-GA for Data Test](image2)

Figure 2. Comparison Chart of RMSE Neural Network Using NN-GA for Data Training

Figure 3. Comparison Chart of RMSE Neural Network Using NN-GA for Data Test

Thus, with the optimization of genetic algorithms against neural networks, there is an increase in prediction, namely by decreasing the value of RMSE (Root Mean Squared Error), so that the accuracy of the Neural Network using Genetic algorithms is better than the Neural Network without using Genetic Algorithms. Likewise when tested as shown in Figure 3 for the test data there was a decrease in RMSE of 0.395907, the RMSE prediction model for the Neural Network alone amounted to 22,322,63721 while the RMSE prediction model for the Neural Network that was optimized for the parameter was 21.92673.

5. Conclusion
Genetic Algorithms has been proven to be able to improve the accuracy of electricity price predictions. Models formed by Neural Networks based on Genetic Algorithms produce better accuracy than neural networks without being optimized. These optimization results are very important in determining the most optimal parameter values, resulting in a high. The increase can be seen from the increase in the accuracy value for the Neural Network model with the RMSE (Root Mean Squared Error) value obtained, after the accuracy value of the Neural Network algorithm based on Genetic Algorithm is optimized, the RMSE value obtained is smaller than before optimization. Based on the changes that occur in the RMSE value, it can be concluded that the application of optimization techniques with Genetic Algorithm can make it easier to find optimal parameter values that can increase the accuracy value in the Neural Network algorithm so that it can be used for policy makers to determine decision making. Short-term planning is related to the issue of electricity prices.

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