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APPLICATION OF NEURO FUZZY MODEL FOR FORECASTING CONSUMER PRICE INDEX IN YOGYAKARTA

Agus Maman Abadi

Department of Mathematics Education, Faculty of Mathematics and Sciences, Yogyakarta State University, Indonesia

Abstract

The aim of this research is to predict the consumer price index (CPI) in Yogyakarta using neuro fuzzy model. The rule bases of neuro fuzzy model is constructed by tipe III, i.e. the consequent of fuzzy rules is linear combination of input variables. We apply the proposed method to predict CPI in Yogyakarta and the MAPE values of the model for training and testing data are 4.23% and 9.59%, respectively.

Key words: neuro fuzzy model, forecasting, consumer price index (CPI)

INTRODUCTION

Consumer Price Index (CPI) is an index that measures the average price changes between the time of a package of goods and services consumed by the population or households in urban areas with the basis of a certain period (http://www.bps.go.id). The Consumer Price Index is a number which shows a comparison between the relative price level (consumer or retail) at the time of the survey month and the price of the previous month (Badan Pusat Statistik, 2013). CPI is also an indicator used by the government to measure inflation in Indonesia.

Cutler, J. et al (2005) researched the empirical relationship between changes in commodity prices and CPI inflation in Hong Kong and Mainland China using a vector autoregression (VAR) analysis. Minarnik (2006) applied intervention method to overcome outliers to analyze time series of the CPI in Indonesia. Hertriesa, A. (2009) examined the Consumer Price Index for foodstuff and health in Jember using time series analysis. Boyacioglu,M.A. and Avci, D. (2010) applied an adaptive network-based fuzzy inference system (ANFIS) for the prediction of stock market return in the case of the Istanbul Stock Exchange. Then, Andriani, R. (2011) have modeled CPI of the food group using intervention and regression spline methods. Tripena, A. (2011) forecasted CPI and inflation in Indonesia with the Box-Jenkins ARIMA method. Listyowati (2011) researched the modeling of the CPI of transportation group based on consumption of fuel oil in Surabaya. Vector Autoregressive Model (VAR) has been used to analyze the effect of oil prices on the CPI (Hadiyatullah, 2011). Chen, T. (2011) evaluated the usefulness of the Bank of Canada Commodity Price Index for a leading indicator of inflation in Canada using bivariate vector autoregressive (VAR) model. Arini, P.S. and Bendesa, IKG (2012) applied ARIMA method to analyze the influence of Galungan Day on Seasonal Adjustment of CPI and to determine the primary commodities that affect inflation in the province of Bali. Azadeh, A. et al (2012) used a neuro-fuzzy approach to improve the natural gas price forecasting in vague and noisy environments. Hemanth, K.P., et al

(2012) predicted stock trends using neuro fuzzy model. Forecasting CPI in Malang using the ARIMA method was done by Rosy,M. (2013). Maryam Ahmadifard et al (2013) predicted stock market return using ANFIS in the case of Tehran Stock Exchange. Kumar, J.K et al (2013) analyzed decision tool for stock market by hybrid network of neuro-fuzzy. Jha, G.K., and Sinha, K. (2013) forecasted agricultural price using artificial neural network (ANN) model. In this paper, the prediction of CPI in Yogyakarta using neuro fuzzy model will be established.

RESEARCH METHOD

The type of data used are secondary data, those are the data of consumer price index in Yogyakarta from January 2004 to December 2013 downloaded from http // www.bps.go.id. The prediction of CPI are done by the following steps.

Step 1. Perform pre-processing data to determine the significant input variables.

Step 2. Determine antecedent part of candidate fuzzy rules based on training data using fuzzy clustering.

Step 3.Determine consequent parameters of each fuzzy rule using least square error (LSE) method.

Step 4. Optimize the parameters of the fuzzy sets in each antecedent by using backpropagation network based on gradient descent method.

Step 5. Determine the neuro fuzzy model output.

Figure 1 shows the flowchart to modeling CPI

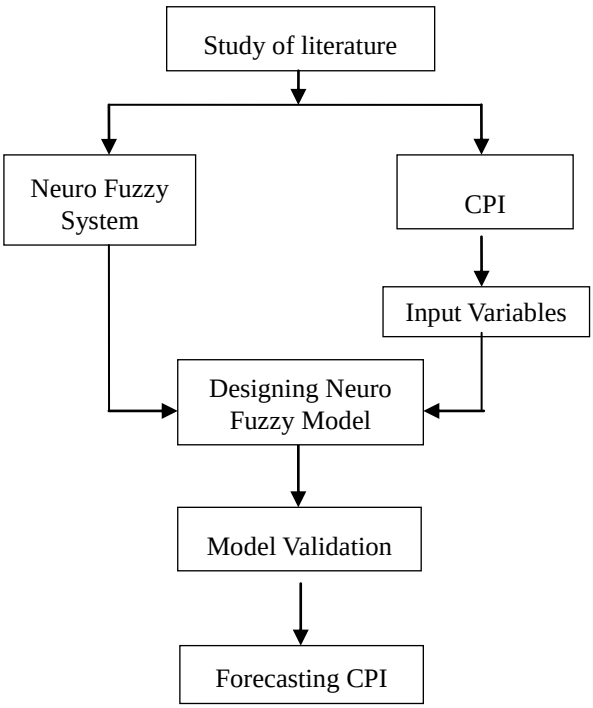


Figure 1. The flowchart of CPI prediction

RESULT AND DISCUSSION

Fuzzy system is a system combining fuzzifier, fuzzy rules, fuzzy inference, and defuzzifier. Neuro fuzzy system is a fuzzy system that optimization of parameters using neural network. In this system, parameters in antecedent and consequent of fuzzy rules are determined by neural network learning with backpropagation algorithm. In this paper, we use type III of fuzzy rule in the following form (Lin & Lee, 1996).

$$\boldsymbol{R^i: IF\ x_1\ is\ A_{i1} and\ x_2\ is\ A_{i2}, \dots, and\ x_n\ is\ A_{in}, THEN\ y_i = c_{i0} + c_{i1}x_1 + \cdots + c_{in}x_n}$$

where:

R^i is ith fuzzy rule

x_k is k^{th} input.

A_{ij} is a fuzzy set in i^{th} fuzzy rule and in j^{th} input.

c_{ij} is a constant to be determined

Figure 2 shows the architecture of neuro fuzzy system with fuzzy rule bases type III.

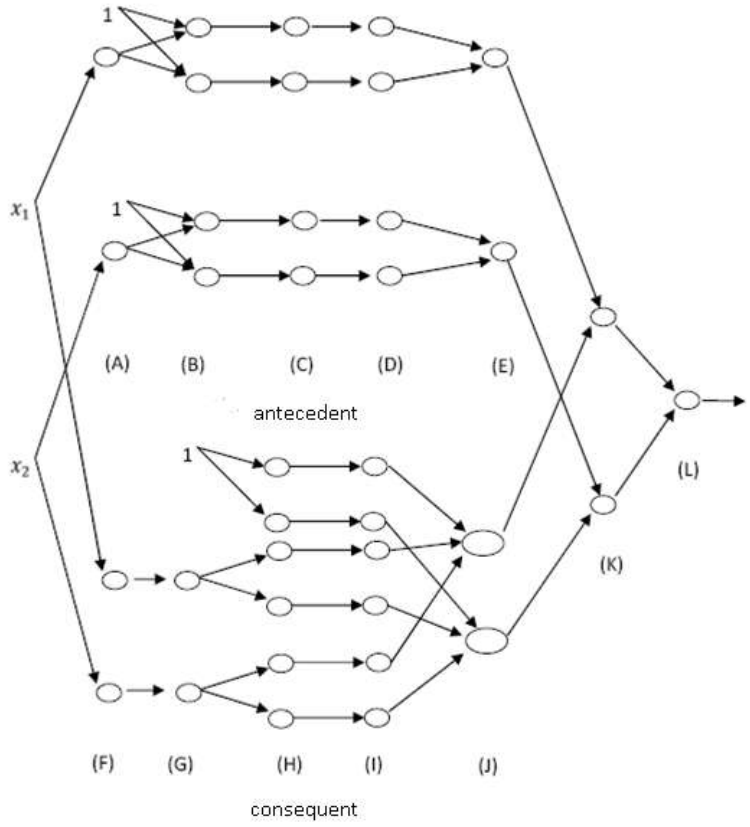


Figure 2. Neuro Fuzzy Model with fuzzy rule bases type III (Lin & Lee, 1996)

The model output *y* is given by the following formula:

$$y(x_1, x_2, ..., x_n) = \frac{\sum_{i=1}^{L} y_i (A_{i1}(x_1) A_{i2}(x_2) ... A_{in}(x_n))}{\sum_{i=1}^{L} A_{i1}(x_1) A_{i2}(x_2) ... A_{in}(x_n)}$$

where L is the number of rules,
$A_{ij}(x_j)$ is degree of membership of x_j on fuzzy set A_{ij} of antecedent part in i^{th} fuzzy rule, and y_i is consequent part of i^{th} fuzzy rule.

The proposed method is applied to predict CPI in Yogyakarta. The data of CPI are taken from January 2004 to December 2013. The first 90 data are used to training and the rest data are used to testing. In the first step, to choose the significant input variables, we identify the plots of ACF and PACF of the data. From this step, lag1, lag2, lag3, lag4, lag5, lag6, and lag7 are candidates as input variables. Plots of ACF and PACF of CPI data are shown in Figure3.

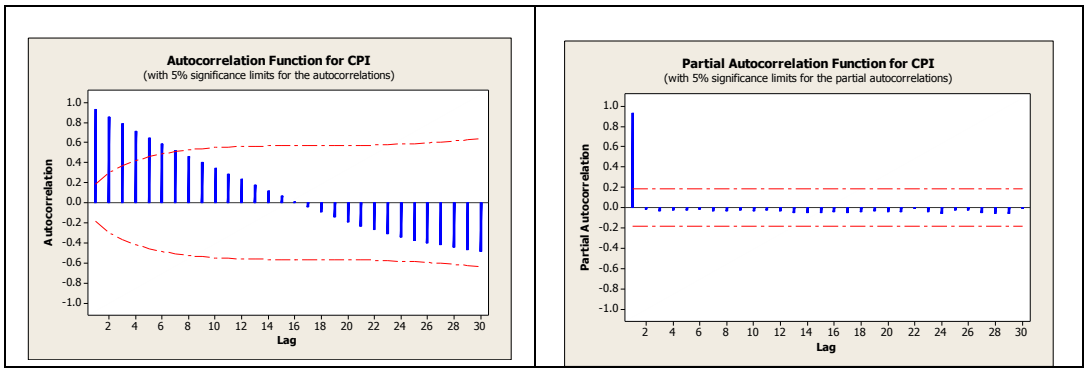
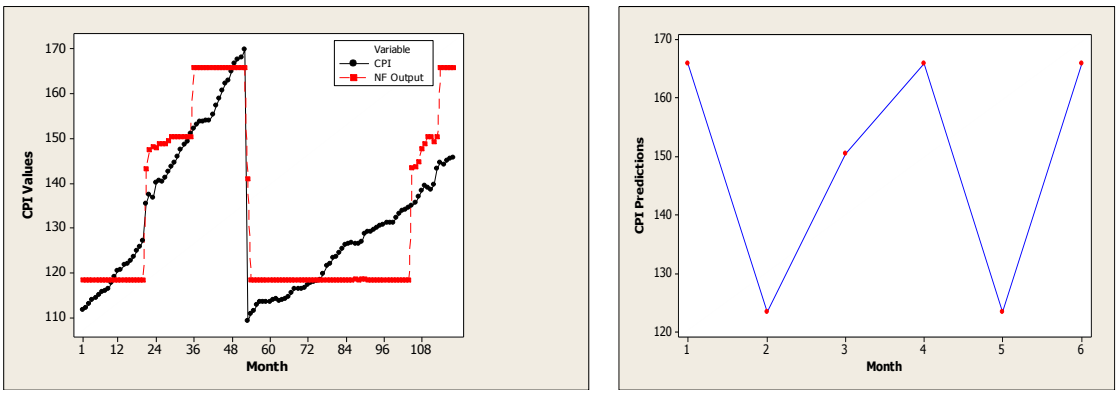


Figure 3. Plots of ACF and PACF of CPI data

Then, selection of input variables is done by eliminating input variables that are not significant. Based on the maximum epoch = 1000, learning rate = 1, error tolerance = 10^{-6}, and the minimum MSE value, the number of optimal neuron are 25, and the significant input is lag1, so we will construct neuro fuzzy model with 25 neurons in the hidden layers with input x(t-1) and output $\boldsymbol{y(t) = c_{i0} + c_{i1} x(t-1)}$. Then, clustering process is applied to get the number of rules. We have three rules. For each rule, parameters in antecedent are determined by backpropagation learning process where fuzzy sets are represented by sigmoid bipolar membership function. Least square error (LSE) method is applied to get parameters in the consequent of each rule. Then, the parameters of the fuzzy sets in each antecedent are optimized by using backpropagation network based on gradient descent method.

The resulted model gives good accuracy where the MAPE values of training data and testing data are 4.23% and 9.59%, respectively. Figure 4 (a) shows the real values and the prediction of CPI. Furthermore, the model is applied to predict CPI values for next six months shown by Figure 4.b.



(a) (b)

Figure 4. (a). Plots of real CPI values and CPI prediction, (b). Plot of CPI prediction for the next six months

CONCLUSION AND SUGGESTION

In this paper, the procedure to construct neuro fuzzy model was established. The procedure was applied to predict the consumer price index (CPI) in Yogyakarta. The result was that the prediction of CPI in Yogyakarta gave good accuracy where the MAPE values of the model for training and testing data were 4.23% and 9.59%, respectively. The effect of seasonal is not considered in this model. In the next research, to improve the accuracy of model, we would like to apply the seasonal effect to modeling neuro fuzzy of CPI.

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