Proceedings of the
1st International Conference on Environmental Health, Socioeconomic and Technology 2022
Lamongan, Indonesia, August 10-11 2022
Vol. 1, No. 1 (https://conference.unisla.ac.id/index.php/icehst/)

THE PREDICTION OF NATIONAL EXAMINATION RESULT FOR JUNIOR HIGH SCHOOL USING NEURAL NETWORK BACKPROPAGATION

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ABSTRACT

The national examination results can be used as a reference for the schools to determine school policy in the future. It also can be used as a basis for training and assistance to education unit in his attempt to improve the education quality as well. One of the prediction methods can be used to predict the national examination result is neural network backpropagation. This study attempts to get the best architecture of artificial neural network backpropagation used to predict the value of national examination results and its accuracy. The simulation of national examination results prediction using the value of last semester examination and school examination as predictors is performed in R software. Data was obtained from SMPN 1 and SMPN 2 Lamongan. The obtained data set as much as 701 data was divided into 75% data as training set and 25% data as testing set. The result of processing data showed that the best architecture of artificial neural network used combination of 7 hidden layer and 0.9 learning rate with the average training error 4.397 and testing RMSE and MAPE were 7.28 and 0.55%. The best architecture of artificial neural network found from this research which is used combination of 7 hidden layer and 0.9 learning rate can be implemented for further research.

KEYWORDS: *Prediction, examination result, backpropagation*

1 INTRODUCTION

The national examination result is no longer be used as a passing students determining factor, based on the policy of minister of education and culture republic of Indonesia number 4 2018 about evaluation of study result by the government and the education unit, the results of the national examination can be used as a basis for education unit quality mapping (Kementerian Pendidikan Nasional, 2018). It can also be used as a consideration of student selection for the next level of education. It also can be used as a basis for training and assistance to education unit in his attempt to improve the education quality as well.

Based on the description above, the result of national examination is still be an important thing for school to be predicted. It can be used as a reference for the school to determine school's policy in the future to improve the education quality. It also can be used as an early evaluation for student's preparation to face the real national examination in order to get an optimum result.

Generally, the prediction of national examination scores is conducted by seeing the average of students try out test scores. The prediction of the national examination can be done previously based on students' last semester test result. The advantage of it is the result of the national examination can be predicted early. It is expected to be able to become an early evaluation for the school management to take a policy in preparing their students to face the real national examination.

One of the prediction methods can be used to predict the national examination result is neural network backpropagation. It is stated that the advantage of using neural network to predict is its main capability to predict and capture very complex relations between predictors and its output (Apriyani, 2018). Neural network adopt the human brain capability to give a stimulation, perform process, and give an output (Pujianto et al., 2018). This method is capable of formulating experience and knowledge of predictor. This method is also very flexible in changes to the rules of the estimated value (Widodo et al., 2017). Beside the advantages above, it is stated that this method is also have some disadvantages such as the training result is not constant and the detail process of how the result is obtained is unknown. Besides that, neural network can produce an invalid prediction when received input value that is out range given during training. It also needs sufficient training data, if not it will produce invalid prediction (Apriyani, 2018).

The research done before which is using backpropagation method to predict the beginning of rainy season showed the smallest RMSE is about 2.51 (Lubis & Buono, 2012). The result of research done to predict the national examination result using backpropagation showed that the smallest MSE is about 0.14 (Kosasi, 2014). Another researcher used this method to predict the national examination result showed that the smallest RMSE about 0.169 (Utomo, 2015). Research about forecasting using neural network backpropagation was also conducted and generated smallest MSE about 0.0168 (Sihananto & Mahmudy, 2018). In addition, the result of the research done before showed that backpropagation method giving the 95.93% accuracy (Widodo et al., 2017). Another research done before using backpropagation method giving 90% accuracy (Pujianto et al., 2018). Another researcher was also using backpropagation method to make a prediction in their research. It showed prediction accuracy about 90% (Lesnussa et al., 2017). Thus, it can be concluded that backpropagation method can result a relatively small RMSE and high accuracy.

This study attempts to get the best pattern or architecture of artificial neural network used to predict the value of national examination results and its accuracy. The best pattern of artificial neural network obtained from the simulation of prediction performed in R software using the value of last semester examination and school examination as predictors.

2 MATERIALS AND METHODS

This research is an experimental research that is attempted to obtain the best pattern or architecture of artificial neural network used to predict the value of national examination results and its accuracy. The independent variable used in this research is combination of hidden layer and learning rate, while the dependent variable is the error produced. The simulation of national examination results prediction using the value of last semester examination result and school examination result as predictors is performed in R software. The steps of this research presented in Figure 1.

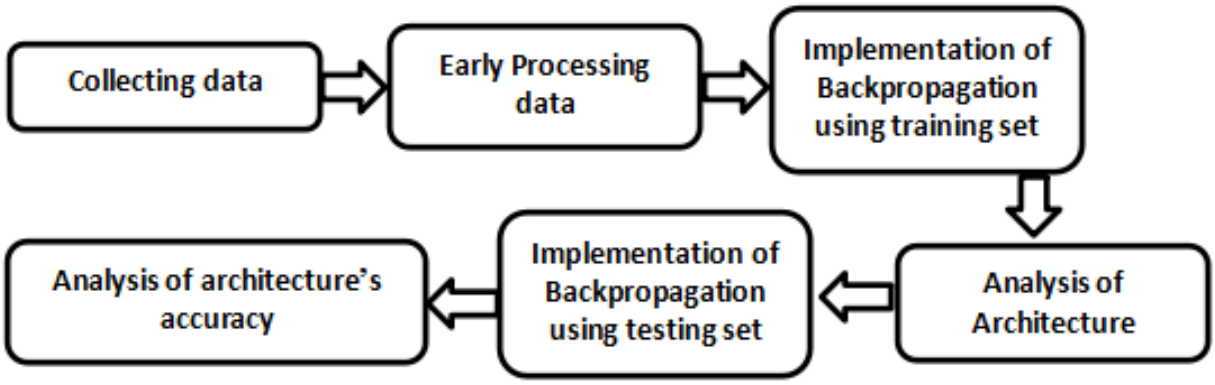

Figure-1. The research steps

Data was collected from SMPN 1 and SMPN 2 Lamongan. The collected data are students' last semester examination result, school examination result, and national examination result from batch 2015. In early processing data, the obtained data set as much as 701 data was divided into 526 (75%) data as training set and 175 (25%) data as testing set. The next process in early processing data is normalization (scaling process) of the data. This process is performed in order to make the output of this backpropagation neural network matches the activation function used (Subianto et al., 2018).

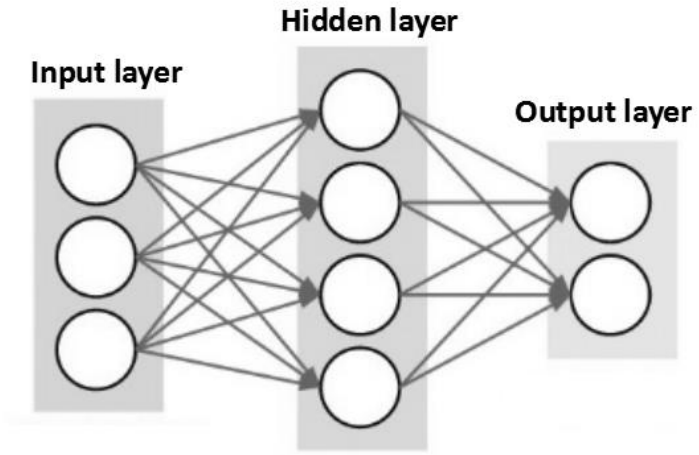

Figure-2. The general architecture of neural network backpropagation

The next process is the implementation of backpropagation algorithm. First, backpropagation method is implemented in training set to generate the best architecture of artificial neural network based on error produced. Architecture of artificial neural network used in this research is multilayer network using combination of hidden layer and learning rate. The variation of hidden layer unit used in this research were 3, 5, and 7, while the learning rate used in this research were 0.1, 0.5, and 0.9. This architecture of neural network using 7 input layer, single hidden layer with the variation above, and 1 output layer. This implementation performed in R software. The general architecture of neural network used in this research presented in Figure 2.

The next step is the analysis of the architecture generated from the previous process. The architecture generated from various combination of hidden layer and learning rate is compared based on the error produced. The best architecture is chosen based on the smallest error produced.

The next process is the second implementation of backpropagation algorithm. Backpropagation method is implemented to test the best architecture of artificial neural network that was chosen. The best architecture of artificial neural network was tested using testing set to obtain its accuracy. The parameter of accuracy used in this research was Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE). The result of MAPE calculation can be used to calculate the accuracy of the architecture of artificial neural network. The formulas is given below:

$$RMSE = \sqrt{\frac{\sum \left| D_t - F_t \right|^2}{n}} \quad (1)$$

$$MAPE = \frac{\sum \left| D_t - F_t \right| / D_t}{n} \quad (2)$$

With:
D_t = actual data
F_t = forecast data
n = number of data

3 RESULT

The experiment in this research was done using combination of hidden layer unit and learning rate while implementing backpropagation algorithm. The number of hidden layer unit used in this research were 3, 5, and 7, while the learning rate used in this research were 0.1, 0.5, and 0.9. The result of this experiment presented in Table-1.

Based on Table-1, it is shown that the smallest error produced from the architecture of artificial neural network backpropagation combination of 7 hidden layer and 0.9 learning rate with the value of average error about 4.397. This is in accordance with the results of the study done before that shows the more the number of hidden neurons units the lower error resulting . The plot of the chosen architecture of artificial neural network backpropagation for each subject can be seen in Figure-2, Figure-3, Figure-4, and Figure-5.

Table- 1. The result of hidden layer unit and learning rate combination

No	Hidden Layer	Learning Rate	Error for every subject				Average Error
			Bahasa	Math	Nat. Sience	English	
1	3	0.1	3.672	6.279	6.128	4.889	5.242
2	3	0.5	3.625	6.572	6.180	4.805	5.295
3	3	0.9	3.586	6.492	6.078	4.974	5.283
4	5	0.1	3.497	6.029	5.228	4.753	4.877
5	5	0.5	3.484	5.555	5.614	5.012	4.916
6	5	0.9	3.374	5.241	5.395	4.416	4.606
7	7	0.1	3.186	5.958	5.539	4.299	4.746
8	7	0.5	3.288	6.062	5.299	3.821	4.618
9	7	0.9	3.385	5.206	5.030	3.968	4.397

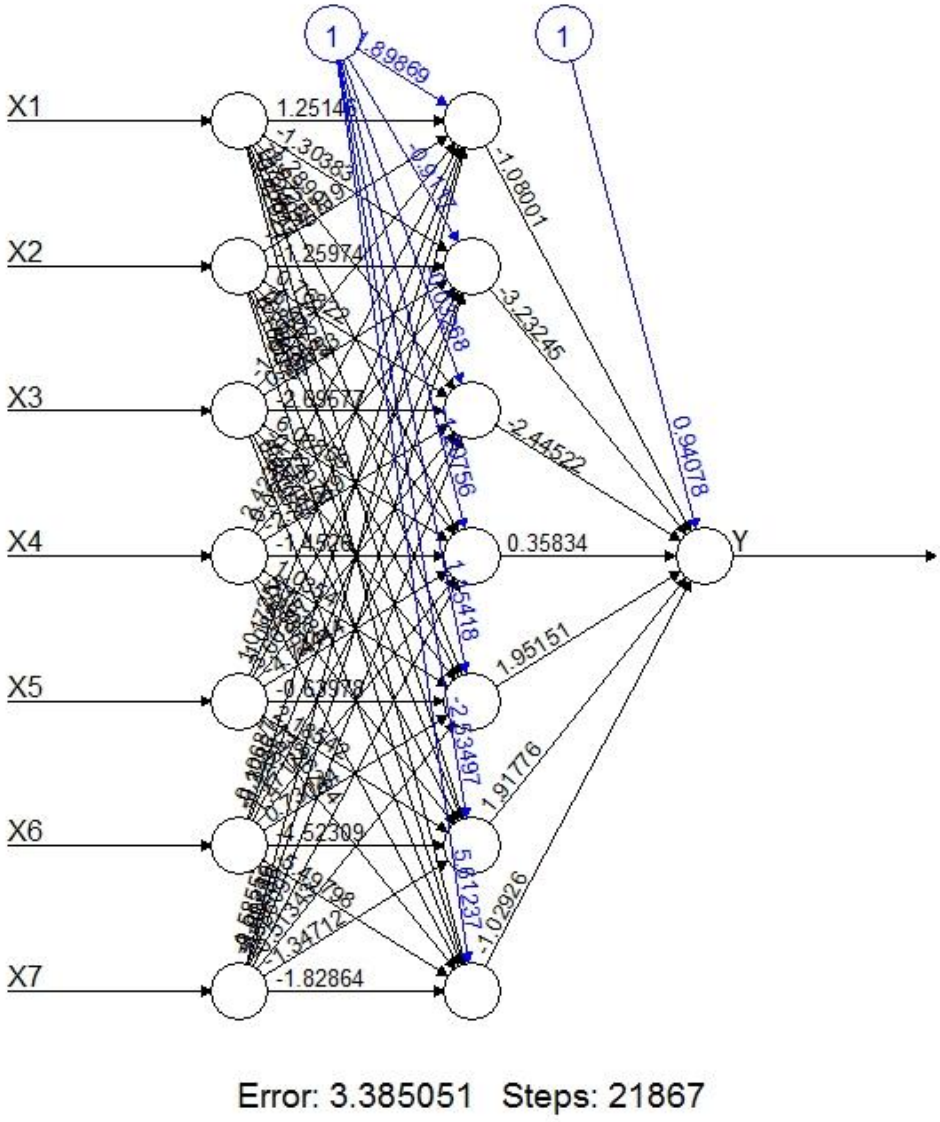

Figure-2. The plot for Bahasa using combination 7 hidden layer and 0.9 learning rate

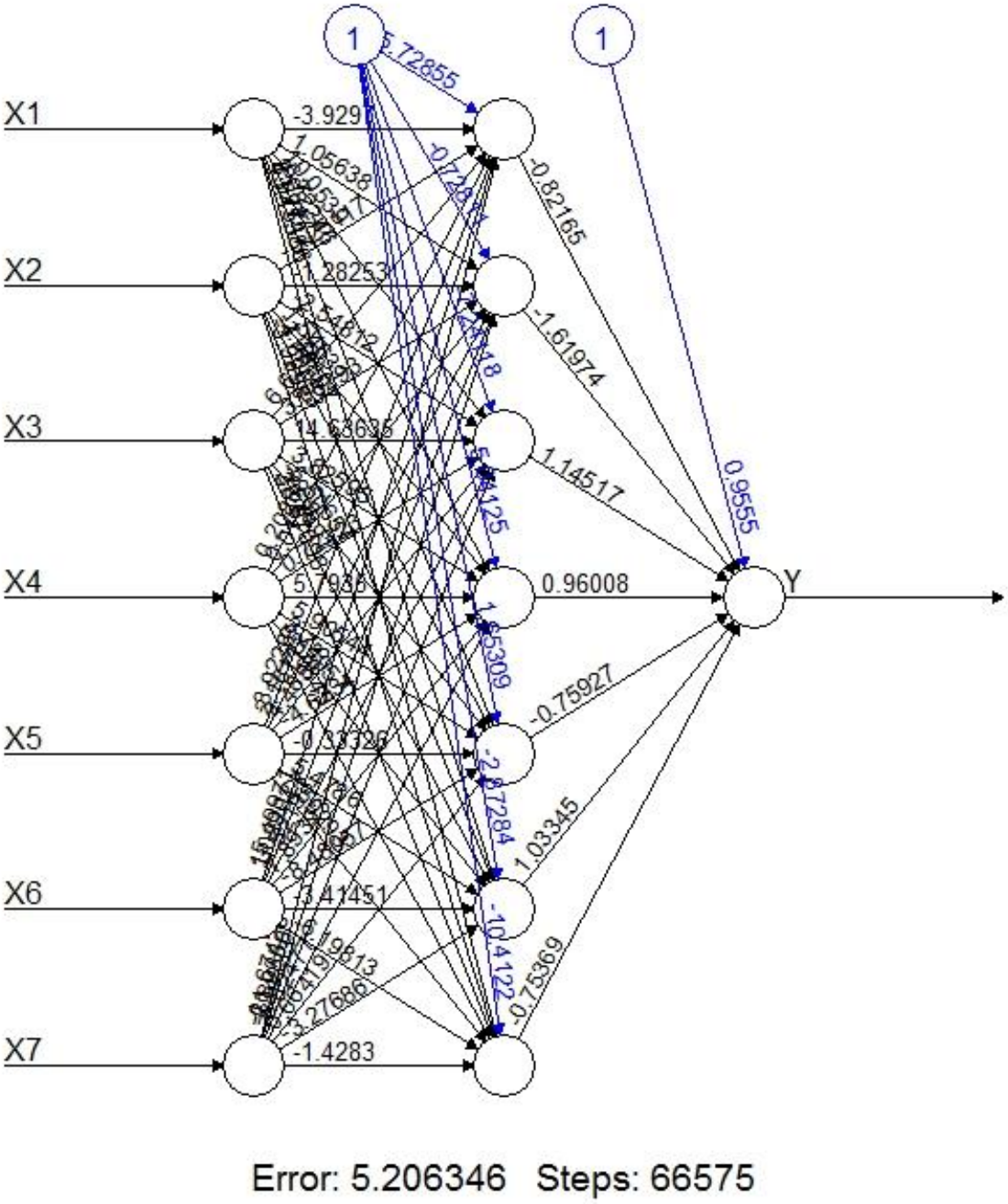

Figure-3. The plot for Math using combination 7 hidden layer and 0.9 learning rate

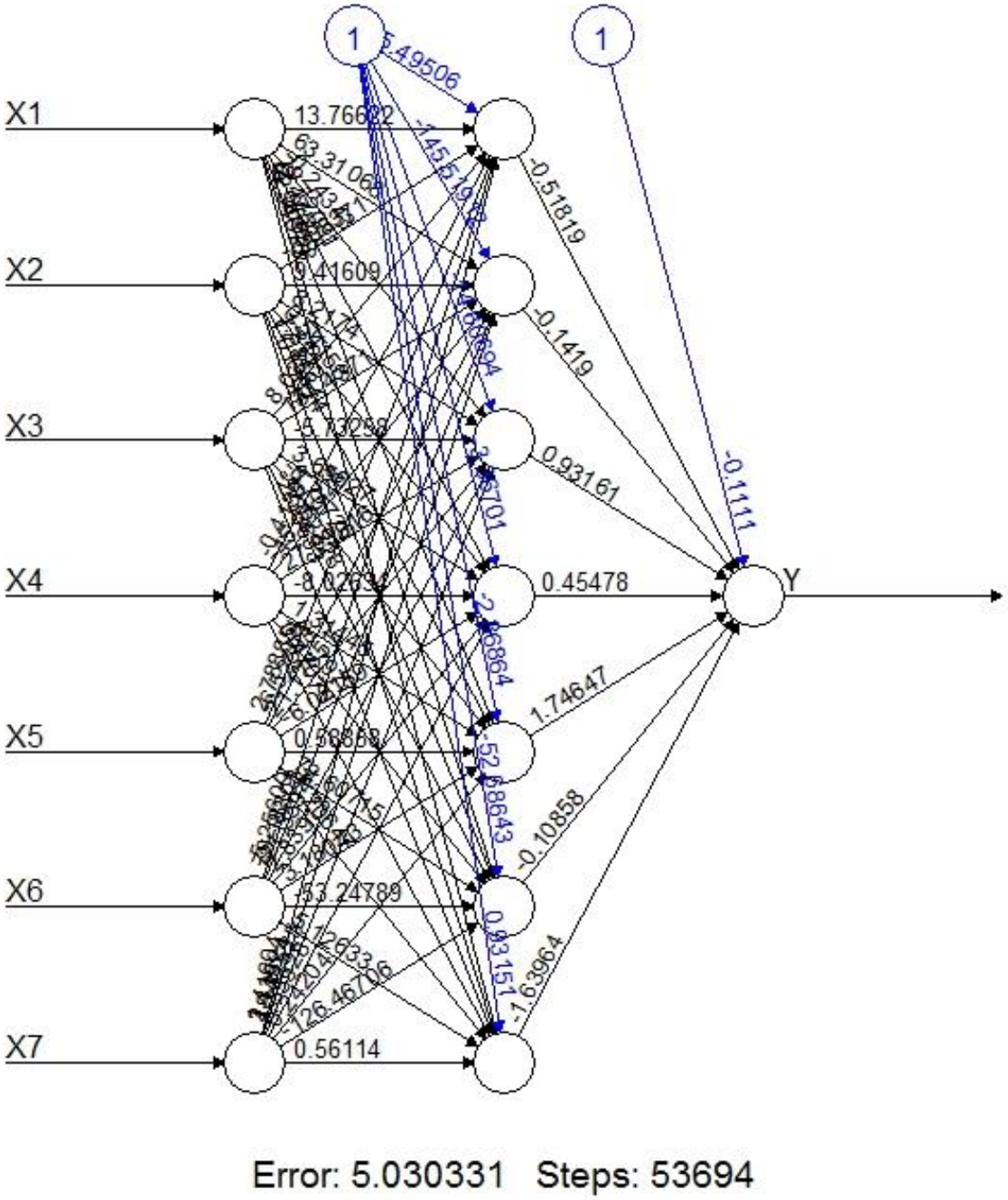

Figure-4. The plot for Natural Science using combination 7 hidden layer and 0.9 learning rate

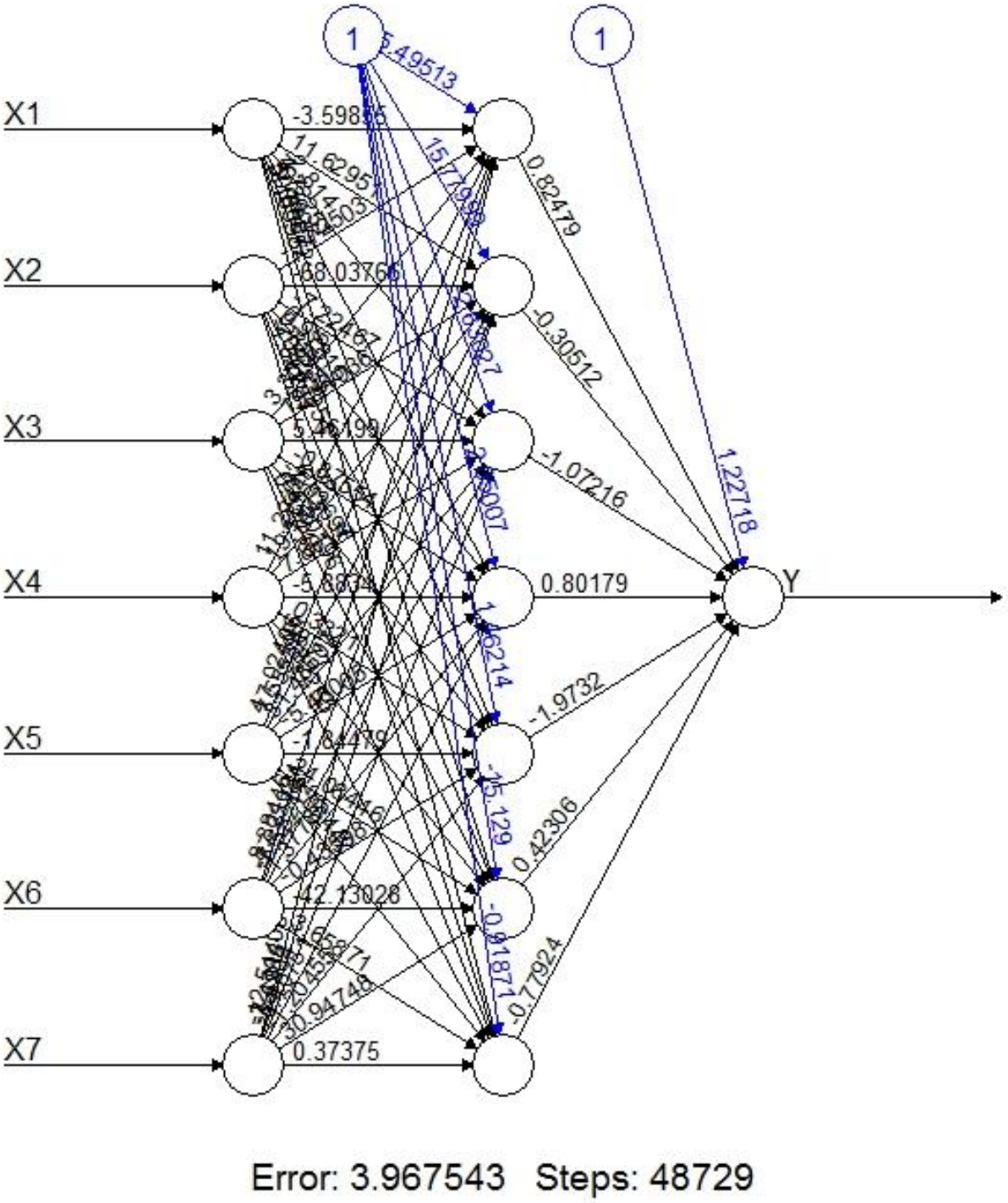

Figure-5. The plot for English using combination 7 hidden layer and 0.9 learning rate

The chosen architecture will be used in the next process. The best architecture of artificial neural network chosen then was tested using testing data set to obtain its accuracy. The implementation of architecture chosen from previous step on testing set giving the result as shown in Table-2.

Table-2 Result of the chosen architecture implementation

No	Error	Subject				Average
		Bahasa	Math	Nat. Science	English	
1	MSE	51.77	98.65	89.94	6.31	**61.67**
2	RMSE	7.19	9.93	9.48	2.51	**7.28**
3	MAPE	0.11%	0.64%	0.03%	1.42%	**0.55%**

Based on Table-2. above, it is shown that the average MSE is about 61.67, average RMSE is about 7.28, and average MAPE is about 0.55% generated from the chosen architecture. It means that this architecture of artificial neural network giving 99.45% accuracy. This is in accordance with the results of the studies done by (Kosasi, 2014; Lesnussa et al., 2017; Lubis & Buono, 2012; Pujianto et al., 2018; Sihananto & Mahmudy, 2018; Utomo, 2015; Widodo et al., 2017) that show backpropagation method can result a relatively small RMSE and high accuracy.

4 CONCLUSION

The result of this research showed that the best architecture of artificial neural network backpropagation used combination of 7 hidden layer and 0.9 learning rate with the average training error 4.397. The implementation of backpropagation on chosen architecture generated RMSE and MAPE about 7.28 and 0.55%. Future research may implement another various parameter to generate better architecture of artificial neural network used to predict the result of National Examination for Junior High School.

Research on providing best architecture of artificial neural network backpropagation still needs to be studied further using another various parameter to generate better architecture of artificial neural network used to predict the result of National Examination for Junior High School.

5 ACKNOWLEDGEMENTS

The author would like to thank to DRPM Ristekdikti who provided funding for this research. We would also like to thank to the staff of SMPN 1 and SMPN 2 Lamongan for their involvement in the process of collecting data. Last but not least, we would like to thank to all parties who supported the implementation of this research.

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