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Research Paper

Adaptive Neuro Fuzzy Inference System for Prediction : a Study Approach

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Abstract

Prediction is a process of systematically estimating something that is most likely to happen in the future, based on past information and current information held, so that the difference between something that happens and the expected result can be minimized. Prediction does not have to give a definite answer to the event that will occur, but trying to find the answer as closely as possible that will happen. The ANFIS (Adaptive Neuro Fuzzy Inference System) method is a functionally similar method to the fuzzy rule base of the Sugeno model, as well as the neural network with radial functions with few restrictions that can be used to predict certain data.

Keywords: *ANFIS, Fuzzy, Prediction, Neuro Fuzzy, Inference System*

1. Introduction

With the advancement of science and computerized technology nowadays has become a very important and necessary, especially for the organization and management of companies or business world both government and private[1]–[8]. One effort to increase the activities of an organization or agency that is by accelerating the flow of information that is efficient[9]–[11], useful and accurate so that what will be decided by a leader can be more leverage[12]–[14], caused by this quality information, so that good performance in a company, agencies and organizations can be seen from the level of completion of a problem quickly and accurately, so the computer can also be very helpful in the delivery of information if the use in accordance with the path that has been determined.

XYZ Company is a business entity engaged in the health sector that sells some health products for use by humans and for the environment. The need for medication data is essential to make the service to consumers quick and efficient. To overcome the number of drug needs at any time of the month or next year to be applied forecasting or prediction method to determine the amount of drug in the future and one method that can be used is Adaptive Neuro Fuzzy Inference System[15]–[18].

ANFIS method is a method of determining the order or priority. With the right consideration, this method can be one tool for determining the descriptions or priorities for the product to be made [19]–[22]. Determination taken as a basis for using criteria that can be clearly and objectively defined. ANFIS method (Adaptive Neuro Fuzzy Inference System) is a method that uses artificial neural network to implement fuzzy inference system [23]–[29]. The advantage of a fuzzy inference system is that it can translate knowledge from experts in the form of rules, but it usually takes a long time to establish its membership function. So it takes the learning technique from artificial neural network to automate the process so that it can reduce the search time, it causes ANFIS method is very well applied in various fields.

2. Methodology

Adaptive Neuro Fuzzy Inference System (ANFIS) is a functional architecture similar to the fuzzy rule base model of Sugeno, and also similar to neural networks with radial functions with few restriction[30]–[32]. It can be said that ANFIS is a method which in doing the setting rules used algorithm learning data. For networks with radial-based functional equivalent of fuzzy-based rules of the 1st Sugeno model, it is necessary to limit:

a. The rules must have the same aggregation method (weighted average or sum) to produce all of its output.
b. The number of activation functions must be equal to the number of fuzzy rules (IF-THEN)
c. If there are multiple inputs on the base of the set then each function must be the same as the membership function of each input.
d. The activation function and fuzzy rules must have the same functionality for the neurons and the rules that exist on the output side.

For example there are two inputs x_1, x_2 and one y output. There are two rules on the sugeno model rule basis.

If x_1 is A_1 and X_2 is B_1 Then $y_1 = C_{11}X_1 + C_{12}X_2 + C_{10}$

If x_1 is A_2 and X_2 is B_2 Then $y_1 = C_{21} + C_{22}X_2 + C2_0$

If the α predicate for the rule of two rules is w1 and w2, then we can calculate weighted averages[33].

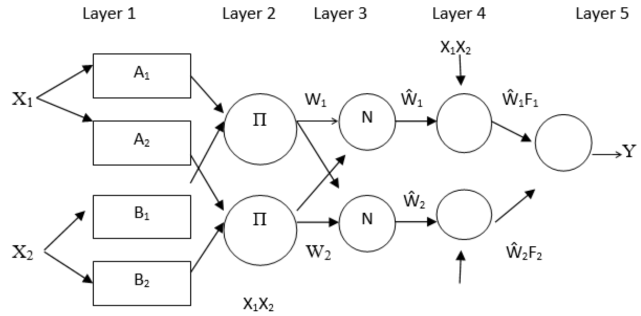

Fig.1: ANFIS Structure

The ANFIS network in Figure 1 consists of layers as follows:

a. Each neuron in the first layer is adaptive to the parameters of an activation function. The output of each neuron is the degree of input membership: αA1 (X1), (αA2 (X2) or AB2 (X2).
b. Each neuron in the second layer is a fixed neuron whose output is the result of the input. Usually used AND operators. Each node presents a predicate rule α to i.
c. Each neuron in the third layer is a fixed node which is the result of the ratio calculation of α predicate (w), from the rule i to the sum of the overall α predicates.
d. Each neuron in the fourth layer is an adaptive node to an output.
e. Each neuron in the fifth layer is a fixed node which is the sum of all inputs.

3. Results and Discussion

The input data and output data are connected to a function that is processed by ANFIS (Adaptive Neuro Fuzzy Inference System) method. From the adjustment between input and output will produce a function that can map the input and output. Then the input data is changed in the form of data input in 2016 and 2017, and matched with data in 2018. If the error generated by a small function then the function is optimal. The following table data are alternative medicine requirements in 2016, 2017, and 2018.

Table.1: Total Alternative Medicine in 2016/2017/2018

No	Alternative	Year		
		2016	2017	2018
1	Alternative 1	580	960	868
2	Alternative 2	450	320	546
3	Alternative 3	430	870	691
4	Alternative 4	240	360	348
5	Alternative 5	650	780	884
6	Alternative 6	140	360	248
7	Alternative 7	340	650	534
8	Alternative 8	650	450	785
9	Alternative 9	240	540	402
10	Alternative 10	430	450	565
11	Alternative 11	650	340	752
12	Alternative 12	540	440	672
13	Alternative 13	430	230	499
14	Alternative 14	550	430	679
15	Alternative 15	430	230	499
16	Alternative 16	150	340	252
17	Alternative 17	310	440	379
18	Alternative 18	430	230	499
19	Alternative 19	430	230	499
20	Alternative 20	440	230	509
21	Alternative 21	230	130	269
22	Alternative 22	150	330	249
23	Alternative 23	170	560	338
24	Alternative 24	340	770	571
25	Alternative 25	390	880	654

Analytical system used is ANFIS method, the components used in this system is the data of medicine needs (Alternative) from 2016 to 2017. Where the data of 2016 and 2017 as input and data of 2018 as an event then compared whether the predicted data is close to the data in fact so as to create the right amount of need so that there is no excess or deficiency in the provision of the medicine.

Table.2: Data Input 2016 and 2017

No	Alternative	Input	
		2011(X_1)	2012(X_2)
1	Alternative 1	580	960
2	Alternative 2	450	320
3	Alternative 3	430	870
4	Alternative 4	240	360
5	Alternative 5	650	780
6	Alternative 6	140	360
7	Alternative 7	340	650
8	Alternative 8	650	450
9	Alternative 9	240	540
10	Alternative 10	430	450
11	Alternative 11	650	340
12	Alternative 12	540	440
13	Alternative 13	430	230
14	Alternative 14	550	430
15	Alternative 15	430	230
16	Alternative 16	150	340
17	Alternative 17	310	440
18	Alternative 18	430	230
19	Alternative 19	430	230
20	Alternative 20	440	230
21	Alternative 21	230	130
22	Alternative 22	150	330
23	Alternative 23	170	560
24	Alternative 24	340	770
25	Alternative 25	390	880

The next process looks for mean and deviation values on each cluster with the following results:

Table.3: Clustering Item

No	X_1	X_2
1	0,108	0,892
2	0.969	0,031
3	0,032	0,968
4	0,914	0,087
5	0,130	0,870
6	0,822	0,178
7	0,169	0,831
8	0,598	0,0402
9	0,567	0,433
10	0,813	0,187
11	0,742	0,258
12	0,720	0,280
13	0,967	0,033
14	0,730	0,270
15	0,967	0.33
16	0,844	0,156
17	0,969	0,031
18	0,967	0,033
19	0,967	0,033
20	0,963	0,037
21	0,897	0,103
22	0,849	0,151
23	0,529	0,471
24	0,044	0,956
25	0,044	0,957

The mean and standard deviation values will then become c and a beginning. From the data provided, obtained:

$$c = \begin{bmatrix} 0,3716 & 0,3384 \\ 0,4550 & 0,8183 \end{bmatrix} \text{ and } a = \begin{bmatrix} 0,1657 & 0,1175 \\ 0,1303 & 0,1083 \end{bmatrix}$$

Thus for every neuron in the first layer will be:

$$A_1 = \mu(X_1) = \frac{1}{\left\| \frac{X_1 - 0,3716}{0,1657} \right\|^2 \leftarrow}, , A_2 = \mu(X_1) \frac{1}{1 + \left| \frac{X_1 - 0,3384}{0,1175} \right|^2 \leftarrow}$$

$$B_1 = \mu(X_2) = \frac{1}{1 + \left| \frac{X_2 - 0,455}{0,1303} \right|^2 \leftarrow} \; ; \quad B_2 = \mu(X_2) = \frac{1}{1 + \left| \frac{X_2 - 0,3384}{0,1083} \right|^2 \leftarrow}$$

The output of the first layer in the degree of membership of each data can be calculated and the results can be seen in table 4 below.

Table.4: First Layer

Data	Membership Degree			
	μ_{a1}	μ_{a2}	μ_{b1}	μ_{b2}
1	0,3873	0,5208	0,0345	0,3687
2	0,8171	0,9985	0,9761	0,0451
3	0,8895	0,9645	0,0466	0,8144
4	0,6132	0,2686	9673	0,0529
5	0,2616	0,3087	0,0661	0,8888
6	0,3386	0,1461	0,9673	0,0529
7	0,9645	0,5621	0,1245	0,2928
8	0,2616	0,3087	0,5257	0,0796
9	0,6132	0,2686	0,2536	0,1315
10	0,8895	0,9645	0,5257	0,0796
11	0,2616	0,3087	0,9998	0,0488
12	0,4919	0,7015	0,5722	0,0757
13	0,8895	0,9645	0,5402	0,0328
14	0,4631	0,6529	0,6220	0,0722
15	0,8895	0,9645	0,5402	0,0328
16	0,3586	0,1543	0,9998	0,0488
17	0,8786	0,4468	0,5402	0,0328
18	0,8895	0,9645	0,5402	0,0328
19	0,8895	0,9645	0,5402	0,0328
20	0,8544	0,9869	0,5402	0,0328
21	0,5779	0,2511	0,2412	0,0242
22	0,3586	0,1543	0,9949	0,0469
23	0,4032	0,1729	0,2195	0,1495
24	0,9649	0,5621	0,0690	0,8341
25	0,9878	0,8007	0,0450	0,7550

In the second layer multiply the degree of membership by using the function $w_1 = (\mu A_1)(\mu B_1)$ and $w_2 = (\mu A_2)(\mu B_2)$ next on the third layer is normalized to get $\hat{W}$ and $\hat{W}_2$ the results can be seen in table 5.

Table.5: Second and Third Layer

Data	Second Layer		Third Layer	
	W_1	W_2	$\hat{W}_1$	$\hat{W}_2$
1	0,0134	0,1920	0,0651	0,9349
2	0,7976	0,0450	0,9466	0,0534
3	0,0415	0,7855	0,0501	0,9499
4	0,5931	0,7855	0,9766	0,0234
5	0,0173	0,0142	0,0593	0,9407
6	0,3275	0,0077	0,9769	0,0231
7	0,1201	0,1646	0,4219	0,5781
8	0,1375	0,0246	0,8484	0,1516
9	0,1555	0,0353	0,8149	0,1851
10	0,4676	0,0768	0,8590	0,1410
11	0,2615	0,0151	0,9455	0,0545
12	0,2815	0,0531	0,8413	0,1587
13	0,4805	0,0316	0,9382	0,0618
14	0,2880	0,0471	0,8594	0,1406
15	0,4805	0,0316	0,9382	0,0618
16	0,3585	0,0075	0,9794	0,0206
17	0,4746	0,0147	0,9700	0,0300
18	0,4805	0,0316	0,9382	0,0618
19	0,4805	0,0316	0,9382	0,0618
20	0,4615	0,0324	0,9345	0,0655
21	0,1394	0,0061	0,9582	0,0418
22	0,3568	0,0072	0,9801	0,0199
23	0,0885	0,0258	0,7740	0,2260
24	0,0666	0,4688	0,1243	0,8757
25	0,0445	0,6045	0,0685	0,9315

This network is then trained by hybrid learning algorithm, with maximum epoch = 400, error tolerance = 10^{-6}, learning rate = 0.4, and momentum = 0.9. Then the final result will be obtained in table 6.

Table.6: Result

No	Error(%)	Prediction	Data Year 2018
1	0,01 %	869	868
2	0,03 %	549	546
3	0,00 %	691	691
4	0,01 %	349	348
5	0,03 %	887	884
6	0,02 %	250	248
7	0,00 %	534	534
8	0,05 %	791	785
9	0,03 %	405	402
10	0,01 %	566	565
11	0,00 %	752	752
12	0,03 %	675	672
13	0,00 %	499	499
14	0,00 %	679	679
15	0,00 %	499	499
16	0,01 %	253	252
17	0,00 %	379	379
18	0,00 %	499	499
19	0,00 %	499	499
20	0,03 %	512	509
21	0,02 %	301	269
22	0,01 %	350	249
23	0,04 %	412	338
24	0,03 %	574	571
25	0,03 %	657	654

Table.7: Final Result

No	Alternative	2018	Prediction	Error %
1	Alternative 1	868	869	0,01 %
2	Alternative 2	546	549	0,03 %
3	Alternative 3	691	691	0,00 %
4	Alternative 4	348	349	0,01 %
5	Alternative 5	884	887	0,03 %
6	Alternative 6	248	250	0,02 %
7	Alternative 7	534	534	0,00 %
8	Alternative 8	785	791	0,05 %
9	Alternative 9	402	405	0,03 %
10	Alternative 10	565	566	0,01 %
11	Alternative 11	752	752	0,00 %
12	Alternative 12	672	675	0,03 %
13	Alternative 13	499	499	0,00 %
14	Alternative 14	679	679	0,00 %
15	Alternative 15	499	499	0,00 %
16	Alternative 16	252	253	0,01 %
17	Alternative 17	379	379	0,00 %
18	Alternative 18	499	499	0,00 %
19	Alternative 19	499	499	0,00 %
20	Alternative 20	509	512	0,03 %
21	Alternative 21	269	301	0,02 %
22	Alternative 22	249	350	0,01 %
23	Alternative 23	338	412	0,04 %
24	Alternative 24	571	574	0,03 %
25	Alternative 25	654	657	0,03 %

4. Conclusion

ANFIS method is one of the effective method in prediction determination so as to reduce the occurrence of errors in the provision of items and also by utilizing computerized system a problem can be documented in the form of programs that can be used in the process of drawing conclusions to a problem.

References

[1] R. Rahim *et al.*, "C4.5 Classification Data Mining for Inventory Control," *Int. J. Eng. Technol.*, vol. 7, no. 2.3, 2018.

[2] M. Mesran *et al.*, "Expert system for disease risk based on lifestyle with Fuzzy Mamdani," *Int. J. Eng. Technol.*, vol. 7, 2018.

[3] M. D. T. P. Nasution *et al.*, "Decision support rating system with Analytical Hierarchy Process method," *Int. J. Eng. Technol.*, vol. 7, 2018.

[4] L. Liyan, "The Impact of Information Technology on Accounting Theory , Accounting Profession , and Chinese Accounting Education Profession , and Chinese Accounting Education," *Wuhan Int. Conf. E-bus. 2013 Proc.*, 2013.

[5] W. Yu and R. Ramanathan, "Effects of business environment on international retail operations: case study evidence from China," *Int.*

J. Retail Distrib. Manag., vol. 40, no. 3, pp. 218–234, 2012.

[6] D. Napitupulu, M. Syafrullah, R. Rahim, A. Amar, and Y. Sucahyo, “Content validity of critical success factors for e-Government implementation in Indonesia,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 352, p. 012058, May 2018.

[7] A. Alesyanti, R. Ramlan, H. Hartono, and R. Rahim, “Ethical decision support system based on hermeneutic view focus on social justice,” *Int. J. Eng. Technol.*, vol. 7, no. 2.9, pp. 74–77, 2018.

[8] D. Napitupulu, M. Syafrullah, R. Rahim, D. Abdullah, and M. Setiawan, “Analysis of user readiness toward ICT usage at small medium enterprise in south tangerang,” *J. Phys. Conf. Ser.*, vol. 1007, no. 1, p. 012042, Apr. 2018.

[9] T. Suryanto, R. Rahim, and A. S. Ahmar, “Employee Recruitment Fraud Prevention with the Implementation of Decision Support System,” *J. Phys. Conf. Ser.*, vol. 1028, no. 1, p. 012055, Jun. 2018.

[10] A. Yanie *et al.*, “Web Based Application for Decision Support System with ELECTRE Method,” *J. Phys. Conf. Ser.*, vol. 1028, no. 1, p. 012054, Jun. 2018.

[11] R. Rahim *et al.*, “TOPSIS Method Application for Decision Support System in Internal Control for Selecting Best Employees,” *J. Phys. Conf. Ser.*, vol. 1028, no. 1, p. 012052, Jun. 2018.

[12] K. Adiyarta, D. Napitupulu, H. Nurdianto, R. Rahim, and A. Ahmar, “User acceptance of E-Government Services Based on TRAM model,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 352, p. 012057, May 2018.

[13] Y. Rossanty, D. Hasibuan, J. Napitupulu, M. Dharma, and T. Putra, “Composite performance index as decision support method for multi case problem,” *Int. J. Eng. Technol.*, vol. 7, no. 2.9, pp. 33–36, 2018.

[14] A. Indahingwati, M. Barid, N. Wajdi, D. E. Susilo, N. Kurniasih, and R. Rahim, “Comparison Analysis of TOPSIS and Fuzzy Logic Methods On Fertilizer Selection,” *Int. J. Eng. Technol.*, vol. 7, no. 2.3, pp. 109–114, 2018.

[15] A. Pranolo, F. I. ammurrohman, Y. Hendriana, and D. Octaviani, “A Decision Support System using ANFIS to Determine the Major of Prospective Students in A Vocational School of Indonesia,” *Int. J. Comput. Trends Technol.*, vol. 27, no. 2, pp. 100–105, Sep. 2015.

[16] M. Yousefi, D. Hooshyar, A. Remezani, K. S. M. Sahari, W. Khaksar, and F. B. I. Alnaimi, “Short-term wind speed forecasting by an adaptive network-based fuzzy inference system (ANFIS): an attempt towards an ensemble forecasting method,” *Int. J. Adv. Intell. Informatics*, vol. 1, no. 3, pp. 140–149, Dec. 2015.

[17] M. Alsamhi, S. H., Ansari, M., Hebah, M., Ahmed, A., Hatem, A., & Alasali, “Adaptive Handoff Prediction and Appreciate Decision Using ANFIS between Terrestrial Communication and HAP.”

[18] L. Suganthi, S. Iniyan, and A. A. Samuel, “Applications of fuzzy logic in renewable energy systems - A review,” *Renewable and Sustainable Energy Reviews*, vol. 48. pp. 585–607, 2015.

[19] A. S. Ahmar *et al.*, “Implementation of the ARIMA(p,d,q) method to forecasting CPI Data using *forecast package* in R Software,” *J. Phys. Conf. Ser.*, vol. 1028, no. 1, p. 012189, Jun. 2018.

[20] A. S. Ahmar, D. Napitupulu, R. Rahim, R. Hidayat, Y. Sonatha, and M. Azmi, “Using K-Means Clustering to Cluster Provinces in Indonesia,” *J. Phys. Conf. Ser.*, vol. 1028, no. 1, p. 012006, Jun. 2018.

[21] S. H. Sahir, R. Rosmawati, and R. Rahim, “Fuzzy model tahani as a decision support system for selection computer tablet,” *Int. J. Eng. Technol.*, vol. 7, no. 2.9, pp. 61–65, 2018.

[22] A. S. Ahmar *et al.*, “Modeling Data Containing Outliers using ARIMA Additive Outlier (ARIMA-AO),” *J. Phys. Conf. Ser.*, vol. 954, no. 1, 2018.

[23] W. Sulandari, S. Subanar, S. Suhartono, and H. Utami, “Forecasting electricity load demand using hybrid exponential smoothing-artificial neural network model,” *Int. J. Adv. Intell. Informatics*, vol. 2, no. 3, pp. 131–139, Nov. 2016.

[24] L. Guo, D. Rivero, J. A. Seoane, and A. Pazos, “Classification of EEG signals using relative wavelet energy and artificial neural networks,” in *Proceedings of the first ACM/SIGEVO Summit on Genetic and Evolutionary Computation - GEC ’09*, 2009.

[25] S. Narad and P. Chavan, “Cascade Forward Back-propagation Neural Network Based Group Authentication Using (n, n) Secret Sharing Scheme,” *Procedia Comput. Sci.*, vol. 78, no. December 2015, pp. 185–191, 2016.

[26] Haviluddin, F. Agus, M. Azhari, and A. S. Ahmar, “Artificial Neural Network Optimized Approach for Improving Spatial Cluster Quality of Land Value Zone,” *Int. J. Eng. Technol.*, vol. 7, no. 2.2, pp. 80–83, 2018.

[27] Hartono, O. S. Sitompul, E. B. Nababan, Tulus, D. Abdullah, and A. S. Ahmar, “A new diversity technique for imbalance learning ensembles,” *Int. J. Eng. Technol.*, vol. 7, no. 2, pp. 478–483, 2018.

[28] Uca, E. Toriman, O. Jaafar, R. Maru, A. Arfan, and A. S. Ahmar, “Daily Suspended Sediment Discharge Prediction Using Multiple Linear Regression and Artificial Neural Network,” *J. Phys. Conf. Ser.*, vol. 954, no. 1, 2018.

[29] Surahman, A. Viddy, A. F. O. Gaffar, Haviluddin, and A. S. Ahmar, “Selection of the best supply chain strategy using fuzzy based decision model,” *Int. J. Eng. Technol.*, vol. 7, no. 2.2, 2018.

[30] P. harliana and R. Rahim, “Comparative Analysis of Membership Function on Mamdani Fuzzy Inference System for Decision Making,” *J. Phys. Conf. Ser.*, vol. 930, no. 1, p. 012029, Dec. 2017.

[31] U. Khair, H. Fahmi, S. Al Hakim, and R. Rahim, “Forecasting Error Calculation with Mean Absolute Deviation and Mean Absolute Percentage Error,” *J. Phys. Conf. Ser.*, vol. 930, no. 1, p. 012002, Dec. 2017.

[32] H. Haviluddin and A. Jawahir, “Comparing of ARIMA and RBFNN for short-term forecasting,” *Int. J. Adv. Intell. Informatics*, vol. 1, no. 1, pp. 15–22, Mar. 2015.

[33] I. Güler and E. D. Übeyli, “Adaptive neuro-fuzzy inference system for classification of EEG signals using wavelet coefficients,” *J. Neurosci. Methods*, 2005.