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Academic Performance Assessment Prediction Model Using the Adaptive Neuro-Fuzzy Inference System Method

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Abstract

Performance evaluation of Human Resources is an important part of an organization or company. One of the HR in tertiary institutions that must be evaluated is academic performance. The author conducted research on the factors of academic performance assessment. Therefore, we need a system that can classify academic performance optimally in order to improve the quality of academic performance. In this research, we construct a predictive model for academic ability evaluation using Adaptive Neuro-Fuzzy Inference System method. The ANFIS method shows a very good data accuracy of 92.20%. From each variable motivation to work appraisal show is a Good, competence to work appraisal = Good, compensation to work appraisal show is a Good, responsibility to work appraisal show is a Good, and job satisfaction to work assessment show is Good.

Keywords: *Academic Performance; HR; ANFIS; Job Satisfication*

1. Introduction

Performance evaluation of HR is an important part of an organization or company. One of the HR in tertiary institutions that must be evaluated is academic performance. The academic performance in question is the lecturer. Lecturer performance in a tertiary institution is the specific behavior displayed by each lecturer in work performance obtained by each lecturer according to their role. Lecturer performance appraisal is a process of evaluating academic performance satisfaction and evaluating the output of lecturer work based on several factors such as education, research, community service and other supports. In this context, it is very difficult to find job satisfaction in lecturers. Several factors such as salary differences based on class, position, commissions for publishing scientific papers and so on are factors of job satisfaction in lecturers. This causes poor academic performance due to a feeling of fatigue or lack of enthusiasm in the lecturers in every job.

Several previous studies have found that predictions of the academic work environment with demographic characteristics are based on age, gender, work experience, marital status, and academic ranking [1], [2]. In addition, other studies have demonstrated its applicability to groups of male and female participants based on significant abstraction and perfectionism traits [3], [4]. Other research also shows that the comparison of the average rating of lecturers based on school background is significant than the relationship between the reward system and lecturer satisfaction, lecturer commitment awards, lecturer satisfaction, lecturer participation and lecturer performance, and lecturer performance reward systems [5], [6], [7]. Overall work time allocation is significant for career and non-work attitudes rather than implications for success [8]. Although the relationship between salary and job pressure is not significant, reward programs have a clear positive impct on job satisfaction and provide employers with an attractive compensation system (salary, benefits) is recommended. [9]. Meanwhile, the results of other studies also show that perceived job satisfaction in teaching academic staff is based on a more significant assessment of the facilities used by academic staff in teaching [10], [11]. The respondent's level of 'concern for oneself' is more significant than the summary level of the respondent's 'concern for impact', a comparison of the difference in mean scores on the lecturer's concern for himself, tasks and the impact of the lecturer's work [12]. Comparison of the impact of educational, social, organizational, cognitive, significant satisfaction and service quality [13]. In addition, other studies have shown that university lecturers' sense of job satisfaction is more significant than that of vocational institutions [14]. as well as a more significant assessment of the work of young lecturers than other university lecturers [15].

In this study carried out a development of a predictive model of academic performance assessment. This study uses the ANFIS method. The purpose of this research was to find out what factors influence the assessment of academic performance and to develop a predictive model to measure academic performance.

2. Research Methods

2.1. Data Collection Methods

Data collection methods are one aspect that plays an important role in research fluidity and success. This study uses a questionnaire or questionnaire documentation method as the data collection method.

Questionnaire/questionnaire is a data collection technique using a form containing written questions to individuals or groups to obtain answers, answers, or information needed by researchers. Questionnaires or questionnaires are used in this study. The questionnaire consists of 109 multiple choice and open-ended questions, including 5 independent variables and 1 dependent variable. This method is used to collect data on respondents' perceptions of interior design.

The documentation approach is data collection where researchers investigate objects that support lecturer performance, both in literature, documents, regulations, etc. This method is used to add references and collect data on teacher performance satisfaction.

2.2. Data Processing Methods

The data processing method is carried out as shown in Figure 1. starting from Problem, Approach, Implementation, Development, Measurement and Results.

The first stage, namely Problem, determines the problems that will be discussed in this study with solutions to make predictive models for academic performance assessment. The next stage, namely Approach, collects data to test the data using the ANFIS method. The next stage is Implementation, namely measuring academic performance objects on lecturers and conducting sampling techniques for training data and testing. The next step is Measurement, which is to compare the results of different types of membership functions. In the final stage, namely Result, making conclusions from the results of the data that has been processed for the development of future academic performance assessments.

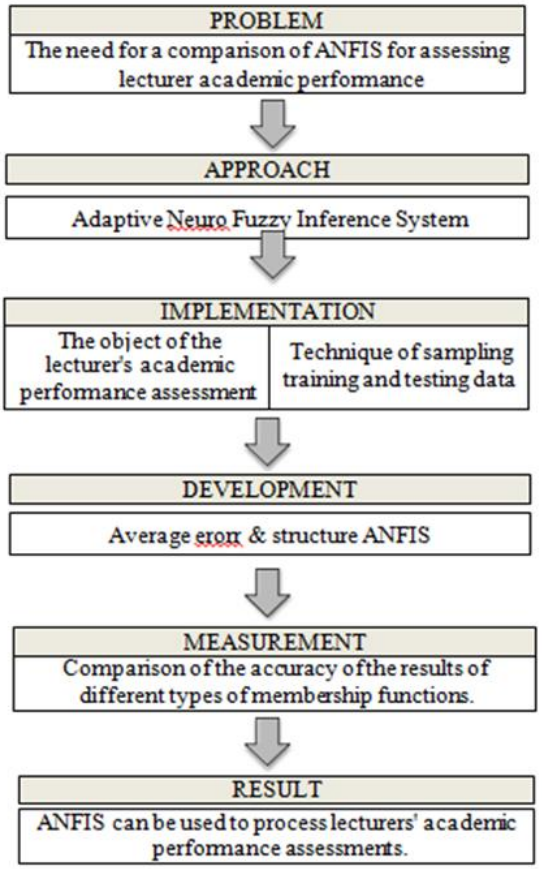

Fig. 1: Stages of the ANFIS Method

2.3. ANFIS Method

ANFIS is a functionally identical architecture to Sugeno's fuzzy rule-based model. The ANFIS architecture resembles a radial function neural network with some limitations. ANFIS can be said to be a technique that uses a learning algorithm to determine the rules of a dataset. ANFIS also allows custom rules [16].

The ANFIS method is an effective method for prediction because the error rate is lower than using the artificial neural network (ANN) method. In addition, the accuracy of the ANFIS method is affected by the quantity and quality of the data samples. Neural-fuzzy systems are used to predict satisfaction with learning outcomes. Neuro-fuzzy is a combination of fuzzy logic system and neural network [17], [18].

The research method used is survey and experimental methods. The survey was conducted using a questionnaire. Prepositioning data is done from the results of the data obtained from the questionnaire. The results of the prepositional data were tested with ANFIS, where the research object was the measurement of lecturer performance.

The sampling technique used is the entire population where the data is divided into training data and testing data. The measurement of the test is seen from the comparison of the average error of the different membership types. Where it is produced that ANFIS can be used to process academic performance assessments [19], [20].

2.4 ANFIS form

In ANFIS, there are five layers/outputs (marked with a capital O) in each layer [21], [22]. From the first layer, it works to convert chroma numbers to fuzzy numbers using fuzzy sets. The output is:

$$0_i^2 = w_i = \mu_{A^i}(x) * \mu_{Bi}(y)\ ,\ i = 1,2 \quad (1)$$

If the first layer involves only each input, in the second layer each input will switch to the same layer to determine the firing force. Fuzzy sets are multiplied with each other this input has the following relationship to another input:

$$0_i^3 = w_i = \frac{w_i}{w_1 + w_2},\ i = 1,2 \quad (2)$$

In the third layer, normalized calculations are performed before applying on the 4th layer. Normalization is the process of reweighting to get the maximum sum/value of 1.

$$0_i^4 = \overline{w}_i * f_i = \overline{w}_i(p_i * x + q_i * y + r_i \quad (3)$$

Once the normalized weights are complete, the process continues by multiplying the inputs (x and y) by a function to produce the output already in CRISP form.

$$0_i^4 = \overline{w}_i * f_i = \overline{w}_i(p_i * x + q_i * y + r_i \quad (4)$$

The last step is from the fourth layer (for two rules) to collect results.

$$\mathbf{0_i^5} = \sum \boldsymbol{i}\, \overline{\boldsymbol{w}}_{\boldsymbol{i}} * \boldsymbol{f}_{\boldsymbol{i}} = \frac{\sum \boldsymbol{i}\, \boldsymbol{w}_{\boldsymbol{i}} * \boldsymbol{f}_{\boldsymbol{i}}}{\sum \boldsymbol{i} \boldsymbol{w}_{\boldsymbol{1}}} \quad (5)$$

Meanwhile, for learning methods, two methods can be used, which are: backpropagation and hybridization. The principle is to minimize the errors that occur. There are two methods of error calculation: 1) Mean absolute percentage error (MAPE) and 2) mean absolute deviation.

$$\boldsymbol{MAPE} = \frac{\mathbf{1}}{\boldsymbol{n}} \sum_{\boldsymbol{t}=\mathbf{1}}^{\boldsymbol{n}} \left| \frac{\boldsymbol{A_t} - \boldsymbol{F_T}}{\boldsymbol{A_t}} \right| \quad (6)$$

$$\boldsymbol{MAD} = \frac{\mathbf{1}}{\boldsymbol{n}} \sum_{\boldsymbol{t}=\mathbf{1}}^{\boldsymbol{n}} |\boldsymbol{F_t} - \boldsymbol{A_T}| \quad (7)$$

Here is the shape of the five-layer anfis as shown in figure 2.

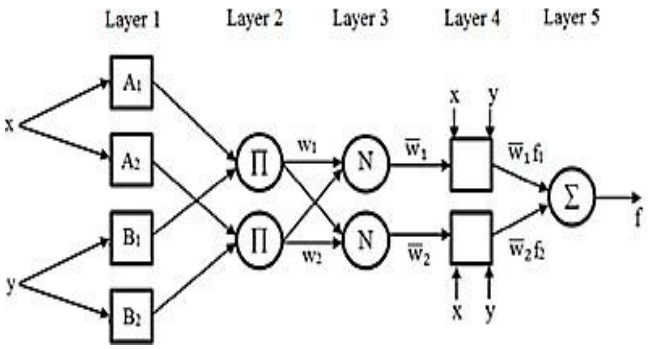

Fig. 2: Layers in ANFIS

3. Results and Discussion

Training data and test data are two classes in data processing using the ANFIS method, using grid partitions in the 3 3 3 3 3 formation, the maximum epochs used is 60 with an error of 0.073-0.079.

After training the data, data testing was then carried out, which obtained very good results. The results show that the close distance between the train data (blue) and testing data (red) is as shown in Figure 3.

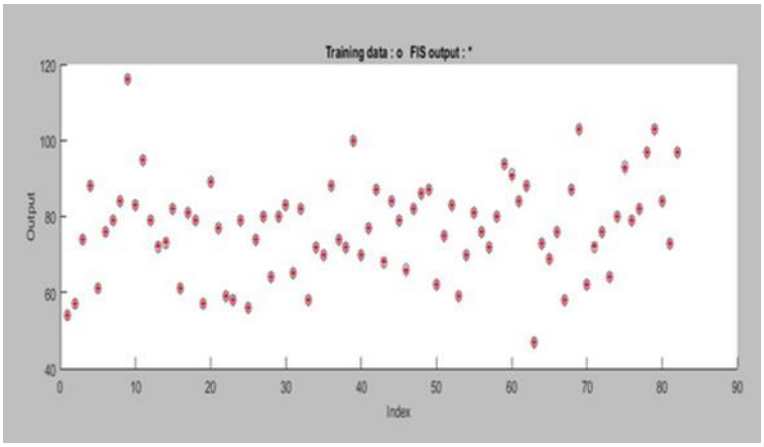

Fig. 3: Testing Data Results

The academic performance assessment prediction model was built with five inputs and one output. The five inputs include: M = motivation, KT = competence, KS = compensation, TJ = responsibility and KK = job satisfaction. One such output is PK = Work Appraisal.

Obtained 243 rules in a combination of five inputs to the class of each variable. For example, if the value M = VG, KT = VG, KS = VG, TJ = VG, and KK = VG, then the calling output is according to rule 243.

In the rule viewer, it can show the output results from the input values between variables. For example, if the value of variable M = 30.5 (Good), variable KT = 24 (Good), variable KS = 38 (Good), variable TJ = 35.5 (Good) and variable KK = 42.5 (Good), then the PK result is 71.8 which means means that the work assessment is G (Good).

ANFIS has three main layers. The data source from which the bounds are retrieved and imported into the model is the main layer. The information layer of the forked framework can be said to be this layer. The main level imported to the next level is the output of this layer, conveying the expansion of the previous membership function (MF). The hub is finished with smooth guidelines on the second layer level. The second layer normalizes all major travel speeds, generates an output based on hub and capacity, and sends it to the output layer or the third layer. The number and type of MF, the ideal technique, and the type of MF produced are important variables in determining the accuracy of ANFIS. The input bounds are the performance evaluation coefficients and the outcome variables are task evaluations of learning performance.

Next is the result of comparing the actual value with the result of testing the data using three MFs. In this study, we predicted 82 respondents as training data and 50 respondents as test data for comparison. Modeling results using ANFIS gave a very good result of 92.20%. From the predicted comparison graph of the actual data and data test results, it can be seen that the judgment results are generally close to the actual values. A comparison of actual and predicted data is shown in Figure 4.

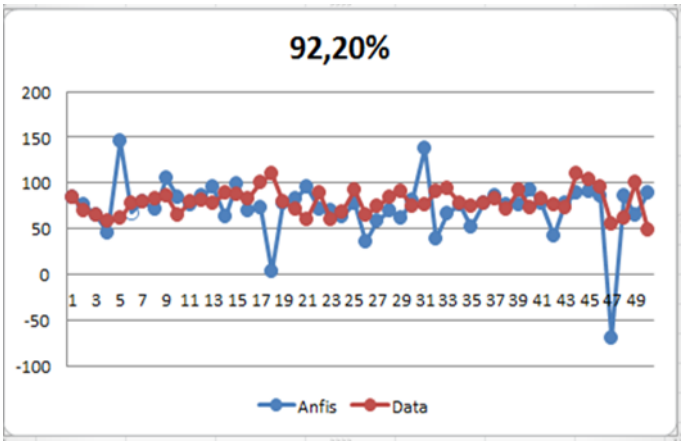

Fig. 4: Comparison of actual predicted value and ANFIS

The surface view for optimal inputs and outputs shows the relationship between responsibility and job satisfaction based on work assessments on academic performance. The surface display shows the level of responsibility towards the level of job satisfaction. For example, the comparison between the responsibility variable which is at the coordinate point 35.5 and the job satisfaction variable is at the coordinate point 44.5. This shows that the Work Appraisal value is 200 as shown in Fig. 5.

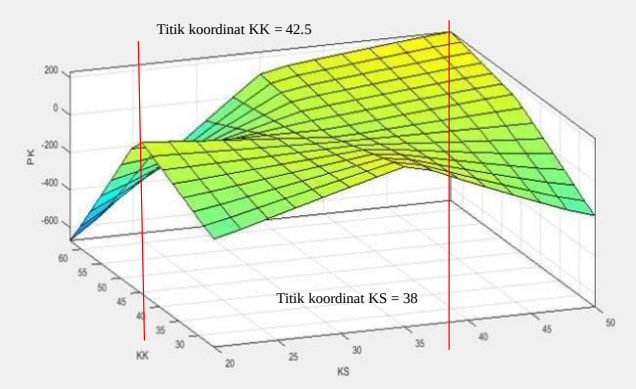

Fig. 5: ANFIS system input and output surface display

4. Conclusion

Based on the results of research on academic performance assessment, the factors for assessing academic performance have been determined, including motivation, competence, compensation, responsibility and job satisfaction. Data accuracy using the ANFIS method shows very good results of 92.20%. From each variable motivation to work appraisal show is a Good, competency to work appraisal show is a Good, compensation to work appraisal show is a Good, responsibility to work appraisal = Good, and job satisfaction to work assessment show is a Good. From the results of the accumulation of all input variables to output, it produces which means that the work assessment is good.

References

[1] S. J. Mgaiwa, "Academics' job satisfaction in Tanzania's higher education: The role of perceived work environment," Soc. Sci. Humanit. Open, vol. 4, no. 1, 2021, doi: 10.1016/j.ssaho.2021.100143.

[2] R. Solberg, … J. S.-J.-P. medicine, and undefined 2021, "Aerobic fitness mediates the intervention effects of a school-based physical activity intervention on academic performance. The school in Motion study–A," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2211335521003399.

[3] C. Mateus, R. Campis, I. Aguaded, A. Parody, F. R.- Heliyon, and undefined 2021, "Analysis of personality traits and academic performance in higher education at a Colombian university," cell.comC Mateus, R Campis, I Aguaded, A Parody, F RuizHeliyon, 2021•cell.com, p. e06998, 2017, doi: 10.1016/j.heliyon.2021.e06998.

[4] G. Tortorella, … G. N.-… F. and S., and undefined 2021, "Operations Management teaching practices and information technologies adoption in emerging economies during COVID-19 outbreak," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0040162521004285.

[5] S. S.-D. in Brief and undefined 2020, "Dataset of lecturer performance appraisal," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2352340920310556

[6] K. Sadeghi, F. Ghaderi, Z. A.- Heliyon, and undefined 2021, "Self-reported teaching effectiveness and job satisfaction among teachers: the role of subject matter and other demographic variables," cell.comK Sade. F Ghaderi, Z AbdollahpourHeliyon, 2021•cell.com, 2017, doi: 10.1016/j.heliyon.2021.e07193.

[7] D. Pachler, A. Kuonath, D. F.-L. and I. Differences, and undefined 2019, "How transformational lecturers promote students' engagement, creativity, and task performance: The mediating role of trust in lecturer and self-efficacy," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1041608018301924.

[8] K. French, T. Allen, M. Miller, … E. K.-J. of vocational, and undefined 2020, "Faculty time allocation in relation to work-family balance, job satisfaction, commitment, and turnover intentions," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0001879120300683.

[9] Y. Gao, X. H.-M. and Microsystems, and undefined 2021, "Forecast of compensation amount based on big data network and machine learning algorithm in intellectual property law," Elsevier, 2020, doi: 10.1016/j.micpro.2020.103623.

[10] K. Thies, R. K.-F.-I. J. of Educational, and undefined 2019, "German higher education academic staff's positive emotions through work domains," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0883035519300783.

[11] Y. Takizawa, K. K.-I. J. of E. Research, and undefined 2022, "Cross-sectional, longitudinal relationships of gender, academic motivation, learning activities, and lifestyle activities with academic performance among," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2666374022000280.

[12] A. U. Chinweuba et al., "Integrated collegiate and professional nursing education in Nigeria universities: Self, task and impact concerns of lecturers," Int. J. Africa Nurs. Sci., vol. 11, p. 100159, Jan. 2019, doi: 10.1016/J.IJANS.2019.100159.

[13] G. Santos, C. Marques, E. Justino, L. M.-J. of cleaner production, and undefined 2020, "Understanding social responsibility's influence on service quality and student satisfaction in higher education," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0959652620306442.

[14] H. Yin, J. Han, B. P.-I. J. of E. Research, and undefined 2020, "Why are Chinese university teachers (not) confident in their competence to teach? The relationships between faculty-perceived stress and self-efficacy," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0883035519302058.

[15] L. Lian et al., "Calling, character strengths, career identity, and job burnout in young Chinese university teachers: A chain-mediating model," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0190740920321988.

[16] V. C. Dewi, V. Amrizal, F. Eka, and M. Agustin, "Implementation of Adaptive Neuro-Fuzzy Inference System and Image Processing for Design Applications Paper Age Prediction," J. Ris. Ilmu Tek., vol. 1, no. 1, pp. 48–61, May 2023, doi: 10.59976/JURIT.V1I1.6.

[17] I. Afriliana, E. Budihartono, A. Maulana, J. Teknik Komputer, P. Harapan Bersama, and J. No, "Pengukuran Kinerja Dosen Menggunakan Metode Adaptive Neuro Fuzzy Inference System (ANFIS)," J. Inform. J. Pengemb. IT, vol. 2, no. 2, pp. 109–112, Jul. 2017, doi: 10.30591/JPIT.V2I2.609.

[18] A. Suárez-Perdomo, … Z. R.-A.-C. &, and undefined 2022, "Profiles of undergraduates' networks addiction: Difference in academic procrastination and performance," Elsevier, Accessed: Aug. 04, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0360131522000306.

[19] M. Turnip et al., "An application of online ANFIS classifier for wheelchair based brain computer interface," ieeexplore.ieee.orgM Turnip, A Dharma, HHS Pasaribu, M Harahap, MF Amri, MA Suhendra, A Turnip2015 Int. Conf. Autom. Cogn. Sci. 2015•ieeexplore.ieee.org, Accessed: Aug. 04, 2023. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/7440192/

[20] A. Turnip, D. Soetraprawata, … M. T.-I., and undefined 2016, "EEG-based brain-controlled wheelchair with four different stimuli frequencies," Res. Turnip, D Soetraprawata, M Turnip, E JoeliantoInternetworking Indones. Journal, 2016•researchgate.net, vol. 8, no. 1, 2016, Accessed: Aug. 04, 2023. [Online]. Available: https://www.researchgate.net/profile/Endra-Joelianto/publication/299184683_EEG-based_brain-controlled_wheelchair_with_four_different_stimuli_frequencies/links/58d16aa6aca2720cd05ecc6a/EEG-based-brain-controlled-wheelchair-with-four-different-stimuli-frequencies.pdf

[21] S. A. Andayani et al., "Prediction model for agro-tourism development using adaptive neuro-fuzzy inference system method," Open Agric., vol. 7, no. 1, pp. 644–655, Jan. 2022, doi: 10.1515/OPAG-2022-0086/HTML.

[22] M. Şahin, R. E.-M. and computational applications, and undefined 2017, "A comparative study of neural networks and ANFIS for forecasting attendance rate of soccer games," mdpi.comM Şahin, R ErolMathematical Comput. Appl. 2017•mdpi.com, doi: 10.3390/mca22040043.