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Multiple Evaluation Models for Education Based on Artificial Neural Networks

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Abstract

Teachers and students' performances are of great importance in education. However, how to evaluate teachers' works and students' academic levels are extremely difficult and complex because it contains various effects of weights that should be used to assess the achievements. Also, education workers often find it difficult to manipulate the large-scale data while evaluating the education works and students' performances. To address this problem, we used machine learning techniques to develop two groups of models for evaluating teachers and students' performances respectively. Using artificial neural networks (ANNs) can ensure the accuracy and fairness of the evaluation works. Our results successfully proved that general regression neural network (GRNN) model can effectively generate the robust responses to analyze different independent variables and give out correct results to distinguish different achievements done by teachers and students.

Keywords: *Evaluation Model; Artificial Neural Network, General Regression Neural Network*

1. Introduction

In education works, people often find it difficult to evaluate different people's works. On the one hand, how to evaluate students' performances and give the fair and correct evaluation is one of the most crucial responsibilities to educators; on the other hand, how to assess teachers' works are of great importance to the title evaluation of teachers, especially young teachers. However, there are various evaluation systems in different institutes and schools, containing many different evaluation weights, which seem unpractical [1-3]. And the data need to addressed during the whole evaluation process is also tremendous. Therefore, how to develop a flexible and robust system for the comprehensive evaluation is very important for educators. However, there is no effective approach that can be definitely used in practical applications, which give us great motivations to do relevant research.

To address this crucial problem, our research was divided into two aspects: teachers and students. Because the evaluation weights and factors are almost totally different between teachers and students, we had to divided our consideration into these two parts. As for the evaluation of teachers' works, we used multi-levels assessment as our main objective, setting multiple independent variables for the evaluation. As for the evaluation of students' performances, we used a simplified approach for the evaluation because the data need to be addressed is too large and time-consuming.

To obtain a strong and flexible system for evaluations, we used artificial neural networks (ANNs) [4-6] as a powerful non-linear tool in order to develop a series of models for the evaluations of teachers and students respectively. We set different

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independent variables to recognize the works of teachers and students. The structure of the recognition method for teachers' works is shown in Figure 1. To teachers, we set teaching contribution, guidance to students, contribution to teaching construction, publications and awards as the independent weights in the primary layer. In the secondary layer, we set different objectives like undergraduate and graduate students (details are shown in Figure 1). In the third layer, we set the real input variables like the number of courses, number of semesters and the rank of the order in the author list of publications. As for students, the input system should be much easier because the scale of the data for students are much larger than that of teachers. One need to input a very large number of data, and so the input system for the evaluation for students should be set as simple as possible in case of mistakes. Figure 2 shows the input law of the novel system we used. We used test results, academic results and awards for the evaluation. Using mid-term results, final results, academic performance, achievement, level of awards and their numbers as the input independent variables.

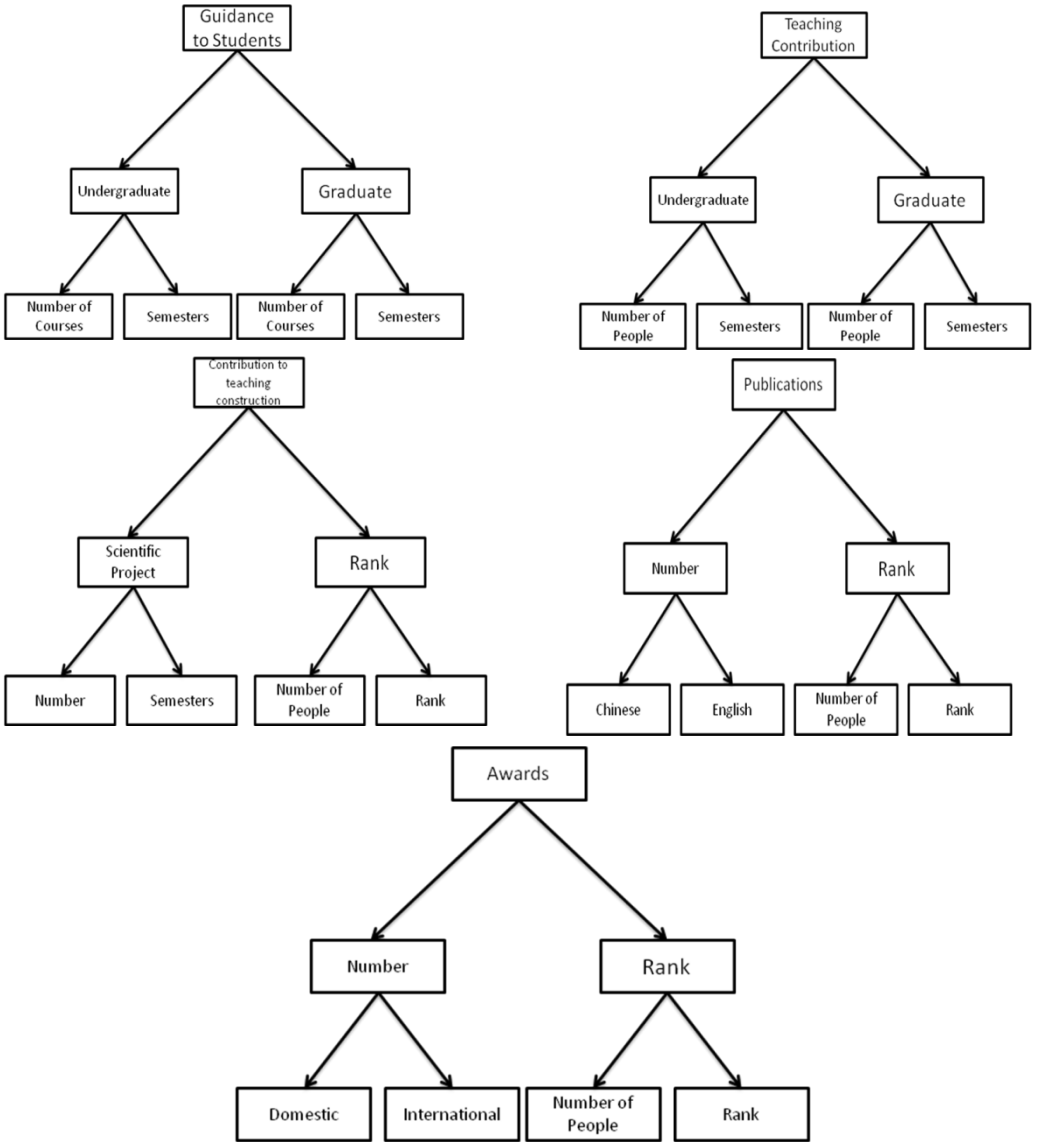


Figure 1. Input Law for the Evaluation System of Teachers

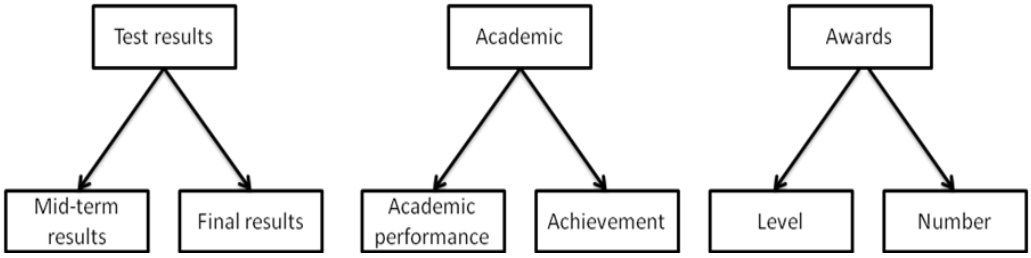


Figure 2. Input law for the Evaluation System of Students

By inputting these independent variables, at the same time, we should also input the dependent variables to ensure the success of the total machine process. We used 1-10 as the evaluated levels for the assessments of teachers or students. Using the existing data and the completed inputted variables, ANN models can fit the relationship quickly using the non-linear methods. In the next section, we present the main framework and the principles of an ANN model we mainly used in the research.

2. Artificial Neural Network

Artificial neural network (ANN) is an information processing system with interconnected components analogous to neurons [4-9]. The system has splendid nonlinear mapping and a good degree of parallel processing of information. On the basis of mathematical models (also computing models), it can simulate the same features and functions of the biological neural networks. That is to say, an ANN model has the ability to adapt the research objectives continuously to new data and learn from the collected experiences and noise data. Here we present the main structure of the specific ANN model we use as a conclusion in this article.

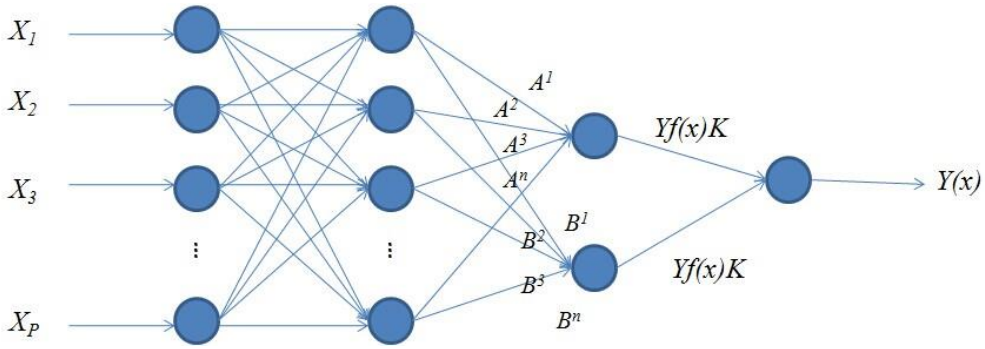


Figure 3. The Structure of General Regression Neural Network

Figure 3 shows the main structure of the general regression neural network (GRNN) [10-11]. Our research shows that the GRNN models can robustly generate the precise results for the evaluation of education. An ANN model consists of three parts: the input layer, the output layer and the hidden layer. The input layer is made up of thousand neurons to accept numerous nonlinear input variables [9]. After a series of computing processes, the output variables can be exported from the output layer. Additionally, the hidden layer is included. It is a layer existing between the input and output layer. The more the number of the neurons in the hidden layer has, the greater robustness of the artificial neural network is. We can input the independent variables and dependent variables for the evaluation, if the data scale is enough, ANN models will generate correct responses and start the process of machine learning, which is what we call "model development". After the model is established, we can input new independent variables to the model and it soon will calculate the dependent variables and present to users. In our research, the dependent variables are the levels of the teachers and

students. To ensure the robustness and correctness of the ANN models we established, we develop the models for teachers and students respectively. The models have been trained over100 times in order to confirm their robustness.

3. Model Development

In recent researches, the most popular software to develop ANN models are SPSS and Neural Tools software® (Trial Version, Palisade Corporation, NY, USA). Models were established by back-propagation neural network (BPNN) [12-14], general regression neural network (GRNN) [10,11] and multilayer feed-forward neural network (MLFN) [15, 16] via SPSS and Neural Tools software® (Trial Version, Palisade Corporation, NY, USA). Nodes of MLFN models were different in each model (from 2 to 15), hence the most robust MLFN model could be found. For comparison, a multiple linear regression model (which we call it "linear predictor") was constructed. To ensure the accuracy of the experiments, training processes were experimented repeatedly, with different composing of trained samples and tested samples. Results of teachers' evaluation models are shown in Table 1.

Table 1. Results of Teachers' Evaluation Models

ANN Model	Trained Samples	Tested Samples	Average RMS Error	Training Time
Linear	80	20	1.31	0:00:01
Predictor	80	20	2.55	0:00:01
BPNN	80	20	0.44	0:00:02
GRNN	80	20	1.23	0:01:14
MLFN 2 Nodes	80	20	1.77	0:02:34
MLFN 3 Nodes	80	20	1.81	0:02:21
MLFN 4 Nodes	80	20	3.69	0:03:71
MLFN 5 Nodes	80	20	1.15	0:06:58
MLFN 6 Nodes	80	20	1.44	0:08:77
MLFN 7 Nodes	80	20	1.11	0:07:63
MLFN 8 Nodes	80	20	2.67	0:10:21
MLFN 9 Nodes	80	20	9.90	0:11:39
MLFN 10 Nodes	80	20	2.31	0:15:44
MLFN 11 Nodes	80	20	3.33	0:11:23
MLFN 12 Nodes	80	20	2.22	0:21:74
MLFN 13 Nodes			1.87	0:18:88
MLFN 14 Nodes			1.78	0:50:07
MLFN 15 Nodes				

Table 1 show that GRNN model is the most precise model during the experiments, with the lowest average RMS error (0.49). From the results presented in the table, we can observe that GRNN still predominates in the ANN models during this experiment compared to other models either from the value of RMS

error or the training time. Results confirm that GRNN model can be effectively used for the evaluation of teachers' works.

Similarly, results of students' evaluation models have been developed, which are shown in Table 2:

Table 2. Results of Students' Evaluation Models

ANN Model	Trained Samples	Tested Samples	Average RMS Error	Training Time
Linear	72	18	0.60	0:00:03
Predictor	72	18	0.57	0:00:04
BPNN	72	18	0.49	0:00:04
GRNN	72	18	0.76	0:02:01
MLFN 2 Nodes	72	18	0.79	0:02:21
MLFN 3 Nodes	72	18	0.58	0:01:31
MLFN 4 Nodes	72	18	0.84	0:04:23
MLFN 5 Nodes	72	18	0.80	0:04:41
MLFN 6 Nodes	72	18	1.14	0:06:17
MLFN 7 Nodes	72	18	0.99	0:05:12
MLFN 8 Nodes	72	18	1.06	0:05:10
MLFN 9 Nodes	72	18	0.72	0:04:73
MLFN 10 Nodes	72	18	0.89	0:08:41
MLFN 11 Nodes	72	18	1.57	0:08:47
MLFN 12 Nodes	72	18	0.97	0:10:31
MLFN 13 Nodes			1.47	0:12:12
MLFN 14 Nodes			1.07	0:13:27
MLFN 15 Nodes				

Table 2 shows that GRNN model is also the most precise model during the experiments, with the lowest average RMS error (0.49). Results confirm that GRNN model can be effectively used for the evaluation of teachers' works. What's more interestingly, both the results of the two kinds of models (evaluation models for both teachers and students) have the same law: GRNN models are extremely strong during the two kinds of evaluations. Now we can use the same kind of ANN model for the evaluation. However, we still cannot ignore that the two GRNN models are different because they do not use the same inputted system, which may be easily confused by beginners.

4. Results and Discussions

We plot two series of figures to show the learning and testing process of GRNN models in the evaluation for teachers and the evaluation for students respectively.

4.1. Evaluation Models for Teachers

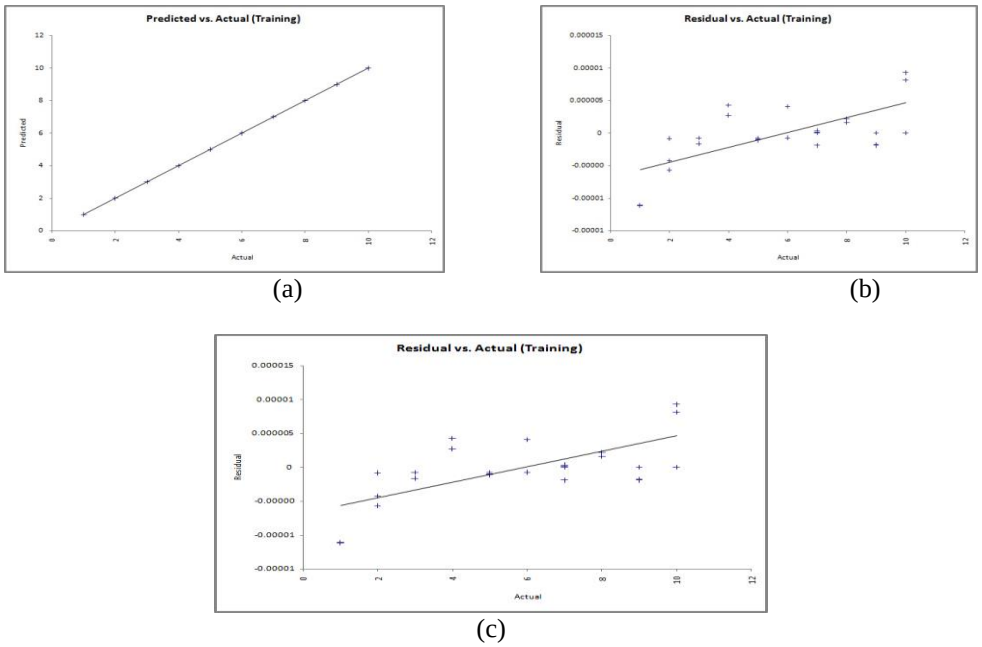


Figure 4. Training Process Of The Evaluation Model For Teachers Using GRNN Model: (A) Predicted Values Versus Actual Values; (B) Residual Values Versus Actual Values; (C) Residual Values Versus Actual Values

Figure 4 depicts the training process of the GRNN model for the assessment of teachers' works. Results show that the memory ability of the GRNN model is very strong, showing that the total process is robust.

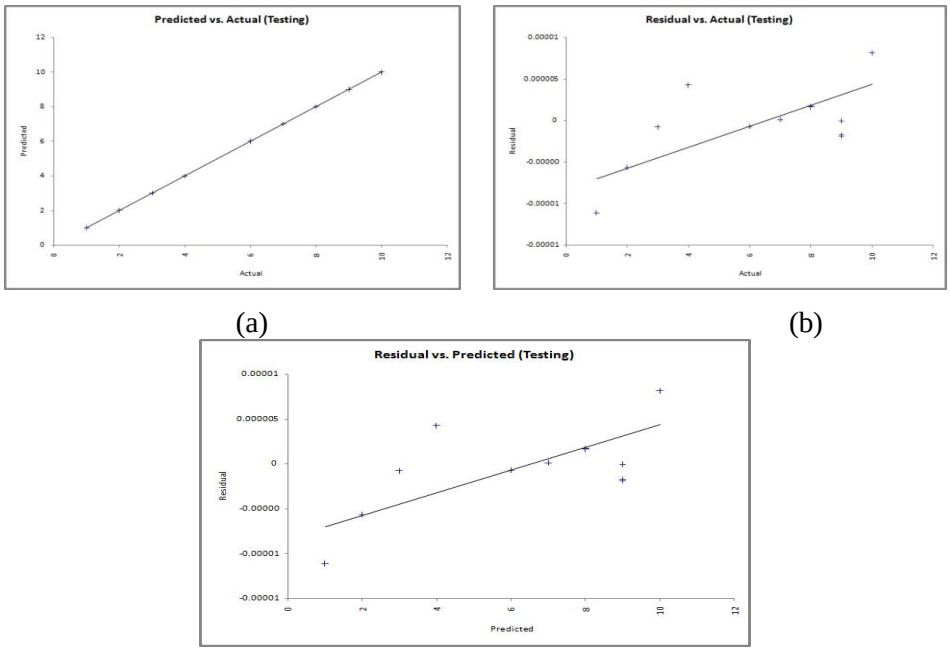
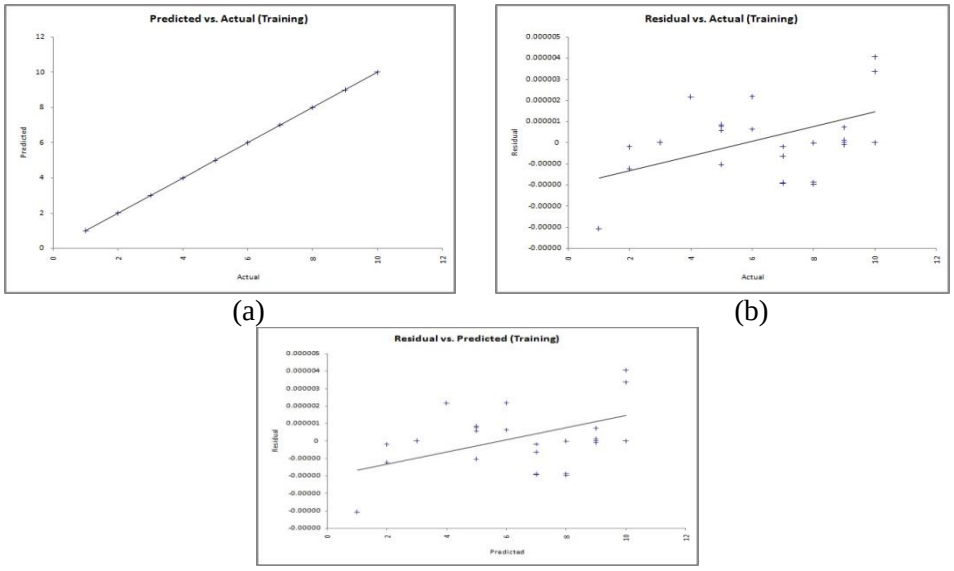


Figure 5. Testing Process Of The Evaluation Model For Teachers Using GRNN Model: (A) Predicted Values Versus Actual Values; (B) Residual Values Versus Actual Values; (C) Residual Values Versus Actual Values

Figure 5 depicts the testing process of the GRNN model for the assessment of teachers' works. Results show that the prediction function of the model is also very strong, showing that we can use this model for the further evaluation.

4.2. Evaluation Models for Teachers

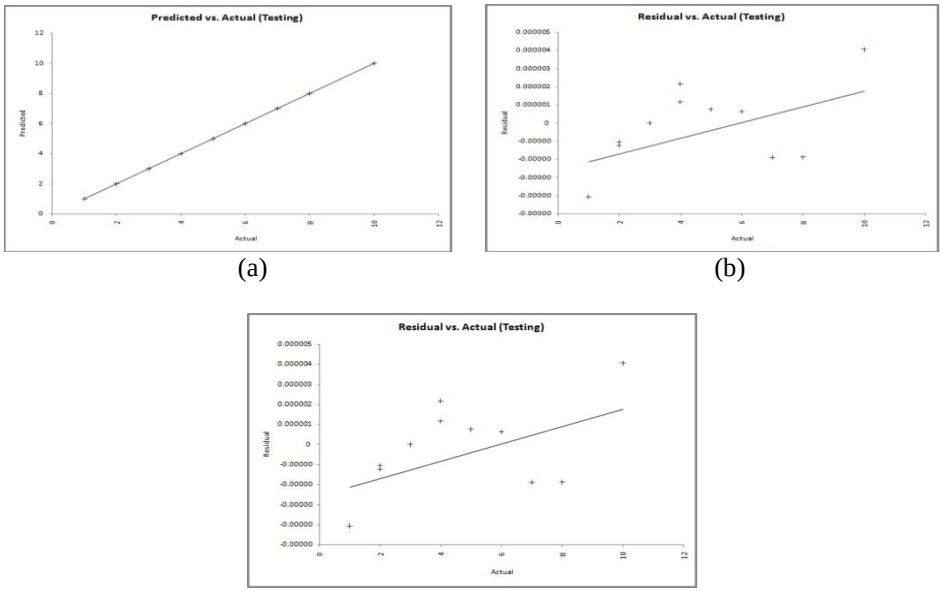


(a) (b)

(c)

Figure 6. Training Process Of The Evaluation Model For Students Using GRNN Model: (A) Predicted Values Versus Actual Values; (B) Residual Values Versus Actual Values; (C) Residual Values Versus Actual Values

Figure 6 depicts the training process of the GRNN model for the assessment of students' works. Results show that the memory function of the model is robust.



(a) (b)

(c)

Figure 7. Testing Process of The Evaluation Model For Students Using GRNN Model: (A) Predicted Values Versus Actual Values; (B) Residual Values Versus Actual Values; (C) Residual Values Versus Actual Values

Figure 7 depicts the testing process of the GRNN model for the assessment of students' performance. Results show that the model is robust and precise, which can be used for practical applications.

All results shown in Figures 4-7 are robust. In addition, although different institutes and schools have various evaluation standards for the evaluation of teachers' works and students' performances, we can still use ANN models such as GRNN model for the evaluation by using different input independent variables. We aimed at providing a strong and novel method for the evaluation, so the input independent variables are not limited by the inputted independent variables presented in this paper.

5. Conclusion

Teachers and students' performances are of great importance in education. However, how to evaluate teachers' works and students' academic levels are extremely difficult and complex because it contains various effects of weight that should be used to assess the achievements. Also, education workers often find it difficult to manipulate the large-scale data while evaluating the education works and students' performances. To address this problem, we used machine learning techniques to develop two groups of models to evaluate teachers and students' performances respectively. Using general regression neural network (GRNN) can ensure the accuracy and fairness of the evaluation works. Here, we aim at presenting a novel method and idea for addressing this problem. And the independent variables and dependent variables in our research can also be changed in accordance to different criterions in different institutes and schools. In future studies, we will pay more attention to develop a completed and integrated ANN system for the evaluation of both teachers and students' performances.

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References

[1] G. R. Galluzzo, An Evaluation of a Teacher Education Program (**1983**)
[2] S. Mathison, Evaluation and Program Planning, 15, 3 (**1992**)
[3] D. L. Stufflebeam, The Relevance of the CIPP Evaluation Model for Educational Accountability (**1971**)
[4] B. Samanta, K. R. Al-Balushi. Mech. Syst. Signal Pr., 17, 2 (**2003**)
[5] W. G. Baxt, Ann. Int. Med., 115,11, (**1991**)
[6] M. Shao, X. J. Zhu and H. F. Cao, Energy, 67 (**2014**)
[7] C. H. Aladag, A. Kayabasi and C. Gokceoglu, Neural Comput. App., 23, 2 (**2013**)
[8] J. Van Schependom, G. Nagels and W. Yu, Schizophrenia Bulletin (**2013**).

[9] E. C. Santos, E. D. Armas and D. Crowley, Soil Bio. Bioche., 69 (**2014**)
[10] H. Yip, H. Fan, Y. Chiang, Auto. Const. 38 (**2014**)
[11] C. M. Hong, F. S. Cheng, C. H.Chen, Int. J. Elect. Power & Energy Syst., 60 (**2014**)
[12] P. Wang, X. Ji and L. Zhu, Sensors and Actuators A: Physical, 201 (**2013**)
[13] P. Wang, L. Zhu and Q. Zhu, NDT & E International, 55 (**2013**)
[14] K. Z. Huang, X. K. Xiong and C. M. Zhang, E Protein and peptide letters (**2014**)
[15] D. Svozil, V. Kvasnicka, J. Pospichal, Chemo. Intel. Lab. Syst., 39, 1 (**1997**)
[16] T. D. Sanger, Neural Networks, 2, 6 (**1989**).

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