IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-2, Feb 2019 E-ISSN: 2347-2693

Student Learning Behavior: an Artificial Neural Network approach

K. S.Oza[1], R.K.Kamat[2], P.G.Naik[3]

[1,2] Department of Computer Science, Shivaji University, Kolhapur, Maharashtra, India
[3] Department of Computer Studies, CSIBER, Kolhapur, Maharashtra, India

[*]*Corresponding Author: kso_csd@unishivaji.ac.in, Tel.: +91-9850766660*

DOI: https://doi.org/10.26438/ijcse/v7i2.800804 | Available online at: www.ijcseonline.org

Accepted: 20/Feb/2019, Published: 28/Feb/2019

Abstract— E-Learning has made learning easy with most of the courses floated online for convenient 24X7 learning at learners ease. With virtual learning environment, learning behavior of the online learner has become one of the significant factor. To facilitate fast learning on virtual platform, there is need to analyze online learning pattern of learner. Once the pattern are mined personalized learning environment can be created for the learner as per his/her learning behavior, which will make online learning interesting faster. For finding learning pattern artificial intelligence can be a good tool. Proposed work classifies the learning behavior of the learners with application of artificial neural networks. Proposed work used two types of students test data, one where test was conducted on Moodle server with objective questions and negative marking and second was descriptive test in pen paper mode. First test was conducted to analyze fundamental concepts and their applications in problem solving and second test was to check the innovative thinking ability of students. Three artificial neural networks were trained to classify students in to each three categories based on their number of attempts in the test. All the three models classified the students accurately with negligible mean square error.

Keywords— Learning behavior, Artificial Neural Network, Classification, Supervised learning

I. INTRODUCTION

Students' progress is the progress of any academic institute. In this era of digitization all the information related to students is readily available in different forms. Student attendance data can be collected from university servers, test and assignment data from Moodle server, web usage data from web server, data from Learning Management System (LMS) etc. So there is vast amount of data available which can be used for student benefit. Nowadays there are many artificial intelligence and machine learning tools available having good application in education domain. These tools can be used to predict student's performance in test, student retention, project groups, dropout ration etc. Some tools can used to cluster students with similar characteristics or learning behavior or even for sitting arrangement in class or project assignment.

Another tool which plays an important role in education domain is classification technique. There are different types of learning techniques associated with classification. Some of them are Supervised, Unsupervised, Semi-supervised and Reinforcement learning. This work focuses on supervised learning. Here algorithm is trained using already classified data i.e. dataset having class labels assigned to it. These labels are assigned by domain experts manually. Dataset is divided into training and testing part. Training dataset is used to train the algorithm and testing dataset is used to check its accuracy. Here algorithm tries to generate a function which can map relationship between input dataset and target variable or class learnt from training dataset. This work has used Artificial Neural Network for supervised classification.
Artificial Neural Network (ANN): ANN tries to simulate working of human brain. It consists of nodes which are similar to neurons in human brain. There are three types of nodes in ANN: input, output and hidden nodes. Input nodes are in input layer, hidden nodes in hidden layer and output nodes are in output layer. Input nodes receives the input , carries out some operation on that input and result is passed as input to hidden nodes. This process is again repeated at hidden layers and its output is input to output layer nodes. To generate output, activation function is used at each node. Each link between the nodes have some weight assigned and altering of these weights helps in learning. A constant, bias is used commonly by all the nodes to get desired output. Number of nodes in the output layer is equivalent to number of outputs desired.

Rest of the paper is organized as follows, Section I contains the introduction of research work, section-II contain the related work of researchers, Section-III talks of methodology used in data collection and algorithms used in data analysis, and Section-IV concludes research work with future directions.

II. RELATED WORK

Lots of research is going on student performance prediction using artificial neural networks. Student performance is accurately predicted in blended learning environment by training an artificial neural network model by [1, 2]. Retention of engineering students is predicted using three different neural network models. Comparison of outputs of these models is also carried out by [3]. ANN is also used to predict which research institute a student is likely to join in particular area [4]. Neural networks couldn't perform that well in predicting the relationship between teaching effectiveness and learning outcomes in some business courses [5]. Researchers have shown that attention can play a vital role in smearing artificial neural network to different domains [6]. ANN's are not only used for student performance prediction but are also used to predict performance of teachers in an academic Institution [7].

ANN's are also trained to interpret students' performance in acquisition of cognitive skills by [8]. Classification algorithms have been used to predict whether student will be able to complete the course or no by [9]. A real time classification using ANN to detect on screen information comprehension by learner has been designed by [10]. To get good classification results by artificial neural network researchers have used optimization algorithms like modified version of particle swarm algorithm and Artificial Bee Colony algorithm to train ANN [11, 12].

Web based business weblogs are examined to catch customers behavior in online scenario by [13]. Comparison of various data mining algorithms to find their efficiency was carried out by [14].

III. METHODOLOGY

Data set preparation and pre-processing:

Proposed work is based on classification of students based on their learning abilities. Dataset consist of 99 records. These are the postgraduate student's data where they attempted the test based on Java programming. A test paper was designed thoroughly covering the questions from basic to advance. Questions were divided into three categories with 8 questions in each category. Here student is not evaluated based on correct or wrong answers but on only whether the question is attempted or no. First category was to check fundamental concepts of students. This section had 8 questions based on basic understanding of the subject. Test conducted was objective in nature with negative marking. A record was maintained to count how many questions are attempted by the student. Second category was based on checking up to what level they can apply the basic concepts to a given problem. Even this section had 8 questions of same level. Test conducted was objective in nature with negative marking.

Third section had a collection of questions to check whether student can think in innovative way or can generate a new knowledge based on earlier experience. This section was descriptive in nature with no negative marking. Here again only students attempts were recorded in the dataset.

Three datasets were created for three categories namely, Basic concepts, Application of concepts and innovative thinking. Following is the snapshot of raw data.

	Application of concepts						
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	0	1	1	1	1	1	1
1	0	1	1	1	1	1	0
1	0	1	1	1	1	1	1
1	0	1	1	1	1	1	0
1	0	0	1	1	1	1	0
0	0	0	1	1	1	1	1
1	0	0	1	1	1	1	0
1	0	1	1	1	1	1	0
1	0	0	1	1	1	1	0
1	0	1	1	1	1	1	1
1	0	0	0	1	1	0	0
1	0	1	1	0	1	1	1
1	0	0	1	1	1	1	0
1	1	1	1	1	1	0	0

Fig.1. Sample Dataset

As observed in fig. 1. It consists of entries only 0 and 1. '0' indicating question is not attempted and vice versa.

Classification: Here students are classified into different categories based on their learning abilities. Some are good in fundamentals, some may be good in application and some may be with out-of-box thinking capability. The test consists of two types of questioning mode one is objective and other is descriptive. Objective questions are with negative marking which helps in getting the right data as student will think before attempting. This will also help in judging the confidence level of student in that subject.

Three datasets created were saved in the .csv form for processing viz. Basic.csv, application.csv and Innovative.csv. A class label was assigned to each record depending on number of attempts and time spent on that particular question. This was done in consultation with subject expert. No. of attempts were highest in basic dataset with only three class labels as Excellent, Good and Average. In this dataset almost all the students have attempted maximum number of questions. These class labels were renames as 1, 2 and 3 respectively for easy training of neural network.

Dataset was split in to 80:20 proportion for training and testing. A neural network was trained with different number of hidden layers and two hidden layers having four nodes and two nodes respectively gave good results. Following artificial neural network was trained to classify students based on their subject basic knowledge.

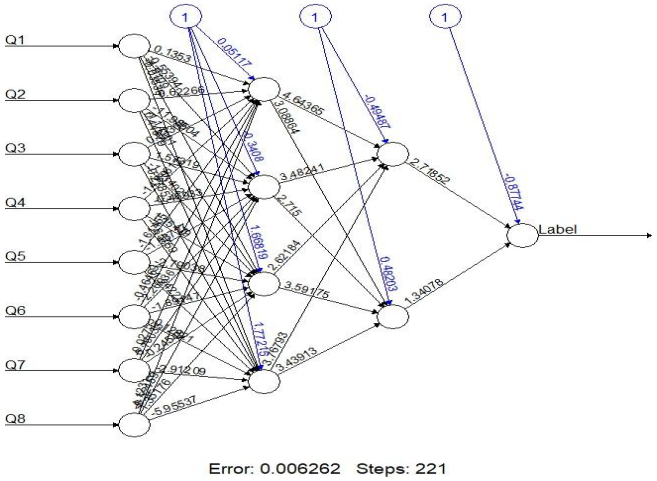

Fig. 2. Artificial Neural Network for Basic Concepts

As seen in fig. 2. Neural network is trained with negligible error. It has 8 nodes in the input layer indicating different types of input and a single node in output layer which will assign class label to the data. Input layer is followed by two hidden layers one with four nodes and second with nodes. This model was validated by calculating Mean Square Error (MSE) rate. This gives the difference between what was predicted and what is actual. Following formula was used to calculate MSE.

MSE= Σ(predictedClass - actualClass)2/ size (test data set)

= 0.00001283232288 ---Eq(1)

As shown in equation 1. Mean square error was minimum thus validating our neural network model. This model will accurately classify students based on their subject fundamental knowledge into three categories excellent, good and average. This data will help the tutor to identify the students who needs more attention and who can be moved up to next level.

Second neural network model was trained to classify students based on their ability to apply the basic concepts in solving the problems. Here again the neural network has eight inputs nodes in input layer and one node in output layer. Here it has four class labels thus classifying students into four categories viz. Excellent, Good, Average and Poor

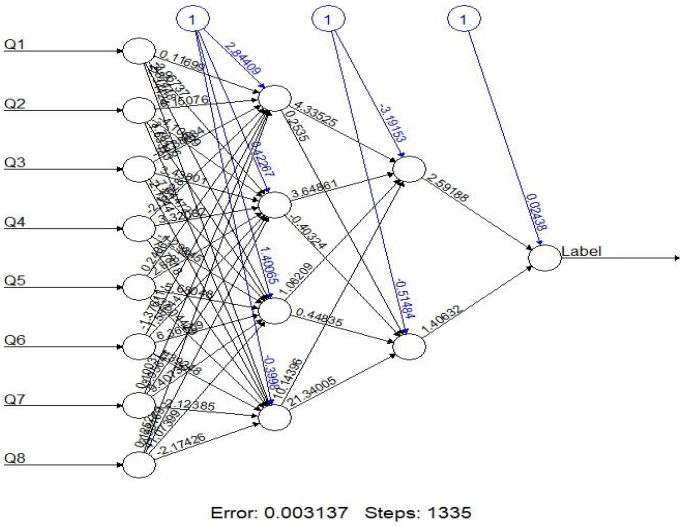

Fig.3. Artificial Neural network for Application of concepts.

As observed in fig.3 neural network is trained with two hidden layers with four nodes in first layer and two in second layer giving minimum error of 0.003137 in 1335 iterations. The mean square error was calculated for the accuracy of the model and is as follows.

MSE= Σ(predictedClass - actualClass)2/ size (test data set)

= 0.05179298205 --- Eq(2)

As the MSE is quite less indicating the model will classify accurately. Here student's response to attempt questions was bit less as compared to first category of basic concepts. Due to this here students were classified into four categories instead of three as in first category. Anew Class label Poor was added here as few students attempted only one question. The results indicated that tutor needs to emphasize more on real life examples while teaching the concepts so that students can visualize its applicability.

Third category was to test innovative thinking of students. Here questions were not objective but descriptive without negative marking. Here again in this section response was quite poor as some students did not attempt any question thus increasing the number of Class Labels from four to five. Students were classified into Excellent, Good, Average, Poor and Very poor. Following figure gives the neural network model for classification.

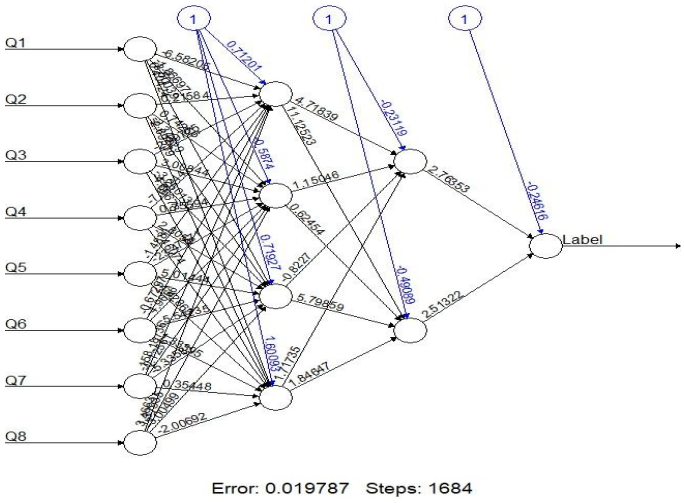

Fig. 4. Artificial Neural Network model for Innovative Category

As observed in fig.4 neural network is trained with two hidden layers with four nodes in first layer and two in second layer giving minimum error of 0.019787 in 1684 iterations. The mean square error was calculated for the accuracy of the model and is as follows.

MSE= Σ(predictedClass - actualClass)2/ size (test data set)

= 0.07241013501 --- Eq(3)

The mean square error as given in eq. 3 validates the neural network model. This classification model will help in identifying the students who can be motivated towards research and higher studies. These are the students who can think of innovative ideas. Designing questions in this section was a tough time as question quality will directly affect classification results

IV. Conclusion and Future Scope

This is an era of competition where everyone wants to move ahead of others. For Academic institutes to survive in this competition then they have to concentrate more on student community development. Here a question set of 24 questions with three categories was designed to test different learning abilities of students. Students confidence level is checked by counting the number of attempts as well as time spent on the question. A neural Network model was trained to classify students into different categories. This classification will help tutors to identify students who needs for more attention or who has good learning ability or who can think in innovatively. Thus each student will get personalized teaching experience. From students point of view they will be aware of their learning ability and can work more on it to improve. The classification results can also be used by employers to employ employees on different projects and can also help students in identifying their career goals.

Tables should be numbered sequentially using Arabic numerals (e.g., Table 1, Table 2), and each table should have a descriptive title. The table number and title should be typed in normal type, single-spaced, and centered across the top of the table, in 8-point Times New Roman, as shown below.

References

[1] Nick Z. Zacharis, "*Predicting Student Academic Performance In Blended Learning Using Artificial Neural Networks"*, International Journal of Artificial Intelligence and Applications (IJAIA), Vol. 7, No. 5, September 2016

[2] Samy Abu Naser, Ihab Zaqout, Mahmoud Abu Ghosh, Rasha Atallah and Eman Alajrami, "*Predicting Student Performance Using Artificial Neural Network: in the Faculty of Engineering and Information Technology"*, International Journal of Hybrid Information Technology, Vol.8, No.2 (2015), pp.221-228

[3] Mason, C., Twomey, J., Wright, D. et al. "*Predicting engineering student attrition risk using a probabilistic neural network and comparing results with a backpropagation neural network and logistic regression",* Research in Higher Education, Volume 59, Issue 3, pp 382–400, May 2018, Springer

[4] González, J.M.B. & DesJardins, S.L., "*Artificial Neural Networks: A New Approach to Predicting Application Behavior"*, Research in Higher Education, Volume 43, Issue 2, pp 235–258, (2002) , Springer

[5] Galbraith, C.S., Merrill, G.B. & Kline, D.M. "*Are Student Evaluations of Teaching Effectiveness Valid for Measuring Student Learning Outcomes in Business Related Classes? A Neural Network and Bayesian Analyses",* Research in Higher Education, Volume 53, Issue 3, pp 353–374,(2012), Springer

[6] .Sergey Zagoruyko, Nikos Komodakis, "*Paying More Attention To Attention: Improving The Performance Of Convolutional Neural Networks Via Attention Transfer"*, Published as a conference paper at ICLR 2017, pg. 1-13, https://arxiv.org/abs/1612.03928v3

[7] Ahmed Hamza Osman, "*An Evaluation Model Of Teaching Assistant Using Artificial Neural Network"*, VAWKUM Transactions on Computer Sciences, Volume 11, Number 2, November- December , 2016

[8] Ying Cui, Mark Gierl & Qi Guo, "*Statistical classification for cognitive diagnostic assessment: an artificial neural network approach"*, Educational Psychology Vol. 36, Iss. 6, 2016

[9] Ali Daud, Naif Radi Aljohani, Rabeeh Ayaz Abbasi, Miltiadis D. Lytras, Farhat Abbas , Jalal S. Alowibdi, "*Predicting Student Performance using Advanced Learning Analytics*", Proceedings of the 26th International Conference on World Wide Web Companion, Pages 415-421, Perth, Australia — April 03 - 07, 2017

[10] Mike Holmes , Annabel Latham , Keeley Crockett, James D. O'Shea, "*Near real-time comprehension classification with artificial neural networks: decoding e-Learner non-verbal behaviour"*, IEEE Transactions on Learning Technologies (Volume: PP, Issue: 99), 20 September 2017

[11] Erdinç Kolay , Taner Tunç, Erol Eğrioğlu , "*Classification with Some Artificial Neural Network Classifiers Trained a Modified Particle Swarm Optimization"*, American Journal of Intelligent Systems 2016, 6(3): 59-65.

[12] .Nor Liyana Mohd Shuib, Ahmad Shukri Mohd Noor,

Haruna Chiroma, and Tutut Herawan, "*Elman Neural Network Trained by using Artificial Bee Colony for the Classification of Learning Style based on Students Preferences"*, Appl. Math. Inf. Sci. 11, No. 5, 1269-1278 (2017) 1269.

[13] N.Sujatha, K. Prakash, "*An Efficient and Scalable Auto Recommender System Based on Users Behavior*", International Journal of Scientific Research in Computer Science and Engineering, Vol.6, Issue.6, pp.35-40, December (2018)

[14] A.Jenita Jebamalar, "*Efficiency of Data Mining Algorithms Used In Agnostic Data Analytics Insight Tools*", IJSRNSC, Volume-6, Issue-6, December 2018, pp 14-18.

Authors Profile

Dr. Kavita S. Oza pursued her PhD from Shivaji University and is currently working as Assistant Professor at Department of Computer Science, Shivaji University, Kolhapur, Maharashtra. She has guided two research scholars to pursue their PhD and has good number of research publications as well conference papers. She has co-authored six books and is life member of CSI.

Professor (Dr.) R. K. Kamat pursued his PhD from Goa University and is currently working as Director IQAC, Director Innovation & Incubation centre, and Heading Department of Computer Science & Electronics at Shivaji University, Kolhapur, Maharashtra. He has excellent research track with more than ten research projects, fifty research publications, and guided ten research scholars to pursue their PhD. He has authored ten international reference books and has delivered more than fifty invited talks at international conferences and seminars.

Dr. Poornima G. Naik, received her M.Sc. degree in Physics and Mathematics and Ph.D. degree in physics from Karnataka University, Dharwad. She received MCA degree from IGNOU with first class Distinction. Currently, she is working as Professor in the Department of Computer Studies, CSIBER, Kolhapur. Her areas of interest are network security, soft computing and cloud computing. She has participated in several national and international conferences, authored 10+ books on various cutting edge technologies in IT and has published more than 50 papers in International and national journals of repute.

