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Review Article

A Comprehensive Review of Current Applications of Artificial Neural Networks in E-Learning Environment

Rana Khudhair Abbas Ahmed

Alrafidain University College/Computer Techniques Engineering Department, Baghdad, Iraq

Email address:
rana_ruc@yahoo.com

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Abstract: With the rapid increase in the development of online learning technology and the huge amount of learning materials generated on the web. Besides, the learning resources are growing infinitely making it difficult for users to choose appropriate resources for their learning. This paper discusses current applications of artificial neural networks and its great potential to help users in a personal learning environment to identify relevant and interesting items from a large number of items by suggesting actions to learners.

Keywords: E-Learning, Neural Networks, Artificial Intelligence, Applications, Developments

1. Introduction

An artificial neural network (ANN) does not emulate the thought processes and if then logic of the human brain as done by an expert system. It mimics certain aspects of the information processing and physical structure of the brain with a web of neural connections. Therefore, some writers classified it as a "microscopic", "white-box" system and an expert system as a "macroscopic", "black-box" system [1].

Recently, e-Learning has become an active field of research and experimentation, with remarkable investments from all parts of the world. It represents the Web-based delivery of personalized, comprehensive, dynamic learning contents, aiding the development of communities of knowledge, linking learners and practitioners with experts. E-Learning supports the different phases of traditional learning and in some cases it is the only possible method of learning, allowing knowledge acquisition also in particular conditions (e.g. impaired students, absence of teaching structures, etc.). In this context, an important role is played by the definition of educational structure that must be contextualized and tailored on the basis of the requirements of: i) teachers, who have personal teaching approaches, and ii) students, who have personal studying approaches [2].

Today, educational institutions often prefer designing artificial intelligence supported e-learning scenarios and applying them in different courses or educational activities in order to improve teaching and learning experiences. Day by day, more emphasis is given on teachers' and the students' role on educational activities and their situations changing dynamically along a typical process [3, 4].

2. Artificial Neural Networks

Artificial Neural Networks are relatively crude electronic models based on the neural structure of the brain. The brain basically learns from experience. It is natural proof that some problems that are beyond the scope of current computers are indeed solvable by small energy efficient packages. This brain modeling also promises a less technical way to develop machine solutions. This new approach to computing also provides a more graceful degradation during system overload than its more traditional counter parts. These biologically inspired methods of computing are thought to be the next major advancement in the computing industry. Even simple animal brains are capable of functions that are currently impossible for computers [5, 6, 7, 8, 9].

3. How Neural Networks Differ from Traditional Computing and Expert Systems

Neural networks offer a different way to analyze data, and to recognize patterns within that data, than traditional computing methods. However, they are not a solution for all computing problems. Traditional computing methods work well for problems that can be well characterized. Balancing checkbooks, keeping ledgers, and keeping tabs of inventory are well defined and do not require the special characteristics of neural networks [9].

Traditional computers are ideal for many applications. They can process data, track inventories, network results, and protect equipment. These applications do not need the special characteristics of neural networks. Expert systems are an extension of traditional computing and are sometimes called the fifth generation of computing. (First generation computing used switches and wires. The second generation occurred because of the development of the transistor. The third generation involved solid state technology, the use of integrated circuits, and higher level languages like 13 COBOL, Fortran, and "C". End user tools, "code generators," are known as the fourth generation.) The fifth generation involves artificial intelligence [9].

4. E-Learning

A science of e-learning involves the scientific investigation of how people learn in electronic learning environments. Three elements of a science of e-learning are: a) evidence—a base of replicated findings from rigorous and appropriate research studies; b) theory—a research-based theory of how people learn in electronic learning environments, which yields testable predictions; and c) applications—theory-based principles for how to design electronic learning environments, which themselves can be tested in research studies. In this article, I offer a rationale for a science of e-learning and then provide examples of the three elements—evidence, theory, and applications—from our program of research on multimedia learning [10].

5. An Artificial Intelligence Approach on E-Learning

The e-learning software has an intelligent mechanism for improving students' learning experiences. At this point, the main objective of this mechanism is to determine appropriate digital materials that will be viewed along a possible e-learning activity process. In order to ensure that, two different artificial intelligence techniques: artificial neural networks and cognitive development optimization algorithm have been used in order to form a hybrid evaluation approach under the e-learning software. More details regarding to the intelligent evaluation approach can be expressed briefly as follows [4]:

- Artificial intelligence based evaluation mechanism is able to determine which material will be viewed next according to students' learning levels. In order to achieve this mechanism, each digital course material (lecture notes, exams, quizzes…etc.) have some importance points with the category tags defined by teachers.
- Categories related to the e-learning materials and learning level types for students are same values, which are typically subjects associated with the course given. So, it is possible for the teacher to define a new learning level type and also a new material category at the same time.
- By taking the related explanations above, we can say that determining the most appropriate material depends on matches among low learning levels and categories meeting with these levels.
- Artificial neural network model is trained with training data set stored in infrastructure of the e-learning software. This data set can be updated with additional data sets given by teachers. As default, teachers are able to feed the model with examples of learning level output values according to different success point scenarios for the digital materials provided over the software.

6. Developments Till Now: Current Applications

Table 1 illustrates the current applications of neural networks in e-learning for the last thirteen years.

Table 1. *Current applications of neural networks in e-learning.*

SL No.	Author and year of Research	Explanation of Application	Limitations
1.	Ting Fie., et al., 2003.	Authors proposed a text categorization model using an artificial neural network trained by the backpropagation learning algorithm as the text classifier. Their test results show that the system achieved the performance in terms of F1 value of nearly 78% [11].	The objective values (LMS error) of ANN algorithm decreases when the number of neurons is increased. When N is set to 10, the objective value is about 0.012, which means the trained ANN has little bias with the target [11].
2.	J. E. Villaverde, et al, 2006.	Authors presented an approach to recognize automatically the learning styles of individual students according to the actions that he or she has performed in an e-learning environment. This recognition technique was based upon feed-forward neural networks [12].	The lowest variance (1.53%) is obtained when the number of neurons is 22. Based on these results, Authors had chosen 24 neurons for achieving the maximum accuracy. For this value, the variance (1.70%) of the classifier is not the minimum but it is still acceptable [12].

SL No.	Author and year of Research	Explanation of Application	Limitations
3.	Lykourentzou, I., et al., 2008.	The authors recognized that the growing use of e-Learning requires the establishment of a mechanism for predicting the marks of the students at an early stage of the course. The authors applied a method for predicting the marks of the students in an online course lasting 10 weeks. The method proposed a multilayer neural network without a feedback is used, in order to predict the marks of the students [13].	The obtained results show that the creation of an accurate prognosis is possible after the third week of the 10-weeks course. The low levels of the false prognosis demonstrate the adequacy of the chosen method [13].
4.	Halil C., et al., 2009	The authors explored the relationship between the student performance and instructional design. Multiple-regression and supervised artificial neural network (ANN) models were used to examine the relationship between student grade point averages and the scores on the five design factors. The results indicated that there is no statistical difference between the two models. Both models identified the use of examples and applications as the most influential factor. The ANN model provided more information and was used to predict the course-specific factor values required for a desired level of success [14].	uncontrollable variables such as socio-economic and demographic factors, which are indirectly related to students' success, have not been considered [14]
5.	Lykourentzou, I., et al., 2009.	Authors developed a method based on three different types of neural network architectures in order to predict the indicator students, that have dropped out of e-Learning, The authors compared the results obtained by other methods used on similar problems and find that the solution obtained by NN is significantly better [15].	The authors noted that the NN architecture may fail to accurately classify some of the students, and offer three different schemes of taking decision, which combine the results of three NN architectures [15].
6.	Elena S., 2010.	In order to increase computational speed, the author presented a method that uses artificial neural network, multilayer perceptron (MLP) and radial basis function (RBF), through modelling a performance predictor of the students attending an e-learning course [16].	Big error rates were achieved in the case of a greater number of classes, this implies training a network whose architecture would allow discrimination of the data hyperspace of some regions with different shapes and dimensions [16].
7.	Parminder K., et. al, 2012.	In order to improve the e-learning environment, the authors presented a model that depicts successful implementation of neural networks to enhance e-learning systems [17].	Big error rates were achieved in the case of a greater number of classes; this implies training a network whose architecture would allow discrimination of the data hyperspace of some regions with different shapes and dimensions, by using the neural networks it can have best configuration from the error point of view [17].
8.	Petar, H, 2012.	The author proposed a model for prediction of the outcome indicators of e-Learning, based on Balanced ScoreCard (BSC) by Neural Networks (NN). The neural network was used for obtaining accurate predicting structure with small data samples is proposed in the present paper. The data was processed in advance by correlation analysis, interpolation and PCA. In this case the outcome indicators for e-Learning efficiency are predicted on the basis of key performance indicators from BSC [18].	The author work did not claim to discuss and resolve the whole spectrum of problems in assessing and predicting the efficiency of e-Learning in higher education. Its purpose is to give some recommendations and conclusions related to the various aspects of e-Learning evaluation [18].
9.	Mohamed S., Fares, B., 2015.	Authors introduced an artificial neural network model as a type of supervised learning and described a converging mathematical model to efficiently predict student's performance and reduce the danger of failing in an enrolled e-course [19].	Authors only selected a subset predictors in the training algorithm for students, the major problem in training a neural network is deciding when to finish operations as well as the overtraining phenomena which occur when the system memorizes patterns and thus lacks the power to extrapolate [19].
10.	Ankita P., Poonam M., 2015.	Authors presented a new concept of intelligent e-learning systems with intelligent two-way communication between an e-learning system and the user. The system uses intelligent methods for analysis, evaluation and assessment of user knowledge and skills as well as e-learning process control, supervision and optimization [20].	One of the main difficulties in designing intelligent tutoring systems is the time and cost required and the authoring tools [20].

7. Developments in Process: Future Applications

Future work may be by using a statistical analysis of more factors that affect the students' success can be investigated, natural language processing, such as expression normalization, and sentence understanding should be used more extensive experiments should be conducted by using larger training and test sets. Make more comparison of ANN with SVM, KNN, etc.., can be used to check the performance of each method. Reducing development time and cost) provide a simple development shell for educators to author their own courseware and provide a means for programmers to more easily represent the domain and teaching strategies.

8. Conclusion

E-learning is evolving with the use of artificial intelligence. Artificial Intelligence caused greater impact and better results in speed and accuracy when used with e-learning environment. We have discussed in our paper the previous and current applications of artificial neural networks in e-learning environment for the last thirteen years and showed its significance in this field.

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