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Neural Network Application on Knowledge Acquisition for Adaptive Hypermedia Learning

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ABSTRACT Computers have been used in education for over 20 years. Computer-based training and computer aided instruction were the first such systems deployed as an attempt to teach using computers. For a computer based educational system to provide individualized attention that a student would receive from a human tutor, it must reason about the domain and the learner. This has prompted research in the field of intelligent tutoring system particularly in adaptive hypermedia learning. On the other hand, in a nonlinear system, the effect depends on the values of other inputs, and the relationship is a higher-order function. Neural Network is an approach that can cater nonlinear problems, and an implementation of an algorithm inspired by research into the brain. It is a technology in which computer learns directly from data, thereby assisting in classification, function estimation, data compression, and similar tasks. In this paper, we present a neural network model in classifying students level of knowledge acquisition in adaptive hypermedia learning environment. The data of students knowledge acquisition are normalized in the close interval of (0,1), and the performance of neural network model towards these data are compared to the original data.

Keywords : neural network, adaptive hypermedia learning

INTRODUCTION

In today's competitive world, to stay solvent organization must surge itself in predicting its future. Malaysian's economy is getting better with time because of its well-versed organization management and so forth. In fact, financial forecasters now make money the new-fashioned way : they learn it. That is, they train a neural network to mimic a market, then use its predictions to guide investments. To play the market with a neural network, it helps to have expertise both in financial strategies and in neural network engineering [1]. The former means choosing economic variables and indicators and understanding their significance and correlation. The later means choosing a neural network, specifying its structure, training it, and testing it to see if it's a good bet. Neural networks have recently been proposed to possibly remove deficiencies in conventional methods. Neural network can automatically learn previous experience from examples without going through tedious acquisition and representation procedures. Because of this, it has attracted much attention from both industry and academics.

Hypermedia system is basically a non-linear method of organizing, structuring and accessing information around a network of multimedia nodes connected together by links. It is a system by which users can freely retrieve pieces of information in a flexible and interactive way. Hypermedia has become a potential technology for educational tool, where the teaching materials can be presented in a non-linear representation of interconnected multimedia documents. It allows individualized learning, in which the students can learn by themselves and at their own paces. It can also become a cognitive tool that allows students to explore and acquire learning with high degree of student control. However, hypermedia systems have some drawbacks. The flexibility left to the user appears to pose disorientation problem. This could happen when the information space is very large. With all the freedom, students may loose track of the position from the starting point, miss some important materials, and use the navigational feature unwisely. Furthermore, the contents and structures of most hypermedia educational systems are static. This means that, the students can only move between linked nodes and the system cannot adapt the materials

according to the students' different background, levels of knowledge acquisition and preferences.

Adaptive hypermedia system is one of the most promising technique that can be applied in educational hypermedia systems. An adaptive hypermedia system aims to provide a solution to the problem of disorientation and the need to accommodate varied users by being capable of searching for and filtering out the information most relevant to the user's needs, goals, knowledge level and interest [2]. In this paper, we discuss the use of neural network in classifying student's level of knowledge acquisition in adaptive hypermedia learning using normalised data and we compare networks performance to the original data.

MATERIALS AND METHODS

Adaptive Hypermedia Learning

Adaptive Hypermedia Learning is basically an educational hypermedia system that incorporate artificial intelligence techniques to enable it learn about the user or student of the system. The educational part of the system will guide the student to the right track, whilst the artificial intelligence techniques will try to entertain the different needs of the students so as to provide a more individualized system. The system adapts to the student's current behaviour implicitly.

The adaptiveness of the system can be achieved through adaptive presentation and adaptive navigation support. Adaptive presentation manipulates the contents to be displayed to the student. It involves structuring the contents of the domain to suit different categories of students. Possible techniques are providing multiple ways of teaching the same material, different levels of details and complexity, different approach and examples to suit different background and remedial topics. Adaptive navigation focuses on the links to be followed by individual student. Based on the student's initial status and his current behavior, the system will decide which links are made available to him at a given time.

Capturing the student's behaviour via a student model is very important to adaptive hypermedia learning. The student's initial status can be captured explicitly by asking the student the required information at the beginning of the system. However this initial status can and will change as the student uses the system. These changes must be captured implicitly by the student model. Possible techniques are by assessing the student's level of knowledge acquisition and also his current level of knowledge of the domain.

Methodology of Classifying Level of Knowledge Acquisition

The student model is used to identify the students level of knowledge acquisition and to make hypothsesis on the approach that can be employed. The students knowledge acquisition can be categorized to weak, average and excellence based on several criteria. The criteria that have been chosen are the students CPA, the study duration, the score of the questions answered and the frequency of backtracking and using an aid. Based on the CPA, we define that the students with CPA less than 2.7 are classified as weak, students with CPA between 2.7 to 3.5 are categorized as average, while those with CPA greater than 3.5 aree categorised as excellence.

In order to identify the level of knowledge acquisition based on the time taken using the system, initally, the average time studying for a normal student using the system is identified. A weak student spends more time on studying compare to the setting time, an average student spends between 80 – 100% time on studying from the time setting, and an excellence student uses less than 80% from the time setting. Through the examination questions provided by the system, the students with score less than 60 percent, are categorized into weak students, those with score between 60 to 80 percent are categorized into average students and students with score more than 80 percent are categorized as excellence students.

While studying, the frequency of backtracking facilities in the system show either the student is lost, confused or strayed away from the study objective. In this study, we assume that a weak student is he/she who backtrack more than three times, an average student is he/she who backtrack between 2 to 3 times and an excellence student is he/she who backtrack at most once. The system that the students use provides help study facilities. The frequency of using this aid will determine either the student is weak, average or excellence. As the students using the system, data of students knowledge acquisition are collected. These data will be used to identify the students category and thus he/she will be adapted to his/her level.

Neural Network (NN) Approach and Its Methodology

A neural network is a computer program that is constructed of multiple artificial neurons which have interacted with one another and "learned" a model that can be used to take

intelligent action. They are better than traditional statistical systems at recognising data patterns because NN data need not be linearly separable or independent. NN can organize and sift through data in such a way as to discern very subtle and complex relationships among variables. In addition, they can deal with qualitative assessments and uncertainty through a branch of mathematics known as fuzzy set theory [3].

In general, neural systems match large amounts of input information simultaneously, generating either categorical or relational output. NNs are adaptive which mean that they can take data and learn from it. Thus they infer solutions from the the presented to them, often capturing quite subtle relationships. They can reduce development time by learning underlying relationships even it they are difficult to find and describe. They can correctly process data that only broadly resembles the data they were trained on originally. They can handle imperfect or incomplete data, providing a measure of fault tolerance. The networks are nonlinear, in that they can capture complex interactions among the input variables in a system. In a linear system, changing a single input produces a proportional change in the output, and the input's effect depends only on its own value. In a nonlinear system, the effect depends on the values of other inputs, and the relationship is a higher-order function.

One of the easiest networks to understand is backpropagation. Its learning and update procedure is intuitively appealing because it is based on a relatively simple concept - if the network gives the wrong answer, the weights are corrected so that the error is lessened and as a result, future responses of the network are more likely to be corrected. When the network is given an input, the updating of activation value propagates forward from the input layer of processing units through each internal layer, to the output layer of processing units. The output units then provide the network's response. When the network corrects its internal parameters, the correction mechanism starts with the output units and back propagates backward through each internal layer to the input layer. Backpropagation can adapt two or more layer of weights and uses a more sophisticated learning rule. Its power lies in its ability to train hidden layers.

Normalize the data is almost always recommended if a variable is being used to train output neurons, and the output neurons have an activation function with bounded range, then we certainly must limit the target activations to values that can comfortably learned [4]. Nonlinear activation functions such as the logistic function typically have the squashing role in restricting or squashing the possible output from a node to typically, (0,1) or (-1,1). Data normalization is often performed before the training process begins. Thus, in this paper we discuss the use of neural network model particularly backpropagation learning in classifying students's level of knowledge acquisition based on the data given. These data are selected based on the criteria chosen. Thus in this paper we introduce only five criteria and these are CPA, study duration, score response on answering the questions, frequency of backtracking and aid. These data will be the input of the network (Fig. 1). The data is represented in 3-d surfaces to show the data behavior of the students knowledge acquisition. In this study, we categorize the data into normalized data and original data in order to discover neural networks performance based on the arguments given by Timothy.

In designing neural network model, we take into account parameters involve such as number of training data, number of hidden layers, number of processing units in input layer, hidden layer and output layer. The neural network for this paper is structured in a three layered network as shown in Fig. 2 : 5 nodes for input layer, 13 nodes for hidden layer and 3 nodes for output layer. Input layer will represent various patterns for level of knowledge acquisition. Meanwhile output layer will have three nodes that represent students categorization of knowledge acquisitions either weak, average or excellence.

The selection of transfer function mainly depends on the nature of input data and what the network is trying to learn. If the problem is to pick up an exceptional structure such as bankruptcy prediction and stock picking, hyperbolic tangent function works better; on the other hand, if the problem is to classify an object from the others, sigmoid function is a better choice [5].

RESULTS AND DISCUSSION

Experiments on this problem for 70 data either original data or normalized data are implemented with sigmoid of $1/(1+e^{-x})$as an activation function, and the parameters involved using mean square error on backpropagation model are as follows :

$$\alpha = 0.7, \beta = 0.2$$

where α is the learning rate, β is the momentum.

The processing time taken with original data using standard backpropagation is 5409 seconds and 1551 seconds for normalized data (Fig.3 and

Fig.4). The network used random starting weights and biases. A network is considered well trained if the maximum error is $|e| \leq 0.05$

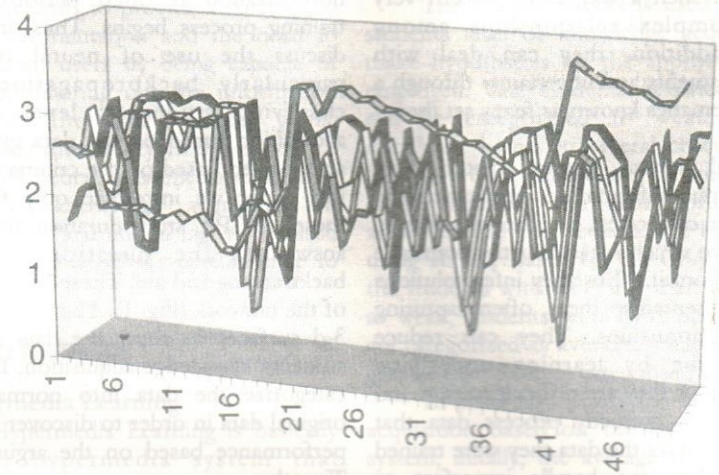

Figure 1 : Input Data Behavior of Students Knowledge Acquisition

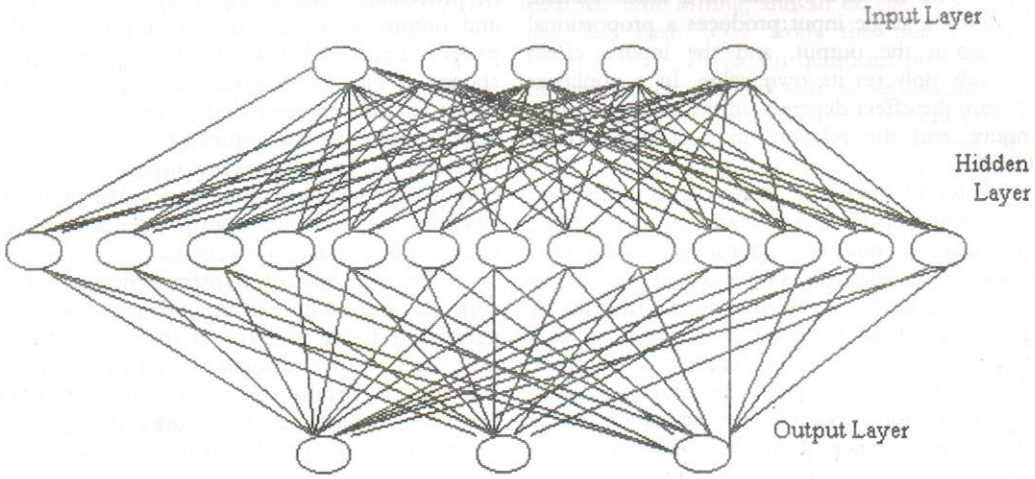

Figure 2 : Neural Network Model for Level of Knowledge Acquisition

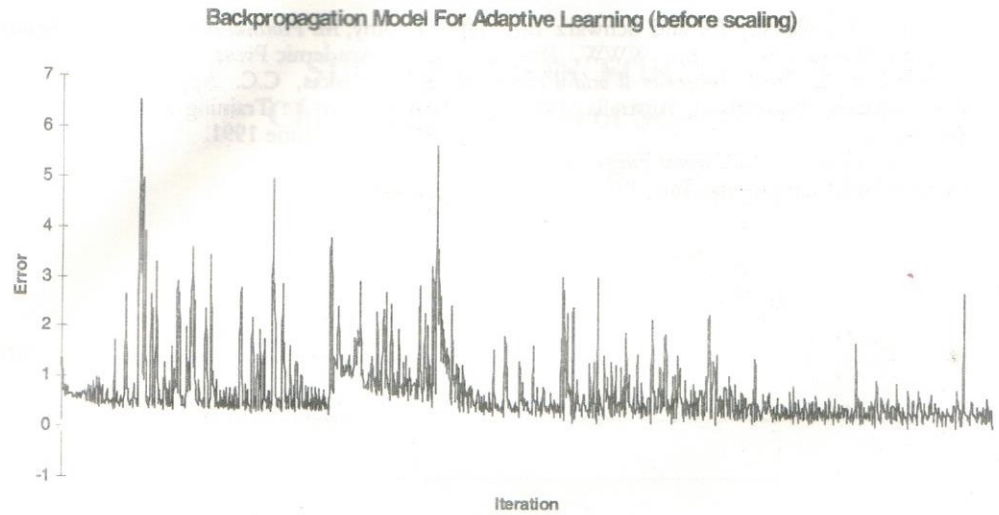

Figure 3 : Convergence rate for the original data

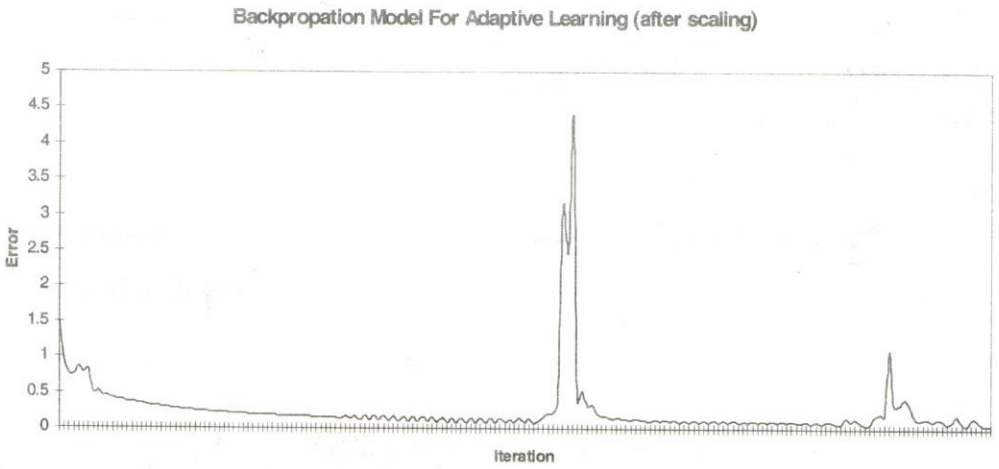

Figure 4 : Convergence rate for normalized data

From the experiments, we conclude that classification with normalized data gives us faster convergence rate compared to the original data eventhough both approaches give 100% classification rates. This is comformed with Timothy arguments that when nonlinear transfer functions are used at the output nodes, the desire output values must be transformed to the range of the actual outputs of the network. Even if a linear output transfer function is used, it may still be advantageous to standardize the outputs as well as the inputs to avoid computational problems, to meet algorithm requirement, and to facilitate network learning. In general, data normalization is beneficial in terms of the classification rate and the mean squared error, but the benefit diminishes as network and sample size increase.

Conclusion, In this paper, we discuss neural network approach in classifying students levels of knowledge acquisition in adaptive hypermedia learning environment. From the experiments, we see that the convergence rates using normalized data is faster compared to the original data. Thus this conform with [4] that normalization is strongly recommended for the data involves in classifications since we use bounded activation function. The processing time can further be improved using arbitrary values of learning rate, α, momentum parameter, β, number of hidden nodes and layers.

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