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APPROXIMATION AND PREDICTION USING NEURAL NETWORK

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Abstract: Numerous advances have been made in developing intelligent programs, some inspired by biological neural networks. Researchers from many scientific disciplines are designing artificial neural networks (ANNs) to solve a variety of problems in pattern recognition, prediction, optimization, associative memory, and control. Although successful conventional applications can be found in certain well-constrained environments, none is flexible enough to perform well outside its domain. ANNs provide exciting alternatives, and many applications could benefit from using them. This article is for those readers with little or no knowledge of ANNs to help them understand the other articles in this issue of this journal. It discusses the motivation behind the development of ANNs, describes the basic biological neuron and the artificial computation model, outlines network architectures and learning processes. This paper includes an interesting example approximation and prediction for a teacher evaluation system using neural network. The author also explains how to effectively use Matlab software to successfully apply the modeling and simulation techniques presented.

Key words: artificial neural network, ANN, prediction, approximation, Matlab.

Introduction

Neural networks are very sophisticated modeling techniques capable of modeling extremely complex functions. In particular, neural networks are nonlinear. Linear modeling has been a commonly used technique in most modeling domains since linear models have well-known optimization strategies. Where the linear approximation was not valid, the models suffered accordingly. Neural networks also keep in check the curse of the dimensionality problem that bedevils attempts to model nonlinear functions with large numbers of variables.

Neural networks learn by example. The neural network user gathers representative data, and then invokes training algorithms to automatically learn the structure of the data. Although the user does need to have same heuristic knowledge of how to select and prepare data, how to select an appropriate neural network, and how to interpret the results, the level of user knowledge needed to successfully apply neural networks is much lower than would be the case using (for example) the same more traditional nonlinear statistical methods.

We can explain neural networks as a broad class of models that mimic the functions inside the human brain and are known as biological neurons.

Artificial Neuron

When creating a functional model of the biological neuron, there are three basic components of importance. First, the dendrites of the neuron are modeled as weights. The strength of the connection between an input and a neuron is noted by the value of the weight. Negative weight values reflect inhibitory connections, while positive values designate excitatory connections. The next two components model the actual activity within the neuron cell. An adder sums up all the inputs modified by their respective weights. This activity is referred to as a linear combination. Finally, an activation function controls the amplitude of the output of the neuron. An acceptable range of output is usually between 0 and 1, or -1 and 1. The output is passed through axon to give outputs. Mathematically, this process is described in Fig. 1.

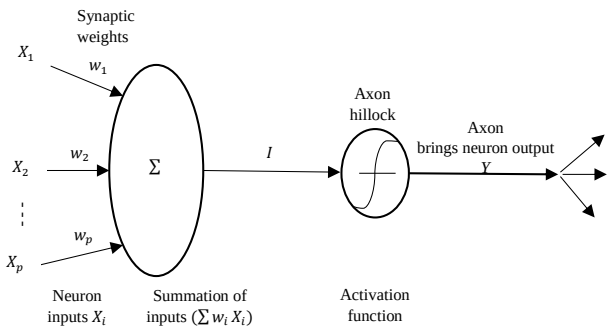

Fig. 1: Artificial Neuron.

The artificial neuron receives the information $(X_1, X_2, X_3, \ldots, X_p)$ from other neurons or environments. The inputs are fed in connection with weights, where the

total input is the weighted sum of inputs from all the sources represented as:

$$I = w_1 \times X_1 + w_2 \times X_2 + w_3 \times X_3 + \ldots + w_p \times X_p = \sum w_i X_i. \quad (1)$$

The input I is fed to the transfer function or activation function which converts input I into output Y.

$$Y = f(I) \quad (2)$$

The output Y goes to other neuron or environment for processing.

ANN consists of many simple elements called neurons. The neurons interact with each other using weighted connection similar to biological neurons. Inputs to artificial neural net are multiplied by corresponding weights. All the weighted inputs are then segregated and then subjected to nonlinear filtering to determine the state or active level of neurons.

Applications of Neural Network Modeling

Data Mining Applications:

Prediction: For a prediction application of ANN, past history is taken as input and based on the future trend may by predicted, as shown in Fig. 2.

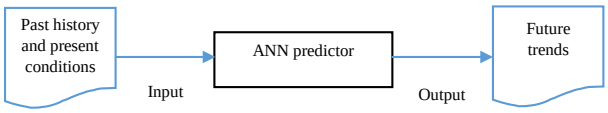

Fig. 2: MISO ANN Predictor

Classification: Classify data into different predefined classes based on the inputs, for example, if the color, shape, and dimensions of different fruits are given, we may classify then as lemon (class 1), orange (class 2), banana (class 3), etc., as shown in Fig. 3.

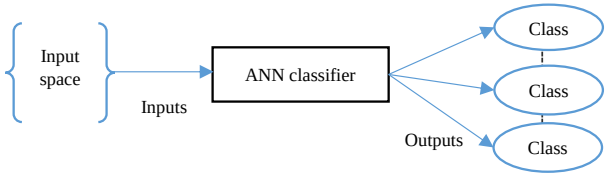

Fig. 3: MIMO ANN Classifier

Change and deviation detection (interpolation): To find certain data that are missing from the records or to detect and determine suspicious records/data. It is quite similar to the ANN predictor. The ANN predictor normally extrapolates while this interpolates the values.

Knowledge discovery: The ANN is a very good tool for knowledge discovery. We may apply unforeseen inputs and determine the output for study purposes. This will help in finding new relationships and non-obvious trends in the data. With the help of ANN, we may explore our own ignorance.

Response modeling: Train the ANN model to find the systems response.

Approximation and Prediction Using Neural Network

In the current education system, to improve education quality, teacher evaluation is a must. The teacher can be evaluated on basis of student feedback, results, peer feedback, and educational activities as shown in Fig. 4.

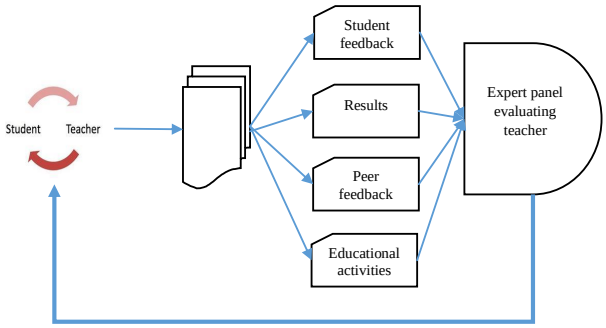

Fig. 4: Teacher Evaluation System

The evaluation is based on fixed mathematical formula, and, hence, there are many problems:

- Each expert has his/her own intuition for judgment; often it is not taken into account;
- Different weights are assigned to different parameters by each expert, but it is not easy due to subjectivity in weights;
- Mathematical computation is not fact;
- Many experts become biased with the candidate teacher, and it influences the results.

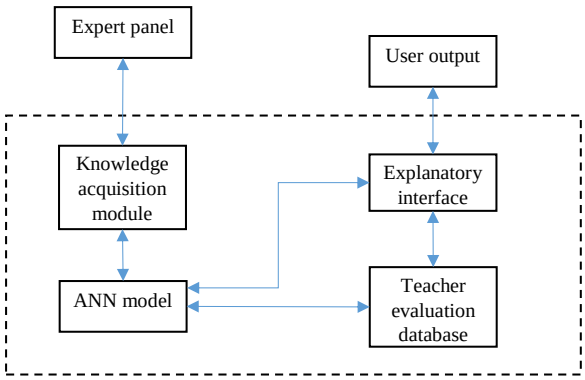

Fig. 5: Block Diagram for Teacher's Evaluation System

The block diagram for ANN approach is shown in Fig. 5. For this example, the system model has a teacher

Table 1: Training Data for ANN Model

Student Number	Student Results	Examination Result	Peer Feedback	Educational Activities	Expert Total
1	8,4	10	7,53	8,2	8,7333333
2	8,4	5,8	7,85	8,4	7,9
3	8,84	5,8	7	9,2	7,966667
...					
58	3	3	3,63	2,8	4,033333

evaluation database, which has three experts who have judged the teachers on the basis of their feeling. The average of the experts' judgments were taken as the overall judgment.

The judgment of the teacher is done at a 10-point scale. The evaluated data as shown in Table 1 is given to the neural network for training and testing.

Matlab code is written for simulating the ANN model with the following data set. The ANN performance during training testing is shown in Fig. 6.

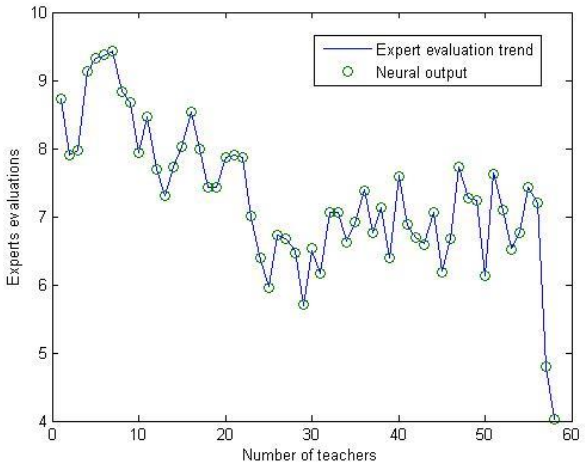

Fig. 6: Comparison of Results

Due to the above difficulties, the conventional methods are not so effective for this problem. The soft computing techniques such as the ANN model may be used to overcome some of the difficulties mentioned above.

Conclusions

Artificial neural networks (ANNs), representing computational paradigms based on a biological metaphor, are rapidly gaining popularity among researchers. The number of ANN applications to problems has increased dramatically in the last years, fired by both theoretical and application successes in a variety of disciplines. Potential areas of application are identified and future trends are discussed. For example, Financial applications, Medical, Marketing, HR management, Operational analysis, Industrial applications, Energy, Science are interesting. In the area of science, ANN may be used on a number of problems such as physical system modeling, image recognition, identification and optimization, ecosystem evaluation, classification, signal processing, systems analysis, etc.

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