UNIVERSAL APPROXIMATION WITH NON-SIGMOID HIDDEN LAYER ACTIVATION FUNCTIONS BY USING ARTIFICIAL NEURAL NETWORK MODELING

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Abstract

Neural networks are modeled on the way the human brain. They are capable of learning and can automatically recognize by skillfully training and design complex relationships and hidden dependencies based on historical example patterns and use this information for forecasting. The main difference, and at the same time is biggest advantage of the model of neural networks over statistical techniques seen that the forecaster the exact functional structure between input and Output variables need not be specified, but this by the system with certain Learning algorithms is "learned" using a kind of threshold logic. Goal of the learning procedure is to define the training phase while those parameters of the network, with Help the network has one of those adequate for the problem behavior. Mathematically, the training phase is an iterative, converging towards a minimum error value process. They identify the processors of the network, minimize the "total error". The currently the most popular and most widely for business applications algorithm is the backpropagation algorithm. This paper opens the black box of Backpropagation networks and makes the optimization process in the network over time and locally comprehensible.

Keywords: FPGA; Sigmoid Activation Function; Artificial Neural Network (ANN).

1. Introduction

Neural networks are capable of learning, information processing systems, the large from a Number of simple units (cells, neurons, or "units") which is the information in the form of activation of the cells via their connections ("connections, links"). A distinction is generally made between biological and artificial networks. in the event of a biological or natural neural network represent the neurons and the network is part of the nervous system of a biological organism. The processed information is biological information essentially of nerve impulses In an artificial neural network are the Neurons implemented as mathematical models whose formalized behavior principle the biological neurons corresponds. The processed information here can be call pattern ("pattern"). The information processing itself is done by Interaction between the individual units, which have a positive (excitatory) or negative (inhibitory) signals lovely reminder, if certain thresholds exceed. The Units are available via links in contact, which the Strengthen or weaken signals. The compounds at the entrance of a unit each having a weight which determines the strength of the connection. The weights of connections (algorithms) can be changed due to certain regulations. This process is called one training, learning or self-adaptation. Puts the "knowledge" of an ANN So in the weights and is distributed over the entire network (distributed knowledge representation) . The complex and intense combination of the individual neurons with each other ultimately determines the concept of connectionism. Simplified mathematical model to simulate neural network information biological nervous system to perform certain aspects of treatment. Adopted a number of principles in nature, including parallel processing, for example, by learning and knowledge abstraction. Neural computing is a fast-growing branch of study, which is different from the continuous development of new applications of neural networks. Pattern recognition and classification is a typical application of this method. Many tasks in earth sciences, especially in the interpretation of data, consider and treat the classification problem. In this terminology, the study (earth model, for example, sub-region) of the object is divided into a characteristic (e.g., physical

properties), based on the rock type. Numerical solutions to face as incorrect and incomplete nature of the data and the overlapping challenges in some of the properties of different lithologies. Self-organizing map is an interesting concept, which allows classification of certain behavior by unsupervised learning. We have developed a workflow GFZ, including data preparation, application of learning rules, segmentation maps trained, using image processing technology, and application of knowledge. The application displays the Northeast basin from Germany and Indonesia, merged into a joint lithologic interpretation of geothermal exploration projects in different geophysical models of the same research.

2. Literature Survey

Many different physical systems of financial markets, because we know that time is the financial market is a complex feedback mechanism. What people expect prices affect the price of their observations, and then observe their prices in turn affect how they form what price they will be expected next period. Market is basically a beast unclear or uncertain system is a system that people exchange rate risk, exchange rate risk, which is why it is there. Therefore, it is possible to predict if there will be dangerous. In person, I think there is no system available to the public, in order to predict the financial markets. On the other hand, neural networks have been found in predicting stock prices is useful. Both feedforward and feedback neural networks have been studied, and success. This means that the prediction software will be very useful to help people make the final decision. In this article, assume that it is possible to predict the market, forecasting system using fuzzy neural network learning algorithm to predict future stock value development. Several modules of the system by neural networks. These models are used to study the relationship between the technical and economic indicators and decide to buy or sell stocks. Input to the network in the technical and economic indices. The output of the system is to decide to buy and sell. There are several methods for neural network stock prediction method of time series, often neural network and feedforward neural network method. When compared with these technologies, the process of fuzzy neural network, which will be described in subsequent sections of a very useful and effective method. Learning algorithm to train the network, when you start learning, tolerance is defined as output units. In learning, the weights only when the output error exceeds the allowable limit updates. Power error within the tolerance range of learning data is eliminated from the training data set. Each network input data by using a Java program is directly obtained from the average value data of the week moving average site. The simulation output data is the data amount of the weekly average. Predictive analysis of past projects estimated time series data and future data values. Basically, this method attempts to derive value from the past recursive relationship model nonlinear function. Recursive relationship can be used to predict the time sequence in which the hope that the new value is a good approximation of the actual value. Two basic types of time series forecasting: univariate and multivariate analysis. Single-factor model, such as boxes Jenkins, including recurrence equation is only one variable. Containing equations used in the model, and the moving speed of the intermediate values in the past. Box Jenkins good short-term prediction, but requires large amounts of data, and is complicated to determine an appropriate process model equations and parameters. Multivariate model is a single-variable model was extended to "behavior found to affect the data causal factor. As its name implies, these models contain a number of variables in their equations. Regression analysis is a multivariate model, which is often compared to the neural network. In the general case, the time series forecasting with reasonable accuracy for a short time, but the accuracy of the time series forecasting a sharp decline in the predicted length increases. Many other computer techniques have been used to predict the stock market. They range from tracking program to complex expert systems. Fuzzy logic is also used. Process expert system knowledge of the order and the development of regulations. They can be used to develop trading rules based on technical indicators. In this capacity, the expert system can use neural networks to predict the market combined. In the combined system, neural network can perform its forecast, while the expert system can verify the prediction based on the well-known commercial standards. Advantage of the expert system, they can be obtained by interpretation of their results. Neural network, the input data is difficult to analyze, and the importance of how to get the result in the network. However, the speed of neural networks faster because they run in parallel, and fault tolerant. The main problem is the use of expert systems market in developing markets, because we ourselves do not fully understand the difficulty of knowledge. Expert systems have the advantage of fuzzy neural networks because they can extract rules, without the need for explicit formalization. In a highly confused and only partially understood, such as the stock market, this environment is an important factor. Expert information is difficult to extract and use by the expert system in the form of regularization. Knowledge of expert system, its scope is only good part, when it does not work, there are missing or incomplete information. Neural networks to better manage dynamic data, can be summarized, so that "speculation." Therefore, the neural network expert system is more suitable for the stock market environment. In a variety of different models, so far described, each model has its own advantages and disadvantages. The best way is to use these methods works best when we work together. Using fuzzy neural network is the main advantage of the network to learn how to use these methods combine efficiency, and want to understand the behavior of the market as a factor in our collective consciousness.

3. Methodology

The activity control system based on fuzzy logic, fuzzy neural network usually has five functional layers: (1) The first layer is the input layer. (2) Layer 2 is the fuzzy layer; (3) Layer 3 is the fuzzy inference layer may consist of one or more layer of Y and; (4) Layer 4 is the defuzzification layer; (5) The fifth layer is output layer. Fuzzy neural network structure shown in Figure 1 depicts a general fuzzy neural network input crisp map Hee (I = 1,2, ..., N) crisp output Yi (J = 1, 2, ..., M). Fuzzy neural network is built layer by layer as linguistic variables, IF-THEN rules fuzzy control system, fuzzy logic, fuzzy reasoning and fuzzy fuzzy reasoning schemes and fuzzy programs. Enter the representatives of each neuron fuzzy layer of a fuzzy rule antecedent membership functions. Membership functions for common way to apply this coating is expressed in discrete points. Therefore, the fuzzy rule "if X1 and X2 is for A1 A2 ..... then Y is B", A premise of the terms "X is a" possibility distribution features. Each of the fuzzy inputs is defined as in the spatial reference point of hidden nodes. Defuzzification layer, the function of the rules evaluated. In each neuron layer is a subsequent proposal, "then y is B" and the membership functions can be combined with one or two S-shaped function and the linear function to achieve.

Learning Algorithm

An *n* inputs and one output fuzzy neural network has *m* fuzzy if-then rules, by the specified

$$\text{IF } x_1 \text{ is } A_1^k \text{ and } \ldots \text{ and } x_n \text{ is } A_n^k \text{ THEN } y \text{ is } B^k,$$

Where x_i and *y* are input and output fuzzy linguistic variables, respectively. Fuzzy linguistic values A_i^k and B^k are defined by fuzzy membership functions as follows,

$$\mu_{A_k^i}(x_i) = \exp[-(\frac{x_i - a_i^k}{\sigma_i^k})^2] \quad (1)$$

$$\mu_{B^k}(y) = \exp[-(\frac{y - b^k}{\eta^k})^2] \quad (2)$$

The *n*-input-*1*-output fuzzy neural network with modest fuzzy cognitive is defined below:

$$f(x_1,...,x_n) = \frac{\sum_{k=1}^m b^k [\prod_{i=1}^n \mu_{A_i^k}(x_i)]}{\sum_{k=1}^m [\prod_{i=1}^n \mu_{A_i^k}(x_i)]} \quad (3)$$

Given *n*-dimensional input data vectors x^p *(i.e.,* $x^p = (x_1^p, x_2^p, \ldots, x_n^p)$*)* and one-dimensional output data vector y^p for *p*=1,2,...,N, (i.e., N training data sets). The energy function for *p* is defined by

$$E^p = \frac{1}{2}[f(x_1^p,...,x_n^p) - y^p]^2 \quad (4)$$

For simplicity, let *E* and f^p denote E^p and $f(x_1^p,...,x_n^p)$, respectively. After training the centers of output membership functions ($\frac{\partial E^p}{\partial b^k}$), the widths of output membership functions ($\frac{\partial E^p}{\partial \delta^k}$), the centers of input membership functions ($\frac{\partial E^p}{\partial a^k}$) and the centers of input membership functions ($\frac{\partial E^p}{\partial \sigma^k}$), then we obtain the training algorithm:

$$b^k(t+1) = b^k(t) - \theta \left.\frac{\partial E^P}{\partial b^k}\right|_t \quad (5)$$

$$\sigma^k(t+1) = \sigma^k(t) - \theta \left.\frac{\partial E^P}{\partial \sigma^k}\right|_t \quad (6)$$

$$a^k(t+1) = a^k(t) - \theta \left.\frac{\partial E^P}{\partial a^k}\right|_t \quad (7)$$

$$\eta^k(t+1) = \eta^k(t) - \theta \left.\frac{\partial E^P}{\partial \eta^k}\right|_t \quad (8)$$

Where, η is the learning rate and t = 0, 1, 2… The main steps using the learning algorithm as follows:

Step 1: Present an input data sample, compute the corresponding output;

Step 2: Compute the error between the output(s) and the actual target(s);

Step 3: The connection weights and membership functions are adjusted;

Step 4: At a fixed number of epochs, delete useless rule and membership function nodes, and add in new ones;

Step 5: IF Error > Tolerance THEN go to Step 1 ELSE stop.

When the error level falls below the tolerance specified by the user, the weight of the weight of the interconnected ends of the change reflects the initial fuzzy rules and membership functions. If the resultant weight rule is close to zero, the rule can be safely removed from the rule base, because it is negligible compared to other. Further, by adjusting the parameters of neurons, in the process of forming these layers and adjusted to the fuzzification of the shape and position of the fuzzy membership function layer.

4. Proposed System

The system can predict the future of any exchange or market index. For example, to predict the number of days of Microsoft's value shares, it requires historical data. Data for the neural network may be the most important aspect of the training. No user intervention, including data obtained with the needs of users directly via the Internet, in this process, the user can decide what kind of action they want to achieve, how long the relevant price information. Pre-processing operation is necessary as a preparation step of the next stage. As an example of pre-treatment, the daily price data is downloaded, the periphery of a packet through, and the average is calculated every week for the next step. Write an HTML parser in Java to retrieve data.

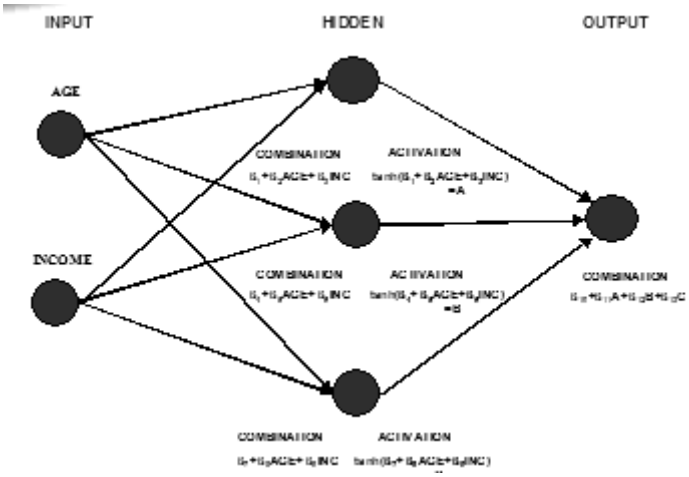

Figure 1 Sigmoid activation function

The program analyzes the entire file line by line, in order to obtain the necessary information, and insert it into the database. All training data system, the preparation of 2-input 1-output formats: (D_1, D_2, D_3 ...), (D_2, D_3 D_4 ---), wherein for said first vector, d1 and D_2 and D_3 is input as the output, and the second vector, d_2 and d_3 and d_4 is the entry is a way out. It has some of the parameters to be used during training. Exact results son error threshold, depending on tolerances, etc. These parameters. In order to quickly achieve our goals, some of the parameters pretreatment. For example, the diffusion function of the members 1 and 2, there are two important parameters: the center and the width of fuzzy sets. Their initial value on system performance has a critical influence. A random value generated by the machine is not optimal. In this system, a simple method is proposed to optimize the initial values: all of the data from the Internet to sort, and then divided into five groups of data to obtain an average value of each group, these values are used in the fuzzy set of features the initial value of the center. The prediction algorithm will need to enter these parameters. When you click to enter the stock symbol, the prediction system called the future of this algorithm. This algorithm allows neural network learning. The algorithm returns to the next output values are stored in witch finally results in the Table for each population. The average error until you click on this special group for all analog, we will track these results. An organic neural network has 10 one billion parallel highly interconnected neurons. Each neuron may receive other neurons over 200,000 electrochemical signal. These connections can be changed by environmental stimuli. If the correct input is received, the trigger signal in neurons and send excitatory or inhibitory signals to other neurons. In the data analysis, artificial neural network is a kind of prediction for the supervision, flexible non-linear models. However, due to the attached analog neurophysiology, and is generally considered more attractive than other predictive

models. Artificial neural network construction basic building blocks are called hidden units. Hidden units are model neurons. Each hidden unit receives input variable linear combination. The weight coefficients are known weight. Transform a linear combination of the activation function, and then send them to another drive and then use it as input.

5. Experiment Result

The input vector and the corresponding destination vector to be used to train the network until it can be approximated function to the input vector of the input vector of the vector associated with a particular output, or classified in an appropriate manner as defined by you. Network prejudices, S-shaped layer, and a linear output layer can approximate any function discontinuous finite number. Is a standard back-propagation gradient descent algorithm, such as learning the rules of Widrow- Hof, where network weights, moving along the slope of the negative performance of the function. This term refers to multiple back-propagation network nonlinear gradient layer calculated. There are some changes in the basic algorithm is based on other conventional optimization techniques, such as Newton's method and conjugate gradient. Properly trained back-propagation network often presents with their investment never seen when making a reasonable answer. Usually lead to a new input is similar to the correct output using the input vector in the training input is similar to the new proposed output. This property allows a group to summarize / destination entry represents, and get a good result on the training network, and all possible input / output training network. Still, aimed at improving the generalization of neural network software network two characteristics: regularization and early stopping. The popularity of the algorithm is that the flexibility of the network, capture the hidden features in your application data. Simple view may represent linearly separable FNS limits are exceeded. Only BP algorithm provides a multi-layer network of more power before general learning rules. The foundation is called gradient descent optimization algorithm that, during the study, each connection WTS technology. The slope at the current location of the network by a global amount proportional to the amount of error metrics can be adjusted. Based on the results in the formation stage of the iterative process, we found that the best architecture of MLP neural network comprising an input layer, eight, 10 hidden neurons in the first hidden layer, 14 neurons in the second hidden layer, the hidden and layer neuron output a (building 8-10-14-1). Scatter ozone concentrations predicted values and observed the training set and test set is in Figure 4, the average absolute error (MAE) and root mean square error shown (RMSE), for the training data for 8.64 and 11.84 ppbv respectively. The test data set corresponding errors were 10.26 and 13.53 ppbv, respectively. In order to further validate the accuracy of the MLP model developed to predict the ozone concentration was observed to predicted values are shown in Figure 5 and 6 are in good agreement with the recording density, a graph of ozone, O3 represents a horizontal maximum taken by MLP mode is quite good.

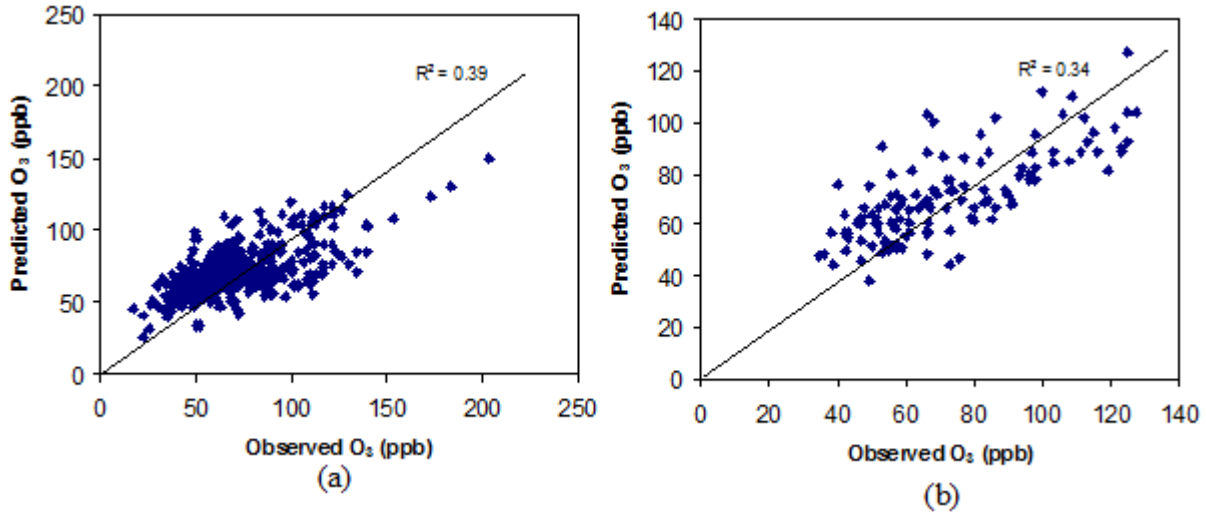

Figure 2: Scatter plots of observed versus predicted ozone levels of regression model.
(a) Training dataset; and (b) testing dataset.

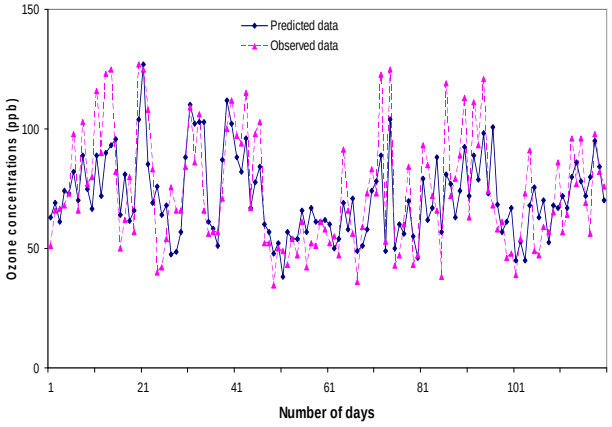

Figure 3: Comparison of observed and predicted ozone levels of regression model for the testing dataset.

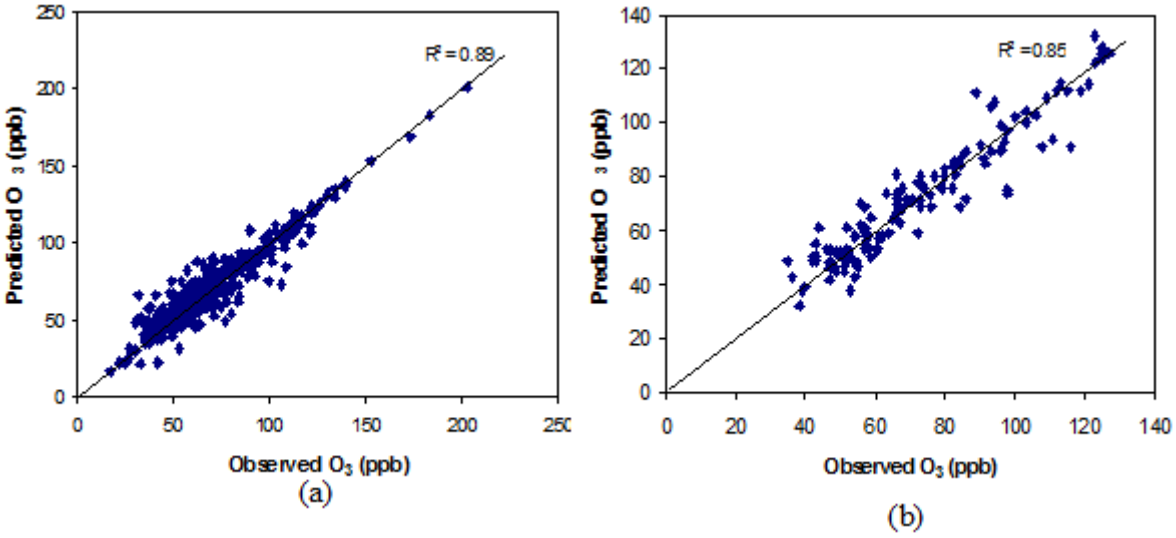

Figure 4: Scatter plots of observed versus predicted values of MLP model. (a) Training dataset; and (b) Testing dataset.

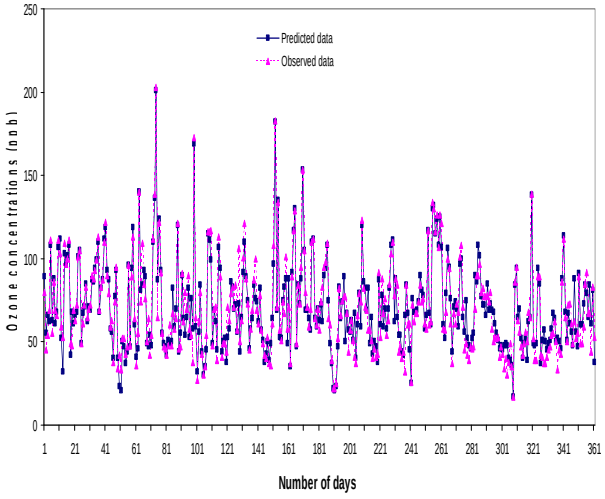

Figure 5: Comparison of observed and predicted ozone for the training dataset of the MLP model.

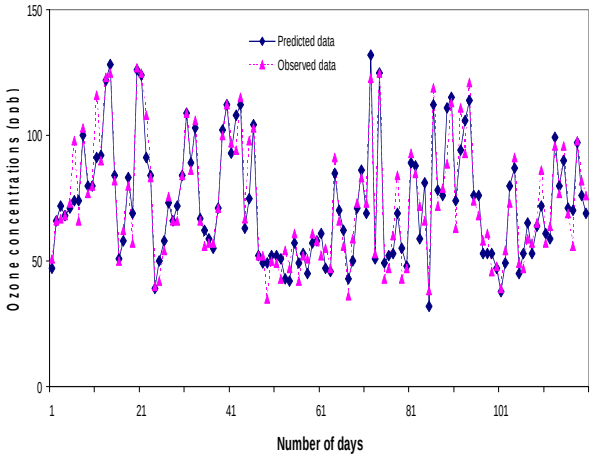

Figure 6: Comparison of observed and predicted ozone for the testing dataset of the MLP model.

Comparative analysis of the developed models

We examined the relative effectiveness of the models in predicting ozone levels using the testing data set. The performance of the developed models was evaluated using statistical indicators and graphical comparisons (Table 2 and Figure 7).

Table 2: Performance statistical indicators for the developed models

Indicators	MLP		LR	
	Training	Testing	Training	Testing
MAE (ppb)	8.64	10.26	16.91	16.42
RMSE (ppb)	11.84	13.53	21.4	22.42
R^2	0.89	0.85	0.39	0.34
d	0.92	0.89	0.74	0.68

It can be seen clearly under the best results for all of the statistical indicators of the MLP model. In terms of beauty and rms values, MLP model than the regression model for better performance datasets. Figure 6 shows a high concentration of ozone in the horizontal prediction is significantly worse linear regression model. The reason for this is undervalued is placed in question the regression coefficients, the use of "least squares" standard solutions. A direct consequence is that the LR model properties, such that the low level and a high value there is no difference. The purpose of regression analysis method is to simulate the "normal" to forecast the amount of variables (output), with respect to the behavior of air quality standards, the level of extreme O3 forecast is much more important from the point of a health standpoint. Despite the s trongly nonlinear, the MLP this phenomenon is given daily maximum 1 hour ozone AAQS pretty good predict 100 ppbv. In order to study the results of this study and previously published prediction model ozone compare artificial neural network, which is the most common manifestation of the three indicators, namely the United States, root mean square error and the coefficient of determination, R 2, is used. Table 3 shows the results of some selected published. Table 3 shows the neural network model range worldwide Bangkok results with similar studies reported results. Interesting to note that, in the study examined the neural network model similar performance, although the test cases were applied to different urban environments, in different weather conditions and at different time periods. The MLP model Bangkok urban development should take into account specifically for this area. While this is possible, it is impossible to extend this study to other websites accurate model, this method may be generalizable. With our specific data model another issue is the choice in this study is limited to the period 2000-2003, January 1 to April 30 of. This period is interesting because it represents the worst case ozone pollution in the Bangkok area. Seasonal factors in the model to minimize the impact of this choice. Therefore, it may not be appropriate for use of the model for the other seasons due to seasonal changes in ozone formation. Measuring prediction model developed in this study in the morning with the independent variables in predicting the day. Use the balance of the predicted value is not severely limited the effectiveness of the model to predict ozone levels in advance, because the model can be modified by using more alternative variables.

6. Conclusion

This paper describes the number between neurons and hidden nodes and connection weights before MLP model can be used to predict the hidden layer of MLP network through an iterative process using training data (learning) stage determined through statistical indicators of performance (see Annex details) training error measured error below. The initial values of the weights are randomly selected, and may be negative and positive values. In addition, the activation function used in the hidden layer and output layer is studied by the accuracy required to determine the problem. In this study, the learning algorithm used is Levenberg - Marquardt back-propagation neural network MATLAB toolbox. Sigmoid layer through logical and linear activation functions for the hidden layer to the output layer selected. They tried to hide layers and hidden neurons (nodes) and to systematically increase the number of checks each time, graphs obtained if the neural network performance and stability of yield errors preparation. The best MLP network was found most suitable for the iterative process. The MLP network trained model is used to model the performance of the test pattern 120 of the test data set. Predict the results obtained with the observed data for comparison, and calculate statistical performance indicators.

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