ARTIFICIAL NEURAL NETWORK BASED MODEL TO ESTIMATE PROFIT FOR SME'S

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ABSTRACT

The behavior of any company is complicated. This work aims at evaluation of financial performance for business specific company. Numerous financial indicators can be tabled, but bear sparing relation to output performance. Several efforts were made by scientists to bind input output parameters. Neural network is similar technique to grip input output binder. It handles any non-linearity with an ease. This work employs Artificial Neural Network based model to estimate profit using four independent parameters for SME. The output so obtained has less error, compared to Regression Analysis. Established relation permits to understand detailed intricate behavior of the sector and thereby analyze the criticality of parameters under consideration. It may be useful to Companies, Board Members, Stock Holders, and Entrepreneurs.

Keywords— Correlation coefficient, Neural networks, Back Propagation, Univariate Analysis

INTRODUCTION

All industries operate and achieve their goal by using a system in which a set of inputs are fed to achieve desired outputs over a period of time. There exists a relation between these input and output variables. Management can be aided with powerful decision making if a model establishing relation as well as criticality of these variables can be developed. Hence by addressing this very need a model has been devised for the given problem. At present SME's has been considered for study.

PROBLEM DEFINITION & OBJECTIVE FUNCTION

"To design a model which can establish a relationship between the inputs and output variables of an industrial sector (SME) in order to predict the output & analyze the influence of different input parameters, thereby establishing their critically and the length of influence of that particular parameter."

This project consists of an evaluation cum forecasting model which can establish a relationship between the input and output of an industrial sector. The model is based on the interrelationship of the inputs and outputs which would be studied as well as corrected to a considerable extent so as aid in predicting and analyzing performance of the industry. The model uses artificial neural networking to analyze and predict the future performance.

The model will enlighten the existing companies as well as the new entrants in the specified sector. An artificial neural network is a system based on the operation of biological neural networks which is an adaptive, most often nonlinear system that learns to perform a function (an input/output map) from data.

Correlation is used to justify input parameter selection for artificial neural network. These parameters are changed during operation, normally called training phase of the artificial neural network. After the training phase the artificial Neural Network parameters are fixed and the system is deployed to solve the problem at hand.
To perform Univariate analysis to find the most influential input parameter which affect the output.

AVAILABLE METHODS AND SELECTION OF BEST ALTERNATIVE

1. Regression Analysis
2. Artificial Neural Network (ANN) along with correlation

REASONS FOR SELECTING ANN AS THE BEST ALTERNATIVE

- Regression analysis is subject to considerable manipulation.
- The forecasted results obtained as error (difference between actual and obtained value) in the subsequent regression analysis were significantly high.
- A neural network can perform tasks that a linear program can not
- When an element of the neural network fails, it can continue without any problems by their parallel nature.
- A neural network learns and does not need to be reprogrammed.
- Back Propagation method has been found to be a strong forecasting tool and is in an advantageous position in comparison to Regression analysis [1].

LITERATURE REVIEW

Artificial Neural Network (ANN): Artificial neural networks are computer systems that can learn from the features of nervous system, derive new information using the new information learned, and work similarly to decision making structure. ANN has emerged as a result of mathematical modeling of the learning process by taking the human brain as an example [2]. As shown in figure2.1, the neural network processes a number of inputs to obtain a number of outputs. The input/output units behave similarly as in feed-forward networks i.e. the input units serve as buffers to distribute the signals without processing them, and, output units linearly sum the inputs from the preceding layer and have a linear activation function. The hidden units can have linear or non linear activation function [3].

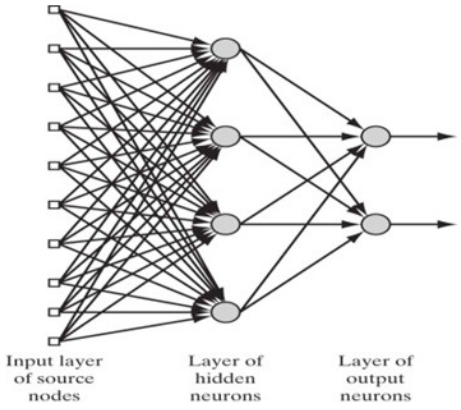

Fig.:2.1 Artificial Neural Networks

ANN along with "Correlation": Correlation is the most widely used method of measuring the degree of relationship between two variables [4]. Correlation is a statistical technique that can show whether and how strongly pairs of variables are related. The main result of a correlation is called the correlation coefficient.

The calculation of the correlation coefficient for two variables, say x_i and x_j, is given by

$$r(x_i, x_j) = \frac{n\sum x_i x_j - \sum x_i x_j}{\sqrt{n\sum x_i^2 - ¿¿¿¿¿}} \qquad (2.1)$$

where, n is the number of pairs of data.

There are many factors responsible for running an industry. But here a very genuine question arises that does each factor which plays a significant role in itself dependent on other factor or totally independent of each other. To prove that there exists some relationship between each factor, we need a mathematical tool. Correlation is that statistical tool which helps us to find a

definite relationship between a numbers of factors. Through correlation we come to know that how much a factor in the industry is dependent or what kind of relationship it possesses. Correlation coefficient is denoted by r which ranges from -1 to +1. If the value is near +1 or -1 then the factors are closely related. And if it is 0 then there is no relationship between variables [4]. Now, selection of least dependent variables needs to be done.

Back Propagation: Back propagation (BP) is the most popular training algorithm for multilayer Neural Networks [5]. Back propagation algorithm is popular for its simplicity of implementation and its ability to quickly generate networks that have the capacity to generalize [6].As the algorithm's name implies, the error (and therefore the learning) propagate backward from the output nodes to the inner nodes. The back propagation algorithm looks for the minimum of the error function in weight space using the method of gradient descent.

The combination of weights which minimizes the error function is considered to be a solution of the learning problem.

Since this method required computation of the gradient of the error function at each iteration step, the continuity and differentiability of the error function must be guaranteed. So technically speaking, back propagation is used to calculate the gradient of the network with respect to the network's modifiable weights. Neurons in the hidden layer are assumed to be sigmoidal and those in output layer are assumed as linear [7].

Multi Layer Perceptron (MLP) is a popular form of ANN. Moreover BP is a well-known gradient-based approach for training MLP [8]. It is very successfully used in many applications in various domains such as prediction, function approximation and classification. Mean Square Error (MSE) has been considered to obtain the optimal NN model among all the NN models developed. The mean square error (MSE) criterion is given by:

$$MSE = \frac{1}{2}[\sum_{p}\sum_{k}|t_{kp} - O_{kp}|^2] \qquad (2.2)$$

Where t_{kp} and O_{kp} are the true and observed outputs, respectively, for neurons k in the output layer when input vector x_p corresponding to the p^{th} training record is applied to the network. The root-mean square error (RMSE) also describes the average magnitude of the errors, given by

$$RMSE = MSE^{0.5} \qquad (2.3)$$

Since the errors are squared before they are averaged, more weight is given to large errors [9].

The output from neuron j in a given layer (other than the input layer) is calculated as:

$$O_j \text{¿} f\left(\sum_i W_{ij} O_i\right) \quad (2.4)$$

Where i indicate a neuron in the preceding layer and f(x) is the activation function for neuron j. The activation function is often a sigmoid function of the form:

$$f(x) = \frac{1}{1+e^{-x}} \quad (2.5)$$

With the gradient descent approach to error minimization, weights are changed in proportional to the error gradient, i.e.,

$$\Delta w_{ij} = \frac{-\partial E}{\partial W_{ij}} \quad (2.6)$$

Where η is a constant that determines the learning rate. To improve convergence characteristics, weight changes is given by (Park, Marks, Atlas, & Damborg, 1991):

$$\Delta W_{ij}(n) = \eta \delta_j O_i + \alpha \Delta W_{ij}(n-1) \quad (2.7)$$

Where η is the learning rate, α is the momentum factor, and δ_j is the error signal for the destination neuron j. When neuron j is the output layer,) δ_j is given by:

$$\delta_j = (t_j - O_j)\, O_j\, (1 - O_j). \quad (2.8)$$

When neuron j is in a hidden layer, δ_j is given by:

$$\delta_j = O_j\, (1 - O_j) \Sigma\, \delta_k\, W_{jk}, \quad (2.9)$$

Where k indicates neurons in the succeeding layer next to that containing neuron *j.* [10].

The learning rate and the momentum factor influence the speed and stability of network training [11]. The process continues until the error criterion on the training set is reduced below a specified limit.

Univariate Analysis: Univariate analysis is one of the methods for analyzing data on a single variable at a time. Univariate analysis explores each variable in the data set, separately. In this method we change only one variable at a time and seek to produce a sequence of improved approximation to the minimum point. The Univariate method is very simple and can be implemented easily. However, it will not converge rapidly to the optimum solution. Hence it will be better to stop the computation at some point near to the optimum point rather than trying to find precise optimum point [12].

METHODOLOGY

Algorithm

- Draw 21*13 (m*n) matrix of datasets.
- 21 common parameters are financial ratio or any other parameter, taken from n Financial Years audited accounts of few companies belonging to the sector under consideration.
- In the proposed model we have utilized the following inputs for calculation:
- Share Capital
- Reserve & Surplus
- Secured Loans
- Unsecured Loans
- Fixed Assets
- Current Assets
- Current Liabilities
- Pre Operating Expenses
- Sales
- Closing Stock
- Opening Stock
- Purchases
- Freight Inwards
- Gross Profit
- Other Income
- Administrative expenses
- Depreciation
- Profit before tax
- Tax
- GST
- Net Profit
- Net Profit has been selected as the output of the network.
- Apply Correlation for selection of independent variable. To know that inputs taken are how much dependent on each other and to also find the least dependent i.e.

independent variable. Correlation gives the dependency as correlation factor r of x and y inputs).

- Do the selection of the most independent variable which will be further taken as inputs for the neural network.
- Set the network parameters.
- Input the data from file and set input and output parameter.
- Find out the minimum and maximum of each row and column.
- Compute scale value. It is calculated to bring all values between 0 and 1.
- $Scaled\,value\,(SV) = \frac{Original\,value - min\,value}{Max\,value - min\,value}$
- Assign threshold and weights using random numbers.
- Compute prevailing value of each cell using prevailing value of previous cell.
- Repeat this step for all inputs.
- Compute error (RSME). Check whether it is in the permissible limits or not.
- If the error is in acceptable limits then calculate threshold and weights for each cell and set the network parameters.
- Else adjust the threshold and weight by back propagation technique in which we find a learning factor through error and which helps us in assigning new weights and values and this step is carried out till we achieves a permissible error. And after that set the network parameters and network is ready to use.

HOW TO APPLY UNIVARIATE?

- Suppose there are four input parameters.
- Keeping any three inputs constant we test single input parameter by increasing the input value and record the changes in output.
- The input variable having greatest effect on the output will prove out to be the most influential parameter.

Deciding Network Topology: Using more number of layers will help the network learn faster. Place 2 neurons in each layer and train the network and test for the performance. Increase the number of neurons in a layer and train the network again till satisfactory performance. This systematic procedure helps to obtain an optimal NN architecture [13].

Steps involved in Univariate Analysis: Determining the most influential input parameter

Step 1: The value of 1st input parameter is increased by 1 keeping other parameter constant i.e. maintaining their original values and the output is calculated.

Step 2: The value of 2nd input parameter is increased by 1 keeping other parameter constant i.e. maintaining their original values and the output is calculated.

Step 3: The value of 3rd input parameter is increased by 1 keeping other parameter constant i.e. maintaining their original values and the output is calculated.

Step 4: The value of 4th input parameter is increased by 1 keeping other parameter constant i.e. maintaining their original values and the output is calculated.

Step 5: The output values which is calculated in the previous steps (step1-4) is then compared and the input parameter giving maximum output value is considered as the most influential parameter.

RESULT & CONCLUSION

Most of the available prediction techniques are generally based on assumptions, this model is not based on assumption but based on supervised learning using back propagation algorithm, thereby enhancing its applicability and accuracy. The model learns from the existing and past situations, adjusts itself accordingly & make required change which helps in a most accurate prediction of the parameter under consideration.

The model will help each and every organization to understand the sensitivity, criticality and limits of variation of each parameter, which will help the management to earn more profits and reduce their losses.

SCOPE OF FUTURE WORK

- The model can be fine tuned by establishing sensitivity relationship between the input & output.
- The predictive capability of the model can be enhanced by analyzing each and every aspects of the sector.
- One of the most obvious extensions is to extend our selected application domain to include mix input. The idea is to use certain inputs as groups.
- This simplified approach can be further extended to replace the lower level system with fuzzy systems or rule based system i.e. simplified neural fuzzy systems.

- There are many other types of activation functions available for use in hidden layer, the simplified Neural Network approach can therefore be investigated with other activation functions.
- Some powerful, stochastic optimization methods such as simulated annealing and genetic algorithms, which can overcome the local minima, can be used.
- In addition to that, there are many learning algorithms available in Matlab for experimentation and evaluation purposes e.g. Gradient Descent Learning with Momentum, etc. can be used.

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