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EFFICACY OF ARTIFICIAL NEURAL NETWORK FOR FINANCIAL LITERACY PREDICTION

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Abstract: *Financial forecasting is becoming more and more dependent on advanced computer techniques due to high non-linearity and high volatility nature of finance domains. An Artificial Neural Network (ANN) is the current technique being used that can model flexible linear or non-linear relationship among variables and predict financial data more accurately. Financial Literacy (FL) is a combination of attitude, knowledge, skill and behavior to achieve desired financial goals. FL shows non linear dependencies on various socio demographic attributes which are in turn responsible for FL level of an individual. This paper brings neural networks applications in the financial domain. An attempt has been made in this research work to analyze the usefulness of artificial neural network for predicting FL level of individuals. The classification accuracy of 75% has been achieved through MLPNN that can help in knowing the efficacy of demographic determinants. The studies done in this work show that neural network have great promise for financial applications.*

Keywords: *Financial Literacy; Artificial Neural network; Sensitivity; ROC.*

1. INTRODUCTION

Financial literacy is the knowledge regarding personal financial matters. Financial literacy enables individuals to handle their personal finances effectively and efficiently [1]. Thus financially literate individuals feel more satisfied and confident in decisions relating to money matters. The ability to handle personal finances is must as it helps in achieving individuals financial well being. Financial literacy has gained much importance in the recent past on account of changing financial landscape. These days many new innovative financial products are available in the market as investment options. Most individuals are not willing to invest in such products due to lack of knowledge regarding such products. More chances of getting

misled on financial matters also increase if an individual is not financially literate. Thus minimum acceptable level of FL is necessary for individuals. Past research has pointed out that level of FL is low across the world. Thus the need of the hour is to improve the level of financial literacy across the world. The level of FL can be increased by way of imparting financial education to the population. Financial education programs are effective only if it becomes clear which section of population are the most financially illiterate [2]. The prediction regarding the level of FL which we can make from this model can help policy makers, academicians and researchers to identify the target population with low levels of FL. Accordingly, financial education programs can be targeted to those sections of population which are identified as being financially illiterate.

Authors in [3] have measured the financial literacy level of salaried individuals in India. They studied the determinants of FL. Their results showed that level of FL gets affected by gender, education, income, nature of employment and place of work whereas it does not get affected by age and geographic region. The model used in this paper also considers the socio-demographic variables which are used by authors in [3].

Recently, computer technologies have gain popularity and prominence as a potential tool in solving problems related to finance. One of the contemporary methods is Artificial Neural Networks (ANNs) that are good at classification, forecasting and recognition which make them good candidates for financial forecasting and for decision making process [4]. An ANN has to be trained and then tested such that the application of a set of inputs produces the desired set of outputs. Training involves feeding of teaching patterns to the network and defining a learning rule with a set of desired responses. A forward pass is done, and the errors or discrepancies between the desired and actual response for each node in the output layer are found [5]. These networks have self-learning capability and are fault-tolerant as well as noise immune.

In literature, several studies have been conducted who emphasize the Nonlinear Model proving to be more effective for finance forecasting. For this reason, ANN applications have been widely used in a variety of areas in financial markets. Authors in [6] have examined the current trends of applications of neural networks in finance. They have exhaustively compared the common characteristics of these applications with applications based on statistical and econometrics models.

This paper presents the use of machine learning in predicting the level off FL possessed by an individual based on demographic and socio-economic factors. To predict the level of FL, an Artificial Intelligence Model was implemented using ANN.

The rest of the paper is organized as follows. Section 2 describes the methodology adopted and includes a description of the procedure used to frame the demographic attributes random samples. Section 3 presents empirical results, the performance achieved and discussion of these results followed by conclusion in Section 4.

2. METHODOLOGY

The development of Financial Literacy Prediction (FLP) model is a two stage prediction system. The first stage is feature extraction and selection and second stage comprises of prediction technique, employing Artificial Neural network model. The flow diagram of the proposed methodology is depicted in Figure 1.

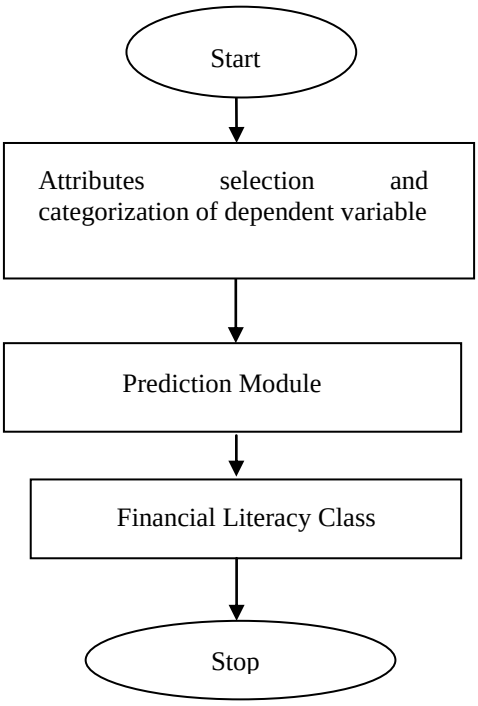

Fig 1. The structural flow diagram of the proposed FLP model

Dataset

For carrying out this study, primary data was collected with the help of a questionnaire. The questionnaire was divided into two parts. First part collected personal information of the respondents relating to various socio-demographic factors. The second part consists of multiple choice questions in order to check the FL level of respondents. The study was confined to the state of Himachal Pradesh. Due to large geographic area, multistage sampling

has been used. The population of the study was salaried individuals working in the state of Himachal Pradesh. There are total of twelve districts in Himachal Pradesh out of which three districts were selected randomly. Further two sub-divisions from each selected districts were selected randomly. Finally respondents from these sub-divisions have been selected conveniently so that sample is representative of the population. The sample size of 516 is used for this study.

Respondents were asked thirteen multiple choice questions in various areas of risk, return, savings and investments, borrowings and financial planning. Based on the correct answers, FL score was calculated for each respondent. We have created a dichotomous dependent variable and named it as Financial Literacy Level. The respondents whose scores were either equal to or below the median score, were put in one category labeled as low financial literacy. The respondents whose scores were more than the median value were put in another category labeled as high financial literacy. The methodology adopted for creating the database for the research work is depicted in Fig. 2.

3. RESULTS AND DISCUSSION

Model Selection

Structure of the neural network and network configuration depends on the number of hidden layers, number of neurons in each hidden layer, number of input neurons and the selection of activation function. The architecture of ANN is mostly problem dependent.

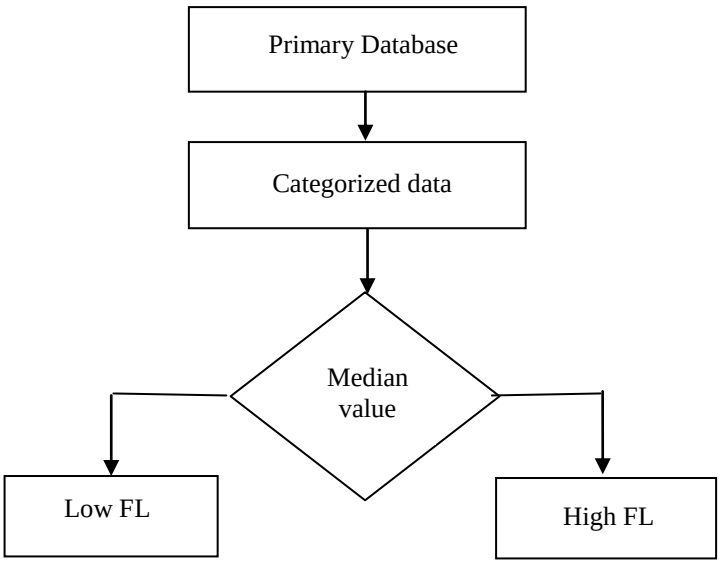

Fig 2. The flow diagram for categorizing FL score

Neural networks are capable of solving complex and non linear problems by learning and by being trained. Networks learn by getting exposed significant features of difficult problem. The best model was constructed after trying different topologies and different parameter settings, as there are no hard and fast rules in determining the best ANN architecture [7].

The FLPNN model consist of an ANN with set of attributes selected in the datset as the input, one hidden layer with eight hidden neurons, and two output neuron. The activation function chosen is hyperbolic tangent function in the hidden layer and softmax in the output layer. The error function employed at the output layer is cross-entropy. In total 516 samples of population were taken, out of which 71 % of the samples (= 367 people) were used for training the Neural network and remaining 29% samples (= 149 persons) data were used for testing the network using bootstrapping method with 1000 seed points. No samples were excluded and none of them were missing. The learning rate of 0.07 is chosen after testing the net with values ranging from 0 to 1, as small values of learning rates are always preferable. The graphical representation of the FLP neural network is depicted in Fig. 3 on the last page because of space constraint.

Performance Metrics

A set of performance metrics is used to provide a more detail analysis of the prediction model. Sensitivity, Selectivity and Accuracy, are the three key parameters used for the performance evaluation and validity of the proposed method [8]. These values are tabulated in the form of confusion matrix. The values obtained for this model are summarized in Table 1.

$$Specificity = \frac{TrueNegative}{TrueNegative + FalsePositive}$$

$$Sensitivity = \frac{TruePositive}{TruePositive + FalseNegative}$$

$$Accuracy = \frac{TrueNegative + TruePositive}{All}$$

Confusion matrix is tabular description of classification of cases in the test dataset. In confusion matrix, the columns denote the actual cases and the rows denote the predicted class. Both the sensitivity and specificity measure classification accuracy against the ground truth diagnosis and are defined by Sensitivity is an assessment of the two upper quadrants

while specificity is represented in the lower two quadrants. They are both bounced between 0 and 100%, and higher values indicated better accuracy. FLPNN succeeded in predicting Financial Literacy of individuals based on various socio demographic attributes. with the total accuracy of 75%. The empirical results show that proposed FLP model exhibits good sensitivity and specificity.

ROC curve

ROC curve is graphical representation of classification of test cases. It represents all the cases, actual and predicted on the plots with sensitivity (true positive rate) represented on the Y-axis and (1-specificity) (false positive rate) on X-axis. Area under the ROC curve is preferred to evaluate the performance of a classifier and its value lies between 0 and 1. The classifier has a perfect discriminating ability if area of the ROC curve is 1, and classifier is unable to discriminate between two classes if area under the curve is 0.5[9]. The ROC curve obtained for FLP model using ANN is plotted shown in Fig 4. Area unnder ROC curve is 80% which is an indicator of good discrimination capability of FLPNN model.

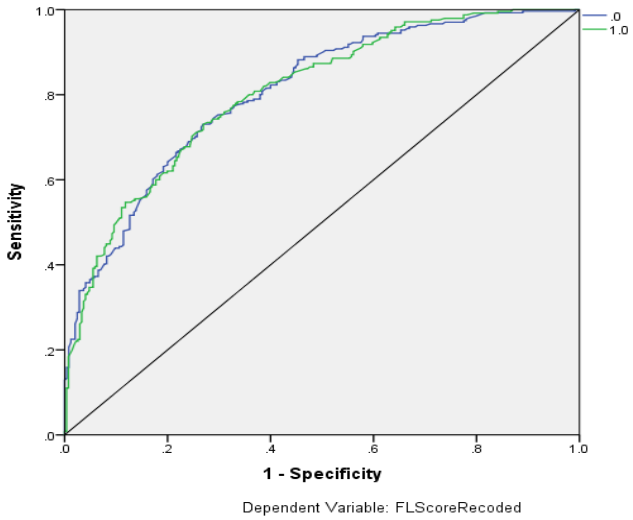

Fig 4. ROC curve of the FLP neural network model

Table 1. Confusion Matrix for classification

Sample	Observed FL	Predicted FL		
		0	1	Percent Correct
Training	0	134	65	67.3%
	1	41	127	75.6%
	Overall Percent	47.7%	52.3%	71.1%
Testing	0	56	16	77.8%
	1	21	56	72.7%
	Overall Percent	51.7%	48.3%	75.2%

CONCLUSION

It is almost impossible to do an exhaustive search for the best ANN model to be conclusive. The objective of this work is to design and implement an automatic prediction system of financial literacy level of individuals based on various demographic and socioeconomic factors. The authors have laid emphasis on selection of relevant attributes those are less related, balanced and converge to best solution. Authors have analyzed the applications of neural networks in finance and have concluded that neural networks have the capability of forecasting financial performance at the least cost. The uniqueness of the proposed methodology is that given the characteristics of various socio-demographic variables we are able to predict the level of financial literacy of individuals. The results obtained are clear indicators of the great potential of neural networks in the areas of finance.

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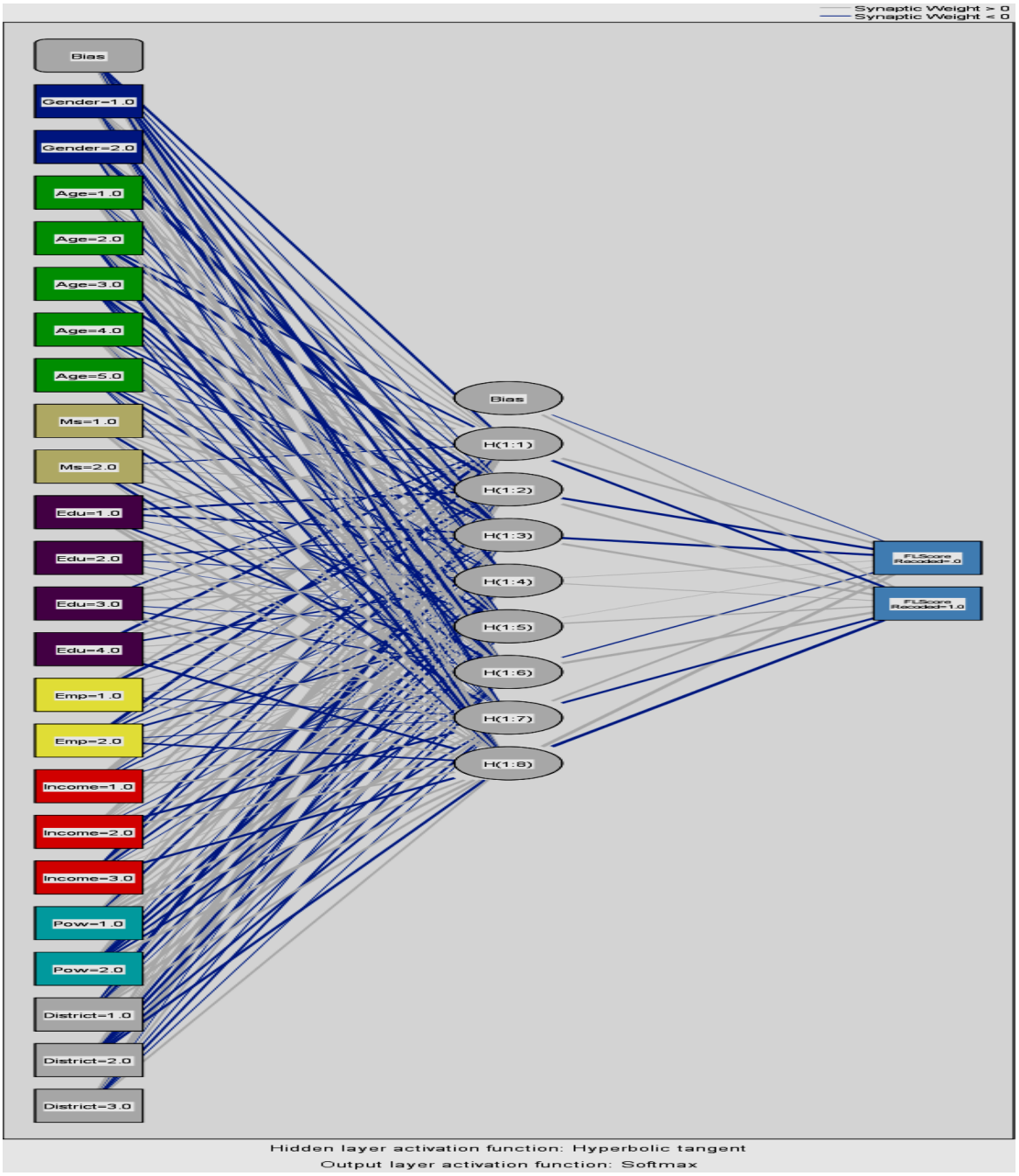

Fig. 3: FLP neural network architecture