2018 International Conference on Computing, Power and Communication Technologies (GUCON)
Galgotias University, Greater Noida, UP, India. Sep 28-29, 2018

A Comparison Study between ANN and ANFIS for the Prediction of Employee Turnover in an Organization

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***Abstract*—The purpose of this work is to investigate the employee characteristics and various organizational variables that may result in Employee Turnover. Product innovations and corresponding product variables can be duplicated, but the harmony of an organization's employees can never be replicated, hence they are of utmost importance. Due to this reason, an organization's success and long term growth depends not only on recruiting the new talent but also retaining them. This study will help in explaining what factors make the employees leave. Predicting Employee Turnover may help us in identifying the at-risk employees that have to be retained in the organization, by further facilitating us to be focused on their specific needs or concerns. Two classification methods that were used for the comparison of the prediction accuracy and generalization capabilities are, Artificial Neural Network (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS).**

Index Terms— ANN, ANFIS, MATLAB, Employee Turnover

I. INTRODUCTION

Nowadays, Employee Turnover is one of the most vital problems confronted by the organizations because of its negative effects on organization's productivity, disturbances in project approval, stability and extended term progress plans. One way of dealing with this situation is by finding, when an employee may leave the organization, and for that purpose intelligent computational techniques like ANN, ANFIS provide organization leaders necessary foresight to take prior steps for retention of their workforce.

ANN and ANFIS are capable of modelling superiority of human knowledge features without wasting too much time in analysis which is the reason these techniques are attracting great deal of attention worldwide. Here, the models are categorized by non-random uncertainties which is linked with vagueness and subtlety in real-time systems. Most of the problems above outlined can be easily solved by neural networks as stated by many reputed researchers. The theory of fuzzy sets is also capable of solving problems with uncertainty like neural networks [1]. However, the application of artificial neural network is limited because of its hidden knowledge representation, the excessive computational work, time etc. The main advantage of fuzzy logic system is its explicit representation of the knowledge by using IF-THEN rules. However, this benefit is also somewhat of a limitation for it [2]. The Employee Turnover prediction because of being dependent on many unknown parameters cannot be easily described by simple networks. The incorporation of ANN and fuzzy logic makes it possible for a fuzzy system to learn and pick up patterns from the previous recorded data set. The goal of this research is to check application of both ANN, ANFIS models for the prediction of Employee Turnover in an Organization and to recognise the technique which stands the best for the chosen dataset.

II. LITERATURE REVIEW

One way of interpreting Employee Turnover is a departure of intellectual capital from the organization [3]. While calculating an organisation's turnover rate often referred as Attrition Rate, one should determine what sort of separation will be included for the calculation purpose. Unavoidable separations like, retirement, demise, permanent disability, or a spouse changing jobs to a different region should not be included for the calculation as these are not the same as voluntary separations in which the organisation have a role to play in retaining the employee.

Keeping Employee Turnover under control is a challenging task for the Managers. Firstly, they may have difficulty accepting the very fact that employee turnover exists within their organization premises. However, managers who don't have such qualms can certainly make a difference by identifying the main causes, understanding the situation, and finding possible solutions to avoid the employee turnover [4] [5]. Despite not having any concrete framework to tackle the problem of employee turnover, we can follow a set of rules which involves various factors which helps in the interpretation of Employee Turnover.

High Employee Turnover has some damaging effects on an organization like negative impact on ongoing projects, work and overall productivity of organisation. There are many costs related to acquiring new employees as replacement, like employing costs, training costs etc. Since, new employees due to inexperience, will be looking to enhance their own learning curves and to achieve the satisfactory levels of technical and business proficiency as an experienced employee [3].

Table I below gives in brief the related work for employee turnover prediction by using various machine learning techniques: -

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TABLE I. EMPLOYEE TURNOVER PREDICTION

Authors	Objective	Techniques used	Recommended Technique
"Jantan, Hamdan and Othman [6]"	"Data Mining techniques for performance prediction of employees".	"C4.5 decision tree, Random Forest, Multilayer Perceptron(MLP) and Radial Basic Function Network".	"C4.5 decision tree"
"Hong, Wei and Chen [7]"	"Feasibility of applying the Logit and Probit models to employee voluntary Turnover predictions".	"Logistic regression model (logit), probability regression model (probit)".	"Logistic regression model (logit)"
"Marjorie Laura KaneSellers [8]"	"To explore various personal, as well as work variables impacting employee voluntary turnover".	"Binomial logit regression".	"Binomial logit regression"
"Saradhi and Palshikar [9]"	"To Compare data mining techniques for redicting employee churn".	"Naïve Bayes, Support Vector Machines, Logistic Regression, Decision Trees and Random Forests".	"Support Vector Machines"

III. METHODOLOGY

A. ANNs

A customized neural network system is used in this study. After a network has been trained, it starts to interpret the testing information. Many algorithms exist for training artificial neural network, amongst which Back-Propagation Algorithm (BPA) is the ultimate flexible, robust, and widely used technique as it offers the effective way of learning the multi-layer neural nets. BPA is especially capable of solving problems related to prediction, which makes them very useful.

During the training of a network, data is processed through it until it reaches the layer where the final output is generated output layer. Here, the output of the network is checked against the recorded value. The error between the computed and the recorded value is processed back through the network by using BPA and connection's weights between the neurons and the biases of the each neurons are updated accordingly. The process stated here is continued for every training example from the data set. Once the error has converged to a sufficient minimum as dictated by the cost functions, the Root Mean Squared Error (RMSE), Mean Squared Error (MSE), etc., the training is stopped.

This customized neural network is used for predicting Employee Turnover. A number of 5,000 training data example and 10 testing data examples were used for training and testing the network respectively. Out of the different configurations tested, a suitable configuration was chosen, consisting of two hidden layers, with 25 and 50 hidden neurons respectively. The logistic sigmoidal function was chosen as the activation function for the network.

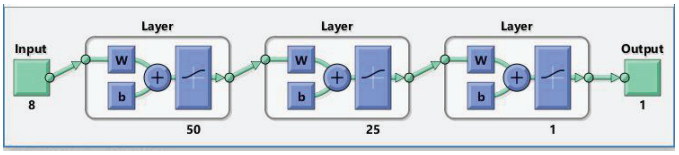

Fig. 1. ANN Structure

B. ANFIS

Adaptive Neuro-Fuzzy Inference System was first proposed by JSR Jang. An algorithm based on neural network theory is used to train this fuzzy system. This algorithm is hybrid mix of back propagation and the least squares method. BPA defines the parameters which govern the shape of MFs (MFs) and the consequent parameters of the MFs are defined by least square approach. The structure of ANFIS is denoted by a different three- layered feed forward neural network in which layers corresponds to Input variables, Fuzzy Rules and Output respectively.

According to conventional theory of Fuzzy Inference System (FIS), the number of rules is defined by someone with the expertise in the target system to be modelled. As in simulation, no expert is required and the total number of MFs allotted to every input variable is decided by using an algorithm. As for data sets having four or more inputs, one has to heavily rely on trial and error as visualization techniques are inefficient. Generally, it becomes cumbersome for the user to describe the rules for reaching the precision required with the minimum number of MFs. For this purpose, a computerised model identification method realized by training set of input-output pairs, is essential, [10], [11], [12].

The subtractive clustering algorithm is a versatile approach for the creation of ANFIS networks, which estimates the cluster number and its corresponding location. In this algorithm, every sample point is visualised as a potential cluster centre. Therefore, computation time in this method becomes linearly proportional to size of the data, but is not dependent of the dimension problem under consideration [11], [12], [13].

The input data used for Employee turnover prediction are the different employee characteristics and this data is acquired by **Kaggle**, an open source dataset platform. Size of this data set is 5,000 which was normalized to avoid overfitting of the data. Furthermore, 10 data points were taken for prediction.

IV. ANALYSIS METHODS FOR THE TECHNIQUES USED

A. ANFIS

The following steps have to be carried out for the purpose of generating membership functions: -

- Compute the input data to be clusters.
- Set the variable values of minimum data value, maximum data value, accept ratio, reject ratio and quash factor.
- Set the normal data value based on minimum and maximum data value.
- Set the potential of each data point.
- Set the maximum potential of the data.
- Set cluster centre and update the potential value that corresponds to another data.

- Employ the real data into the model.
- Set the cluster sigma.
- Return the membership values

After the membership functions are generated fuzzification and defuzzification processes are carried out to generate output.

Fuzzification consists of a transformation in which crisp inputs are converted into fuzzy inputs. Crisp inputs may be defined as the exact numerical values which are measured physically or being recorded whereas fuzzy input represents the extent of agreement to a particular variable and it generally ranges from '0' to '1'.

Defuzzification consists of changing the fuzzy outputs back to crisp outputs for easier observation.

B. ANN

A simple neural network architecture for this study can be represented as shown below:-

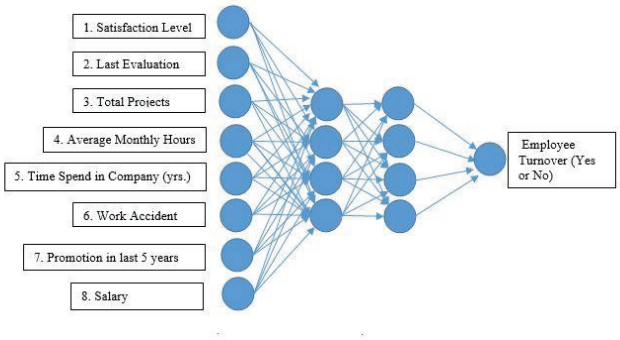

Fig. 2. ANN basic Architecture

The linkages in the network are the most crucial findings and they are called weights of the linkages.

Following is the working method of artificial-neural networks.

- At the start of the algorithm random weights are assigned to the linkages.
- Using inputs and linkages the neural network output is determined from the the transfer functions of the nodes.
- The error between this output an the actual target is calculated, this error is minimised by using an algorithm for determning the change of weights required.
- The new calculated weights are assigned to the network and the network results are again calculated.
- Again the error is calculated and the weights are optimised using certain algorithm, and the process is repeated until minimum error is reached.

V. COMPARISON BETWEEN THE ANN AND ANFIS MODELS

This section includes outcomes from the concerned models which would be used to access and make comparison between the prediction accuracy as well the generalization capabilities of the two techniques. The datasets for training and testing of networks were kept same so that more accurate results and solid conclusion can be extracted.

Mean square error (MAE), root mean square error (RMSE) were calculated according to the corresponding recorded data. Analysis of unseen data clearly shows that ANN model is better for the purpose of prediction of Employee turnover than ANFIS, which is shown in further discussion.

VI. CONCLUSION AND FUTURE SCOPE

In this work we have represented the capability of ANN and the ANFIS in predicting the employee turnover and potential candidates who may leave the firm.

TABLE II. SIDE BY SIDE COMPARISON OF THE NETWORK DESIGN OF THE MODELS USED

ANN model		**ANFIS model (Subtractive Clustering)**	
No. of total layers	3	Inference Radius	0.85
No. of hidden layers	2	Initial Step Size	0.001
No. of neurons in input layers	8	Step Size Decrease Rate	0.9
No. of neurons in hidden layers	25 , 50	Step Size Increase Rate	1.1
No. of epochs	1000	No. of epochs	200
Error goal	0.01	Error goal	0.01

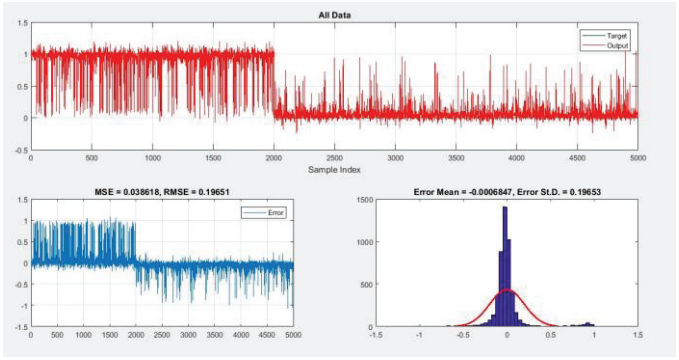

Fig. 3 Training Results for ANFIS

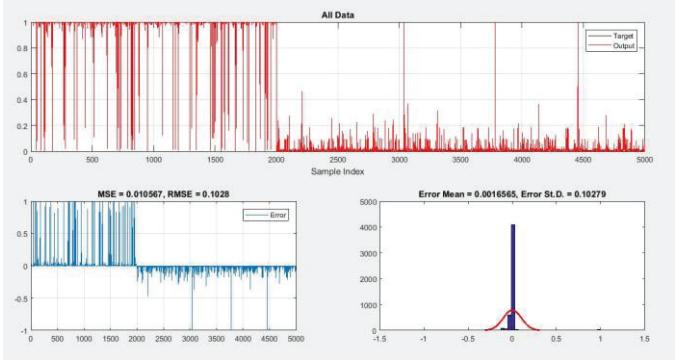

Fig. 4 Training Results for ANN

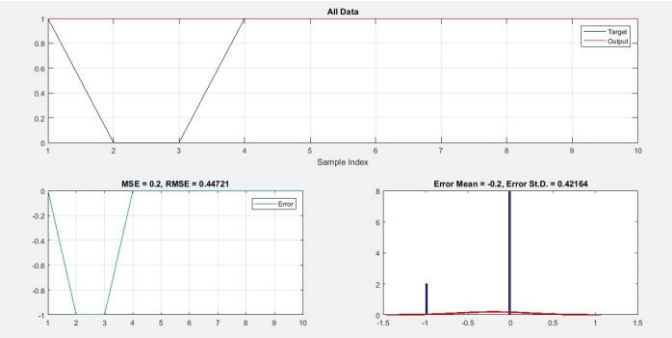

Fig. 5 ANN on unseen data

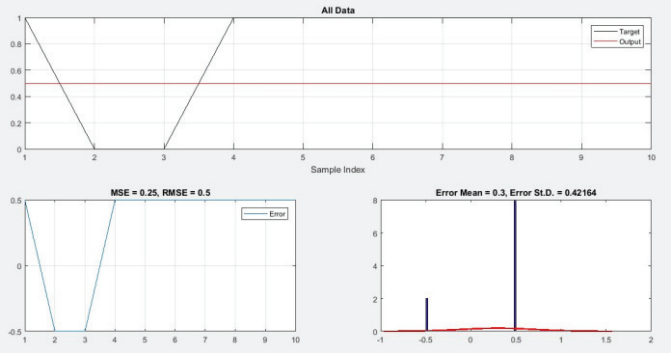

Fig. 6 ANFIS on unseen data

The results display that the RMSE, MSE for the training dataset were 0.10, 0.01 for the ANN model, and 0.19, 0.03 for the ANFIS model. As for unseen data, the RMSE, MSE were 0.4, 0.23 for the ANN and 0.5, 0.25 for the ANFIS model. The sensitivity of ANN model was found to be more than the ANFIS model on the training and unseen data set and is performing better for the same. Therefore, we can conclude that ANN model is much better at fitting the output than the ANFIS model for the unseen data set. Thus in generality ANN is better than ANFIS . It was therefore chosen as the technique for the purpose of developing the prediction model.

For further studies in this subject, the authors suggest to capture the data publicly available and to extract the features and train our models. The application of deep learning models in such case studies is also recommended. There are many other techniques being used for making prediction models but they cannot adapt quite well like these two models.

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