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# A COMPARATIVE STUDY ON BACK-PROPAGATION NETWORK AND ART NETWORK FOR PREDICTION OF STUDENTS' PERFORMANCE

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Abstract :Nowadays in the academic field it is very important to keep a check on performance of the students. By doing so the authorities can better the results of their institutes and also by knowing the capacity and performance of a student in prior, they can provide them help required for their upcoming exams and make them able to achieve the high goals. Here, in our model we are going to present a comparison study on Feed forward Back propagation network and ART network. The factors considered as relevant to student achievements were the marks of various standards, their travel time, study time etc., which were used as input variables to an ANN. Two models were prepared using Feed forward Back propagation network and ART network and trained using the collected data of students. The output obtained from both the networks will be in the form of graphs and accuracy. Implementation of such user friendly software tool makes it easy for the user to classify and distinguish the students with low capabilities and achievements.

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## Introduction

A huge expansion in the field of education has been seen in the recent times. Students, their parents and the educational institute authorities have become extremely concerned about the results and performance of the students during their academic years. More and more new technologies have been developed which help students in their academic years to achieve good results.

Here we are going to prepare a comparison study between two predictive analysis models which will predict the future performance of students based on their past records and let their guardians know about their progress in the academics. Knowing the progress well in advance the students can better their results if it is not up to the mark and their institutes can help them in achieving the desired results by providing additional support such as additional learning activities, resources and learning tasks. By doing so even the institutes will be benefitted as their institute will be considered as the one providing good education to the students. The use of Artificial Neural Networks has been increased in the recent times as it is very much helpful for such predictive analysis. We are going to take the help of ANN for preparing our analysis models. ANN will be extensively used in our model.

The datasets taken to prepare the models will be trained by the neural nets so as to give us the desired output. The output that we desire will have an acceptable accuracy so as to successfully complete our model.

The main purpose of our project is to help the students struggling with their academics. If we provide them such a tool by which they can improve their performance in their academics then it would be beneficial for them, their institute as well as our country. At the end they are the bright future of our glorious country and if they will educate themselves in the best possible way with the best available resources and facilities then our country will also prosper day and night.

The data of various students from the college will be taken and a dataset will be formed with those data. The data of the students will consist of their $10^{th}$, $12^{th}$ and JEE marks, also their study time, travel time and education of their parents, extra-curricular activities, employment and addiction. Taking these data and processing them with the help of feed forward back propagation algorithm, we will receive a graph as output which has to be accurate enough and should be very precise. As it is a comparison study, the same dataset will be used to train and analyze using ART network. The output obtained from both the techniques will be compared and the best out of the both will be obtained

## Study Objectives

The objectives of this study are: 1) to determine some suitable factors that affect a student's performance, 2) to transform these factors into forms suitable for an adaptive system coding, 3) to model an Artificial neural network that can be used to predict students' performance based some data for a given student, 4) to help the students to improve their results after prediction.

## Background

Artificial Neural Network: Computer science and other research disciplines extensively use neural networks as a computational approach which is based on a large collection of artificial neurons. An Artificial Neural Network (ANN) is an information processing paradigm that is similar to biological nervous systems. It is composed of a large

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number of highly interconnected processing elements called neurons. An ANN is configured for a specific application, such as pattern recognition or data classification. Each neural unit is connected with many other units. Its links can be responsible for the specific effect on the activation state of connected neural units. Each individual unit has a summation function which combines the values of all its inputs together. These systems are self-learning and trained. They are not explicitly programmed and they excel in areas where there is a difficulty in expressing it in a traditional computer program.

## Feed forward Neural Network:

A feed forward neural network is an artificial neural network. Here, the connections between the neurons do not form a cycle. The first and simplest type of artificial neural network devised was the feed forward neural network. The information in this network moves in only one direction. It moves only forward from the input nodes, through the hidden nodes and to the output nodes. No cycles or loops are formed in the network.

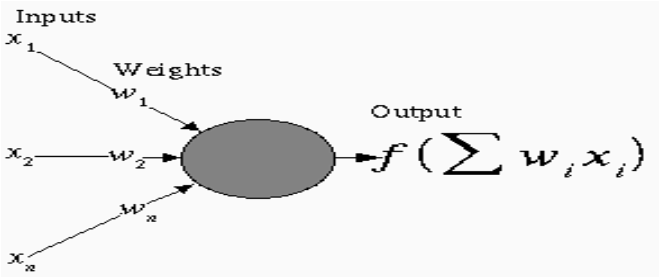


Fig.1 Feed forward Neural Network

## Back Propagation Network:

As the name suggests, the errors propagate backwards from the output nodes to input nodes through inner layers. It is used to calculate gradient of the error of the network according to its weights. The input layer is connected to the hidden layer and the output layer is connected to the output layer through weights. More the number of hidden layers more is the complexity of the network. As a result, time taken to compute the errors may be high.

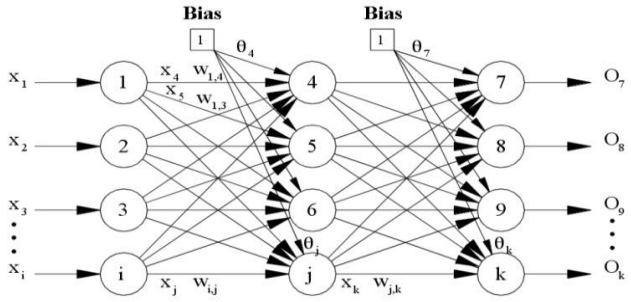


*Fig.2 Back Propagation Network*

| | | |
|---|---|---|
| 1. $\frac{\partial E}{\partial w_{ij}} = \delta_j * x_i$ | for all weights and biases |
| 2. $o_j' = o_j * (1 - o_j)$ | for output layer nodes using softmax |
| 3. $\varphi_j' = (1 - \varphi_j) * (1 + \varphi_j)$ | for hidden layer nodes using tanh |
| 4. $\varphi_j' = \varphi_j * (1 - \varphi_j)$ | for hidden layer nodes using logistic sigmoid |
| 5. $e_j = (o_j - t_j)$ | for hidden and output layer nodes |
| 6. $\delta_j = e_j * o_j'$ | if $j$ is an output node |
| 7. $\delta_j = (\sum \delta_j w_j) * \varphi_j'$ | if $j$ is a hidden node |
| 8. $\Delta w_{ij} = \alpha * \frac{\partial E}{\partial w_{ij}}$ | delta for all weights and biases |
| 9. $w_{ij}' = w_{ij} + \Delta w_{ij}$ | update for all weights and biases |

Fig.3 Feed forward Neural Network

## ART Network:

Adaptive Resonance Theory, or ART, is a cognitive and neural theory of how the brain independently learns to attend, categorize, recognize, and predict objects and events in a changing world. ART currently has the wide explanatory and predictive range of available cognitive and neural theories. Central to ART's predictive power is its ability to autonomously carry out fast, incremental, unsupervised and supervised learning in response to a changing world, without erasing previously learned memories.

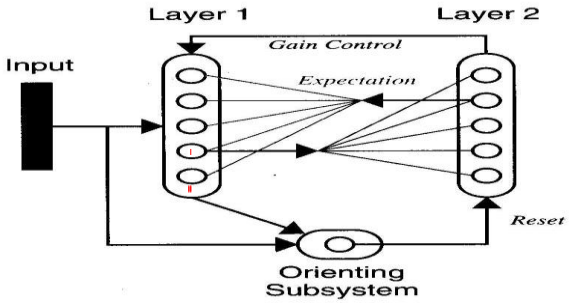


*Fig.4 ART Network*

The basic ART system is unsupervised learning model. It typically consists of a comparison field and a recognition field composed of neurons, a vigilance parameter, and a reset module.

# Methodology

## Input Variables

| Sr. No | Input Parameters | Domain | Class |
|---|---|---|---|
| 1 | SSC & HSC marks | (100-90) | 10 |
| | | (89-80) | 9 |
| | | (79-70) | 8 |
| | | (69-60) | 7 |
| | | (59-50) | 6 |
| | | (49-40) | 5 |
| | | (39-30) | 4 |

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| | | | |
|---|---|---|---|
| | | (29-20) | 3 |
| 2 | JEE marks | (360-240)<br>(239-180)<br>(179-120)<br>(119-60)<br>(< 60) | 5<br>4<br>3<br>2<br>1 |
| 3 | Study Time | (8-10)<br>(6-8)<br>(4-6)<br>(2-4)<br>(0-2) | 5<br>4<br>3<br>2<br>1 |
| 4 | Travel Time | (0-1)<br>(1-2)<br>(2-3)<br>(3-4)<br>(4-5) | 5<br>4<br>3<br>2<br>1 |
| 5 | Parents' Education (Father-f, Mother-m) | (f-m) Grad<br>(f/m) Grad<br>(f-m) HSC<br>(f/m) SSC<br>Uneducated | 5<br>4<br>3<br>2<br>1 |
| 6 | Extra-Curricular Activities | Rare<br>Sometimes<br>Often | 3<br>2<br>1 |
| 7 | Employment | Yes<br>No | 1<br>2 |
| 8 | Addiction | Yes<br>No | 1<br>2 |

*Table.1 Input Variables*

The table above contains all the parameters used in the dataset for training. Total eight factors closely related to the students have been taken for analysis. These parameters have been differentiated in various ranges or domains and each one has been assigned with a particular class which will be used by the algorithm for training. The class values can be considered as weights given to these parameters for training. They have been assigned with class values or weigh as the system evaluates only on the basis of numerical values.

## Output Variables: Table.2 Output Variables

| Sr No. | Output Variable | Domain | Grade | Class |
|---|---|---|---|---|
| 1 | Good | 1st Class | (8.0-10.0) | 1 |
| 2 | Average | 2nd Class | (6.0-7.9) | 2 |
| 3 | Poor | 3rd Class | (3.0-5.9) | 3 |

The output variable represents the performance of a student. In the above table, the classification of output variable is done as Good, Average, Poor so that the students can be classified as per their capabilities and necessary actions can be taken for every student as and when required. Good has been assigned as 1st Class, Average as 2nd Class and Poor as 3rd Class. Such classification has been done keeping the grades of students into consideration. Each Output Variable has been assigned with a class value for the system to differentiate the students into their deserving categories.

# Results

After training the datasets, the outputs will be obtained in the form of graphs.

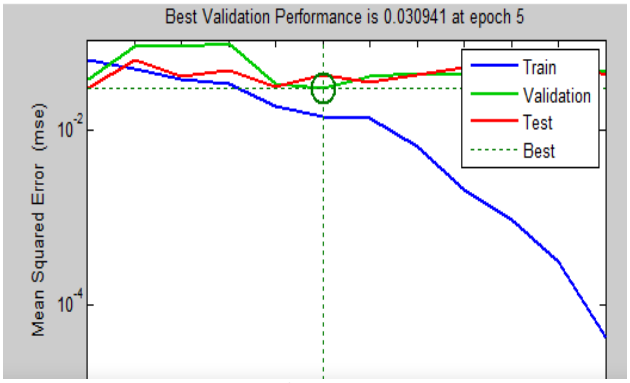


Fig.5 Performance Graph

The Mean Squared Error (MSE) is a measure of how close a fitted line is to data points. The smaller the MSE, the closer the fit is to the data. After running the neural network we have the predicted result. The result is best validated at 5 epochs out of 11 epochs. The above figure shows the performance of the neural network. The dot in the figure represents best results. We observe validation results touch our dot line at 5 epochs and the performance is 0.030941 which represents performance accuracy is around 98% [6].

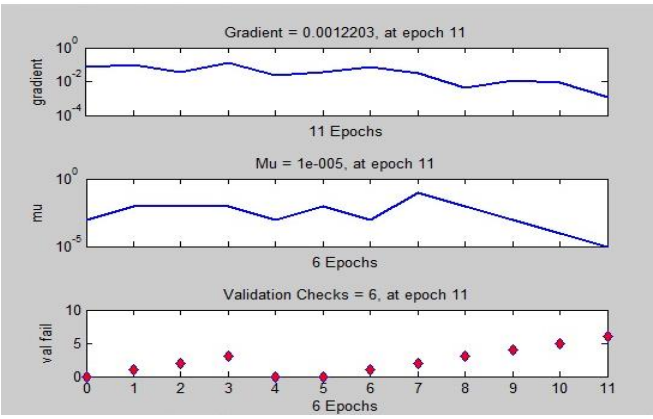


Fig.6 Training State Graph

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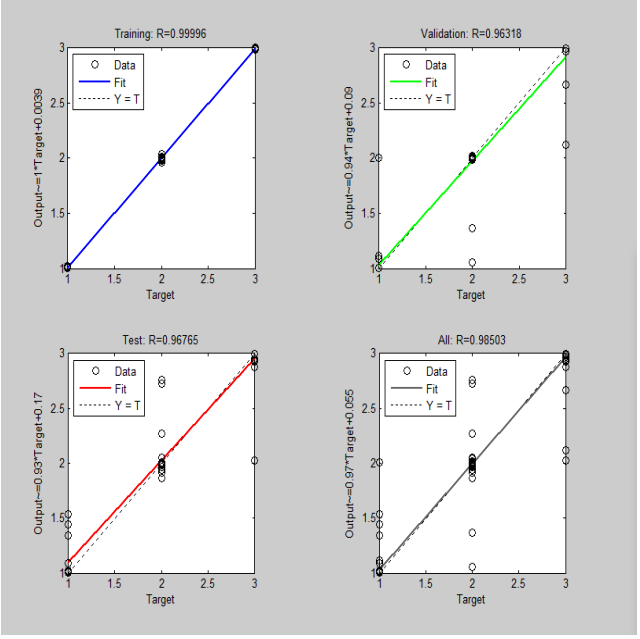


Fig.7 Regression Graph

We use three parts of dataset regression. In the above figure, the graphs shown are training, testing, validation and all phase regression analysis of the network. Where dash line represents the target and solid line represents the best fit linear regression line between outputs and targets [6].
Also we have carried out the prediction process using ART network. The results of this prediction are shown the below images. The accuracy depends on the values of training set and testing set. The results change according to their values.

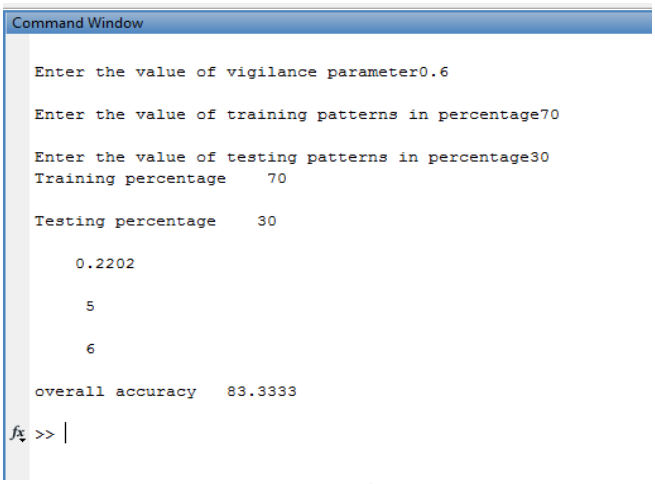


Fig.8 Output of ART

The table below shows the different results obtained by ART network and Back Propagation network.

| Vigilance Parameter | Training Data | Testing Data | Result by ART Network | Result by Back Propagation |
|---|---|---|---|---|
| 0.6 | 70 | 30 | 83.33% | 98% |
| 0.6 | 80 | 20 | 80% | 94.13% |
| 0.6 | 60 | 40 | 71.42% | 93.8% |

*Table.3 Comparative Result of ART & Back Propagation*

# Conclusion

The study has unveiled that the students' performance greatly depends on not only academic activities but also on external activities. It presents a comparison study between feed forward back propagation network model and ART network based prediction model to predict students' performance based on multiple factors. From the findings, the feed forward back propagation model achieved an accuracy of 98% and the ART network gives the accuracy of nearly 80%. From which it can be derived that for this particular research work, the feed forward back propagation model is better for prediction of Students' performance. The ART network is not much useful here. The study shows the potential efficacy of Artificial Neural Network as a prediction tool and such a criterion for students which can help them get better. The outcome of its model is divided into three categories which makes the classification very simple.

# Future Work

In this work, we have used the ART network in its simplest form. The prediction can be done using the other techniques of ART network and the desired output can be obtained. By taking the data of more students, the same analysis can be done using different ANN models such as Perceptron and Bayesian network and still better accuracy can be obtained.
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