Forecasting Student Admission in Colleges with Neural Networks

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Summary
In this study, the use of neural networks in predicting the performance of college at the admission counseling, before the actual event takes place, is analyzed. In our model, we aim to convert this forecasting problem into a classification one, i.e., a college based on its its total no. of seats filled during the counseling is classified in one of the five output categories chosen. This model can be used as a powerful decision aid by the university management, the individual college management & the anticipating students. We've presented the basic overview of ANN followed by few words on forecasting. The input decision variables & the output classes have been clearly laid out.

Key words:
Forecasting, Admission, Neural Networks

1. Introduction

For many centuries, one of the goals of human kind has been to develop machines. We envisioned these machines as performing all cumbersome & tedious tasks so that we might enjoy a more fruitful life. Artificial neural networks are present day examples of such machines that have a great potential to further improve the quality of our life.
A neural networks ability to perform computation is based on hope that we can reproduce some of the flexibility and power of human brain by artificial means. Basically a neural network is machine that is designed to model the way in which the brain performs a particular task or function of interest. The network is usually implemented by using electronic components or is simulated in software on a digital computer.
We may also define neural network as "a massively parallel distributed processor made up of simple processing units called neurons which have a natural propensity to store experiential knowledge & making it available for use. It resembles brain in 2 respects:

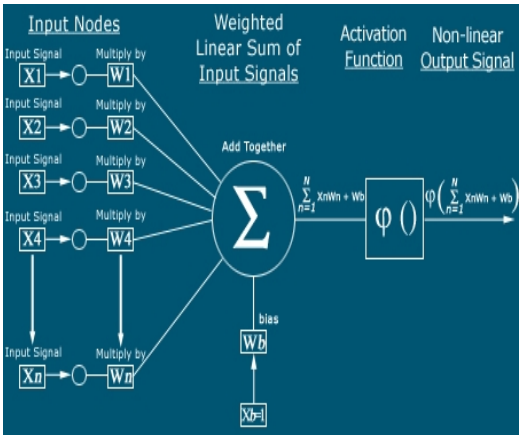

Figure 1- model of a neuron

1) Knowledge is acquired by network from its environment through a learning process, called learning algorithm.
2) Inter neuron connection strengths, called synaptic weights, are used to store the acquired knowledge.

Now a neuron is an information-processing unit that is fundamental to the operation of a neural network. The figure below shows the model of the neuron, which forms the basis for designing artificial neural networks. [6]

As can be seen from the diagram, there are 3 basic elements of the neuronal model:

1) A set of SYNAPSES or CONNECTING LINKS, each of which is characterized by a weight of its own.
2) An ADDER for summing the input signals, weighted by respective synapses of the neuron.
3) An ACTIVATION FUNCTION for limiting the amplitude of the output of a neuron.

The model also contains an externally applied BIAS, which has the net effect of increasing or lowering the net input of the activation function.
The property of neural network that is of primary significance is the ability of network to learn from its environment, & to improve its performance through learning. A neural network learns about its environment through an interactive process of adjustments applied to its

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synaptic weights & bias level. After completing the learning process successfully the network is ready to be deployed for independent functioning. [6]

Neural networks have been applied to an increasing number of real world problems of considerable complexity. The most important advantage is that artificial neural networks are capable of solving problems that are too complex for conventional technologies − problems that do not have an algorithmic solution or that solution is too complex to be found.

The application domain of neural networks today touches almost the entire sphere of science. These include: Association, Clustering, Classification, Pattern Completion, Regression & Generalization, Forecasting, Optimization etc to name a few.

In the next section we proceed to discuss the neural networks with respect to 'Forecasting' along with its various applications in the same field. The subsequent section then describes the method we intend to use for implementing the problem. Afterwards specific configurations, i.e., the data & variable definitions are presented and the proposed architecture is discussed. Finally in the conclusion section we discuss he benefits this approach has to offer as well as our plan of action that we intend to take in order to implement this problem.

2. ROLE OF ANN IN FORECASTING

Artificial Neural Networks have become objects of everyday use ... although few people are aware of it. Their superior performance in optical character recognition, speech recognition, signal filtering in computer modems etc. have established NN as an accepted model & method. However, neural networks have not yet been established as a valid and reliable method in the business-forecasting domain, either on a strategic, tactical or operational level. Following we present selected applications of NN, which have demonstrated their applicability in specific scenarios [1].

1) Locate common characteristics in large amounts of data

Locating common characteristics in large amounts of data is a type of classification problem. Neural networks can be used to solve classification problems, typically through Multi-Layer Perceptron (MLP) and Support Vector Machines (SVM) type networks. Examples of classification applications in medicine include dividing research populations or data into groups for further study.
An example: Classification of Hand Movements:
Key points: EEGs of 6 normal subjects were recorded during sequences of periodic left or right hand movement. Left or right was indicated by a visual cue. The question posed was: 'Is it possible to move a cursor on a monitor to the right or left side using the EEG signals for cursor control?' For this purpose the EEG during performance of hand movement was analyzed and classified on-line. A neural network in form of a learning vector quantizertion (LVQ) with an input dimension of 16 was trained to classify EEG patterns from two electrodes and two time windows.
Conclusion: After two training sessions on 2 different days, 4 subjects showed a classification accuracy of 89-100%. For two subjects classification was not possible. These results show that in general movement specific EEG-patterns can be found classified in real time and used to move a cursor on a monitor to the left or right.
Conclusion: On-line EEG classification is necessary when the EEG is used as input signal to a brain computer interface (BCI). Such a BCI can be help for handicapped people. [7]

2) Better-forecast results based on existing data.

Forecasting results based on existing data is a type of function approximation problem. Neural networks can be used to solve function approximation problems, typically through Multi-Layer Perceptron (MLP), Radial Basis Function (RBF) Examples of function approximation applications in medicine include the prediction of patient recovery and automated changes to device settings.
An example: Functional recovery of stroke survivors: Objective is to predict the place of discharge or discharge Functional Independence Measure (FIM) score for stroke survivors with moderate disability using neural network modeling.
Key points: One hundred forty-seven consecutive stroke survivors admitted for rehabilitation with admission FIM scores between 37 and 96 were used as the training and internal test set. Seventeen other randomly selected stroke survivors were used as the external test set. A neural network model was developed using a small set of clinical variables and the admission FIM score. A working and accurate model was developed to predict the discharge FIM score.
Conclusion: The model was able to predict the 17 external test cases with an accuracy = 88%, sensitivity = 83%, specificity = 91%, positive predictive value = 83%, and negative predictive value = 91%. Neural network modeling is useful in the prediction of functional recovery and helps in discharge planning and allocation of rehabilitation resources.

3) Predict the progression of medical data over time

Predicting the progression of medical data over time is a type of time-series prediction problem. Neural networks can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRNN) type network. Examples of time-series predictions in medicine include the prediction of cell growth and disease dispersion
An example: Control of Arm Movements Application: A new approach to the control of point-to-point, single joint arm movements by an artificial neural network (ANN) controller is presented.
Key points: The ANN controller was used to learn and store the optimal patterns of muscle stimulation for a range of single joint movements. These stimulation patterns were obtained from an optimal control strategy that minimizes muscle activation or muscular effort. Feed forward, recurrent feedback, and time delay topologies of neural networks were considered for this application.
Conclusion: A comparison showed that the feed forward network combined with recurrent feedback and input time delays can most effectively capture the optimal temporal profiles of muscle stimulation. This neural network controller further demonstrated remarkable ability to generalize the learned optimal control to a class of scaled movements. This study showed that neural networks were promising as an open-loop pattern generator for muscle stimulation signals in movement restoration by functional electrical stimulation. [7].

4) Determine relationship between business factors to forecast effects of changes
Forecasting the relationship between multiple factors in business data is a type of function approximation problem. Neural networks can be used to solve function approximation problems, typically through Multi-Layer Perceptron (MLP), Radial Basis Function (RBF) and CANFIS (Co-Active Neuro-Fuzzy Inference System) type networks. Examples of function approximation in business include predicting changes to prices and costs.
An example: Bankruptcy Prediction for Credit Risk: This sample study highlights important and widely studied topic since it can have a significant impact on bank lending decisions and profitability.
Key points: Inspired by one of the traditional credit risk models, the neural network approach provides a significant improvement in the out-of-sample prediction accuracy (from 81.46% to 85.5% for a three-year-ahead-forecast). The prediction of corporate bankruptcies is an important and widely studied topic since it can have significant impact on bank lending decisions and profitability. This work presents two contributions. First we review the topic of bankruptcy prediction, with emphasis on neural-network (NN) models. Second, we develop an NN bankruptcy prediction model. Inspired by one of the traditional credit risk models developed by Merton (1974), we propose novel indicators for the NN system.
Conclusion: We show that the use of these indicators in addition to traditional financial ratio indicators provides a significant improvement in the (out-of-sample) prediction accuracy (from 81.46% to 85.5% for a three-year-ahead forecast)

5) Forecast trends based on previous data
Forecasting the relationship between multiple factors in business data is a type of time-series prediction problem. Neural networks can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRNN) type network. Examples of time-series predictions in business include forecasting revenue and expense cost

An example: Predicting Expense Cost: This study is used to predict the total contingency cost allowance for variations on a construction project is described. By determining cost factors for engineering and business decisions you could provide better estimations towards the manufacturing process. [7].

3. METHOD USED

In our study, we explore the use of neural networks in forecasting the college selections, by students going for technical education before the actual admissions take place. Here, we convert the forecasting problem into a classification problem [3].

Neural networks (NN) are known to be biologically inspired analytical techniques, capable of modeling extremely complex non-linear functions. For many years, linear modeling has been the commonly used technique in capturing and representing functional relationships between dependent and independent variables, largely because of its well-known statistically explainable optimization strategies. Applications of neural networks have been reported in many diverse fields addressing problems in areas such as prediction, classification, and clustering. Although many application bibliographies exist but none of them includes an application of forecasting the success of technical colleges in gaining maximum admissions in an academic year. This study is one of the first to attempt the use of neural networks for addressing this challenging problem that has drawn the attention of many researchers in such areas of decision support systems and management science. Multi layer perceptron (MLP) neural network architecture is known to be a strong function approximator for prediction & classification problems. MLP is capable of learning arbitrarily complex non-linear functions to an arbitrary accuracy level [5].

Thus it is a candidate for exploring the rather difficult problem of mapping college performance to the underlying characteristics.

4. DATA & VARIABLE DEFINITIONS

In our study, n technical colleges, affiliated to the same university & located in a state in northern India are being used. The variable of interest in the study is the total number of seats filled during the counseling sessions based on merit only. It does not include any management seat, NRI seat etc.

We propose to convert this forecasting problem into a classification one. i.e. a college based on it's total number of seats filled (on the basis of merit) is

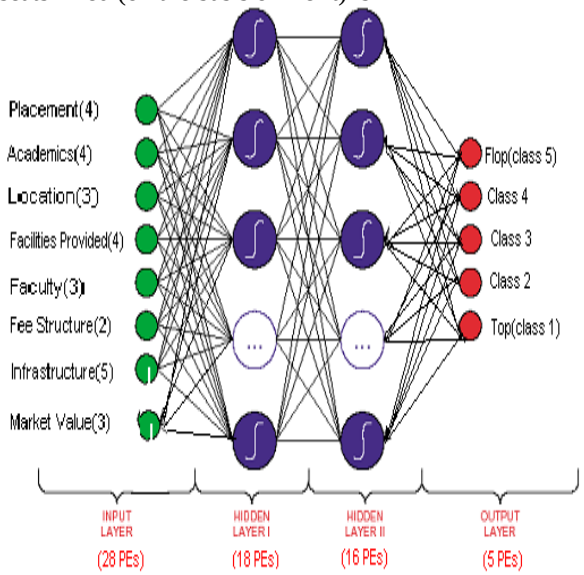

Figure 2. Graphical representation of MLP Neural network model used

classified in one of the five categories, ranging from 'FLOP' to 'TOP' [2].

We plan to use eight different types of independent variables. Each categorical- independent variable is converted into 1-of-N binary representations. Thus we get a number of pseudo- representations that increases the independent variable count from 8 to 28.

. A neural network treats these pseudo variables as different mutually exclusive information channels. All pseudo representations of a categorical variable will be given a value of 0, except the one that holds true for the current case, which will be given the value of 1.

For e.g. the variable 'Fee Structure' would be represented with two pseudo variables – High & Low. Now as an example consider the college IIT, it's a govt. college & hence the fee structure is very nominal, therefore because of its low fees the value of variable 'LOW' would be set to 1 & that of 'high' would be set to 0.

We now present a brief description of the variables chosen.

1. **Placement:** The most common thing mostly people see before choosing any technical college is its placement. The better is its placement the more famous a college would be. Two main things contribute to the worth of the placement parameter- one is the number of students placed in different companies & secondly the category (standard) of companies coming for placement. If big & renounced companies are coming for campus placements then the market value of that college would definitely increase. There are 4 possible ratings in this category, viz, High (placement>80%), Fair (60 – 80%), Average (40-60%) & Poor (<40%).

2. **Academics:** Each affiliated college competes with all other colleges for the same bunch of students anticipating to take admission. The crucial feature that differentiates these colleges is their academic standard. Obviously the college offering better study environment, or in other words has good academics, has an edge over others. We classify this independent variable into 4 categories- Excellent, Good, Fair, Average.

3. **Location:** Is yet another very important feature that determines a college's fate. Any technical college located at some prime location, e.g., within a city will surely be benefited, as all students might want to take admission into a college that is closer to home. Thus we categorize Location onto 3 main categories. This are- Within a city, NCR, Distant area.

4. **Facilities Provided**- Any student seeking admission in a technical college looks forward to get some basic facilities from the college. These common facilities that everyone wants to get are: 1) Transportation Facility 2) Good Hostel 3) Canteen or Mess 4) Co-Curricular activities. Based on these four parameters we classify this independent variable in 4 classes- Good; Fair; Average & Poor.

5. **Faculty:** The faculty of a college plays a very vital role in deciding the future if the college. Good, dedicated & dutiful faculty ensures good academics, which in turn ensures good results & therefore better placements. The decision variable Faculty may be divided into 3 main classes- Good, Fair, Average.

6. **Fee structure:** This forms yet another important parameter in deciding any college's fate. Three different situations reside within this variable.
   a) The college is good in all respects & the fee is nominal, mostly in case of govt. colleges. Then such a college is surely going to earn maximum number of students.
   b) The college is good in all respects but the fee structure is also high, like in private colleges, in such cases people, people don't mind taking admission, despite high fee structure because they're getting all the facilities & features desired from a good technical college. So the parameter high fee structure then takes a backseat.
   c) The last situation is that the college is not good i.e. it does not have good infrastructure, good faculty & does not provide any other facilities also but its fees is Low. Now in such a situation despite the fact that the fees are low, people will decide against taking admission in such colleges. This implies that Low fee parameter cannot save a college if it is poor in other areas. We've assigned 2 values to this variable. One value is 'Low' & the other value is 'High'.

7. **Infrastructure:** what are the sure shot ingredients of a technical college - The Labs, The Library (preferably digital), Seminar Halls, and Lecture rooms Computer center etc. These techno savvy features make a college fit for survival & these constitute the infrastructure of a college. We thus classify this independent variable into 5 classes, viz, Excellent, Good, Fair, Average & Poor.

8. **Market Value:** This decision variable, represented by 3 pseudo representations – High, Medium & Low, shows the market value of the college in current scenario. It tries to depict how much the college is able to earn through its name. Data for this variable has been collected by surveys i.e. by considering expert opinion as well as common man's notion.

A summary of above-mentioned variables is given in Table 1. In all there are 28 decision variables & 5 output variables that we intend to use in our approach.

S. No.	Independent Variable Name	No. Of Values	1. Possible values
1)	Placement	4	High (>80%), Fair (60-80%), Average (40-60%), Poor (<40%)
2)	Academics	4	Excellent; Good; Fair; Average
3)	Location	3	City; NCR; Distant place
4)	Facilities Provided	4	Good; Fair; Average; Poor
5)	Faculty	3	Good; Fair; Average
6)	Fee Structure	2	High; Low
7)	Infrastructure	5	Excellent; Good; Fair; Average; Poor
8)	Market Value	3	High; Medium; Low

Table 1: Summary of independent Variables

5. CONCLUSION

Our approach of using Neural Networks in this field aims to classify the technical colleges in Five Output categories & thus forecasts their performance in the counseling session even before the actual event happens. We've started implementing our problem & would come up with the results soon. This study is the first attempt to use Neural Networks for addressing this challenging problem that combines two different application domains of Forecasting & Classification & brings out the much-desired output. This model would be highly beneficial to the:

a) University Management- They'll be able to rank their colleges. Also the over all standard of the university can be improved by identifying week colleges & thus by taking corrective actions.

b) College Management- They would be benefited for they can come to know their strong & weak points & can therefore make appropriate changes.

c) Anticipating Students- and finally the students seeking admission would be benefited for they'll have all the comparative information that is needed & therefore at a glance they can decide which college to opt for.

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