PREDICTING STUDENT'S MOST PREFERRED UNIVERSITY USING ARTIFICIAL NEURAL NETWORK

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ABSTRACT

Machine learning techniques have proved in time past to be very efficient in predicting phenomena with non-linear relationships. Based on the fact that Artificial Neural Networks (ANNs) have been tested and used in classification, this study was performed to enhance student's chance of admission into the tertiary institution using artificial neural networks model. The back propagation algorithm technique was used to develop this system because of its ability to minimize error and maximize accuracy. The prediction of most the preferred university was based on candidate's years of delay before admission, state of origin, post JAMB score, socio economic characteristics, geographical location, interests and referrals. The data used in modeling and prediction of ANN was collected from a structured online questionnaire administered to five hundred (500) undergraduate students in tertiary institutions in Ogun state. The study further revealed that machine learning technique accurately predicted students' most preferred tertiary institutions; the model was validated by a low Root Mean Square Error (RMSE) of 0.15 and correctly classified instances of 83.2%. The study concludes that the application of innovations such as the artificial neural network modeling is a valid tool for enhancing the Nigerian educational System.

Keywords: Machine learning, Artificial Neural Networks (ANN), Classification,

1.0 INTRODUCTION

University placement is usually extensive because of the large number of students compared to the very limited number of slots at the institution (Franklin and Fullgence, 2011). This is further made complex by the fact that the selections are done based on student choice and the available courses of the university, as a result the university may be overwhelmed by the number of students demanding access against limited university spaces (Mikailu et al., 2014). Information and Communication Technology (ICT) has the potential to provide tools or technologies for building suitable systems for preventing insider abuses and ensuring appropriate use of the limited resources available (Sodiya & Onashoga, 2009). Innovations in the field of Information Technology (IT) continue to increase at an ever spiraling rate; advances in operating systems, software, communication devices, and methodologies are renovating the inventory of IT products on a near daily basis (Gillard, Bailey, & Nolan, 2008). One of such trendy innovations is the utilization of machine learning techniques involving Artificial Neural Network.

Artificial Neural Networks (ANNs) are mathematical models that try to imitate the behaviour of the human brain (Kriesel, 2007). ANNs involve nonlinear relationships among different datasets that cannot always be fully identified using conventional analyses. ANNs manage several types of input data to produce a clinically relevant output, for example, the probability of a certain pathology or classification of biomedical objects (Amato, 2013). They are a potent tool to simulate several non-linear systems, and have been applied to various problems of significant complexity in many fields, such as engineering, agriculture (Rodríguez et al., 2010), education (Naik and Ragothaman, 2004; Siri, 2014), medicinal chemistry (Pandini,

2013), diagnostic systems (Liu & Jiang, 2013; Irfan Khan et al., 2013), and pharmaceutical research (Wesolowski & Suchacz, 2012; Patel et al., 2012). Similarly, to the biological nervous system, ANNs are made up of neurons and each neuron consists of a 'summation block' and an 'activating block'. This makes ANNs a powerful innovative tool that could be applied in decision making as to student university preferences.

The selection process for university admission has denied many capable students a chance in a public university, because the process is prone to bias, errors, or favour, leading to disadvantaging innocent students, and in the long run, poor performance, drop outs, and reduced university standard (Mikailu et al., 2014). More so, universities are becoming competitive as more universities in Nigeria are waiting Federal Government approval. It is therefore expedient to develop an optimized university selection process which will increase students 'chance of being admitted into tertiary institutions in Nigeria and help the University management to have an idea of the number of the student that are likely to choose their university . Hence, this study seeks to predict student's most preferred university using artificial neural network. In order to achieve the aim of the study, the objectives considered were to develop an online questionnaire, to collect data based on candidate's years of delay before admission, state of origin, post JAMB score, socio economic characteristics, geographical location, interests and referrals from the developed online questionnaire, to develop several architectures of artificial neural networks, to evaluate the performance of the developed models and to validate the best prediction model.

2.0 METHODOLOGY

Since the development of an accurate prediction model based on a classifier for students' preference is a very attractive and challenging task involving large data set. The study used of descriptive survey design which involved the development of an online questionnaire. The developed system was a client- server web base application system that gathered questionnaire related to a particular research title presenting it to each participant of the questionnaire survey to seek their opinion on each question and at the server end collate the response of the participant giving the admin the statistic view of the response base on the question for other decision making.

2.1 SYSTEM DESIGN

The system uses a top-down design which is a software design technique that aims to describe functionality at a very high level, then partition it repeatedly into more detailed level one at a time. The system was made possible through the development of software using; HTML, PHP language, JavaScript (angular JS), CSS, MySQL server as the database.

2.1.1 Input Design

The system had a user-friendly interface which makes it easy to use. The entering of data is achieved through keyboard via web.

The online questionnaire was design in a way that the research questions can be inputted. The questionnaire gives instruction to the respondent which was fashioned with close ended

questions. Information from the user serves as the source document. The information was supplied to the computer during run-time. The user becomes an active user by clicking the link to the system. The users then complete the forms and at the end, click submit and process button so that the information is stored in the database of the server.

2.2 PROCESSING ALGORITHM

Since the application is a Client – Server application the algorithm will come in two ways and the algorithm are bellow

Server Side Algorithm

BEGIN

Step 1: Create Admin Account

Step 2: If account Exist GOTO3 else GOTO 1;

Step 3: store account to DB

Step 4: create new Research Title

Step 5: if research title exist GOTO 6 else GOTO 4

Step 6: Store New research title

Step 7 Add Questions to new research Title

END

Client Side Algorithm

BEGIN

Step 1: Fill the participant information

Step 2: respond to the questionnaire

Step 3: submit response

Step 4: close

END

2.3 SYSTEM SPECIFICATION

System requirement has to do with the hardware and software requirement for this application system. These specification requirements must be meet for effective design and implementation of the proposed system.

2.3.1 Hardware Requirement

Hardware is the physical component of a computer system. For the system to work at its best, the following minimum hardware requirement must be satisfy;

1. Computer with internet or intranet connection.
2. Intel® Pentium® processor (recommended; Pentium IV or higher).
3. 100MB of available hard-disk space or more.
4. 1G of RAM or higher recommended
5. 16- Bit colored monitor.
6. Keyboard and Mouse or compatible pointing device.

2.3.2 Software Requirement

Software is specially written code needed to instruct the hardware to carry out the needed operation, the software requirement includes:

1. Microsoft Internet Explorer 6.0 or higher, Mozilla Firefox, Opera, Google Chrome.
2. Apache XAMPP server
3. Window 7 operating system or higher version for faster processing.

2.4 DEVELOPMENT OF ANN MODEL

The neural network model based on multilayer perception was used for the study because a single layer perception can only be used for the classification of a special type of patterns which are linearly separable. The feed forward architecture (supervised network architecture) was employed and the model was trained with the back propagation algorithm. The Neuralnet package installed in R programming language was used for designing, implementing, visualizing, validating and simulating neural networks. For easy coding of R, Rstudio GUI was used.

2.4.1 The Input Layer

Table 1 describes the developed ANN models with input variables,

Table 1: Input variable for Development of Various ANN Students' University Preference Models

s/n	Input Variable	Factors
1	Time Before Admission	Score
	1 year	1
	2 years	2
	3 years and above	3
2	Geopolitical Zone of Origin	Score
	South-west	1
	South-south	2
	South-east	3
	North Central	4
	North-east	5
	North-west	6
3	Jamb Score	Score
	below 180	1
	181-300	2
	above 301	3
4	Socio Economic Status	Score
	High	1
	Medium	2
	Low	3
5	Interest in Institution	Score
	Yes	1
	No	2
6	Referral	Score
	Yes	1
	No	2

2.4.2 The output layer

The output layer used for the prediction has only one neuron which is the stream flow values. The stream flow values computed from the ANN model would be used for the validation of the model.

Table 2: Summary of Output Variable

Universities	Output variable	Score
Babcock University	BU	1
Bells University	BLU	2
Covenant University	CVU	3
Crawford University	CFU	4
Crescent University	CSU	5
Federal University of Agriculture, Abeokuta	FUNAB	6
Olabisi Onabanjo University	OOU	7
Redeemer's University	RU	8
Tai Solarin University Of Education	TASUED	9

2.4.3 The hidden layer

It has being proven that a single hidden layer network is sufficient to uniformly approximate any continuous function (Hajek, 2005). However, maximum of two hidden layers and various neurons would be used. The number of hidden layers that yields the best result would be adopted for the study.

2.4.4 Activation functions

It has been proven that two-layer networks with sigmoid transfer functions in the hidden layer and linear transfer functions in the output layer can approximate virtually any function of interest to any degree of accuracy, provided sufficiently many hidden neurons are available (Hagan, 2002). For the purpose of this research, different transfer functions would be tested and the one that yields the optimal result would be adopted for the study.

2.4.5 The algorithm

Back propagation algorithm would be used to train the network because back propagtion algorithm is used to train multilayer feed forward network. The back propagation algorithm has been applied successfully to multilayer perceptions to solve some difficult diverse problems (Hajek, 2005).

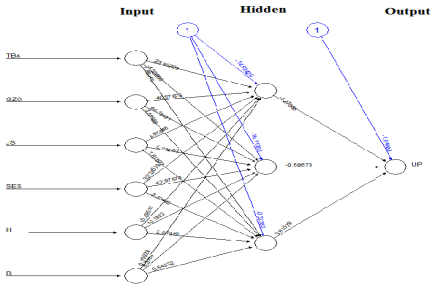

Figure 1: 3-layer ANN Architecture used for University Preference Prediction

2.4.6 Neural Network Model Training

The initial weights of the model would be chosen at random by the Neuralnet software package of R programming. The learning process is maintained on an epoch-by-epoch basis until the synaptic weights stabilize and the average squared error over the entire training set converges to some minimum value. The training samples would be randomized from one epoch to the next because it tends to make the search in weight space stochastic over the learning cycles, thus avoiding the possibility of limit cycles in the evolution of the synaptic weights vectors. For this study, the data was divided into two groups with a ration of 75% to 25%. The 75% of the data was used for training of ANN, while the 25% was used for the testing (validation).

2.4.4 MODEL PERFORMANCE EVALUATION

The model with the lowest MSE-Mean square error, and lowest RMSE-Root Mean square error would be chosen as the best. These two statistical values were calculated by R programming. The MSE is represented by equation 1, while the RMSE is represented by equation 2.

MSE = $\sum_{i=1}^{n}(y_i \quad x_2)^2/n$ eqn. 1

RMSE = $\sqrt{\sum_{i=1}^{n}(y_i \quad x_i)^2/n}$ eqn.2

Where, Y_i = observed data

Xi = predicted data

α = mean of predicted

= mean of observed

2.4.5 VALIDATION OF MODELS

After series of training and testing of the neural network models, the model with best performance was validated using confusion matrix.

3.0 RESULT AND DISCUSSION OF FINDINGS

3.1 Development and Performance Evaluation of ANN Models

Several ANNs models were developed based on the back propagation algorithm, to predict students' university preference. Table 3 shows the summary of the performance of the best five ANN models. It could be seen that ANNs model E which had two hidden layers (15 and 5 nodes) had the lowest MSE of 0.05 and RMSE of 0.15; therefore model E performed best of the five models. The topology of model E is presented in figure 2.

Table 3: Summary of performance of Models

Model	Topology	MSE	RMSE
A	6-3-1	2.11	1.45
B	6-6-1	1.17	1.08
C	6-10-1	0.89	0.93
D	6-15-1	0.85	0.93
E	6-15-5-1	0.05	0.15

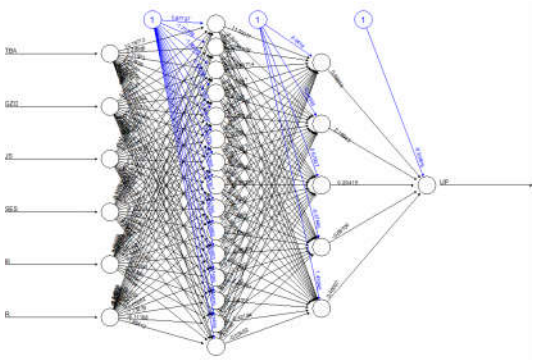

Figure 2: Topology of Best Performance Model

3.2 Validation of Best Preformed Model

Table 4 shows the summary of the classification of the best model. Based on the test split of the input data, the model was able to predict 104 cases correctly, while the remaining 21 cases were incorrectly classified. This shows that the developed ANN model is capable of predicting student's university preference being 83.2% accurate.

Table 4: Summary of Classification of ANN Model

Classified Instances	Cases	Percent
Correctly	104	83.2 %
Incorrectly	21	16.8 %

The model was further validated by the confusion matrix presented in table 5. It can be observed in the table that from the 125 test split of the input data, 5 cases of Babcock University was correctly predicted, out of 8 cases, 1 case of the Bells University was incorrectly predicted as Olabisi Onabanjo University, while out of 9 cases of Covenant University, 2 cases were incorrectly predicted as Bells University, while the 3 cases were

incorrectly predicted as Crescent University. The table further sows that the 3 cases of Crawford University were incorrectly predicted OOU, of the 6 cases of Crescent University, 4 cases were incorrectly predicted as OOU, it was also observed that all 14 cases of Federal University of Agriculture, Abeokuta and OOU were correctly predicted. In addition, all 30 cases of Redeemer's University were correctly predicted, whereas, 28 cases of Tai Solarin University of Education were correctly predicted out of 33 cases.

Table 5: Confusion Matrix

Output/Desired	BU	BLU	CVU	CFU	CSU	FUNAB	OOU	RU	TASUED
BU	5	0	0	0	0	0	0	0	0
BLU	0	7	0	0	0	0	1	0	0
CVU	0	2	4	0	3	0	0	0	0
CFU	0	0	0	0	0	0	3	0	4
CSU	0	0	0	0	2	0	4	0	0
FUNAB	0	0	0	0	0	14	0	0	0
OOU	0	0	0	0	0	0	14	0	0
RU	0	0	0	0	0	0	0	30	0
TASUED	0	0	1	0	0	2	1	1	28

3.3 Discussion of Findings

The online questionnaire developed was used to collect data based on candidate's years of delay before admission, state of origin, post JAMB score, socio economic characteristics, geographical location, interests and referrals. This served as input for developing several architectures of artificial neural networks, five of the best models were presented in study, since they had low mean square error and root mean square error. The best model having MSE of 0.05 and RMSE of 0.15 was chosen as the best model. This was in agreement with Oladokun et al. (2008) who evaluated student's academic performance prediction models. The selected model had a single input layer consisting 6 nodes, two hidden layers which consists of 15 nodes and 5 nodes, and a single output layers with a single node. The model validated by being able to predict student's university preference with an accuracy of 83.2%, which is a fair performance going by similar results from the literature (Emuoyibofarhe et al., 2003; Adefowoju and Osofisan, 2004; and Oladokun et al., 2006).

Artificial Neural Network model has the capacity of enhancing the process of student's choice of university, because it could speed up processing of large volumes of student data within a very short time. Furthermore, the model could be used in developing an adaptive system for assisting student in selecting university based on their background information. This system could be used eliminate error, favour and biasness that exist during admission process.

4.0 CONCLUSION

The study revealed that application of artificial neural network is effective in enhancing student's chance of admission into the tertiary institutions in Ogun state. Therefore application of innovations such as the artificial neural network modeling is a valid tool for enhancing the Nigerian educational System.

5.0 RECOMMENDATION

This study was limited to Ogun State universities as well as few covariates such as candidate's years of delay before admission, state of origin, post JAMB score, socio economic characteristics, geographical location, interests and referrals. It is therefore recommended that an extension of this research should increase the scope of the study to other universities in Nigeria as well as increasing the input data for the model.

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