Original Research Article

Artificial Neural Network (Ann) Forecast of University Growth: A Focus on College of Technology Education, Kumasi, University of Education, Winneba Admissions.

Abstract

The definition of growth can mention nature that growth can be take: Physical and Abstract. The growth of Academic institutions especially universities has become a major concern in Ghana. Growth of Academic institutions (Universities and Colleges) can take different dimensions. Some of these dimensions include the number of undergraduate admissions per each year, number of postgraduate admissions per each year, Number of Teaching Staff, infrastructure, logistics, and Research. In the Corporate strategic plan of University of Education (2015), the targets enshrined in it indicate that the University of Education would pursue non-reluctant growth strategy in all spheres of academic life including infrastructure growth, increase in enrollment of students and continuous pursuant of higher academic research. A focus shall be on the admissions of College of Technology Education, Kumasi, one of the University's campuses. This admission growth of the college shall be used as a proxy for the entire University of Education. The Neural Autoregressive (NAR) model is specified based on the Autoregressive (AR) five (5) in terms of the lag length and variables used. The AR had mean forecast error of 22.58 % whiles the NAR had a mean forecast error of 5.89 %. It is self-evident from the results that the College of Technology Education, Kumasi is growing in terms of students numbers. Future studies should be done on Faculty basis.

Keywords: Artificial Neural Network, Forecast, University Growth, Autoregressive, Neural Autoregressive

1.0 INTRODUCTION

Growth refers to a positive change in size, and/or maturation, often over a period of time. Growth can occur as a stage of maturation or a process toward fullness or fulfillment. The definition of growth can mention nature that growth can be take: Physical (e.g., growth in height, growth in an amount of money) and Abstract (e.g., a system becoming more complex, an organism becoming more mature) (wiki).

Growth occur to natural living things like Human beings and Plants. In the same way, institutions also grow. These institutions include Academic institutions , Health institutions, Financial institutions etc. The growth of Academic institutions especially universities has become a major concern in Ghana.

Growth of Academic institutions (Universities and Colleges) can take different dimensions. Some of these dimensions include the number of undergraduate admissions per each year, number of postgraduate admissions per each year, Number of Teaching Staff, infrastructure, logistics, and Research. Different researchers may lay emphasis on different measure of growth depending on the core objective of the research.

The University of Education has four main campuses. The University has since its inception continued to graduate increasing number of quality students (Vice Chancellors Report, 2014). In a sense it is direct to say that the University of Education is growing. However, growth of students number comes with its own challenges: availability of teaching staff, Lecture rooms, Laboratories and Student accommodation facilities.

The continuous increase in the number of students has rang the bell to ensure a commensurate match of staffing to students number. This call for a good forecast of student enrollment to enable easy planning.

2.0 PROBLEM STATEMENT

In the Corporate strategic plan of University of Education (2015), the targets enshrined in it indicate that the University of Education would pursue non-reluctant growth strategy in all spheres of academic life including infrastructure growth, increase in enrollment of students and continuous pursuant of higher academic research.

Growth has its own challenges as already mentioned above. Besides, peculiar challenge to increasing enrollment of students has fundamentally been the problem of infrastructure and academic staffing. This means that whiles the university think of increasing enrolment it should also think of these problems that have cast their shadows in advance.

The question remains as to what level of infrastructure and staffing would meet the growth of student enrollment. Technically the National Accreditation Board, Ghana, requires Lecturer to Students ratio of 1:27. This means one lecturer should handle Twenty- seven students. To be able to meet this ratio University of Education requires a good forecast of student enrollment. The forecast will enable successful planning for academic staff as well as infrastructure .

As already mentioned, the University of Education has four campuses. To enable correct forecast, a focus shall be on the admissions of College of Technology Education, Kumasi, one of the University's campuses. This admission growth of the college shall be used as a proxy for the entire University of Education.

Notably amongst better forecasting models is the Artificial Neural Network (ANN) model. The model has been tried and tested to provide best forecast with the minimum possible error (Hadrat YM, Eshun Nunoo Isaac K, and Effah Sarkodie E, 2015). Therefore, a forecast of the university's growth shall be made using the Artificial Neural Network (ANN) model with admissions data from the College of Technology Education, Kumasi.

2.0 Literature on Artificial Neural Network (ANN)

Artificial Neural Network (ANN) model is currently a popular forecasting technique in several fields such computer science, engineering, economics, finance etc. ANNs have been used to predict variables such as bond prices, exchange rates, stock returns, money supply, electricity demand, construction demand, inflation rates and it forecasts have proven worthwhile etc (Fernandez et al, 2000;Redenes& White, 1998;etc). The artificial neuron is a mimic of the natural human neuron. The human brain, for example, contains approximately ten billion (10^{10}) neurons, each connected on average to ten thousand (10^4) other neurons, making a total of 10^{15} synaptic connections (Larose, 2004).

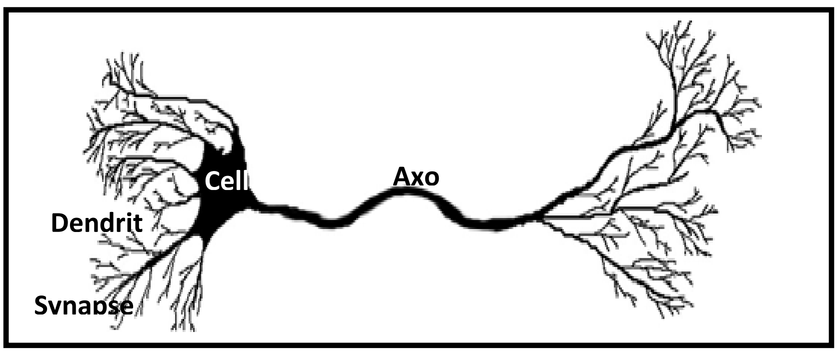

Figure 1. Biological Model of Human Neuron (artist's conception)

The human brain learns by experience: It receives information and recognizes the pattern; the brain then generalizes and is able to predict based on the information received. It is this way of information processing by the brain that the ANN model tends to mimic. Although ANN models are too far from the way the human brain performs, by mimicking the basic features of the biological neural networks, they have succeeded in doing certain jobs very well (Moshiri, 1997).

A mimic of the way biological networks perform may appear more than complex. Artificial neural networks represent an attempt at a very basic level to imitate the type of nonlinear learning that occurs in the networks of neurons found in nature.

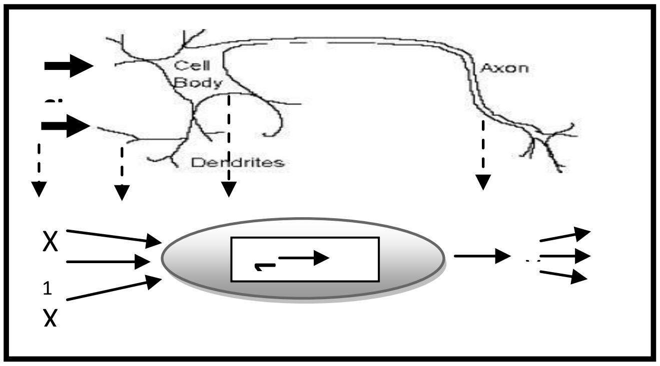

Figure 2. Natural and artificial neurons (a relational sketch)

As shown in figure 2, a natural neuron uses the synapses located on the dendrite to gather inputs (signals) from other neurons and combines the input information, generate a nonlinear response ("firing") when some threshold is reached, which it sends to other neurons using the axon. Similarly, the artificial neuron collects inputs (x_i) from input neurons, attaches weights and combines them through a combination function such as summation ($\sum$). It is then activated by a function (usually nonlinear) to produce an output response (y), which is again sent to other neurons.

3.0 Model Specification

The main objective of the study is to forecast University growth using the ANN method. The Neural Autoregressive (NAR) model is specified based on the Autoregressive (AR) five (5) in terms of the lag length and variables used. The ANN model is constructed with twenty (20) hidden layer units and one (1) output layer unit. The ANN transfer function is also the tan-sigmoid function in the hidden units and the linear function in the output unit. The model is specified as:

NAR (5): $$\mathrm{F}_h = b_h + \sum \beta_{\mathrm{hj}} \left(tansig \left(b_j + \sum \gamma_{\mathrm{ji}}\, \mathrm{p}_{\mathrm{t-i}} \right) \right), \quad \mathrm{i} = 1, .., 12 \quad \mathrm{j} = 1, .., 20 \quad \mathrm{h} = 1 \qquad (1)$$

where p_{t-i} are past values of the dependent variable, γs and βs are hidden and output layer weights respectively and the (**b**s) are the biases.

4.0 Estimation and Forecasting

The model uses the data up to 2013/2014 academic year for estimation and uses 2015/2016 for future forecasts. This was to ensure that at least the 2015-2018 forecasts are compared to their respective actual values.

5.0 Data type and Source

The study uses time series data (1993-2015) on admissions obtained from the college of Technology Education, University of Education, Winneba.

6.0 Results and Discussion

The table below shows the forecast results of the Neural Autoregressive (NAR) which represents the ANN. For comparison sake one traditional econometric model (AR) which possess similar structure like the NAR is also estimated and used. From the table it could be observed that both the AR and the NAR provided different forecasts. However, forecasts of the Nar were closer to the actual for the various years. The AR had mean forecast error of 22.58 % whiles the NAR had a mean forecast error of 5.89 %.

Table 1.The Summary of Forecast Results

Year / Month	*AR (12) Forecasts*	*% FE(AR)*	*NAR (12) Forecasts*	*% FE (NAR)*	*ACTUAL*
2015/16	2341	-7.69	2598	2.44	2536
2016/17	3997	10.75	3633	0.67	3609
2017/18	4456	64.67	3100	14.56	2706
2018/19	5421	****	3564	****	****
		22.58*		**5.89***	

*****Figures that are yet to be determined. *Average percentage forecast error that excludes figures of 2019. Source: Author's construction 2018*

The NAR forecasts indicates that the College of Technology Education, Kumasi would double its admission figure by 2018/19 academic year. That is by students size the college of Technology Education is expected to grow rapidly as per the annual forecasts provided by the NAR.

7.0 CONCLUSION AND RECOMMENDATIONS FOR POLICY

It is self-evident from the results that the College of Technology Education, Kumasi is growing in terms of students numbers. The growth moreover looks very rapid as indicated by the figures. This implies that the products (programmes) of the College of Technology Education, Kumasi are increasingly demanded by prospective University graduates. It is also an indication that the facilities of the college in terms of lecture halls, residential facilities, library and ICT have to be expanded to meet the increasing number of students in the college. Further, the college has to increase both academic and non-academic staff. this will prevent high student-lecturer ratio.

9.0 FOR FUTURE STUDIES

Future studies should be done on Faculty basis. This will enable comparative growth amongst the various faculties in the college and by that provide Faculty based needs accordingly. If possible, program based analysis would be very beneficial.

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