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MACHINE LEARNING PREDICTIVE MODELING OF THE PRICE OF CASSAVA DERIVATIVE (GARRI) IN THE SOUTH WEST OF NIGERIA

Abstract

Fluctuation in prices of Agricultural products is inevitable in developing countries faced with economic depression and this, has brought a lot of inadequacies in the preparation of Government financial budget. Consumers and producers are poorly affected because they cannot take appropriate decision at the right time. In this study, Machine Learning(ML) predictive modeling is being implemented using the MATLAB Toolbox to predict the price of cassava derivatives (garri) in the South Western part of Nigeria. The model predicted that by the year 2020, all things being equal, the price of (1kg) of garri will be ₦500. This will boost the Agricultural sector and the economy of the nation.

1. INTRODUCTION

Artificial Intelligent (AI) is an aspect or area of computer science that is widely applicable in solving some fundamental real life problems. It has become a very useful tool in solving real life problems in different areas of life. For instance, AI has been found to be very useful in the field of science, engineering, medicine, bio-technology, cybernetics, mathematics, game theory etc. Its application has become so wide or broad to the extent that it is becoming increasingly difficult to give it a precise or single definition.

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AI could be defined as a science of automating intelligence behavior (Vandal, 2010) .This definition suffers the fact that the word intelligence cannot be absolutely defined. Olanloye (2017) defined intelligence as the capacity of a system to achieve a goal or desired behavior under condition of uncertainty.

Intelligence can also be defined as ability to think, learn, and act appropriately when it is necessary. Just like the way man can think, learn and act appropriately under certain condition because of its natural intelligence, so it is possible to create intelligence (artificial) in machine such that the machine too can solve real life problems in a humanlike manner. Therefore, AI can be defined as an aspect of computer science which makes attempts to create intelligence in machine such that the machine too can solve real life problem in a humanlike manner.

Machine learning is an important branch of AI which is defined as optimizing a performance criterion using example data and post experience (Ethem, 2010). In ML, data plays an important and indispensable role and the learning algorithm therefore acquire its knowledge or experience from data. Hence, the nature of data and the quality of the data will affect the learning and the prediction performance(Wei-lun,2011).Machine learning is used extensively in the area of forecasting and predictive modeling. Many researchers have made series of attempts to use predictive modeling to solve different types of real life problems.

In this research work, an attempt is being made to predict the price of cassava derivative (garri) using machine learning predictive model. The prices were predicted for every 5 years between 1980 and 2050 using periodic and exponential coefficient. Machine learning in MATLAB toolbox was used for the purpose of implementation.

2. STATEMENT OF PROBLEM

Nigeria grows more cassava than any other country in the world and about 70% of cassava produced in Nigeria is processed into garri which has become the most commonly traded and consumed product of cassava (Orewa & Egware, 2012). The trading and consumption of garri is not even restricted to local level as it is being exported to different parts of the world.

Producers and processors are constantly faced with problem of seasonal variation in the product price (Olagunju , Babatunde & Salimonu, 2012) as stated in (Izekor, Alufohai & Eronmwon, 2016). This is one of the major problems of agricultural product – i.e. the price of the product produced by farmers suffers several price variations.

The price of garri continues to fluctuate in the market. This has been a serious concern to both the consumer and the producers of this product. During the season of cassava, the buyer buys garri at lower prices and this is disadvantageous to the farmers. When cassava season is off, the garri buyers buy at higher prices but the producer (the farmers) can only supply in low quantity. Hence, one can

conclude that the driving force that controls the demand and supply of cassava in Nigeria is the price garri. How can we then predict or forecast the price of garri such that the farmers, producers, buyers and consumers can have good idea of the price of the product in the market? This will assist them in the area of planning and decision making. Such prediction will also assist the Government in mapping out good economic policies.

A lot of models (most especially Statistical model) have been developed to solve similar problems with respect to some other agriculture product but no attempt has been made to predict the price of garri using AI approach.

3. OBJECTIVES OF THE STUDY

The main objective of this research is to use machine learning predictive modeling to predict the price of cassava derivatives (garri) in the south Western part of Nigeria.

4. LITERATURE REVIEW

Izekor, Alufohai and Eronmwon (2016) presented a research work on analysis of market integration and price variation in garri market in Edo State. Price behavior between rural and urban market for Garri was examined to determine the price transmission. The method used was statistical and no predictive model algorithm was developed.

With statistical approach, Orewa and Egware (2012) were able to compare the price of Garri in both rural and urban market of Edo State between the periods of 1990 to 2005. No model or algorithm was developed and the research work did not make any prediction.

Iwayan et al. (2010) also predict the quality of cocoa using image processing and Artificial Neural Network(ANN). Though this research work made use of AI principles but it has nothing to do with neither cassava nor its derivatives.

Again, Gurudeo and Tereq (2016) presented a research work on oil price forecasting using univariable time series models. The method used is more of statistics than AI. Though, the developed model was able to make predictions on the oil price. The area of application is in oil sector and has nothing to do with cassava and its derivatives.

Literature also reveals that Faisal and Wumi (2005) made use of AI principle, precisely ANN to predict the crude oilprice trend. The prediction was not on the price of cassava and its derivatives.

Sunday et al. (2014) were able to carry out monthly price analysis of cassava derivatives in rural and urban market in Akwa Ibom State in southern Nigeria. No algorithm or model was developed and there was no prediction. The research only carried out the price analysis using statistical approach and not AI approach.

Ernest (2002) used AI (i.e. Neural Network and Genetic Algorithm) to predict the future price of commodity. The work is not particular about price of cassava or its derivatives, and again NN and GA approach were used. The method used was quite different from the proposed method.

Obe and Shangodoyin (2010) were able to use ANN based model to forecast sugar cane production. This study applied heuristic technique to develop an ANN model to forecast sugar cane production in Nigeria. The model was proved by the authors to have carried out a very accurate prediction. Though, AI principles were used as the method of prediction but the research has nothing to do with cassava and its derivatives.

Going through the literature, one can conclude that prediction of the price of cassava and its derivatives has not been seriously addressed using AI principles. These researchers therefore made an attempt to predict the price of cassava and its derivatives using ML approach.

5. THE CONCEPT OF MACHINE LEARNING

Machine learning can be defined as an automated learning. Learning is the process involved in converting experience into expertise. In Machine learning, the machine is trained with large amount of data to acquire enough knowledge or experience and such knowledge or experience is applied in solving future problems. The input is presented to the learning algorithm in form of training data which represent experience and the output is in form of expertise which usually takes the form of another computer program that can perform some task. It is needed where there is a large amount of data to be considered and when there is need for adaptability.

According to Harrington (2012), the steps involved in developing a machine learning application are:
- **Collect the data:** this could be done personally or though some devices. It could be from RSS or an API. It could be through satellite, remote sensors, internet etc.
- **Prepare the input data:** one should ensure that the data is in the right format. In most cases, the algorithm specific formatting will be taken into consideration. Some algorithm can deal with target variables expressed in form of strings whereas some other algorithms make such variables in form of integers.
- **Analyze the data:** The data to be used should be carefully analyzed. One may need to study the pattern and make some grouping. Analysis again may call for plotting the data in form of two or three dimensional structure. When we have multiple dimensions, technical reduction may be used to reduce the dimension so as to make data visualization very easy.

- **Train the Algorithm:** This is the core area of machine learning where sufficient data should be supplied to the system for training and the system is expected to learn from such data. The type of learning could be supervised or unsupervised type.It is supervised learning if the type of result (output) expected is provided for the algorithm and hence the algorithm works towards obtaining such output. It is an unsupervised learning if there is no target output but the algorithm struggle on its own to recognize the pattern of the input data to carry out some classification to generate the required output.
- **Test the Algorithm:** Having trained the algorithm, it is imperative to test for the level of performance of the algorithm. This will help to evaluate the training process. This is just a way of evaluating the algorithm. If the performance is not satisfactory, one may go back to effect some changes and test the algorithm again until the performance is accessed to be quite satisfactory.
- **Update**: For the purpose of implementation, a notable programming language like python, MatLab, R and so on,are used.

There are different types of machine learning algorithm depending on the type of the problem to be solved. They includes
- **Regression:** This is basically for prediction e.g.predicting the price of a building based on the facilities that are available in the building, predicting the weather condition based on data of the previous weather conditions etc.
- **Binary Classification:** It is also meant for prediction but unlike the regression, the output of prediction is either a yes or no e.g. predicting whether a woman has breast cancer ornot. It groups the women into 2 parts i.e. those with breast cancer and those without.
- **Multiclass Classification:** In multiclass classification, there are many classes, what it does is to predict the most appropriate class for a particular sample. For instance, the algorithm could predict whether a particular student should belong to science, Arts, Commercial or Technical Class.
- **Ranking:** There are set of objects which are to be arranged in a particular order based on predictive model. Examination scores of the students could be arranged according to the magnitude or the size of the scores.
- **Prediction:** Prediction is the act of developing hypothesis or algorithm to forecast future events based on the set of historical events. It is the act of developing a model for the purpose of forecasting future events. A perfect prediction provides insight into the implication of an action and it serves as a metric to judge one's ability to influence or judge future events (Hetemäki & Mikkola,2005; Peralta et al., 2010).

6. METHODOLOGY

Large historical market price of cassava derivative (garri) was collected for a period dating from 1970 till present date from South Western part of Nigeria. The collected data was then compared with the simulated model to determine the actual values of the exponential and periodic factor. A computational machine learning algorithm (regression) was developed with equation 1, 2, 3:

$$Y = sin(cp * t) \tag{1}$$
$$Z = exp(ce * t) \tag{2}$$
$$Zy = Z * (Y + 1) \tag{3}$$

where: cp – periodic coefficient,
ce – exponential coefficient,
t – time variable which is the periodic components of the Garri price,
z – exponential component of the garri price.

We simulate with the various exponential factor and periodic factor. The exponential factor was varied from –0.01 to 0.13 .The periodic factor was varied from 0.8 to 2.2. Comparing with actual data shows that the exponential factor for actual data is around 0.1 and the periodic factor is around 2.0. The fluctuation period is about 5 years and the growth is an exponential function with an exponential growth of 0.1.

The algorithm is implemented using MatLab ML toolbox. Series of efforts were made to obtain the best model which learn from the previous data (change in price of garri over certain period of time) and then predict the future prices for every 5 years.

7. RESULT AND DISCUSSIONS

Series of results were generated and presented in three dimensional visualization showing both the periodical and exponential factors. Some of these were shown in Figure 1 and 2. Results obtained in Figure 2 appears to be better than others. The result obtained shows the price of garri continues to increase overtime. The price of a 1kg of garri was ₦0.05 in 1970. Since then, it has been fluctuating every year. Considering the fluctuation period of 5 years, in 1975, the price was around ₦0.16. In the year 1980, 1985, 1990, 1995, 2000 the prices were 0.5, 1, 2, 7 and 20 naira respectively. Following the same trend, the model predicts that all things being equal, the price of 1kg of garri will be ₦500 in the year 2020. Figure 2, 3, 4 and Table 1 explain further.
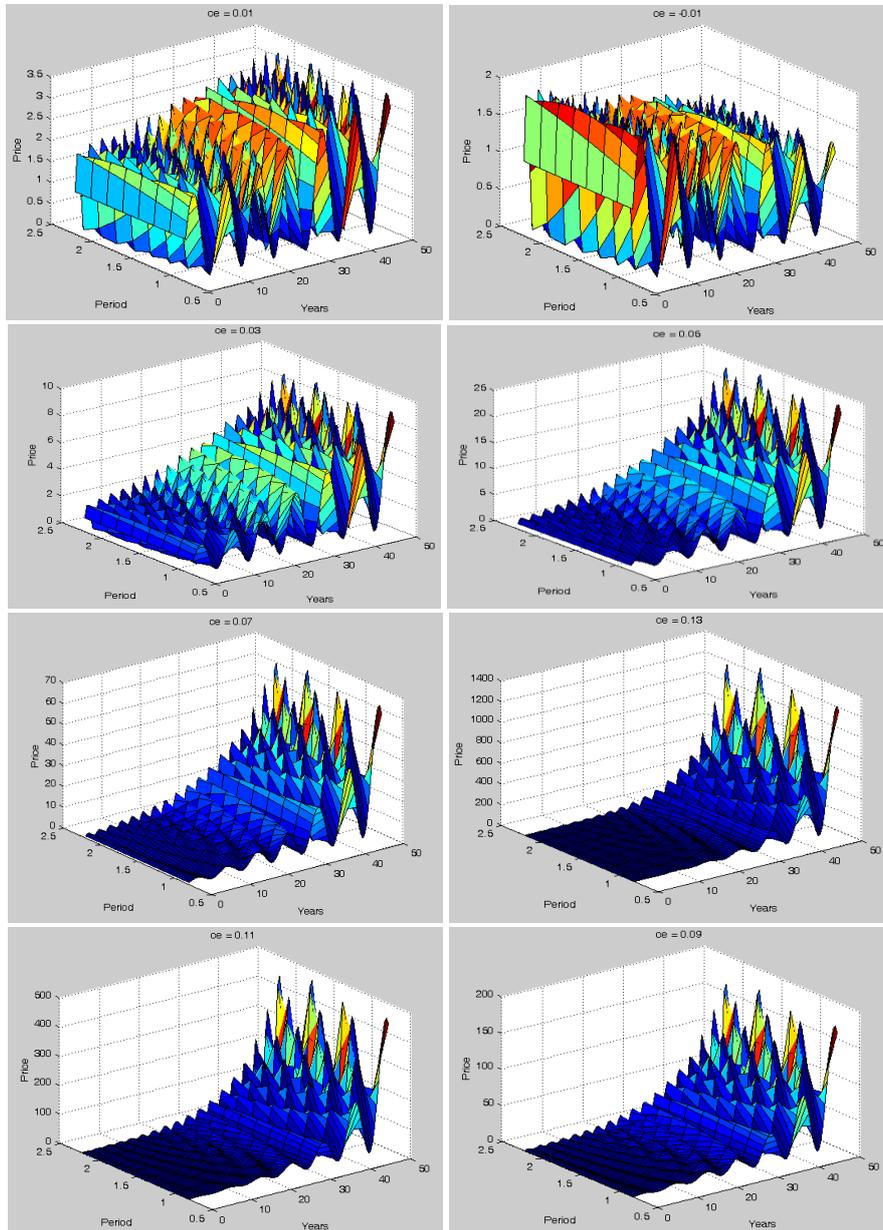
**Fig. 1. Sample Models to Predict the Price of Garri**
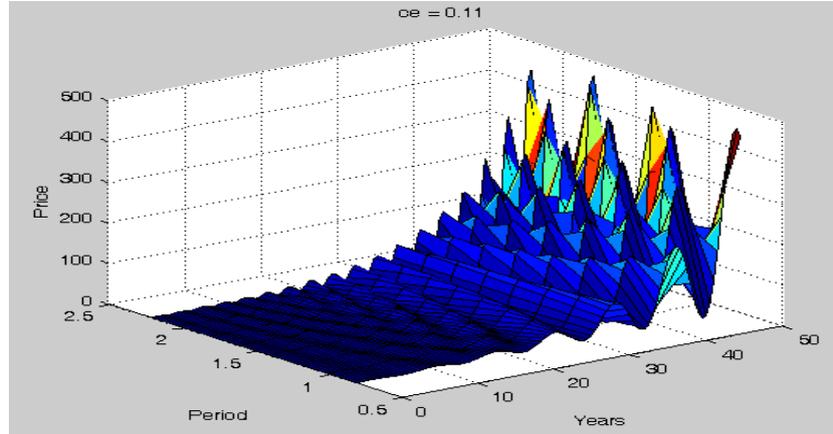
Fig. 2. The most Accurate Model for Garri Price Prediction

The values (prices) of 1 kg of garri in the market and from the model (as displayed in the in the 3 dimensional shapes in Figure 2) were displayed in the Table 1 below. Figure 3 shows the graphical variation in the price of garri as determined by the new model. It further explains the basic characteristics of Nigeria economy where the prices of goods and services continue to increase. An attempt was also made to show clearly the differences between the market price and the model price using simple bar chart as shown in Figure 4.

Finally our model predicts that by the year 2020 the price of 1 kg of garri will be as high as ₦500, all things being equal.

Tab. 1. Comparison of the Model Price with the actual Market Price.

S/N	Year	Model Price (MP) in Naira	Market Price (KT) in Naira
1	1970	0.05	0.06
2	1975	0.16	0.15
3	1980	0.50	0.70
4	1985	1.00	1.10
5	1990	2.00	1.80
6	1995	7.00	6.80
7	2000	20.00	22.00
8	2005	50.00	55.00
9	2010	100.00	95.00
10	2015	200.00	250.00
11	2020	500.00	–
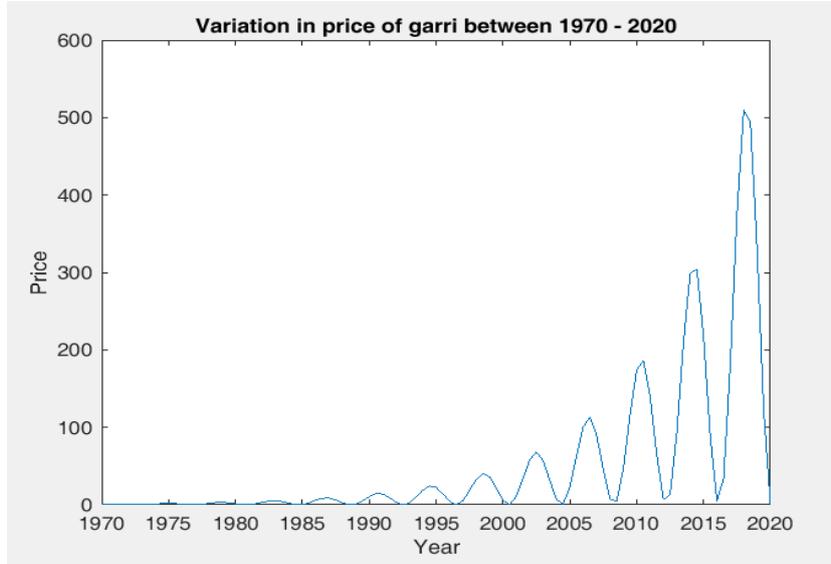
Fig. 3. Graphical Variation in the Price of Garri as Determined by the New Model
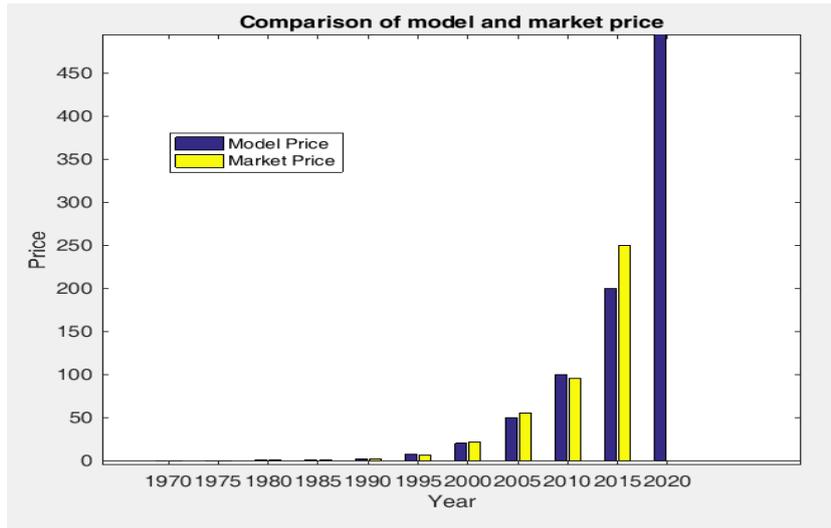
Fig. 4. Comparism of Model and Market Price

8. CONCLUSION

This research work introduced an AI principle precisely ML algorithm to develop a model that can be used to predict the price of garri. The exponential coefficient and the periodic coefficient were used to formulate the model using machine learning algorithm. The implementation was done using MatLab tools. The model was made to predict the price of garri for every five years, starting from 1970 to 2020. It was eventually predicted by our model that by the year 2020, all things being equal, the price of 1Kg of garri will be ₦500. Therefore this research work will serve as a good predictive tool that will be of great assistance to the all the stakeholders in garri industry in term of taken appropriate decisions at the right time. It will boost the nation agricultural sector. It will also assist the government to prepare good financial budget for the nation.

In fact, there will be overall improvement in the standard of living and hence the economy of the nation.

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