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Modeling and forecasting of rare events in Nigeria

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ABSTRACT

This paper examined three (3) different forecasting techniques in the modeling of twenty (20) years time series data of accident that occurred on Nigeria roads. Road accident, being a rare event is considered for this forecasting process using the techniques of Least Square, Quadratic and Single Exponential Smoothening. Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Square Deviation (MSD) were adopted as the basis of comparison. Results revealed that the MAPE of 93.10, MAD of 672.55 and MSD of 912.82 attached to the Least Square Model is smaller than that of Quadratic and Exponential Smoothening techniques and hence adjudged the later to be the best model for the forecast.

INTRODUCTION

Most people view the world as consisting of a large number of alternatives. Futures research evolved as a way of examining the alternative futures and identifying the most probable. Forecasting is designed to help decision making and planning in the present (Walonick, 1993).

The term forecasting is used more frequently in recent time series literature than the word prediction. However, most forecasting results are derived from a general theory of linear prediction developed by Kolmolgrov (1941), Wiener (1949), Whittle (1983) and Yaglom (1962).

Forecasting connotes an attempt to see into the future, while prediction is the systematic procedure of doing so (Olatayo and Alabi, 2011).

In our daily life, people often use forecasting techniques to model and predict economy, population growth, stocks, weather, insurance / re – insurance, port folio analysis and etc. In this research, we attempt to model rare event and forecast appropriately to enable government and policy makers to take adequate steps toward forestalling its occurrences.

Rare events are those events that occur occasionally. They are events that their occurrence cannot be said to follow a stochastic or random process. Examples of this event are earth quake, road accident, plane crash, boat mishap etc. Rare events inherently occur in all kinds of processes. In hospitals, there are medication errors, infections, patient falls, ventilator-associated pneumonias, and other rare, adverse events that cause prolonged hospital stays and increase healthcare costs.

Road accident, being one of the most frequently occurred rare events in this part of the world, is considered in this paper. Deaths, resulting from road accidents have become a big problem in developing countries like Nigeria.

Unfortunately, about 80% of the world accident occurs in developing countries in which Nigeria is classified. Road accident are very critical not only because they result in harm and eventual disability or death of people, but also because they result in waste of resources such as those hospital services that could be used for other purposes, and loss of savings and working days of the accident victims which may improve the future life style of their families.

The most dominant factor in the chain of events leading to an accident is bad road, though coupled with human factor as a result of lackadaisical attitude of some drivers behind the wheel.

Due to negative impact of road accident on any economy, some countries have provided creative methods of educating people on the need to drive carefully on highway, which is the scene of most major accident.

The history of death due to road accident in Nigeria especially in most commercial cities has become more alarming. There has being a serious and fatal cases of death due to road accident in the last few years. Consequently, many organizations have shown a great interest in carrying out research on how to combat this issue.

In Nigeria, agencies like Nigeria Police Force (NPF), Federal Road Safety Commission (FRSC) and Lagos State Road Traffic Officers (LASMA) and a host of some other nongovernmental organization are charged with the responsibility of combating this ugly situation in the country.

In this paper, forecast techniques of three models; Least Square, Quadratic and Single Exponential Smoothening are compared in modeling. The models of primary interest are:

$$Y_t = \beta_o + \beta_1 t + e_t \quad (1)$$

$$Y_t = \beta_o + \beta_1 t + \beta_2 t^2 + e_t \quad (2)$$

$$Y_t = \beta_o \beta_1^t + e_t \quad (3)$$

Equation 1, 2 and 3 are called Least Square, Quadratic and Exponential models respectively.

MATERIALS AND METHODS

The data used for this research work was sourced from publication of National Bureau of Statistics (NBS) and Nigerian police Headquarter, Lagos Annex.

Statistical figures on total number of road accident, person injured and person killed were extracted from these publications between the periods of 1991 and 2010.

The trend analysis and forecast were carried out with the following methods:

Least Square Method

Let Y_t be a given series over time t, with Y depending on t, the Least Square model is given as

$$Y_t = \beta_o + \beta_1 t + e_t \quad (4)$$

Where β_o and β_1 are the parameters to be estimated and e_t is the ith error term distributed normally with mean 0 and variance σ_e^2 .

In predicting the future values based on equation (4), we adjust the data for the effect of seasonal variation and compute the forecast values from

$$\hat{Y}_t^{(A)} = T_t S_t \quad (5)$$

Where T_t and S_t are trend and seasonal index over time.

Quadratic Model

This is a special case of the general linear model. It contained squared of the predictor variable (t) making the response function curvilinear. Thus the model derived is

$$Y_t = \beta_o + \beta_1 t + \beta_2 t^2 + e_t \quad (6)$$

And the predicted model becomes,

$$\hat{Y}_t = \hat{\beta}_o + \hat{\beta}_1 t + \hat{\beta}_2 t^2 + e_t \quad (7)$$

Exponential Smoothing Techniques

This is one of the most successful forecasting methods. In this research, we consider single exponential smoothing which calculates the smoothed series as a damping coefficient times the actual series plus 1 minus the damping coefficient times the lagged value of the smoothed series.

Thus the model derived becomes

$$Y_t = \beta_o \beta_1^t + e_t \quad (8)$$

With a prediction model of

$$F_{t+1} = \alpha D_t + (1 - \alpha) F_t \quad (9)$$

Where D_t is the actual value

F_t is the forecasted value

α is the smoothing constant, which ranges from 0 to 1

t is the current time period

Comparism of Forecasting Techniques

We shall consider efficiency of forecasting with Least Square technique compared with both the Quadratic and Exponential smoothening technique. The performance measures to be considered are as follows:

Mean Absolute Deviation (MAD) = $\sum |e(t)| / n$

Mean Squared Deviation (MSD) = $\sum [e(t)]^2 / n$

Mean Absolute Percentage Error (MAPE) = $100 \sum [e(t) / Y(t)] / n$

RESULTS

The data used are the twenty (20) years road accident in Nigeria between years 1991-2010.

Fitting of Least Square Model

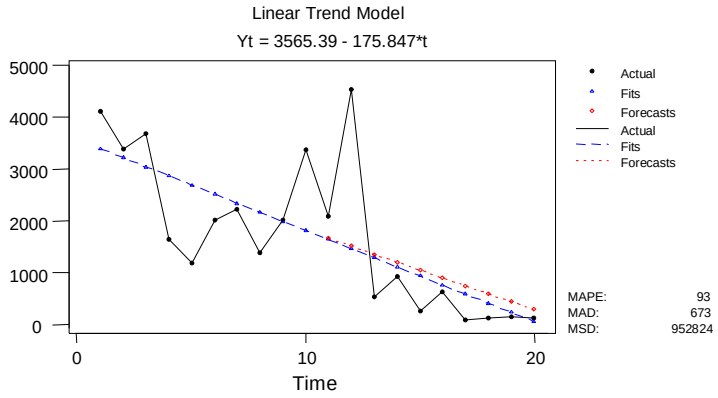
The fitted model is

Yt = 3565.39 - 175.847*t

The graph and forecast values are shown below

Row	Period	Forecast	Row	Period	Forecast
1	11	1656.20	6	16	889.84
2	12	1502.93	7	17	736.56
3	13	1349.65	8	18	583.29
4	14	1196.38	9	19	430.02
5	15	1043.11	10	20	276.75

Fig 1: LINEAR FORECASTING AND TREND ANALYSIS OF TOTAL KILLED FOR TEN YEARS



Fitting of Quadratic Model

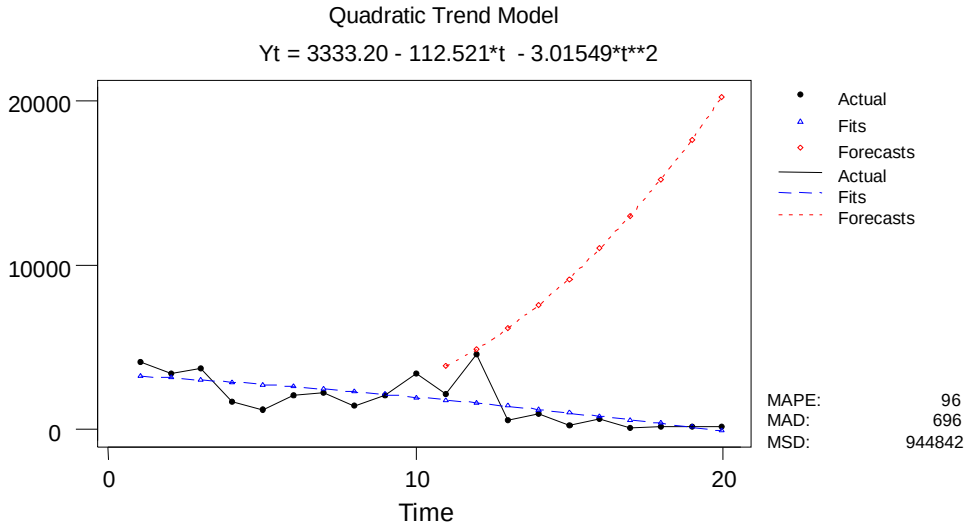
The Quadratic model is

Yt = 3333.20 - 112.521*t - 3.01549*t**2

The graph and forecast values area are shown below

Row	Period	Forecast	Row	Period	Forecast
1	11	3836.5	6	16	10998.7
2	12	4872.5	7	17	13025.7
3	13	6106.7	8	18	15251.0
4	14	7539.2	9	19	17674.5
5	15	9169.8	10	20	20296.2

Fig 2: QUADRATIC FORECASTING AND TREND ANALYSIS OF TOTAL KILLED FOR TEN YEARS

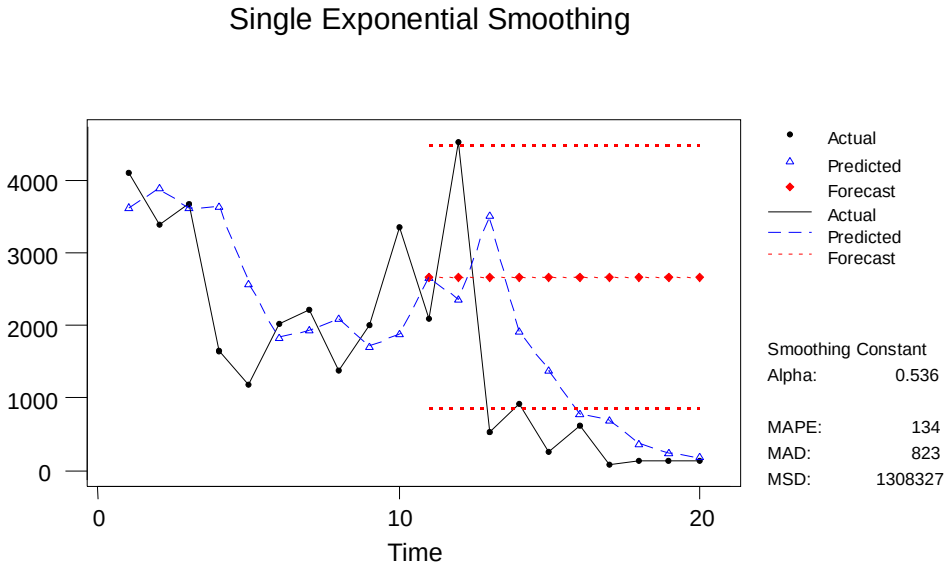


Fitting of Exponential Smoothing Model

The model is Yt = 6730.51*(0.831234**t).

The graph and forecast values are shown below

Row	Period	FORE1	Lower	Upper	Row	Period	FORE1	Lower	Upper
1	11	2668.91	849.796	4488.02	6	16	2668.91	849.796	4488.02
2	12	2668.91	849.796	4488.02	7	17	2668.91	849.796	4488.02
3	13	2668.91	849.796	4488.02	8	18	2668.91	849.796	4488.02
4	14	2668.91	849.796	4488.02	9	19	2668.91	849.796	4488.02
5	15	2668.91	849.796	4488.02	10	20	2668.91	849.796	4488.02



DISCUSSION

Table 1: Performances of Mean Absolute Percentage Error, Mean Absolute Deviation and Mean Square Deviation

	MAPE	**MAD**	**MSD**
Least Square Model	93.1030	672.545	912824
Quadratic Model	95.7738	696.275	944842
Exponential Smoothing Model	134	823	1308327

In this study, we have seen clearly the estimation of the parameter of Least Square, Quadratic and Single Exponential Smoothing models. All the three techniques gave a downward trend in the forecasting of road accidents in Nigeria, which is an evident of several traffic regulations already put in place by the government. Also, Mean Absolute Percentage Error, Mean Absolute Deviation and Mean Squared Deviation are computed to know which of the techniques a better forecasting model is. The Least square technique gives the smallest error, as shown in table 1 above.

CONCLUSION

As a result we have seen the performance of Least Square model on the other two models. Though it is good to forecast with the three models which we have done, but the forecast attached to the Least Square should be preferred because of its computational efficiency. Thus, forecasting model of Least Square shows a downward trend in road accident for the ten years forecast, and this may be due to serious attention government is given to several causes of this ugly incident.

REFERENCES

1. Walonick, D. S : An overview of forecasting Methodology, StatPac.,1983
2. Kolmogrov, A : Stationary Sequences in Hilbert Space, Bull. Math. Univ. Moscow 2, No. 6, 1941
3. Wiener, N : The Extrapolation, Interpolation and Smoothing of Stationary Time Series with Engineering Applications. Willey, New York, 1949
4. Whittle, P : Prediction and Regulation by Linear Least Square Methods. 2nd Edition, University of Minnesta, Minneapolis,1983

5. Yaglom, A.M : An Introduction to the Theory of Stationary Random Functions. Prentice-Hall, Englewood Cliffs, 1962
6. Olatayo, T.O and O.O Alabi : Forecasting Modeling in Stochastic Time Series Process. Jour. Of Mathematical Sciences Vol.22, No.2 , 135-142,2011
7. Ojo J.F., Olatayo T.O. and Alabi, O.O : Forecasting in Subsets Autoregressive Models and Autoprojective Models . Asian Journal of Scientific Research 1(5); 481-491, 2008
8. Chartfield, C : The Analysis of Time Series; An Introduction, Chapman and Hall, 1980
9. Hanke, J. and Reitsch. A : Business Forecasting: Fourth Edition. New York: Simon & Schuster.
10. Journal of Mathematical Sciences, Vol. 22, No.2 (2011) 135-142, 1992
11. Yule G.U : On the Method of Estimating Periodicities in Disturbed Series With Special Reference to Nolfer's Sunspot Numbers. Phil Trans. Roy. Soc. London Serie (A), 226-267, 1927