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Review Article

FORECASTING ACCEPTANCE OF NEW STUDENTS USING DOUBLE EXPONENTIAL SMOOTHING METHOD

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Abstract

Forecasting is the activity of estimating what will happen in the future. There are several methods that can be used in the forecasting process, including double exponential smoothing. In this research, forecasting is done to predict the number of new student admissions in a study program at a university by using the double exponential smoothing method. The results of the study are based on admission data for 10 years, the best forecasting value is obtained using the parameters α = 0.8 and β = 1, with a Mean Percentage Error (MPE) value of 0.1172.

Keywords: Forecasting, Double Exponential Smoothing, Mean Percentage Error (MPE)

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Introduction

Forecasting is the art and science of predicting events that will occur using historical data and projecting it into the future with some form of mathematical model [1]. In the case of forecasting data that is often used is quantitative data. The results of a forecast do not have to always produce a definite answer to an event, but rather try to find an answer that is as close as possible for an event that will occur [2]. The forecasting method is a way to estimate quantitatively what will happen in the future on the basis of the relevant data in the past.

Forecasting methods provide a sequence of workmanship and solution to the approach of a problem in forecasting so that if the same approach is used in a problem [3]. Forecasting methods provide a sequence of workmanship and solution to the approach of a problem in forecasting so that if the same approach is used in a problem in forecasting activities, then the same rationale and solution will be obtained.

There are several methods related to forecasting, including the exponential smoothing method, the box-jenkins method and the regression method [4]. Exponential smoothing is a method that continuously improves forecasting by taking the average value of past value refinement of a time series data in a decreasing way [5]. The exponential smoothing method is divided into several methods, one of which is double exponential smoothing.

Double exponential smoothing method is used to overcome the differences that arise between the actual data and forecasting values if there is a trend in changes in the data [6]. The level of double exponential smoothing is an estimation which is smooth from the data value at the end of each period (the value of the smoothing level of the forecasting data) [7]. A trend is a smoothed estimate of the average growth at the end of each period.

The number of student admissions at a university can be determined by several factors. For example, the availability of study programs available at the university, facilities, and curriculum used [8]. In an effort to increase the admission of new students, usually at a university, a new admissions team is formed. In addition to conducting promotional activities, the new student admissions team must also be able to predict or predict the number of new students in the coming new school year.

In some cases, the forecasting process is not based on a real method. Forecasting is only by using intuition by the student admissions team so that the results obtained with forecasting can be very different. Based on these reasons, this research discussed the process of forecasting the admission of new students to a study program using the double exponential smoothing method.

Materials and Method

Forecasting is the activity of estimating what will happen in the future. While the forecast is a situation or condition that is expected to occur in the future [9]. There are several methods related to forecasting, including the exponential refinement method, the box-Jenkins method and the regression method [4].

The forecasting method is a way to estimate quantitatively what will happen in the future on the basis of the relevant data in the past [10]. Forecasting methods provide a sequence of workmanship and solution to the approach of a problem in forecasting so that if the same approach is used in a problem in forecasting activities, then the same rationale and solution will be obtained. Whether or not a forecast is compiled, besides being determined by the method used, also whether or not the information used is well determined.

Exponential smoothing is a method with a procedure of continuous improvement in forecasting the latest observation objects. This method focuses on decreasing priorities exponentially on older observation objects [5]. In other words, the latest observation will be given a higher priority for forecasting than the longer observation.

Double exponential smoothing is used when data show an exponential smoothing trend with a trend such as simple smoothing except that two components must be updated every period-level and trend. Level is an estimate that is smoothed from the data value at the end of each period (the value of the refinement of the forecasting data). A trend is a smoothed estimate of the average growth at the end of each period [7]. The double exponential smoothing method is carried out according to the following equation:

$$L_t = \propto Y_t + (1-\propto)(L_{t-1} + b_{t-1}) \quad (1)$$
$$b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1} \quad (2)$$
$$F_{t+m} = L_t + b_t m \quad (3)$$

Where the weighting α and β are between 0 to 1. L_t states the estimated magnitude (level) states the forecast value at time t, and b_t states the value of slope at time t.

The results of accurate forecasting are forecasts that can minimize forecasting errors. A measure of the accuracy of forecasting results which is a measure of forecasting error is a measure of the degree of difference between forecasting results and requests that occur [11]. Some of the measurements used are as follows :

Mean absolute deviation (MAD) is a method used to measure the accuracy of a forecasting data [12]. The smaller the value, the more accurate the forecasting is. The MAD value is calculated using equation 4.

$$MAD = \frac{\sum|Ft|}{m} \quad (4)$$

Where :
Ft = Forecasting requests in the t-period
m = Number of forecasting periods involved

Mean square error (MSE) is calculated by adding up the squares of all parametric errors in each period and dividing by the number of forecasting periods [9]. MSE is mathematically formulated according to equation 5.

$$MSE = \sum\frac{(Ft-Yt)^2}{m} \quad (5)$$

Where :
Yt = Actual requests in the t- period
Ft = Forecasting requests in the t-period
m = Number of forecasting periods involved

Mean percentage error (MPE) is very effective to know whether a forecast result during a certain period is too high or too low. MPE is calculated by adding up all forecasting errors during the forecasting period and dividing it by the number of forecasting periods [9]. MPE is mathematically formulated according to equation 6.

$$MPE = \frac{100\%}{n}\sum\frac{(Ft-Yt)}{m} \quad (6)$$

Mean absolute percentage error (MAPE) is a measure of the relative error. MAPE states the percentage of error forecasting results from actual requests during a certain period that will provide information on the percentage of errors too high or too low [13]. Mathematically MAPE is formulated according to equation 7.

$$MAPE = \sum\frac{\left|\frac{Yt-Ft}{Yt}\right|}{nYt}x100 \quad (7)$$

Root mean square error (RMSE) is a standard residual deviation (prediction error). Root mean square error is commonly used in climatology, forecasting, and regression analysis to verify experimental results [9]. RMSE is calculated using equation 8.

$$RMSE = \sqrt{\sum\frac{(Yt-Ft)^2}{m}} \quad (8)$$

Forecasting calculations will be done by using data from the data input. For example, the data used are new student admission data for 6 years in all study programs, as in Table 1.

Table 1. Examples of Data for Student Admissions for 6 Years

Periode (m)	Actual Data (Yt)	Level (Lt)	Trend (bt)	Forecasting(Ft)
1	50			
2	60			
3	80			
4	59			
5	62			
6	30			
7				?

Calculation of level value, trend value, and forecast value, the value of α used is 0.5, while the value of β used is 0.4. Calculation of forecasting is done starting from year 3. Based on equation 1, the 3rd year level values are obtained :

L_{t3}= 0.5 x 60 + (1-0.5) x 80
= 70

Based on equation 2, the value of the 3rd year trend is obtained :

b_{t3} = 0.4 x (70-0)+(1-0.4) x 80
= 76

Based on the results of L_{t3} and b_{t3}, the forecast for the 4th year is equal to :

$$F_{t+m} = L_t + b_t m$$
$$F_{t4} = L_{t3} + b_{t3}$$
$$F_{t4} = 70 + 76$$
$$F_{t4} = 146$$

L_{t4}= 0.5 x 59 + (1-0.5) x 146
= 102.5

b_{t4} = 0.4 x (102.5-70)+(1-0.4) x 76
= 58.6

F_{t5}= 102.5+58.6
= 161.1

L_{t5}= 0.5 x 62 + (1-0.5) x 161.1
= 111.55

b_{t5} = 0.4 x (111.55-102.5)+(1-0.4) x 58.6
= 38.78

F_{t6}= 111.55+38.78
= 150.33

L_{t6}= 0.5 x 30 + (1-0.5) x 150.33
= 90.165

b_{t6} = 0.4 x (90.165-111.55)+(1-0.4) x 38.78
= 14.714

F_{t7}= 90.165+14.714
= 104.879

Next performed the calculation of the value of MAD, MSE, RMSE, MAPE and MPE based on the forecasting results obtained. The following is given a calculation of the data in the period m = 3.

$$MAD = \frac{\sum|Ft|}{m}$$
MAD = 80-80
= 0

$$MSE = \sum\frac{(Ft-Yt)^2}{m}$$
MSE = 0

$$RMSE = \sqrt{\sum\frac{(Yt-Ft)^2}{m}}$$
RMSE = 0

$$MAPE = \sum\frac{\left|\frac{Yt-Ft}{Yt}\right|}{nYt}x100$$
MAPE = 0

$$MPE = \frac{100\%}{n}\sum\frac{(Ft-Yt)}{m}$$
MPE = 0

The calculation of each criterion for forecasting data obtained is presented in Table 2.

Tabel 2. Forecasting Result

Periode (m)	Data Aktual (Yt)	Forecasting (Ft)	MAD	MSE	MAPE
3	80	80	0	0	0.00
4	59	146	87	7569	1.47
5	62	161	99	9801	1.60
6	30	150	120	14400	4.00
7	101	104	3	9	0.03
Total			309.00	31779.00	7.10
Value			61.80	6355.80	1.42
RMSE					79.72
MPE					0.28

Result

In this study forecasting the admission of new students in a study program at a university based on data on admission of new students for the last 10 years. The data on admission of new students is presented in Table 3.

Table 3. New Student Admission Testing Data

Period (m)	**Actual Data (Yt)**
1	80
2	68
3	55
4	60
5	70
6	58
7	73
8	80
9	68
10	102

Forecasting calculations using the Double Exponential Smoothing method, are performed using the values of the variables α and β which vary between 0 to 1. Table 4 is the result of data processing using the value of α = 1 and the value of β = 0.1. While Table 5 is the result of data processing using the value α = 0.8 and the value β = 1.

Table 4. Forecasting Results Using the Value α = 1 and the value β = 0.1

Number	Actual Value	Forecast Value
1	80	73
2	68	61
3	55	47
4	60	53
5	70	65
6	58	52
7	73	69
8	80	78
9	68	65
10	102	102
MAD		19.55942
MSE		747.30396
RMSE		27.33686
MAPE		0.25511
MPE		0.16562

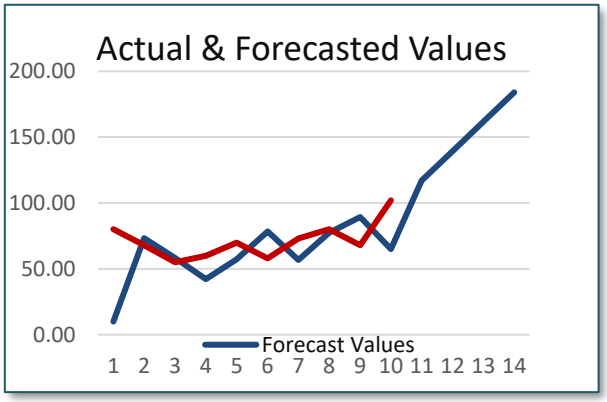

Figure 1. Comparison of Actual Value and Forecast Value Graph Using Value α = 1 and value β = 0.1

Table 5. Forecasting Results Using the Value α = 0.8 and the value β = 1

Number	Actual Value	Forecast Value
1	80	73
2	68	58
3	55	42
4	60	57
5	70	78
6	58	57
7	73	77
8	80	89
9	68	65
10	102	117
MAD		20.65656
MSE		792.68151
RMSE		28.1546
MAPE		0.27722
MPE		0.11719

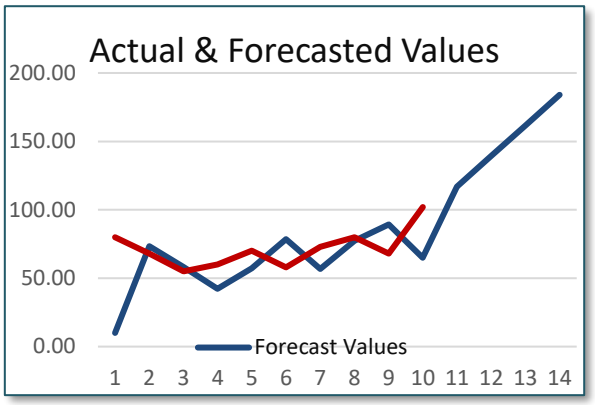

Figure 2. Comparison of Actual Value and Forecast Value Graph Using the Value α = 0.8 and the value β = 1

The results of forecasting data processing using the double exponential smoothing method based on changes in the values of α and β are presented in graphical form in Figure 3.

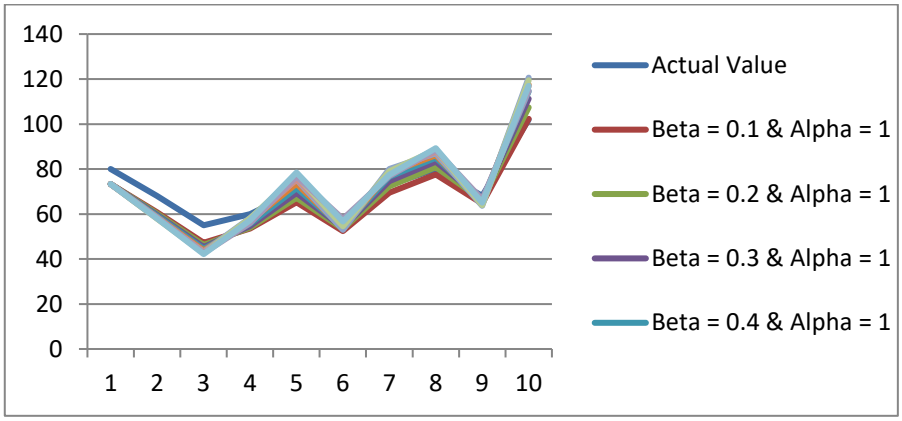

Figure 3. Graph of Results of Data Processing Changes in α and β values

The smallest MPE values processed in each iteration based on changes in the values of α and β are presented in Table 6.

Table 6. The Smallest MPE Value of Each Iteration Based on Changes in α and β Values

Number	α	β	MPE
1	1	0.1	0.1656
2	1	0.2	0.1529
3	1	0.3	0.1429
4	1	0.4	0.1354
5	1	0.5	0.1299
6	1	0.6	0.126
7	0.9	0.7	0.1233
8	0.9	0.8	0.1208
9	0.8	0.9	0.1191
10	0.8	1	0.1172

Conclusion

Based on the data processing carried out in this study, it was concluded that the best forecasting was obtained when the value of α = 0.8 and the value of β = 1, with an MPE value of 0.1172. Forecasting process by using double exponential smoothing will be influenced by the values of α and β, where changes in the values of α and β will result in changes in the MPE value of the forecasting process.

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