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Call Forecasting for Inbound Call Center

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Call Forecasting for Inbound Call Center

Abstract
In a scenario of inbound call center customer service, the ability to forecast calls is a key element and advantage. By forecasting the correct number of calls a company can predict staffing needs, meet service level requirements, improve customer satisfaction, and benefit from many other optimizations. This project will show how elementary statistics can be used to predict calls for a specific company, forecast the rate at which calls are increasing/decreasing, and determine if the calls may stop at some point.

Keywords
Call Forecasting, Linear Regression, Extrapolation

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PROBLEM STATEMENT

The data provided in Table 1 was the template used to determine future trends and expectations. Other specific items that will be addressed include:

(1) Finding an expression that will represent the best line.

(2) Plotting the points on a graph and using the chart to determine what inferences can be made.

Date	Calls Handled
Jan-08	93063
Feb-08	83982
Mar-08	81342
Apr-08	82143
May-08	77217
Jun-08	76592
Jul-08	81861
Aug-08	76219
Sep-08	71736
Oct-08	71799
Nov-08	61333
Dec-08	64857
Jan-09	68236
Feb-09	62689
Mar-09	65644
Apr-09	55710
May-09	53534
Jun-09	56355
Jul-09	60975
Aug-09	58577
Sep-09	56918
Oct-09	54316
Nov-09	40865

Table 1: Calls handled over a 23 month time period.

MOTIVATION

This project is a direct relationship to my job as an Assistant Program Manager in an Inbound Call Center. The ability to apply my calculus knowledge to this real life scenario allows me to retain the information much better than a traditional classroom learning environment.

MATHEMATICAL DESCRIPTION AND SOLUTION APPROACH

For a set of n points (x_1, y_1), ... , (x_n, y_n) the linear least-square approximation is given by $y = \hat{\beta}x + \hat{\alpha}$ where

$$\hat{\beta} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (1)$$

and

$$\hat{\alpha} = \bar{y} - \hat{\beta}\,\bar{x}. \quad (2)$$

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In the case of the call center data, the months must first be represented as numbers to obtain the x values. For convenience, set Jan-08→ 1, Feb-08→ 2, … , Nov-09→ 23. Now

$$\bar{x} = \frac{1}{23}\sum_{i=1}^{23} x_i = 12 \qquad \text{and} \qquad \bar{y} = \frac{1}{23}\sum_{i=1}^{23} y_i = \frac{1{,}555{,}963}{23} \approx 67{,}650.6$$

and using (1) and (2) the parameter values are calculated as

$$\begin{cases} \hat{\beta} = -1{,}746.6 \\ \hat{\alpha} = 88{,}609.8\,. \end{cases} \tag{3}$$

Now that the best linear approximation has been established, some justification for using a linear model is needed. For this, the sample correlation coefficient R is calculated. Mathematically, the sample correlation coefficient is defined as the following:

$$R = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2}} \tag{4}$$

Geometrically, a data set with an R of 1 or -1 may be fit exactly as linear function. These results are summarized below. When $R = 0$, there is no linear correlation between the x's and y's. The sign of the sample correlation coefficient indicates whether the x's and y's have a positive or negative correlation. For the call center data,

$$R = -\frac{883{,}781}{\sqrt{878{,}977{,}245{,}498}} \approx -0.9427 \tag{5}$$

which indicates that there is strong evidence for using the linear approximation.

DISCUSSION

The following chart (Figure 2) was created in Excel and summarizes the statistics presented in the preceding section. Using the linear model $y = -1746\,x + 88610$, it is possible to forecast the future number of calls beyond the given data.

The reliability of this regression model is reinforced by the extreme correlation coefficient $R \approx -0.94$ calculated in (5). For a sample of size 23, a correlation of $-1.0 \leq R \leq -0.5$ is considered to be a strong negative correlation. The data clearly suggests that the number of inbound calls is strongly dependent on time and decreasing at a steady pace of around 1,746 calls per month. If this trend continues, the model predicts the center will stop receiving calls by March 2012. For further details, see Table 3 and Figure 4 in the Appendix.

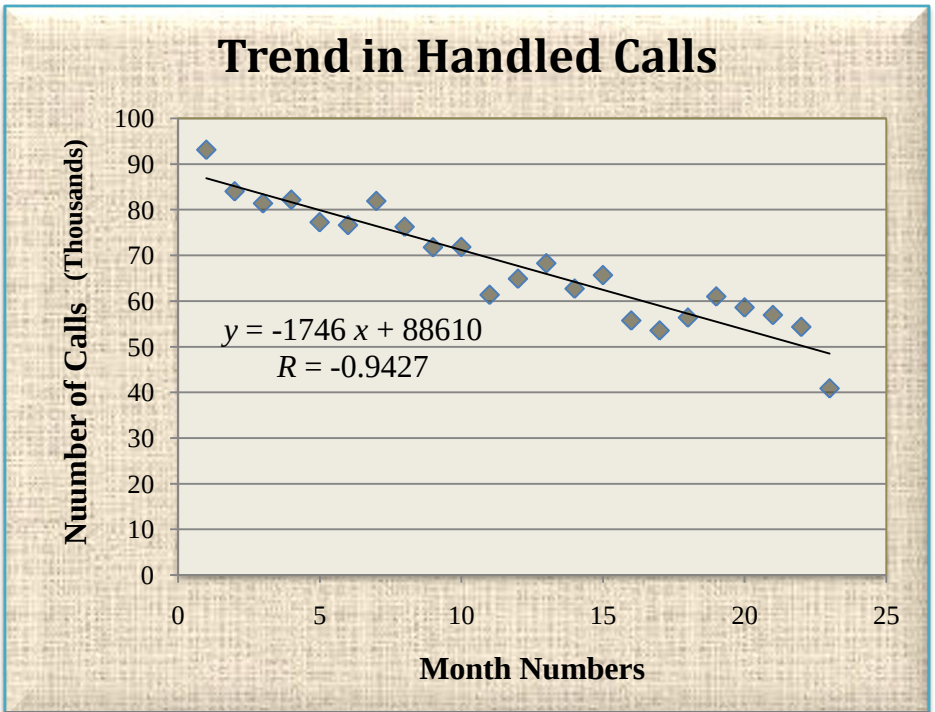

Figure 2: Number of calls handled from January 2008 to November 2009.

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CONCLUSION AND RECOMMENDATIONS

The forecasting model created from the data confirmed both computationally and graphically that there is a simple linear relationship between time and the number of calls received by the inbound call center. By extrapolating this model, it was determined that the center would stop receiving calls by March 2012. If the business does not change this trend and increase the number of calls soon, there will not be a need for this call center.

REFERENCES

WEB REFERENCE:

http://www.weibull.com/DOEWeb/simple_linear_regression_analysis.htm

OTHER REFERENCES:

- All charts and data were plotted using Microsoft Excel 2007.
- Workforce Manager and Catrinia Hanlon provided the data for the calls received.

APPENDIX

Month Number	Month Name	Actual Calls	Estimated Calls
1	Jan-08	93063	86863.2
2	Feb-08	83982	85116.6
3	Mar-08	81342	83370.0
4	Apr-08	82143	81623.4
5	May-08	77217	79876.8
6	Jun-08	76592	78130.2
7	Jul-08	81861	76383.6
8	Aug-08	76219	74637.0
9	Sep-08	71736	72890.4
10	Oct-08	71799	71143.8
11	Nov-08	61333	69397.2
12	Dec-08	64857	67650.6
13	Jan-09	68236	65904.0
14	Feb-09	62689	64157.4
15	Mar-09	65644	62410.8
16	Apr-09	55710	60664.2
17	May-09	53534	58917.6
18	Jun-09	56355	57170.9
19	Jul-09	60975	55424.3
20	Aug-09	58577	53677.7
21	Sep-09	56918	51931.1
22	Oct-09	54316	50184.5
23	Nov-09	40865	48437.9
24	Dec-09	-	46691.3
25	Jan-10	-	44944.7
26	Feb-10	-	43198.1
27	Mar-10	-	41451.5
28	Apr-10	-	39704.9
29	May-10	-	37958.3
30	Jun-10	-	36211.7
31	Jul-10	-	34465.1
32	Aug-10	-	32718.5
33	Sep-10	-	30971.9
34	Oct-10	-	29225.3
35	Nov-10	-	27478.7
36	Dec-10	-	25732.1
37	Jan-11	-	23985.5
38	Feb-11	-	22238.9
39	Mar-11	-	20492.3
40	Apr-11	-	18745.7
41	May-11	-	16999.1
42	Jun-11	-	15252.5
43	Jul-11	-	13505.9
44	Aug-11	-	11759.3
45	Sep-11	-	10012.7
46	Oct-11	-	8266.1
47	Nov-11	-	6519.5
48	Dec-11	-	4772.9
49	Jan-12	-	3026.3
50	Feb-12	-	1279.7
51	Mar-12	-	-466.9

Table 3: Calls Estimated by Linear Regression

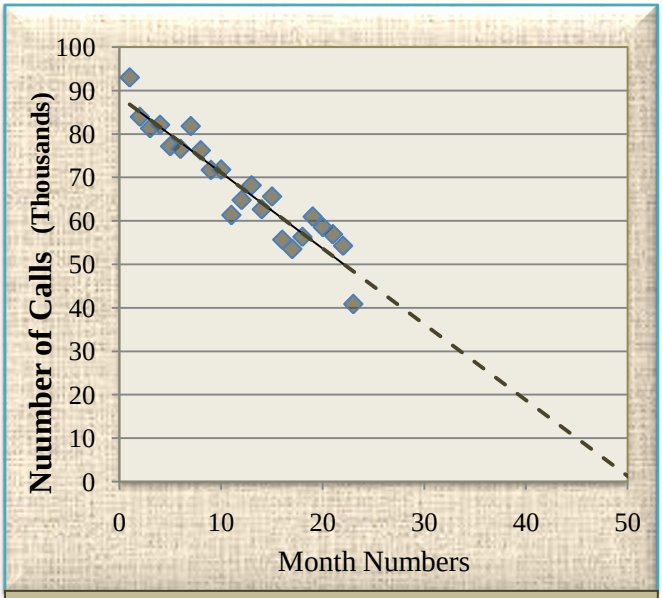

Figure 4: Projected trend for the next 27 months of calls received as predicted by the linear model.

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