ISyE 3013 Supply Chain Modeling: Logistics
Summer 2012
Homework 4
Issued: June 6, 2012
Due: June 13, 2012

50 points.

Exercises 2 and 3 in this homework are based on data sets. You can download the data sets from t-square (t-square.gatech.edu) where they are posted as text (ASCII) files.

Exercise 1
The following gives the number of pints of type A+ blood used at Woodlawn hospital in the past six weeks.

<table>
<thead>
<tr>
<th>WeekOf</th>
<th>PintsUsed</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 31</td>
<td>360</td>
</tr>
<tr>
<td>September 7</td>
<td>389</td>
</tr>
<tr>
<td>September 14</td>
<td>410</td>
</tr>
<tr>
<td>September 21</td>
<td>381</td>
</tr>
<tr>
<td>September 28</td>
<td>368</td>
</tr>
<tr>
<td>October 5</td>
<td>374</td>
</tr>
</tbody>
</table>

1. Forecast the demand for the week of October 12 using a 3-week moving average.

2. Use a 3-week weighted moving average with weights of 0.1, 0.3, and 0.6. Use 0.6 for the most recent demand observation. Forecast the demand for the week of October 12.

3. Compute the forecast for the week of October 12 using exponential smoothing with a forecast for August 31 of 360 and $\alpha = 0.2$.

Exercise 2
Data set 1 “ukdeaths.txt” gives the number of deaths and serious injuries in road accidents for each of 192 consecutive months. Also given, in the second column, is an indicator that shows when a seatbelt law was in effect. (The seatbelt law was introduced in month 170.) A large transportation company hired you as a consultant to forecast the number of deaths and serious injuries in road accidents for the next month (month 193).

Use exponential smoothing and regression to make forecasts. Clearly explain your regression model.

How long does exponential smoothing take to “learn” the pattern of the data?

Did the seatbelt law decrease the number of deaths and serious injuries in road accidents? Justify your answer with the results of your data analysis.
For the regression forecast, compute the number of accidents such that the probability that the number will be exceeded is 0.2.

Compare the forecasts produced by the different methods. Do you think one method works better than another method? Why? To do the comparisons, make appropriate plots and calculate appropriate quantities.

Exercise 3
For the purpose of this exercise you may assume that a year has exactly 52 weeks. Data set 2 “fuelsales.txt” gives the amount of 87 octane gasoline sold at a gas station in each of 109 consecutive weeks, 2 years and 5 weeks. A promotion was run early in the second year, in weeks 3, 4, and 5 (inspect the data to see the effect of the promotion).

Use exponential smoothing and regression to forecast 87 octane gasoline sales for week 110 (“this year, week 6”). Clearly explain your regression model. Do you think one method works better than another method? Why?

Exercise 4
We want to forecast the time it will take a driver to perform a number of tasks. Suppose a “task” consists of driving a certain distance, and then delivering and/or picking up a certain number of packages. Let

\[ Y_i = \text{the time to perform task } i, \text{ in minutes} \]
\[ X_{1i} = \text{the distance to be driven, in km} \]
\[ X_{2i} = \text{the number of packages to be delivered} \]
\[ X_{3i} = \text{the number of packages to be picked up} \]
\[ X_{4i} = \begin{cases} 1 & \text{if a signature has to be obtained with task } i \\ 0 & \text{otherwise} \end{cases} \]

We chose the following model to estimate.

\[ \hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 \sqrt{X_{1i}} + \hat{\beta}_2 X_{2i} + \hat{\beta}_3 X_{3i} + \hat{\beta}_4 X_{4i} \]

We estimated the following from our data that contain 30 observations. We assumed that the error terms \( \varepsilon_i \) are independent \( N(0, \sigma^2) \) distributed.

\[ \hat{\beta}_0 = 1.5 \]
\[ \hat{\beta}_1 = 7.2 \]
\[ \hat{\beta}_2 = 0.4 \]
\[ \hat{\beta}_3 = 0.8 \]
\[ \hat{\beta}_4 = 2.3 \]
\[ \text{Var}(\hat{\beta}_0) = 0.13 \]
\[ \text{Var}(\hat{\beta}_1) = 16.4 \]
\[ \text{Var}(\hat{\beta}_2) = 0.02 \]
\[ \text{Var}(\hat{\beta}_3) = 0.19 \]
\[ \text{Var}(\hat{\beta}_4) = 0.7 \]
3.1 In terms of the parameters, what is your estimate of the difference in time between picking up a package and delivering a package?

3.2 In terms of the parameters, what is your estimate of the incremental time to obtain a signature?

3.3 Construct a 90% confidence interval for $\beta_1$.

3.4 We want to estimate the time for the driver to perform the following task: drive 9km, deliver 2 packets and pick up 3 packets, and obtain a signature for the delivered packets. Forecast the time that it would take the driver to perform this task.

3.5 We estimate the variance of the forecast to be

$$\hat{Var}(\hat{Y}) = 2.3$$

Thus there is some doubt as to the accuracy of the forecast. We want to give the driver some benefit of the doubt. Make a conservative time estimate, such that the probability that the estimate is exceeded is approximately 0.3.