UCM V Modelling Week
Forecasting the demand for bread

Problem Description

March 2011

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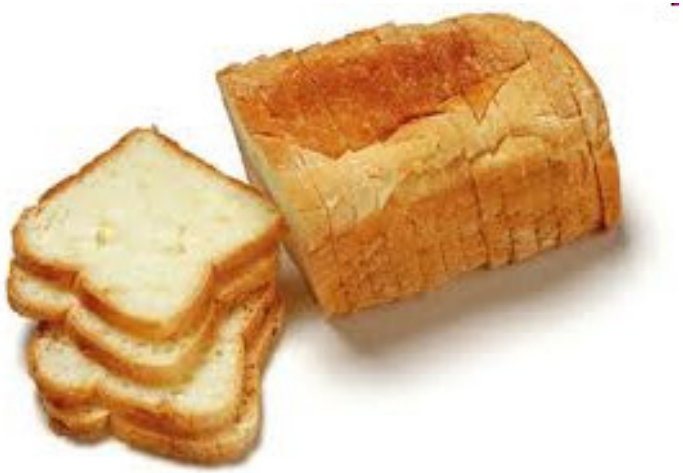
01 Problem Description

- The determination of the daily demand for bread in stores is a very complex mathematical problem, for wich a more or less accurate solution can have a significant economic impact on the income of distribution companies

- Tha ability to forecast the number of units that will be sold in each point of sale gives a way to control the two major costs involved:

  – “Returns” factor: The number of returns for point of sale (due to the expiration of the product)
  – “Out of stock” factor: The lack of supply in the event that stocks are exhausted



01 Problem Description

- Addressing the problem by modelling the time series of bread daily demand for point of sale has several characteristics that must be taken into account when building the mathematical models:

  – The outlets are too many to build a different model for point of sale. It is therefore necessary to construct a model with a common structure and then adjusting the model for point of sale, estimating the parameters of the model from the data associated to each point of sale
  – The best fitting is not necessarily the one that minimizes the error or other statistical metrics, because it must be taken into account the loss associated to underestimate the demand and the cost of returns
  – The factor “out of stock” skews the number of units sold: when all existing units in shop have been sold, no one knows for sure how many units could have been sold
  – The data for “returns” is not immediately known but is provided once the product has expired. To simplify the problem, we will assume the following hypothesis: “if a unit is not sold one day, the return is done that very same day”

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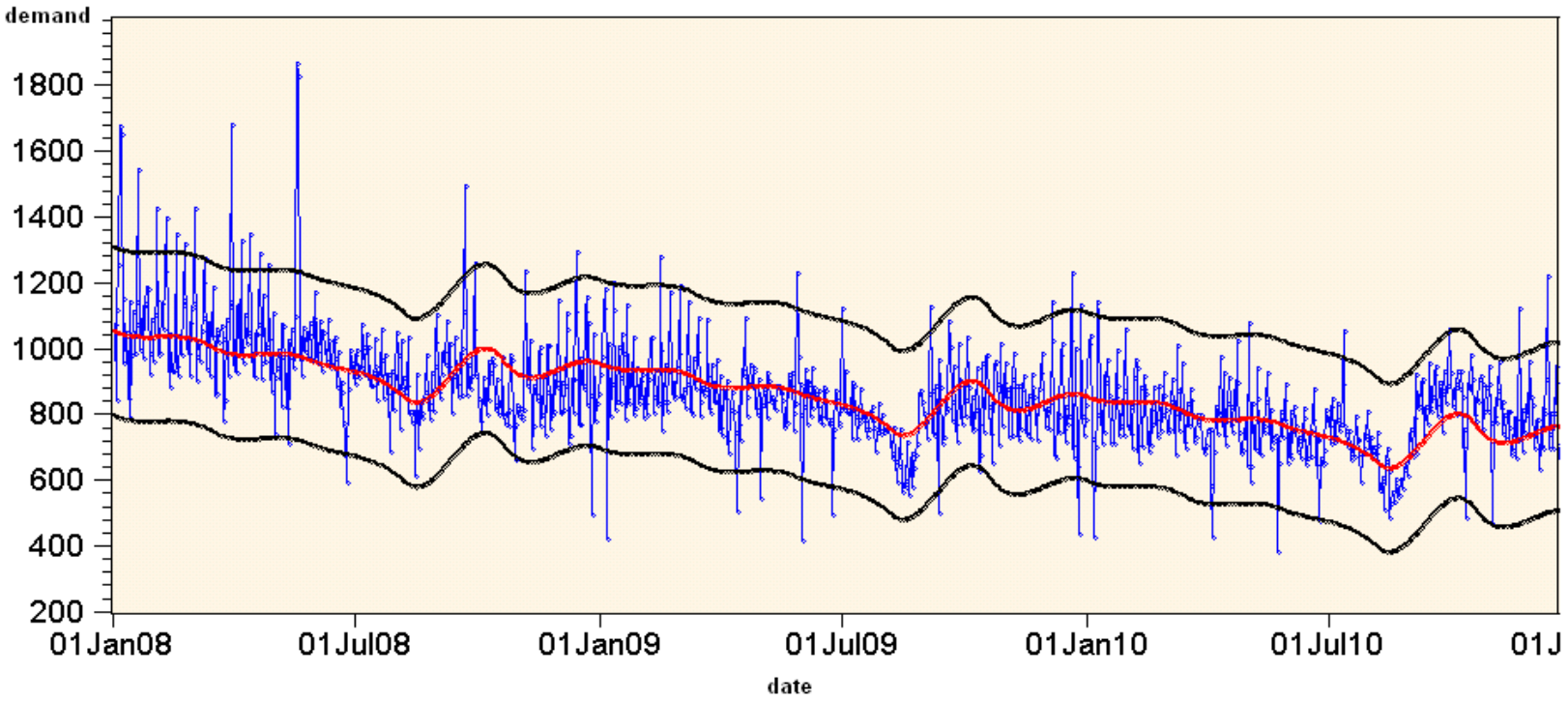
02 Mathematical treatment

- The aim of this analysis is to design a basic model for the treatment of this kind of series. Some examples will be provided in order to test whether the model fits well enough to data:

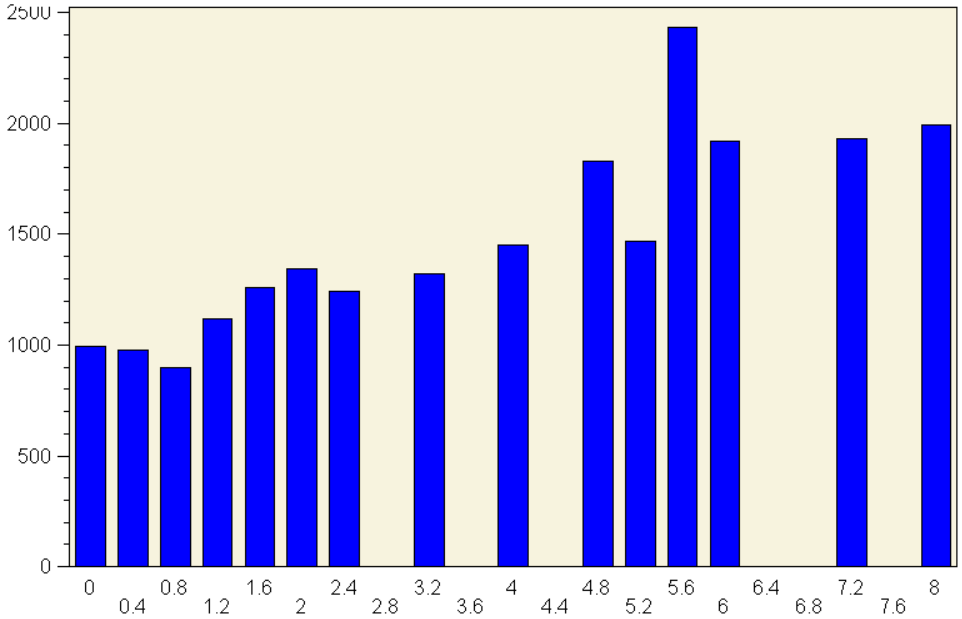
  - In this model trend and weekly seasonality should be collected at least
  - As the prediction horizon that arises is 7 days, it is not necessary to add to the model a cycle component which reflects the annual periodicity



02 Mathematical treatment

- Some other considerations that should be reflected in the model are:
  - Outliers detection: calendar consideration is essential
  - For shop closing dates, when there is no data, the use of interpolation is allowed
  - It is also available a variable which shows daily advertising pressure that measures the intensity of the campaigns carried out to improve sales (transfer function models)

Average demand



Advertising pressure

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03 Problem resolution information

- The following information will be provided to help solve the problem:
  - Historical data by point of sale
    - Point of sale code
    - Date: day
    - Number of units shipped every day by point of sale
    - Number of units returned daily (due to out-of-date) in each outlet
  - Notes about point of sales
    - Data of several randomly chosen points of sale will be provided
    - In case of no sales (products sold equals to zero) it will be because of shop closing dates:
      "Information on whether the point of sale is closed or not, will be known at the time of the prediction"
  - Calendar data and marketing campaigns
    - To assist in the prediction, you will be provided with several calendar variables for each day that may be useful in building the model, as well as a daily advertising campaign variable that measures the intensity of advertising to improve sales made that day
    - These data are also known at the time of the prediction

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04 ROI Analysis

- The prediction desired is that of knowing how many units should be sent to every point of sale in every day for the next 7 days

- Alternatively it is proposed that the final determination of the demand is adjusted by optimizing a cost function that takes into account the concepts “out of stock” and “returned product”

  - To do so, it will be provided the cost of a return and the profitability of each unit not sold

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value on every interaction