

Sales Forecasting Model. Analysis of Covariables and Inclusion in the Model.

IX Modelling Week
Universidad Complutense de Madrid
15th to 19th June 2015

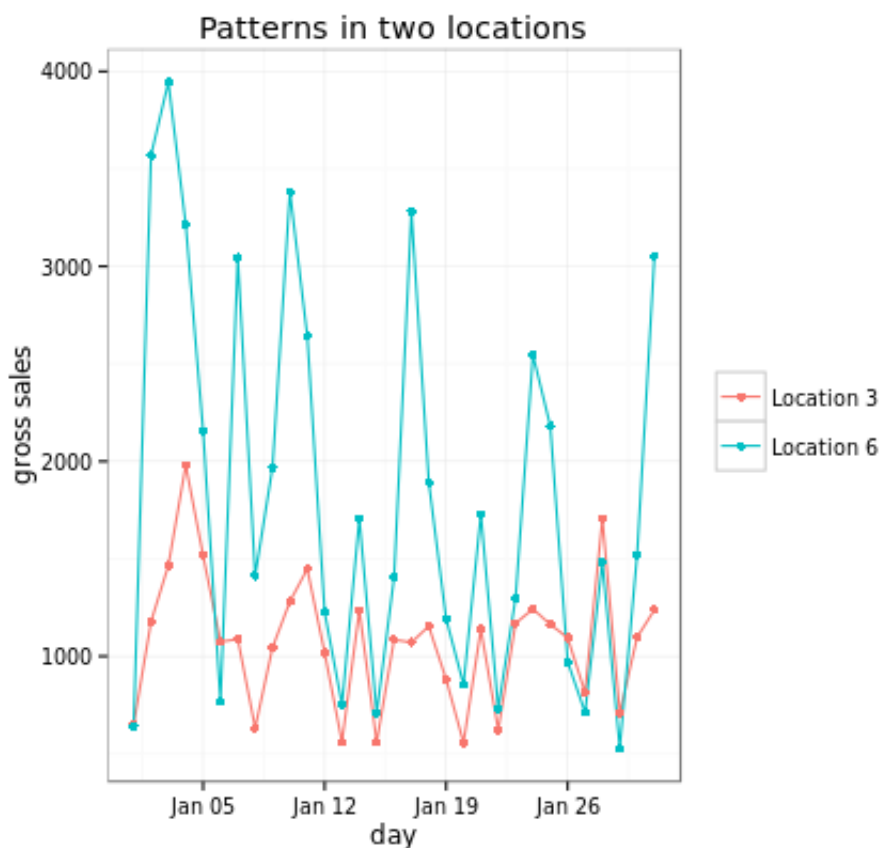


1 The sales forecast challenge

A good and accurate prediction of demand is a key step in any business optimization process. In the restaurant sector, this accurate estimate is necessary not only to guarantee a good service to the client but also to control operating expenses.

In the restaurant industry, demand is highly patterned: sales figures represent a year periodicity, but also monthly, weekly and even hourly patterns within the day arise.

Every restaurant has its own circumstances that determine its actual figures and periodicities, but it's reasonable to think that similar concepts show similar patterns.



With this in mind, a practical approach to estimate the total sales amount for a certain day can be performed through a nearest neighbour procedure. However, there are other variables that have a great influence in the actual sales figure, like special events, singular dates or active promotions that encourage or discourage client consumption, over the baseline prospect.



As we can see, there is an important positive correlation between the sales figures of a certain day compared to the same figure of the *comparable day*¹ of the previous year.

The objective of this challenge is to refine the forecasting model to include other significant variables like active promotions and weather variables, evaluate whether or not they are significant and, if so, estimate the weight of their influence and modify accordingly the initial model.

¹In the sector, the *comparable day* is defined as the same day of the week in the calendar for the year of comparison.

2 The problem formulation

As we have mentioned in the previous section, given the patterned structure of sales in this sector, we can in practice approximate the estimation of the total sales for a day as the same value of the comparable day of the previous year, corrected by a multiplicative factor.

$$\hat{V}_Y(k) = \alpha V_{Y'}(k') \quad (1)$$

where k represents the day of year Y for which we want to estimate the sales, and k' is the comparable day for k in year Y' (typically $Y' = Y - 1$).

The factor α reflects the estimated trend for the year. It can be set based on already observed data, or on additional information like the economical prospect, the neighbourhood trend, business maturity...

However, some estimates are not very accurate. The actual figures are corrected by other factors like the weather conditions or the presence or absence of active promotions.

We propose an additive model that includes some of these variables over the baseline nearest neighbour model described in (1).

$$\hat{V}_Y(k) = \alpha V_{Y'}(k') + \theta_R \Delta_R(k, k') + \theta_T \Delta_T(k, k') + \theta_P \Delta_P(k, k') \quad (2)$$

where θ_R is the parameter for the *Rain variable*, $\Delta_R(k, k')$ is the difference in rain conditions for days k and k' . Equivalently, θ_T , θ_P are the parameters for the *Temperature variable* and the *Active Promotions variable*, and Δ_T , Δ_P are respectively the variation in temperature and promotions.

We can also estimate the influence of the additional variables in relative terms, so that an alternative model can be explored:

$$\hat{V}_Y(k) = \left(\alpha + \theta_R \Delta_R + \theta_T \Delta_T + \theta_P \Delta_P \right) V_{Y'}(k') + \left(\varphi_R + \varphi_T + \varphi_P \right) \quad (3)$$

3 Working plan

Mapal Software will provide the participants with a collection time series representing the actual sales figures of different restaurants, as well as the weather conditions and the active promotions for the concerned dates.

The (non exhaustive) possible steps the participants could follow are :

- Evaluate the best model to complement the current model (1), which is commonly used in the restaurant sector.
- Evaluate the influence of the new variables.
- Estimate the parameters of the new model.
- Provide a final algorithm as a deliverable so that Mapal Software can reproduce the analysis and variable contrast in the future.
- Propose new approaches to sales forecasting: ARIMA, exponential...