

Heuristic Approach for Demand Forecasting under the Impact of Promotions

¹Sahana.N, ²Dr. N.V.R. Naidu

¹Student, MTech II Year, Department of IEM, Ramaiah Institute of Technology, Karnataka, India

²Principal, Ramaiah Institute of Technology, Karnataka, India

Abstract— A Balance between the demand and supply is one of the indicator of the position of your organization in the Market. Every organization tries to match their supply with the demand. However, balancing between the two is highly impossible because of the changing customer requirements. Retail stores whose customer are the end users is very dynamic system as it is prone to the fluctuations immediately. Hence balancing the supply and demand is very difficult. Forecasting the demand of products helps in making products available readily. If there are no changes in demand, forecasting the future demand would be very easy. However, in this uncertain environment this is a complicate work. Forecasting the demand of products when promotions are offered is a crucial step as maintaining high inventory would increase inventory cost and less inventory would lead to losing the customers. Time series method are the best techniques available for forecasting the demand when subjected to constraints. However, while considering a new variable, promotions these methods are not effective. Support Vector regression(SVR) is one such method that will produce the forecast the demand based on the different type of promotions planned by the stores

Key words— Support Vector regression, MAPE, Simple moving average, Weighted moving average, MAD, Retail stores, Demand forecast.

1. Introduction

Demand planning can be said as an art of getting the right stock to the right store at the right time. The key challenge for any retail store is to minimize or eliminate shelf out of stock. Consumer behaviour has a significant value for retailers, more than ever. Today consumers are affected by various non-price factors such as quality, availability, store attribute, entertainment shopping and many such non-price attributes. To maintain this optimum inventory, the forecast of demand of the products needs to be made precisely. Promotions refers to raising awareness among the customers about the product in order to increase the sales of the product. Promotions also may refer to offers provided on the product which will attract the customers towards them and in turn increase the sale of the products.

Forecasting using time series methods provide an effective result. However, in the presence of constraints like promotions, these methods do not produce effective

forecasts. In this paper Support Vector Regression(SVR) method is used to forecast demand when promotions are applied. The demand for the retail store under study was predicted using Simple moving average, weighted moving average and SVR. MAPE was used for comparing the results. Finally, an effective method was developed by coming the moving average and SVR to forecast demand of SKU's at division level.

2. Literature Review

Forecasting is a process of estimating a future event by casting forward the past data. The past data are systematically combined in a predetermined way to obtain the estimate of future. Prediction is the estimation of future event based on the various consideration other than just past data. Thus, forecasting is an estimate of future values of specified indicator relating to decisional/planning situation [6]. The number of variables/factors and degree of details required in the forecasting depends on the intend of use of the forecasted value.

2.1 Support Vector Regression

SVM and its regression version, Support vector regression (SVR) implicitly map instances to higher dimensional feature space using kernel function. SVR ideally seeks to identify a linear function in this space that is within epsilon distance to the mapped output points. One of the major shortcoming of the SVR methodology is its difficulty in giving explanation beyond prediction.

The foundation for support vector machine was laid by Vapnik in 1995 and gaining popularity due to high empirical performance. The formulation uses Empirical risk minimization (ERM) principle, which has proven to be more superior than Structural risk minimization (SRM) principle that is used by conventional Neural networks [5].

Unlike the neural network where training is a search that may or may not yield the best model, the SVM is based on yields the best model for the inputs. Maximizing the margin of separation and minimizing the total empirical error in a balanced way, SVM have performed well where complex relationship between input attributes and output attribute exist [1].

3. Methodology

3.1 Data Description

Past data was collected about the types of promotions, promotional and non-promotional sales (number of units) at weekly level. There are three types of promotions offered by the retail stores. Further it was seen that 3 divisions of the total seven divisions contributed to 80% of the sales. Hence the study is based on the three divisions sales data.

3.2 Exploratory data analysis

There existed a high correlation between the promotional sales and total sales. The correlation and data operation was performed using R language. It was also found that of the seven product divisions sold in the stores, the three divisions contributed to the app. 80% of the sales. Hence, the further study was based on the three divisions only.

In the above figure, the bar graph represents the total sales and the line graph represents the three divisional sales. It was further identified that for all divisions where the sales are higher are during the presence of promotions.

Before concluding that during promotions sales increase, a T test was carried out to check whether the promotions had a positive impact on total sales or not. A hypothesis test was carried out. The hypothesis was stated as below:

H_0 : Promotional sales have same effect has Non-Promotional sales

H_1 : Promotional sales is more effective than non-promotional sales

For the two samples, mean and standard deviation was calculated and the t value was calculated using below formula

$$t = \frac{\bar{x}_1 - \bar{x}_2 - \Delta}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

For the study data, t calculated was lower t value from table at 95% confidence interval, indicating the rejection of null hypothesis. Hence, statistically it was concluded that the promotions had a positive impact on sales.

Since promotions are proved to add to the increase in sales, forecasting demand during promotional period was identified to be a crucial point. Hence our model development came into picture.

Also, the data was checked for stationarity before running the model. It was also identified that type1 promotions had higher impact on sales than the other two at both overall and division level. This trend helps in applying the model developed for all divisions and at overall level.

A high importance was given to analysis section as the project was carried out from a analytical company point of view. It was the insights obtained from various tests and visual data analysis that helped in developing the model that would forecast accurately during presence and absence of promotions in a retail firm.

3.3 Forecasting model.

The study was made at division level. For each division, the data was separated for promotional and non-promotional sales. Forecasting was done for both the data set, for all three divisions using simple moving average, weighted moving average and SVR. For all the six cases MAPE was calculated for comparing the efficiency of prediction.

Sales were used as the independent variable in the case of moving average techniques and Sales along with offers were used as independent variables for SVR.

The MAPE showed that for all the division, weighted moving average produced less error was non-promotional sales period and SVR produced less MAPE during the presence of promotions.

From the results obtained, one new model was built in R programming which will forecast demand using WMA when there are no promotions and forecast is obtained using SVR technique when there are promotions. The MAPE was calculated for this model which is low compared to the individual technique's output.

4. Results

The new method, a combination of Weighted moving average and SVR was used to forecast demand at division level. The WMA was used for forecasting non-promotional units and SVR was used to forecast demand for promotional period. The new MAPE obtained while predicting at division was found to be below 10%. Which means the error percentage was reduced by 5-10% in all divisions studied.

Further, the model can be applied at item level to obtain a better forecasted value.

5. References

- 1) SKU demand forecasting in the presence of promotions, Özden Gür Ali, Serpil Syan, Tom van Woensel, Jan Fransoo, Expert system with Application, Elsevier, December 2009
- 2) A tutorial on support vector regression, Alex J Smola and Bernhard Scholkopf, Statistics and Computing 14:199-222, 2014
- 3) Forecasting Energy Demand in Large Commercial Buildings Using Support Vector Machine regression,

David Soloman, Rebecca Winter, Albert Boulanger,
Roger Anderson and Leon Wu

- 4) Impacts of Advertising and Promotion on the Demand for scanned Purchases of Vadalía Onions, Ecio F Costa, James E Epperson, Chung L Huang and John C Mckissick, Journal of Food Distribution research, March 2002.
- 5) Support vector machine and support vector regression by Steve R Gunn 10May 1998.
- 6) Forecasting Techniques, Dr.Ravi Mahendra Gor, Industrial statistics and operational management.