Consumer Data Research Centre

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SHOP DIRECT

Pricing optimisation - a key tool in successful retailing

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Project Background

Few decisions impact the success of a retailer more than product pricing optimisation. It requires balancing a multitude of tradeoffs which together determines a company's success. The decision maker has the difficult task of selecting the right price when faced with multiple, competing objectives such as maximising profits and revenue whilst minimising the price distance between competitors and maintaining proper inventory levels. Optimal prices are essential to the marketing mix and to the business as a whole. An inaccurate price could lead to significant forfeited profit, inflated inventory management costs from excess stock or low consumer satisfaction due to stock shortages. Thus, the main objective for this project was to explore methodologies that produce sets of optimal price alternatives for a sample of products at a given time at the individual product level.

Data and Methods

Non-dominated Sorting Genetic Algorithms (NSGA) were used for this project for their efficient, flexible methodology and limited input data requirements. The project first required calibrating the initial demand forecasting models using daily historical sales data at the individual product level to better predict revenue and profits in the ultimate goal of using their estimated parameters as revenue and profit maximising objective functions in the pricing optimisation. The competing objective entailed minimising the distance from the average competitor price. Sets of time-dependent optimal price solutions were produced for 13 electronic products within Shop Direct's 'Very' fascia utilising various functional forms to model revenue and profit. The pricing optimisation was completed using Liger, an open-source optimisation environment, and Python. The demand forecasting was completed with R. This study utilized both NSGA-II and NSGA-II-PSA algorithms, the latter is a partition-based selection algorithm.

Key Findings

For the Electronics trading department as a whole, the linear-log demand model, including price, promotion, a price-promotion interaction term and seasonal dummy variables as predictors of demand, had the best out-of-sample prediction accuracy. The log-log demand model consistently showed evidence of overfitting, and the additional terms of competitor price ratio and substitutes price ratio as well as their measures of variance did not greatly reduce out-of-sample prediction error. Linear models are not the most robust choice of demand modelling, as predictions errors are inflated, however, their low complexity is a useful choice as objective functions in pricing optimisation for scalability. Depending on business needs, prices could be updated daily, weekly or monthly by changing which historical data are used to forecast demand. Finally, there was no significant difference between the performance of the NSGA-II-PSA algorithm compared to NSGA-II when deriving optimal prices for the electronic goods.

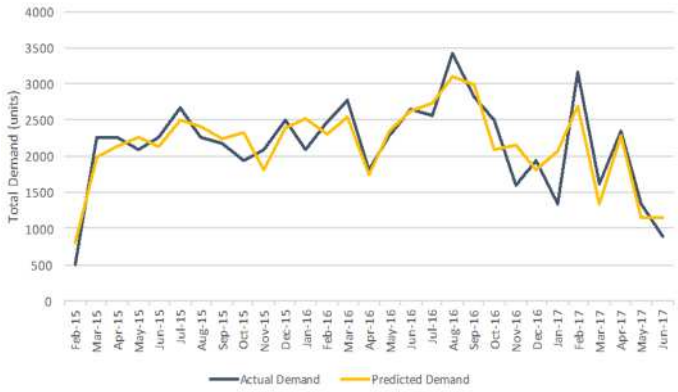

Figure 1. Actual (blue) vs. predicted (yellow) demand for a particular product

Value of the Research

This project served as a Proof of Concept utilising Genetic Algorithms for the multi-objective optimisation problem of setting optimal prices. This methodology produces a range of optimal solutions the Decision Maker can choose from promoting competitive advantage within the dynamic electronic market. Though a small sample of products was assessed, the results can be generalised to the greater electronics department. Further study is required to generalise to other product categories before scaling up to the entire product portfolio. Overall, this project was a valuable base on which to build Shop Direct's in-house pricing optimisation workflow.