

Category: Multi-store retailer with multi product manufacturing capabilities

Methods: Deep Learning LSTM, Prophet, Autoregressive Time-Series Regression, Ensemble Model, Model Validation, Time-Series, Forecasting

Problem Summary:

A client company (a Multistore Retailer) had experienced unprecedented volatility in the demand of some specific SKUs from a single product category. The client desired to build a forecasting model to forecast the demand of certain SKUs, for 1 to 12 months into the future. A time-series dataset was constructed, including monthly data for the price, sales and approximately 50 current-period or lagged potential predictor variables. An ensemble of LSTM and Autoregressive Time-Series Model were developed to predict future demand. The client company used forecasted demand to better control costs of production & inventory and to increase profitability.

Strategic Challenge:

Rapid growth in Indian middle-class wealth is causing periodic excess demand and large increases in the demand of particular SKUs to the client's production process. In addition, new supplies of the similar products in market were rapidly appearing causing its periodic oversupply and consequent reduction in price due to competition. In order to better manage product inventories and improve profitability, our client needed to anticipate future changes in the demand.

Research Objectives:

The purpose of the research was to develop a forecasting model of the demand of a particular product category SKUs. Specifically, the goals were to:

- Collect a database of micro & macroeconomic time-series variables that would serve as potential predictors of the demand along with transactional data.

- Apply time-series regression along with deep learning techniques to build a robust forecasting model of the demand of specific SKU.
- Produce a forecast simulation web based tool, enabling client to input updated predictor variables and view updated forecasts of the SKU demand.

Analytical Design:

The Advanced Analytics team constructed a time-series analysis dataset, adjusting all series to be monthly, appropriately handling missing values, holidays, sales seasons etc. Variable selection methods were applied to more than 20 macroeconomic variables to identify the most promising linear and nonlinear predictors, lagged predictors, and combinations of predictors. Measurement of predictive power was based on mean absolute prediction error. More than 10 unique models were investigated & evaluated to identify the 5 top models for each desired forecast time horizon (1,2,3,6,9 & 12 months). A forecast simulator was built based on an ensemble of LSTM & Autoregressive Time-Series Models to forecast 1, 2, 3, 6, 9, & 12 months into the future, correcting appropriately for serial correlation (the correlation over time of the impact of unobserved variables on the variable being predicted—in this case, demand). The ensemble technique combined forecasts from multiple models, thus increasing forecast reliability.

Results:

A Web-based forecasting tool was developed that allowed the client's management team to enter updated values of predictor variables each month and forecast the future demand of the specific SKU. The client company subsequently validated the model by comparing forecasted vs. actual values for the first several months. The resulting forecast accuracy was impressive, causing the client company to:

- Use the model forecasts as an input to business operations.
- Conduct a subsequent study, applying the forecasting method in another product category.