A Novel Approach to Predict Store Inventory

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ABSTRACT

This work provides insights on how to understand inventory patterns and when products go out of stock (OOS) to improve replenishment decisions for retail stores. The solution uses different product categories based on the grocer's business segments, and then specific predictive models are implemented to forecast store inventory. This work is novel in how OOS data is utilized to advise the retail stores on the timely replenishment of stock to reduce overall lost sales. This study aims to evaluate and compare multiple classification algorithms for predicting store inventory at a store-product level on highly skewed data.

INTRODUCTION

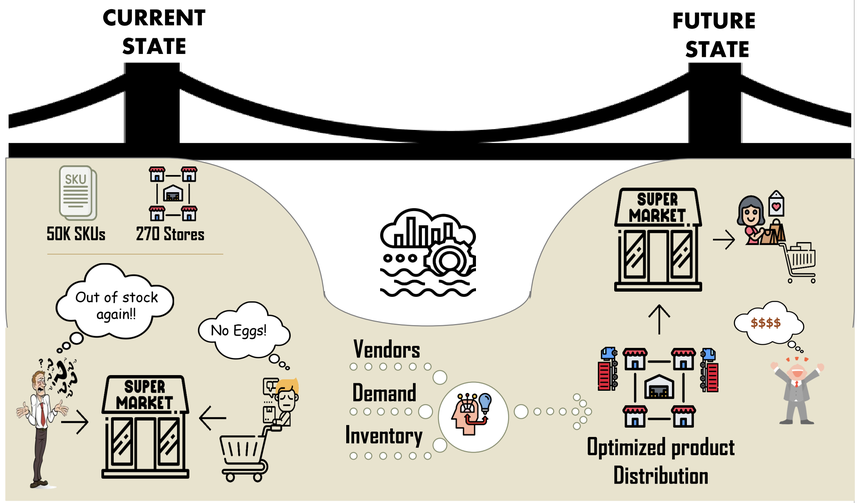

Fig 1. Business Problem

The primary research questions of this study:

- What are the most important drivers for identifying store inventory?
- What is the business impact across business units?

LITERATURE REVIEW

Various studies across the field helped us in analyzing the right model to select.

Study	TS	ANN	RF	LMT	Ensemble
Dimitris Papakiriakopoulos, 2011			✓	✓	✓
M.W.T. Gemmink, 2017	✓				
Enzo Morosini Frazzon, 2019		✓			
Bart L MacCarthy, 2019	Used a generalized store wave picking model				
Our Study, 2021	✓		✓		✓

METHODOLOGY

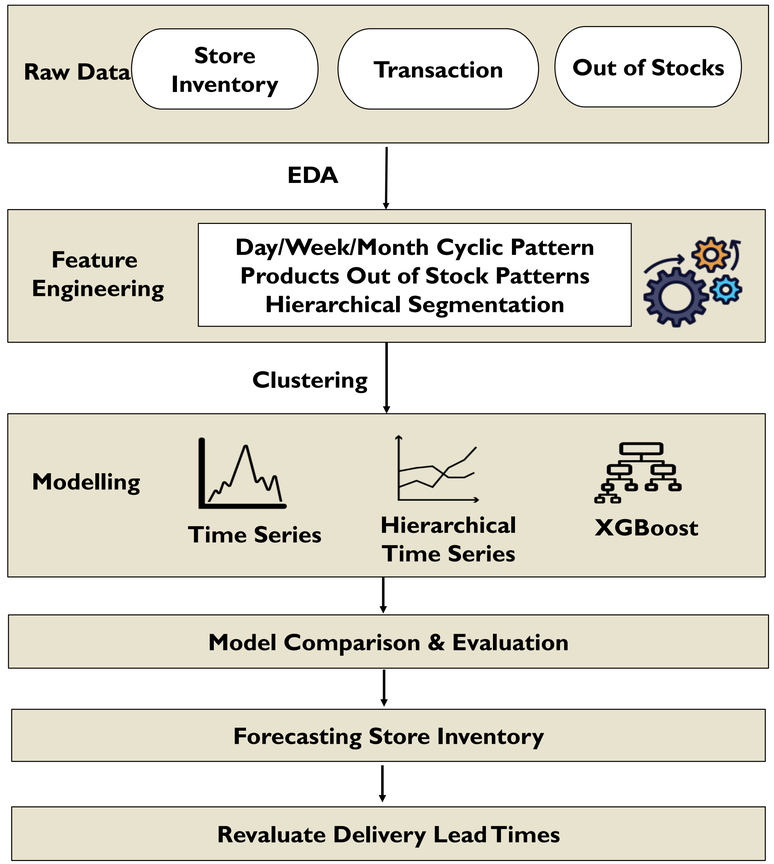

Fig 2. Study Design

FEATURE ENGINEERING

Day of the week

Vendor On Time

Vendor Fill Rate

Fig 3. Important Features

Variables such as sales and demand could not be used to predict the store inventory due to their unavailability until the day.

The weekly cyclic nature of the store inventory, out of stocks, and demand cycle implied the selection of the day of the week as a main feature to be used for the prediction.

VOT & VFR are the two vendor features that integrates the vendor efficiency into inventory prediction.

RESULTS AND IMPACT

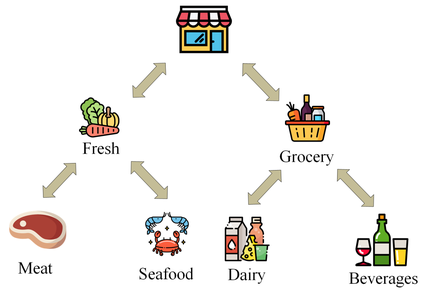

Fig 4. Hierarchical Time Series

Hierarchical time-series was used for forecasting since the products are categorized using a hierarchical pattern with the focus on two main categories being Fresh and Groceries. The method used was optimal combination since we required the forecasts on individual product level. This resulted in coherent forecasts across the entire aggregation structure.

As we have 3 months data, time-series would only predict inventory for a short period i.e., ~2-3 weeks.

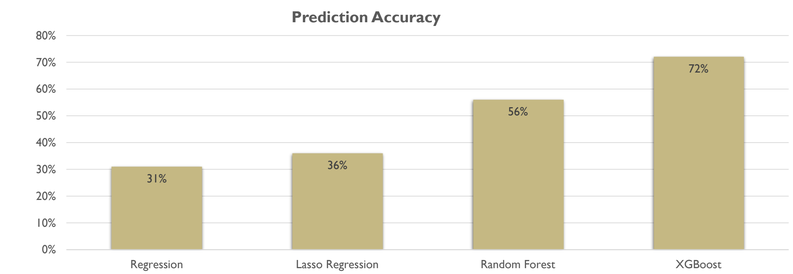

Fig 5. Prediction Accuracy

XGBoost is giving the best accuracy of 72%. Further hyperparameter tuning would improve the prediction accuracy. In order to further improve the results, we will implement some advanced models like LSTM

CONCLUSIONS

Engineered features showed significant improvement on model performance such as weekly VFR,VOT, and day of week prove do have the highest importance in identifying OOS rate at product-store level.

After analyzing the forecasted demand for top 1000 products, the accurate inventory prediction would help the client in preventing opportunity loss of ~$2M per year

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