Detecting Changes In Customer Purchasing Patterns Through Changepoint Analysis

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ESD
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Integrated Decision Systems Consultancy Pte Ltd

Specializes in provision of advanced analytics through consultancy

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Project Objectives

Given 2 years of sales data for 3 bread products across 6 locations, we have to determine

- *Changepoint Locations*
- *Duration of Change*
- *Demand Patterns & Predictability of Sales*

Methodology

1. Understanding The Problem
2. Data Wrangling using SQL & Excel
3. Research on Changepoint Analysis
4. Execute Changepoint Analysis Using R's 'changepoint' package
5. Analyse Results
6. Conduct Predictive Analysis Forecast Using Facebook's 'prophet' library

Changepoint Analysis

Detects the **location and duration of change** in a given time-series data.

What is our methodology?

We plotted our data using 2 distributions

1. Poisson distribution test statistic
2. Exponential distribution test statistic

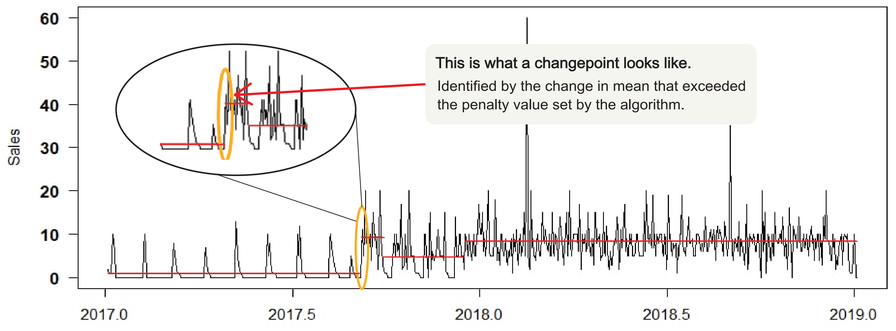
↓

Detected changepoints using **mean** and **variance** method.

Why did we choose our method?

Using mean & variance offsets the inconsistency of our largely scattered dataset

This method automatically adjusts the sensitivity of the algorithm to identify changepoints more accurately.



*The red line across the graph indicates the mean of the data set.

Fig 1.0 An example of the cpt.meanvar method with binary segmentation using a poisson distribution testing statistic.

Some of our main observations

Product Legend: A1L1 — Product type, Location of product

Sales at **location 1 generally decrease** from one date for all products

↓

13 August 2018

Location 5 have **ZERO** changepoint identified

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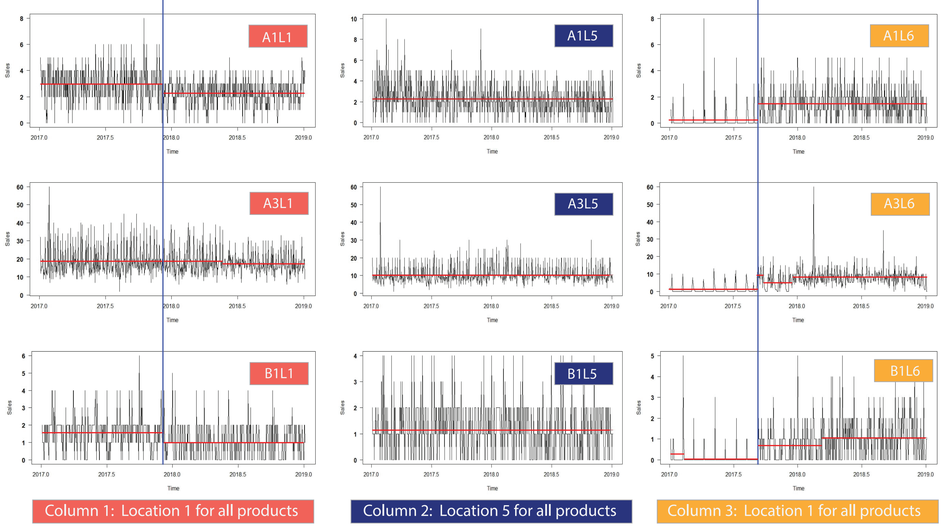
(As seen from a uniform straight red line)

Sales at **location 6 generally increase** from one date for all products

↓

12 December 2017



Column 1: Location 1 for all products | Column 2: Location 5 for all products | Column 3: Location 1 for all products

Predictive analysis and forecasting

Our Forecasting & Analysis Tools

Prophet Library
- A procedure for forecasting time-series data
- Accurate, fully automated and tunable by hand

Turnover Ratio
- The percentage of sales over inventory
- Acts as a justification to our forecasted demand patterns

Our Oberservation and Analysis

Products with decreasing forecasted trend tend to have low turnover ratios as shown in Fig. 2.1.

Products with increasing forecasted trend tend to have high turnover ratios as shown in Fig 2.2.

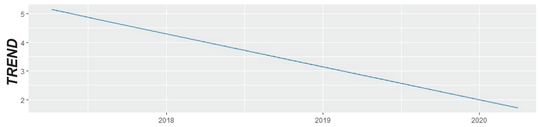


Fig 2.1 Product B1 at Location 1 (Turnover ratio = 42%)

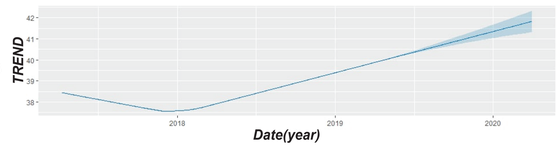


Fig 2.2 Product A3 at Location 3 (Turnover ratio = 83%)

Our Insights

Increasing forecasted demand for product
↓
Increase inventory to ensure supply can meet demand
↓
Maximise potential profits

Decreasing forecasted demand for product
↓
Decrease inventory to prevent wastage/losses
↓
Implement a different marketing strategy to increase sales and profit

Assumptions and limitations

- **Some products at different location showed low turnover ratio yet increasing trend.**
  This can be due to product being newly introduced at that location and inventory is getting stocked at the intial phase
- **High turnover ratio yet decreasing trend was also observed.**
  This could be due to temporary promotion deals to clear inventory
- **Improving accuracy by manual tuning of algorithm penalty values could allow us to obtain a more precise result**