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Demand Forecasting and Budget Optimization with Python

publicis sapient

Rising AI 2020

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  - Additional Factors for consideration
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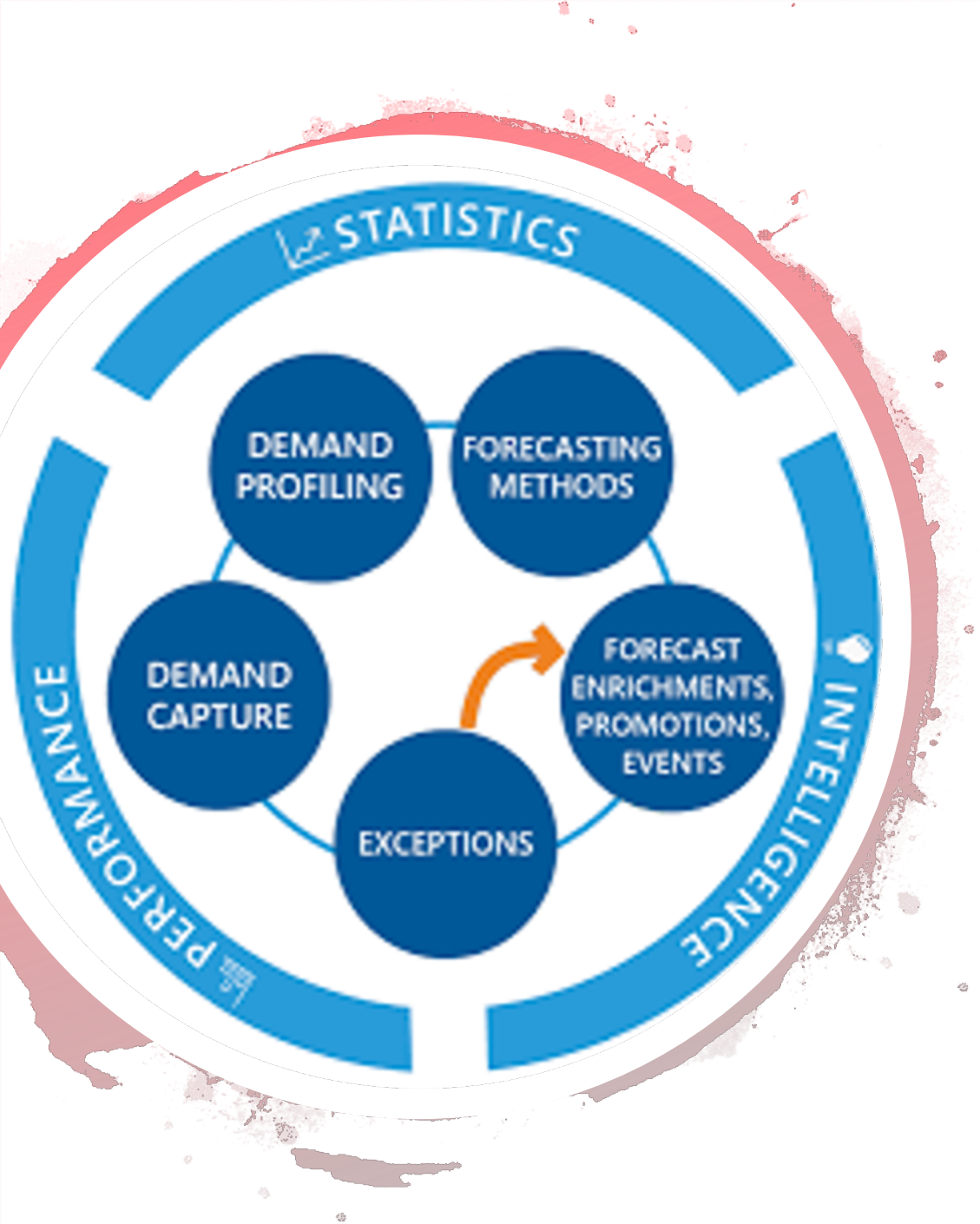
  - Demo
- Budget Optimization
  - Introduction
  - Impact on forecasting
  - Use Case

About PS

Demand Forecasting



Introduction

What is demand forecasting?

Demand forecasting is a science or an art of predicting customer demands. These predictions are analyzed and leveraged to make key business decisions to optimize their supply chain and keep their costs lean.

What are the typical business problems where forecasting plays an important role?

- Can I optimize my inventory to minimize costs as well as manage demand.
- Can I create custom campaigns and increase my customer base using past behavior
- How can I **optimize** my costs on marketing spend

Techniques and Comparison

In this section, we like to present the various techniques used for forecasting as well as the uniqueness of each of them

Conventional demand forecasting techniques

Survey methods

One of the most common and direct methods of forecasting demand in the short term. This method encompasses the future purchase plans of consumers and their intentions. Typically, an organization conducts surveys with consumers to determine the demand for their existing products and services and anticipate the future demand accordingly.

Statistical methods

These are complex set of methods of demand forecasting used to forecast demand in the long term. In this method, demand is forecasted on the basis of historical data and cross-sectional data.

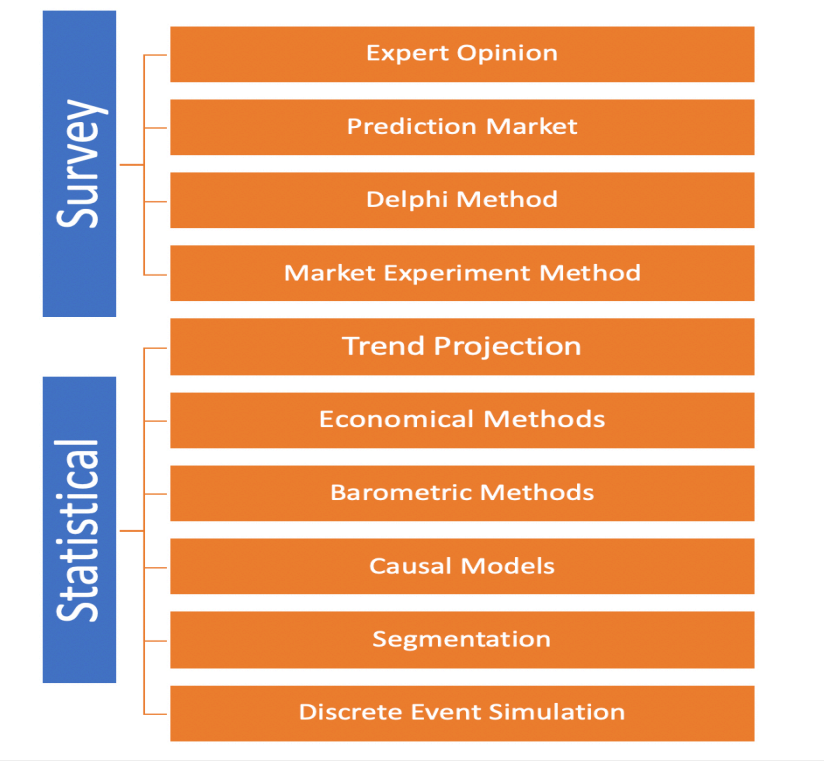
Another perspective of looking at forecasting can be also

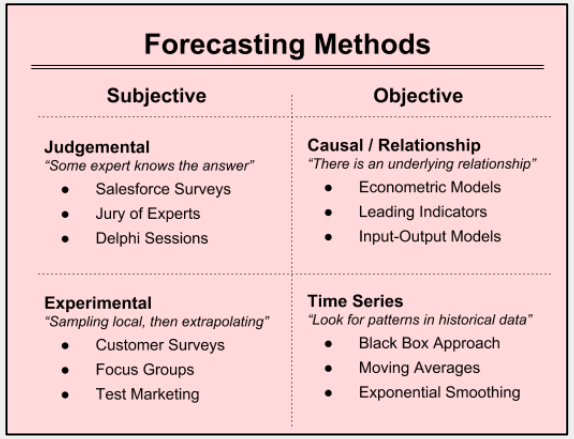
Time series forecasting

- moving average method
- exponential smoothing method
- trend projection methods

Causal methods

- chain-ratio method
- consumption level method
- end use method
- leading indicator method





First-hand knowledge of salesman

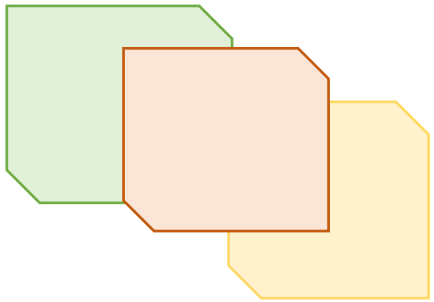
Expert Opinion

Buyer's Intention

Prediction Market

Survey Based Demand Forecasting

Consensus decision making



Delphi method

Market Experimentation Method

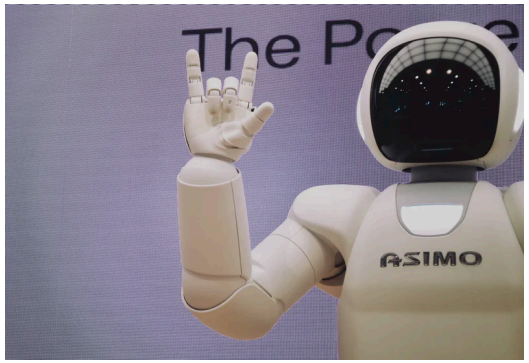
Dynamic change of price to match demand

Trend Projection

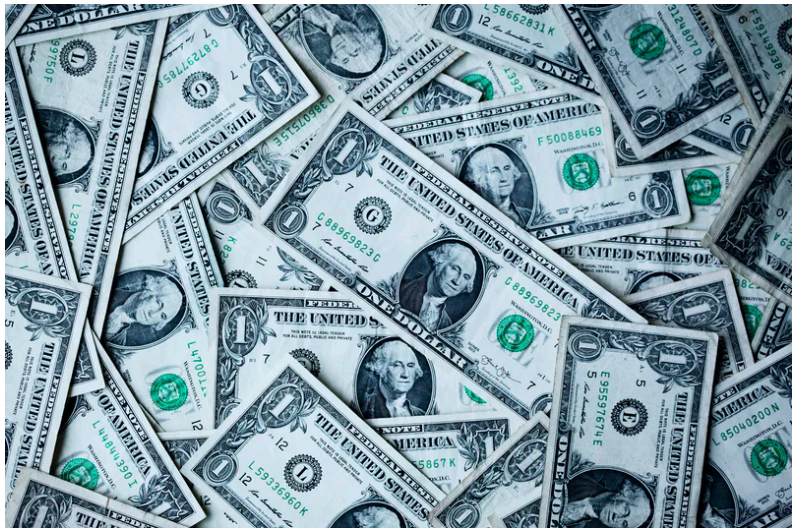
@Sharmistha

curvilinear relation between economic indicator and demand

Past demand for future forecast



Barometric Methods



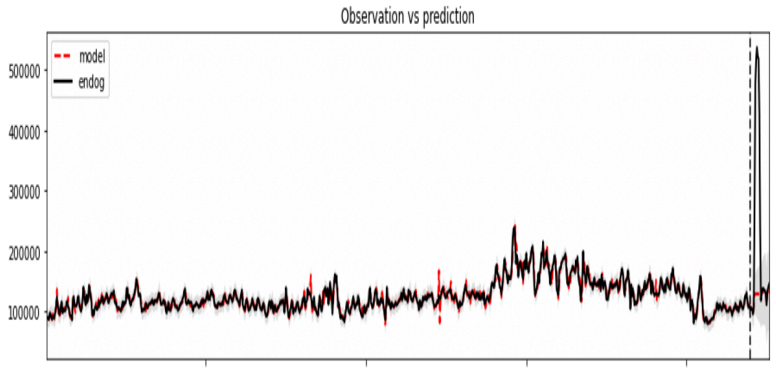
Economic Methods

Segmentation

Existing and New segment generation

Statistical Demand Forecasting

Discrete Event Simulation



Casual Impact

@Sharmistha

CasualImpact - Bayesian structural time series model

- Variable to be forecasted has a cause-effect relationship with one or more other independent variables
- Forecast time series for time period after the event
- Measure ROI (Return-on-Investment) of marketing campaign
- Multiple comparable control groups/markets
- Study cumulative impact
- Selection of best algorithm with Dynamic Time Wrapping Algorithm by determining the most similar Control groups to the Test group

Additional Factors for consideration

Now that we understand the techniques of forecasting and the client impact, let's think about some of the other factors that needs to be considered while designing such system

Causal forecasting methods

Causal forecasting is the technique that assumes that the variable to be forecast has a cause-effect relationship with one or more other independent variables. Causal techniques usually take into consideration all possible factors that can impact the dependent variable. It implements an approach to estimating the causal effect of a designed intervention on a time series. For example, how many additional daily clicks were generated by an advertising campaign? Answering a question like this can be difficult when a randomized experiment is not available.

What is ARIMA model?

ARIMA

The **ARIMA** model (Auto-Regressive Integrated Moving Average) analyzes the time data to predict the future data points. The biggest advantage of this model is that it can be applied in cases where the data shows evidence of non-stationarity.

Below is the interpretation of the ARIMA

$$X_t - \alpha_1 X_{t-1} - \cdots - \alpha_{p'} X_{t-p'} = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q},$$

Additional Factors for consideration

Now that we understand the techniques of forecasting and the client impact, let's think about some of the other factors that needs to be considered while designing such system

ARIMAX

The ARIMAX (Autoregressive Integrated Moving Average with Explanatory Variable)model can be viewed as a multiple regression model with one or more autoregressive (AR) terms and/or one or more moving average (MA) terms. This method is suitable for forecasting when data is stationary/non stationary, and **multivariate with any type of data pattern, i.e., level/trend /seasonality/cyclicity**

Below is the interpretation of the ARIMAX

ARIMAX model extends the univariate ARIMA model through inclusion of exogenous variables X, whose effect on forecasted values is calculated through regression.

$$\Delta^D y_t = \sum_{i=1}^{p} \phi_i \Delta^D y_{t-i} + \sum_{j=1}^{q} \theta_j \epsilon_{t-j} + \sum_{m=1}^{M} \beta_m Xm, t + \epsilon_t$$

ARIMA

Univariate Time Series Forecasting

Exogenous Variables

Independent Variables influencing forecasted values

Use Case – Automotive Client

@Priyamvada

Let's look at how we applied these techniques to solve the business problem for one of our automotive client.

How did we apply our customized model to predict the future demands and then provide better conversion for the automotive client

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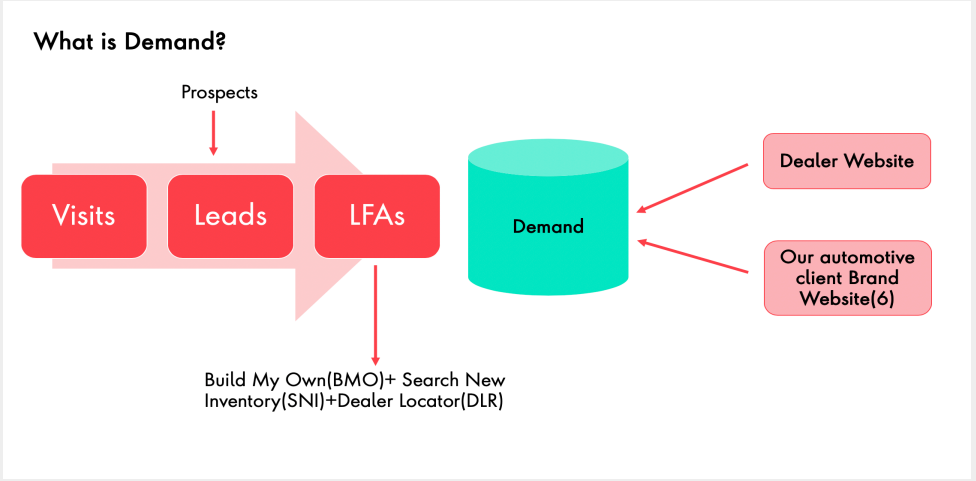

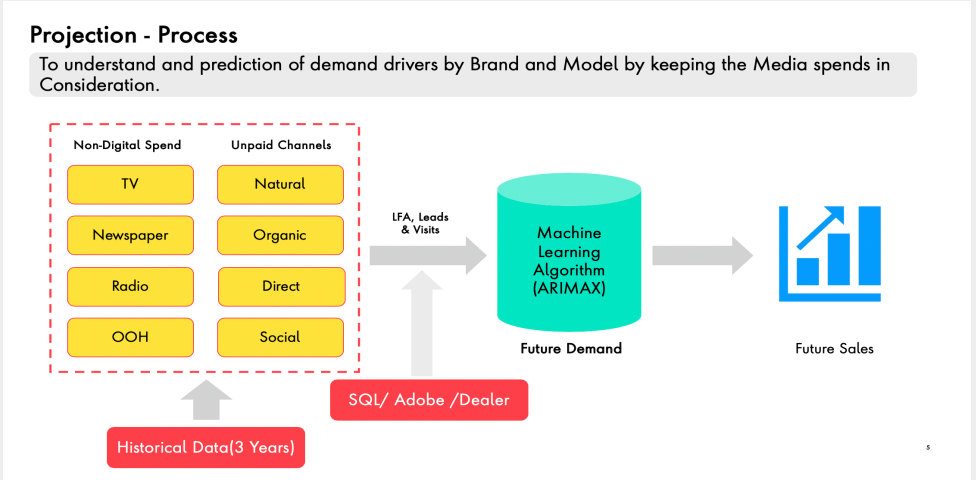

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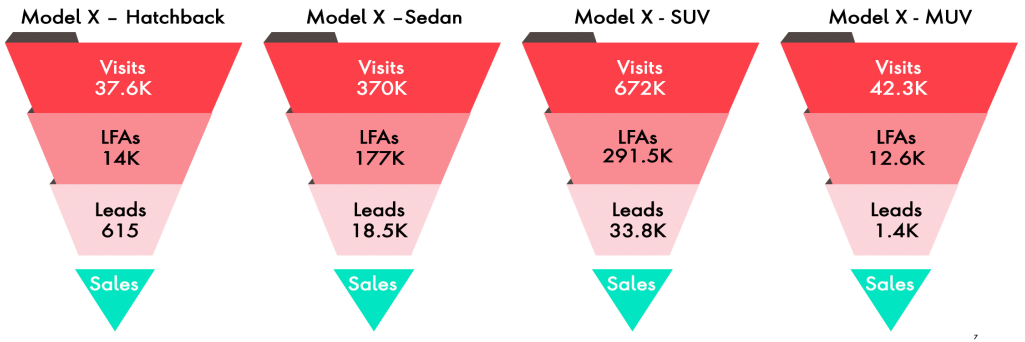
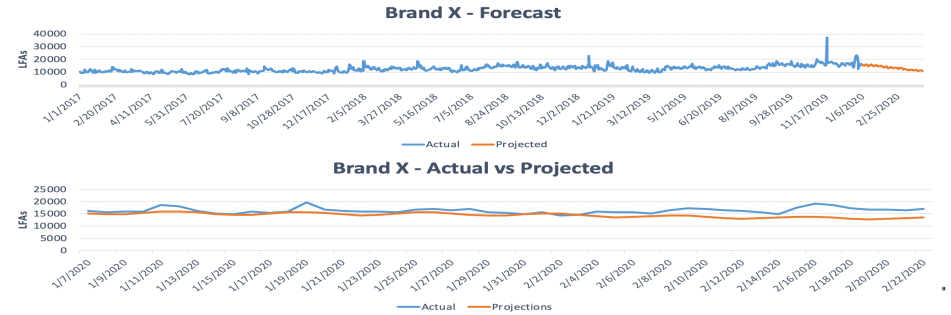
Projections - Result

Model X – Projection Funnel



Projections - Result

Model X –Projections



Our Impact: With AI & Machine Learning We Can Now...

Identify KPIs

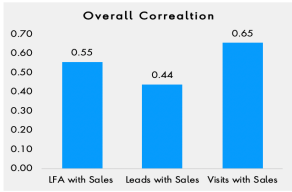
Identify the top KPIs responsible for sale and their prediction.

Forecast Test Drive Bookings

Forecast test drive bookings for upcoming months with 86% accuracy.

Predict LFAs

Predict Lower funnel activities done by customer with 85% accuracy.



Predict Visitors

Predict Visitors coning to website with 80% accuracy.

Forecast Car Model Demands

Forecast the KPIs at model level with 80% accuracy.

Budget Optimization

@Sharmistha

Budget Optimization and its impact for forecasting

Let's understand about budget optimization and how it influences forecasting in the context of the automotive client use case that we briefly discussed earlier

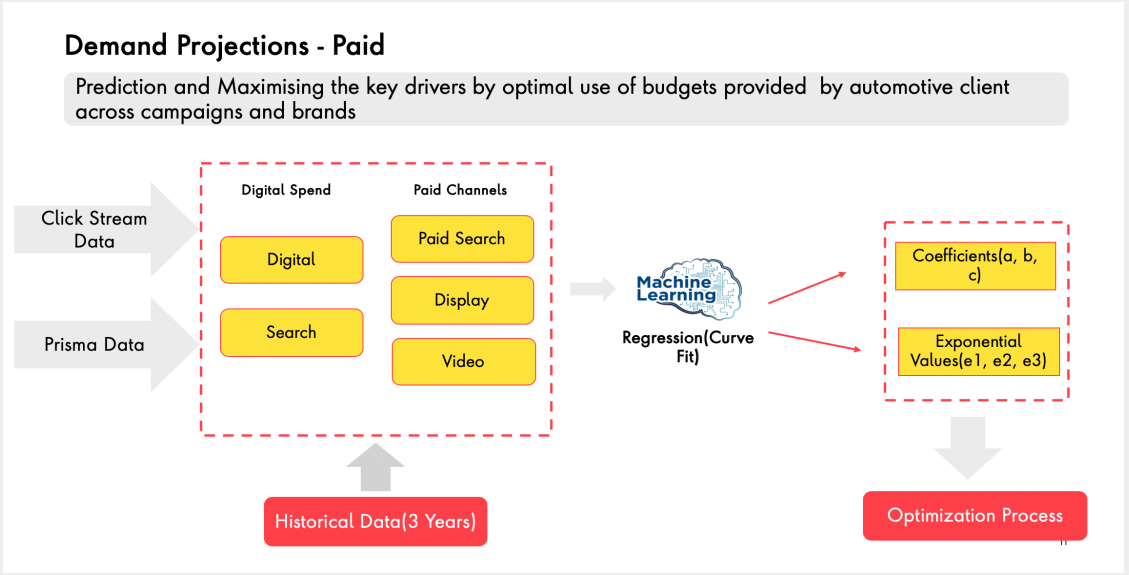
Budget Optimization is a vital part of any business and it is essential ingredient to determine the forecasting as it is key for all the assumptions based on which business make their investment and spend

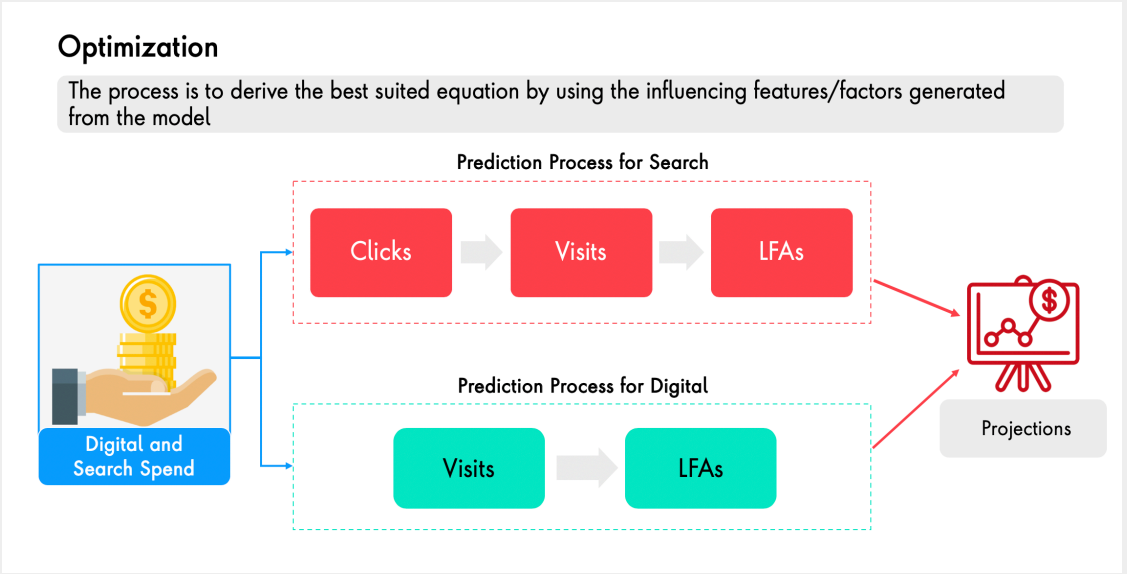
So how did we address this problem for our client ?

Our team collated data from **disparate sources** to create a unified view to understand how spend was affecting the demand drivers. This provided the ability to quickly model and interpret how effectively spend across various online and offline avenues was generating value

Based on the influencing factors and features we looked upon the applying this on the spend and determine the predicted sales

Factors which can influence the forecasting.





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Budget Optimization and its impact for forecasting

Let's understand about budget optimization and how it influences forecasting in the context of the automotive client use case that we briefly discussed earlier

Post our analysis, we derived the most optimal equation that suited the client need to leverage the budget and also derive maximum LFAs

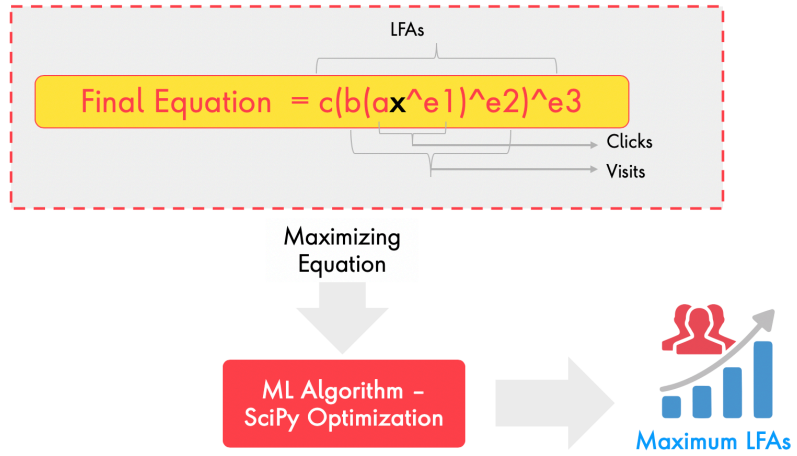
The first picture on the right represents the equation that we arrived for the budget optimization

The optimization equation also had to cater to constraints provided by the business. For e.g where the budget is mandatory and where these can be optional.

The second picture is a sample illustration of what is mandatory and optional for the automotive client

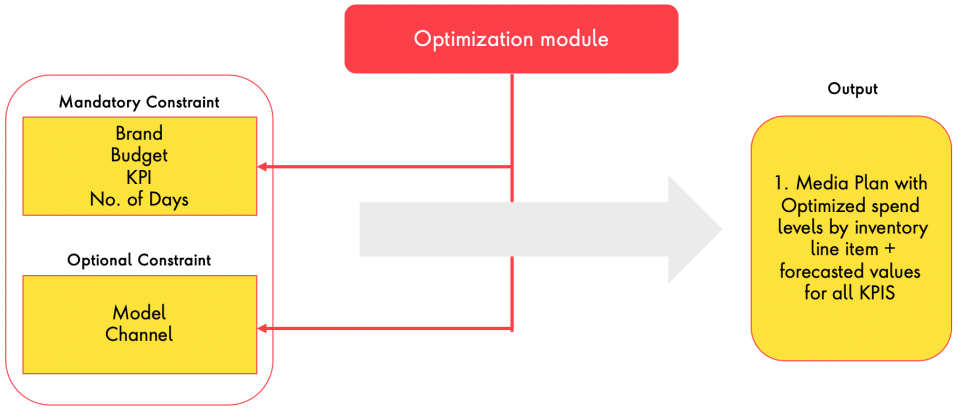
Optimization Equation

Optimising the overall budget and maximising the equation to get maximum LFAs with 99% utilisation of entire budget allocated to specific brand.



Optimization Equation Constraints

After setting up the equation , we had set some constraints as per the business requirement.



Budget Optimization and its impact for forecasting

Let's understand about budget optimization and how it influences forecasting in the context of the automotive client use case that we briefly discussed earlier

Using all of the above, we setup the goal setting equation which would be applied to derive the spend across the various models

Also we have captured the outcome of the model where the optimized budget is allocated as per the model to arrive at the goal

Goal Setting Equation

Target Generator:
Generates optimal media plan to achieve KPI targets for any budget & brand

$$Spend = \left(\frac{LFA}{a^{e_2 * e_3} * b^{e_3} * c} \right)^{(e_1 * e_2 * e_3)^{-1}}$$

Maximizing Equation

ML Algorithm – Optimization

Target KPI

Key Features

Intelligence @ Scale

1. Ability to maximize the LFAs with given budget in a single click by using Machine Learning Algorithms.

2. Ability to achieve the LFAs by Optimizing the budget along with the business level constraints

Extensibility

Currently used for our automotive client but can be used for other clients to achieve targets and Budget Optimization

Predict Targets

Predict Targets with 80% accuracy.

Performance @ Scale

Reduced the processing time from 45 mins to under 3 mins thus enabling faster delivery and scalability across different brands

Goal Setting - Result

Total Target: 800K, Total Campaigns: 350, No of Days = 31

Nameplate	LFAs	Budget
Model A	20,175	5,06,515
Model B	2,668	42,564
Model C	4,45,658	55,07,300
Model D	98,601	19,41,071
Model E	4,976	60,358
Model DX	81,470	21,13,756
Model CX	1,46,112	27,61,168
Total	8,00,022	1,29,41,193

Channel level Constraints
Digital = 450K, Search = 350K

Nameplate	LFAs	Budget
Digital	445,605	7,831,590
Search	354,417	5,109,602
Total	8,00,022	1,29,41,193


Discussion Time !!!

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thank you