Vehicle Demand Forecasting Solution using SageMaker

About Maruti

Maruti Suzuki India Limited (MSIL) - 12 billion USD revenue company. MSIL is a subsidiary of Suzuki Motor Corporation, Japan, is India's largest passenger car maker. India's first Company to produce and sell more than a million cars in India in a year, Maruti Suzuki is credited with having ushered in the automobile revolution in the country. The Company, formerly known as Maruti Udyog Limited, was incorporated as a joint venture between the Government of India and Suzuki Motor Corporation, Japan in February 1981.

AWS Services used

Amazon Sagemaker   Amazon Lambda   Amazon API Gateway

Amazon S3   Amazon CloudWatch

Business Problem

Maruti wanted to save costs by optimizing their sales forecasting to ensure right production plan. The challenge was to accurately forecast the sales of selected vehicle models for the upcoming months based on several time series datasets. Based on the forecast predictions they would adjust the production plan of selected vehicles. They previously relied on manual forecasting techniques with sub-optimal results.

Based on discussions with the Line of Business owners, the following key points were identified to address this with a ML solution.

- To forecast the sales of the selected vehicles models for the upcoming months based on multiple time-based economic indicators.
- Multiple data sources were to be consolidated to get a holistic view. Some challenges with the data were
  - Data in multiple formats and granularity level
  - Missing data points
  - Public data with no defined interfaces

Proposed Solution

Based on discussions with customer, MIND team examined various data sources and data sets which can help to address the business problem, and proposed a ML based demand forecasting models, comprising of following steps

- MIND received three years data for selected vehicles to model it for for forecasting.
- We had scrapped economic indicators, competition, and holiday's data from Internet. These economic indicators include Bank Credit Growth, Bond Yields, Capacity Utilization, RBI Repo rate, and Fuel rates, Stocks, CPI and GDP.
- Client also provided other secondary parameters like Social Listening, Brand Track, Website Hits, Discounts & promotions for modelling of demand.
- Did analysis on the data using multiple techniques, like exploratory data analysis, feature selection, dimensionality reduction (PCA), regression analysis. Did PCA for dimensionality reduction in order increase accuracy.
- Created ML models for demand forecasting –
  - Tried Holts Winter, Deep AR models to map the demand
  - Created LSTM models to forecast sales of the selected vehicles using custom LSTM algorithm on sagemaker as its less prone to variance and seasonality but because of limited data points availability it led to subdued accuracy and hence adopted a better model than this.
  - Created model using fbprophet which is a third-party library from Facebook, for forecasting using Amazon SageMaker and went ahead with this approach as fbprophet was giving better accuracy and better results. Used Pytorch estimator in sagemaker for training and deployment of the model.
- Used spot instances as spot training can optimize the cost of training models up to 90% over on-demand instances.
- Deployed the ML model using Flask API.

Solution Outcome

With all the customizations and hyperparameters tuning we selected a model with which we were able to forecast the sales with up to 93% accuracy. This helped to optimize manpower at sales channels. This helped the production team in adjusting the production plan as per the forecast.

After running various models and trying various algorithms we reached to the decision of selecting one i.e., fbprophet.

Reduced model training and deployment costs by using spot instances

Architecture Diagram
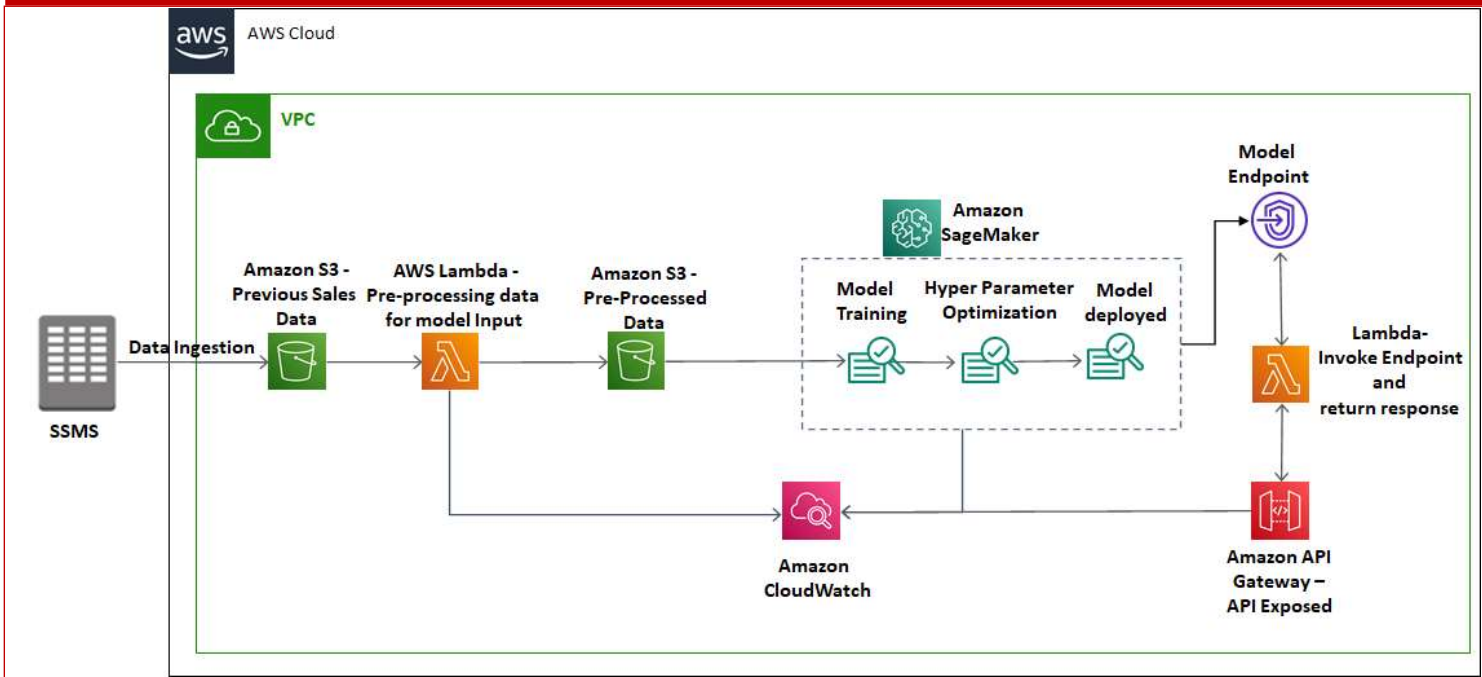
How AWS services helped in building the model for sales Forecasting

Amazon SageMaker
- Amazon SageMaker is used to create and manage Jupyter notebooks that were used to prepare and process data and to train and deploy the machine learning models.
- Amazon SageMaker High Power GPU Instance used for training of fbprophet Model
- Model is optimized using Amazon SageMaker Hyper Parameter Optimization

AWS Lambda to handle the backend API calls
It helped to initialize and validate the input and acted as the backend of the whole task. AWS Lambda lets us run code without provisioning or managing servers. Also, it helped to connect with various AWS API's to acquire various insights from the inputs.

Amazon API Gateway
Amazon API Gateway is an AWS service for creating, publishing, maintaining, monitoring, and securing REST, HTTP, and WebSocket APIs at any scale.

Amazon S3 to store CSV raw documents
It is an object storage service that offers industry-leading scalability, data availability, security, and performance.

Amazon CloudWatch
Amazon CloudWatch monitors your Amazon Web Services (AWS) resources and the applications you run on AWS in real time. You can use CloudWatch to collect and track metrics, which are variables you can measure for your resources and applications.

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