Woodpecker-Hackathon

Demand Forecasting Model for Inventory Management

TEAM:Algorithm Amazons

External factors to consider for Demand Forecasting

Competitors

Demographics

Technology

Economic conditions

Social factors

PROBLEM STATEMENT AND DOMAIN

Problem Statement: *Organizations encounter challenges in accurately forecasting demand, leading to issues like stockouts and excess inventory due to inefficient inventory management.*

Domain:*Retail, Manufacturing, E-commerce, Consumer Goods, Pharmaceuticals, Automotive, Healthcare, Technology, Telecommunications, Energy and Utilities, Banking and Financial Services.*

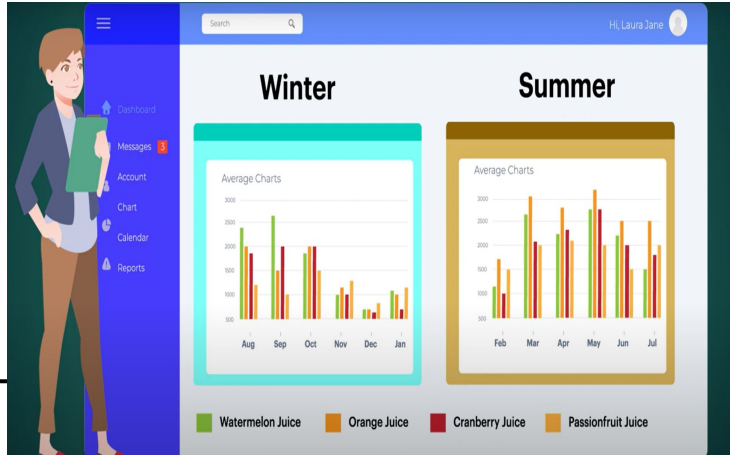
Why we chose this topic?

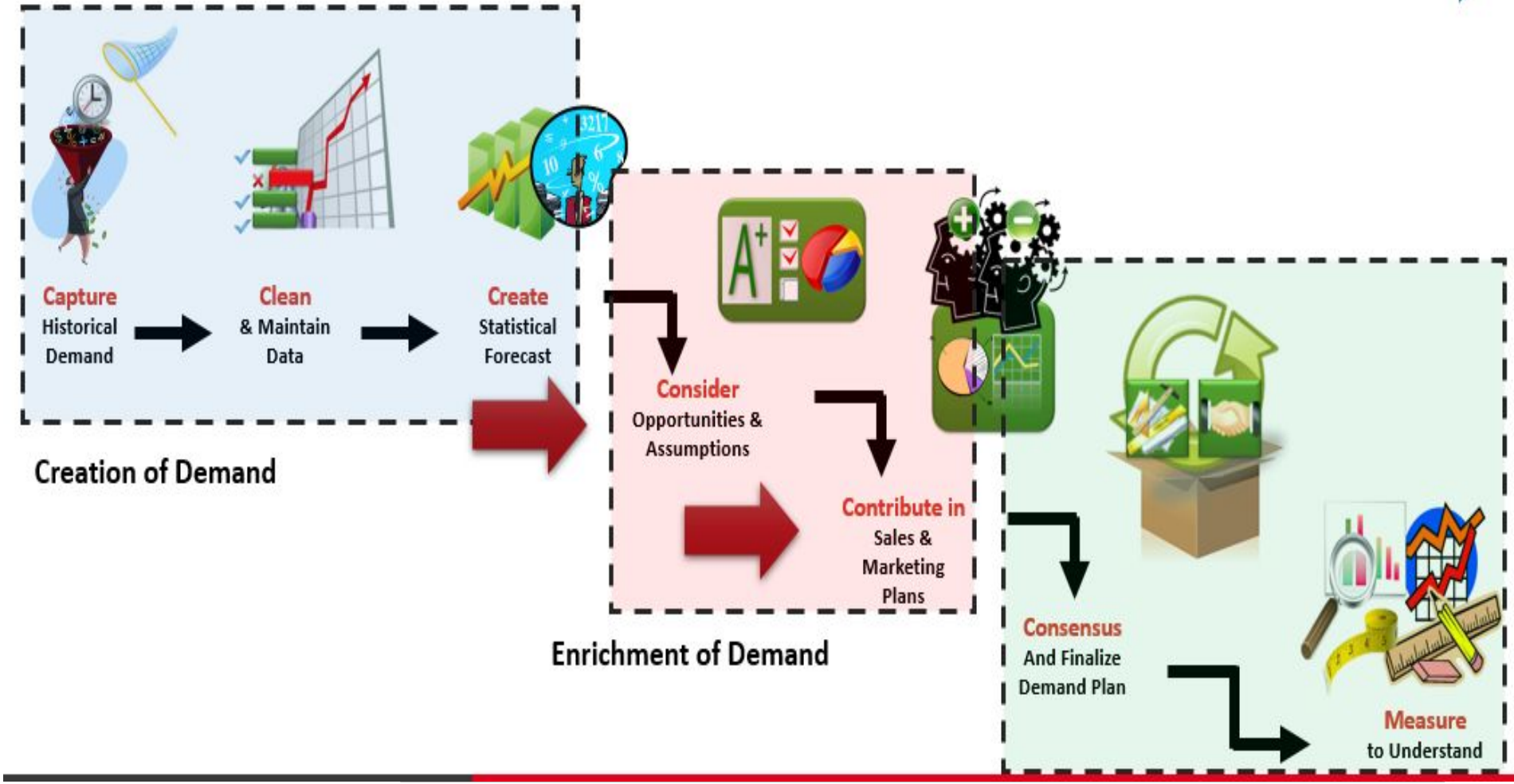
Demand forecasting is a crucial tool for businesses and industries. By accurately predicting future demand, businesses can optimize inventory levels, reduce waste, and allocate resources more effectively. We chose this problem to improve in the following fields:

Significance :	Achieving Balance:	Inventory management:
When demand exceeds supply, stockouts can result in lost sales, unsatisfied customers, and damage to the brand's reputation. Conversely, overestimating demand leads to excess inventory, tying up capital, increasing storage costs, causing obsolescence and spoilage, and reducing cash flow.	Organizations that balances supply and demand through accurate demand forecasting easily mitigate these risks and ensures smooth process throughout their business .	Effective demand forecasting helps businesses maintain optimal inventory levels, ensuring that they can meet customer demand without overcommitting resources. This balance enhances operational efficiency, customer satisfaction, and financial stability.

Our objective

Our main goal is to create advanced forecasting models that can predict demand by analyzing historical sales data and market trends. By doing so, we aim to provide accurate forecasts, which will help us enhance inventory management and production planning efficiency. This will enable us to optimize our resources and respond more effectively to shifts in demand, ultimately improving our overall operational performance and leading to a permissible profit of our organisation.




Capture
Historical
Demand
Clean
& Maintain
Data
Create
Statistical
Forecast
Creation of Demand
Consider
Opportunities &
Assumptions
Contribute in
Sales &
Marketing
Plans
Enrichment of Demand
Consensus
And Finalize
Demand Plan
Measure
to Understand

Tools and Techstack used:

Python–Machine learning

- Matplotlib
- Numpy
- Pandas
- Seaborn
- Sklearn

The dataset is acquired from Kaggle.
IDE : Google collab .

FOOD DEMAND FORECASTING

WHAT ?

Our ML model is specifically designed for food and beverages industries . We found difference between demand and supply affects the profit of the industry and environment to a great extent .

WHY ??

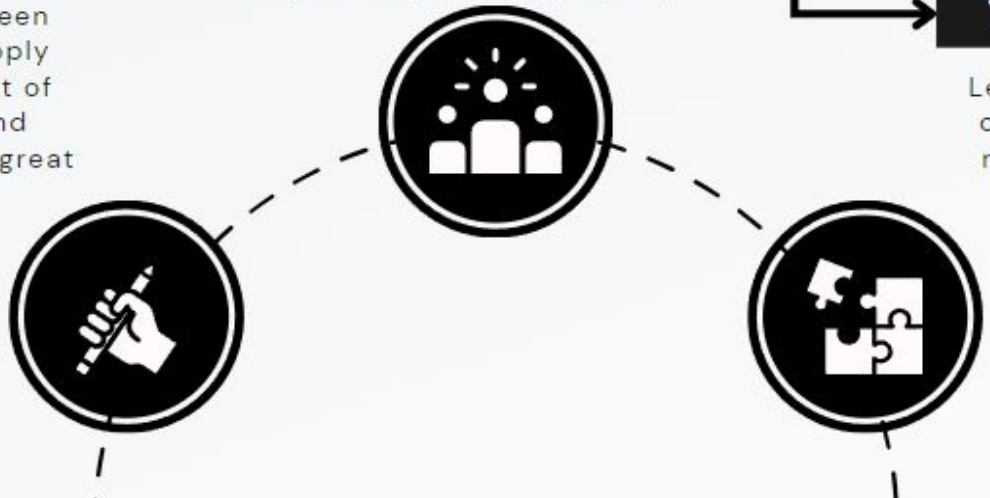
Inventory required for this industry is mainly grocery and edible fluids . They are required fresh and no doubt they decompose very rapidly .

TOO MUCH ?

Leads to wastage of food ,money and energy for further waste management.

TOO SHORT ?

Leads to unsatisfied customers , loss of reputation ,Loss in business .



Food Demand Forecasting Model

Context

It is a meal delivery company which operates in multiple cities. They have various fulfillment centers in these cities for dispatching meal orders to their customers. The client wants you to help these centers with demand forecasting for upcoming weeks so that these centers will plan the stock of raw materials accordingly.

Content

The replenishment of majority of raw materials is done on weekly basis and since the raw material is perishable, the procurement planning is of utmost importance. Secondly, staffing of the centers is also one area wherein accurate demand forecasts are really helpful. Given the following information, the task is to predict the demand for the next 10 weeks (Weeks: 146-155) for the center-meal combinations in the test set.

PRODUCT DATASET

centre_info

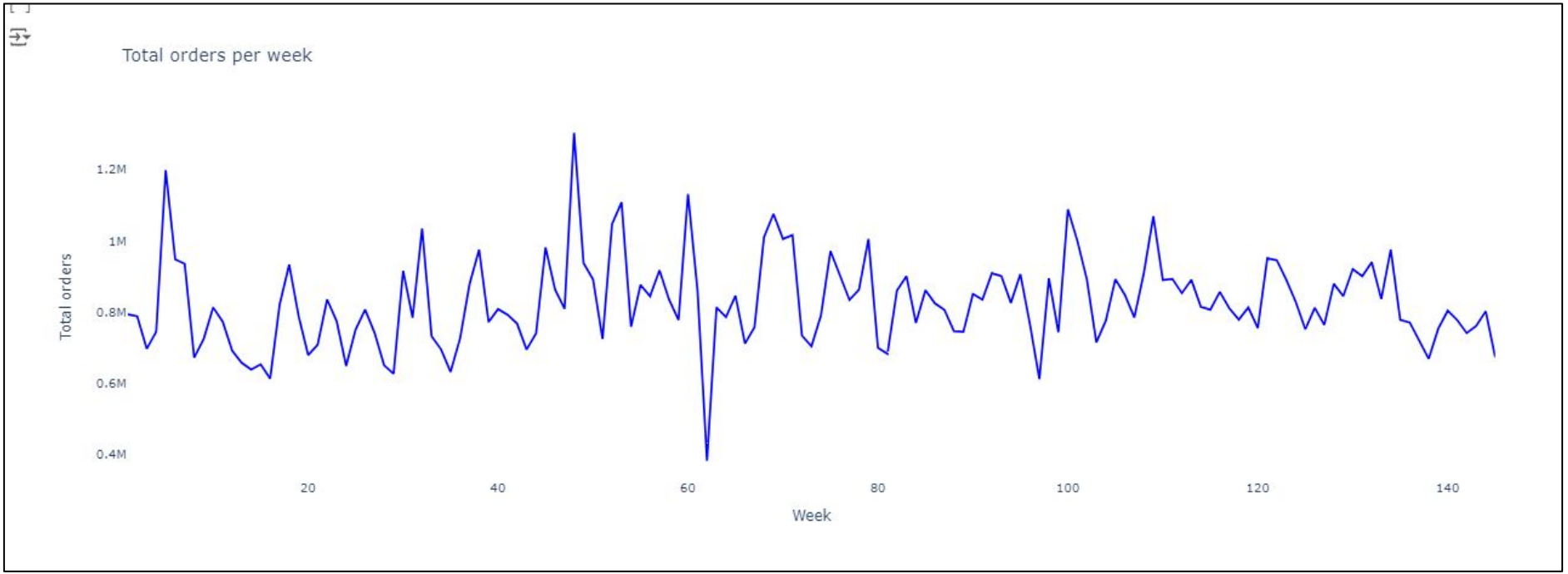
	center_id	city_code	region_code	center_type
0	11	679	56	TYPE_A
1	13	590	56	TYPE_B
2	124	590	56	TYPE_C
3	66	648	34	TYPE_A
4	94	632	34	TYPE_C
...	...	...	...	...
72	53	590	56	TYPE_A
73	30	604	56	TYPE_A
74	76	614	85	TYPE_A
75	68	676	34	TYPE_B

food_info

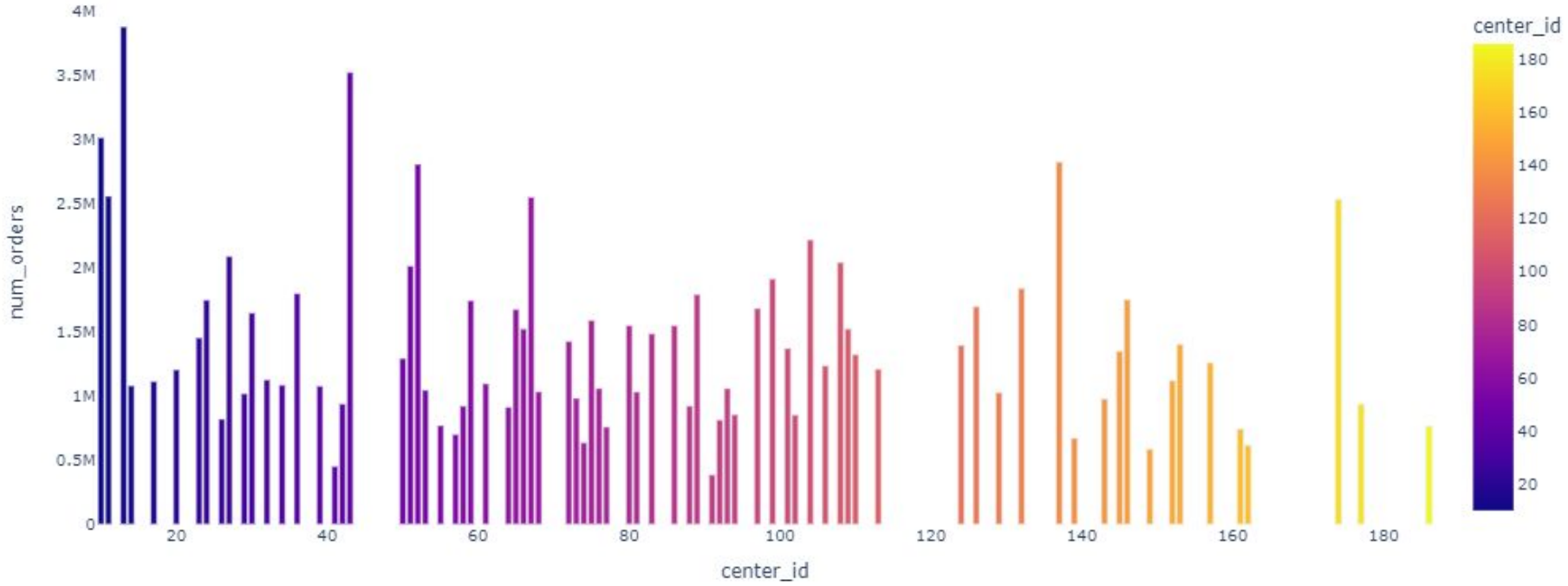
	meal_id	category	cuisine
0	1885	Beverages	Thai
1	1993	Beverages	Thai
2	2539	Beverages	Thai
3	1248	Beverages	Indian
4	2631	Beverages	Indian
5	1311	Extras	Thai
6	1062	Beverages	Italian
7	1778	Beverages	Italian
8	1803	Extras	Thai
9	1198	Extras	Thai
10	2707	Beverages	Italian
11	1847	Soup	Thai
12	1438	Soup	Thai
13	2494	Soup	Thai
14	2760	Other Snacks	Thai
15	2490	Salad	Italian

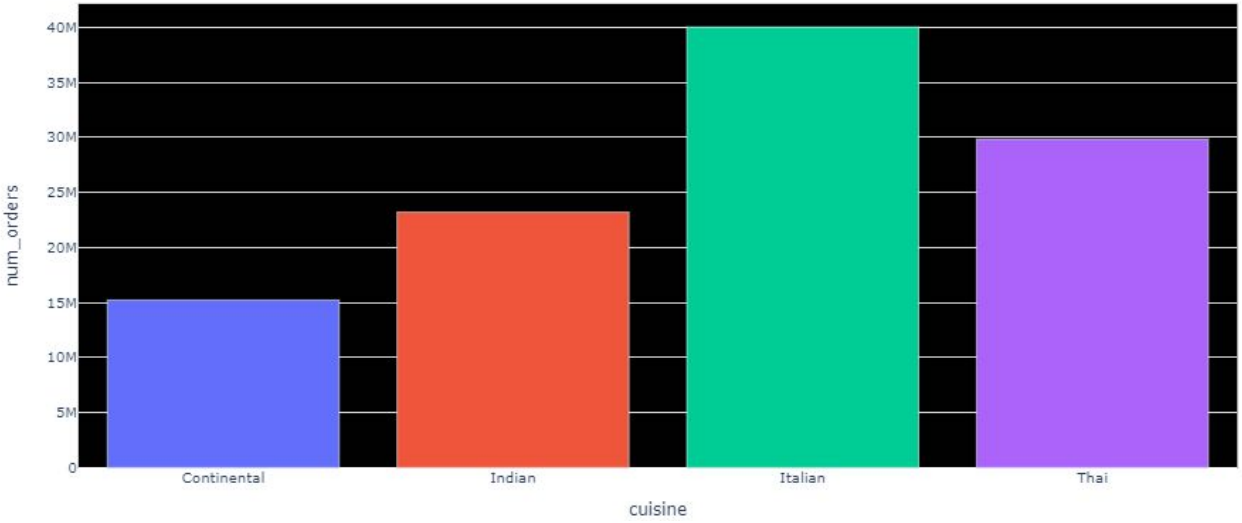
Visualizing Orders per week

Time series for number of orders using matplotlib :

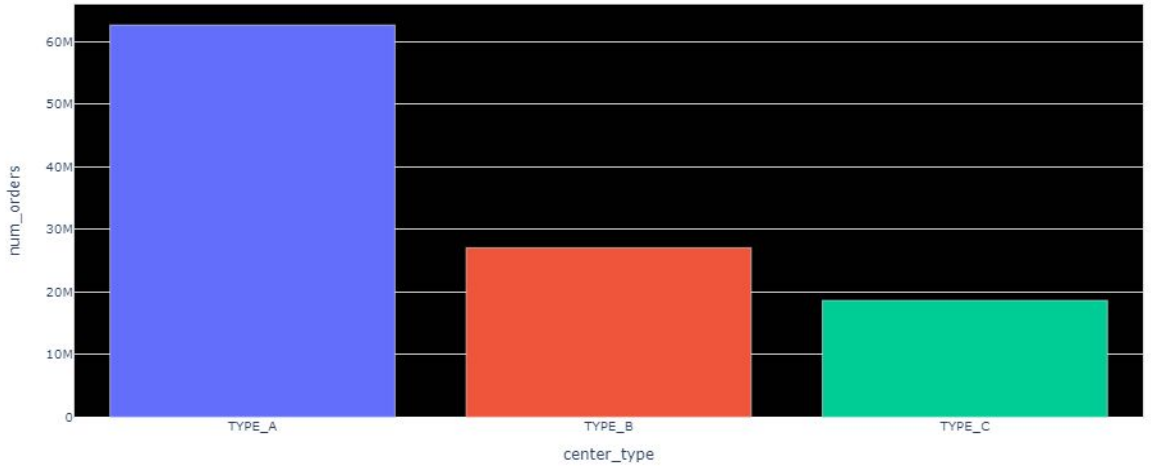


Variation of number of order with respect to center id :

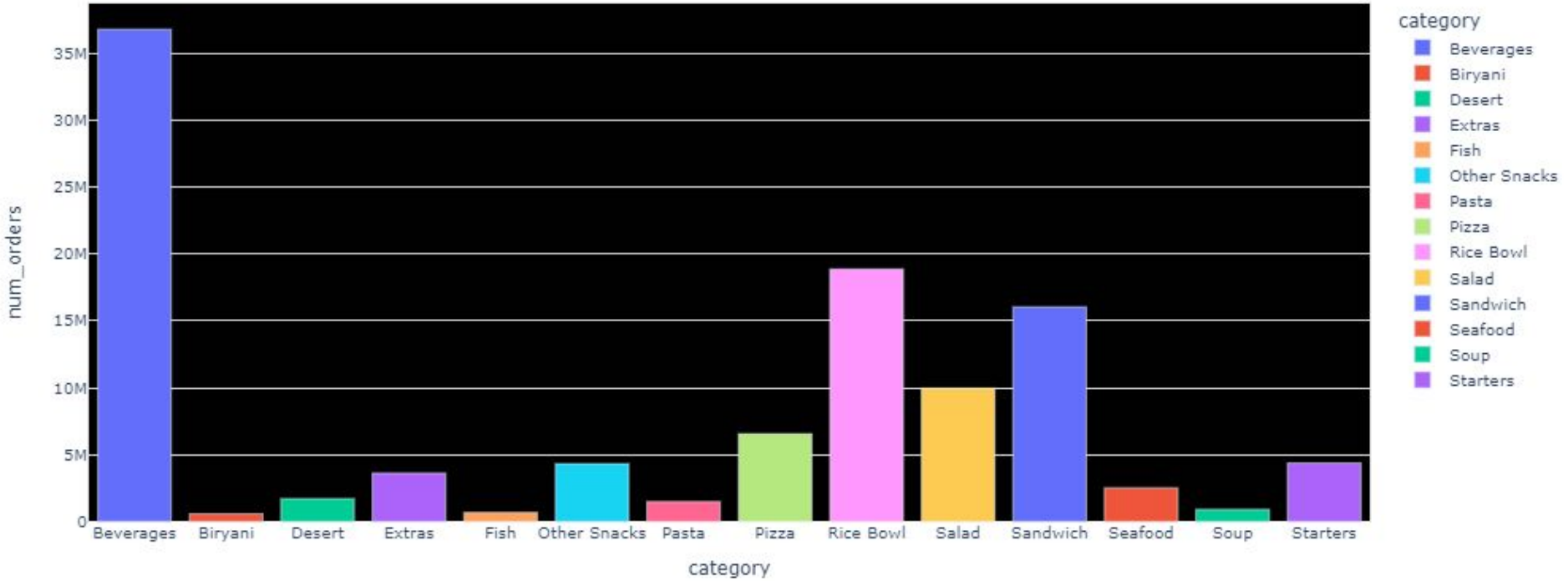




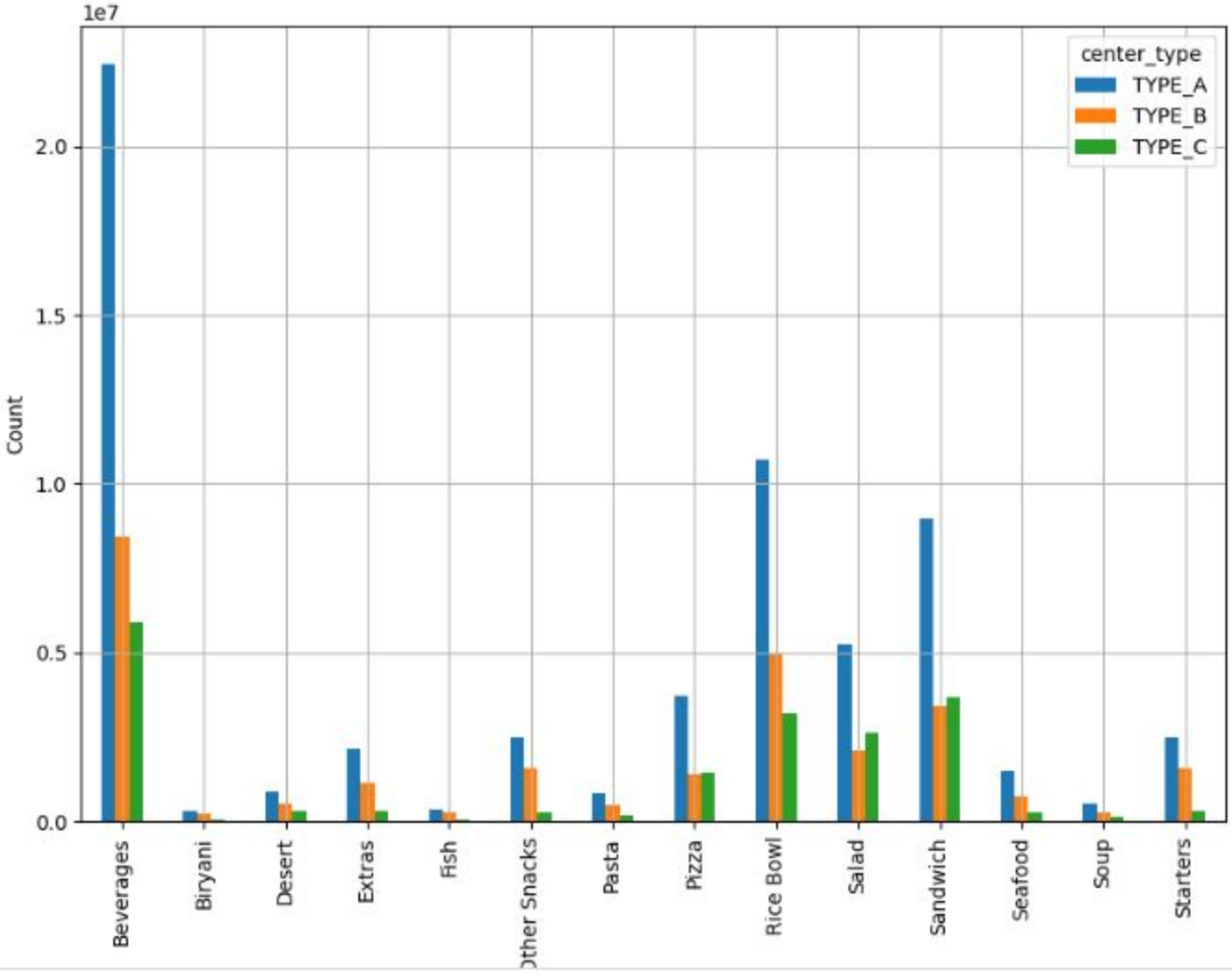
Variation of number of orders with respect to cuisines and different centers.



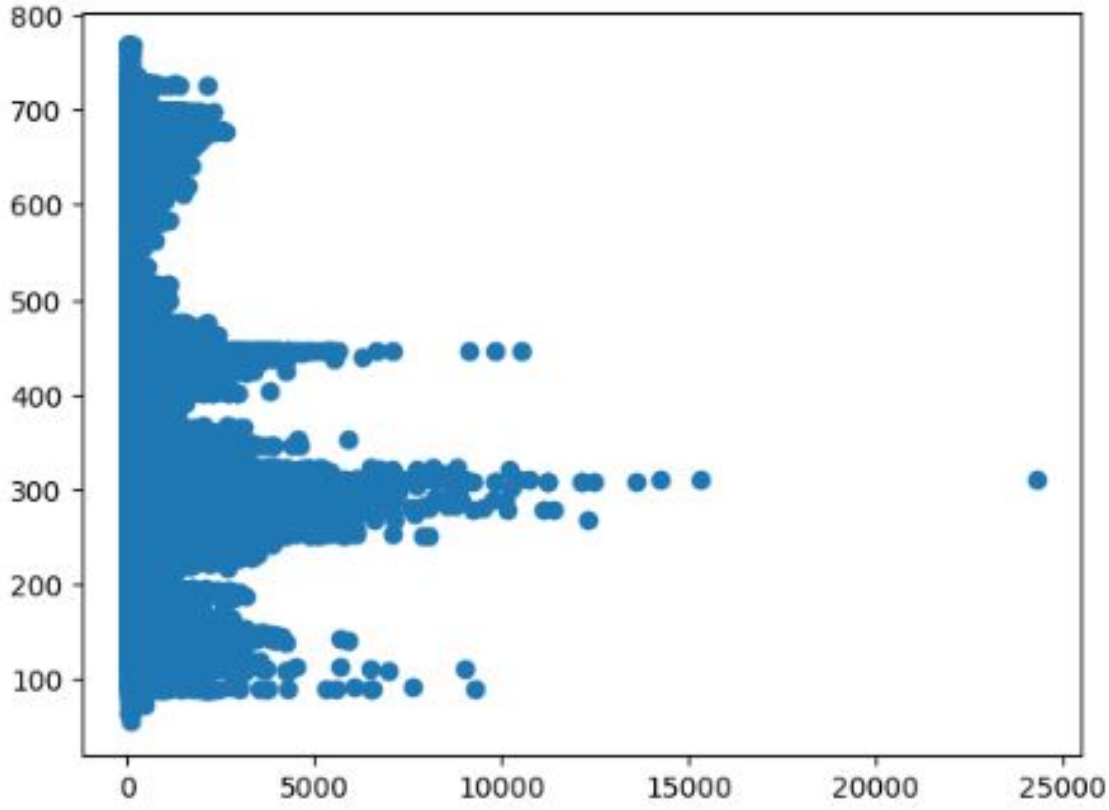
Variation of number of orders wrt category



Variation of orders wrt different meals at different centers :



Variation of sales wrt meals of different prices :



Variations form patterns :

Visualising the model for different parameter helped us identify different patterns that we must account in order to produce a reliable demand forecasting model !

For the brute approach we can just rely upon the ***past sales of different meals at different centres weekly .***

Then we encounter some more important parameters such as ***different cuisines,merged category of centres and meals which may tell us most demanded and least demanded meals at different centres , price , etc .***

A more advanced approach towards developing a very accurate and robust model is by considering little factors such as ***budget , storage space , seasons , competitions , surrounding situation , etc .***

Algorithms used to train the model :

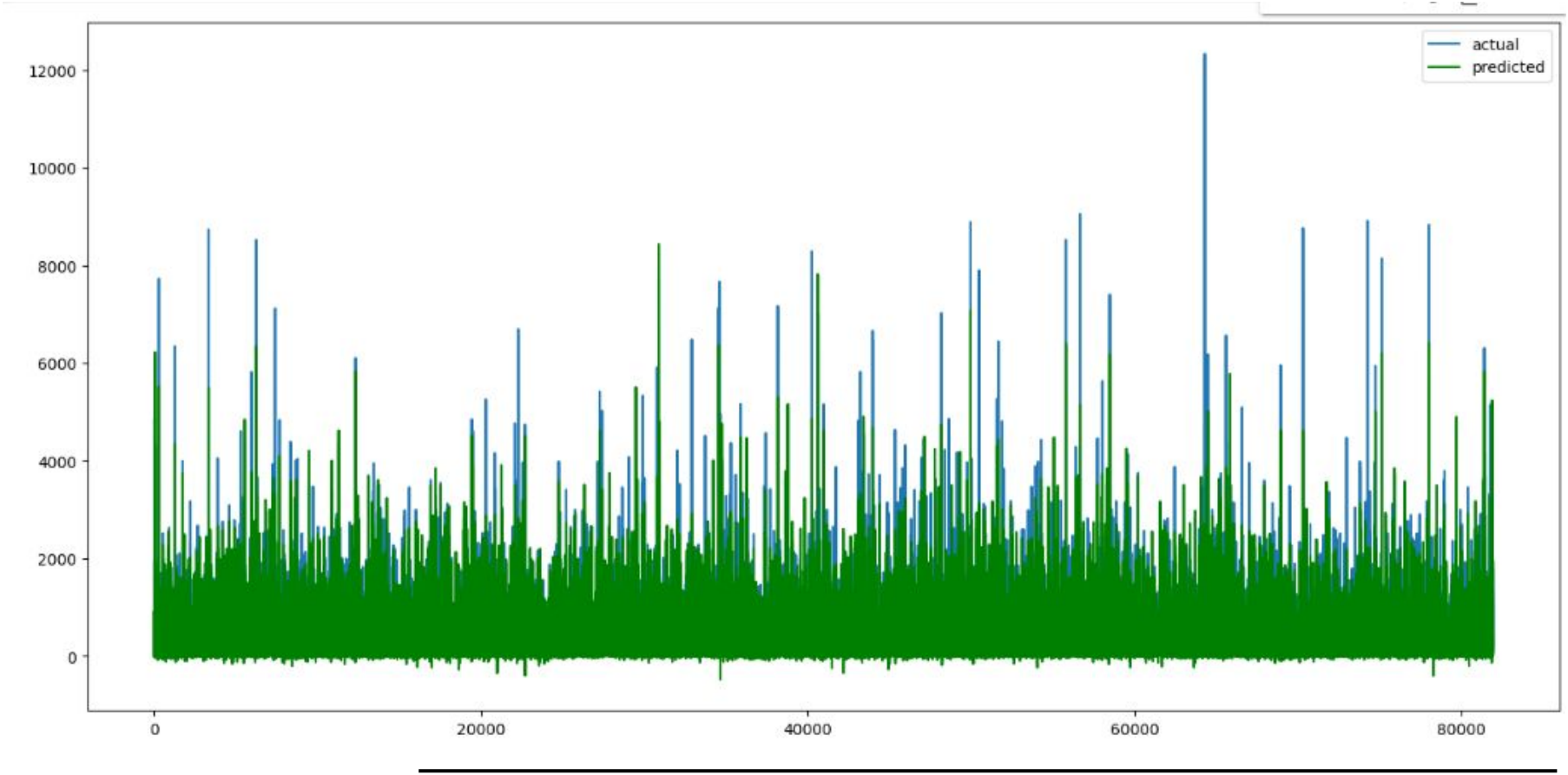
Linear regression : It gave a blunt prediction , the difference between the actual orders and predicted orders was big :

Decision tree regressor : It improved the model but still accuracy was lacking so we added :

Random forest regressor and xgb regressor : It combines the decision of multiple decision tree and gave a quite accurate predictions of the orders .

Now we're ready to test and implement the model !

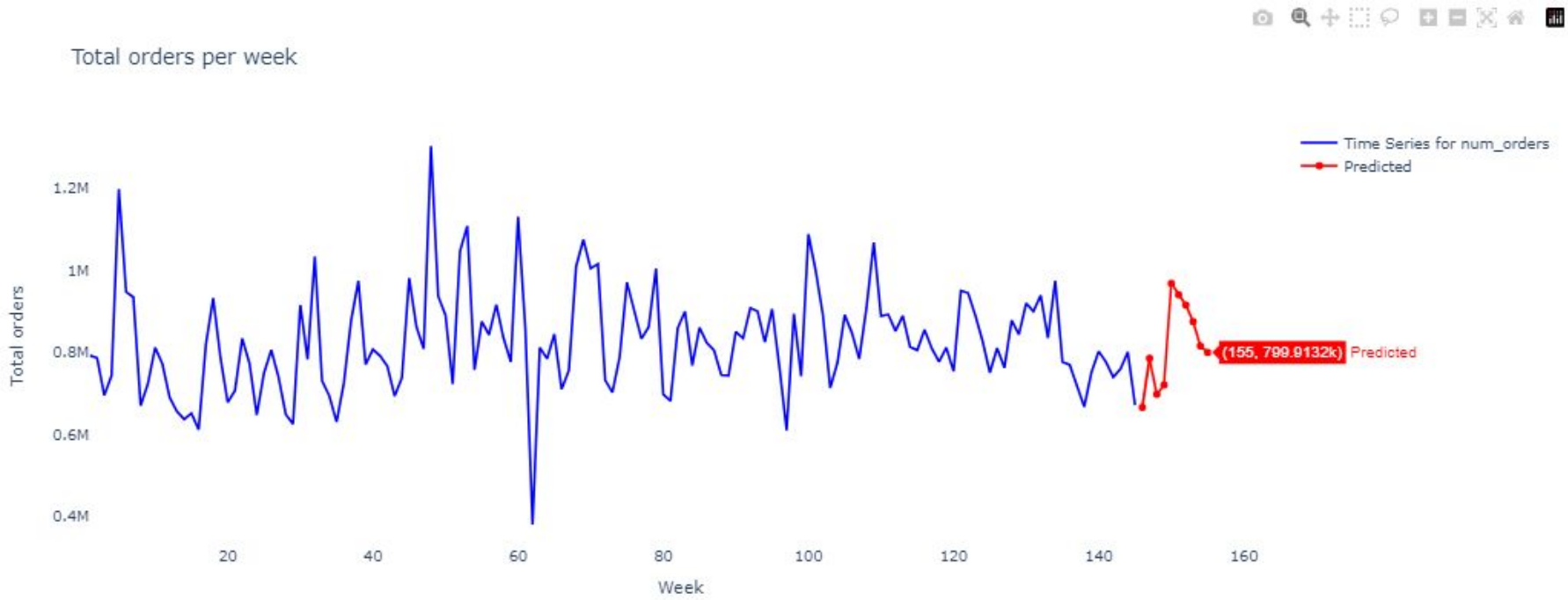
Predicticted orders(Green) and Actual orders(Blue) :



Now plotting the time series graph using matplotlib including a test data and generating a graph forecasting orders for the upcoming weeks and according predicting inventory required !

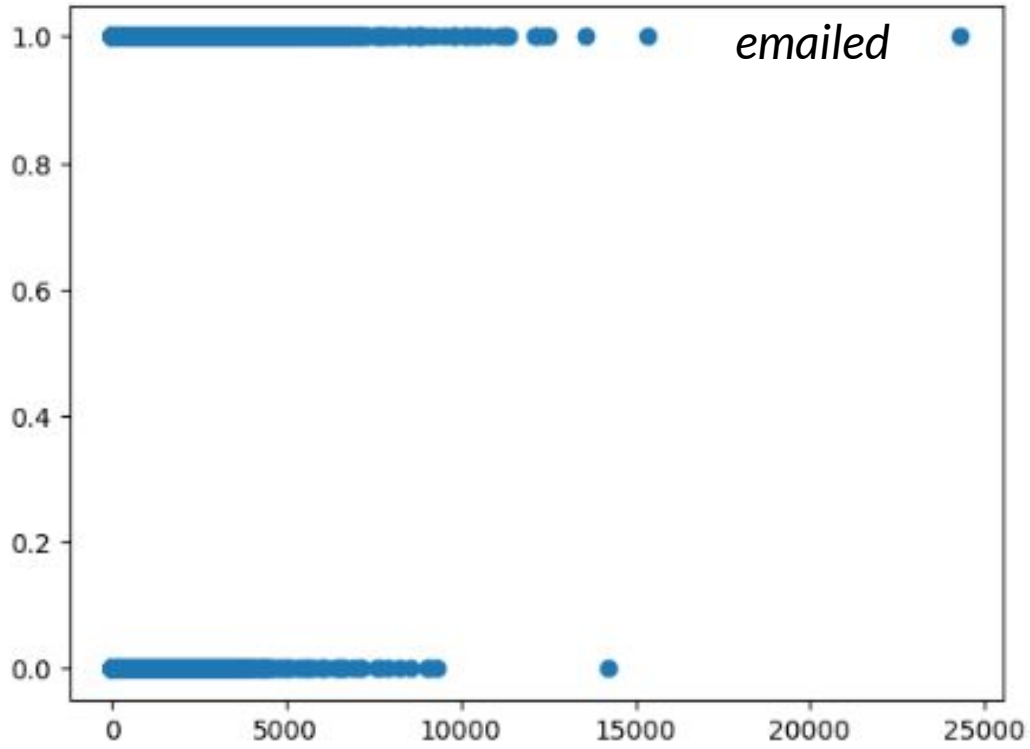
```
import plotly.graph_objs as go
import plotly.offline as pyoff
plot_data = [
    go.Scatter(
        x=ts_tot_orders.index,
        y=ts_tot_orders['num_orders'],
        name='Time Series for num_orders',
        marker = dict(color = 'Blue')
        #x_axis="OTI",
        #y_axis="time",
    ),
    go.Scatter(
        x=ts_tot_pred.index,
        y=ts_tot_pred['num_orders'],
        name='Predicted',
        marker = dict(color = 'Red')
        #x_axis="OTI",
        #y_axis="time",
    )

]
plot_layout = go.Layout(
        title='Total orders per week',
        yaxis_title='Total orders',
        xaxis_title='Week',
        plot_bgcolor='rgba(0,0,0,0)'
    )
fig = go.Figure(data=plot_data, layout=plot_layout)
pyoff.iplot(fig)
```

Model's Order prediction for upcoming weeks :



Marketing Strategies :

We can plot numbers of orders against meals that are marketed via different ways - emails , youtube , posters , pamphlets ,none , etc .
This way we can recognise the platform through which we can reach the most customers attention and will switch to that platform for future marketing process .



Graph : plotted orders against meals advertised through emails vs which were not .

Implementation

We can put our solution into action which will be accessible by businesses , industrialist , individuals and others . We can do this by extending it to apps and websites .

App / Website- we will build a general app that will be beneficial for small scale organisations along with a customised facility that will benefit large scale businesses and industries .

Future Scope

- Accurate demand prediction.
- Sustainable
- Automated management
- Enhanced supply chain visibility
- Automatic order execution
- Tailored inventory
- Reduce waste and reuse product
- Enhanced cooperation
- Marketing analysis
- Scalable solutions
- Deep insights and actionable data

Conclusion

Integrating machine learning and AI into demand forecasting transforms inventory management by enhancing accuracy and efficiency. These technologies analyze large datasets to uncover patterns, enabling real-time adjustments to inventory levels. AI continuously improves predictions with new data, reducing excess stock and avoiding stockouts. This leads to cost savings, increased customer satisfaction through reliable product availability, and a competitive edge through strategic, data-driven decisions. In essence, AI and machine learning make inventory management more efficient, responsive, and proactive.

Our Team

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