Problem Statement

In this project we want to predict the order patterns for various restaurants using time-series forecasting. We want to explore different time-series forecasting models to understand and analyse the order patterns for specific SKUs for a particular restaurant and determine the perfect model for the use case.

Why is it crucial?

The models can help figure out patterns based on order volume, weather conditions, order type etc. which can then help in making better business decisions and rectifying flaws is any. Furthermore, we want to leverage recommendation system to enhance the user experience.

Data Retrival - Importing the Dataset Using URL

```
import os
import zipfile
import numpy as np
import pandas as pd
import matplotlib.pyplot  as plt


# Step 1: Download the dataset from Kaggle
os.system('kaggle datasets download -d gauravmalik26/food-delivery-
dataset')

# Step 2: Extract the ZIP file
with zipfile.ZipFile('food-delivery-dataset.zip', 'r') as zip_ref:
    zip_ref.extractall('food_delivery_dataset')

# Step 3: List the files in the extracted directory to find the
correct CSV file name
extracted_dir = 'food_delivery_dataset'
files = os.listdir(extracted_dir)
print("Extracted files:", files)

# Step 4: Use the correct file from the extracted list
csv_file_path = f"{extracted_dir}/train.csv"  # Replace with
'train.csv' since it's one of the files

# Step 5: Create a DataFrame from the extracted CSV file
df = pd.read_csv(csv_file_path)
```

```
# Display the first few rows of the DataFrame
print(df.head())
```

```
Extracted files: ['Sample_Submission.csv', 'train.csv', 'test.csv']
        ID Delivery_person_ID Delivery_person_Age
Delivery_person_Ratings  \
0  0x4607     INDORES13DEL02                  37
4.9
1  0xb379     BANGRES18DEL02                  34
4.5
2  0x5d6d     BANGRES19DEL01                  23
4.4
3  0x7a6a    COIMBRES13DEL02                  38
4.7
4  0x70a2     CHENRES12DEL01                  32
4.6

   Restaurant_latitude  Restaurant_longitude
Delivery_location_latitude  \
0            22.745049             75.892471
22.765049
1            12.913041             77.683237
13.043041
2            12.914264             77.678400
12.924264
3            11.003669             76.976494
11.053669
4            12.972793             80.249982
13.012793

   Delivery_location_longitude  Order_Date Time_Orderd
Time_Order_picked  \
0                    75.912471  19-03-2022    11:30:00
11:45:00
1                    77.813237  25-03-2022    19:45:00
19:50:00
2                    77.688400  19-03-2022    08:30:00
08:45:00
3                    77.026494  05-04-2022    18:00:00
18:10:00
4                    80.289982  26-03-2022    13:30:00
13:45:00

       Weatherconditions Road_traffic_density  Vehicle_condition  \
0       conditions Sunny                 High                  2
1      conditions Stormy                  Jam                  2
2  conditions Sandstorms                  Low                  0
3       conditions Sunny               Medium                  0
4      conditions Cloudy                 High                  1
```

```
  Type_of_order Type_of_vehicle multiple_deliveries Festival
City  \
0        Snack      motorcycle                    0      No
Urban
1        Snack         scooter                    1      No
Metropolitian
2       Drinks      motorcycle                    1      No
Urban
3       Buffet      motorcycle                    1      No
Metropolitian
4        Snack         scooter                    1      No
Metropolitian

  Time_taken(min)
0        (min) 24
1        (min) 33
2        (min) 26
3        (min) 21
4        (min) 30
```

Data Cleaning

The data cleaning steps that we have followed are -

1. Replacing "Nan" text with actual Nan values and replacing values accordingly. (Replacing values is different for different columns)
2. Removing duplicates
3. Replacing Nan in Delivery Person Age with an average value for the complete dataset.
4. Replacing Nan in Delivery Person Rating with an average value for the complete dataset and rounded to single decimal place.
5. Replace Nan values for Multiple Deliveries with the most frequent values. The values are 0,1,2,3
6. Replace the value with the average of the difference. You need to subtract the average time difference from the Time Packed.
7. Calculate the range of values for Latitude and Longitude. Replace the 0 values.
8. Replace each column with a random value from the range. Make sure to add float values with 4 decimal points.
9. Convert the data type accordingly (String to Float for Rating, Latitide and Longitude, String to Int for multiple deliveries, Removed (min) prefix from Time Taken)
10. Handled Outliers for various columns

```
# Replacing 'NaN' with NaN.
df = df.replace('NaN', np.nan, regex=True)

print("Finding SUM of Nan values")
# Finding the count of NaN for each column
```

```python
print(df.isna().sum())
print("------------------------")
print("Finding SUM of 0 values")
# Finding columns with count as 0.
print((df == 0).sum())
```

```
Finding SUM of Nan values
ID                                0
Delivery_person_ID                0
Delivery_person_Age            1854
Delivery_person_Ratings        1908
Restaurant_latitude               0
Restaurant_longitude              0
Delivery_location_latitude        0
Delivery_location_longitude       0
Order_Date                        0
Time_Orderd                    1731
Time_Order_picked                 0
Weatherconditions               616
Road_traffic_density            601
Vehicle_condition                 0
Type_of_order                     0
Type_of_vehicle                   0
multiple_deliveries             993
Festival                        228
City                           1200
Time_taken(min)                   0
dtype: int64
------------------------
Finding SUM of 0 values
ID                                0
Delivery_person_ID                0
Delivery_person_Age               0
Delivery_person_Ratings           0
Restaurant_latitude            3640
Restaurant_longitude           3640
Delivery_location_latitude        0
Delivery_location_longitude       0
Order_Date                        0
Time_Orderd                       0
Time_Order_picked                 0
Weatherconditions                 0
Road_traffic_density              0
Vehicle_condition             15009
Type_of_order                     0
Type_of_vehicle                   0
multiple_deliveries               0
Festival                          0
City                              0
```

```
Time_taken(min)                         0
dtype: int64

threshold = 0.01

# Task 1: Identify the valid range for Restaurant Latitude and
Longitude
valid_restaurant_latitude = df[df['Restaurant_latitude'] > threshold]
['Restaurant_latitude']
valid_restaurant_longitude = df[df['Restaurant_longitude'] >
threshold]['Restaurant_longitude']

# Task 2: Identify the valid range for Delivery Latitude and Longitude
valid_delivery_latitude = df[df['Delivery_location_latitude'] >
threshold]['Delivery_location_latitude']
valid_delivery_longitude = df[df['Delivery_location_longitude'] >
threshold]['Delivery_location_longitude']

# Task 3: Calculate the min and max for each of the valid columns
min_rest_lat, max_rest_lat = valid_restaurant_latitude.min(),
valid_restaurant_latitude.max()
min_rest_long, max_rest_long = valid_restaurant_longitude.min(),
valid_restaurant_longitude.max()
min_del_lat, max_del_lat = valid_delivery_latitude.min(),
valid_delivery_latitude.max()
min_del_long, max_del_long = valid_delivery_longitude.min(),
valid_delivery_longitude.max()

# Task 4: Replace zero or near-zero values with random values from the
respective range
df['Restaurant_latitude'] = df['Restaurant_latitude'].apply(
    lambda x: round(np.random.uniform(min_rest_lat, max_rest_lat), 4)
if x <= threshold else x
)
df['Restaurant_longitude'] = df['Restaurant_longitude'].apply(
    lambda x: round(np.random.uniform(min_rest_long, max_rest_long),
4) if x <= threshold else x
)
df['Delivery_location_latitude'] =
df['Delivery_location_latitude'].apply(
    lambda x: round(np.random.uniform(min_del_lat, max_del_lat), 4) if
x <= threshold else x
)
df['Delivery_location_longitude'] =
df['Delivery_location_longitude'].apply(
    lambda x: round(np.random.uniform(min_del_long, max_del_long), 4)
if x <= threshold else x
)

# Display the updated DataFrame
```

```
print(df[['Restaurant_latitude', 'Restaurant_longitude',
'Delivery_location_latitude', 'Delivery_location_longitude']])
```

```
       Restaurant_latitude  Restaurant_longitude
Delivery_location_latitude  \
0                22.745049             75.892471
22.765049
1                12.913041             77.683237
13.043041
2                12.914264             77.678400
12.924264
3                11.003669             76.976494
11.053669
4                12.972793             80.249982
13.012793
...                    ...                   ...
...
45588            26.902328             75.794257
26.912328
45589            27.425200             81.111200
0.070000
45590            13.022394             80.242439
13.052394
45591            11.001753             76.986241
11.041753
45592            23.351058             85.325731
23.431058

       Delivery_location_longitude
0                        75.912471
1                        77.813237
2                        77.688400
3                        77.026494
4                        80.289982
...                            ...
45588                    75.804257
45589                     0.070000
45590                    80.272439
45591                    77.026241
45592                    85.405731

[45593 rows x 4 columns]
```

```
df['Time_Orderd'] = pd.to_datetime(df['Time_Orderd'], errors='coerce')
df['Time_Order_picked'] = pd.to_datetime(df['Time_Order_picked'],
errors='coerce')

# Step 1: Calculate the time difference where "Time Ordered" is not
NULL
df['Time_Difference'] = df['Time_Order_picked'] - df['Time_Orderd']
```

```python
# Step 2: Calculate the average time difference (exclude rows where Time Ordered is NULL)
average_time_diff = df['Time_Difference'].mean()

# Step 3: Replace NULL values in "Time Ordered" by subtracting the average time difference from "Time Packed"
df['Time_Orderd'] = df.apply(
    lambda row: row['Time_Order_picked'] - average_time_diff if pd.isnull(row['Time_Orderd']) else row['Time_Orderd'],
    axis=1
)

# Drop the Time_Difference column if it's no longer needed
df.drop('Time_Difference', axis=1, inplace=True)

# Display the updated DataFrame
print(df[['Time_Orderd', 'Time_Order_picked']])
```

```
<ipython-input-37-22f806f3b529>:1: UserWarning: Could not infer format, so each element will be parsed individually, falling back to `dateutil`. To ensure parsing is consistent and as-expected, please specify a format.
  df['Time_Orderd'] = pd.to_datetime(df['Time_Orderd'], errors='coerce')
<ipython-input-37-22f806f3b529>:2: UserWarning: Could not infer format, so each element will be parsed individually, falling back to `dateutil`. To ensure parsing is consistent and as-expected, please specify a format.
  df['Time_Order_picked'] = pd.to_datetime(df['Time_Order_picked'], errors='coerce')
```

```
              Time_Orderd   Time_Order_picked
0     2024-10-09 11:30:00 2024-10-09 11:45:00
1     2024-10-09 19:45:00 2024-10-09 19:50:00
2     2024-10-09 08:30:00 2024-10-09 08:45:00
3     2024-10-09 18:00:00 2024-10-09 18:10:00
4     2024-10-09 13:30:00 2024-10-09 13:45:00
...                   ...                 ...
45588 2024-10-09 11:35:00 2024-10-09 11:45:00
45589 2024-10-09 19:55:00 2024-10-09 20:10:00
45590 2024-10-09 23:50:00 2024-10-09 00:05:00
45591 2024-10-09 13:35:00 2024-10-09 13:40:00
45592 2024-10-09 17:10:00 2024-10-09 17:15:00

[45593 rows x 2 columns]
```

```python
#Convert 'Delivery_person_Age' to numeric
df['Delivery_person_Age'] = pd.to_numeric(df['Delivery_person_Age'], errors='coerce')
```

```
#Replace null values in 'Delivery_person_Age' with the average
Average_age = df['Delivery_person_Age'].mean()
df['Delivery_person_Age'] =
df['Delivery_person_Age'].fillna(int(Average_age))

#Convert 'Delivery_person_Ratings' to numeric
df['Delivery_person_Ratings'] =
pd.to_numeric(df['Delivery_person_Ratings'], errors='coerce')

#Replace null values in 'Delivery_person_Ratings' with average(1
decimal point)
Average_rating = df['Delivery_person_Ratings'].mean()
df['Delivery_person_Ratings'] =
df['Delivery_person_Ratings'].fillna(round(Average_rating, 1))

#Convert 'Delivery_person_Ratings' to numeric
df['multiple_deliveries'] = pd.to_numeric(df['multiple_deliveries'],
errors='coerce')

#Replace null values with the most frequent value which is the mode of
the data
most_frequent_value = df['multiple_deliveries'].mode()[0]
df['multiple_deliveries'] =
df['multiple_deliveries'].fillna(most_frequent_value)

print(df.head())
```

```
        ID Delivery_person_ID  Delivery_person_Age
Delivery_person_Ratings  \
0  0x4607     INDORES13DEL02                 37.0
4.9
1  0xb379     BANGRES18DEL02                 34.0
4.5
2  0x5d6d     BANGRES19DEL01                 23.0
4.4
3  0x7a6a    COIMBRES13DEL02                 38.0
4.7
4  0x70a2     CHENRES12DEL01                 32.0
4.6

   Restaurant_latitude  Restaurant_longitude
Delivery_location_latitude  \
0            22.745049             75.892471
22.765049
1            12.913041             77.683237
13.043041
2            12.914264             77.678400
12.924264
3            11.003669             76.976494
11.053669
```

```
4            12.972793             80.249982
13.012793

   Delivery_location_longitude  Order_Date         Time_Orderd  \
0                    75.912471  19-03-2022 2024-10-09 11:30:00
1                    77.813237  25-03-2022 2024-10-09 19:45:00
2                    77.688400  19-03-2022 2024-10-09 08:30:00
3                    77.026494  05-04-2022 2024-10-09 18:00:00
4                    80.289982  26-03-2022 2024-10-09 13:30:00

    Time_Order_picked      Weatherconditions Road_traffic_density  \
0 2024-10-09 11:45:00       conditions Sunny                High
1 2024-10-09 19:50:00      conditions Stormy                 Jam
2 2024-10-09 08:45:00  conditions Sandstorms                 Low
3 2024-10-09 18:10:00       conditions Sunny              Medium
4 2024-10-09 13:45:00      conditions Cloudy                High

   Vehicle_condition Type_of_order Type_of_vehicle
multiple_deliveries  \
0                   2        Snack      motorcycle
0.0
1                   2        Snack         scooter
1.0
2                   0       Drinks      motorcycle
1.0
3                   0       Buffet      motorcycle
1.0
4                   1        Snack         scooter
1.0

  Festival            City Time_taken(min)
0      No           Urban         (min) 24
1      No   Metropolitian         (min) 33
2      No           Urban         (min) 26
3      No   Metropolitian         (min) 21
4      No   Metropolitian         (min) 30
```

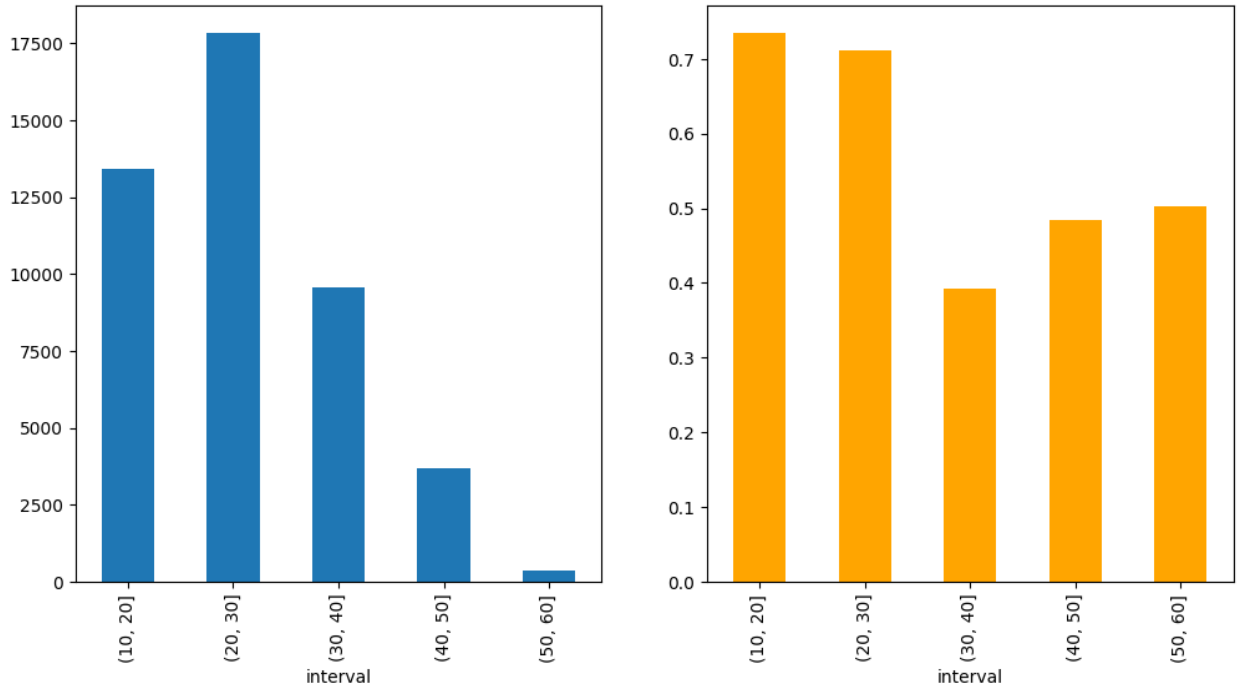
Hypothesis 1.1 When the time taken for a delivery increaese the average rating decreases.

Here are are assuming that as the delivery time increases, the rating decreases.

```
time_taken = df['Time_taken(min)'].str.split(" ").str[1]

time_taken = pd.DataFrame(time_taken)

time_taken["Time_taken(min)"] =
```

```
time_taken["Time_taken(min)"].astype(int)

print(time_taken.max())
print(time_taken.min())

bins = [10, 20, 30, 40, 50 , 60]

time_taken['interval'] = pd.cut(time_taken["Time_taken(min)"], bins)

bin_count = time_taken['interval'].value_counts().sort_index()

time_taken['rating'] = df['Delivery_person_Ratings'].astype(float)

average_rating_per_interval = time_taken.groupby('interval')
['rating'].mean() - 4

plt.figure(figsize=(12, 6))
plt.subplot(1, 2, 1)
bin_count.plot(kind='bar')
plt.subplot(1, 2, 2)
average_rating_per_interval.plot(kind='bar', color='orange')
```

```
Time_taken(min)    54
dtype: int64
Time_taken(min)    10
dtype: int64

<ipython-input-39-c1e6c1bc46e9>:18: FutureWarning: The default of
observed=False is deprecated and will be changed to True in a future
version of pandas. Pass observed=False to retain current behavior or
observed=True to adopt the future default and silence this warning.
  average_rating_per_interval = time_taken.groupby('interval')
['rating'].mean() - 4

<Axes: xlabel='interval'>
```



As we can see on the left is the number of orders for different time intervals. As the time increases (in the right), we see the ratings gradually decrease.

Hypothesis 1.2 As the distance increases, the delivery time increases

As the distance between the restaurant and the delivery place increases, time taken to deliver the order also increases.

```
def haversine(lat1, lon1, lat2, lon2):
    lat1, lon1, lat2, lon2 = map(np.radians, [lat1, lon1, lat2, lon2])

    dlon = lon2 - lon1
    dlat = lat2 - lat1
    a = np.sin(dlat/2)**2 + np.cos(lat1) * np.cos(lat2) *
np.sin(dlon/2)**2
    c = 2 * np.arcsin(np.sqrt(a))
    r = 6371
    return c * r

delivery_time_vs_distance =
df[['Restaurant_latitude','Restaurant_longitude',
'Delivery_location_latitude','Delivery_location_longitude']]
delivery_time_vs_distance['Distance_km'] =
delivery_time_vs_distance.apply(lambda row: haversine(
    row['Restaurant_latitude'],
```

```
    row['Restaurant_longitude'],
    row['Delivery_location_latitude'],
    row['Delivery_location_longitude']
), axis=1)

delivery_time_vs_distance['time_taken'] =
df['Time_taken(min)'].str.split(" ").str[1]

df_replaced = df.replace('NaN', np.nan, regex=True)

df_dropped = df_replaced.dropna()

df_dropped['Time_Order_picked'] =
pd.to_datetime(df_dropped['Time_Order_picked'])
df_dropped['Time_Orderd'] = pd.to_datetime(df_dropped['Time_Orderd'])


# result = (df_dropped['Time_Order_picked'] -
df_dropped['Time_Orderd']).dt.total_seconds() / 60

delivery_time_vs_distance["time_taken"] =
delivery_time_vs_distance["time_taken"].astype(float)

delivery_time_vs_distance["time_taken"] =
delivery_time_vs_distance["time_taken"]

delivery_time_vs_distance['interval'] =
pd.cut(delivery_time_vs_distance["time_taken"], bins)

average_distance_per_interval =
delivery_time_vs_distance.groupby('interval')['Distance_km'].mean()


average_distance_per_interval.plot(kind='bar')


<ipython-input-40-49795bb7a68b>:12: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  delivery_time_vs_distance['Distance_km'] =
delivery_time_vs_distance.apply(lambda row: haversine(
<ipython-input-40-49795bb7a68b>:19: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
```

```
returning-a-view-versus-a-copy
  delivery_time_vs_distance['time_taken'] =
df['Time_taken(min)'].str.split(" ").str[1]
<ipython-input-40-49795bb7a68b>:25: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  df_dropped['Time_Order_picked'] =
pd.to_datetime(df_dropped['Time_Order_picked'])
<ipython-input-40-49795bb7a68b>:26: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  df_dropped['Time_Orderd'] =
pd.to_datetime(df_dropped['Time_Orderd'])
<ipython-input-40-49795bb7a68b>:31: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  delivery_time_vs_distance["time_taken"] =
delivery_time_vs_distance["time_taken"].astype(float)
<ipython-input-40-49795bb7a68b>:33: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  delivery_time_vs_distance["time_taken"] =
delivery_time_vs_distance["time_taken"]
<ipython-input-40-49795bb7a68b>:35: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  delivery_time_vs_distance['interval'] =
pd.cut(delivery_time_vs_distance["time_taken"], bins)
<ipython-input-40-49795bb7a68b>:37: FutureWarning: The default of
observed=False is deprecated and will be changed to True in a future
```

```
version of pandas. Pass observed=False to retain current behavior or
observed=True to adopt the future default and silence this warning.
  average_distance_per_interval =
delivery_time_vs_distance.groupby('interval')['Distance_km'].mean()

<Axes: xlabel='interval'>
```