***Project report on***

DemandEst - AI Powered Food Demand

Forecaster

***Prepared by***

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# INTRODUCTION

* 1. **OVERVIEW**

A food delivery service to be deal with a lot of perishable raw materials which makes it all, the most important factor for such a company is to accurately forecast daily and weekly demand. The application of AI in the food industry has been growing for years due to various reasons such as food sorting, classification and prediction of the parameters, quality control, and food safety. Expert system, fuzzy logic, ANN, adaptive neuro-fuzzy inference system (ANFIS), and machine learning are among the popular techniques that have been utilized in the food industries.

# PURPOSE

The use of forecasting methods is nowadays regarded as a business ally since it supports both the operational and the strategic decision making processes. This paper is based on a research project aiming the development of demand forecasting models for a company (designated here by PR) that operates in the food business, more specifically in the delicatessen segment. In particular, we focused on demand forecasting models that can serve as a tool to support production planning and inventory management at the company. The analysis of the company ’ s operations led to the development of a new demand forecasting tool based on a combination of forecasts, which is now being used

# LITERATURE SURVEY

* 1. **EXISTING PROBLEM**

The replenishment of the majority of raw materials is done on weekly basis and since the raw material is perishable, the procurement planning is of utmost importance. Anyways the recruiting of staff members at the fulﬁllment center is an prospect wherein the prediction of orders would be beneﬁcial. Although this is a process that can be done manual process.

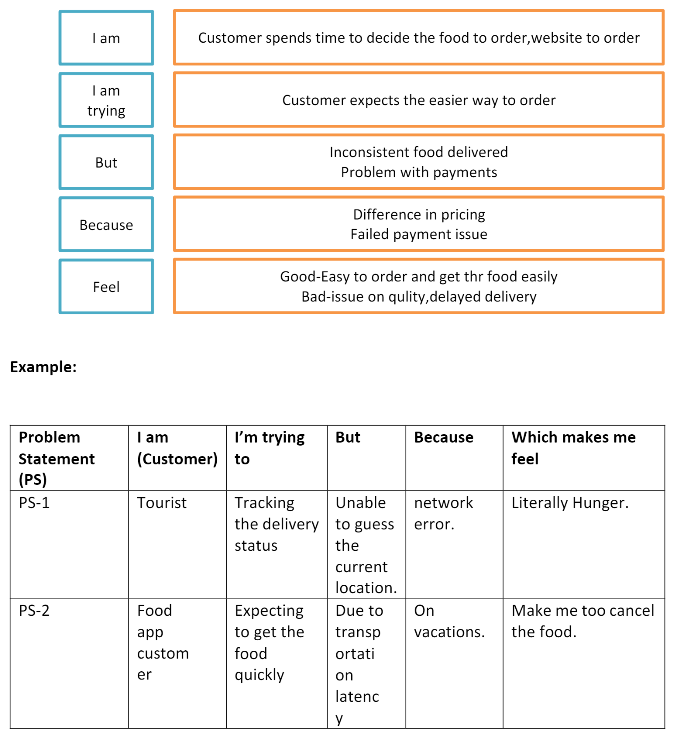
# REFERENCE

* + - Adi, G. N. (2018, March 9). Thousands of GO-CAR Drivers on Strike in Surakarta. The Jakarta Post. https:/[/www.thejakartapost.com/news/2018/03/08/thousands-of-go-car-](http://www.thejakartapost.com/news/2018/03/08/thousands-of-go-car-)

drivers-on-strike-in-surak arta.html

* + - Alkhatib, A., & Bernstein, M. (2019, May). Street-level algorithms: A theory at the gaps between policy and decisions. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (pp. 1-13).
    - Brown, Tim. (2008). Design Thinking. Harvard Business Review. 86. 84-92, 141.
    - Colley, A., & Häkkilä, J. (2018, November). Service Design Methods for Human Computer Interaction. In Proceedings of the 17th International Conference on Mobile and Ubiquitous Multimedia (pp. 563-566).
    - Clarke, S. (2006). Transformation Lessons from Coca-Cola Enterprises Inc.: Managing the Introduction of a Structured Forecast Process. Foresight: The International Journal of Applied Forecasting, (4), 21-25.

# PROBLEM STATEMENT DEFINITION

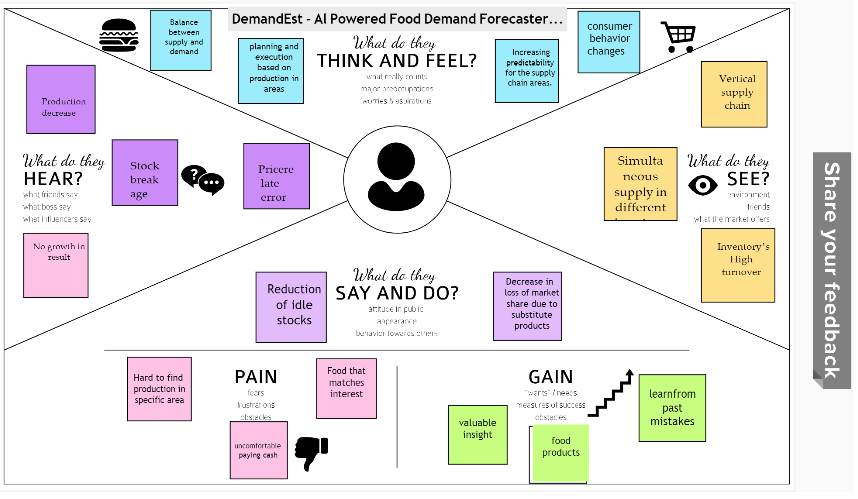
****

1. **IDEATION & PROPOSED SOLUTION**

# Empathy Map Canvas

An empathy map is a collaborative visualization used to articulate what we know about a particular type of user. It externalizes knowledge about users in order to 1) create a shared understanding of user needs, and 2) aid in decision making.

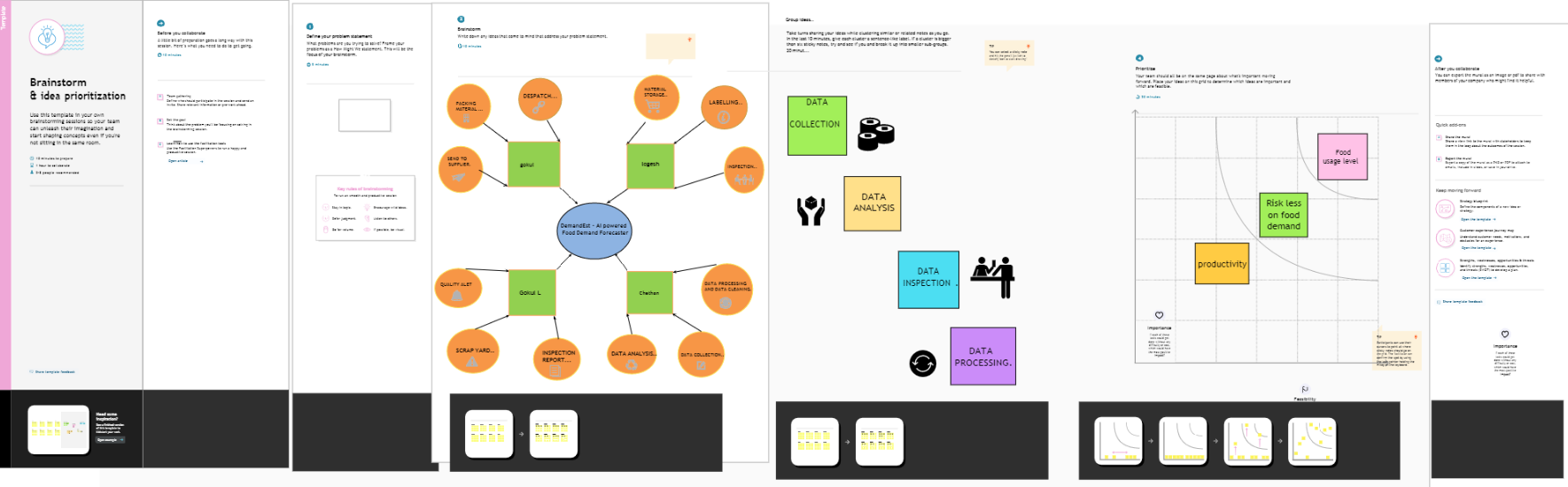
Traditional empathy maps are split into 4 quadrants (Says, Thinks, Does, and Feels), with the user or persona in the middle. Empathy maps provide a glance into who a user is as a whole and are not chronological or sequential.



# Ideation & Brainstorming

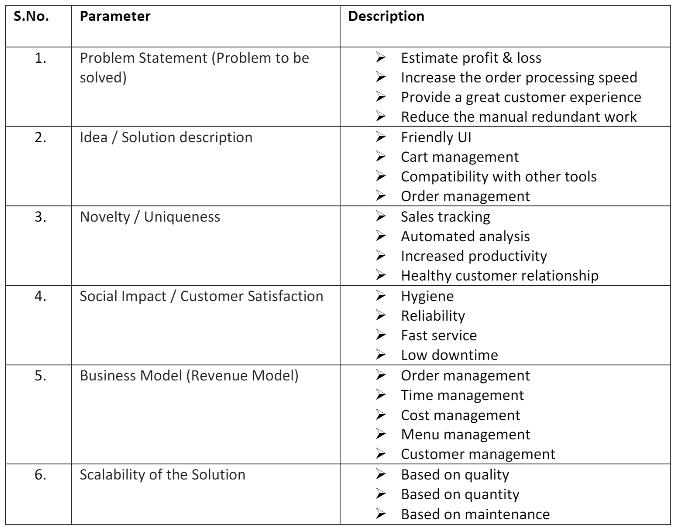
Brainstorming is a method design teams use to generate ideas to solve clearly deﬁned design problems. In controlled conditions and a free-thinking environment, teams approach a problem by such means as “How Might We” questions. They produce a vast array of ideas and draw links between them to ﬁnd potential solutions

Everyone in a design team should have a *clear* deﬁnition of the target problem. They typically gather for a brainstorming session in a room with a large board/wall for pictures/Post-Its. A good mix of participants will expand the experience pool and therefore broaden the idea space.



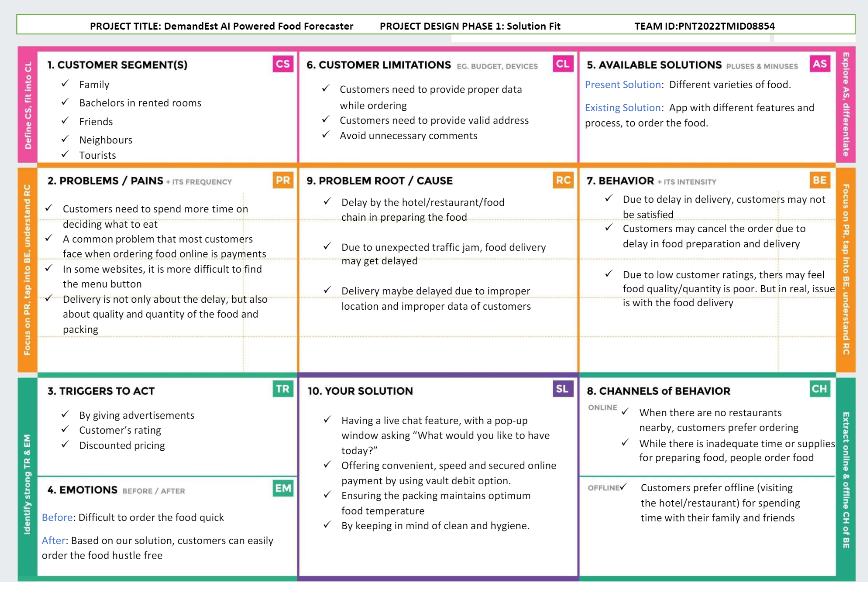
# 3.2 Proposed Solution

[Proposed Solution](https://www.lawinsider.com/dictionary/proposed-solution) means the technical solution to be provided by the Implementation agency in response to the requirements and the objectives of the Project.[Proposed Solution](https://www.lawinsider.com/dictionary/proposed-solution) means the Proposed System with modiﬁcations that meet the Agency’s requirements as set forth in this RFP.[Proposed Solution](https://www.lawinsider.com/dictionary/proposed-solution) means the combination of software, hardware, other products or equipment, and any and all services (including any installation, implementation, training, maintenance and support services) necessary to implement the solution described by Vendor in its Proposal.



# 3.4 Problem Solution Fit

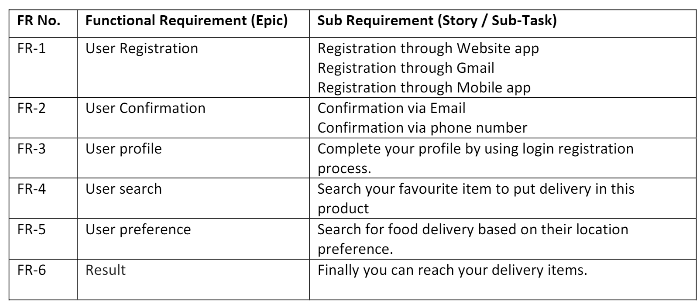
The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem.



# REQUIREMENT ANALYSIS

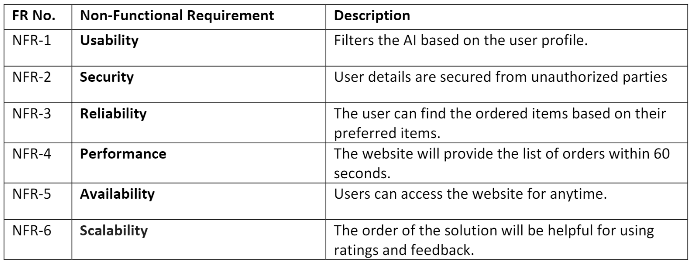
* 1. **Functional requirement**

Functional requirements may involve calculations, technical details, data manipulation and processing, and other speciﬁc functionality that deﬁne what a system is supposed to accomplish. Behavioral requirements describe all the cases where the system uses the functional requirements, these are captured in use cases.



# Non-Functional requirements

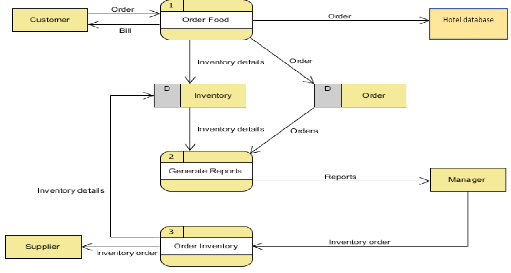
In [systems engineering](https://en.wikipedia.org/wiki/Systems_engineering) and [requirements engineering](https://en.wikipedia.org/wiki/Requirements_engineering), a non-functional requirement (NFR) is a [requirement](https://en.wikipedia.org/wiki/Requirement) that speciﬁes criteria that can be used to judge the operation of a system, rather than speciﬁc behaviours.

****

# PROJECT DESIGN

* 1. **Data Flow Diagrams**

A Data Flow Diagram (DFD) is a traditional visual representation of the information ﬂows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

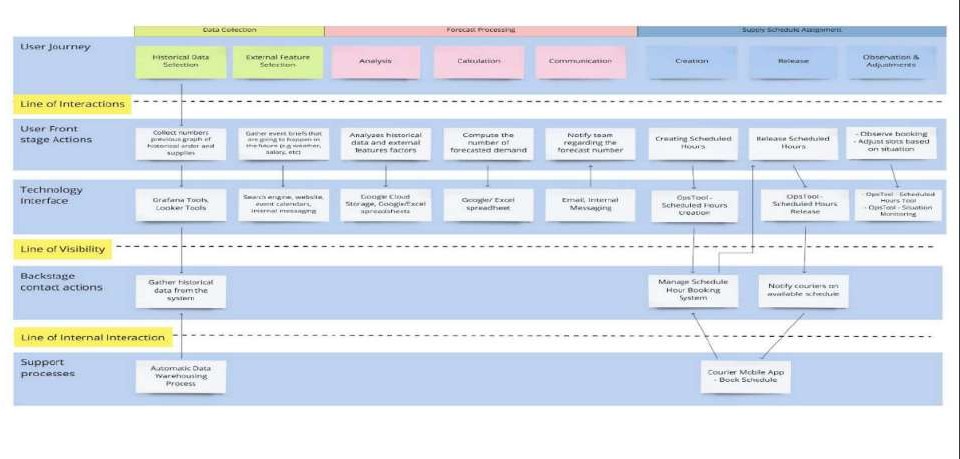


# Solution & Technical Architecture

Solution Architecture:

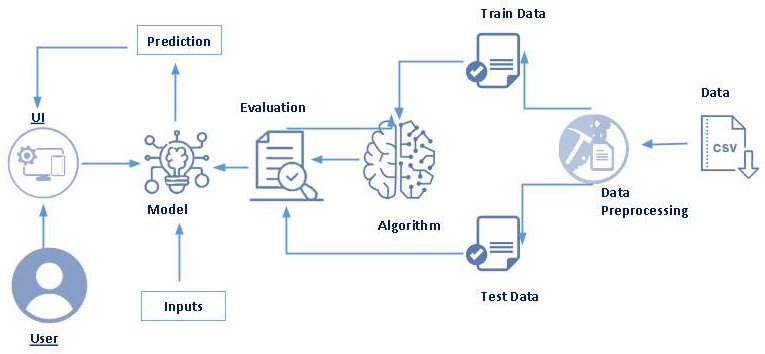
A solution architecture (SA) is an architectural description of a speciﬁc solution.

SAs combine guidance from different enterprise architecture viewpoints (business, information and technical), as well as from the enterprise solution architecture (ESA).



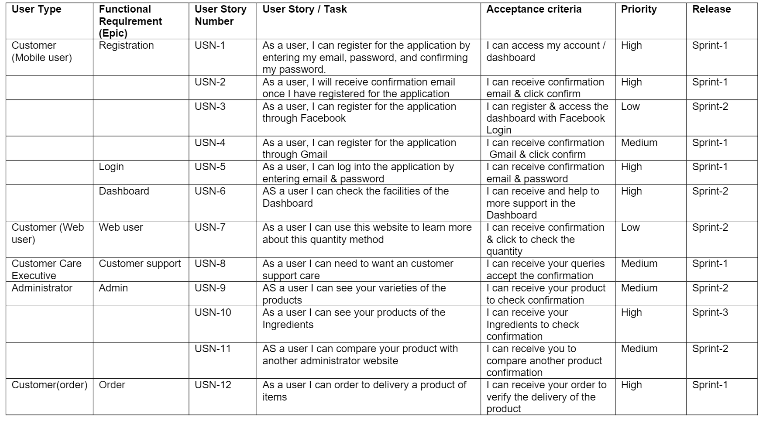
Technical Architecture:

Technical Architecture (TA) is a form of IT architecture that is used to design computer systems. It involves the development of a technical blueprint with regard to the arrangement, interaction, and interdependence of all elements so that system- relevant requirements are met.



# User Stories

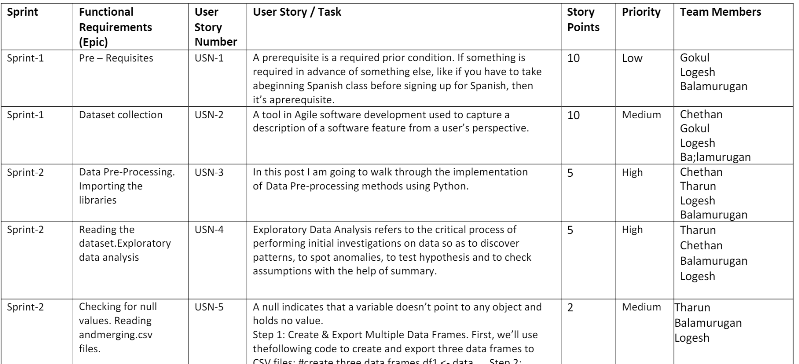
A user story is an informal, general explanation of a software feature written from the perspective of the end user or customer. The purpose of a user story is to articulate how a piece of work will deliver a particular value back to the customer.

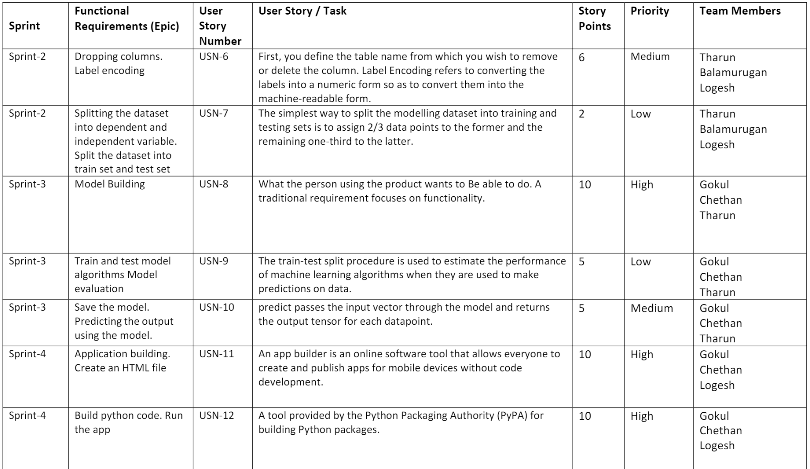


# PROJECT PLANNING & SCHEDULING

* 1. **Sprint Planning & Estimation**

In Scrum Projects, Estimation is done by the entire team during Sprint Planning Meeting. The objective of the Estimation would be to consider the User Stories for the Sprint by Priority and by the Ability of the team to deliver during the Time Box of the Sprint.





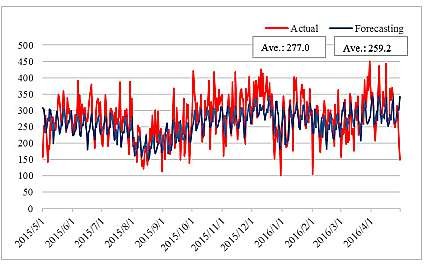
# Sprint Delivery Schedule

A sprint schedule is a document that outlines sprint planning from end to end. It's one of the ﬁrst steps in the agile sprint planning process—and something that requires adequate research, planning, and communication.



# Reports From JIRA

Jira helps teams plan, assign, track, report, and manage work and brings teams together for everything from agile software development and customer support to start- ups and enterprises. Software teams build better with Jira Software, the #1 tool for agile teams.



# CODING & SOLUTIONING

* 1. **Data Dictionary**

Our base data consists of four csv ﬁles containing information about test data, train data and other required information.

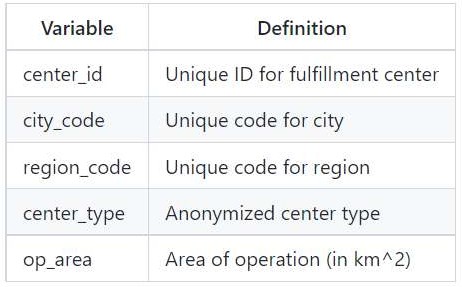
* + - train.csv: Contains information like id, week, center id, meal id, checkout price, base price, emailer for promotion, homepage featured, number of orders. This ﬁle is used for training.



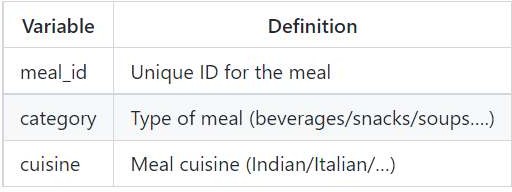
* + - test.csv: Contains information like id, week, center id, meal id, checkout price,

base price, emailer for promotion, homepage featured. This ﬁle is used for testing.

* + - fulﬁlment\_center\_info.csv: Contains information of each fulﬁlment center.



* + - meal\_info.csv: Contains information of each meal being served.



# Libraries Used

pandas, numpy, scikit learn, matplotlib, seaborn, xgboost, lightgbm, catboost

# Data Pre-Processing

* + - There are no Missing/Null Values in any of the three datasets.
    - Before proceeding with the prediction process, all the three data sheets need to be merged into a single dataset. Before performing the merging operation, primary feature for combining the datasets needs to be validated.
    - The number of Center IDs in train dataset is matching with the number of Center IDs in the Centers Dataset i.e 77 unique records. Hence, there won't be any missing values while merging the datasets together.
    - The number of Meal IDs in train dataset is matching with the number of Meal IDs in the Meals Dataset i.e 51 unique records. Hence, there won't be any missing values while merging the datasets together.
    - As checked earlier, there were no Null/Missing values even after merging the datasets.

# Feature Engineering

Feature engineering is the process of using domain knowledge of the data to create features that improves the performance of the machine learning models.

With the given data, We have derived the below features to improve our model performance.

* + - Discount Amount : This deﬁnes the difference between the “base\_Price” and “checkout\_price”.
    - Discount Percent : This deﬁnes the % discount offer to customer.
    - Discount Y/N : This deﬁnes whether Discount is provided or not - 1 if there is Discount and 0 if there is no Discount.
    - Compare Week Price : This deﬁnes the increase / decrease in price of a Meal for a particular center compared to the previous week.
    - Compare Week Price Y/N : Price increased or decreased - 1 if the Price increased and 0 if the price decreased compared to the previous week.
    - Quarter : Based on the given number of weeks, derived a new feature named as Quarter which deﬁnes the Quarter of the year.
    - Year : Based on the given number of weeks, derived a new feature named as Year which deﬁnes the Year.

# Data Transformation

* + - Logarithm transformation (or log transform) is one of the most commonly used mathematical transformations in feature engineering. It helps to handle skewed data and after transformation, the distribution becomes more approximate to normal.
    - In our data, the target variable ‘num\_orders’ is not normally distributed. Using this without applying any transformation techniques will downgrade the performance of our model.
    - Therefore, we have applied Logarithm transformation on our Target feature ‘num\_orders’ post which the data seems to be more approximate to normal distribution.
    - After Log transformation, We have observed 0% of Outlier data being present within the Target Variable – num\_orders using 3 IQR Method.

# Evaluation Metric

The evaluation metric for this competition is 100\*RMSLE where RMSLE is Root of Mean Squared Logarithmic Error across all entries in the test set.

# Initial Approach

* + - Simple Linear Regression model without any feature engineering and data transformation which gave a RMSE : 194.402
    - Without feature engineering and data transformation, the model did not perform well and could'nt give a good score.
    - Post applying feature engineering and data transformation (log and log1p transformation), Linear Regression model gave a RMSLE score of 0.634.

# Advanced Models

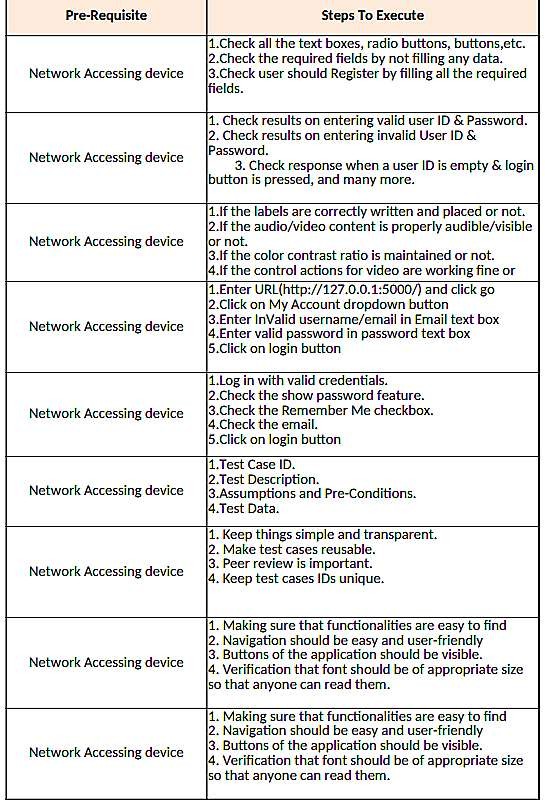
* + - With improvised feature engineering, built advanced models using Ensemble techniques and other Regressor algorithms.
    - Decision Tree Regressors performed well on the model which gave much reduced RMSLE.
    - With proper hyper-parameter tuning, Decision Tree Regressor performed well on the model and gave the lease RMSLE of 0.5237

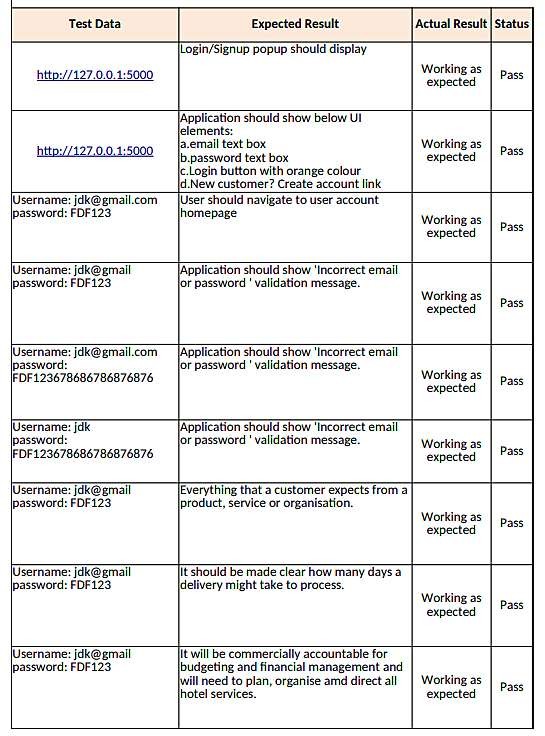
# TESTING

* 1. **Test Cases**

A test case includes information such as test steps, expected results and data while a test scenario only includes the functionality to be tested.



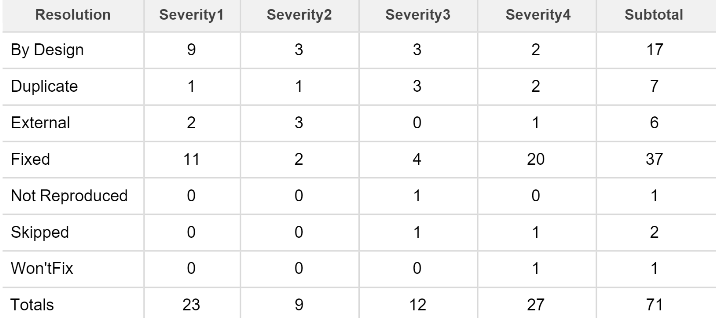




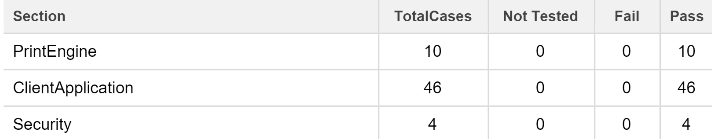
# User Acceptance Testing

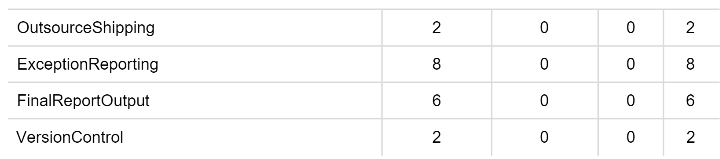
User Acceptance Testing (UAT), which is performed on most UIT projects, sometimes called beta testing or end-user testing, is a phase of software development in which the software is tested in the "real world" by the intended audience or business representative.

Defect Analysis:



Test Case Analysis:

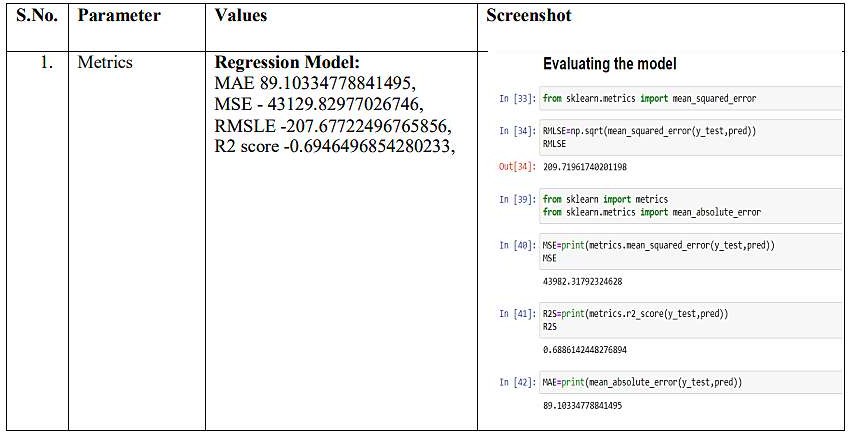


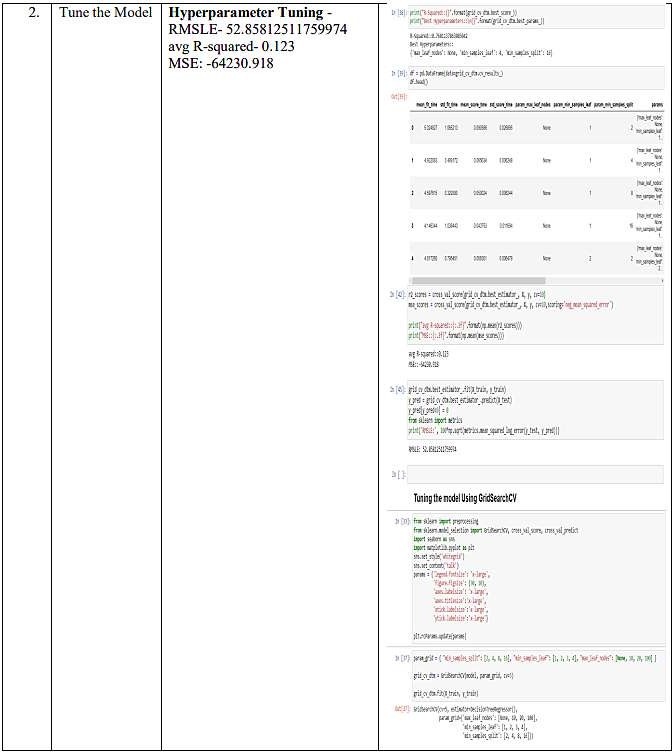


# RESULTS

* 1. **Performance Metrics**

Performance testing is the practice of evaluating how a system performs in terms of responsiveness and stability under a particular workload. Performance tests are typically executed to examine speed, robustness, reliability, and application size.





# ADVANTAGES & DISADVANTAGES

**Advantages:**

1. Food wastage will be minimized.
2. Simple and easy to use framework.

# Disadvantages:

1. The output obtained may not be precised, due to the use of limited datasets.

# APPLICATIONS

This project focuses on one food delivery client, which delivers food in many different cities through distribution networks and fulﬁllment centers.

# CONCLUSION

The main moto behind this project is to reduce food wastage.The availability of the food items makes the society better. Our purposed model would deﬁnitely come handy to a company for predicting then number of food orders and help them to serve their customers better.

# FUTURE SCOPE

* 1. Working on the frontend to make the framework more dynamic.
  2. In the future, we also plan to improve forecasting accuracy and research on the eﬃciency of store management.

# APPENDIX

**SOURCE CODE**:

# home.html

<!DOCTYPE html>

<html lang="en">

<head>

    <meta charset="UTF-8">

    <meta http-equiv="X-UA-Compatible" content="IE=edge">

    <meta name="viewport" content="width=device-width, initial-scale=1.0">

    <title>DemandEst - AI powered Food Demand Forecaster</title>

    <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.0.2/dist/css/bootstrap.min.css" rel="stylesheet"

            integrity="sha384-EVSTQN3/azprG1Anm3QDgpJLIm9Nao0Yz1ztcQTwFspd3yD65VohhpuuCOmLASjC" crossorigin="anonymous">

    <style>

        .bg-for-all{

            background-color: #08AEEA;

            background-image: linear-gradient(0deg, #08AEEA 0%, #2AF598 100%);

        }

        .bg-for-nav{

            background-color: #21D4FD;

            background-image: linear-gradient(19deg, #21D4FD 0%, #B721FF 100%);

        }

    </style>

</head>

<body>

    <div>

        <div class="card" style="border:none;">

            <div class="card-header h4 text-light p-3 bg-for-nav">

                DemandEst - AI powered Food Demand Forecaster

            </div>

            <div class="container p-4">

                <div class="row">

                  <div class="col-md-6">

                    <img src="https://images.pexels.com/photos/1640772/pexels-photo-1640772.jpeg?auto=compress&cs=tinysrgb&w=600"

                        class="img-fluid p-4 rounded-start" alt="...">

                  </div>

                   <div class="col-md-6">

                        <div class="card-body container">

                            <h2 class="card-title">know your food supply for 10 weeks?</h2>

                            <p class="card-text col">

                                A food delivery service has to deal with a lot of perishable raw materials which makes it all,

                                the most important factor for such a company is to accurately forecast daily and weekly dem and.

                                Too much inventory in the warehouse means more risk of wastage, and not enough could lea d to

                                out-of-stocks - and push customers to seek solutions from your competitors.

                                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, the task is to predict the demand for the next 10

                                weeks.

                            </p>

                            <br>

                            <a href="#pred\_form" class="btn-lg bg-for-nav text-light rounded-pill text-decoration-none">start predicting</a>

                        </div>

                   </div>

                </div>

                <!-- background-color: #FFDEE9;

background-image: linear-gradient(0deg, #FFDEE9 0%, #B5FFFC 100%);

 -->

 <!--  style="background-repeat: repeat, repeat;background-image:linear-gradient(19deg, #21D4FD 0%, #B721FF 100%), url('https://i.gifer.com/Y3ie.gif');background-blend-mode: multiply;opacity: 0.5" -->

                <div class="card border-warning mb-3">

                    <div class="card-header h4"> Results </div>

                    <div style="padding:70px 0;text-align:center;">

                    {% if prediction\_text %}

                    <div class="card-body text-center">

                        <p class="h2">Predicted number of food orders: {{ prediction\_text }}</p>

                    </div>

                    {% endif %}

                    {% if not prediction\_text %}

                    <button class="btn" type="button">

                        <span class="spinner-grow spinner-grow-sm" role="status" aria-hidden="true"></span>

                        <span class="spinner-grow spinner-grow-sm" role="status" aria-hidden="true"></span>

                        waiting for prediction...

                    </button>

                    {% endif %}

                    </div>

                </div>

            </div>

        </div>

        <!--  -->

        <!-- svg -->

        <svg style="background-color:#28F19E;border-style:none;" width="100%" height="70" viewbox="0 0 100 100" preserveAspectRatio="none">

            <path d="M0,0  L110,0C35,150 35,0 0,100z" fill="#ffffff" />

        </svg>

        <!-- svg -->

    <!-- upload page -->

    <div class="container-fluid">

    <div class="row card p-4 text-white bg-for-all" id="pred\_form" style="min-height:568px;background-color: #26EEA0;border:none">

        <div class="col h2 text-center  p-4">

            Get your number of food orders?

        </div>

        <form class="col row g-4 needs-validation" action="{{ url\_for('predict') }}" method="POST">

            <div class="col-md-4">

                <label for="validationCustom01" class="form-label fs-5">homepage\_featured</label>

                <select class="form-select" id="homepage\_featured" name="homepage\_featured" required>

                    <option value="">----</option>

                    <option value="0">No</option>

                    <option value="1">Yes</option>

                </select>

            </div>

            <div class="col-md-4">

                <label for="validationCustom01" class="form-label fs-5">emailer\_for\_promotion</label>

                <select class="form-select" id="emailer\_for\_promotion" name="emailer\_for\_promotion" required>

                    <option value="">----</option>

                    <option value="0">No</option>

                    <option value="1">Yes</option>

                </select>

            </div>

            <div class="col-md-4">

                <label for="formGroupExampleInput" class="form-label fs-5">Enter your op\_area</label>

                <input type="text" class="form-control" id="formGroupExampleInput" name="op\_area"

                    placeholder="like op\_area=27" required>

            </div>

            <div class="col-md-4">

                <label for="formGroupExampleInput" class="form-label fs-5">Enter your region code</label>

                <input type="text" class="form-control" id="formGroupExampleInput" name="region\_code"

                    placeholder="Enter region\_code" required>

            </div>

            <div class="col-md-4">

                <label for="formGroupExampleInput" class="form-label fs-5">Enter your city code</label>

                <input class="form-control" type="text" name="city\_code" placeholder="Enter city\_code" required>

            </div>

            <div class="col-md-4">

                <label for="validationCustom01" class="form-label fs-5">select the food cuisine</label>

                <select class="form-select" id="cuisine" name="cuisine" required>

                    <option value="">----</option>

                    <option value="0">Continental</option>

                    <option value="1">Indian</option>

                    <option value="2">Italian</option>

                    <option value="3">Thai</option>

                </select>

            </div>

            <div class="col-md-4">

                <label for="validationCustom01" class="form-label fs-5">select the food category</label>

                <select class="form-select" id="category" name="category" required>

                    <option value="">----</option>

                    <option value="0">Beverages</option>

                    <option value="1">Biryani</option>

                    <option value="2">Desert</option>

                    <option value="3">Extras</option>

                    <option value="4">Fish</option>

                    <option value="5">Other Snacks</option>

                    <option value="6">Pasta</option>

                    <option value="7">Pizza</option>

                    <option value="8">Rice Bowl</option>

                    <option value="9">Salad</option>

                    <option value="10">Sandwich</option>

                    <option value="11">Seafood</option>

                    <option value="12">Soup</option>

                    <option value="13">Starters</option>

                </select>

            </div>

            <div></div>

            <div class="col-md-4 d-grid gap-2 col-6 mx-auto">

                <input class="btn btn-dark btn-lg rounded-pill" type="submit" value="predict" data-bs-toggle="modal"

                data-bs-target="#exampleModal">

            </div>

        </form>

    </div>

    </div>

</div>

<!-- upload page-->

<!-- about page -->

<!-- <div class="container px-4 py-5" id="featured-3">

    <h2 class="pb-2 border-bottom">About us</h2>

    <div class="row g-4 py-5 row-cols-1 row-cols-lg-3">

        <div class="feature col">

            <div class="feature-icon bg-primary bg-gradient">

            </div>

            <h2>Featured title</h2>

            <p>Paragraph of text beneath the heading to explain the heading. We'll add onto it with another sentence and

                probably just keep going until we run out of words.</p>

            <a href="#" class="icon-link">

                Call to action

            </a>

        </div>

        <div class="feature col">

            <div class="feature-icon bg-primary bg-gradient">

            </div>

            <h2>Featured title</h2>

            <p>Paragraph of text beneath the heading to explain the heading. We'll add onto it with another sentence and

                probably just keep going until we run out of words.</p>

            <a href="#" class="icon-link">

                Call to action

            </a>

        </div>

        <div class="feature col">

            <div class="feature-icon bg-primary bg-gradient">

            </div>

            <h2>Featured title</h2>

            <p>Paragraph of text beneath the heading to explain the heading. We'll add onto it with another sentence and

                probably just keep going until we run out of words.</p>

            <a href="#" class="icon-link">

                Call to action

            </a>

        </div>

    </div>

</div> -->

<!-- about page -->

    <script src="https://cdn.jsdelivr.net/npm/bootstrap@5.0.2/dist/js/bootstrap.bundle.min.js"

        integrity="sha384-MrcW6ZMFYlzcLA8Nl+NtUVF0sA7MsXsP1UyJoMp4YLEuNSfAP+JcXn/tWtIaxVXM"

        crossorigin="anonymous"></script>

</body>

</html>

# app.py

import numpy as np

import pickle

import os

from flask import Flask, request, render\_template

import requests

import json

app = Flask(\_\_name\_\_, template\_folder="templates")

@app. route('/', methods=['GET'])

def index():

    return render\_template('home.html')

@app. route('/home', methods=['GET'])

def about():

    return render\_template('home.html')

@app.route('/predict', methods=['GET', 'POST'])

def predict():

    print('[INFO] Loading model…')

    #print(request.form.values())

    input\_features = [float(x) for x in request.form.values()]

    print(input\_features)

    API\_KEY = "RSUKnz\_dvhPrn3OXEeNdh0hZHTYSaexP0OEFqJgSFU9a"

    token\_response = requests.post('https://iam.cloud.ibm.com/identity/token', data={"apikey":

                                                                                    API\_KEY, "grant\_type": 'urn:ibm:params:oauth:grant-type:apikey'})

    mltoken = token\_response.json()["access\_token"]

    header = {'Content-Type': 'application/json',

            'Authorization': 'Bearer ' + mltoken}

    # NOTE: manually define and pass the array(s) of values to be scored in the next line

    payload\_scoring = {"input\_data": [{"fields": ['homepage\_featured', 'emailer\_for\_promotion', 'op\_area', 'cuisine',

                                                  'city\_code', 'region\_code', 'category'], "values": [

        input\_features]}]}

    response\_scoring = requests.post('https://jp-tok.ml.cloud.ibm.com/ml/v4/deployments/8c4cb961-7490-4977-8763-65929bc9bfb7/predictions?version=2022-11-17', json=payload\_scoring,

                                    headers={'Authorization': 'Bearer ' + mltoken})

    print("Scoring response")

    #res\_scr=response\_scoring.json()

    pred\_res = response\_scoring.json()['predictions'][0]['values'][0][0]

    prediction=round(pred\_res)

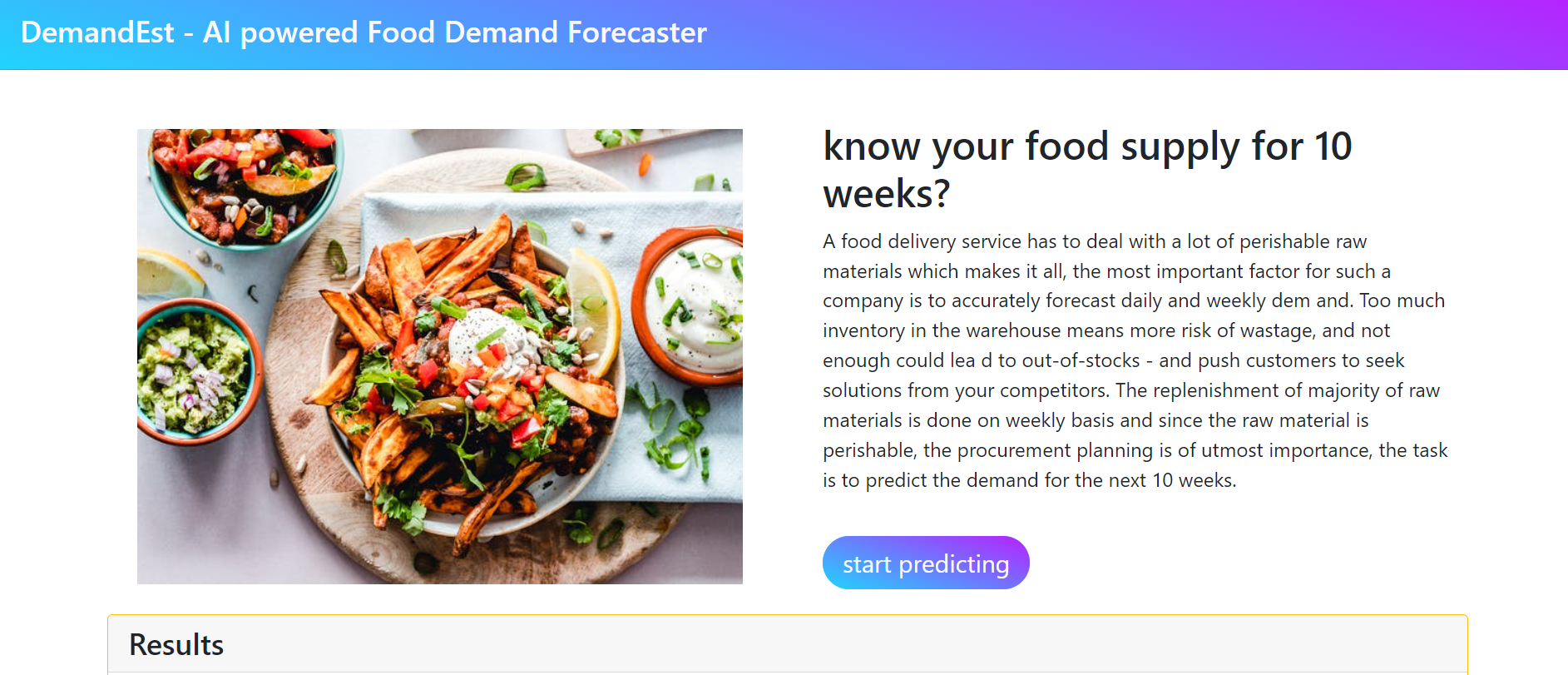
    return render\_template('home.html', prediction\_text = prediction)

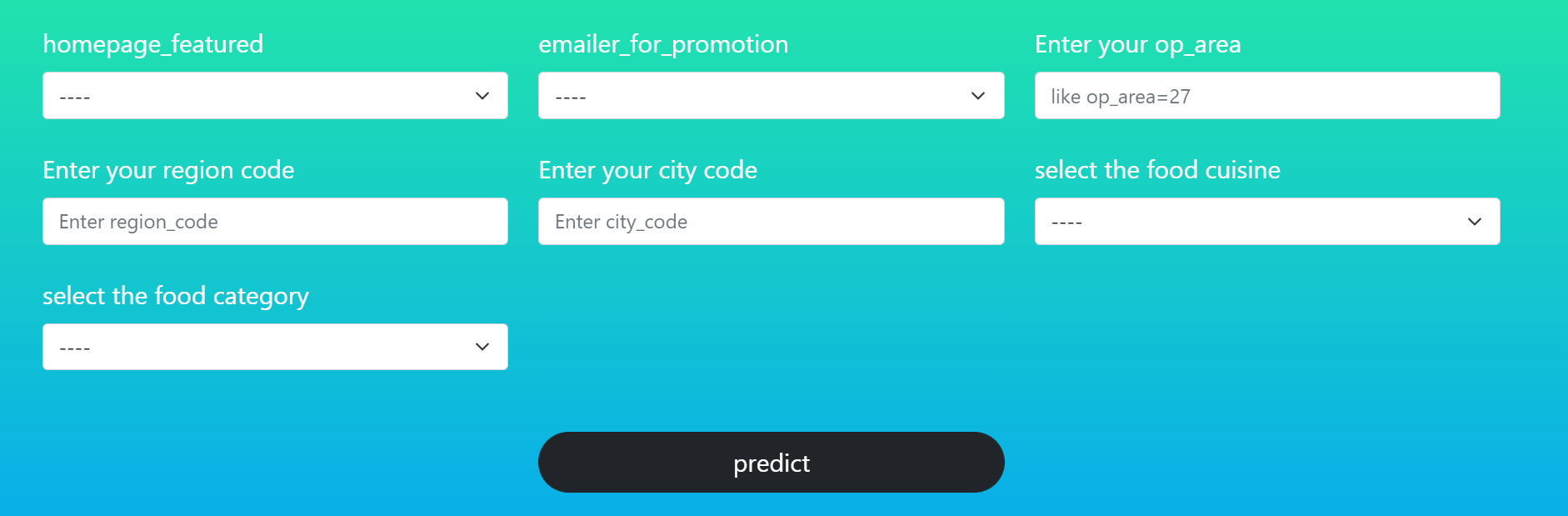
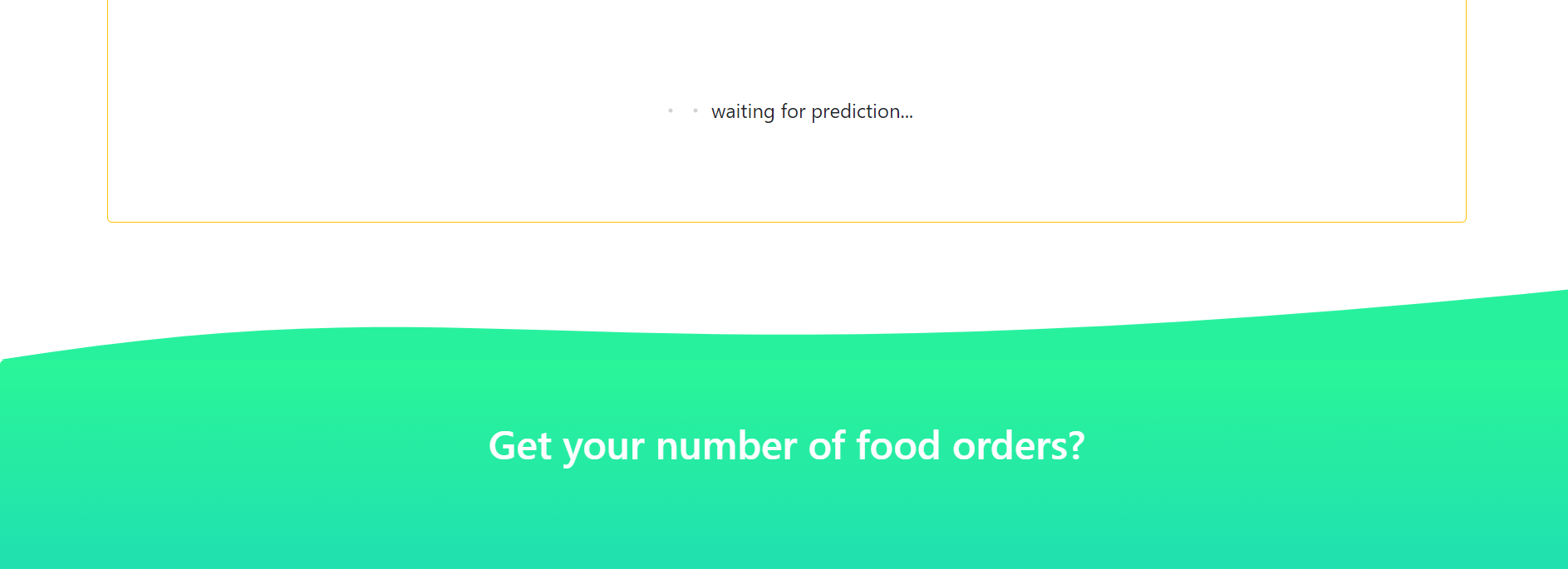
if \_\_name\_\_ == "\_\_main\_\_":

    app.run(debug=True)

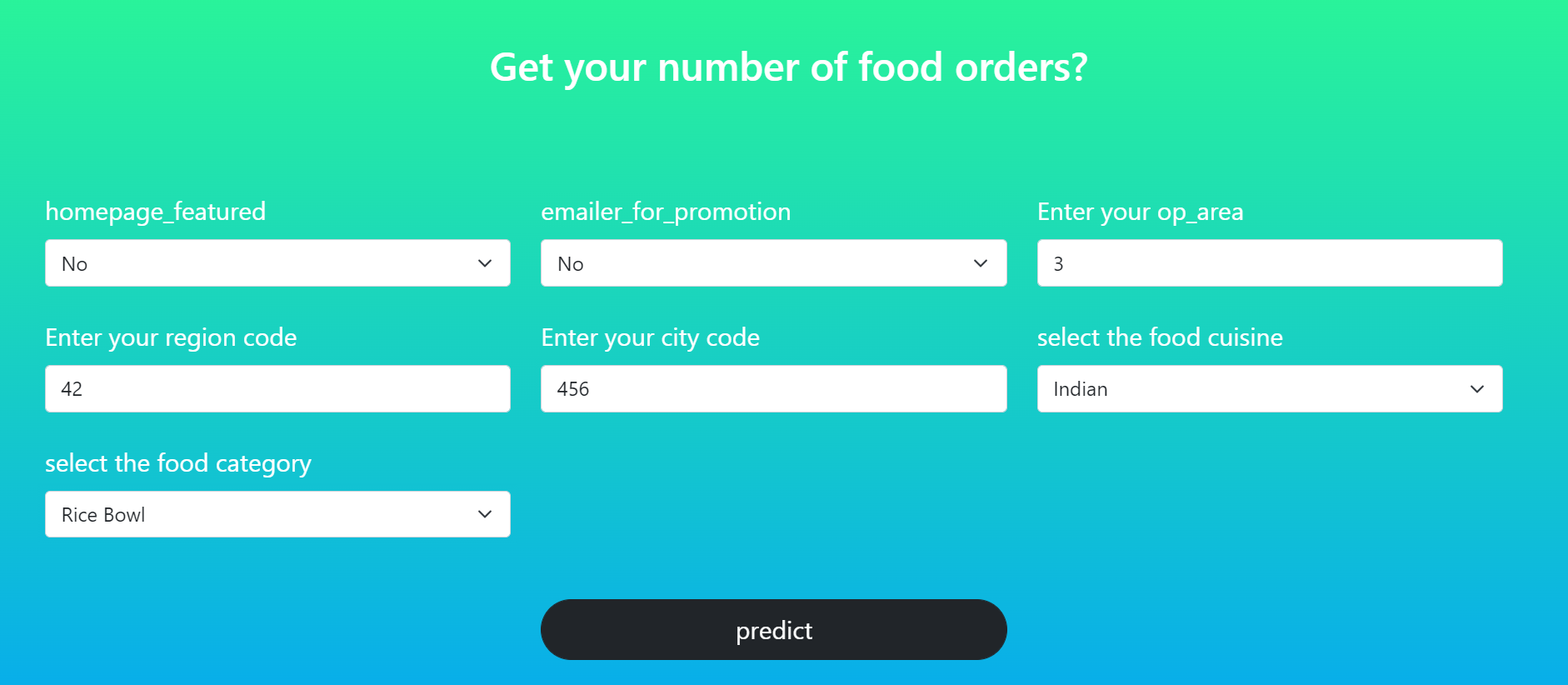
# OUTPUT

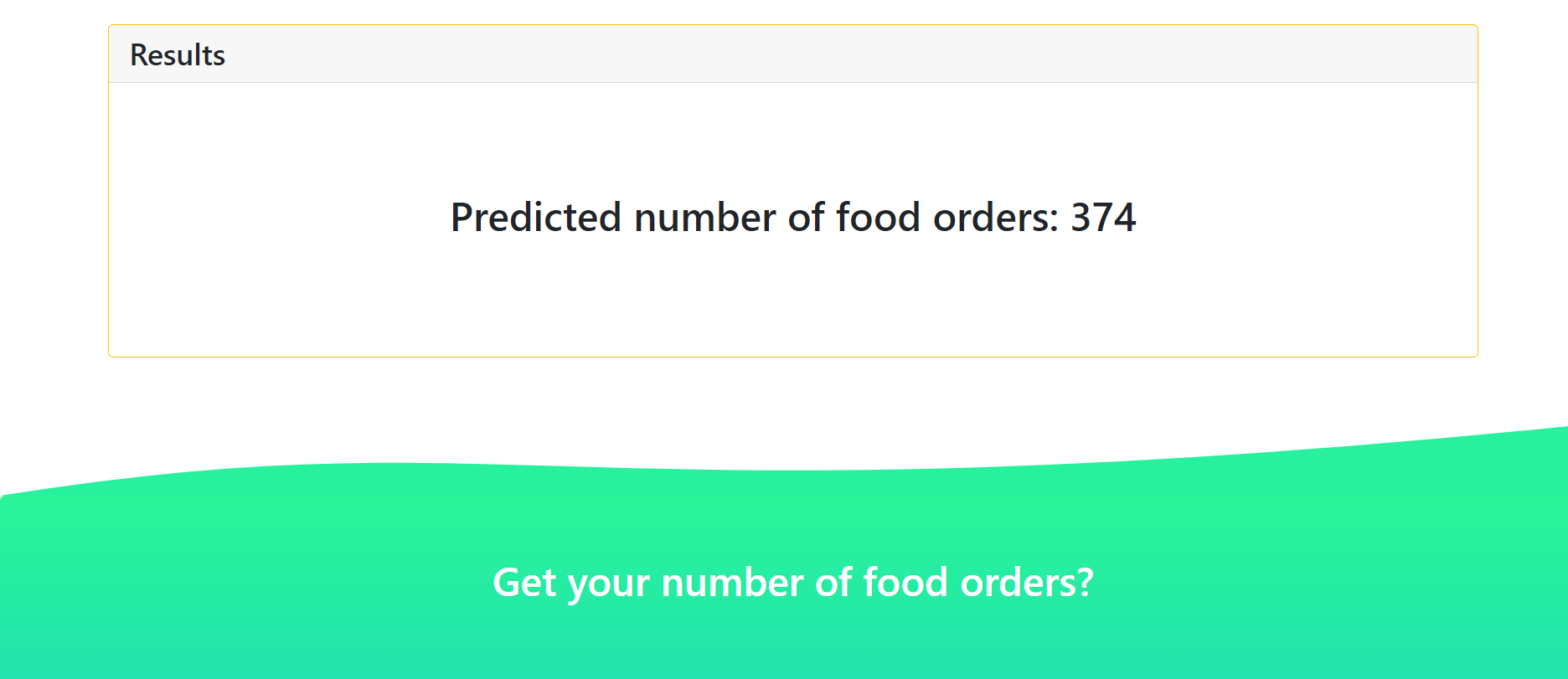
# SCREENSHOTS:





Demo:





**GITHUB LINK:**

https://github.com/IBM-EPBL/IBM-Project-2589-1658475994

# PROJECT DEMO LINK:

# https://youtu.be/uVlSKh80vBs