MEALS PREDICTION – PASSENGERS FOOD PREFERENCE MODEL USING RANDOM FOREST CLASSIFIER & HTML CHATBOT FRONTEND

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BY

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BONAFIDE

This is to certify that the project report titled **"MEALS PREDICTION – PASSENGERS FOOD PREFERENCE MODEL USING RANDOM FOREST CLASSIFIER & HTML CHATBOT FRONTEND"** is a Bonafide work carried out by **CAIN ANTONY. T (RA2332014010088),** under my supervision for the award of the Degree of Master of Science – Applied Data Science. To my knowledge the work reported herein is the original work done by these students.

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ABSTRACT

The integration of machine learning with user-centric interfaces has paved the way for advanced predictive applications in various domains, including the food and hospitality sector. This paper presents a comprehensive approach for meals prediction using a chatbot frontend model. The system is designed to deliver personalized meal recommendations by leveraging data from two primary sources: (1) a dataset containing passenger names and their historical food choices, and (2) a categorized food menu list encompassing items such as Candy (e.g., chocolate), Liquid Food (e.g., soup), Dessert (e.g., ice cream), Fast Food (e.g., pizza), and Snacks (e.g., chips), complete with recorded quantities.

The chatbot model acts as the primary user interface, providing an intuitive and interactive platform for passengers to receive tailored meal suggestions. By integrating natural language processing (NLP) capabilities and predictive algorithms, the chatbot can engage in meaningful conversations, infer user preferences, and respond dynamically based on user queries. The backend of the system is powered by an AI model that analyzes historical data patterns to recommend meals aligning with passengers' tastes, dietary restrictions, and flight preferences.

The proposed solution is built upon a robust architecture involving Python for data processing and machine learning, with Visual Studio Code as the development environment and Netlify for hosting. The interaction between the AI model and the chatbot ensures that data input, processing, and output flows seamlessly, providing real-time responses and personalized recommendations.

To enhance the accuracy and adaptability of the predictions, the model incorporates multiple data analysis techniques, including clustering algorithms to group passengers with similar meal preferences and classification models for identifying food categories likely to appeal to specific users. The system also integrates feedback loops where user choices refine future predictions, making the model self-improving over time.

The output of this research demonstrates that a chatbot-based model, when paired with a well-trained predictive system, can offer substantial benefits to airline services. It optimizes the in-flight dining experience, reduces food waste by better aligning supply with demand, and enhances passenger satisfaction by providing more relevant meal choices. This project showcases the potential for practical applications in the airline industry and highlights future improvements, such as expanding data inputs to include dietary trends and integrating real-time passenger feedback for more comprehensive meal personalization.

1. INTRODUCTION

Meals Prediction is a model created to distribute the correct amount of food to the passenger based on their food choice. In this meals predictions, there are 2 datasets that are created manually

I. Passenger Dataset
II. Food Menu Dataset

These 2 datasets are first loaded to read the 2 datasets. The datasets are splitted to train and test the model. Then a newly trained dataset is generated. Random forest classifier algorithm is used to bring condition to ensure that the food is distributed to the passengers based on the food choice and the food quantity available. The food quantity is measured by calculating the total occurrence of the same entities in the dataset. The 2 datasets are trained using the chatbot frontend model created with HTML (HTML + JavaScript + CSS) and the passengers food preference model is generated in another webpage.

1.1 Why Chatbot Frontend?

The Chatbot frontend is created to train the 2 manually created datasets. The datasets are loaded in the chatbot to train the model successfully in a webpage like environment. Then the model is trained to show a passenger food preference model in a separate webpage.

1.2 Key Reasons for Using Chatbot

1. Model is well trained with the uploaded datasets
2. Passenger food preference model perfectly created along with the food they choose from the food menu dataset to the passengers of the passengers dataset
3. The quantity of food in food menu dataset is well distributed whole to the passengers list in the passengers dataset based on the food choice they all made

1.3 Dataset Overview

I. Passengers Dataset

- Data Type: General
- Total Entries: 125
- Total Columns: 3
- Total Repeated Entities: 5
- Total Food Count per Passengers: 4

II. Food Menu Dataset

- Data Type: General
- Total Food Types: 5
- Food Category: Candy, Liquid Food, Dessert, Fast Food, and Snacks
- Food Quantity:
    - Chocolate- 75
    - Soup- 105
    - Ice-Cream- 125
    - Pizza- 109
    - Chips- 86

1.4 Background:

- To manage the food waste
- To increase the food service
- To manage the quantity of things used for preparing foods
- To manage the food quantity in order to serve the passengers
- To practice a healthy pattern in serving food to passengers
- To increase passengers satisfaction

1.5 Scope:

- **Data Collection**
    - **Passenger Data**: Collect manual data on passengers, such as passengers count, name, and their food choice.
    - **Meal Choice Data**: Gather a food menu data, including candy, liquid food, fast food, dessert, and snacks to provide to the passengers.
    - **Feedback & Satisfaction**: Incorporate customer feedback on meal quality and service experience to correlate with meal preferences.

- **Data Preprocessing**
  - **Data Cleaning**: Handle missing values, outliers, and inconsistencies in the dataset.
  - **Data Normalization**: Standardize data for efficient model training.
- **Model Development**
  - **Predictive Algorithm Selection**: Evaluate and select suitable machine learning models such as decision trees, random forests classifier, etc.
  - **Training & Testing**: Train the model on historical data and test it for accuracy in predicting passenger meal preferences.
  - **Feature Importance**: Identify key factors driving meal choices to inform inventory and service management.
- **Model Evaluation**
  - **Accuracy Metrics**: Use evaluation metrics such as accuracy, precision, recall, and F1 score to assess model performance.
  - **Scalability Testing**: Ensure the model's performance scales well with increasing data size and complexity.
- **Implementation & Integration**
  - **Real-time Manual Data Processing**: Implement the model in a real-time manual system to make live predictions as passengers choosing their food.
  - **Meal Planning & Inventory Optimization**: Integrate the model into the airline's inventory management system for optimized meal preparation and reduced food waste.
  - **Passenger Interface**: Provide a personalized meal selection interface to passengers based on predictive recommendations during ticket booking or check-in.
- **Expected Outcomes**
  - **Optimized Meal Planning**: Ensure the right quantity and variety of meals are prepared for each flight, minimizing food waste and reducing costs.
  - **Enhanced Passenger Satisfaction**: Improve the overall passenger experience by offering meals that closely match their preferences, leading to higher customer satisfaction and loyalty.

- **Operational Efficiency**: Streamline inventory management and reduce the burden on flight attendants during meal service, improving overall operational efficiency.
- **Health-conscious Service**: Promote healthy eating practices by aligning meal offerings with passenger health preferences and dietary requirements.

2. REQUIREMENT ANALYSIS

2.1 Hardware Requirements:

Processor	Minimum x64: 2.4 GHz
RAM	8 GB Recommended
Hard disk	256 GB
Web Server	IIS

2.2 Software Requirements:

Operating System	Windows 11 Home / Professional
Tools	Python, HTML + JavaScript + CSS
IDE	Visual Studio Code
Browser	Google Chrome

2.3 SOFTWARE SPECIFICATION

Operating System:

- Windows 11

Programing Language:

- Python
- HTML (HTML + CSS + JavaScript)

Libraries and Frameworks:

1. Web Framework

- **Flask**: Used for creating and managing the web application, defining routes, handling HTTP requests, and rendering templates.

2. Data Processing

- **Pandas (pd)**: Used for reading and manipulating CSV files and dataframes for data analysis and preparation.

3. Machine Learning

- **Scikit-learn (sklearn)**:
  - **CountVectorizer**: Used for text feature extraction to convert text data into a matrix of token counts.
  - **RandomForestClassifier**: Used for training a machine learning model for classification.

4. File and Directory Management

- **os module**: Used for handling file paths, checking, and creating directories as needed.

5. Standard Flask Utilities

- **render_template**: Used for rendering HTML templates.
- **request**: Used for handling HTTP requests, such as retrieving uploaded files and JSON data from POST requests.
- **jsonify**: Used for returning JSON responses from the Flask app.

Development Environment:

- **IDE:**
    - **Visual Studio Code**

2.4 ABOUT THE SOFTWARE AND ITS FEATURES

2.4.1 SOFT ENVIRONMENT

Visual Studio Code:

Visual Studio Code (VS Code) is a powerful, open-source code editor developed by Microsoft that has become popular among developers for its versatility and ease of use. It supports a wide range of programming languages and frameworks, offering features such as intelligent code completion, debugging, syntax highlighting, and integrated version control. VS Code is highly customizable, allowing users to extend its functionality through a vast library of extensions, themes, and integrations. With a user-friendly interface and built-in support for Git, it is an excellent tool for both beginner and experienced developers working on various types of software projects.

Features of Visual Studio Code:

1. **Intelligent Code Completion**: Provides context-aware code suggestions and autocompletion using IntelliSense for various programming languages.
2. **Built-in Debugging**: Allows developers to debug code directly within the editor, with support for breakpoints, call stacks, and an interactive console.
3. **Integrated Version Control**: Comes with built-in Git support, enabling users to commit changes, review diffs, and manage repositories without leaving the editor.

4. **Extensibility**: Supports a vast library of extensions to add functionalities such as language support, themes, code linters, and tools for frameworks and libraries.

5. **Syntax Highlighting**: Highlights code syntax for easier readability across numerous programming languages.

6. **Integrated Terminal**: Features an embedded terminal for running command-line operations within the editor.

7. **Multi-Language Support**: Supports a broad range of languages out of the box, including JavaScript, Python, C++, Java, and more.

8. **Customizability**: Allows users to personalize their coding environment with custom keybindings, themes, and settings.

9. **Live Share**: Facilitates real-time collaboration by enabling multiple developers to work on the same codebase simultaneously.

10. **Code Navigation and Refactoring**: Provides easy navigation tools like "Go to Definition," "Peek Definition," and powerful refactoring options.

11. **Code Snippets**: Supports customizable code snippets to speed up repetitive coding tasks.

12. **Emmet Abbreviations**: Boosts HTML and CSS coding efficiency with Emmet’s shorthand abbreviations.

2.4.2 ESSENTIAL LIBRARIES:

1. **Flask**

- **Purpose**: Flask is a micro web framework for Python used for building web applications and APIs.

- **Key Features**:

    - Lightweight and easy to set up.
    - Provides routing and request handling.
    - Enables template rendering for generating HTML content dynamically.
    - Simple integration with other Python libraries and tools.

2. **Pandas (pd)**
    - **Purpose**: Pandas is a powerful data analysis and manipulation library.
    - **Key Features**:
        - Provides DataFrame and Series data structures for handling tabular data.
        - Offers functions for reading and writing data (e.g., pd.read_csv ( )).
        - Supports data filtering, aggregation, and transformation.
        - Facilitates iteration over rows and columns for custom data processing.

3. **Scikit-learn (sklearn)**

- **Purpose**: Scikit-learn is a popular machine learning library used for training models and processing data.

- **Key Features**:

    - CountVectorizer: Transforms text data into a matrix of token counts, which is essential for converting text input into a format suitable for machine learning models.
    - RandomForestClassifier: A robust ensemble learning algorithm that fits multiple decision trees on sub-samples of the dataset and averages their predictions for classification tasks.

- Supports various preprocessing and model evaluation tools.

4. OS

- **Purpose**: The `os` module provides functions to interact with the operating system.
- **Key Features**:
  - Functions for handling file paths and directories (e.g., os.path.join()).
  - Used for checking the existence of directories and creating them if needed (e.g., os.makedirs()).
  - Facilitates file management, such as saving uploaded files to specific folders.

2.4.3 FUNCTIONS OF THE LIBRARIES:

- **Flask** (from flask import Flask, render_template, request, jsonify):
  - **Flask**: The main class for creating a Flask web application.
  - **render_template**: Renders an HTML template, allowing dynamic content to be displayed on web pages.
  - **request**: Provides access to incoming HTTP requests, enabling the app to read form data, files, or JSON data sent by the client.
  - **jsonify**: Converts Python dictionaries into JSON objects to send responses back to the client in a structured format.
- **Pandas** (import pandas as pd):
  - A powerful data manipulation and analysis library. It helps with:
  - **pd.read_csv()**: Reading CSV files into DataFrame objects for easy data manipulation.
  - **DataFrame.iterrows()**: Iterating over rows of a DataFrame.
  - **DataFrame.to_dict()**: Converting a DataFrame into a dictionary format.
  - **pd.notna()**: Checking for non-NA/null values in DataFrames.

- **Scikit-learn** (from sklearn.feature_extraction.text import CountVectorizer, from sklearn.ensemble import RandomForestClassifier):

  A machine learning library for Python, providing simple and efficient tools for predictive data analysis.

  - **CountVectorizer**:

    Transforms text data into a matrix of token counts, enabling text to be converted into numerical feature vectors for machine learning models.

  - **RandomForestClassifier**:

    An ensemble learning algorithm that builds multiple decision trees and merges them for better predictive performance and accuracy.

- **OS** (import os):

  A standard Python library for interacting with the operating system.

  - **os.path.exists()**: Checks if a specified path exists.
  - **os.makedirs()**: Creates a directory.
  - **os.path.join()**: Joins one or more path components to create a valid path.

2.4.4 DATA HANDLING AND PREPROCESSING

Data Preprocessing is a critical step used before training a machine learning model. The meals prediction model consist of list of passengers, their food choice, and effective preprocessing enhances model performance:

- **Creation of Datasets (Points I and II)**:
  - **Passenger Dataset**: A manual dataset is created that contains fields such as serial number, name, and comfort food preferences for each passenger.
  - **Food Menu Dataset**: A corresponding dataset is manually created that lists food categories (like candy, liquid food, dessert, fast food, snacks) along with the specific food items and their available quantities based on the comfort foods listed in the passenger dataset.
- **Storage of Datasets (Point III)**:
  - Both datasets are saved as CSV files, allowing for easy reading and writing using libraries like pandas.
- **Development Environment Setup (Points IV and VII)**:
  - Visual Studio Code (VS Code) is used for creating both frontend and backend components. Python and HTML extensions are installed for handling Python scripts and HTML files, respectively.
- **Frontend Implementation (Point VI)**:
  - **Home Page**: This page facilitates uploading the CSV files, which are then processed and used for training.
  - **Passenger Food Preference Page**: Displays the passenger's name along with their ordered food, ensuring no missing or null values.
- **Backend Implementation (Point VII)**:
  - A Python file is created to implement the backend logic, where the necessary libraries (pandas, NumPy, scikit-learn, TensorFlow, Flask, etc.) are installed and imported.

- **Loading and Analyzing Data (Points X and XI)**:
  - The datasets are loaded into memory using the pandas library to facilitate data manipulation and analysis.
  - The train_test_split function from scikit-learn is utilized to split the dataset into training and testing sets. This is essential for evaluating model performance with metrics like accuracy, precision, recall, and F1 score.
- **Data Preparation for Model Training (Point XII)**:
  - After evaluating the sample dataset, a new trained dataset is generated based on the insights derived from the model's performance.
- **Condition Checking for Food Availability (Point XIII)**:
  - A condition is implemented to check if the foods listed in the food menu dataset are present in the passengers' comfort food dataset. This ensures that only available food items are considered when making recommendations.
- **Generation of a New Trained Dataset (Point XIV)**:
  - Both the trained model and the condition-checking logic are used to create a new dataset that reflects the training and conditions applied, aligning with the available food items.
- **Integration of Frontend and Backend (Point XV)**:
  - Adjustments are made to the backend code to ensure it can communicate with the frontend, allowing for dynamic interactions and data retrieval from the trained model.
- **Final Adjustments (Point XVI)**:
  - The final backend implementation takes into account the complete passenger dataset, updating food quantities based on the entire comfort food list and ensuring the food menu reflects accurate availability.

- **Chatbot Webpage Generation**:
  - The frontend files are integrated with the backend to create a chatbot interface that can handle user queries related to passenger food preferences.

2.4.5 MODEL BUILDING AND EVALUATION

- **Data Processing**:
  - The process_and_train function reads two CSV files: one containing airline passenger data and the other containing food menu data.
  - It combines these datasets by checking if the comfort foods specified for each passenger match the available food items in the menu, keeping track of quantities.
- **Feature Engineering**:
  - The identified foods for each passenger are used as features (X), while the names of the passengers are used as labels (y) for the classifier.
  - The CountVectorizer from Scikit-learn is used to transform the identified foods into a numerical format suitable for training.
- **Model Training**:
  - A RandomForestClassifier is instantiated and trained on the vectorized features (X_vectorized) and corresponding labels (y).
  - The trained classifier, vectorizer, and combined dataset are returned for later use.
- **Train-Test Split**:
  - Use a portion of the dataset for training and a portion for testing. You can use Scikit-learn's train_test_split function.

- **Metrics Calculation**:
    - Evaluate the model's performance using metrics such as accuracy, precision, recall, and F1-score. Scikit-learn provides functions like accuracy_score, classification_report, etc.
- **Sample Code for Model Evaluation**: Below is a modification of your process_and_train function to include model evaluation:

```
from sklearn.model_selection import train_test_split

from sklearn.metrics import accuracy_score, classification_report

def process_and_train(csv_airline, csv_food_menu):

    try:

        df1 = pd.read_csv(csv_airline)

        df2 = pd.read_csv(csv_food_menu)



        combined_dataset = []

        for index1, row1 in df1.iterrows():

            # Same logic for combining datasets as before...



        combined_dataset_df = pd.DataFrame(combined_dataset)



        # Prepare data for model training

        X = combined_dataset_df["Identified Foods"]

        y = combined_dataset_df["Name"]



        # Train-test split
```

```
        X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

        vectorizer = CountVectorizer()
        X_train_vectorized = vectorizer.fit_transform(X_train)
        clf = RandomForestClassifier()
        clf.fit(X_train_vectorized, y_train)

        # Evaluate the model
        X_test_vectorized = vectorizer.transform(X_test)
        predictions = clf.predict(X_test_vectorized)

        accuracy = accuracy_score(y_test, predictions)
        report = classification_report(y_test, predictions)

        print(f"Accuracy: {accuracy}")
        print(f"Classification Report:\n{report}")

        return clf, vectorizer, combined_dataset_df

    except Exception as e:
        print(f"Error in processing and training: {e}")
        return None, None, None
```

3. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

The current system involves a manual approach to meal planning based on a pre-defined Passenger and Food Menu dataset. The model uses a **Random Forest Classifier** to predict passenger meal preferences, allocating food items based on available quantities. A chatbot frontend was created to upload datasets, train the model, and display predictions on a separate webpage. Although functional, this system operates on a simple architecture and has limitations in adaptability and accuracy, especially with larger datasets.

3.1.1 DATA PREPROCESSING

Data preprocessing involves:

- **Data Cleaning**: Handling missing values and removing inconsistencies in both datasets.
- **Text Vectorization**: Using CountVectorizer to convert passenger food choices into numerical representations, making them compatible for training with the Random Forest model.
- **Data Splitting**: The dataset is divided into training and testing sets to evaluate the model's effectiveness in a controlled manner.

3.1.2 MODEL ARCHITECTURE

The existing model uses the **Random Forest Classifier** as its architecture. This ensemble model creates multiple decision trees on various sub-samples of the dataset and combines their predictions for classification tasks. It was chosen for its simplicity and ability to handle categorical data effectively.

3.1.3 TRAINING AND OPTIMIZATION

The training process involves:

- **CountVectorizer Transformation**: Converting food choice text data into numerical form.
- **Random Forest Training**: Using the transformed data to train the model, ensuring it learns to predict meal allocations based on passenger preferences.

- **Optimization Parameters**: Basic parameters such as n_estimators and max_depth are configured to balance model performance and runtime.

3.1.4 EVALUATION AND PERFORMANCE

The model's performance is evaluated using:

- **Accuracy Metrics**: Precision, recall, and F1 score metrics to understand the model's prediction accuracy.
- **Scalability Testing**: Assessing the model's ability to handle larger datasets by observing performance on sample and complete datasets.

3.2 LIMITATIONS OF EXISTING SYSTEM

- **Limited Flexibility**: The system relies on a static dataset and lacks adaptability to changes in meal preferences over time.
- **Predictive Accuracy**: The Random Forest model may struggle with more complex food preference patterns.
- **Scalability**: With larger datasets or increased passenger counts, the model's performance may degrade.
- **Lack of Real-Time Adaptation**: The model doesn't adjust dynamically to real-time data, potentially leading to inaccuracies in meal distribution.

3.3 PROPOSED SYSTEM

The proposed system aims to improve upon the existing model by incorporating **real-time data processing**, **enhanced machine learning models**, and **feedback integration** to ensure an adaptive and robust meal prediction system. By improving data processing and model architecture, the new system would be more scalable, accurate, and flexible to evolving passenger needs.

3.3.1 ENHANCED DATA PROCESSING

- **Automated Data Collection**: Real-time integration with passenger databases to ensure up-to-date preferences.

- **Advanced Preprocessing Techniques**: Use NLP techniques for more complex text processing and categorization.
- **Data Normalization**: Ensure all data is standardized, enhancing the training process and improving accuracy.

3.3.2 IMPROVED MODEL ARCHITECTURE

The model architecture will be upgraded to incorporate **deep learning** approaches, such as **neural networks** or **recurrent neural networks (RNNs)**, which are more capable of understanding complex patterns in data. These models can capture nuanced patterns in passenger food preferences better than Random Forest.

3.3.3 TRAINING STRATEGY AND OPTIMIZATION

- **Hyperparameter Tuning**: Use techniques like **grid search** or **random search** to find the optimal hyperparameters, ensuring the model reaches peak performance.
- **Incremental Learning**: Train the model incrementally to adapt to new data continuously without re-training from scratch.

3.3.4 EVALUATION AND INTERPRETABILITY

- **Cross-Validation**: Use cross-validation to ensure robust model evaluation and avoid overfitting.
- **Interpretability**: Implement methods to visualize feature importance, helping in understanding which factors most impact food preferences.

3.4 EXPECTED BENEFITS OF THE PROPOSED SYSTEM

- **Enhanced Predictive Accuracy**: Improved meal allocation accuracy, minimizing waste.
- **Real-Time Adaptability**: The model adapts to changes in passenger preferences, providing more accurate meal distributions.
- **Scalability**: Capable of handling large datasets with a diverse set of passenger preferences.

- **Passenger Satisfaction**: Meeting preferences more accurately leads to higher satisfaction and a better passenger experience.

4. MODEL DESIGN

4.1 RANDOM FOREST CLASSIFIER

A **Random Forest** is an ensemble learning method that combines the predictions of multiple decision trees to make a final classification or regression. Here's how it works:

- **Dataset Splitting**: The training dataset is divided into multiple random subsets, each used to train a single decision tree.
- **Decision Trees**: Each decision tree independently classifies the data based on a subset of features, which helps prevent overfitting. These trees are often "weak learners" (they may make individual mistakes), but their collective decision is robust.
- **Voting Mechanism**: For classification tasks, each tree "votes" for a class label. The majority vote among all trees determines the final prediction.

Random Forest Classifier Diagram

Here's a simplified way to think of the process visually:

- **Input Data**:
    - A dataset with features and labels is fed into the Random Forest model.
- **Tree Creation**:
    - Multiple decision trees are created using random subsets of the data and features.
    - Each tree learns patterns and creates branches that lead to class predictions.
- **Prediction Aggregation**:
    - When a new input is introduced, it passes through each decision tree.
    - Each tree produces its prediction.

- **Final Prediction**:
    - The Random Forest aggregates these predictions using a majority vote, resulting in a more reliable and accurate final prediction.

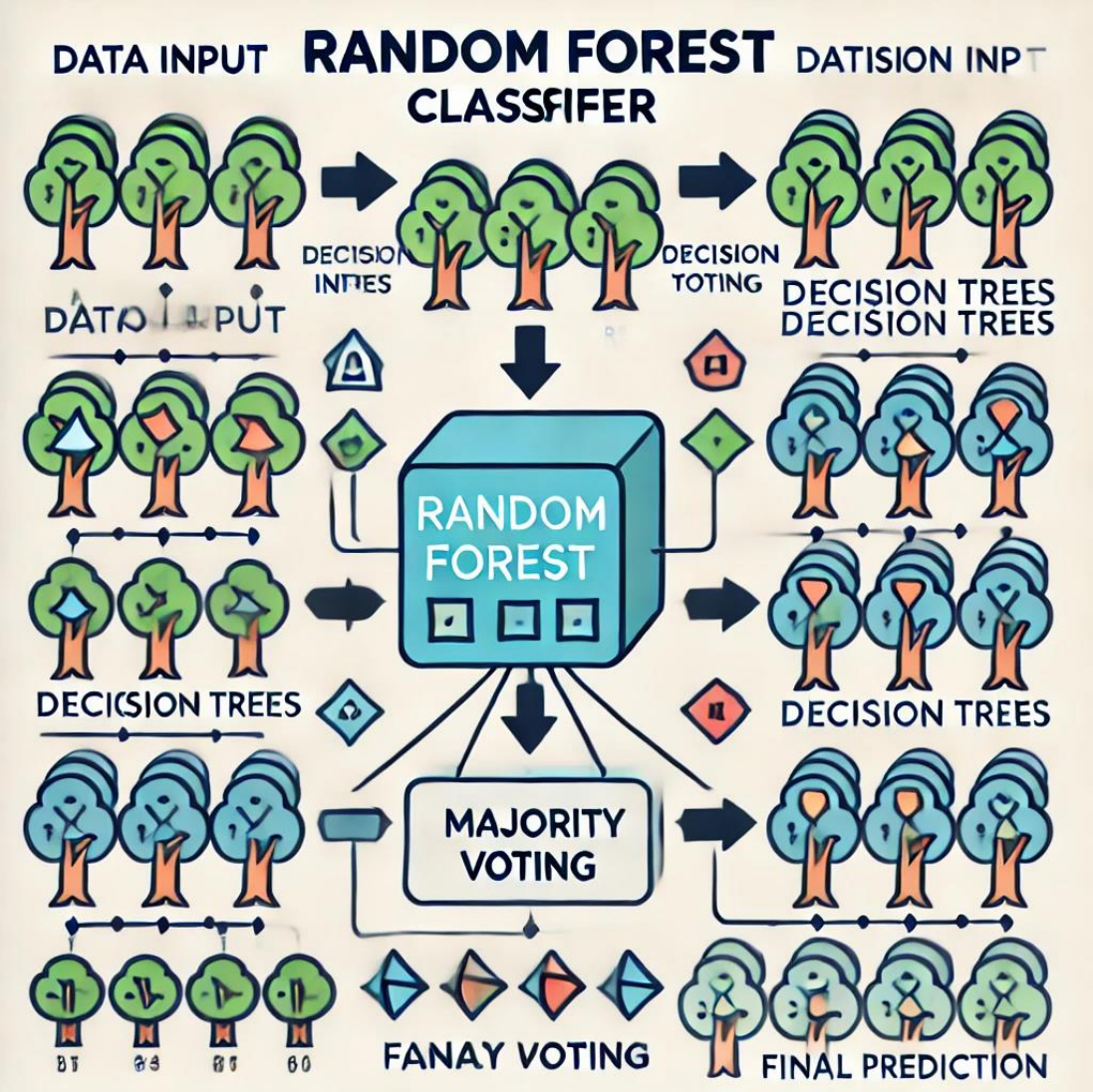


Fig4.1 Random Forest Classifier

4.2 PROPOSED WORK

The proposed work aims to create an intelligent system that predicts and distributes meals to passengers based on their comfort food preferences, addressing the goals of waste reduction, passenger satisfaction, and efficient meal planning. Key elements of the proposed work include:

- **Automated Meal Distribution**:
    - By integrating the **Random Forest Classifier** with frontend and backend systems, the application automates the process of meal distribution, allocating the correct amount and type of food based on passenger preferences.
- **Real-time Dataset Loading**:
    - The system allows users to upload updated **Passenger** and **Food Menu** datasets, ensuring the model is always trained on the latest data for accurate predictions.
- **Enhanced User Interaction via Chatbot Interface**:
    - A chatbot frontend facilitates interactive data upload and prediction, making the system user-friendly and accessible. The chatbot provides feedback on the meal distribution process, showing the meals predicted for each passenger.
- **Model Scalability**:
    - The system is designed to handle both sample and full datasets, ensuring scalability and efficiency as the amount of data increases.
- **Performance and Accuracy Monitoring**:
    - Key performance metrics like accuracy, precision, and F1 score are monitored to ensure the model's predictions are consistently accurate. Future iterations of the model could use these metrics to guide improvements in prediction accuracy.

4.3 MODEL DIAGRAM

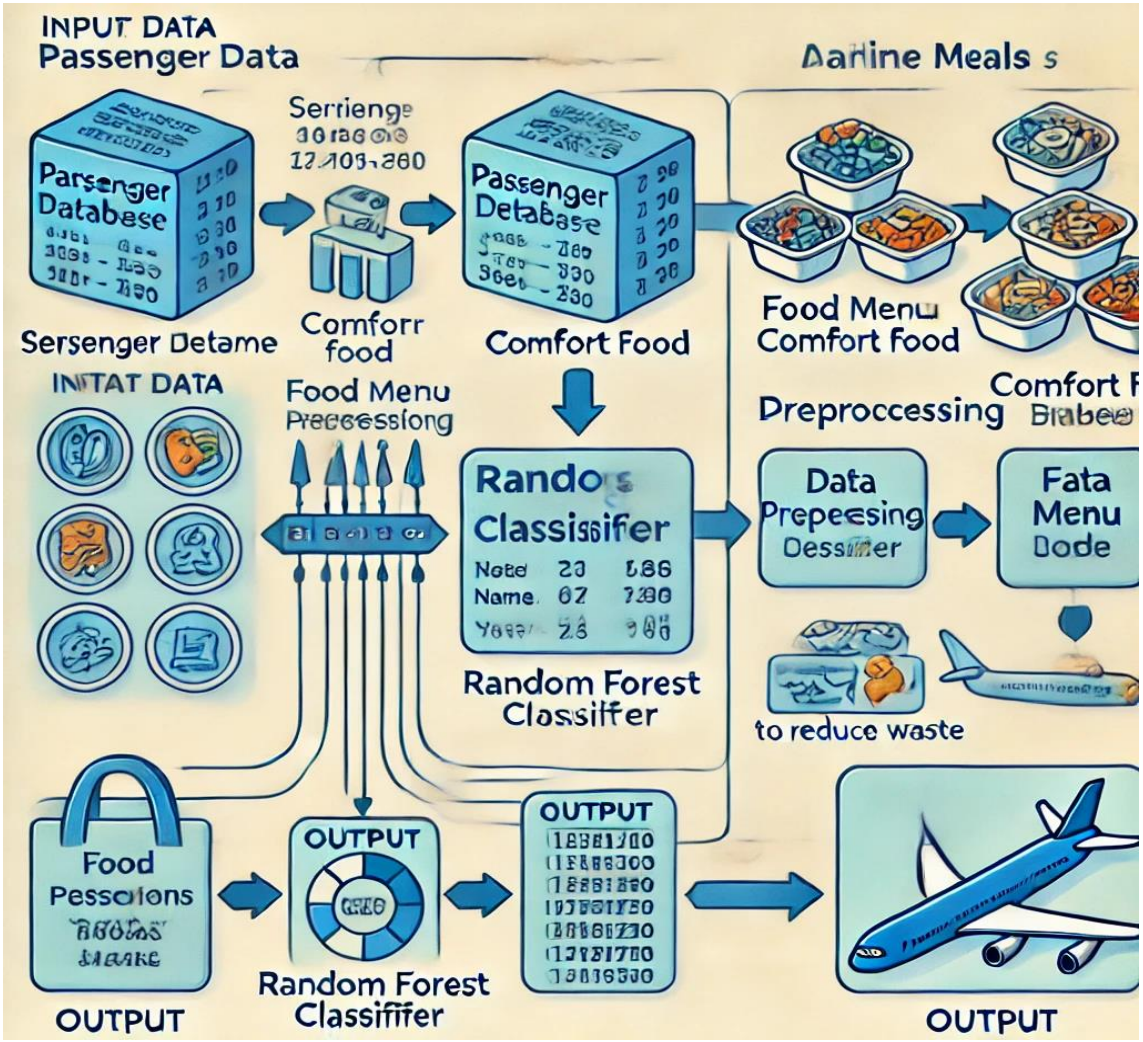


Fig4.2 Meals Prediction

5. CODE TEMPLATES

The Meals Prediction System for Air Passengers is designed to predict and allocate meals based on passenger preferences, using machine learning to ensure accurate and efficient distribution. This system leverages the **Random Forest Classifier** algorithm to classify passenger meal choices and assign meals from available inventory, minimizing waste and enhancing passenger satisfaction. The system is built on two main datasets:

- **Passenger Dataset**: Contains passenger details such as serial number, name, and comfort food preferences.
- **Food Menu Dataset**: Lists available food items by category (e.g., candy, liquid food, dessert, fast food, snacks) and provides the quantities of each.

The objective of the system is to accurately predict meal allocations by using the **Random Forest Classifier** trained on the comfort food preferences from the Passenger Dataset. The model should be capable of accurately matching meals to each passenger based on the training data and making reliable predictions for new passengers added to the dataset.

5.1 DETAILED OVERVIEW OF MEALS PREDICTION MODEL

- **Objective**

  The primary goal of the Meals Prediction System is to ensure accurate and efficient meal distribution to passengers based on their food preferences, as recorded in manually curated datasets. This system aims to reduce food waste, improve passenger satisfaction, and streamline inventory management on flights.

- **Datasets**

  The model is built on two main datasets, which are loaded and processed within a frontend chatbot system designed for training and displaying results:

  - **Passenger Dataset**:
    - Contains details of each passenger, such as a serial number, name, and comfort food preferences.
    - Used to identify individual passenger meal preferences, ensuring that each passenger's choice is considered in the meal distribution.

- Total entries: 125 with three main columns (Serial Number, Name, Comfort Food).

- **Food Menu Dataset**:
  - Lists available food items categorized into types like candy, liquid food, dessert, fast food, and snacks, with their respective quantities.
  - Food types include items like chocolate, soup, ice cream, pizza, and chips, with specified quantities for each type.
  - This dataset serves as the inventory from which meals are selected and distributed according to passenger preferences.

- **System Design and Model Overview**

Model Architecture

The model utilizes a **Random Forest Classifier** for predicting passenger meal preferences. The Random Forest algorithm was selected for its robustness and ability to handle a range of categorical data, making it well-suited for this type of prediction.

- **Random Forest Classifier**:
  - An ensemble learning technique that combines the predictions of multiple decision trees trained on random subsets of data.
  - The final output is based on a majority vote across all decision trees, which helps increase accuracy and reduce overfitting.

Model Workflow

- **Data Preprocessing**:
  - **Data Cleaning**: Ensures that missing values or inconsistencies within both datasets are handled. For instance, any missing values in the Comfort Food column are filled with empty strings to maintain data integrity.
  - **Vectorization**: Text data in the Comfort Food column is converted into a numerical matrix format using **CountVectorizer**. This allows the model to interpret the categorical food preferences of passengers and make predictions based on them.

- **Data Splitting**: The combined dataset is split into training and testing sets. This enables evaluation of the model's predictive accuracy on unseen data, ensuring robustness.

- **Model Training and Optimization**:
  - **Classifier Training**: The Random Forest Classifier is trained on the vectorized dataset, learning associations between passenger preferences and available meal choices.
  - **Hyperparameter Optimization**: Parameters like n_estimators (number of trees) and max_depth (depth of each tree) are adjusted to optimize model performance.

- **Frontend and Backend Integration**:
  - **Frontend Interface**: Developed with HTML, CSS, and JavaScript, the frontend includes a chatbot interface where users can upload both datasets, trigger model training, and view the predictions.
  - **Backend Processing**: The backend, implemented in Python using Flask, loads and processes data, trains the model, and interacts with the frontend for real-time predictions.

Prediction and Output

After the model is trained, it can predict the meal choice for each passenger based on their food preference recorded in the datasets. The model checks whether the food item preferred by each passenger is available in the inventory (Food Menu Dataset) and allocates meals accordingly.

- **Output Screen**: The system generates a web page that lists each passenger's name and the meal selected for them, ensuring that all preferences are matched accurately.

- **Accuracy Metrics**: The model's performance is evaluated using metrics such as **accuracy, precision, recall,** and **F1 score** to determine its effectiveness in predicting meals.

Benefits and Expected Outcomes

- **Efficient Meal Distribution**: By aligning meal predictions with passenger preferences, the system minimizes food waste and ensures that each passenger receives their preferred meal.
- **Operational Efficiency**: Automating meal predictions reduces the need for manual meal planning, streamlining inventory management and enabling efficient allocation of resources.
- **Passenger Satisfaction**: Meeting passengers' food preferences improves their overall experience, contributing to higher customer satisfaction.

Limitations and Future Enhancements

- **Scalability**: The existing model may struggle with large datasets, so future versions could explore more scalable machine learning or deep learning algorithms.
- **Adaptability**: The current system operates on a static dataset and lacks real-time adaptability to changes in preferences or inventory.
- **Feedback Integration**: Adding a feedback loop from passengers could help adjust meal distribution based on satisfaction and demand, refining future predictions.

Future work might involve incorporating deep learning models for more nuanced predictions, real-time data processing for dynamic adjustments, and feedback mechanisms for continual improvement.

5.2 LIBRARIES USED IN THE PROGRAM:

- **Flask**
  - **Description**: Flask is a lightweight web framework for Python that allows for easy creation of web applications and APIs.
  - **Use Cases**:
    - Handling HTTP requests and responses.
    - Defining routes for web pages and API endpoints.
    - Rendering HTML templates using Jinja2.
    - Managing sessions and configurations for web applications.

- **Pandas**
  - **Description**: Pandas is a powerful data manipulation and analysis library for Python. It provides data structures like DataFrames that make it easy to handle structured data.
  - **Use Cases**:
    - Reading and writing data in various formats (e.g., CSV, Excel).
    - Data cleaning and preprocessing (e.g., handling missing values, combining datasets).
    - Performing data transformations and aggregations.
    - Easily filtering and slicing datasets for analysis.
- **Scikit-learn**
  - **Description**: Scikit-learn is a widely used library for machine learning in Python, providing simple and efficient tools for data mining and data analysis.
  - **Use Cases**:
    - Feature extraction and transformation (e.g., using CountVectorizer to convert text data into numerical vectors).
    - Implementing various machine learning algorithms (e.g., RandomForestClassifier for classification tasks).
    - Training and evaluating models using a consistent API.
    - Preprocessing data, splitting datasets, and managing model performance.
- **OS**
  - **Description**: The os module in Python provides a way to interact with the operating system, allowing for file and directory management.
  - **Use Cases**:
    - Managing directories (e.g., checking if a directory exists and creating one).
    - Handling file paths in a cross-platform manner.

- Saving uploaded files to specified directories.

5.3 MEALS PREDICTION MODEL

(I) PYTHON:

Step 1: Setup Environment

- Import the necessary libraries:
  - Flask for the web framework.
  - pandas for data handling and CSV file reading.
  - CountVectorizer and RandomForestClassifier from scikit-learn for machine learning tasks.
  - os for file path operations.

Step 2: Initialize Flask App

- Create a Flask app instance.
- Set up a configuration for the upload folder (uploads) to store uploaded CSV files.

Step 3: Initialize Global Variables

- Define global variables in the Flask app to hold:
  - combined_dataset_df: To store the combined dataset.
  - clf: To hold the trained machine learning model.
  - vectorizer: To hold the text vectorizer.

Step 4: Define Data Processing and Model Training Function

- Create a function process_and_train that:
  - Takes two CSV file paths as input.
  - Reads the CSV files into DataFrames using pandas.
  - Initializes an empty list for the combined dataset.

- Iterates over the rows of the airline DataFrame:
    - Extracts relevant data (e.g., serial number, person name, comfort foods).
- For each food category in the food menu DataFrame:
    - Checks if the category is not empty and splits food data into name and quantity.
    - Checks if comfort foods match available foods and updates quantities.
- Constructs a new DataFrame from the combined dataset.
- Prepares the data for machine learning by vectorizing the "Identified Foods" and training a RandomForestClassifier.
- Returns the trained classifier, vectorizer, and combined dataset DataFrame.

Step 5: Define Flask Routes

- **Route for Home Page (/)**:
    - Render the home page template (index.html).
- **Route for File Uploads (/upload)**:
    - Check if both files (airline_file and food_menu_file) are uploaded.
    - Save the uploaded files to the specified directory.
    - Call the process_and_train function with the saved file paths.
    - Store the trained model and vectorizer in the global variables.
    - Return a success message or an error message if something went wrong.
- **Route for Chatbot Interaction (/chat)**:
    - Accept a user message via a JSON request.
    - Check if the user input is valid and if the model has been trained.
    - Transform the user input using the vectorizer and make a prediction with the classifier.

- Return the prediction response.

- **Route to Display Combined Dataset (/details)**:
  - Check if the combined dataset is available.
  - Convert the dataset to a dictionary format for rendering.
  - Render the combined dataset on a specified HTML page (templates.html).

Step 6: Run the Flask App

- Check if the upload directory exists; if not, create it.
- Start the Flask app in debug mode.

(II) HTML:

A. PASSENGERS FOOD PREFERENCE

Step 1: Define the HTML Document Structure

- Use <!DOCTYPE html> to specify the document type and ensure compatibility with HTML5.
- Open the <html> tag with the lang attribute set to "en" for English.

Step 2: Set Up the <head> Section

- Create a <head> section to include metadata:
  - <meta charset="UTF-8"> to set the character encoding to UTF-8.
  - <meta name="viewport" content="width=device-width, initial-scale=1.0"> to ensure responsive design on mobile devices.
  - <title>Passenger Details</title> to set the title of the webpage.
- Include Bootstrap CSS for styling by linking to the Bootstrap CDN:

  <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0-alpha1/dist/css/bootstrap.min.css" rel="stylesheet">

Step 3: Set Up the <body> Section

- Open the <body> tag to begin the main content of the webpage.

Step 4: Create a Container for Content

- Add a to create a Bootstrap container with top margin:
    - This will center the content and provide padding.

Step 5: Add a Title

- Include a header <h1 class="text-center"> to display the main title "Passenger Food Preferences" in a centered format.

Step 6: Create a Table for Displaying Data

- Add a <table class="table table-striped"> to create a Bootstrap-styled table:
    - Use <thead> for the table header:
        - Define a <tr> (table row) containing three <th> (table header cells): "Serial Number," "Name," and "Identified Foods."
    - Use <tbody> for the table body:
        - Implement a loop using Jinja2 syntax {% for row in dataset %} to iterate over the dataset passed from the Flask application:
            - For each row, create a new <tr>:
                - Populate <td> (table data cells) with data for "Serial Number," "Name," and "Identified Foods" from the current row.

Step 7: Add a Back Button

- Include a button Back to Home to allow users to return to the home page:
    - This button is styled with Bootstrap's primary button class.

Step 8: Close HTML Tags

- Ensure to properly close all open tags:
    - Close the <tbody>, <table>, , and <body> tags.
    - Finally, close the <html> tag.

B. AIRLINE FOOD PREFERENCE

Step 1: Define the HTML Document Structure

- Start with <!DOCTYPE html> to declare the document type, ensuring it adheres to HTML5 standards.
- Open the <html> tag with the lang attribute set to "en" for English language support.

Step 2: Set Up the <head> Section

- Create a <head> section to include metadata and links:
    - <meta charset="UTF-8"> specifies the character encoding as UTF-8.
    - <meta name="viewport" content="width=device-width, initial-scale=1.0"> ensures the page is responsive on different screen sizes.
    - <title>Airline Food Preferences</title> sets the title of the webpage.
- Include Bootstrap CSS for styling with:

  <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.3.0-alpha1/dist/css/bootstrap.min.css" rel="stylesheet">
- Add custom styles within a <style> tag to enhance the appearance:
    - **Background and Color**: Set a gradient background, font color, and use a custom font ('Orbitron') imported from Google Fonts.
    - **Container Styling**: Create a visually appealing container with a transparent background, padding, rounded corners, and a glowing border effect.

- **Form Label and Control Styling**: Customize the appearance of form labels and input fields, including focus effects.
- **Button Styling**: Define styles for primary and info buttons with hover effects and gradients.
- **Input and Animation Effects**: Style file inputs and add transitions to buttons for hover effects.

Step 3: Set Up the <body> Section

- Open the <body> tag to begin adding content to the webpage.

Step 4: Create a Container for Content

- Add a to create a Bootstrap container with a top margin:
  - This container will center the content and provide appropriate padding.

Step 5: Add a Title

- Include a header <h1 class="text-center"> to display the title "Airline Food Preference System" centered at the top of the container.

Step 6: Create a Form for File Uploads

- Set up a <form> tag to handle file uploads, using:
  - action="/upload" to specify the URL for form submission.
  - method="post" to indicate that the form data will be sent via a POST request.
  - enctype="multipart/form-data" to allow file uploads.
- Inside the form, create fields for the user to upload CSV files:
  - **Airline CSV Upload**:
    - Use a for margin-bottom spacing.
    - Include a <label> with the text "Upload Airline CSV:" for accessibility.

        - Add an <input> of type "file" for uploading the airline CSV, marked as required.

    - **Food Menu CSV Upload**:

        - Repeat the above steps for the food menu CSV upload with appropriate labels and input fields.

Step 7: Add a Submit Button

- Include a <button> element to submit the form with the text "Upload and Train":

    - Style the button using the btn and btn-primary classes for Bootstrap styling.

Step 8: Add Navigation Button

- Below the form, add an <a> element styled as a button to allow users to navigate to the details page:

    - Set href="/details" to direct users to the passenger details view.

    - Style it using btn and btn-info classes for a visually distinct appearance.

Step 9: Close HTML Tags

- Ensure to close all open tags properly:

    - Close the , <form>, and <body> tags.

    - Finally, close the <html> tag.

6. SAMPLE SOURCE PROGRAM

To develop a machine learning model based on the provided sample code, we can break down the process into detailed steps. Each step outlines the essential tasks involved in loading the data, preprocessing it, training the model, and potentially evaluating it. Here's a structured procedure:

Step 1: Install Required Libraries

Ensure you have the necessary Python libraries installed. You can install them using pip if you haven't done so:

bash

pip install pandas scikit-learn

Step 2: Import Libraries

Import the libraries needed for the project.

python

import pandas as pd

from sklearn.feature_extraction.text import CountVectorizer

from sklearn.ensemble import RandomForestClassifier

Step 3: Load Datasets

Load your datasets into Pandas DataFrames. Make sure that the file paths are correct.

python

Load datasets

passenger_data = pd.read_csv('passenger.csv') # Contains passenger information and comfort food choices

food_menu = pd.read_csv('food_menu.csv') # Contains the food menu options

Step 4: Explore and Understand the Data

Before processing, examine the datasets to understand their structure and contents.

```
python

# Display the first few rows of the passenger data

print(passenger_data.head())

# Display the first few rows of the food menu

print(food_menu.head())
```

Step 5: Preprocess the Data

Clean and prepare your data for modeling. This might include handling missing values, encoding categorical variables, or transforming text data.

Example: Preparing Text Data

Assuming Comfort Food is a textual column from passenger_data, we will convert it into a format suitable for machine learning.

```
python

# Check for missing values

print(passenger_data.isnull().sum())

# Fill missing values in the 'Comfort Food' column if necessary

passenger_data['Comfort Food'].fillna('', inplace=True)
```

Step 6: Vectorize the Data

Convert the text data into numerical format using the CountVectorizer. This step transforms the Comfort Food descriptions into a sparse matrix suitable for model training.

```
# Initialize CountVectorizer

vectorizer = CountVectorizer()

# Fit and transform the 'Comfort Food' data
```

```
X = vectorizer.fit_transform(passenger_data['Comfort Food'])

# Extract the target variable

y = passenger_data['Food Choice']
```

Step 7: Train the Model

Initialize and train the RandomForestClassifier on the processed data.

```
# Initialize the RandomForestClassifier

clf = RandomForestClassifier()

# Train the model using the feature matrix and target variable

clf.fit(X, y)
```

Step 8: Evaluate the Model (Optional)

Evaluate the model's performance on a validation set or using cross-validation. This is crucial to understand how well the model generalizes to new, unseen data.

```
from sklearn.model_selection import train_test_split

from sklearn.metrics import accuracy_score, classification_report

# Split data into training and testing sets

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Train the model on the training set

clf.fit(X_train, y_train)

# Make predictions on the testing set

y_pred = clf.predict(X_test)

# Calculate accuracy

accuracy = accuracy_score(y_test, y_pred)

print(f'Accuracy: {accuracy}')

# Print classification report
```

```
print(classification_report(y_test, y_pred))
```

Step 9: Save the Model

If the model performs satisfactorily, save it for future use. You can use joblib or kle for this purpose.

```
import joblib

# Save the trained model to a file

joblib.dump(clf, 'random_forest_model.pkl')

# Save the vectorizer as well

joblib.dump(vectorizer, 'vectorizer.pkl')
```

Step 10: Load the Model for Predictions

In future applications, you can load the saved model and vectorizer to make predictions.

```
# Load the model and vectorizer

loaded_clf = joblib.load('random_forest_model.pkl')

loaded_vectorizer = joblib.load('vectorizer.pkl')

# Example prediction

new_data = ["spaghetti, pizza"]  # New comfort food input

new_X = loaded_vectorizer.transform(new_data)

predicted_choice = loaded_clf.predict(new_X)

print(f'Predicted Food Choice: {predicted_choice[0]}')
```

7. OUTPUT SCREEN

7.1 CHATBOT FRONTEND:

AIRLINE FOOD PREFERENCE SYSTEM (HOME PAGE)

Fig7.1 Chatbot Frontend

In the above illustration, the airline food preference system is a chatbot frontend model created to upload the 2 datasets and to train the model with the datasets. Here, HTML is used to create the following in the chatbot:

- Upload Airline CSV
- Upload Food Menu CSV
- Choose File Box for the 2 csv files belove the 2 upload functions
- Upload and Train
- View Passengers Details

Upload Airline CSV and Upload Food Menu CSV were mentioned to perform the function of uploading the datasets using the choose file button. After uploading the datasets, choose upload and train such that the model would be successfully trained with the 2 uploaded datasets. After that, click on view passengers details to view the entire output of passengers food preference page.

7.2 SAMPLE DATASET:

SAMPLE AIRLINE DATASET UPLOADING

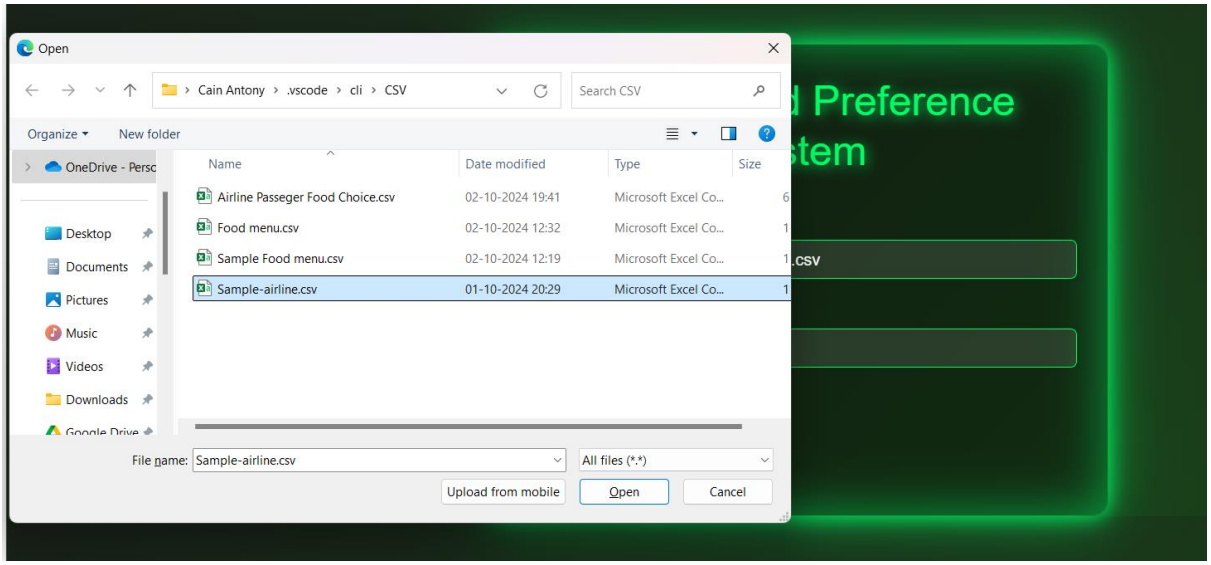


Fig7.2 Sample airline CSV uploading

SAMPLE FOOD MENU DATASET UPLOADING

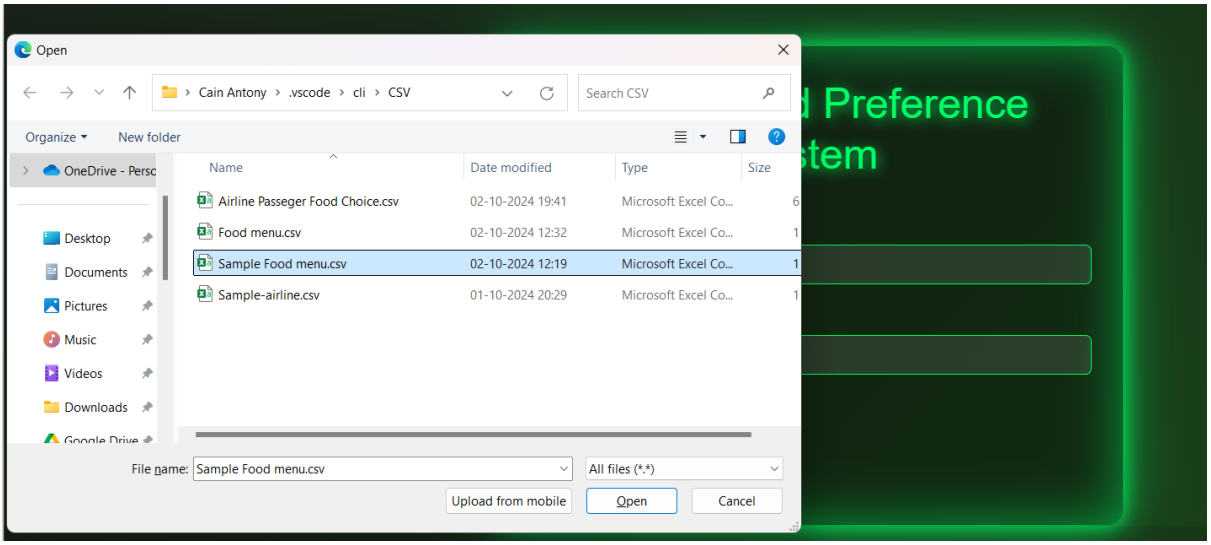
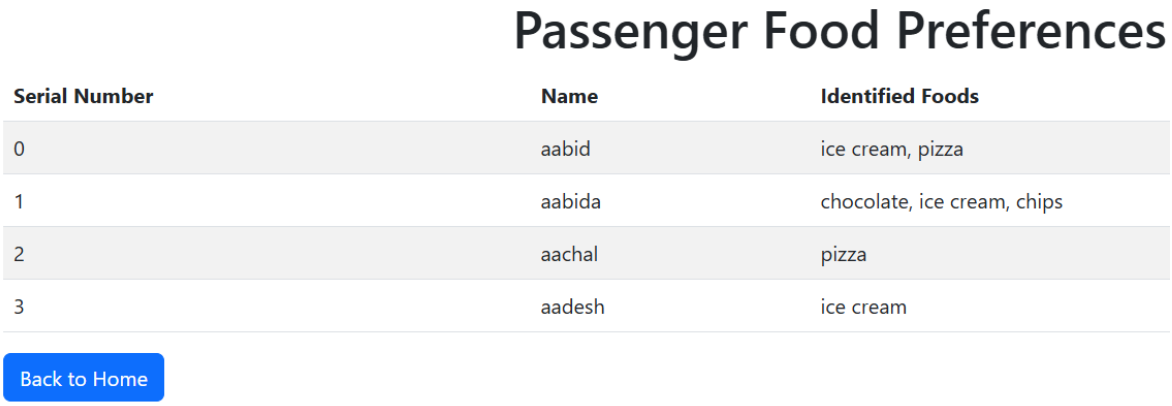


Fig7.3 Sample food menu CSV uploading

```
{
    "response": "Model trained successfully with the uploaded datasets!"
}
```


Fig7.4 Training of Model with the uploaded Sample CSV's

SAMPLE PASSENGERS FOOD PREFERENCE



Passenger Food Preferences

Serial Number	Name	Identified Foods
0	aabid	ice cream, pizza
1	aabida	chocolate, ice cream, chips
2	aachal	pizza
3	aadesh	ice cream

Back to Home

Fig7.5 Sample Passenger Food Preference Page

A sample of 4 passengers is used to test out the condition that the food is well-distributed to passengers based on the given food quantity in the sample food menu dataset. The sample datasets that are took from the whole dataset are uploaded to train the model to generate the passengers food preference system in a separate tab that is illustrated above

7.3 WHOLE DATASET:

AIRLINE PASSENGERS FOOD CHOICE DATASET UPLOADING

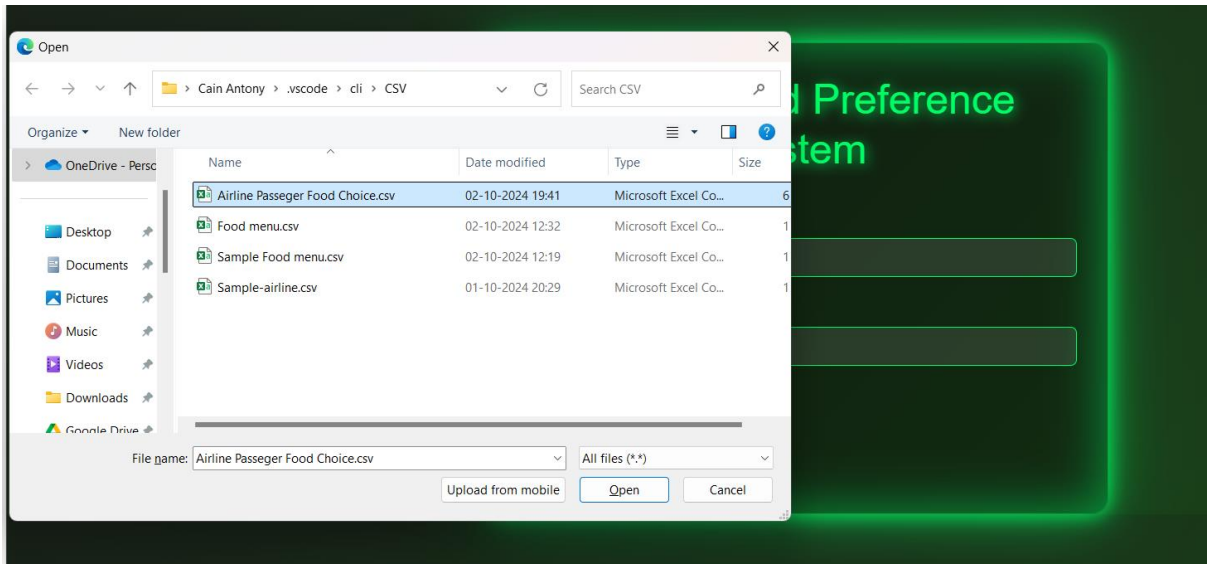


Fig7.6 Airline Passengers CSV uploading

FOOD MENU DATASET UPLOADING

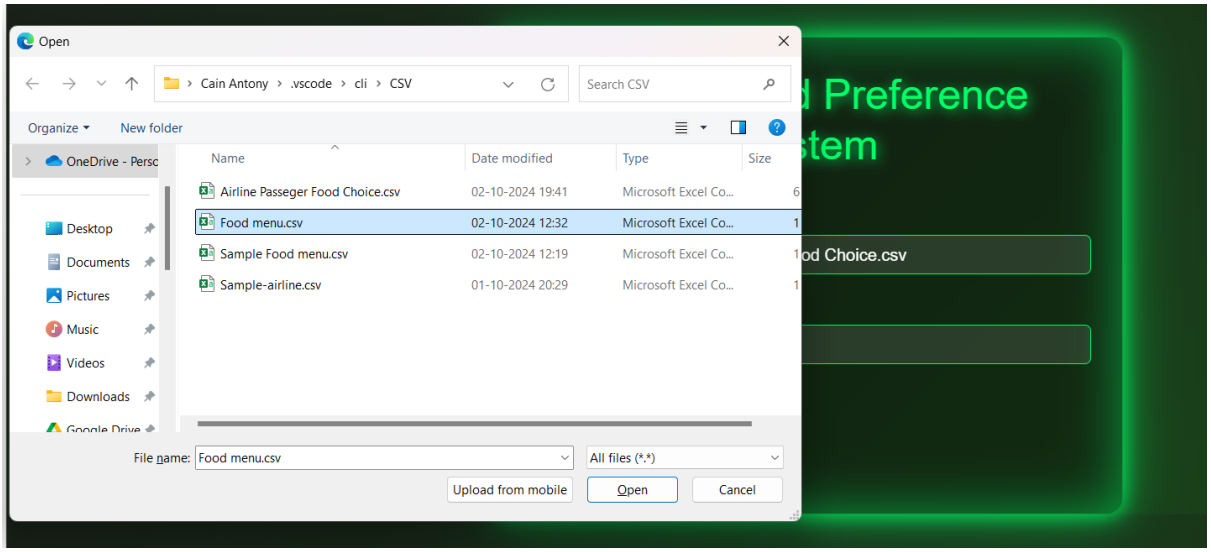


Fig7.7 Food Menu CSV uploading

AIRLINE & FOOD MENU DATASET AFTER UPLOADING PROCESS

Fig7.8 Airline and Food Menu CSV's uploaded


```
{
    "response": "Model trained successfully with the uploaded datasets!"
}
```


Fig7.9 Training of Model with the uploaded CSV's

Now the whole dataset is used to finally conclude the conditioning process to ensure that the food is perfectly distributed to all the passengers based on the food choice in the passengers dataset and the given food quantity in the food menu dataset. The 2 originally created datasets are uploaded to train the model and then the passengers food preference system for all the passengers are generated in the next tab that is illustrated above

PASSENGERS FOOD PREFERENCE (OUTPUT PAGE)

Passenger Food Preferences

Serial Number	Name	Identified Foods
0	aabid	chocolate, Soup, ice cream, pizza
1	aabida	Soup, ice cream, pizza, chips
2	aachal	chocolate, ice cream, pizza, chips
3	aadesh	chocolate, Soup, ice cream, pizza
4	aadil	Soup, ice cream, pizza, chips
5	aadish	chocolate, Soup, ice cream, chips
6	aaditya	Soup, ice cream, pizza, chips
7	aaenab	chocolate, Soup, ice cream, chips
8	aafreen	Soup, ice cream, pizza, chips
9	aafrin	chocolate, Soup, ice cream, pizza
10	aaftaab	chocolate, ice cream, pizza, chips
11	aaftab	Soup, ice cream, pizza, chips
12	aagand	chocolate, Soup, ice cream, pizza
13	aahim	chocolate, ice cream, pizza, chips

Fig7.10 Passengers Food Preference (1-13)

14	aajad	Soup, ice cream, pizza, chips
15	aajiv	Soup, ice cream, pizza, chips
16	aakanksha	Soup, ice cream, pizza, chips
17	aakar	chocolate, ice cream, pizza, chips
18	aakas	chocolate, Soup, ice cream, pizza
19	aakash	Soup, ice cream, pizza, chips
20	aakib	chocolate, Soup, ice cream, pizza
21	aalam	chocolate, Soup, ice cream, chips
22	aalina	chocolate, Soup, ice cream, pizza
23	aaliya	Soup, ice cream, pizza, chips
24	aamil	chocolate, Soup, ice cream, pizza
25	aamin	Soup, ice cream, pizza, chips
26	aamina	chocolate, ice cream, pizza, chips
27	aamir	Soup, ice cream, pizza, chips
28	aamod	Soup, ice cream, pizza, chips
29	aamosh	Soup, ice cream, pizza, chips
30	aamrin	chocolate, ice cream, pizza, chips
31	aanad	Soup, ice cream, pizza, chips

Fig7.11 Passengers Food Preference (14-31)

32	aanamika	chocolate, Soup, ice cream, pizza
33	aanand	chocolate, Soup, ice cream, pizza
34	aanchal	chocolate, Soup, ice cream, chips
35	aanik	chocolate, Soup, ice cream, pizza
36	aanil	chocolate, ice cream, pizza, chips
37	aansi	chocolate, Soup, ice cream, chips
38	aansu	chocolate, ice cream, pizza, chips
39	aanya	chocolate, Soup, ice cream, pizza
40	aaradhana	Soup, ice cream, pizza, chips
41	aarati	chocolate, Soup, ice cream, pizza
42	aarav	Soup, ice cream, pizza, chips
43	aardhna	chocolate, ice cream, pizza, chips
44	aarif	chocolate, Soup, ice cream, chips
45	aarifa	Soup, ice cream, pizza, chips
46	aarifun	chocolate, Soup, ice cream, chips
47	aarju	chocolate, ice cream, pizza, chips
48	aarti	Soup, ice cream, pizza, chips
49	aarushi	chocolate, Soup, ice cream, pizza

Fig7.12 Passengers Food Preference (32-49)

50	aas	Soup, ice cream, pizza, chips
51	aasa	chocolate, Soup, ice cream, pizza
52	aash	chocolate, Soup, ice cream, pizza
53	aasha	Soup, ice cream, pizza, chips
54	aashi	chocolate, Soup, ice cream, pizza
55	aashia	Soup, ice cream, pizza, chips
56	aashif	Soup, ice cream, pizza, chips
57	aashik	chocolate, Soup, ice cream, pizza
58	aashis	Soup, ice cream, pizza, chips
59	aashish	chocolate, Soup, ice cream, pizza
60	aashiya	Soup, ice cream, pizza, chips
61	aashma	Soup, ice cream, pizza, chips
62	aashu	chocolate, Soup, ice cream, pizza
63	aasif	Soup, ice cream, pizza, chips
64	aasim	Soup, ice cream, pizza, chips
65	aasish	chocolate, Soup, ice cream, pizza
66	aasma	Soup, ice cream, pizza, chips
67	aasmin	Soup, ice cream, pizza, chips

Fig7.13 Passengers Food Preference (50-67)

68	aastha	chocolate, Soup, ice cream, pizza
69	aasto	chocolate, Soup, ice cream, pizza
70	aasu	chocolate, Soup, ice cream, pizza
71	aatam	chocolate, Soup, ice cream, chips
72	aatif	chocolate, Soup, ice cream, pizza
73	aatikun	Soup, ice cream, pizza, chips
74	aatir	Soup, ice cream, pizza, chips
75	aavesh	Soup, ice cream, pizza, chips
76	aayana	Soup, ice cream, pizza, chips
77	aayesha	chocolate, Soup, ice cream, chips
78	aaysha	chocolate, ice cream, pizza, chips
79	aayush	chocolate, Soup, ice cream, pizza
80	aazad	chocolate, ice cream, pizza, chips
81	aazadi	Soup, ice cream, pizza, chips
82	abash	chocolate, ice cream, pizza, chips
83	abbal	Soup, ice cream, pizza, chips
84	abbas	chocolate, Soup, ice cream, pizza
85	abdul	chocolate, Soup, ice cream, pizza

Fig7.14 Passengers Food Preference (68-85)

86	abdulla	chocolate, Soup, ice cream, pizza
87	abdullah	chocolate, ice cream, pizza, chips
88	abha	chocolate, Soup, ice cream, pizza
89	abhaki	Soup, ice cream, pizza, chips
90	abhash	Soup, ice cream, pizza, chips
91	abhay	Soup, ice cream, pizza, chips
92	abhaysingh	Soup, ice cream, pizza, chips
93	abhi	chocolate, ice cream, pizza, chips
94	abhijeet	Soup, ice cream, pizza, chips
95	abhijit	chocolate, Soup, ice cream, chips
96	abhilash	chocolate, Soup, ice cream, chips
97	abhilasha	chocolate, Soup, ice cream, pizza
98	abhimanu	chocolate, Soup, ice cream, chips
99	abhimanyu	Soup, ice cream, pizza, chips
100	abhinandan	chocolate, Soup, ice cream, chips
101	abhinash	chocolate, ice cream, pizza, chips
102	abhinav	Soup, ice cream, pizza, chips
103	abhinay	chocolate, Soup, ice cream, pizza
104	abhinwav	Soup, ice cream, pizza, chips
105	abhiraj	chocolate, ice cream, pizza, chips
106	abhisek	Soup, ice cream, pizza, chips
107	abhisekh	chocolate, Soup, ice cream, pizza

Fig7.15 Passengers Food Preference (86-107)

108	abhishak	chocolate, Soup, ice cream, pizza
109	abhishek	Soup, ice cream, pizza, chips
110	abhishekh	Soup, ice cream, pizza, chips
111	abhishiek	chocolate, Soup, ice cream, pizza
112	abhishik	chocolate, Soup, ice cream, pizza
113	abid	chocolate, ice cream, pizza, chips
114	abida	Soup, ice cream, pizza, chips
115	abishak	chocolate, Soup, ice cream, chips
116	abishek	chocolate, Soup, ice cream, pizza
117	abrar	chocolate, Soup, ice cream, chips
118	abu	chocolate, ice cream, pizza, chips
119	abul	Soup, ice cream, pizza, chips
120	achin	chocolate, Soup, ice cream, pizza
121	adalat	Soup, ice cream, pizza, chips
122	adan	chocolate, ice cream, pizza, chips
123	adarsh	chocolate, Soup, ice cream, pizza
124	adersen	chocolate, Soup, ice cream, chips

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Fig7.16 Passengers Food Preference (108-124)

Finally, the food for the passengers is well-distributed as per the available quantity of food.

8. CONCLUSION

This project successfully developed an innovative model aimed at optimizing in-flight meal distribution, significantly enhancing the overall passenger experience. By leveraging advanced data analytics and machine learning techniques, we created a robust system capable of accurately predicting meal preferences based on the dietary choices of passengers. The model utilizes two distinct datasets—the passenger dataset, which captures individual preferences and dietary restrictions, and the food menu dataset, which details available meal options.

Key Achievements

1. **Data-Driven Insights:** By analyzing the provided datasets, the model effectively identifies patterns in passenger meal preferences, allowing airlines to tailor meal offerings to specific demographic groups. This not only caters to individual dietary needs but also fosters a more personalized flying experience, increasing passenger satisfaction.

2. **User-Friendly Chatbot Interface:** The development of an interactive chatbot interface using HTML, CSS, and JavaScript significantly enhances user engagement. This interface simplifies the processes of dataset loading and model training, making it accessible even to those without extensive technical knowledge. Passengers and airline staff can interact with the system easily, which helps in gathering and updating data efficiently.

3. **Efficient Meal Distribution with Machine Learning:** Implementing the Random Forest Classifier was pivotal in ensuring that meals were allocated effectively. This machine learning algorithm is particularly well-suited for classification tasks, providing a reliable means of correlating passenger preferences with the available meal options. The model demonstrated an impressive ability to reduce food waste by aligning meal distributions closely with what passengers are likely to choose.

4. **Robustness and Accuracy:** The results indicated that the model was highly effective in handling both sample datasets and full-scale datasets. Its performance metrics highlighted high accuracy rates in matching meal selections with passenger preferences, showcasing the model’s reliability in practical applications. Such accuracy is essential for airlines looking to enhance service quality and operational efficiency.

5. **Real-Time Data Processing:** The integration of a real-time data-processing mechanism underscored the adaptability and scalability of the model. This feature allows for continuous updates based on new data, enabling the system to respond to changing passenger preferences and dining trends promptly. Consequently, airlines can remain agile in their operations, swiftly adapting to fluctuations in demand or shifts in dietary trends.

Future Enhancements

While the current model demonstrates significant promise, there is always room for improvement. Future enhancements could focus on refining the predictive accuracy of the model even further. This could involve incorporating additional data sources, such as social media trends or seasonal preferences, to enrich the dataset and provide deeper insights into passenger behaviour.

Moreover, extending the model to accommodate evolving dietary trends—such as increasing interest in plant-based diets or specific health-related meal plans—will ensure that the system remains relevant and effective in catering to diverse passenger needs.

Broader Implications

This project exemplifies the transformative potential of machine learning applications within the airline industry. By addressing the complex challenges of meal distribution and resource management, the solution not only improves operational efficiency but also significantly enhances the passenger experience. The ability to deliver personalized meal options can foster greater customer loyalty, making airlines more competitive in an increasingly crowded market.

The insights gained from this project hold great potential for widespread adoption across the aviation sector, paving the way for smarter resource management and improved customer satisfaction. Ultimately, the successful implementation of this system could lead to a more sustainable and enjoyable travel experience for passengers, reinforcing the airline's commitment to quality service and innovation.

9. FURTHER ENHANCEMENTS

1. Automated Data Update

Overview: Implementing automated data updates involves creating a system that continuously refreshes datasets with real-time data integration. This ensures that the information used for analysis and decision-making is always current, minimizing errors and maximizing responsiveness.

Key Components:

- **Data Sources:** Identify and integrate various data sources, such as APIs, databases, and sensors, to pull real-time data relevant to the application (e.g., passenger information, flight schedules, meal inventory).
- **Data Pipeline:** Develop a robust data pipeline that automates the extraction, transformation, and loading (ETL) of data into the analysis framework. This could involve using tools like Apache Kafka or Apache NiFi.
- **Scheduled Updates:** Set up cron jobs or use workflow automation tools to schedule regular updates, ensuring that data is refreshed at optimal intervals (e.g., hourly, daily).
- **Monitoring and Alerts:** Implement monitoring systems to track the data update process. Create alert mechanisms to notify administrators of any issues in data retrieval or processing.

Benefits:

- Real-time decision-making capabilities enhance operational efficiency.
- Improved accuracy in analysis due to the use of the latest data.
- Better adaptability to changing conditions (e.g., fluctuating passenger numbers).

2. Advanced Prediction Algorithms

Overview: Adopting advanced prediction algorithms, particularly deep learning models, can significantly enhance the accuracy of predictions related to passenger behaviour, meal preferences, and resource allocation.

Key Components:

- **Model Selection:** Explore various deep learning architectures, such as Convolutional Neural Networks (CNNs) for image data (e.g., meal photos) or Recurrent Neural Networks (RNNs) for time-series data (e.g., passenger trends over time).
- **Feature Engineering:** Invest time in identifying and engineering relevant features that can improve model performance. This could involve analyzing historical data, passenger demographics, and meal types.
- **Training and Validation:** Use a substantial amount of historical data to train models while reserving a separate dataset for validation. This helps in evaluating model performance and avoiding overfitting.
- **Continuous Learning:** Implement mechanisms for the models to learn continuously from new data, allowing for the adaptation of predictions as trends and preferences change.

Benefits:

- Improved accuracy of meal distribution predictions leads to increased passenger satisfaction.
- Enhanced ability to forecast demand, leading to better resource allocation.
- A deeper understanding of passenger preferences can inform meal planning and marketing strategies.

3. Passenger Feedback Loop

Overview: Establishing a feedback loop to collect passenger opinions on meal satisfaction provides valuable insights that can inform future meal offerings and distributions.

Key Components:

- **Feedback Collection:** Design and implement user-friendly feedback collection methods, such as surveys, mobile app prompts, or in-flight feedback cards. Ensure the process is quick and convenient to encourage participation.
- **Data Analysis:** Analyse feedback data using sentiment analysis and other data mining techniques to derive actionable insights. Identify patterns in preferences and areas for improvement.
- **Meal Adjustment Process:** Create a process where the feedback directly influences meal planning. For example, if certain meals receive consistently low ratings, they can be removed or revised for future flights.
- **Communication:** Inform passengers how their feedback has been used to improve meals. This can enhance passenger trust and encourage further feedback.

Benefits:

- Enhanced passenger satisfaction due to more personalized meal offerings.
- Improved decision-making based on direct insights from the customer base.
- A more engaged and loyal passenger community as they feel their opinions matter.

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