Data Analytics

Waste Less, Taste More

A Deep Dive into Food Waste in Europe &
Using Machine Learning to Cook Up Solutions

Kranta Gaterojn

April, 2024

Table of content

Introduction

In an era where sustainability and resource conservation have become paramount, the issue of food waste stands out as a significant challenge. Each year, a staggering amount of food is discarded globally, contributing to environmental degradation and economic inefficiency. In light of this, my project, titled "Waste Less, Taste More: A Deep Dive into Food Waste in Europe & Using Machine Learning to Cook Up Solutions," aims to tackle the pervasive problem of food waste, with a primary focus on household wastage within European countries.

Aligned with the United Nations Sustainable Development Goals (SDGs), particularly Goal 12: "Responsible Consumption and Production," my project is dedicated to addressing Target 12.3: "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses."

Food waste is a pressing issue with far-reaching implications for both society and the environment. Despite the abundance of resources devoted to food production, distribution, and consumption, a significant portion ends up in landfills, contributing to greenhouse gas emissions, resource depletion, and economic inefficiency. Therefore, I aim to contribute to the global effort to reduce food waste by focusing on household wastage within European countries.

Utilizing data from authoritative sources such as Eurostat and the United Nations, I seek to quantify the extent of food waste and identify key drivers and patterns across the food supply chain. By doing so, I hope to shed light on the root causes of food waste and develop targeted interventions and strategies for waste reduction, in line with the principles of sustainable consumption and production outlined in Goal 12.

Through my project, I aspire to demonstrate the transformative potential of data analytics and machine learning in addressing complex societal challenges. By harnessing the power of data-driven insights, I aim to empower stakeholders with actionable information and innovative solutions to achieve the ambitious targets set forth by the United Nations, paving the way for a more sustainable and resilient future for generations to come.

Business Case:

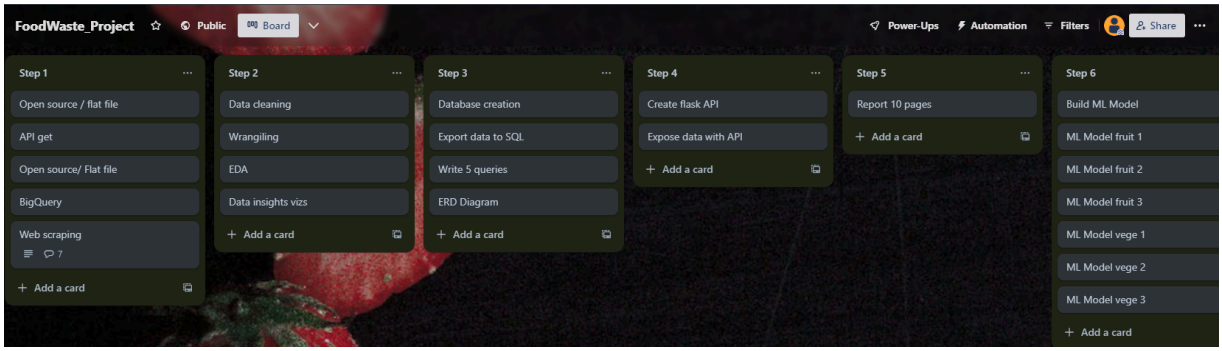
The economic and environmental implications of food waste are substantial, with billions of dollars lost annually and significant greenhouse gas emissions associated with decomposing food in landfills. By focusing on household food waste, I aim to conserve valuable resources, mitigate environmental pollution, and contribute to the global effort towards sustainability. Moreover, addressing household food waste presents an opportunity to instill responsible consumption habits and promote a culture of sustainability within communities. Through my project, leveraging data analytics and machine learning, I seek to showcase the effectiveness of data-driven approaches in reducing food waste, inspiring broader adoption of sustainable practices worldwide.

Goal:

My aim is to reduce food waste, emphasizing households and addressing waste across various stages of the food supply chain. Leveraging data analytics and machine learning techniques, I'll identify key drivers and patterns of food wastage within households, develop targeted interventions, and utilize machine learning to create recipes for leftover food. These efforts aim to promote sustainable consumption practices and contribute to building a more efficient food system for future generations.

Project Plan:

- Planning the project on Trello
- Collecting data using various methods such as web scraping, flat files, APIs, and BigQuery
- Cleaning the collected data
- Creating a database and Entity Relationship Diagram (ERD) using MySQL
- Aggregating the data within MySQL
- Creating APIs with Swagger documentation to expose the collected data
- Processing data for machine learning purposes
- Training and testing models



Data and data sources

Flat file:

Eurostat

In my project, I begin by gathering comprehensive data on food waste across European countries for the years 2020 and 2021. Utilizing datasets from authoritative sources such as Eurostat ensures the reliability and accuracy of my analysis.

For a deep dive into food waste, I further categorize it into specific categories, including food production, manufacturing, distribution, services, and total household activities. This granular analysis allows me to pinpoint key areas with the highest levels of waste generation.

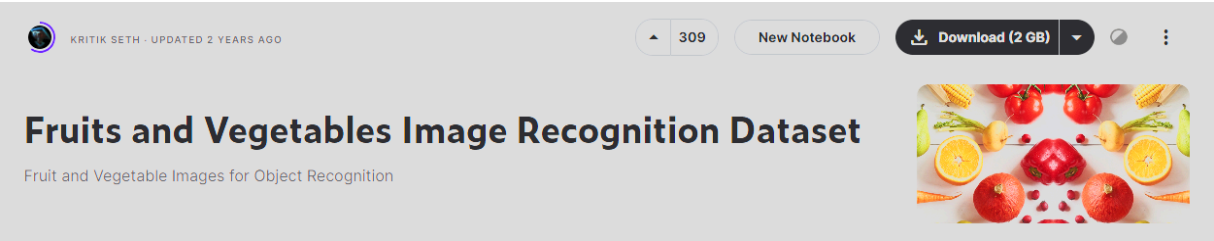
Eurostat is a primary source of statistical information on waste generation, consumption, and related indicators. Specifically, I rely on Eurostat's data on food waste and food waste prevention by NACE Rev. 2 activity - tonnes of fresh mass to enrich my analysis and provide valuable insights into food waste trends.

Kaggle

In line with the objectives outlined in the report, I am integrating image data of fruits and vegetables sourced from Kaggle to train and test the machine learning model. This dataset comprises approximately 100 images for training, 10 images for testing, and 10 images for validation, encompassing 36 different types of fruits and vegetables.

By leveraging these images and employing machine learning techniques, I aim to identify key drivers and patterns of food wastage within households. Additionally, I will develop targeted interventions and utilize machine learning to generate recipes for utilizing leftover food effectively.

Through these efforts, I seek to promote sustainable consumption practices and contribute to the establishment of a more efficient and resilient food system for future generations.

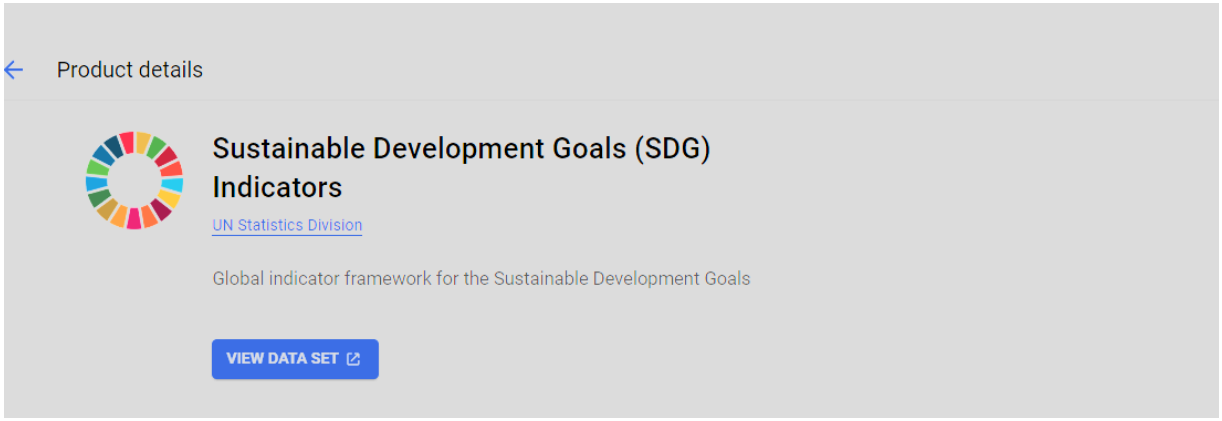


BigQuery:

In my quest to understand food waste and consumption patterns, I tap into various valuable data sources. One of my go-to sources is the United Nations Sustainable Development Goals (SDGs) data repository on Google BigQuery. This treasure trove of information houses a wealth of indicators related to food waste, giving me insights into global trends and how people eat.

With BigQuery's help, I can search through this massive database using keywords like waste, food, hunger, and consumption. This lets me dig out the most relevant data points to enrich my analysis and get a better understanding of what's going on worldwide with food waste.

However, there's a little hiccup when it comes to exporting data directly to my computer in CSV or JSON format. It just doesn't work like that. So, I found a workaround—I export the data to CSV format on Google Drive and then download it from there. It's a bit of a detour, but it gets the job done, and I can keep diving into the data to uncover more insights for my project.



Data collection

API Data:

Leveraging the UN SDG API for Target 12.3

In my project report, I highlight the utilization of the United Nations Statistics Division's API, tailored specifically for Sustainable Development Goal (SDG) indicators, including Target 12.3 addressing food waste reduction. This API, known as the UN SDG API, serves as a pivotal tool in my endeavor to combat food waste.

With the UN SDG API, I have direct access to real-time and historical data on various metrics related to food waste, empowering me to monitor progress, identify trends, and make informed decisions regarding waste reduction strategies. Through personalized Python scripting, I fetch data from the API, allowing me to seamlessly integrate this valuable information into my analysis.

In one Python code snippet from my report, I illustrate how I iteratively retrieve JSON data from the UN SDG API, aggregating it into a cohesive DataFrame using the powerful Pandas library. This consolidated dataset serves as the foundation for my subsequent data analysis and modeling efforts.

By harnessing the capabilities of the UN SDG API, I gain valuable insights into food waste metrics across different regions and time periods. This personalized approach to data collection not only enhances the accuracy of my analysis but also aligns with my commitment to leveraging cutting-edge technology to address pressing societal challenges, such as food waste reduction.

```python
#Import all Goal 12 [Responsible consumption and production] Target 12.3 -Halve Global per capita food waste


# Empty list to store combined data
combined_data12_3 = []

# Iterate through pages
for page in range(1,6):


    api_url = f'https://unstats.un.org/sdgapi/v1/sdg/Target/Data?target=12.3&page={page}&pageSize=1000'

    # Fetch JSON data for each page
    response = requests.get(api_url)
    api_info = response.json()

    # Append the "data" array from each page to the combined list
    combined_data12_3.extend(api_info['data'])

# Add the combined "data" to the original JSON object
api_sum = combined_data12_3

#
df_api = pd.DataFrame(api_sum)
df_api.to_csv('../source/api_data12_3.csv',index=False)
```

Web scraping

Web scraping techniques are essential for me to extract targeted data from online sources. These sources include consumer surveys, scientific studies, and lists of national fruits for each country. They provide valuable insights into consumer preferences, regional variations in food waste, and cultural factors influencing consumption patterns.

By scraping consumer surveys and reports on the top 20 unwanted fruits and vegetables, I gain insights into potential sources of food waste and consumer behavior. Additionally, scientific studies detailing country-specific food waste generation profiles offer crucial data for understanding regional variations in waste.

Despite encountering challenges with inaccessible PDFs and restricted sites, such as the 403 forbidden error, I persist in enriching my dataset with valuable information. Incorporating data on national fruits allows me to understand cultural influences on consumption patterns and identify unique sources of food waste in each region.

This knowledge empowers me to tailor waste reduction strategies to specific cultural contexts, facilitating more effective interventions and promoting sustainable consumption practices. Overall, the inclusion of national fruit data adds depth to my dataset, enriching my analysis and decision-making processes.

```
# Send a GET request to the URL
url = 'https://en.wikipedia.org/wiki/List_of_national_fruits'
response = requests.get(url)

# Parse the HTML content
soup = BeautifulSoup(response.text, 'html.parser')

# Find the table containing the data
table = soup.find('table', {'class': 'wikitable'})

# Extract data from the table
rows = table.find_all('tr')
data = []
for row in rows:
    columns = row.find_all('td')
    row_data = []
    for column in columns:
        row_data.append(column.get_text().strip())  # Strip whitespace
    if row_data:
        data.append(row_data)

# # Create DataFrame
custom_headers = ['country', 'common_name','scientific_name','image','ref','notes']

# Create DataFrame
df = pd.DataFrame(data[1:], columns=custom_headers)
# Display DataFrame
df.columns
df = df.drop(columns=[ 'scientific_name', 'image', 'ref', 'notes'])
```

Data cleaning and Exploratory data analysis

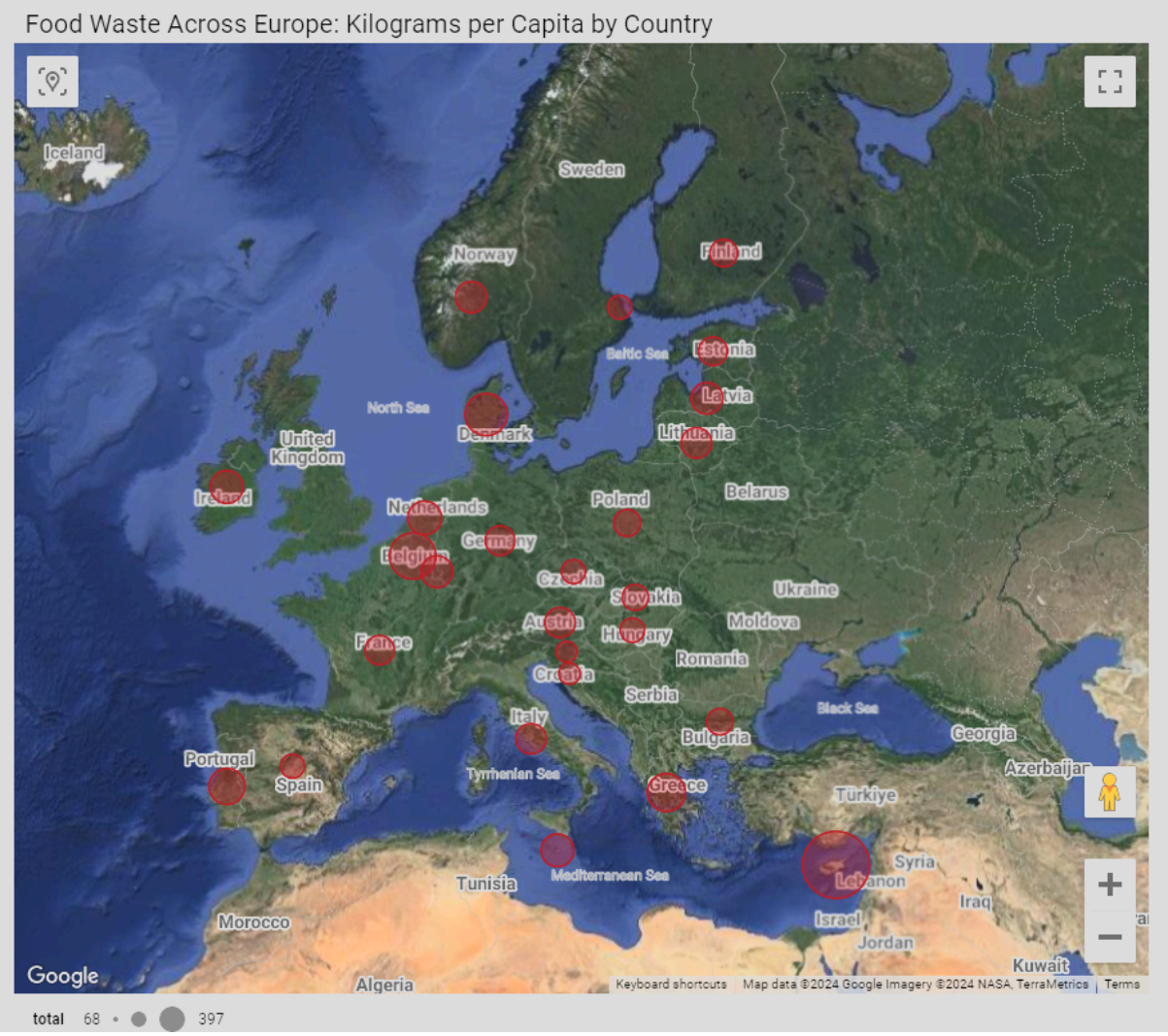
Data Cleaning

During the data cleaning process, I undertook several steps to refine the dataset and prepare it for analysis, focusing on food waste patterns within European countries. Here are the key steps:

1. **Drop Empty Columns:** I removed empty columns to streamline the dataset and eliminate unnecessary information, ensuring a more focused analysis.
2. **Standardization of Country Names:** To maintain consistency across the dataset, I standardized country names, replacing variations with a uniform format. For instance, "United Kingdom of Great Britain and Northern Ireland" was replaced with "United Kingdom."
3. **Filtering for European Countries:** I filtered the dataset to include only European countries, aligning with the project's scope and objectives.
4. **Column Removal:** Irrelevant columns were dropped from the dataset to simplify it and focus solely on essential information relevant to food waste analysis.
5. **ID Generation:** I generated unique identifiers ('id') for each dataset entry based on country name and time period, facilitating efficient data management and analysis.
6. **Rename Columns:** Column labels were renamed to provide clearer and more descriptive names, enhancing the dataset's interpretability and ease of use.
7. **Target Data Filtering:** I filtered and retained data related to the project's target variables, ensuring that only relevant information was included in the dataset.
8. **Data Segmentation:** The dataset was segmented into separate DataFrames based on specific conditions, allowing for more focused analysis on each subset of data and enabling deeper insights into food waste patterns.
9. **Handling Missing Values:** Columns with missing or NaN values were identified and dropped from the dataset to maintain data integrity and accuracy.
10. **Standardization and Formatting:** Column names were standardized by replacing spaces with underscores and converting all letters to lowercase, ensuring consistency and facilitating smoother data manipulation and analysis.

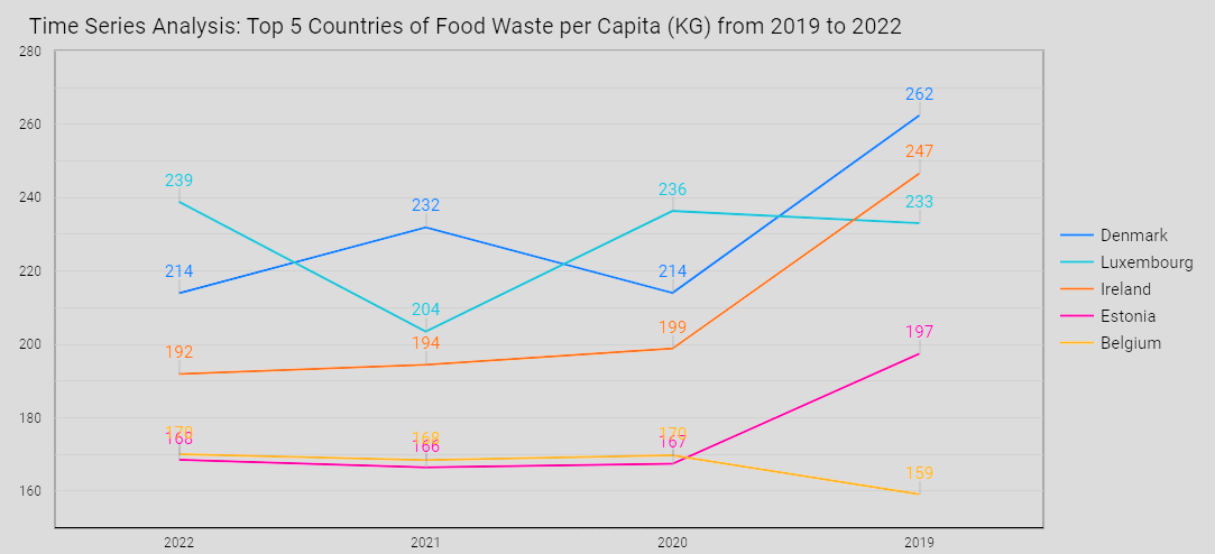
By meticulously following these cleaning steps, I refined the dataset, ensuring that it contained only relevant and consistent information essential for investigating food waste trends within European households. This meticulous preparation laid a solid foundation for subsequent analysis and deriving actionable insights to address food waste challenges effectively.

Data Visualization



The data on food waste across Europe reveals significant variations in kilograms per capita by country:

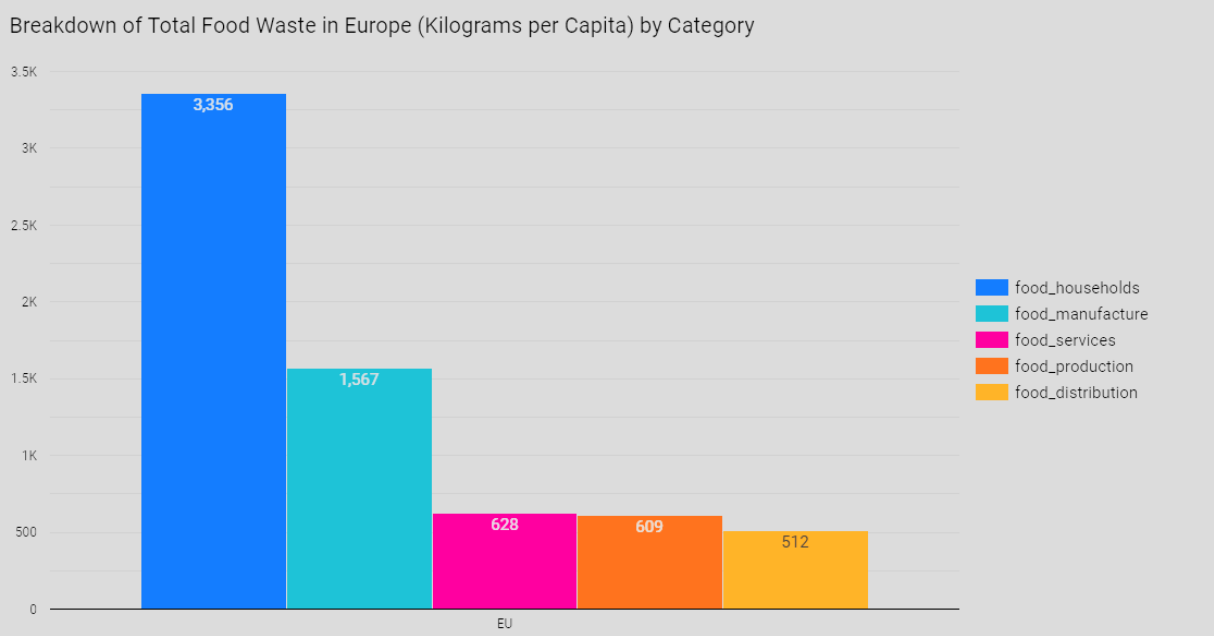
1. Cyprus exhibits the highest food waste level, with 397 kilograms per capita, indicating a substantial challenge in waste management.
2. Several countries, including Belgium, Denmark, and Ireland, also demonstrate high food waste levels, ranging from 221 to 250 kilograms per capita.
3. Moderate food waste levels, ranging from 108 to 191 kilograms per capita, are observed in countries like Bulgaria, Germany, Greece, Italy, and Portugal.
4. Countries such as Slovenia, Croatia, and Slovakia have comparatively lower levels of food waste, ranging from 68 to 106 kilograms per capita.
5. Regional trends show similarities in food waste levels among neighboring countries, emphasizing the importance of tailored waste reduction strategies at both national and regional levels.



The analysis of the top countries is as follows:

1. Denmark: Denmark shows fluctuations in food waste per capita over the years. It had the highest value in 2019 at approximately 262 KG, followed by a decrease to around 214 KG in 2020. However, there was a notable increase in 2021 to about 232 KG. In 2022, the value slightly decreased to approximately 214 KG.
2. Ireland: Ireland exhibits a declining trend in food waste per capita from 2019 to 2021, with values decreasing from around 247 KG to about 194 KG. There is a slight increase in 2022 to approximately 192 KG.
3. Luxembourg: Luxembourg demonstrates fluctuations in food waste per capita over the years, with the highest value in 2022 at approximately 239 KG, followed by values of about 233 KG in 2019, 236 KG in 2020, and 204 KG in 2021.
4. Belgium: Belgium shows relatively stable food waste per capita over the years, with values ranging from approximately 159 KG in 2019 to around 170 KG in both 2020 and 2022, with a slight increase to about 168 KG in 2021.
5. Estonia: Estonia's data shows relatively consistent food waste per capita across the years, with values ranging from around 197 KG in 2019 to approximately 166 KG in both 2021 and 2022.

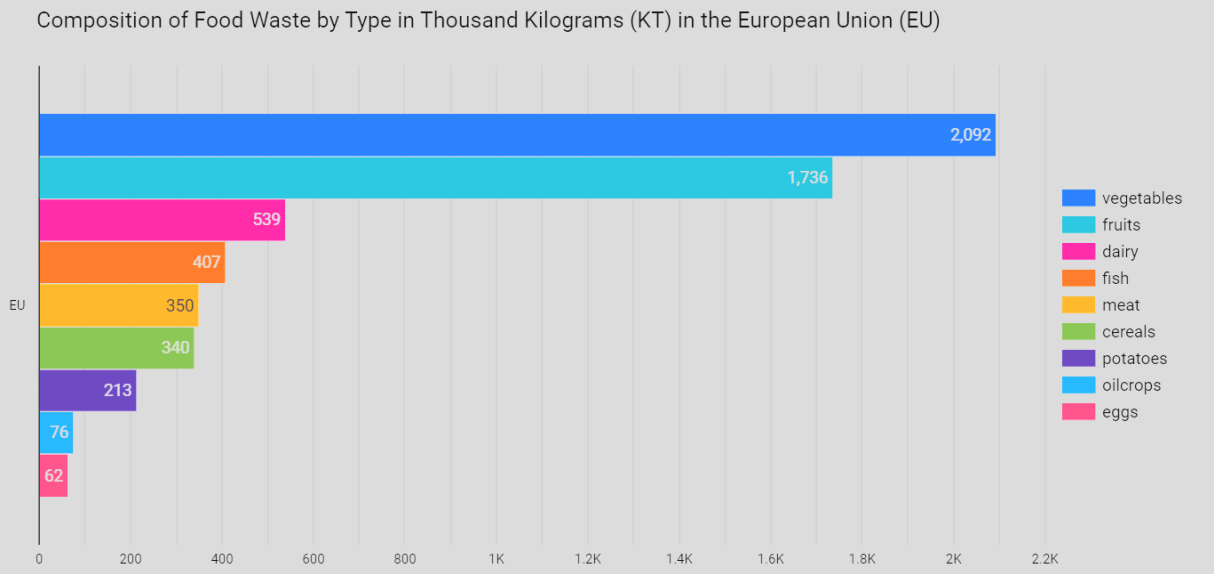
Overall, Denmark and Luxembourg show fluctuations in food waste per capita, while Ireland exhibits a declining trend. Belgium demonstrates relatively stable waste levels, and Estonia maintains consistent values over the years.



Histogram Analysis: Breakdown of Total Food Waste in Europe (Kilograms per Capita) by Category

1. Food Households: Food households contribute the highest and most substantial portion of food waste, with 3,356 kilograms per capita. This underscores the critical role of households in overall food wastage, highlighting the urgent need for targeted interventions to reduce wastage at the consumer level and promote sustainability in food consumption practices.
2. Food Production: Food production contributes 609 kilograms per capita to food waste, indicating a significant portion of waste generated during the production phase.
3. Food Manufacture: Food manufacture accounts for the highest proportion of food waste, with 1,567 kilograms per capita. This highlights the substantial waste generated during the manufacturing process.
4. Food Distribution: Food distribution contributes 512 kilograms per capita to food waste, indicating a notable portion of waste occurring during the distribution stage.
5. Food Services: Food services contribute 628 kilograms per capita to food waste, emphasizing the significant waste generated within the service industry.

Overall: The histogram provides a comprehensive overview of the distribution of food waste across different stages of the supply chain, with households contributing the most significant share. This analysis emphasizes the importance of addressing household food waste through effective strategies and awareness campaigns to achieve sustainable consumption practices.



Histogram Analysis: Composition of Food Waste by Type in Thousand Kilograms (KT) in the European Union (EU)

1. Vegetables: Leading the composition, vegetables contribute approximately 2,092 KT, indicating substantial wastage in this category.
2. Fruits: Following closely, fruits account for around 1,736 KT, underscoring the significant portion of fruit wastage in the EU.
3. Dairy: Dairy products contribute 539 KT to food waste, representing a notable portion of discarded items.
4. Fish: Fish waste amounts to 407 KT, highlighting the need for strategies to minimize seafood wastage.
5. Meat: Meat waste totals 350 KT, indicating a significant but slightly smaller proportion compared to other categories.
6. Cereals, Potatoes, Oilcrops, and Eggs: These categories collectively contribute to food waste, albeit in smaller quantities compared to the top five categories.

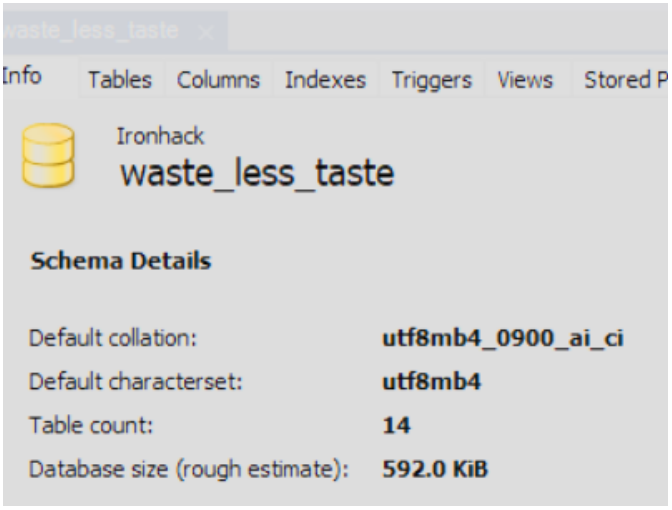
Overall, the histogram provides insights into the distribution of food waste types in the EU, emphasizing the importance of targeted efforts to reduce wastage across various food categories.

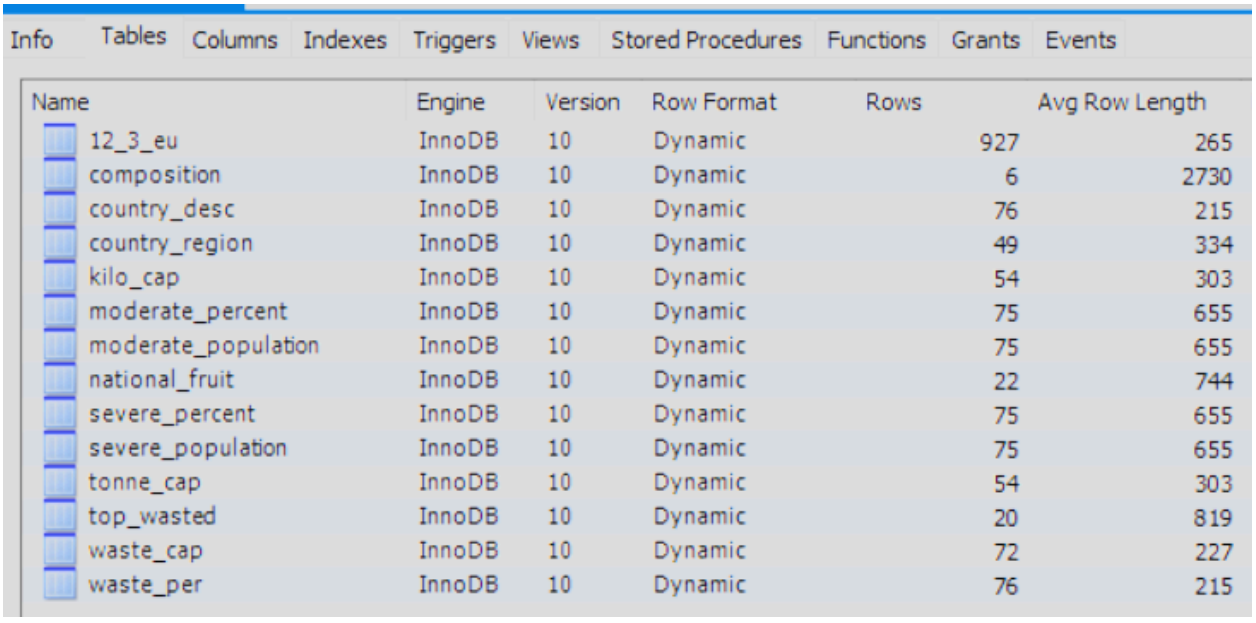
Database type selection

Database Creation

The food waste database was established in MySQL Workbench to encompass 14 tables capturing various aspects of food waste in Europe. Data collection involved sourcing information from flat files, APIs, BigQuery, and web scraping. The tables within the food waste database include:

1. df_waste_per.csv
2. df_waste_cap.csv
3. df_kilo_cap.csv
4. df_tonne_cap.csv
5. df_composition.csv
6. df_severe_percent.csv
7. df_moderate_percent.csv
8. df_severe_population.csv
9. df_moderate_population.csv
10. df_12_3_eu.csv
11. df_national_fruit.csv

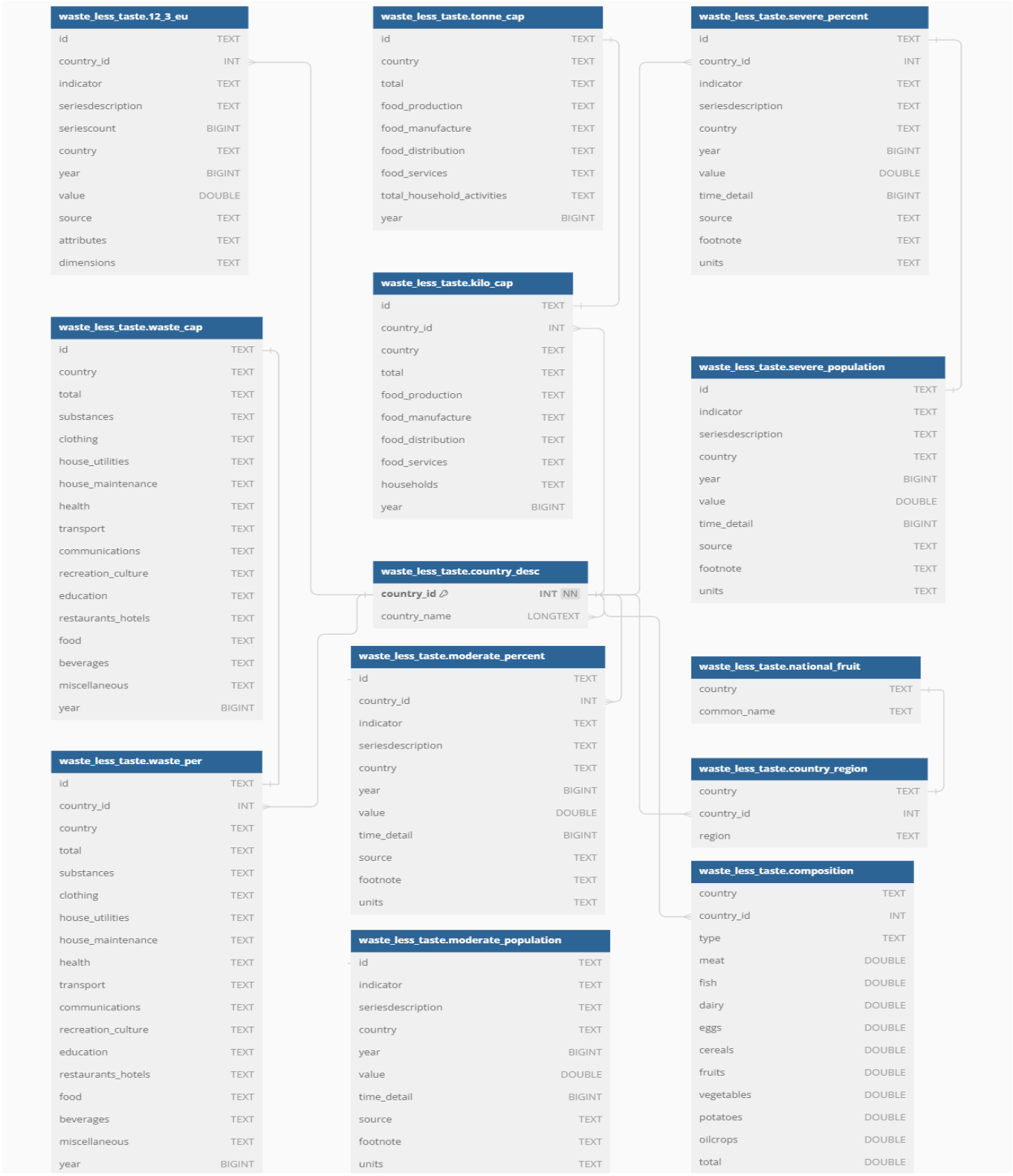




Name	Engine	Version	Row Format	Rows	Avg Row Length
12_3_eu	InnoDB	10	Dynamic	927	265
composition	InnoDB	10	Dynamic	6	2730
country_desc	InnoDB	10	Dynamic	76	215
country_region	InnoDB	10	Dynamic	49	334
kilo_cap	InnoDB	10	Dynamic	54	303
moderate_percent	InnoDB	10	Dynamic	75	655
moderate_population	InnoDB	10	Dynamic	75	655
national_fruit	InnoDB	10	Dynamic	22	744
severe_percent	InnoDB	10	Dynamic	75	655
severe_population	InnoDB	10	Dynamic	75	655
tonne_cap	InnoDB	10	Dynamic	54	303
top_wasted	InnoDB	10	Dynamic	20	819
waste_cap	InnoDB	10	Dynamic	72	227
waste_per	InnoDB	10	Dynamic	76	215

These databases serve as valuable repositories for analyzing and understanding trends related to food waste, offering insights that can inform policy-making and research endeavors. In addition to the original CSV files, a table named country_desc was created to link all the tables using the country_id, and country_region was included to identify countries within specific regions for further analysis.

Entities ERD



SQL Query

```sql
-- Query 1 |Top 10 countries with the highest average foodwaste in tonnes --
SELECT
country, seriesdescription AS target_name,
ROUND(AVG(value), 0) AS average_value
FROM 12_3_eu
GROUP BY country_id, country, seriesdescription
ORDER BY AVG(value) DESC
LIMIT 10;
```

country	target_name	average_value
Turkey	Food waste (Tonnes)	6315670
Germany	Food waste (Tonnes)	4447899
Italy	Food waste (Tonnes)	3449377
France	Food waste (Tonnes)	3262447
Spain	Food waste (Tonnes)	1803699
Poland	Food waste (Tonnes)	1512827
Romania	Food waste (Tonnes)	962189
Portugal	Food waste (Tonnes)	787754
Greece	Food waste (Tonnes)	732924
Switzerland	Food waste (Tonnes)	633276

```sql
-- Query 2 | Top 5 countries with highest aveage percentage and kilo per capita of
food insecurity  --
SELECT
    per.country, per.year,per.seriesdescription AS target_name,
    ROUND(SUM(per.value) / 3,2) AS average_percentage_value,
    ROUND(SUM(cap.value) / 3,2) AS average_capita_value
FROM
    moderate_percent AS per
INNER JOIN
    moderate_population AS cap ON per.id = cap.id
GROUP BY
    per.country_id, per.country, per.year, per.seriesdescription
LIMIT 5;
```

country	year	target_name	average_percentage_value	average_capita_value
Switzerland	2015	Prevalence of moderate or severe food insecurity in the adult population (%)	12.9	1078.9
Germany	2015	Prevalence of moderate or severe food insecurity in the adult population (%)	11.1	9053.7
Portugal	2015	Prevalence of moderate or severe food insecurity in the adult population (%)	43.8	4545
Ireland	2015	Prevalence of moderate or severe food insecurity in the adult population (%)	29.4	1385.6
Slovakia	2015	Prevalence of moderate or severe food insecurity in the adult population (%)	18.6	1005.9

```sql
-- Query 3 | First the county with highest total food waste in tonnes --
SELECT
    year,
    country,SUM(food_production) AS food_production,SUM(food_manufacture) AS food_manufacture,
    SUM(food_distribution) AS food_distribution,
    SUM(food_services) AS food_services,
    SUM(total_household_activities) AS food_household,
    SUM(total) AS total
FROM
    tonne_cap
GROUP BY
    year, country
ORDER BY total DESC
LIMIT 1;
```

year	country	food_production	food_manufacture	food_distribution	food_services	food_household	total
2020	Germany	190203	1612505	762352	1860980	6496282	10922321

```sql
-- Query 4 What is the most common national fruit in Europe and from which countries --
SELECT country,
    common_name
FROM
    national_fruit
WHERE
    common_name = (
        SELECT
        common_name as national_fruit
        FROM
            national_fruit
        GROUP BY
            common_name
        ORDER BY
            COUNT(*) DESC
        LIMIT 1);
```

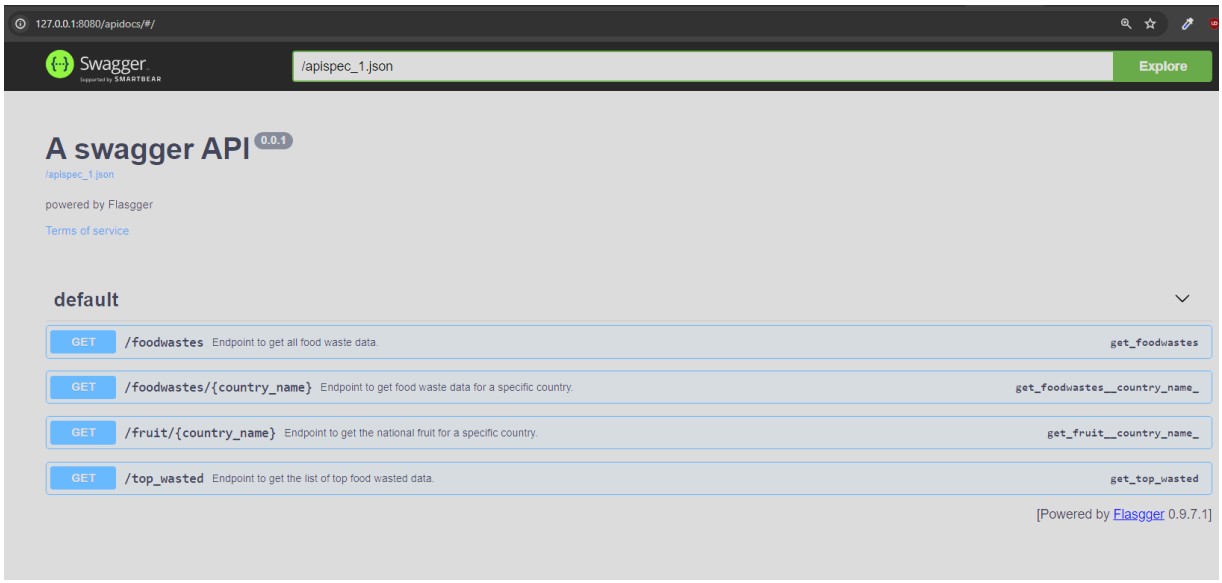
country	national_fruit
Austria	Apple
Belgium	Apple
Bulgaria	Apple
Germany	Apple
Netherlands	Apple
Poland	Apple
Portugal	Apple
Romania	Apple
Sweden	Apple
Switzerland	Apple
United Kingdom	Apple

```sql
-- Query 5 Filtering only France from 4 United Nation tables--
SELECT id, indicator, seriesdescription, country, year, value, time_detail, source,footnote, units
FROM moderate_percent
WHERE country = 'France'
UNION ALL
SELECT
   *
FROM moderate_population
WHERE country = 'France'
UNION ALL
SELECT id, indicator, seriesdescription, country, year, value, time_detail, source, footnote, units
FROM severe_percent
WHERE country = 'France'
UNION ALL
SELECT *
FROM severe_population
WHERE country = 'France';
```

id	indicator	seriesdescription	country	year	value	time_detail
france2015	2.1.2	Prevalence of moderate or severe food insecurity in the adult population (%)	France	2015	5.7	2015
france2015	2.1.2	Prevalence of moderate or severe food insecurity in the adult population (%)	France	2015	8.1	2015
france2015	2.1.2	Prevalence of moderate or severe food insecurity in the adult population (%)	France	2015	6.9	2015
france2015	2.1.2	Adult population in moderate or severe food insecurity (thousands of people)	France	2015	5265.3	2015
france2015	2.1.2	Adult population in moderate or severe food insecurity (thousands of people)	France	2015	3673.1	2015
france2015	2.1.2	Adult population in moderate or severe food insecurity (thousands of people)	France	2015	4469.2	2015
france2015	2.1.2	Prevalence of severe food insecurity in the adult population (%)	France	2015	1.4	2015
france2015	2.1.2	Prevalence of severe food insecurity in the adult population (%)	France	2015	2.1	2015
france2015	2.1.2	Prevalence of severe food insecurity in the adult population (%)	France	2015	0.7	2015
france2015	2.1.2	Adult population in severe food insecurity (thousands of people)	France	2015	505.8	2015
france2015	2.1.2	Adult population in severe food insecurity (thousands of people)	France	2015	1358	2015
france2015	2.1.2	Adult population in severe food insecurity (thousands of people)	France	2015	931.9	2015

API

I created APIs with Swagger documentation to expose the collected data. Using Flask and Flasgger, I set up endpoints to access food waste information. The **/foodwastes** endpoint provided all food waste data, while **/foodwastes/<country_name>** allowed retrieval of data specific to a country. Additionally, I implemented an endpoint **/fruit/<country_name>** to retrieve the national fruit for a given country. My **top_wasted** endpoint returned a list of the top food wasted data. With this setup, users could easily access and interact with my food waste database, enabling informed decision-making and analysis.



Machine Learning

Recognizing Fruits and Vegetables: Leveraging advanced machine learning algorithms, the project aims to develop a sophisticated system capable of accurately recognizing and categorizing various types of fruits and vegetables commonly found in European households. By analyzing images and patterns, the system will efficiently identify produce items, enabling users to streamline their ingredient identification process while reducing the risk of misclassification or wastage.

Personalized Recipe Suggestions: An intuitive mobile application will be developed, allowing users to scan the fruits and vegetables available in their kitchen. Based on the scanned ingredients and user preferences stored in the app, the system will generate personalized recipe suggestions tailored to individual dietary requirements, cooking skill levels, and cultural backgrounds. These tailored recommendations not only promote sustainable cooking practices by encouraging the use of available ingredients but also enhance user engagement and satisfaction by offering relevant and appealing meal ideas.

Conclusion

"Waste Less, Taste More" is a comprehensive initiative addressing food waste, particularly focusing on household wastage within Europe, in line with UN sustainability objectives. Leveraging data from sources like Eurostat and Kaggle, the project meticulously analyzes food waste patterns, employing visualization techniques and API integration to make insights accessible. Through machine learning applications like image recognition for identifying national fruits and recipe generation, the project aims to catalyze sustainable consumption practices and reduce food waste, contributing to a more efficient and resilient food system.

The project's multifaceted approach encompasses data collection, cleaning, and analysis to uncover key insights into food waste trends across Europe. By providing stakeholders with actionable information and innovative solutions, including API access and machine learning-based interventions, "Waste Less, Taste More" seeks to empower individuals and organizations to make informed decisions and drive meaningful change towards a sustainable future.

GDPR

In compliance with GDPR regulations, "Waste Less, Taste More" ensures the protection of personal data throughout the project lifecycle. Any personal information collected, such as user data for API access or data used for machine learning training, is handled with the utmost confidentiality and security measures. Users are informed about the purpose of data collection, their rights regarding their data, and how their data will be used and stored. Additionally, robust data encryption and access controls are implemented to prevent unauthorized access or disclosure. Regular audits and reviews are conducted to ensure ongoing compliance with GDPR requirements and to address any potential data security risks effectively.

References

Trello: :
https://trello.com/invite/b/iBCQVz5W/ATTI38c64c788a6940d2be0bf86912bac023FCC875AC/foodwaste project

Flat file:
https://ec.europa.eu/eurostat/databrowser/view/env_wasfw/default/table?lang=en
https://www.kaggle.com/datasets/kritikseth/fruit-and-vegetable-image-recognition
https://champions123.org/target-123

API
https://unstats.un.org/sdgapi/swagger/#/

Web Scraping
https://swnsdigital.com/uk/2023/02/these-are-the-top-20-unwanted-fruit-and-vegetables-from-bagged-salad-leaves-to-bananas/
https://en.wikipedia.org/wiki/List_of_national_fruits
https://www.sciencedirect.com/science/article/pii/S0921344921000331?ref=pdf_download&fr=RR-2&rr=878c54440e916f0c

GitHub Repository (in progress)
https://github.com/krantagat/food_waste_project