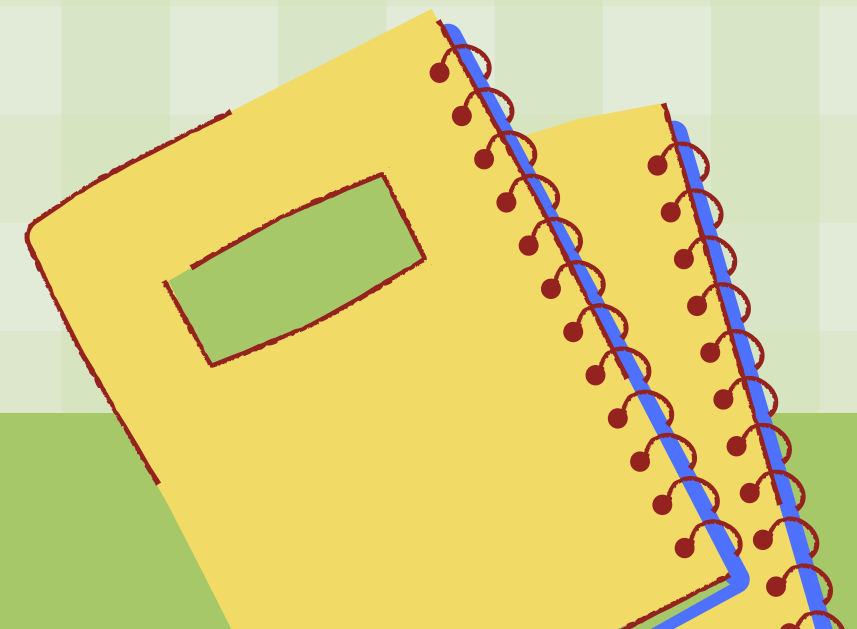


AI-POWERED PERSONALIZED MEAL PLANNER

DATA 606: CAPSTONE IN DATA SCIENCE

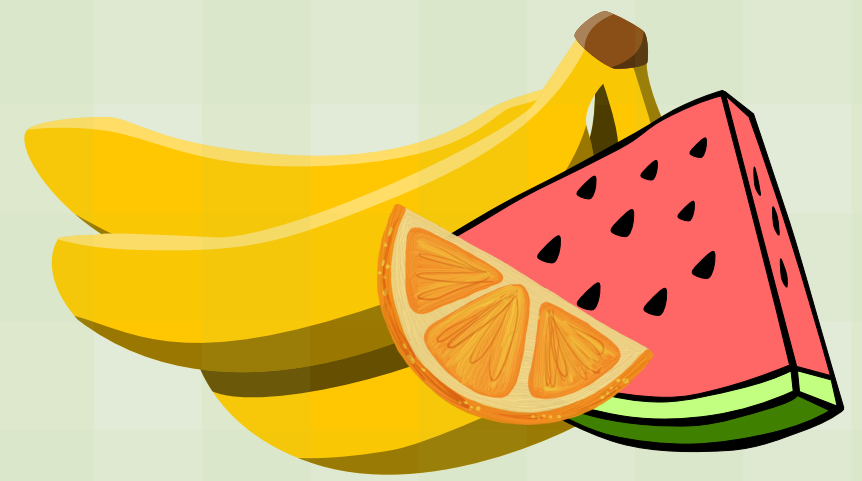
Presented by: Madhu Priya P
Under the Guidance of Dr. Chaojie Wang





INTRODUCTION

- The AI-Powered Meal Planner generates personalized daily meal plans based on calorie needs and nutritional goals.
- Uses unsupervised learning (clustering) to group foods into meaningful nutritional categories.
- Employs a OLLAMA to generate customized meal plans, recipes, and grocery lists.
- Outputs include recipe suggestions, grocery lists, and a macros donut chart for balanced nutrition.



RESEARCH QUESTIONS

- * How can clustering group foods by nutritional similarity?
- * Can an LLM generate meal plans aligned with macro goals?
- * How can we make it actionable for users?

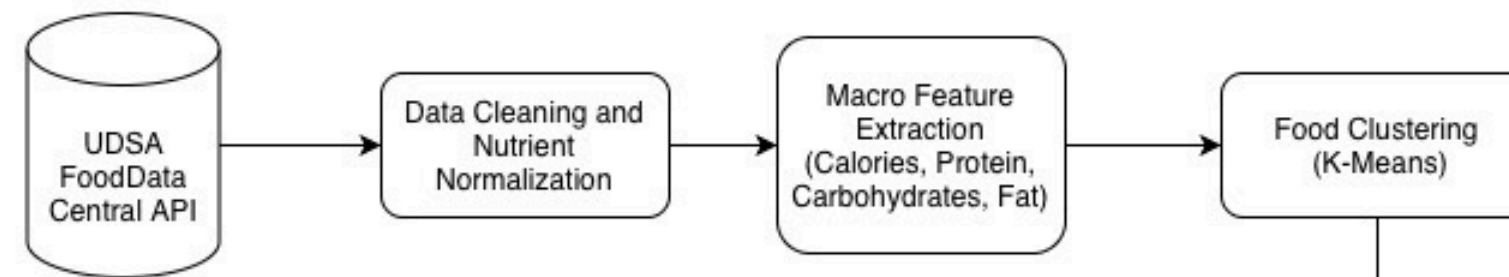




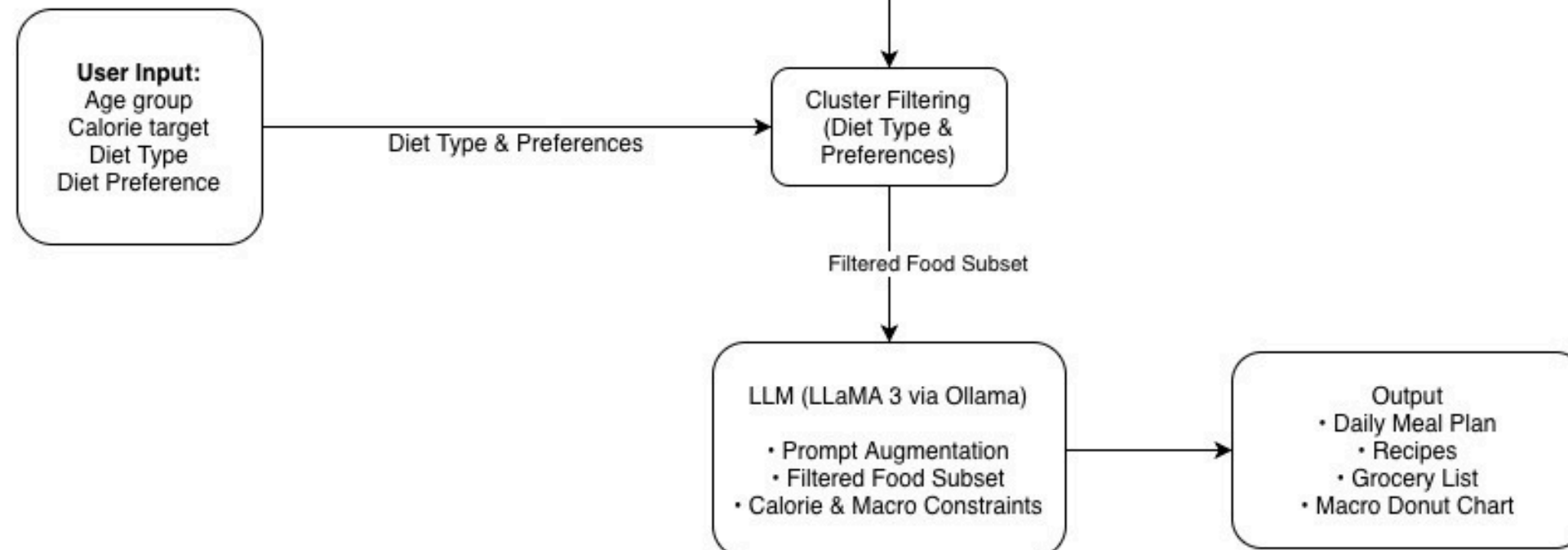
SYSTEM ARCHITECTURE OVERVIEW



Backend: Data Processing & Intelligence



Frontend: Streamlit Web Application



DATA OVERVIEW

- Primary Source: USDA FoodData Central API.
- ~20,000 items, reduced to 19,000 cleaned food records.
- Key Features: calories, protein_g, carbs_g, fat_g, fiber_g.
- Engineered ratios: calorie-to-protein, macro percentages.



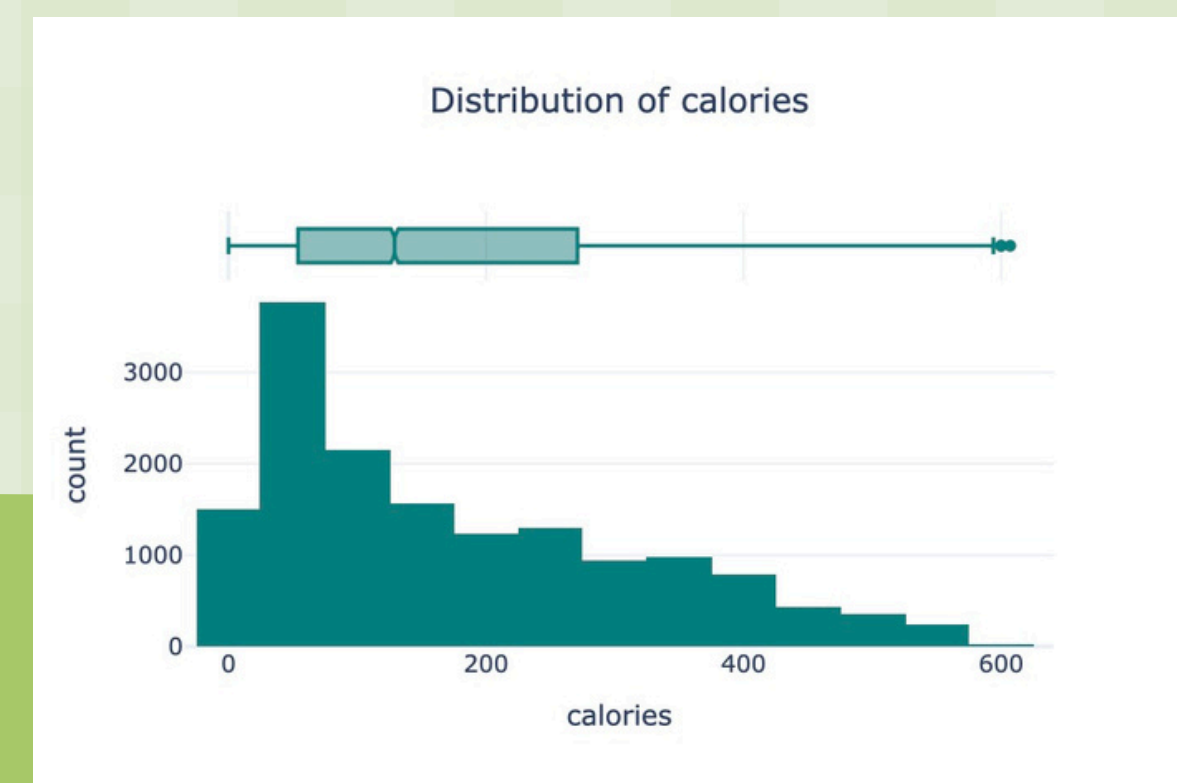
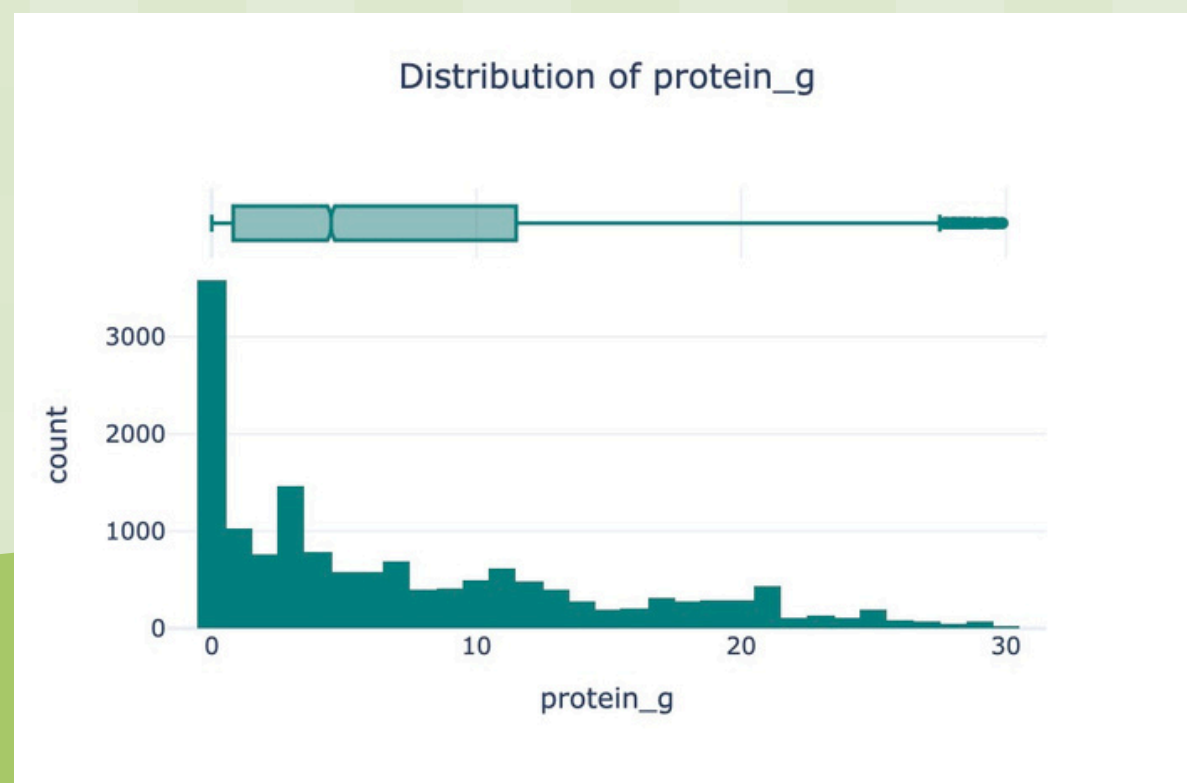
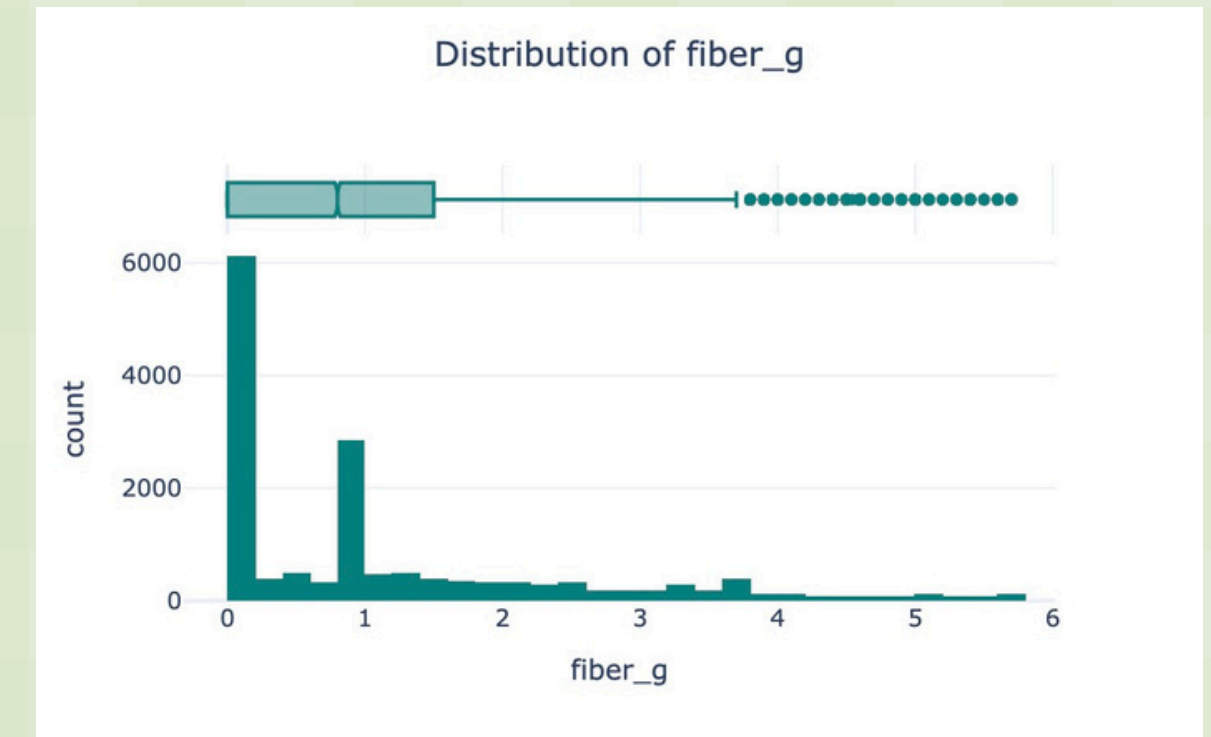
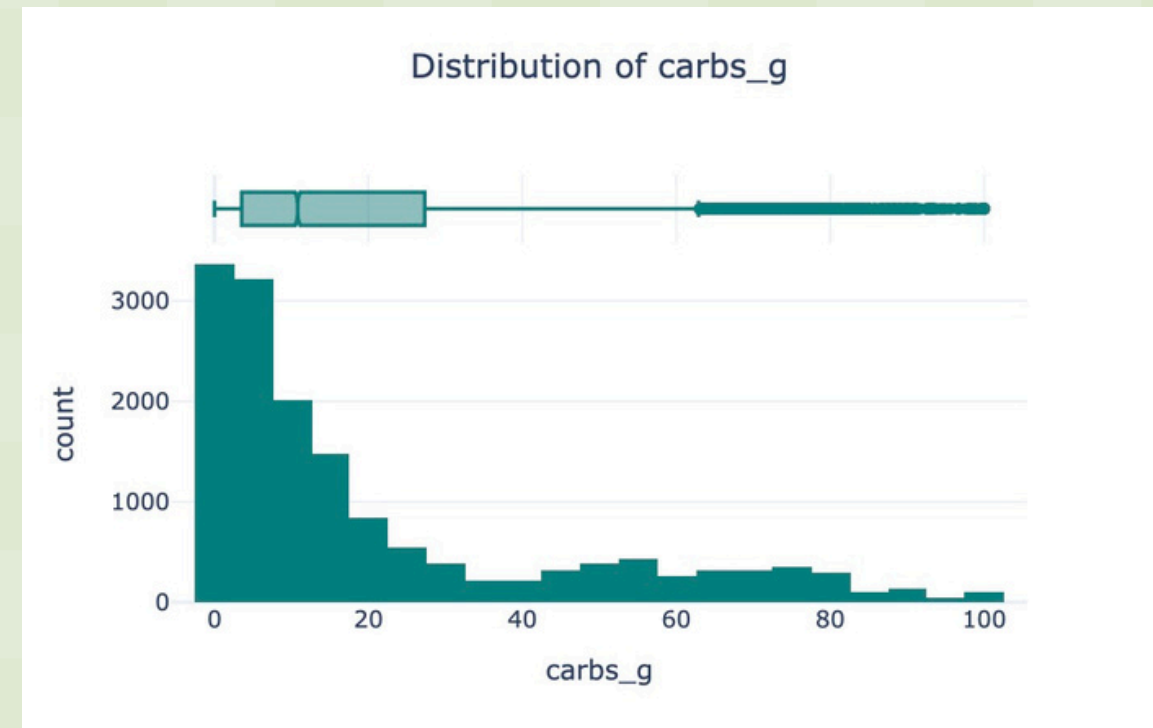
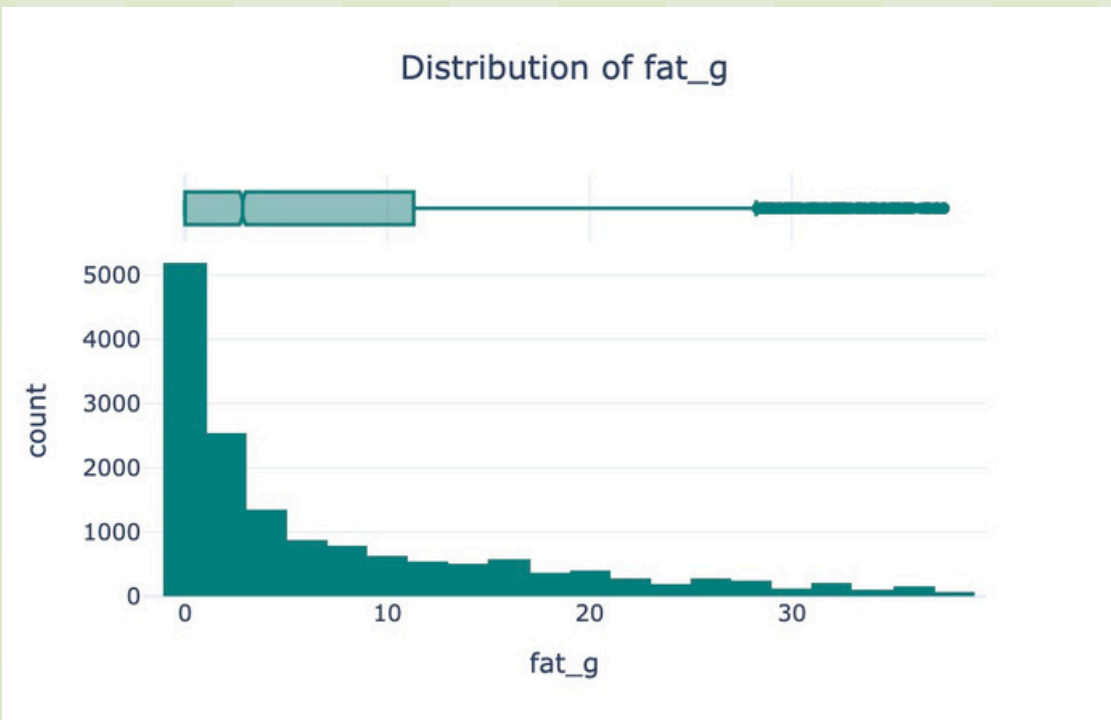
DATA CLEANING PIPELINE

- Dropped all-null columns (sugar_g)
- Median imputation for partial missing values
- Calorie recomputation formula: $\text{Calories} = 4 \times (\text{protein} + \text{carbs}) + 9 \times \text{fat}$
- Scaled using z-score normalization



EDA

All nutrient distributions are right-skewed, showing that most foods are low in calories, fat, carbs, protein, and fiber, with a few high-value outliers.

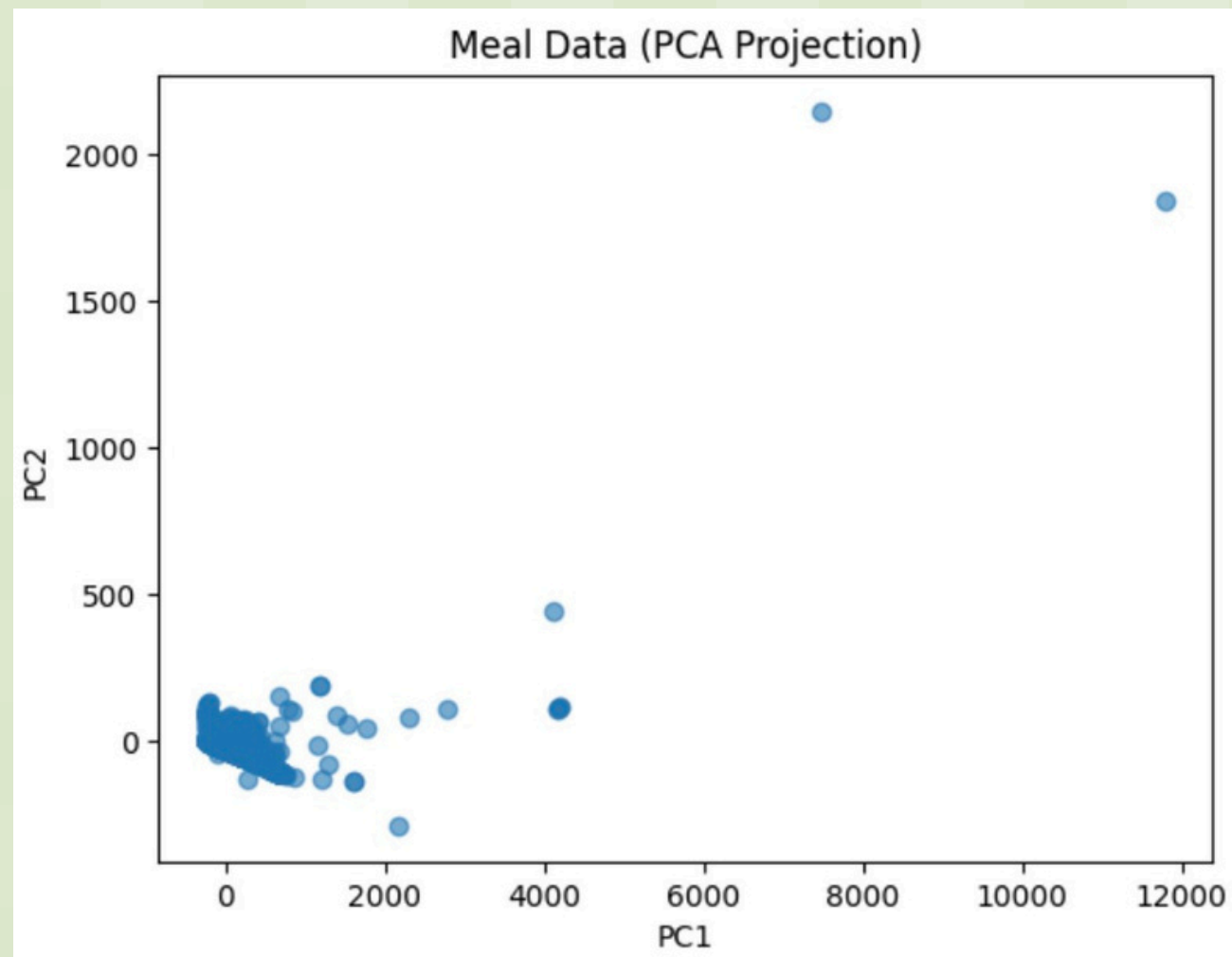


PCA ANALYSIS

Before Cleaning:

Outliers distorted variance (one extreme point).

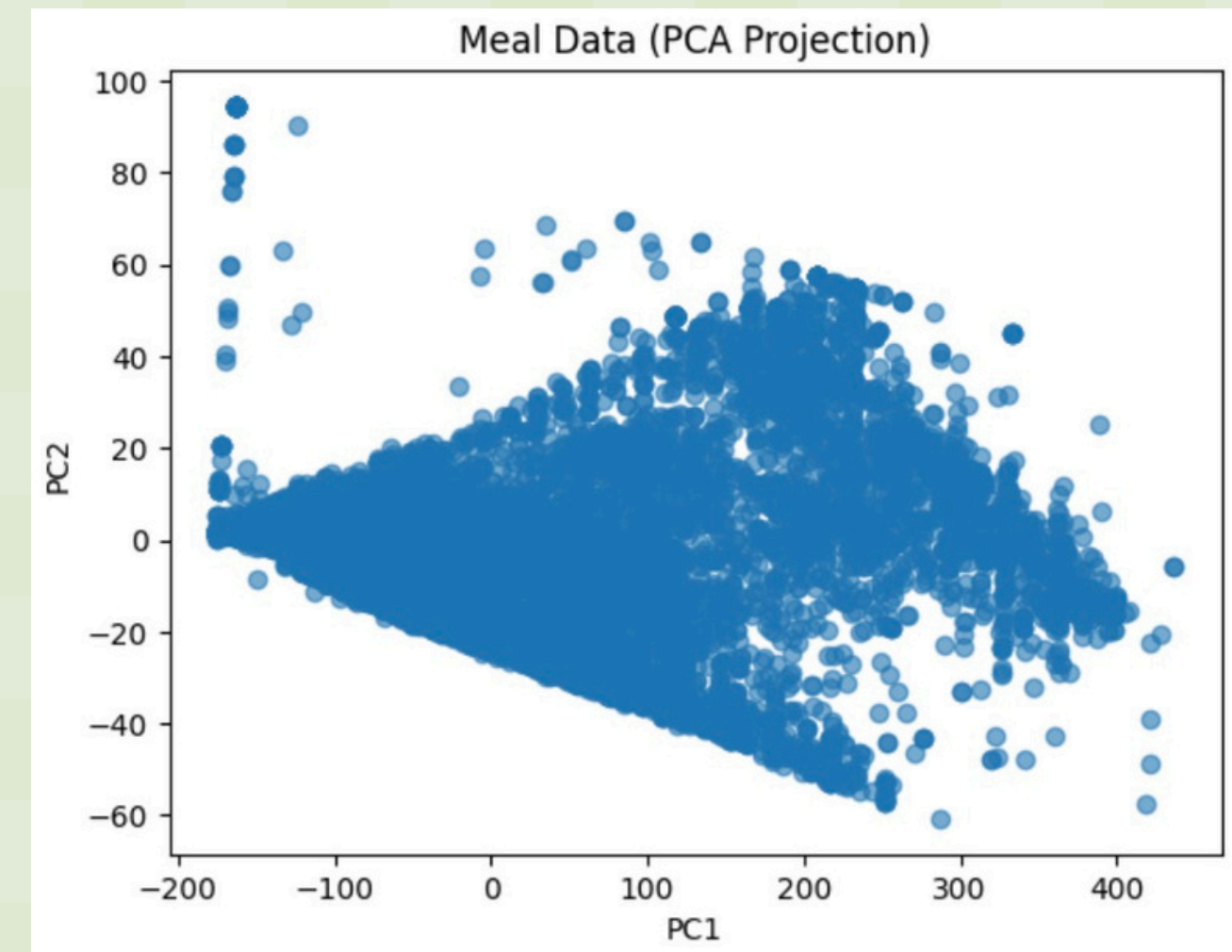
Data heavily skewed by high-calorie foods.



After Cleaning:

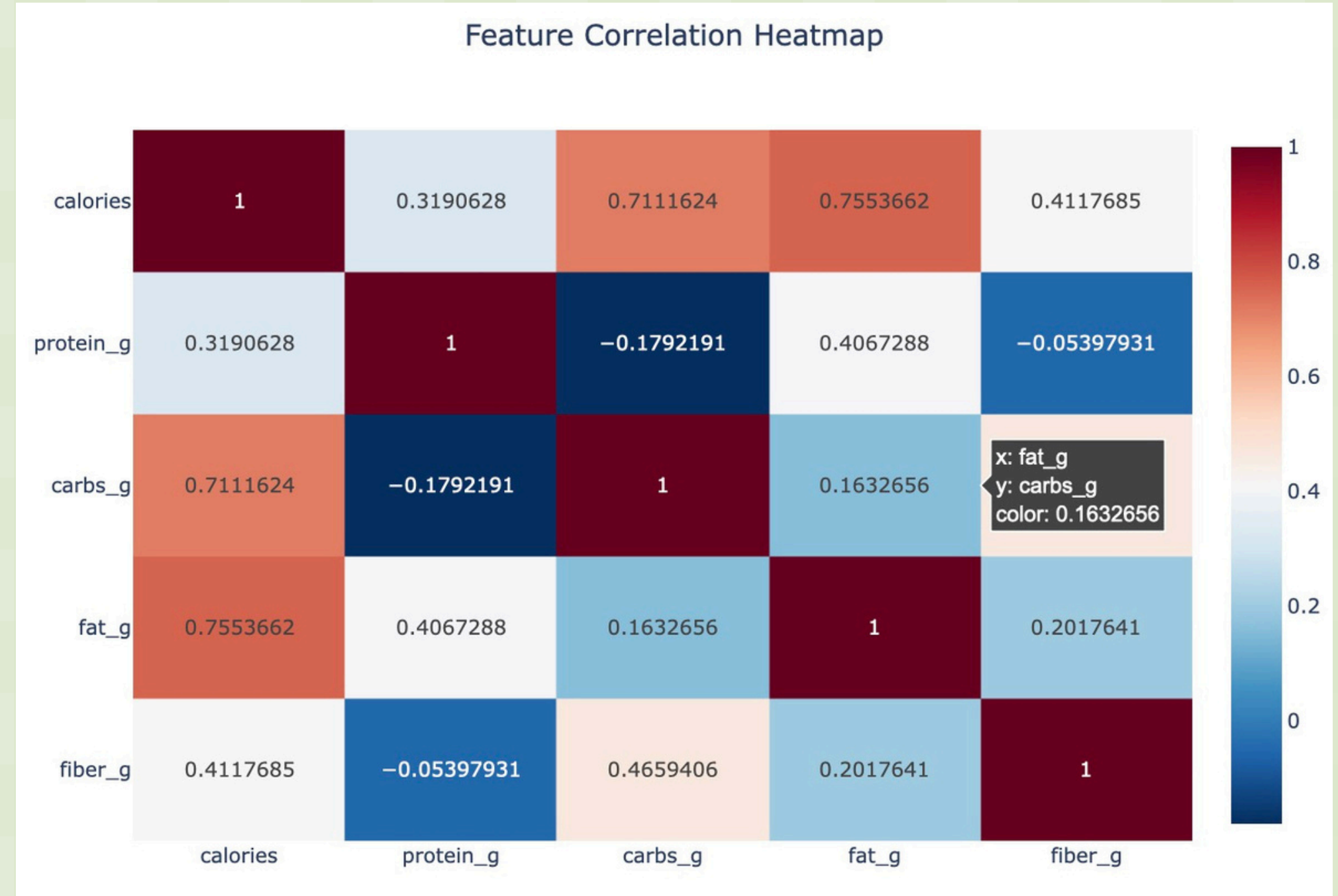
Compact, balanced distribution.

Nutrient patterns clearly visible for clustering.



CORRELATION HEATMAP

Calories show strong positive correlations with fat ($r \approx 0.76$) and carbs ($r \approx 0.71$), indicating these nutrients are the main contributors to energy content.



MODELING APPROACH & CLUSTER INSIGHTS

Evaluated model quality using:

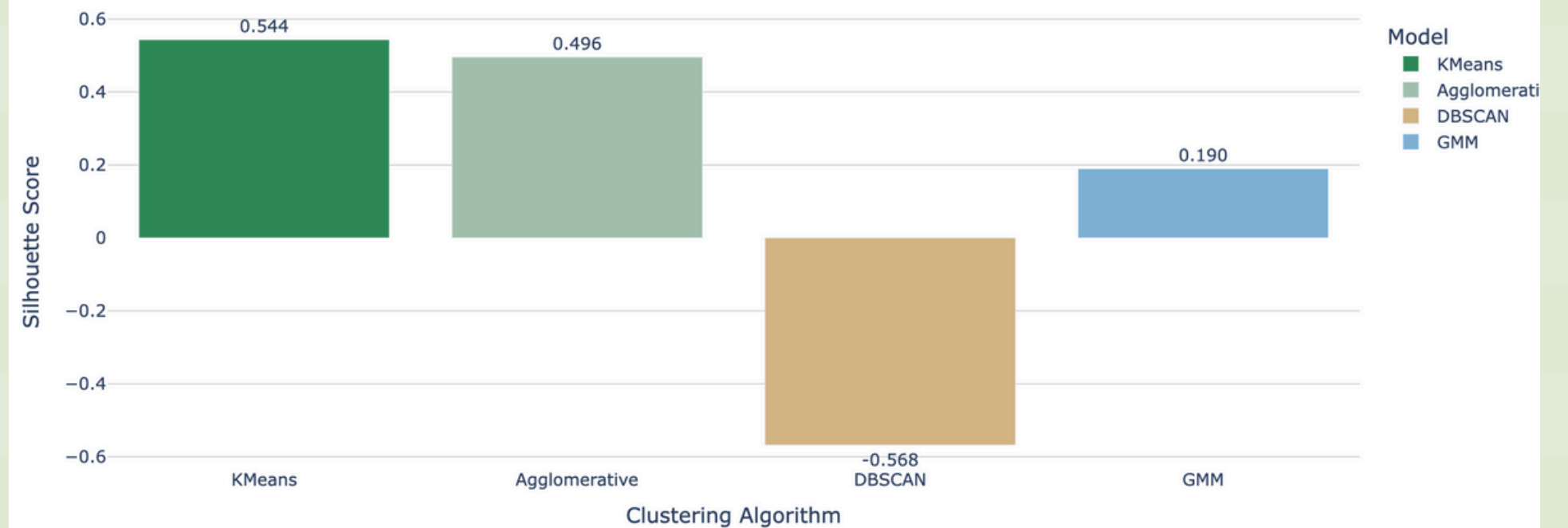
- Silhouette Score
- Elbow Method

Final choice: K-Means with $k = 4$ clusters

KMeans vs Agglomerative Clustering (Silhouette Analysis)



Silhouette Score Comparison Across Clustering Models



FINAL CLUSTERS

Cluster names were assigned based on the mean nutrient values within each cluster, reflecting their dominant nutritional characteristics.

Cluster	Calories	Protein (g)	Carbs (g)	Fat (g)	Fiber (g)	Category Label
0	479.47	7.19	59.23	23.51	2.56	Carb-Dense Balanced Meals — Ideal for Weight Gain
1	55.02	4.07	7.39	1.23	0.62	Low-Calorie Light Foods — Ideal for Weight Loss
2	332.71	9.56	45.49	12.49	1.46	Protein-Rich Balanced Meals — Ideal for Maintenance
3	188.33	11.34	15.15	9.03	1.05	High-Protein Energy Meals — Ideal for Maintenance or Muscle Gain

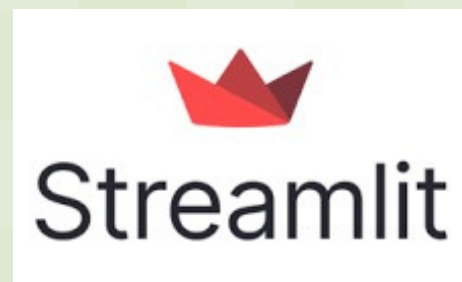
INTEGRATION WITH LLM

- Used structured prompt containing cluster stats + calorie targets + age group + use preference.
- LLM generated:
 - 3 meals per day.
 - Recipe descriptions, Grocery list.
 - Macro details.
- Ensures contextual consistency with nutrition data.



TECH STACK

Frontend



Machine Learning & LLM



LLaMA 3 via Ollama

Data Source

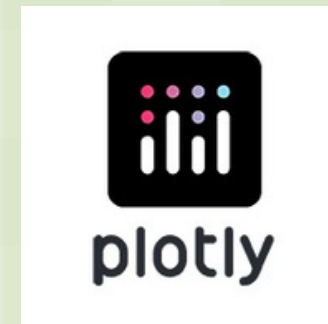


FoodData Central API

Core Application & Orchestration



Visualization



STREAMLIT WEB APP

- Built interactive dashboard for user-friendly planning.
- Generates visual macros with Plotly.

Meal Plan Settings

Select your age group:

26-35

Select your daily calorie goal (kcal):

1200

1800

2500

Diet Type

High-Protein Energy Meals — Ideal for Maintenance or Muscle...

Diet Preference

Pescatarian

AI Meal Planner Assistant

Meal Plan & MacrosRecipesGrocery List

Generate Meal Plan

Generating meal plan for: High-Protein Energy Meals — Ideal for Maintenance or Muscle Gain (Target: 1800 kcal)

AI-Generated Meal Plan

Here is a detailed 1-day meal plan for a 26-35 year old who follows a Pescatarian diet and has a daily calorie goal of 1800 kcal:

Breakfast

Meal Name	Ingredients	Description	Calories (kcal)	Protein (g)	Carbs (g)	Fat (g)
Tuna Scramble	1/2 cup cooked tuna, 1 egg, 1/4 cup spinach, 1 tablespoon olive oil, salt and pepper to taste	Scrambled eggs with tuna, spinach, and a hint of Mediterranean flavor	340	30.5	6.5	20

Lunch

APPLICATIONS

- Personal & fitness nutrition apps
- Healthcare diet planning
- Wellness and lifestyle platforms

LIMITATIONS

- Limited to USDA foods
- Macros only, no micronutrients
- LLM portion estimates may vary

LESSONS LEARNED

- Cleaning & scaling = better clustering
- ML + LLMs → human-like nutrition insights

FUTURE WORK

- Add global food data
- Streamlit cloud deployment
- User feedback & mobile app
- Fine-tune LLM for nutrition



THANK YOU