PersonaPlate: Contextual Language Modeling for Individualised Diets

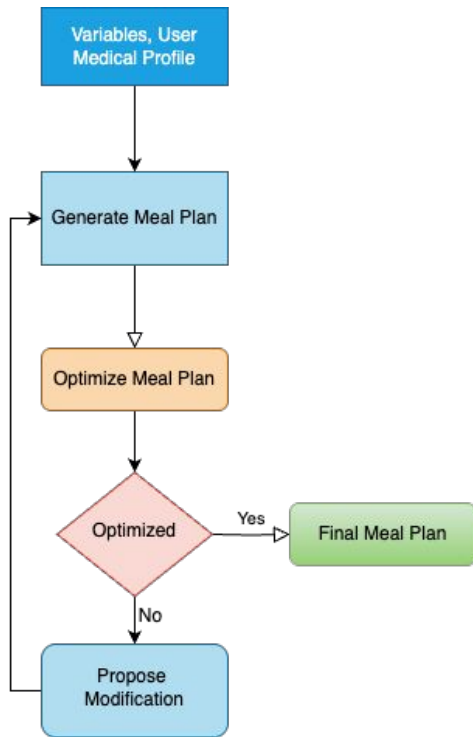Mansi Nanavati, Shweta Pardeshi, Ajjkumar Patel

Problem Statement

- ❖ **Gap in personalized nutrition care**
- ❖ **Missing link between diet and future health metrics**
- ❖ **Limited personalization at scale**

Methodology

Three different techniques

- ❖ Multi-Agent Collaboration
- ❖ RAG based search and generation
- ❖ QLoRA fine-tuned LLM

Multi-Agent Collaboration

- **Nutrition Agent:** Compute nutritional requirements based on an initial user report, which includes health goals, dietary preferences, and restrictions.
- **Planner Agent:** Generate a meal plan consisting of recipes or meals for 1 day.
- **Optimizer Agent:** Refine and fine-tune meal plan portions and ingredient to minimize deviations from nutritional target.
- **Feedback Agent:** Evaluate the plan's quality against user medical profile and provide feedback for further improvement.

Results: Multi-Agent Collaboration

Daily *Sodium* intake comparison for medical patient with hypertension:

- Model: Llama-3.1-8B-Instruct
- Normal Output:
  - 32% greater than hypertension baseline.
  - 6% greater than adult baseline.
  - High Variance: Ranges from 450 - 2550
- Multi-Agent Collab Output:
  - Avg sodium intake level - 1439 (<5% hypertension baseline)
  - Reduce number of "No output"
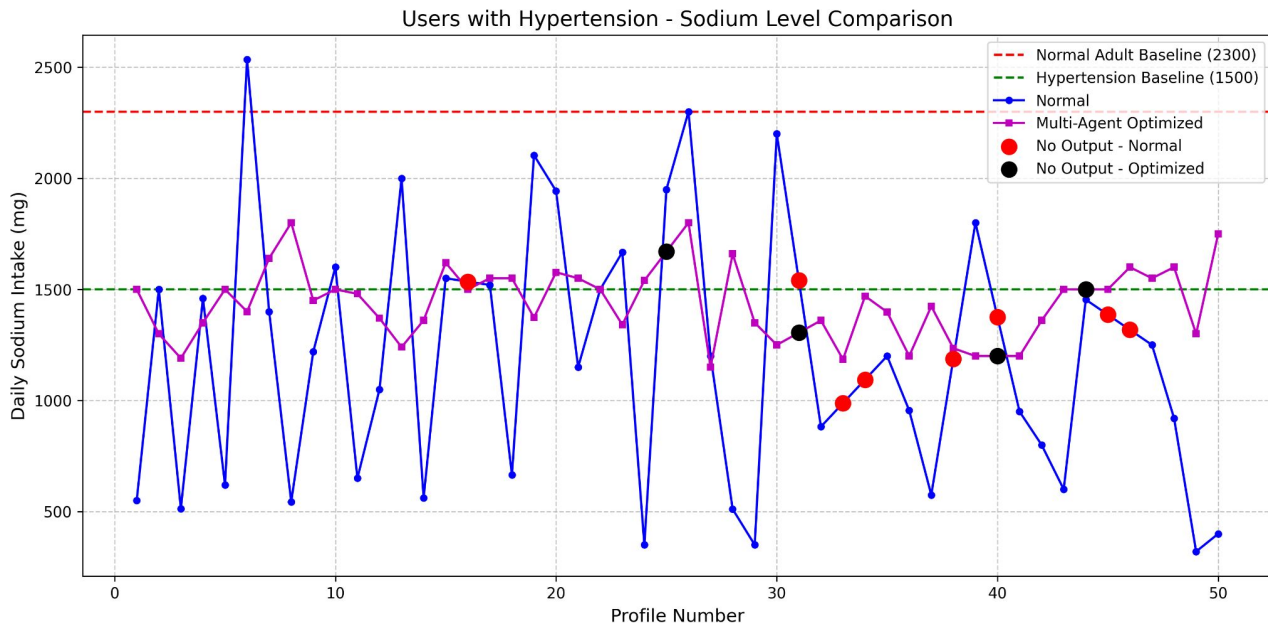
Study Scope: 50 user profile with different hypertension stages

RAG Based search and generation
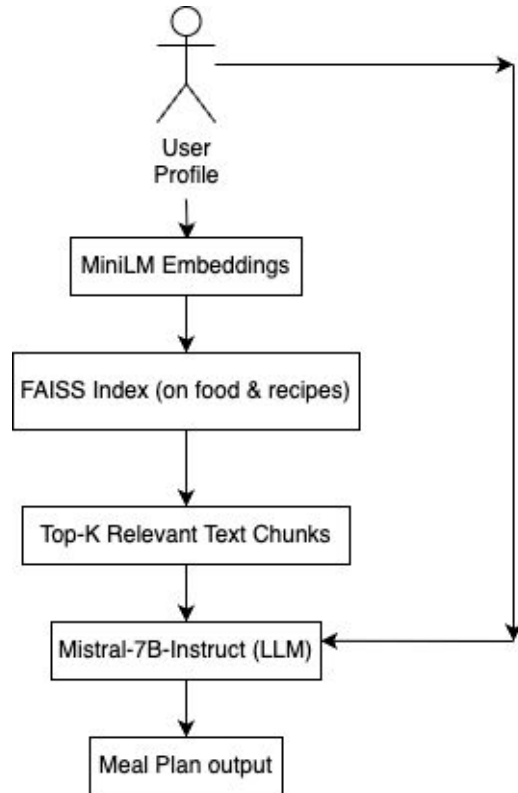
- Combined **SuperTracker** and **recipe** datasets by converting all records into plain-text sentences.
- Embedded all entries using the **all-MiniLM-L6-v2** model and index them using **FAISS** for fast semantic retrieval.
- At runtime, embedded the structured user profile (e.g., diagnosis, labs, BMI) and retrieved the Top-K most similar entries using **cosine similarity**.
- Fed the concatenated profile and retrieved data into a **Mistral-7B-Instruct model** to generate a complete meal plan.

Results - RAG Method

- RAG responses often missed expected structure (e.g., skipped meals, repeated context), making plans hard to parse.

- Nutrient estimation became unreliable without cleanup. Prompt refinement and post-processing improved usable output to ~80% of cases.

Sodium Intake per User Profile – Normal vs RAG-Based Plan
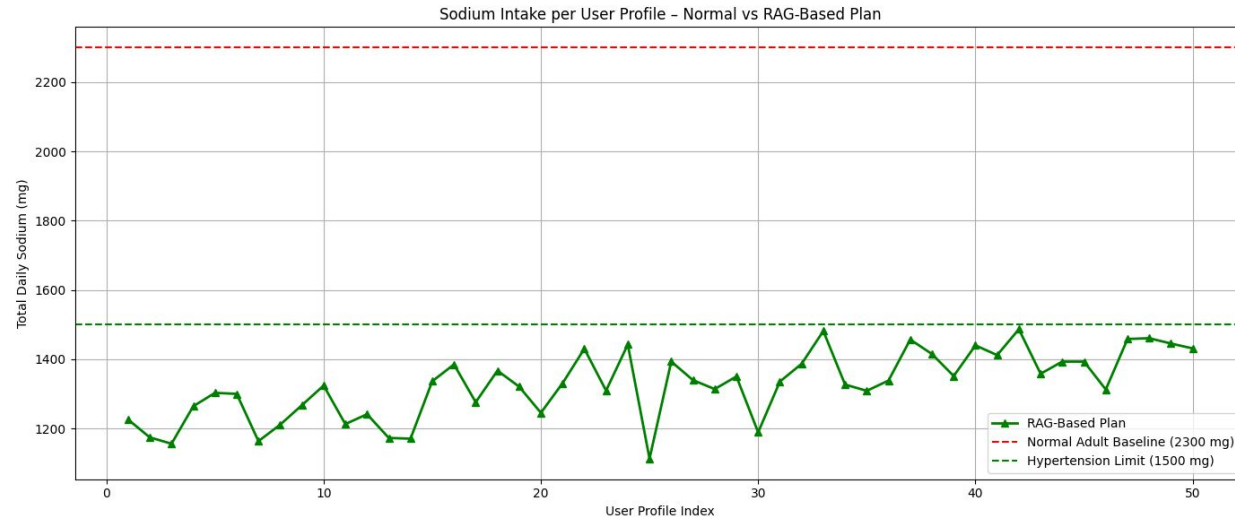
QLoRA fine-tuned LLM

- Motivated by Datahub constraints (1 GPU, 16GB RAM)
- Fine-tuned on Nutribench dataset
- Models considered: Llama-3.2-1B, SmolLM2-360M, gpt-neo-1.3B
- Fine-tuning done with **QLoRA** using SFTTrainer
- **Llama-3.2-1B** performed best
- Pros:
    a. Model size: 1.2B parameters
    b. Quick fine-tuning (1.5 hour/epoch)
    c. Low memory footprint
- Cons:
    a. Meal plan generation was subpar
    b. User profile had to be simplified
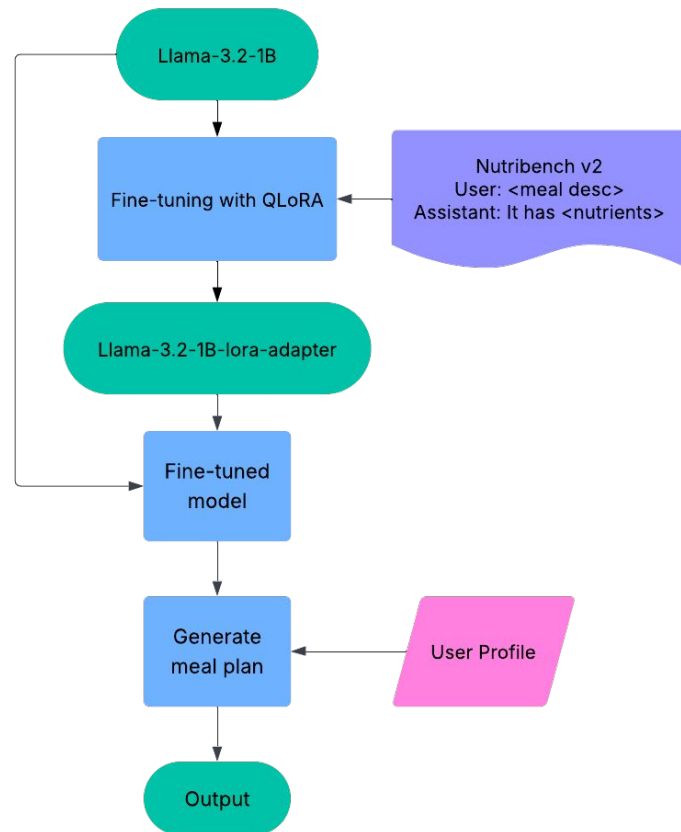
Results

Plan Type	Fib. (g)	Sod. (mg)	Pot. (mg)	Cal. (mg)	Vit. D (IU)	O-3 (mg)	Sat. Fat (% kcal)	Sug. (g)
Normal	25	1500	3800	1000	600	250	10	20
Multi-Agent	35	800	4500	1100	700	350	10	15
RAG-Based	22	600	3700	900	500	300	6	10
QLoRA-finetuned	4.52	4140	N/A	0.05	N/A	N/A	N/A	0.0
Diff (RAG vs Normal)	**-12%**	**-60%**	**-2.63%**	**-10%**	**-16.67%**	**+20%**	**-40%**	**-50%**
Diff (Multi-Agent vs Normal)	**+40%**	**-46.67%**	**+18.42%**	**+10%**	**+16.67%**	**+40%**	**0%**	**0%**
Diff (QLoRA-finetuned vs Normal)	**-81.92%**	**+176%**	**N/A**	**-99.995%**	**N/A**	**N/A**	**N/A**	**-100%**

Table 2: Total Daily Nutrient Breakdown: Normal vs Multi-Agent vs RAG-based vs QLoRA-finetuned LLM Meal Plans.

In comparison, Multi-agent method performs better while QLoRA fine-tuned model has irregular numbers

Results

Meal	Meal Name	Plan Type	Cal.	Fat (g)	Carbs (g)	Prot. (g)
Breakfast	Oatmeal with Banana, Almond, and Honey	Normal	400	7	60	10
	Whole-grain Oatmeal+Almond Butter, Banana, Walnuts	Multi-Agent	650	11	95	18
	Oatmeal with Cooked Heart, Palm Hearts, Mint	RAG-Based	379	4.9	35	31.9
	Breaded Chicken with Banana	QLoRA-finetuned	573	19	50.5	24.2
Lunch	Grilled Chicken and Vegetable Wrap	Normal	500	22	110	40
	Grilled Vegetable and Avocado Wrap	Multi-Agent	880	20	60	25
	Grilled Chicken with Greens and Vinaigrette	RAG-Based	340	3.5	20	30
	Steamed Rice with Sweet Potato and Mixed Sausages	QLoRA-finetuned	201	29.75	33.33	6.3
Dinner	Lentil and Vegetable Curry	Normal	550	12	70	20
	Quinoa+Black Bean Bowl with Roasted Vegetables	Multi-Agent	655	10	90	22
	Grilled Salmon with Quinoa and Broccoli	RAG-Based	330	10	20	24
	Chicken, Ground Beef, and Cooked Potatoes Dinner	QLoRA-finetuned	700	41.24	29.32	51.94
Snacks	Apple Slices with Almond Butter, Pear	Normal	210	18	35	4
	Apple Slices with Almond Butter, Pear, Walnuts	Multi-Agent	390	20	39	8
	Almonds + Energy Drink, Apple + Yogurt	RAG-Based	328	16.5	30	16.42
	Cooked White Rice Snack with Sugar	QLoRA-finetuned	220	1.07	47.29	4.94
Total Daily		Normal	2500	59	275	74
		Multi-Agent	2575	61	284	73
		RAG-Based	1377	34.9	105	102.32
		QLoRA-finetuned	1694	91.06	160.44	87.38

Table 1: Meal plan comparison across Normal, Multi-Agent, and RAG-based generation for a user with hypertension.