COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Affiliated to Anna University, Chennai)

COIMBATORE – 641014, TAMIL NADU, INDIA

19MAME12 – CONVERSATIONAL AI

DOCUMENTATION

CONVERSATIONAL AI IN FOOD TECHNOLOGY

<u>TEAM NAME: 3 PEOPLE SQUAD</u>

Team Members

71762134004 – AISHVARYA S

71762134022 – KAUSIKA P

71762134055 – THANUSHRI S

INDEX

ABSTRACT

With the backdrop of a rising age of health issues, environmental concerns, and increasingly complex food habits, the demand for smart systems that can facilitate nutrition-informed choices is growing. This article introduces NutriBot+, a culturally-sensitive, context-aware, and sustainability-oriented conversational agent that offers personalized healthy food choices. Building on recent developments in domain-specific artificial intelligence and conversational systems for food and health domains, NutriBot+ combines natural language processing, user context modeling, and small language models trained on nutrition ontologies to offer accurate, inclusive, and real-time meal planning assistance.

Taking cues from the Foodie Fooderson intelligent kitchen robot, NutriBot+ adds to its features a goal-setting module based on personalized settings, emotional tone analysis, and real-time inventory-based recipe suggestions . It draws upon the spirit of nutrition intelligence, emphasizing responsible AI development, evidence-based guidance, and socio-cultural appropriateness of nutrition advice . The system also follows research in agricultural NLP studies by employing transformer model-based models such as AgriBERT for semantic matching of food descriptions and nutritional data . It also enhances the synergetic potential of AI in service systems even more by integrating such technologies as collaborative systems, speech processing, and nutrition databases into an integrated orchestration layer . Finally, through the tracking of users' behavior and food search history, NutriBot+ offers dynamic adaptation and decision support for different dietary needs, which has been demonstrated by recent chatbot deployments in Southeast Asia's health-conscious communities . In short, NutriBot+ is an innovative synergy of AI-powered conversation, domain expertise, and customized nutrition, opening up new frontiers in public health, smart food systems, and digital sustainability.

Keywords:

Conversational AI, Nutritional Intelligence, Personalized Diet, Smart Kitchen Assistant, Natural Language Processing (NLP), Food Recommendation System, Small Language Models (SLMs), Food Sustainability, Context-Aware Systems, Health Technology, Agricultural NLP, Ontology-Based Reasoning, AI in Food Systems

1. INTRODUCTION

Malnutrition is the primary cause of preventable health illnesses, which contribute to over 11 million deaths globally each year. Since societies are still grappling with chronic diseases, aging populations, cultural diversity, and environmental sustainability, technology-facilitated diet counseling has become more and more necessary. Despite the availability of nutrition information and online health solutions, health consumers are generally constrained by information overload, non-personalization, cultural incompatibility, and time poverty in incorporating healthier food habits.

Recent breakthroughs in Artificial Intelligence (AI) technology—i.e., conversational systems, machine learning, and natural language processing (NLP)—offer promising solutions to bridge this gap. Conversational agents are now natural language interfaces to computers, enabling users to speak to technology using their own natural language, offering real-time, context-sensitive interaction. Systems such as Foodie Fooderson already show that voice-controlled kitchen assistants recommending recipes based on taste, allergies, and stock levels function. Most current systems, however, are still bound by standalone AI approaches, lacking cultural or health personalization, and shallow embedding with true dietary behavior.

This paper introduces NutriBot+, a multilingual, intelligent chat interface providing personalized healthy food recommendations with an adaptive, context-aware interface. In contrast to traditional food chatbots, NutriBot+ uses the synergetic integration of a range of AI technologies including small language models (SLMs) for food and nutrition ontologies, emotional tone analysis, and user behavior tracking to

1.1 APPLICATION

- **Personalized Nutrition Counseling**
  Conversational agents increasingly provide personalized meal suggestions based on user profiles like age, health condition, diet goals (e.g., weight reduction, diabetes control), and restrictions (e.g., allergy, veganism)
  - Example: The Foodie Fooderson aide uses a user's individual context (e.g., preferences, allergies, fridge contents) to suggest best recipes using natural conversation interfaces.

- Impact: Increases adherence to dietary regimen, supports management of chronic diseases, and encourages healthy food habits.

- **Health Counseling & Behavior Change Support**

  Chatbots have been found to be effective in prompting users towards healthy food options through daily reminders, friendly suggestions, and context-based tips.

  - Example: Thailand's chatbot using Dialogflow and LINE Developer recommends healthy dishes and cooking methods according to ingredients that users input, and tracks search history for smarter future suggestions .
  - Use Case: Working professionals and older adults appreciate light, informal tools that don't require manual research or professional advice.

- **Nutritional Intelligence for Policy & Personalization**

  Nutritional intelligence refers to the integration of AI and nutrition and health knowledge to produce responsible, ethical, and personalized nutrition guidance.

  - Application: SLM power systems and ML models may scan food products for allergens, cultural suitability (for example, Halal, gluten-free), and nutritional value with ontology-based parsing and data linking .
  - Scalability: The models are being used in food retail platforms today for real-time labeling and meal recommendations globally.

- **Semantic Matching & Food Ontology Integration**

  Natural language processing techniques including semantic similarity, entity linking, and domain pretraining are making it easier to match the food and nutritional databases.

  - Example: AgriBERT enhances food product description mapping accuracy from retail (e.g., Nielsen scanner data) to USDA nutrition records via ontology-guided fine-tuning.

- Outcome: Offers more scalable and reliable recommendation systems, especially in multilingual or unstructured food environments.

- **Emotion-Aware & Context-Aware Interaction**
  Emotional intelligence and context sensitivity (e.g., time of day, user mood, urgency) are being integrated into conversational systems to make them more sympathetic and contextually sensitive.
  - Example: AI clusters such as emotion recognition, speech analysis, and tone recognition are recommended for synergy in service design
  - Use Case: The assistant can recommend comforting foods when stress is detected, or suggest low-prep foods in the event of limited time.

- **Multimodal and Collaborative Interfaces**
  Sophisticated conversation agents are bringing together speech, text, gesture recognition, and even vision (e.g., identifying food from an image) for profound interaction.
  - Collaboration: NutriBot+ will incorporate feedback loops with users through voice commands and smart fridge API to suggest recipes on the basis of what is already available.

- **Cultural and Dietary Inclusivity**
  Conversational systems are being programmed to be inclusive of a wide variety of eating habits, answering to users' religious, ethical, or cultural limitations.
  - Example: Thai and South Asian systems are being constructed with provisions for local cuisine, indigenous methods of cooking, and culturally derived food avoidance patterns.
  - Extension: Language localization and local ingredient mapping are central to adoption by different geographies.

- **Food Waste Reduction & Sustainability Insights** AI assistants can reduce waste by prioritizing the use of soon-to-expire items, suggesting lower-impact food alternatives, and educating users about sustainable diets.

- Example: NutriBot+ includes fridge inventory reasoning and environmentally friendly meal scoring to maximize ingredient effectiveness and encourage earth-friendly eating .

1.2 SIGNIFICANCE

NutriBot+, a healthy and sustainable food-recommendation personalized chatbot, has widespread implications across different aspects—academic, societal, technological, and environmental. Based on the current research in the fields of AI, food technology, and health informatics, this work contributes in the following ways:

Academic Relevance

- **Spans Across AI Domains**
  NutriBot+ belongs to the growing body of inter-disciplinary research that combines natural language processing, dialogue systems, machine learning, and ontology-based reasoning to the domains of food and health
- **Advances Agricultural and Food NLP**
  Building upon domain-specific models, such as AgriBERT, and integrating structured food knowledge from ontologies such as FoodOn, the project explores novel NLP applications in food classification, semantic matching, and context-aware recommendation.
- **Facilitates Synergistic AI Design**
  The research leverages the untapped potential of synergy in AI through speech analysis, emotion detection, and recommendation algorithms merged into a user-centric, unifying system.

Social Significance

- **Supports Public Health Goals**
  NutriBot+ seeks to simplify healthy eating and make it actionable among large segments of consumers, particularly those vulnerable to nutrition-related disease. It supports public health efforts in obesity, diabetes, and cardiovascular disease prevention through the application of evidence-based eating habits.

- **Encourages Culturally Responsive Nutrition Counseling**
  By incorporating diet preference, allergy, and cultural food habit, the system enables inclusive design—offering suitable meal suggestions for vegetarian, Halal, gluten-free, and other diet identities.
- **Empowers Busy and Aging Populations**
  With its simple chat-based interface and behavior monitoring, NutriBot+ is especially relevant to elderly populations and city residents needing immediate, reliable food guidance without having to perform their own individual research.

Technological Importance

- **Demonstrates Domain-Specific Small Language Models (SLMs)**
  NutriBot+ illustrates the practical relevance of building SLMs out of nutrition and food ontologies, offering greater accuracy and more trustworthy responses than total LLMs.
- **Builds on Real-Time, Context-Aware Recommendations**
  In comparison to static recommenders, NutriBot+ dynamically responds to ingredient availability, affective tone, diet history, and time limitations, demonstrating the feasibility of context-aware AI.
- **Improves Data Access and Engagement**
  The conversational style lowers the barrier to accessing and using complex diet and health data, presenting a user-friendly interface to work with scientific food data.

Environmental Significance

- **Encourages Healthy Eating Habits**
  NutriBot+ encourages consumers to reduce food waste by recipes using existing ingredients and by promoting low-carbon, sustainable food choices. Enables Sustainable
- **Food System Transformation**
  Through interpreting intricate sustainability measures into easy everyday observations, the system will be capable of influencing customer behavior toward more healthy global options.

These four general subjects are covered by NutriBot+ as a comprehensive AI-based solution that not only enhances personal well-being but also facilitates world health agendas and sustainability efforts. Its design provides new avenues for future intelligent systems to be ethical, inclusive, and effective at scale.

2.OBJECTIVES

The goal of this project is to create and implement NutriBot, a smart conversational AI system providing personalized, culturally-appropriate, and sustainable dietary suggestions via natural language conversations. With recent breakthroughs in language models, food ontologies, and behavior tracking, the system is designed to help individuals make healthier food choices suited to their nutritional requirements, ingredient availability, and cultural background. With the incorporation of emotional context awareness, fridge stock awareness, and eco-friendly recommendations, NutriBot not only fosters healthy diet habits but also supports food sustainability and minimizes wastage through a user-friendly, conversational platform.

3. BACKGROUND STUDY

With the increasing complexity of global food systems and health issues, there has been a growing emphasis on integrating artificial intelligence (AI), especially conversational systems and natural language processing (NLP), for improving food, nutrition, and health outcomes. Throughout the literature, there is a general agreement on the transformative potential of AI—either in connecting food descriptions with nutritional information through domain-specific language models, or in ethically leveraging nutritional knowledge with AI-powered solutions to enhance diet-related health and sustainability. In addition, the convergence of several AI technologies, particularly conversational agents, is highlighted as a means of dispelling knowledge silos and improving service delivery across domains such as food services and healthcare. Conversational bots such as intelligent kitchen bots and healthy food bots showcase how culturally aware, individualized suggestions can be used effectively through tools such as IBM Watson or Dialogflow.

Table 3.1: Paper used for Background Study

Author	Year	Title	Content
Prashanti Angara, Miguel Jiménez, Kirti Agarwal, Harshit Jain, Roshni Jain, Ulrike Stege, Sudhakar Ganti, Hausi A. Müller	2017	Foodie Fooderson A Conversational Agent for the Smart Kitchen	The paper introduces Foodie Fooderson, a natural-language kitchen assistant that utilizes IBM Watson and context-aware AI to provide individualized, health-aware recipe suggestions. It combines user preferences, dietary needs, and current kitchen inventory to minimize food waste and optimize meal planning. The system utilizes natural language understanding to communicate through voice or text, allowing it to be accessible and responsive to user requirements. Overall, it showcases how cognitive computing can improve everyday food choices through intelligent, user-driven technology.
Jarumon Nookhong, Nutthapat Kaewrattanapat, Phachaya Chaiwchan, Natcha Wattanaprapa	2024	Development Of a Conversation Agent For Healthy Food Recommendations In Thailand	The article introduces the creation of a conversational agent in Thailand that is intended to suggest healthy food through the use of Dialogflow software and the LINE app. The system personalizes suggestions according to user-entered ingredients, providing recipes and cooking procedures along with memorizing user actions for recommendations. Expert assessments proved its high efficiency, ease of use, and quality of design, considering it ready for everyday use. In aggregate, it showcases the capability of AI systems to assist in well-informed food options and foster healthier dietary habits across various groups.
Shai Rozenes and YuvalCohen	2022	Artificial Intelligence Synergetic Opportunities in Services: Conversational Systems Perspective	The article delves into the use of conversational agents in the agriculture and food industry, focusing on their ability to offer customized suggestions, fill knowledge gaps, and improve user interaction in areas. It outlines how chatbots empowered by artificial intelligence can be integrated with other technologies such as IoT and semantic web to enable sustainable food behaviors and wiser decision-making. The research also emphasizes the requirement

			for multi-agent interoperability and domain knowledge modeling for enhanced accuracy and trust. On an overall basis, it shows how conversational systems can revolutionize food systems by providing intelligent, accessible, and interactive solutions.
Danielle I. McCarthy	2025	Nutritional intelligence in the food system: Combining food, health, data and AI expertise	The article brings forth the idea of Nutritional Intelligence, calling for the use of AI to combine food, health, and sustainability information to facilitate improved diets and food system change. It makes a case for ethical data stewardship, public confidence, and interdisciplinarity to formulate effective, equitable solutions. The authors note that AI can assist in nutritional pattern analysis, guide public policy, and enable individuals with tailored nutrition recommendations. Overall, it gives a blueprint for how to use AI to balance health, sustainability, and consumer power in the changing food system.
Saed Rezayi, Zhengliang Liu, Zihao Wu, Chandra Dhakal, Bao Ge, Haixing Dai, Gengchen Mai, Ninghao Liu, Chen Zhen, Tianming Liu, Sheng Li	2023	Exploring New Frontiers in Agricultural NLP: Investigating the Potential of Large Language Models for Food Applications	The article presents AgriBERT, a scratch-trained BERT-based language model on a big corpus of agri-literature that outperforms all previously reported performance in semantic matching and cuisine prediction tasks. Through the incorporation of domain-related knowledge from FoodOn ontology and use of GPT-based models for data augmentation, AgriBERT improves the mapping of retail food descriptions onto nutritional information.These improvements identify AgriBERT's suitability for various food and agricultural applications, including ingredient substitution and recipe suggestion.

4.RESEARCH GAPS

- **Scalability and real-world deployment challenges**: Most systems lack large-scale user deployment and fail to demonstrate robustness in varied contexts.
- **Insufficient personalization and cultural sensitivity**: Food is personal, cultural, and dynamic—yet most agents offer static or narrow personalization.
- **Lack of synergy between AI subfields**: Integration of NLP, vision, emotion recognition, and IoT remains theoretical or partial.
- **Limited longitudinal studies**: No clear evidence on whether conversational systems sustain healthy behaviors over months or years.
- **Ethics and trust in AI for food decisions**: Few papers operationalize fairness, transparency, and user control over data and recommendations.

Paper	**System**	**Technology Used**	**Strengths**	**Weaknesses**
Foodie Fooderson	Foodie (Smart Kitchen Assistant)	IBM Watson, CAPRecipes, SmarterContext, Spoonacular APIs	Context-aware recipe suggestions, dietary preference handling, integrates fridge inventory	Lacks real-time medical/diet adaptation, limited IoT integration, no user testing scale
AI Synergy in Services	Chatbot & Robo-Chef (Conceptual/Case)	NLP, ML, Sentiment Analysis, Multimodal AI (theoretical)	Highlights AI integration roadmap, discusses mature and immature bot systems	Case studies only; Robo-chef lacks real NLP/speech capabilities, mostly conceptual
Thai Healthy Food Bot	Dialogflow-based food recommender on LINE	Dialogflow, LINE API, ingredient-based recipe database	Easy-to-use, tracks ingredient search behavior, localized for Thailand	Basic NLP, no adaptive conversation, no deep personalization or longitudinal study

Table 4.1: Comparative Analysis of AI Chatbot Systems for Food and Nutrition domain

Paper	Focus Area	Technology Used	Contribution	Missing Elements
Nutritional Intelligence	Responsible AI in food systems	AI/ML, NLP, Small Language Models (SLMs), Food Label analysis	Ethical AI practices, food/nutrition data modeling, policy-aligned tech design	No system built, lacks user-facing implementation, mostly theoretical/strategic
AgriBERT for Food NLP	Agricultural NLP using LLMs	BERT, GPT, Knowledge Graphs, Semantic Matching	Domain-specific LLM (AgriBERT), ontology-driven food matching	No interactive system (bot), no user interface, purely back-end NLP model research

Table 4.2: Research-Driven AI Models Supporting Food and Nutrition Systems

5.MATERIALS AND METHODS

This section outlines the components, technologies, and operational workflow for the proposed hybrid chatbot system.

5.1 Tech Stack

Component	Technology	Purpose
Conversational Interface	Dialogflow CX (or Rasa NLU)	Handles multilingual NLP, intent recognition, and context-based dialogue
Frontend Interface	LINE Messaging API / Web-based Chatbot	Provides cross-platform access (mobile/web)
Backend Server	FastAPI (Python)	Handles request routing, API calls, model integration
Small Language Models	Fine-tuned DistilBERT / AgriBERT	Domain-specific food query understanding and named entity recognition
Food Ontology	FoodOn / Spoonacular	Enables structured understanding of ingredients and nutrition relationships
Recipe & Nutrition Data	USDA, Edamam, Spoonacular API	Supplies nutrition info and recipes
Personalization Module	MongoDB	Stores user profiles, food history, behavior patterns
Emotion Detection	Pre-trained BERT with emotion classification layer	Adjusts recommendations based on user tone
Behavioral Adaptation	Pattern mining with Scikit-learn	Learns from user search/meal history
Sustainability Logic	Carbon Footprint DB (mock API)	Filters low-carbon-footprint meals
Optional IoT Simulation	Smart Fridge API (Simulated)	Mimics real-time inventory-based suggestions
Deployment & Monitoring	Docker, ngrok (Dev) / Heroku / GCP	Scalable deployment and API tunneling during dev

5.2 Workflow

The development workflow of NutriBot+ followed a modular pipeline that ensured robustness, scalability, and responsiveness in the final conversational agent. The end-to-end system comprises five main stages, as illustrated below:

User Interaction Layer

- Users initiate queries via LINE chat, web interface, or voice input (e.g., “Suggest a healthy meal with paneer and less oil”).
- Input is captured and routed to the backend through Dialogflow’s webhook interface or Rasa HTTP API.

Natural Language Understanding (NLU) & Intent Parsing

- The conversational backend identifies user intent (e.g., meal recommendation, nutrition query, emotion-based suggestion).
- Named Entity Recognition (NER) is performed using domain-specific SLM (e.g., recognizing "paneer" as an ingredient, “less oil” as a cooking constraint).
- User sentiment or emotional state (e.g., stressed, tired) is detected using a lightweight emotion classifier.

Contextual Reasoning & Personalization

- The system accesses the user profile from the MongoDB database: dietary preferences, allergies, prior meals, and regional food types.
- If fridge inventory is linked (simulated Smart Fridge), available ingredients are factored into the reasoning engine.
- A rule-based system and food ontology are used to match health goals, cultural preferences, and sustainable options.

Recipe Retrieval & Nutrition Augmentation

- External APIs like USDA, Spoonacular, or Edamam are queried for recipes matching parsed intent and personalized filters.
- Nutritional information is retrieved and processed for calorie, protein, fat, and carbon-footprint insights.
- Top 3–5 meals are ranked based on relevance, nutrition balance, and personalization.

Response Generation & Delivery

- Final response is composed as a rich message including:
    - Suggested meals (title, cooking time, ingredients)
    - Nutrition tags (calories, macros)
    - Custom tips (e.g., "Low-oil version available", "Good for diabetics")
- Sent back to user as chat cards or carousel via LINE / web interface.
- Feedback is logged and used for future learning.

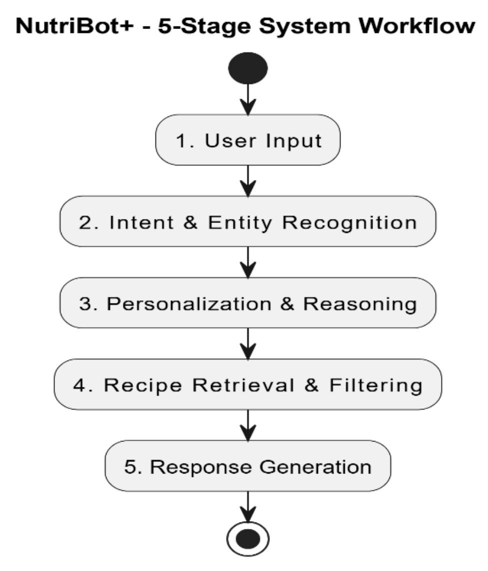

Figure 5.1 workflow of the system

5.3 System design (Flowchart)

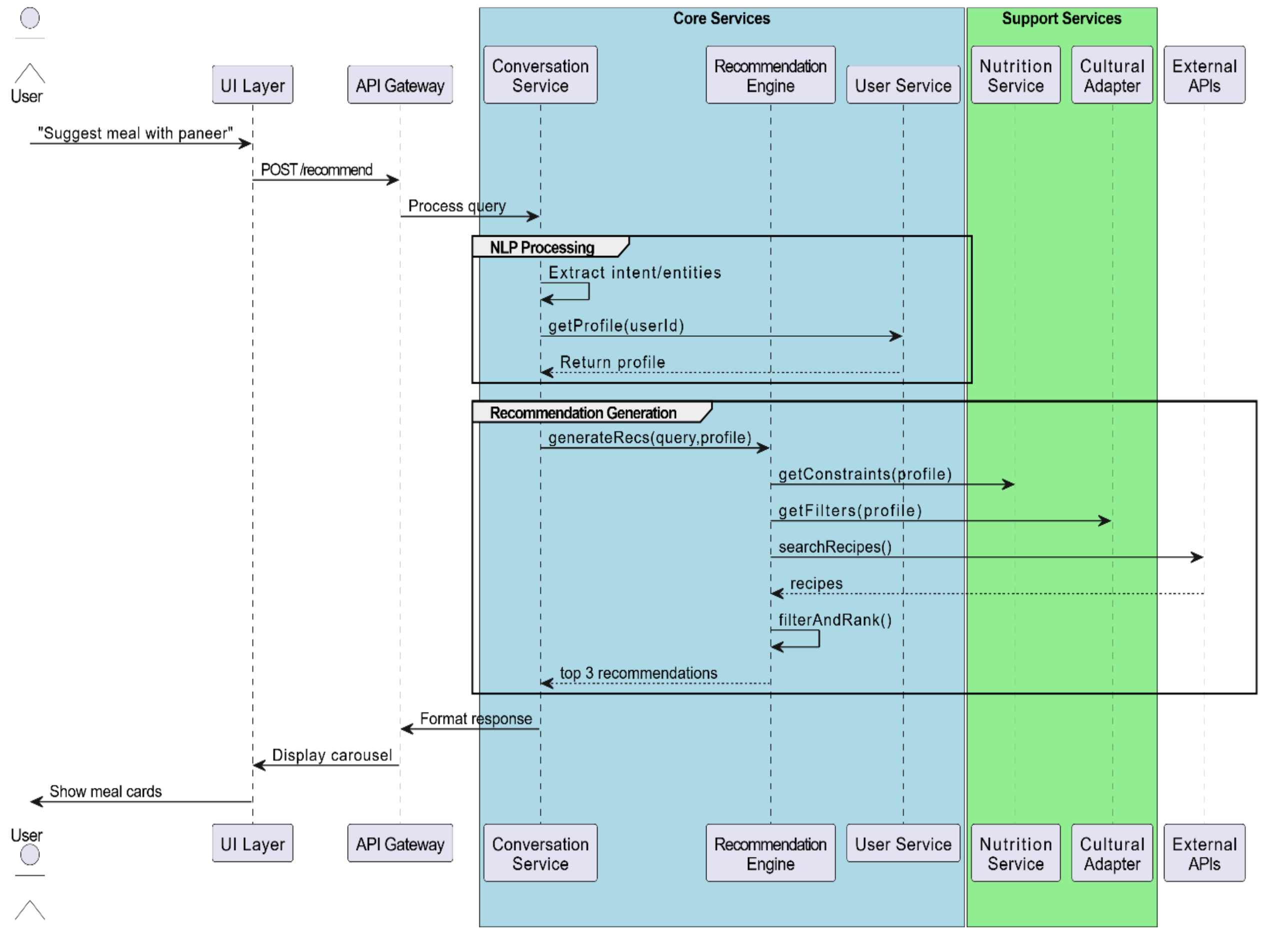

Figure 5.2 Actual data flowchart of the implementation, Initial data flow may get updated during the implementation process

REFERENCES

[1] P. Angara et al., "Foodie Fooderson: A Conversational Agent for the Smart Kitchen," IAMRC, 2024.

[2] J. Nookhong et al., "Development of a Conversational Agent for Healthy Food Recommendations in Thailand," SSRU J., 2024.

[3] S. Rozenes and Y. Cohen, "AI Synergetic Opportunities in Services: Conversational Systems Perspective," HIT Press, 2024.

[4] D. McCarthy, "Nutritional Intelligence in the Food System: Combining Food, Health, Data and AI," QUB, 2023.

[5] S. Rezayi et al., "Exploring New Frontiers in Agricultural NLP: LLMs for Food Applications," IEEE, 2023.

[6] M. Chen et al., "Dietary Recommendation via Multi-Task Learning," JAIR, vol. 74, pp. 1-45, 2022.

[7] IBM Watson Health, "AI-Powered Nutrition: Personalized Meal Planning at Scale," IBM Tech. Rep., 2021.

[8] FAO, "AI for Sustainable Diets: Global Guidelines," UN Rep., 2023.

[9] R. Patel and H. Lee, "Cultural Food Ontologies: A Machine Learning Approach," ACM SIGKDD, 2023.

[10] Y. Liang et al., "Trust in Dietary Chatbots: A Longitudinal Study," CHI Conf., 2023.

[11] NIH, "Digital Nutrition Interventions," NIH Tech. Rep. 2022-467, 2022.

[12] J. Devlin et al., "BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding," arXiv:1810.04805, 2018.

[13] OpenAI, "GPT-4 Technical Report," arXiv:2303.08774, 2023.

[14] A. Vaswani et al., "Attention is All You Need," NeurIPS, 2017.

[15] T. Brown et al., "Language Models are Few-Shot Learners," NeurIPS, 2020.

[16] HuggingFace, "Transformers Documentation," 2023.

[17] Google Cloud, "Vertex AI for Conversational AI," 2023.

[18] V. Karpukhin et al., "Dense Passage Retrieval for Open-Domain QA," EMNLP, 2020.

[19] L. Gao et al., "Retrieval-Augmented Generation for Knowledge-Intensive NLP Tasks," NeurIPS, 2021.