

# CAPSTONE PROJECT

## NUTRIMIND: BUILDING THE SMARTEST AI NUTRITION ASSISTANT

### Presented By:-

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# OUTLINE

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# PROBLEM STATEMENT

## ■ The Challenge: Scaling Expert-Level Personalized Nutrition

In the rapidly growing digital health market, personalized nutrition is a core consumer demand. However, most digital tools offer only generic, one-size-fits-all meal plans. This approach fails to account for an individual's unique health goals, dietary restrictions, and medical conditions, leading to low user engagement and poor health outcomes. This creates a significant industry challenge: providing scalable, expert-level nutrition counseling that is both affordable and deeply personal. The crucial part is the development of an intelligent AI agent that can reason over large-scale dietary databases to generate dynamic, personalized meal plans and adaptive advice, effectively acting as a virtual nutrition expert for every user.

# PROPOSED SOLUTION

The proposed system, "NutriMind," aims to address the challenge of providing scalable, expert-level personalized nutrition guidance. This involves leveraging a multi-layered agentic AI architecture on the IBM watsonx platform to generate dynamic and adaptive meal plans accurately. The solution consists of the following components:

- **Data Collection:**
  - Sourced a comprehensive "Daily Food and Nutrition Dataset" from [Kaggle](#) to serve as the foundational knowledge base.
- **Data Preprocessing:**
  - Performed data cleansing and pre-processing using [Microsoft Excel](#) to handle duplicates, and correct inconsistencies, ensuring high data quality.
- **Retrieval-Augmented Generation:**
  - Implemented a RAG pipeline to ground the AI in factual, verifiable nutritional data.
  - Utilized the powerful [granite-embedding-278m-multilingual model](#) to convert the cleaned dataset into a high-performance vector index for real-time information retrieval.
- **Prompt Engineering & Prototyping:**
  - Leveraged [the IBM watsonx Prompt Lab](#) for rapid prototyping of the agent's core skills.
  - Engineered and tested complex prompts for meal plan generation and food swap recommendations against [the granite-3-8b-instruct model](#) to ensure high-quality outputs.

# PROPOSED SOLUTION

- **Agentic AI Architecture:**
  - Developed the core **"NutriMind"** agent using the **IBM watsonx Agent Lab**, leveraging the **LangGraph framework** to orchestrate complex conversational flows.
  - Implemented a **ReAct (Reason and Act) architecture** to enable intelligent decision-making and tool selection.
  - Integrated the state-of-the-art **llama-3-3-70b-instruct model** as the primary reasoning engine for understanding complex user queries.
  - Equipped the agent with a multi-tool system, including the **custom nutritional RAG database**, Google Search, Wikipedia Search, and a WebCrawler for holistic, up-to-date responses
- **Deployment:**
  - Developed a user-facing testing interface within the watsonx platform for real-time interaction and validation.
  - Deployed the final solution on the scalable and reliable **IBM Cloud platform** as a live AI service with a secure API endpoint for future application integration.
- **Evaluation:**
  - Assessed the agent's performance through qualitative testing with a wide range of **complex nutritional queries** to validate response accuracy and relevance.
- **Result**
  - The final agent successfully generated accurate, **custom meal plans** tailored to user-specific needs and provided context-aware suggestions on how to replace certain food items with healthier alternatives.

# SYSTEM APPROACH

The "System Approach" section outlines the overall strategy and methodology for developing and implementing the NutriMind AI system.

- **System Architecture:**
  - **Cloud Platform:** IBM Cloud (Lite Tier)
  - **AI Environment:** IBM watsonx.ai Studio
  - **Core AI Components:**
    - **IBM watsonx Agent Lab:** For final agent assembly, tool integration, and deployment.
    - **IBM watsonx Prompt Lab:** For rapid prototyping, prompt engineering, and RAG pipeline development.
- **Technology & Models Used:**
  - **Reasoning Engine (LLM):** llama-3-3-70b-instruct
  - **Prototyping Model (LLM):** granite-3-8b-instruct
  - **Embedding Model (for RAG):** granite-embedding-278m-multilingual
  - **Agent Framework:** LangGraph
  - **Agent Architecture:** ReAct (Reason and Act)
  - **Data Pre-processing Tool:** Microsoft Excel

# ALGORITHM & DEPLOYMENT

- In the Algorithm section, we describe the advanced AI architecture chosen for generating personalized nutritional guidance. Here's the structure for this section:
- **Algorithm Selection:**
  - A **ReAct (Reason and Act)** agentic architecture was implemented, powered by the **llama-3-3-70b-instruct model**. This approach was justified by the need to handle complex, multi-step user queries that require both internal knowledge retrieval and external tool use, moving beyond the capabilities of a standard chatbot.
- **Data Input:**
  - The primary input is the **user's natural language query** (e.g., "create a meal plan for me").
  - The secondary data source is a vectorized nutritional database, created from a pre-processed Kaggle dataset using the **granite-embedding-278m-multilingual model**. This serves as the agent's internal, factual knowledge base.
- **Training Process:**
  - The agent's core "skills" were developed through a process of prompt engineering in the **IBM watsonx Prompt Lab**. Specific, detailed prompts for meal plan generation and food swap recommendations were prototyped and validated against the **granite-3-8b-instruct model** to ensure high-quality, reliable outputs.
- **Prediction Process:**
  - The trained agent makes "predictions" (generates responses) by first using the **ReAct framework** to reason about the user's query. It then autonomously selects the appropriate tool—either querying the **internal RAG database** for nutritional facts or using external tools like Google Search for real-time information—before synthesizing the retrieved data into a final, comprehensive answer.

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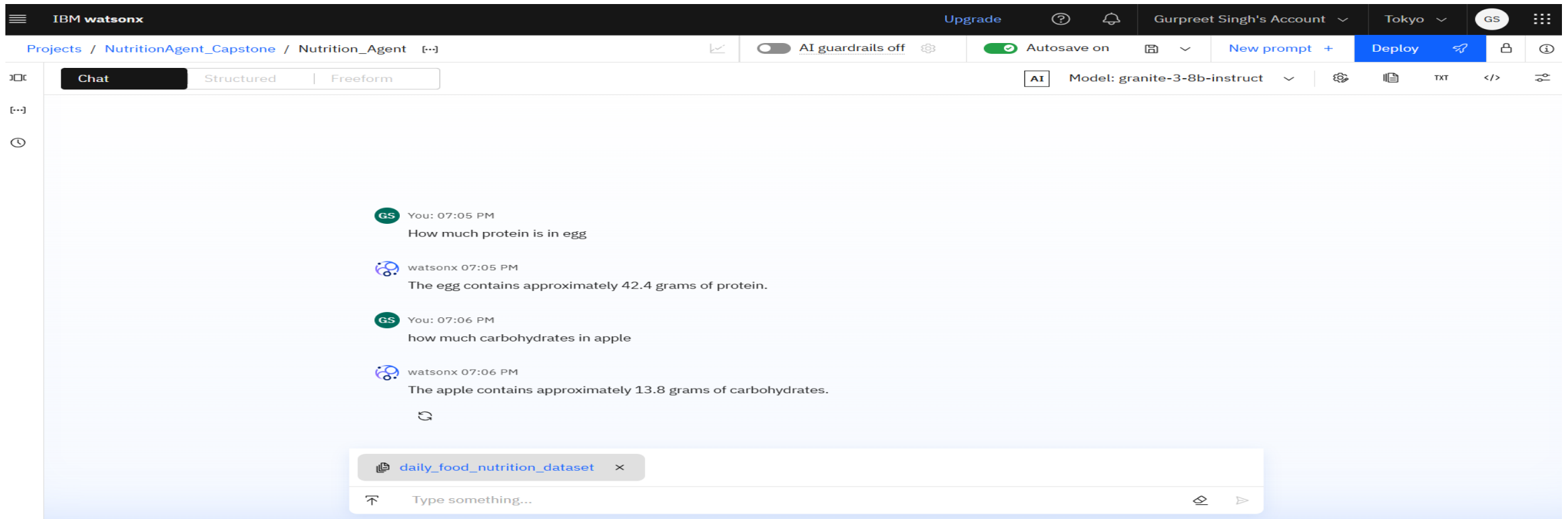
# RESULT

The results of the "NutriMind" AI agent in terms of its accuracy and effectiveness in generating personalized nutritional guidance. Included are visualizations from the live demonstration and comparisons between a user's complex query and the agent's tailored output to highlight the model's performance.



# RESULT

- This screenshot demonstrates the successful validation of the Retrieval-Augmented Generation (RAG) pipeline within the **IBM watsonx Prompt Lab**. The system, grounded with the `daily_food_nutrition_dataset`, is being queried for specific nutritional facts. Using the `granite-3-8b-instruct` model, the agent accurately retrieves precise data points, confirming the knowledge base is successfully integrated and the AI can provide fact-based, non-hallucinated answers.



# RESULT

This screenshot captures the successful generation of a personalized meal plan in the **Prompt Lab**. The **granite-3-8b-instruct** model was given a detailed persona and a complex user request with multiple constraints (Health Goal: Build muscle, 2500 Calorie Target, Peanut Allergy). The model's ability to generate a structured, multi-option meal plan for Breakfast, Lunch, and Dinner validates the core logic of the "NutriMind" agent.

The screenshot displays the IBM watsonx Prompt Lab interface. The top navigation bar includes the IBM watsonx logo, an Upgrade button, a help icon, a notification bell, and user account information (Gurpreet Singh's Account, Tokyo, and a profile icon labeled GS). The breadcrumb trail shows the path: Projects / NutritionAgent\_Capstone / Nutrition\_Agent. The interface is divided into a left sidebar and a main content area. The sidebar contains a 'Saved prompts' section with two entries, both labeled 'Nutrition\_Agent'. The main content area has a 'Freeform' tab selected, showing a chat conversation. The user's prompt is: 'You are an expert AI Nutritionist. Using the provided nutritional data, create a detailed one-day meal plan for a user with these requirements: - Health Goal: Build muscle and have more energy - Medical Conditions: None - Daily Caloric Target: 2500 - Allergies: Peanuts. For each meal (Breakfast, Lunch, Dinner, Snack), provide two distinct options and explain why each option is a good choice for the user's goals.' The AI's response is a structured meal plan: 'Meal Options: 1. Breakfast: a. Option 1: Greek yogurt with mixed berries, honey, and a sprinkle of granola b. Option 2: Scrambled eggs with spinach, whole grain toast, and an orange 2. Lunch: a. Option 1: Grilled chicken salad with mixed greens, cherry tomatoes, cucumber, avocado, and a lemon-tahini dressing b. Option 2: Quinoa and black bean bowl with roasted sweet potato, steamed broccoli, and a dollop of Greek yogurt 3. Dinner: a. Option 1: Baked salmon with a side of quinoa and steamed asparagus b. Option 2: Turkey meatballs with whole'. At the bottom, a status bar shows 'Stop reason: Max tokens parameter reached', 'Tokens: 112 Input + 200 generated = 312 out of 131072', and 'Time: 2.5 seconds'. There are buttons for 'Clear output' and 'Generate'.

IBM watsonx Upgrade ? 🔔 Gurpreet Singh's Account Tokyo GS

Projects / NutritionAgent\_Capstone / Nutrition\_Agent

AI guardrails on

New prompt +

Chat Structured Freeform AI Model: granite-3-8b-instruct {#} TXT </>

From NutritionAgent\_Capstone

Nutrition\_Agent

Nutrition\_Agent

You are an expert AI Nutritionist. Using the provided nutritional data, create a detailed one-day meal plan for a user with these requirements:

- Health Goal: Build muscle and have more energy
- Medical Conditions: None
- Daily Caloric Target: 2500
- Allergies: Peanuts

For each meal (Breakfast, Lunch, Dinner, Snack), provide two distinct options and explain why each option is a good choice for the user's goals.

**Meal Options:**

1. Breakfast:
  - a. Option 1: Greek yogurt with mixed berries, honey, and a sprinkle of granola
  - b. Option 2: Scrambled eggs with spinach, whole grain toast, and an orange
2. Lunch:
  - a. Option 1: Grilled chicken salad with mixed greens, cherry tomatoes, cucumber, avocado, and a lemon-tahini dressing
  - b. Option 2: Quinoa and black bean bowl with roasted sweet potato, steamed broccoli, and a dollop of Greek yogurt
3. Dinner:
  - a. Option 1: Baked salmon with a side of quinoa and steamed asparagus
  - b. Option 2: Turkey meatballs with whole

Stop reason: Max tokens parameter reached  
Tokens: 112 Input + 200 generated = 312 out of 131072  
Time: 2.5 seconds

Clear output Generate →

# RESULT

This image showcases the **IBM watsonx Prompt Lab** in "Freeform" mode, where a core agent skill was engineered and tested. A complex prompt was provided to the **granite-3-8b-instruct** model, tasking it with suggesting and explaining healthier food swaps based on a user's goal. The model's successful generation of detailed alternatives like "Baked Kale Chips" demonstrates its ability to perform contextual reasoning based on the provided nutritional data.

The screenshot displays the IBM watsonx Prompt Lab interface. The top navigation bar shows the path: Projects / NutritionAgent\_Capstone / Nutrition\_Agent. The interface is set to "Freeform" mode. A hint at the top states: "Hint: This model works better when you provide at least 1 example." The prompt input area contains the following text:

A user wants a healthier alternative to potato chips. Their goal is to lose weight. Using the provided nutritional data, suggest three healthier swaps and provide a contextual explanation for why each one is a better choice.

The generated response is as follows:

- \*\*Baked Kale Chips\*\***
  - \*Nutritional Data\*: 100g serving contains approximately 150 calories, 10g of fat, 2g of saturated fat, 0mg of cholesterol, 250mg of sodium, 10g of carbohydrates, 3g of dietary fiber, and 3g of sugar.
  - \*Contextual Explanation\*: Kale chips are a healthier alternative to potato chips because they are lower in calories, fat, and sodium. They also provide more dietary fiber and essential vitamins and minerals, such as vitamins A, K, and C. The high fiber content helps promote satiety, reducing the likelihood of overeating.
- \*\*Roasted Chickpeas\*\***
  - \*Nutritional Data\*: 1

The interface includes a "Clear output" button and a "Generate" button at the bottom right.

# RESULT

This image displays a successful end-to-end test of the fully assembled "NutriMind" agent in the **IBM watsonx Agent Lab preview**. The agent was presented with a complex, multi-constraint user query: a 2000-calorie, vegetarian, weight-gain meal plan. The agent correctly interpreted the user's intent and generated a detailed, structured, and highly relevant response that meets all specified requirements, showcasing its core functionality.

## Agent preview



You: 07:44 PM

Can you create a 2000 calorie meal plan for me? I'm a vegetarian and I'm trying to gain weight



NutriMind 07:44 PM

Here is a 2000 calorie vegetarian weight gain meal plan: Breakfast: Oatmeal with banana and almond milk (500 calories, 33.9g protein, 75.8g carbohydrates, 47g fat) Snack: Apple slices with peanut butter (150 calories, 4g protein, 15g carbohydrates, 8g fat) Lunch: Quinoa and black bean bowl with avocado (700 calories, 36.8g protein, 75g carbohydrates, 20g fat) Snack: Greek yogurt with honey and almonds (200 calories, 20g protein, 30g carbohydrates, 10g fat) Dinner: Vegetable stir-fry with tofu and brown rice (600 calories, 25g protein, 80g carbohydrates, 20g fat) Snack: Smoothie bowl with banana, spinach, almond milk, and almond butter topping (400 calories, 15g protein, 60g carbohydrates, 20g fat) Before bed: Casein protein shake with almond milk and peanut butter (250 calories, 20g protein, 10g carbohydrates, 15g fat)

► How did I get this answer?

# RESULT

This screenshot demonstrates the agent's ability to provide context-aware nutritional advice. When asked for a low-sugar replacement for soda, the "NutriMind" agent successfully swapped those items. The response is not only accurate (recommending water, tea, etc.) but also provides valuable contextual explanation by advising against high-sugar fruit juices, proving its capability to act as a true nutritional assistant.

## Agent preview



You: 07:46 PM

What's a good replacement for soda if my goal is to reduce my sugar intake



NutriMind 07:46 PM

A good replacement for soda if your goal is to reduce your sugar intake is water, as it has zero calories and no added sugars. Additionally, you can consider unsweetened tea or coffee, which are low in calories and sugar. If you prefer a fizzy drink, you can try seltzer water or infused water with fruits or herbs for flavor. It's also a good idea to limit your consumption of fruit juices and smoothies, as they can be high in sugar, and opt for whole fruits instead.

► How did I get this answer?



# RESULT

This image captures the successful test of the final, deployed "NutriMind" AI service. The screenshot shows the live API's "Preview" interface, confirming that the agent is fully operational on IBM Cloud. The agent has successfully processed a complex, natural language request for a personalized meal plan, demonstrating its ability to synthesize information from its knowledge base and generate a detailed, structured, and actionable response. This validates the end-to-end functionality of the entire system, from data ingestion to final deployment.

The screenshot displays the IBM Watsonx interface for the NutriMind AI service. The top navigation bar includes the IBM Watsonx logo, a deployment path (Deployment spaces / Nutrition\_Agent\_nutrimind / NutriMind /), and user account information (Upgrade, Gurpreet Singh's Account, Tokyo, and a GA badge). Below the navigation bar, the NutriMind service is shown as 'Deployed' and 'Online'. The 'Preview' tab is selected, showing a chat interface with a 'New chat' button.

The chat conversation is as follows:

**User:** You are an expert AI Nutritionist. Using the provided nutritional data, create a detailed one-day meal plan for a user with these requirements:

- Health Goal: Build muscle and have more energy
- Medical Conditions: None
- Daily Caloric Target: 2500
- Allergies: Peanuts

**For each meal (Breakfast, Lunch, Dinner, Snack), provide two distinct options and explain why each option is a good choice for the user's goals.**

**NutriMind 08:22 PM:**

To create a one-day meal plan for a user with a health goal of building muscle and having more energy, no medical conditions, a daily caloric target of 2500, and an allergy to peanuts, I would suggest the following meal options:

**Breakfast Options**

1. **Eggs with Apple Slices:** Eggs are a good source of protein, which is essential for muscle building. Apple slices provide a good source of carbohydrates for energy. This meal option is approximately 240 calories, with 18g of protein, 30g of carbohydrates, and 10g of fat.
2. **Oatmeal with Banana:** Oatmeal is a complex carbohydrate that provides sustained energy, while banana is a good source of potassium, which is important for muscle function. This meal option is approximately 300 calories, with 20g of protein, 40g of carbohydrates, and 15g of fat.

**Lunch Options**

1. **Grilled Chicken Breast with Carrot Sticks:** Chicken breast is a lean protein source that is essential for muscle building, while carrot sticks provide a good source of vitamins and minerals. This meal option is approximately 360 calories, with 35g of protein, 10g of carbohydrates, and 10g of fat.
2. **Quinoa Salad with Tomato:** Quinoa is a complete protein that provides all the essential amino acids for muscle building, while tomato is a good source of vitamins and minerals. This meal option is approximately 400 calories, with 25g of protein, 30g of carbohydrates, and 15g of fat.

**Dinner Options**

1. **Grilled Beef Steak with Broccoli:** Beef steak is a good source of protein and iron, which is important for muscle function, while broccoli is a good source of vitamins and minerals. This meal option is approximately 500 calories, with 40g of protein, 10g of carbohydrates, and 20g of fat.
2. **Baked Salmon with Brown Rice:** Salmon is a good source of protein and omega-3 fatty acids, which are important for heart health, while brown rice is a complex carbohydrate that provides sustained energy. This meal option is approximately 480 calories, with 30g of protein, 40g of carbohydrates, and 15g of fat.

**Snack Options**

1. **Yogurt with Strawberry:** Yogurt is a good source of protein and calcium, which is important for muscle function, while strawberry is a good source of vitamins and minerals. This meal option is approximately 200 calories, with 15g of protein, 30g of carbohydrates, and 10g of fat.
2. **Apple Slices with Almond Butter:** Apple slices provide a good source of carbohydrates for energy, while almond butter is a good source of healthy fats and protein. However, since the user has a peanut allergy, I would recommend substituting almond butter with sunflower seed butter or another nut-free alternative. This meal option is approximately 150 calories, with 4g of protein, 20g of carbohydrates, and 8g of fat.

**In conclusion,** these meal options provide a balanced mix of protein, carbohydrates, and healthy fats to support muscle building and energy production, while avoiding peanuts due to the user's allergy. The total daily caloric intake is approximately 2500 calories, which meets the user's daily caloric target.

The chat interface includes a text input field at the bottom with the placeholder text "Type something..." and a send button.

# CONCLUSION

- Successfully developed a sophisticated, proof-of-concept AI Nutrition Assistant, "**NutriMind**," on the **IBM watsonx platform**.
- Demonstrated a complex, multi-tool, RAG-powered agentic architecture capable of delivering personalized and context-aware nutritional guidance, which moves significantly beyond the capabilities of standard chatbots.
- The project successfully integrates the complete end-to-end AI development lifecycle—from rigorous data pre-processing and advanced prompt engineering to the final assembly and deployment of an intelligent agent.

# FUTURE SCOPE

- **Multimodal Input Integration:**
  - **Image Recognition:** Integrate **IBM Watson Visual Recognition** to allow users to upload photos of food items or grocery labels. The service would identify the food, and its name would be passed as text to the NutriMind agent for analysis and recommendations.
  - **Voice Commands:** Incorporate **IBM Watson Speech-to-Text** to enable a hands-free, conversational experience, allowing users to ask questions and receive nutritional advice via voice.
- **Dynamic Feedback & Personalization Loop:**
  - Implement a user profile database to store individual preferences, feedback, and dietary history.
  - The agent would query this database before generating recommendations to ensure it learns and adapts over time (e.g., "remembering" that a user dislikes a certain food).
- **Advanced Health Data Integration:**
  - Connect the agent to health and fitness APIs (like from smartwatches or fitness trackers) to automatically pull in data on activity levels and caloric expenditure, leading to even more precise and dynamic meal planning.



# REFERENCES

- Dataset:

- Shamim, A. (2023). *Daily Food and Nutrition Dataset*. Kaggle. Retrieved August 4, 2025, from <https://www.kaggle.com/datasets/adilshamim8/daily-food-and-nutrition-dataset>

- Core AI Methodologies:

- Lewis, P., et al. (2020). *Retrieval-Augmented Generation for Knowledge-Intensive NLP Tasks*. This foundational paper introduced the RAG technique used to ground the agent in factual nutritional data. Link: <https://arxiv.org/abs/2005.11401>
- Yao, S., et al. (2023). *ReAct: Synergizing Reasoning and Acting in Language Models*. This paper details the ReAct architecture, which was implemented to enable the agent to reason about a user's query and intelligently select the correct tool. Link: <https://arxiv.org/abs/2210.03629>

- Platform & Technology Documentation:

- IBM. (2025). *IBM watsonx.ai Documentation*. This was the primary technical resource for developing and deploying the agent on the IBM Cloud platform. Retrieved August 4, 2025, from <https://cloud.ibm.com/docs/watsonx-ai>.

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This certificate is presented to  
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for the completion of  
**Lab: Retrieval Augmented Generation with  
LangChain**

(ALM-COURSE\_3824998)

According to the Adobe Learning Manager system of record

**Completion date:** 24 Jul 2025 (GMT)

**Learning hours:** 20 mins



**THANK YOU**