

LLAMA Assisted Nutritional Recipe Suggestions: Integrating the Dietary Quality Index for Health Conscious Cooking

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Abstract. Choosing what to eat daily can be challenging due to the variety of ingredients and their differing nutritional values, often leading to health problems such as cardiovascular diseases and psychological disorders. The recent surge in popularity of Large Language Models (LLMs) like ChatGPT, Gemini, and Llama has made it easier for users to obtain information and recommendations from various fields more quickly than traditional online searches. In this study, we trained Llama models using datasets on ingredients and their nutritional values, fast food menus with nutritional values, and the Dietary Quality Index (DQI) to provide personalized recipe suggestions with accurate nutritional information. We compare the performance of Retrieval Augmented Generation (RAG) with Llama-2 model, Llama-3, and the default ChatGPT model in terms of recipe accuracy, nutritional value precision, and user-friendliness. Our findings aim to demonstrate the potential of LLMs in improving dietary health through accessible and understandable nutritional guidance, while also addressing the common problem of hallucination in LLMs by using RAG for context information.

Keywords: DQI, Llama, LLM, RAG, nutritional daily intake, recipe recommendation.

1 Introduction

In kitchens around the globe, a daily dilemma unfolds: “What should I cook today?” With the abundance of recipes and ingredients making a single meal becomes a difficult task, and, beyond this problem, nutritional values of the food are another problem to take in account. With the lack of nutritional knowledge and the lack of knowledge to interpret the information provided by nutrition labels for most people [2, 4], this dilemma becomes hard to answer. In 1990, the Nutrition Labeling and Education Act (NLEA) was introduced in the United States, marking a pivotal moment in public health policy.

Its primary objective was to give consumers the necessary tools to make informed dietary choices. By using standardized labels with essential information, people could opt for healthier products. However, despite the widespread adoption of nutritional labels, research indicates that a substantial portion of the population overlooks or struggles to interpret these labels, Campos et al. (2011) showed that nutrition labels that require calculations concerning nutrient amounts and serving sizes are confusing to many consumers, particularly those with lower education and literacy skills so, a graphical view would be more helpful. Grunert et al. (2010) highlighted that from a questionnaire of 921 people, 27% checked the nutritional labels and from this, 70 to 90% could correctly interpret the information.

This lack of nutritional understanding can lead to imbalanced dietary patterns [7], characterized by both excessive and deficient consumption of certain nutrients. Such dietary imbalances are associated with a spectrum of non-communicable diseases (NCDs), encompassing immediate complications and long-term health consequences, including cardiovascular diseases, diabetes, hypertension, stroke, cancer, dental caries, asthma, and various psychological disorders such as depression [9, 11].

Alarmingly, the International Diabetes Federation reports that approximately 415 million people worldwide suffer from diabetes, with incidence rates projected to surge by over 50% by 2040. Furthermore, the Global Burden of Disease Study underscores the significant contribution of dietary factors to levels of malnutrition, obesity, and overweight, with 11 million preventable premature deaths annually attributed to unreasonable dietary habits [10].

The advancements in machine learning have spurred the development of numerous recommendation systems (RSs) aimed at addressing challenges in recipe suggestions and nutritional knowledge. For instance, Zhang et al (2022) introduced the MaOO model, a vector optimization algorithm designed to optimize multiple objective functions [14]. By seamlessly integrating ingredients' nutritional value, food diversity, and user dietary patterns, the MaOO model correctly suggests suitable food options for users. Similarly, Teng et al. (2012) proposed a methodology leveraging pointwise mutual information (PMI) coupled with support vector machines (SVMs).

This approach establishes correlations among ingredients found in diverse recipes, identifying the most frequently used ingredients. By employing SVMs, it helped to further refine recipe suggestions [12]. or the most akin to this work, introduced by Aljbawi Bushra (2020) who utilized GPT-2 to generate recipe suggestions based on input prompts containing ingredients by training it with different recipes and the ingredients used [1].

The introduction of OpenAI's GPT-3 public model in November 2022 has sparked a surge in interest surrounding Generative Artificial Intelligence (GAI) models. With reports indicating that over 100 million individuals engaged with the model in January 2023 alone [3], GAI technologies have become a focal point of contemporary discourse. Utilizing Generative Pre-trained Transformers (GPT), these models are trained on extensive textual datasets, empowering them to produce coherent and contextually relevant responses. Notably, the GPT-3 model boasts an impressive 175 billion parameters, derived from textual data converted into tokens.

Subsequently, based on user prompts, a retriever mechanism identifies and retrieves the most pertinent information to address user inquiries [8]. As a result of the widespread acclaim garnered by the GPT model, numerous other companies have ventured into the development of their own Generative Artificial Intelligence (GAI) models. Among these is Meta's Llama-2 model, introduced in July 2023 [13]. A refined iteration of the original Llama 1 model, Llama-2 has been trained on extensive datasets, resulting in versions with parameters ranging from 7 billion to 70 billion.

On April 18, 2024, Meta released a new model named Llama-3, with parameters ranging from 8 to 70 billion. It was trained on 15 trillion tokens from public sources, making its training dataset seven times larger than that of Llama-2. Additionally, Llama-3 utilizes a tokenizer with 128,000 tokens to encode language more efficiently. Meta also modified the code to enhance the model's manipulability [6].

Capitalizing on the growing popularity of these models and recognizing the imperative to address malnutrition risks, we have developed an innovative model with enhanced user interaction. This model not only provides recipe suggestions based on available ingredients but also offers personalized nutritional guidance tailored to individual needs. Equipped with memory functionality, our model dynamically adapts to users' dietary preferences, leveraging Dietary Quality Index (DQI) scores to monitor and adjust nutritional intake. This adaptive approach ensures the delivery of healthy recipe suggestions suitable for individuals of all ages and varying culinary skills.

Building upon these capabilities, our model goes a step further by offering recipe suggestions based on portion sizes, enabling more precise monitoring of nutritional intake. This enhanced feature ensures a more controlled approach to recipe recommendations, facilitating accurate tracking of nutrition and promoting healthier dietary habits.

2 Materials and Methods

2.1 Data Collection

We collected data through web scraping from two primary sources: FoodData Central USDA and MenuWithNutrition. From FoodData Central USDA, we obtained a dataset comprising ingredients along with their corresponding nutritional values. The MenuWithNutrition website provided us with a diverse dataset of USA fast food menus, including detailed nutritional information for each menu item. Additionally, to ensure that our model recommends recipes aligned with nutritional guidelines, we integrated data from the Dietary Quality Index (DQI) document.

This document informed our model to prioritize recipes that contribute to achieving the nutritional scores outlined in the DQI. For the data extraction process, we utilized the request library to access the respective websites. Specifically, `urllib.request` and `urlopen` were employed to fetch data from the URLs of these websites. Subsequently, BeautifulSoup was utilized to parse the HTML structure and extract the relevant information needed from the web pages.

Table 1. Fraction of USDA dataset.

Main food description	Food code	WWEIA Number	WWEIA Description	Energy (kcal)	Protein (g)
Milk, human	11000000	9602	Human milk	70	1.03
Milk, NFS	11100000	1004	Milk, reduced fat	52	3.33
Milk, whole	11111000	1002	Milk, whole	61	3.27
Milk, reduced fat (2%)	11112110	1004	Milk, reduced fat	50	3.36
Milk, low fat (1%)	11112210	1006	Milk, lowfat	43	3.38

2.2 Data Understanding

FoodData Central USDA. FoodData Central (FDC) is a comprehensive food and nutrient database maintained by the United States Department of Agriculture (USDA), offering detailed information on the nutritional composition of a wide array of foods consumed in the United States. This database encompasses essential data on nutrients such as vitamins, minerals, carbohydrates, proteins, fats, and other components present in foods. From FDC, we utilized the Food and Nutrient Database for Dietary Studies 2019-2020 (FNDDS 2019-2020). This specialized database provides nutritional details for foods and beverages reported in "What We Eat in America," a component of the National Health and Nutrition Examination Survey (NHANES). This table, with 5625 rows and 69 columns, contains food descriptions and their respective food codes from the FNDDS.

Each 8-digit food code starts with a digit representing one of nine major food groups: Milk and Milk Products, Meat, Poultry, Fish, and Mixtures, Eggs, Dry Beans, Peas, Other Legumes, Nuts, and Seeds, Grain Products, Fruits, Vegetables, Fats, Oils, and Salad Dressings, Sugars, Sweets, and Beverages. The remaining digits specify subgroups, with codes ranging from 11000000 to 99998210. It includes WWEIA Category numbers and descriptions for 170 subgroups, ranging from 1002 to 9999, which classify foods into specific subgroups. The rest of the columns provide nutritional values (micro and macronutrients) per 100 grams of each food item.

MenuWithNutrition. MenuWithNutrition is a website dedicated to providing detailed information on menus from various fast food chains across the USA. They compile data from multiple sources and meticulously verify the accuracy of nutritional values. The website is designed to be comprehensive and user-friendly, helping individuals understand the nutritional content of food items from different restaurant chains. From MenuWithNutrition, we obtained a database similar to that of the USDA. This database includes information on restaurants, menu items, and nutritional values such as macronutrients (fats, proteins, carbohydrates, fiber) and micronutrients (monounsaturated fats, polyunsaturated fats, among others).

Dietary Quality Index. The Dietary Quality Index (DQI) is a metric developed by Soowon Kim et al. [5] to evaluate the overall quality of daily food intake. It is structured into four key categories aimed at assessing different nutritional aspects:

1. **Variety:** This category evaluates the diversity of food sources within the diet, including proteins from various food groups such as meats, fruits, vegetables, dairy, and grains.

Table 2. Fraction of MenuWithNutrition dataset.

Restaurant Name	Food Name	Total Fat	Cholesterol	Sodium	Total Carbohydrate	Protein
aandw restaurant	chocolate cone	4.5 g	15 mg	105 g	26 g	3 g
aandw restaurant	root beer float	5.2 g	39 mg	104 g	70.4 g	2.1 g
aandw restaurant	diet root beer float	5.2 g	39 mg	104 g	31.1 g	2.1 g
aandw restaurant	root beer freeze	18 g	70 mg	400 g	150 g	16 g
aandw restaurant	chocolate shake	28.8 g	124 mg	200 g	100 g	11.2 g

2. **Adequacy:** Adequacy assesses whether the intake of essential dietary elements meets recommended levels to ensure a healthy diet and prevent undernutrition.
3. **Moderation:** This examines the intake of foods and nutrients associated with chronic diseases, emphasizing moderation of total fats, saturated fats, cholesterol, and sodium.
4. **Overall Balance:** The final category evaluates the overall balance of the diet in terms of energy sources and fatty acid composition, aiming for proportional intake across these categories.

2.3 Llama and Retrieval Augmented Generation

The Llama-2 and Llama-3 models, with 7 billion and 8 billion parameters respectively, were used as the foundation for our approach. These models, developed by Meta, were downloaded from Hugging Face. To fine-tune and manipulate these models, we utilized the Langchain library, known for its versatile capabilities in model adaptation. An essential component of our method was the system prompt template, which guided the model's responses. The template used was as follows:

- “”Use the following pieces of information to answer the user’s question. If you don’t know the answer, just say that you don’t know, don’t try to make up an answer.
- Context: context.
- Question: question.

Your task is to suggest recipes and give people information about nutritional information about their food based on the Dietary Quality Index (DQI). The necessary nutritional values to take into account for the DQI and the recipe suggestions are: Protein (g), Lipids (g), Fiber (g), Ascorbic Acid (mg), Cholesterol (mg), Saturated Fatty Acids (g), Calcium (mg), Iron (mg), Sodium (mg), Carbohydrates (g), SFAs, MFAs, PUFAs and Total Energy (Kcal).

- Helpful Answer: “”

This template ensures the model answers questions only if it knows the answer. Also, since it is a safe mode, it doesn’t respond to harmful queries, thus eliminating the need for additional safety instructions in the template.

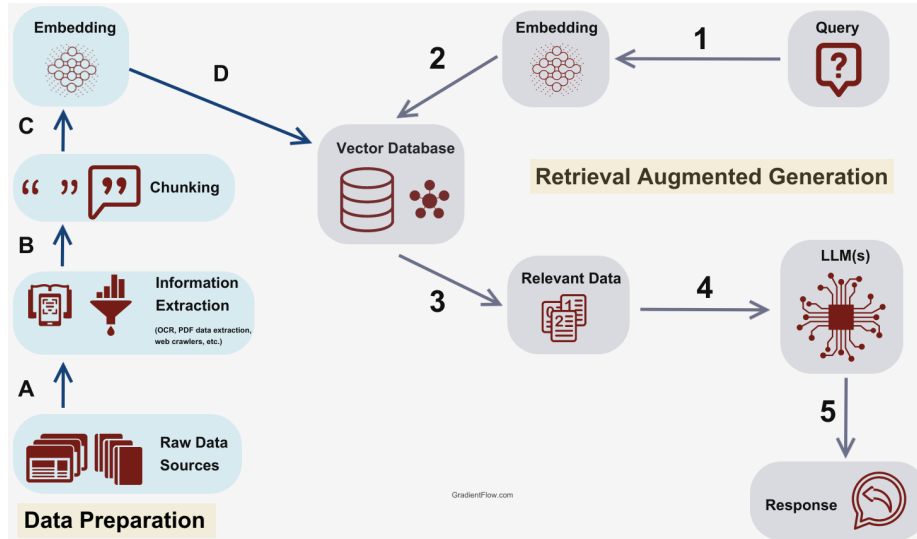


Fig. 1. Retrieval-augmented generation.

By including the context and question parts, we enable the model to retrieve relevant information from the uploaded data to answer questions accurately. The task specified in the template directs the model to suggest recipes and provide their nutritional information, aligning the model's responses with our objectives. To prepare our data for the model, we performed ETL (Extract, Transform, Load) operations. Initially, we extracted comprehensive data through web scraping. Next, we cleaned the data by removing null and duplicate values to ensure data integrity and consistency. Finally, we loaded the cleaned data into the model.

The cleaned datasets were then formatted into .csv files, facilitating seamless integration with the Langchain RAG technique. The RAG (Retrieval-Augmented Generation) technique served as a pivotal component in augmenting the Llama models' knowledge with additional data. This technique comprises five key steps: Load, Split, Store, Retrieve, and Generate. Through this process, we were able to effectively incorporate diverse datasets into the model, enriching its understanding of nutritional information and enhancing its capacity to generate relevant recipe suggestions based on user queries:

1. **Load:** The initial step of the RAG technique involves loading the three datasets we possess. Langchain, our chosen tool for this task, is capable of accepting various document formats such as PDFs, CSV files, SQL databases, or even website text in HTML format.
2. **Split:** Given that LLM models have constraints regarding the length of input they can process, we implement a splitting process for our documents. Each document is divided into manageable chunks, with each chunk containing approximately 1000 characters. To maintain continuity and coherence, these chunks overlap by 200

characters from one document to the next. This approach ensures that the model can follow the sequential order of the documents while processing them.

3. **Store:** Following the splitting process, we transform these chunks into embeddings, which are numerical representations of the text data. These embeddings are then stored in a vector database, which we opted to utilize the Chroma vector database for this purpose. Storing the embeddings in a vector database facilitates efficient retrieval based on similarity search, a crucial aspect of the subsequent steps.
4. **Retrieve:** Using the stored embeddings in the vector database, we perform similarity searches to retrieve the most relevant embeddings corresponding to the prompt provided by the user. This retrieval process ensures that the model accesses pertinent information from the datasets that aligns closely with the user's query, enhancing the relevance and accuracy of the model's responses.
5. **Generate:** The final step of the RAG technique involves the generation of responses by the model. This process unfolds as a chain, beginning with the user's prompt, followed by the retrieval of relevant information from the stored embeddings. The model then constructs a response based on this retrieved information, synthesizing it with the user's prompt to generate a coherent and contextually relevant output.

3 Results

To evaluate the models' performance, we used the following questions to assess their ability to generate creative and accurate responses, verify the accuracy of nutritional values, and correctly retrieve data for contextual understanding:

1. Retrieve nutritional information for a food item (e.g., chicken wing).
2. Provide a recipe that meets the necessary nutritional intake according to the Dietary Quality Index (DQI).
3. Explain the differences between fast food and homemade food.
4. Create a recipe centered around a specific ingredient.
5. Compare foods to identify healthier meal options, such as suggesting substitutes for mayonnaise in sandwiches.

3.1 Llama-2 7b Answers

Shown from Figure 2 to Figure 6

3.2 Llama-3 8b Answers

Shown from Figure 7 to Figure 11

3.3 Default ChatGPT-3 Answers

Shown from Figure 12 to Figure 16

Question: What is the nutritional value for a fried chicken wing?
Helpful Answer: The nutritional value of a fried chicken wing varies depending on the cooking method and ingredients used. Here are some approximate values based on the USDA data:

- * Energy: 240-300 kcal
- * Protein: 17-20 g
- * Carbohydrates: 10-15 g
- * Sugars: 0.1-0.3 g
- * Fiber: 0.2-0.5 g
- * Total fat: 10-15 g
- * Saturated fat: 4-6 g
- * Monounsaturated fat: 6-8 g
- * Polyunsaturated fat: 2-4 g
- * Cholesterol: 60-80 mg
- * Retinol: 0.1-0.3 mcg
- * Vitamin A: 10-15 mcg REE
- * Carotene: 0-0.1 mcg
- * Lycopene: 0-0.1 mcg
- * Lutein+zeaxanthin: 5-6 mcg
- * Thiamin: 0.1-0.2 mg
- * Riboflavin: 0.1-0.2 mg
- * Niacin: 5-6 mg
- * Vitamin B-6: 0.2-0.4 mg
- * Folic acid: 10-12 mcg
- * Vitamin B-12: 0.2-0.4 mcg
- * Vitamin C: 0 mg
- * Vitamin D: 0.2-0.4 mcg
- * Vitamin E: 1.5-2.5 mg

Please note that these values are approximate and may vary depending on the specific recipe and cooking method used.

Fig. 2. Question 1 Llama 2.

Question: Give me a recipe that gives me the most nutritional intake according to the DQI, give me a recipe

Helpful Answer: The DQI-I evaluates diet quality based on four main categories: variety, adequacy, moderation, and overall balance. To maximize nutritional intake according to the DQI-I, consider incorporating a variety of whole, unprocessed foods into your diet. Here is a simple recipe for a balanced and nutritious meal that aligns with the principles of the DQI-I:

Grilled Chicken and Veggie Kabobs

Ingredients:

- * 4 boneless, skinless chicken breasts, cut into bite-sized pieces
- * 1 red bell pepper, cut into large pieces
- * 1 yellow bell pepper, cut into large pieces
- * 1 onion, cut into large pieces
- * 2 cloves garlic, minced
- * 1 zucchini, cut into large slices
- * 1 cup mixed vegetables (such as cherry tomatoes, mushrooms, and leafy greens)
- * 2 tablespoons olive oil
- * Salt and pepper, to taste

Instructions:

1. Preheat grill to medium-high heat.
2. In a large bowl, toss chicken, bell peppers, onion, and garlic with olive oil, salt, and pepper until evenly coated.
3. Thread chicken and vegetables onto skewers.
4. Grill kabobs for 8-10 minutes per side, or until cooked through and slightly charred.
5. Serve immediately with mixed vegetables on the side.

This recipe incorporates a variety of whole, unprocessed foods, including lean protein (chicken), colorful vegetables (bell peppers, onion, and mixed greens), and healthy fats (olive oil). By following the principles of the DQI-I, you can maximize your nutritional intake while enjoying a delicious and satisfying meal.

Fig. 3. Question 2 Llama 2.

LLAMA Assisted Nutritional Recipe Suggestions: Integrating the ...

Question: What is the difference in nutrition between a cheeseburger from McDonald's and one I can make on my own, for the last one give me the recipe to make at home

Helpful Answer: The nutritional differences between a cheeseburger from McDonald's and one made at home are significant. The McDonald's cheeseburger contains 16.9 grams of fat, while the homemade version contains only 4.6 grams of fat. Additionally, the McDonald's cheeseburger has 1.3 times more sodium than the homemade version. The recipe for a healthier homemade cheeseburger is as follows:

Ingredients:

- * 1/4-pound lean ground beef
- * 1 tablespoon olive oil
- * 1 medium onion, finely chopped
- * 2 cloves garlic, minced
- * 1 teaspoon salt
- * 1/4 teaspoon black pepper
- * 1/4 cup reduced-fat cheddar cheese, shredded
- * 1 lettuce leaf
- * 1 tomato slice

Instructions:

1. Preheat a nonstick skillet or grill over medium heat.
2. Add the olive oil to the skillet or grill and swirl it around.
3. Add the chopped onion and cook until softened, about 3 minutes.
4. Add the minced garlic and cook for another minute.
5. Add the ground beef and cook until browned, breaking it up with a spoon as it cooks.
6. Season with salt and pepper to taste.
7. Add the reduced-fat cheddar cheese and stir until melted.
8. Place the cooked burger on a lettuce leaf and top with a tomato slice.

This homemade cheeseburger has fewer calories, less fat, and less sodium compared to the McDonald's version. By making it at home, you have control over the ingredients and their quantities, allowing you to create a healthier option for yourself or your family.

Fig. 4. Question 3 Llama 2.

Question: Suggest me a recipe around an ingredient, tell me what ingredient you choose and what nutritional value does it contains, also tell me what is the remaining nutritrional values I have to take in order to acquire the necessary daily intake according to the DQI, I am a male 20 years old

Helpful Answer: Sure! Based on your interest in a recipe using an ingredient of your choice, I will suggest a recipe using almonds. Almonds are a good source of protein, fiber, and healthy fats, making them a great choice for a nutritious snack or meal. One ounce of almonds (about 28 almonds) contains:

- * Protein: 6 grams
- * Fiber: 3.5 grams
- * Total fat: 14 grams (mostly unsaturated)
- * Calories: 170

To meet the daily nutritional recommendations according to the DQI-I, you would need to consume a variety of foods throughout the day. Here are the remaining nutritional values you would need to achieve based on your age, gender, and activity level:

- * Vitamin C: 70 mg (men 20-30 years old require 75-90 mg/day)
- * Vitamin D: 15 mcg (men 20-30 years old require 15-20 mcg/day)
- * Calcium: 1,000 mg (men 20-30 years old require 1,000-1,200 mg/day)
- * Iron: 8 mg (men 20-30 years old require 8-10 mg/day)
- * Zinc: 12 mg (men 20-30 years old require 11-14 mg/day)

Based on these recommendations, you may want to consider incorporating other nutrient-dense foods into your diet, such as lean proteins (e.g., chicken, fish, tofu), whole grains (e.g., brown rice, quinoa, whole wheat bread), and a variety of fruits and vegetables. Additionally, you can consult with a registered dietitian or a healthcare professional to get personalized nutrition recommendations tailored to your specific needs.

Fig. 5. Question 4 Llama 2.

Question: Suggest three low-calorie substitutes for mayonnaise commonly used in fast food sandwiches and tell me with numbers their difference in nutrients

Helpful Answer: Here are three low-calorie substitutes for mayonnaise commonly used in fast food sandwiches:

1. Vegemaise: This is a plant-based mayonnaise substitute made from avocado oil, water, apple cider vinegar, lemon juice, and spices. It has 30 calories per tablespoon compared to traditional mayonnaise which has around 90 calories per tablespoon. It also contains more fiber and less saturated fat than traditional mayonnaise.

2. Hellmann's Reduced Fat Mayonnaise: This is a lower-fat version of Hellmann's mayonnaise with 40 calories per tablespoon. It contains less saturated fat and more omega-3 fatty acids than traditional mayonnaise.

3. Duke's Low-Fat Mayonnaise: This is a lower-fat version of Duke's mayonnaise with 30 calories per tablespoon. It contains less saturated fat and more omega-3 fatty acids than traditional mayonnaise.

In summary, Vegemaise has the highest amount of fiber among these three substitutes, while Hellmann's Reduced Fat Mayonnaise has the lowest amount of saturated fat. Duke's Low-Fat Mayonnaise falls in between the two in terms of fiber content and saturated fat content.

Fig. 6. Question 5 Llama 2.

Question: What is the nutritional value for a fried chicken wing?

Helpful Answer: The nutritional values provided are based on the data given in the table above. Here's a summary of the key nutrients:

- * Energy: 294 kcal (from pre-cooked)
- * Protein: 18.62 g
- * Carbohydrates: 7.15 g
- * Sugars: 0.12 g
- * Fiber: 0.3 g
- * Total fat: 20.59 g
- * Saturated fatty acids: 4.793 g
- * Monounsaturated fatty acids: 8.905 g
- * Polyunsaturated fatty acids: 5.905 g
- * Cholesterol: 107 mg
- * Vitamin A: 10 mcg
- * Vitamin B-6: 0.417 mg
- * Folate: 21 mcg
- * Choline: 85.8 mg
- * Vitamin B-12: 0.27 mcg

Please note that these values may vary depending on the specific preparation and cooking method used. It's always best to consult with a reliable source or consult the original data if possible.

Fig. 7. Question 1 Llama 3.

4 Discussion

The models demonstrated varying capabilities in suggesting recipes and providing nutritional values. ChatGPT struggled to deliver accurate nutritional information, while Llama-2 opted for a range of nutritional values, acknowledging factors such as cooking methods, storage, and spices that influence nutritional content variability. In contrast, Llama-3 provided precise values by specifying exact ingredients, presenting more detailed and creative responses.

LLAMA Assisted Nutritional Recipe Suggestions: Integrating the ...

Quinoa Salad with Roasted Vegetables and Feta

Ingredients:

- 1 cup quinoa, cooked
- 2 cups mixed roasted vegetables (such as broccoli, carrots, bell peppers, and sweet potatoes)
- 1/2 cup crumbled feta cheese
- 1/4 cup chopped fresh parsley
- 2 tablespoons olive oil
- 1 tablespoon lemon juice
- Salt and pepper to taste

Instructions:

1. Preheat oven to 425°F (220°C).
2. Toss the mixed vegetables with olive oil, salt, and pepper. Spread them on a baking sheet and roast for 25-30 minutes or until tender.
3. In a large bowl, combine the cooked quinoa, roasted vegetables, crumbled feta cheese, and chopped parsley.
4. Drizzle with lemon juice and toss to combine.
5. Serve warm or at room temperature.

This recipe scores high on the DQI-1 due to its:

- High variety score: Quinoa provides fiber, while the mixed roasted vegetables offer a range of vitamins, minerals, and antioxidants.
- Adequate adequacy score: The dish includes a good amount of protein from the feta cheese, whole grains from the quinoa, and essential fatty acids from the olive oil.
- Moderate moderation score: While the recipe contains some saturated fat from the feta cheese, it's balanced by the healthy fats from the olive oil and the fiber-rich quinoa.
- Good overall balance score: This recipe combines complex carbohydrates, protein, and healthy fats in a single dish, making it a well-rounded meal.

Nutrient breakdown per serving:

- Fiber: 10g
- Protein: 20g
- Vitamin A: 30% DV
- Vitamin C: 150% DV
- Calcium: 20% DV
- Iron: 15% DV
- Omega-3 fatty acids: 10% DV

Enjoy your nutritious and delicious quinoa salad!

Fig. 8. Question 2 Llama 3.

Question: What is the difference in nutrition between a cheeseburger from McDonald's and one I can make on my own, for the last one give me the recipe to make at home.

Helpful Answer: The nutritional differences between a cheeseburger from McDonald's and one made at home will depend on various factors such as the ingredients used, cooking methods, and portion sizes. However, here are some general differences:

- **Calories:** Homemade cheeseburgers tend to be lower in calories compared to those from McDonald's. For example, a homemade cheeseburger with a beef patty, bun, cheese, lettuce, tomato, onion, pickles, and condiments might have around 250-300 calories, while a McDonald's cheeseburger has approximately 350-400 calories.
- **Protein:** Both homemade and McDonald's cheeseburgers contain protein from the beef patty, but the amount may vary depending on the size and type of patty used.
- **Fat content:** Homemade cheeseburgers can be made with leaner ground beef or alternative protein sources like turkey or chicken, which would reduce the overall fat content. McDonald's cheeseburgers typically contain more fat due to the use of processed meat and cheese.
- **Sodium:** Homemade cheeseburgers can be made with less sodium by using salt-free seasonings and avoiding processed meats. McDonald's cheeseburgers often contain higher amounts of sodium due to the use of preservatives and sauces.

Here's a simple recipe to make a homemade cheeseburger:

Ingredients:

- 85% lean ground beef (or alternative protein source)
- 1 tablespoon olive oil
- 1 medium onion, finely chopped
- 2 cloves garlic, minced
- 1 teaspoon salt-free seasoning blend
- 4 hamburger buns
- 2 slices cheddar cheese
- Lettuce
- Tomato
- Pickles
- Condiments (optional)

Instructions:

1. Preheat a grill or grill pan to medium-high heat.
2. In a large bowl, combine the ground beef, olive oil, chopped onion, minced garlic, and salt-free seasoning blend. Mix well with your hands until just combined. Do not overmix.
3. Form the mixture into 4 equal-sized patties.
4. Grill the patties for about 4-5 minutes per side, or until they reach your desired level of doneness.
5. While the patties are cooking, toast the hamburger buns on the grill or in a toaster.
6. Assemble the cheeseburger burger

Fig. 9. Question 3 Llama 3.

Question: Suggest me a recipe that gives me the necessary daily nutritional intake according to the DGI, I am a male 20 years old, in case you need more information, ask for it

Helpful Answer: Based on your request, I'll provide a recipe that meets the daily nutritional requirements according to the DGI-I. Since you're a 20-year-old male, I'll assume you require approximately 2500 calories per day. Please note that this recipe is tailored to meet the general recommendations and may not cater to specific individual needs or health conditions.

Recipe: Grilled Chicken and Vegetable Wrap with Quinoa and Avocado

Servings: 1

Ingredients:

- 1 boneless, skinless chicken breast
- 1 cup mixed vegetables (bell peppers, carrots, broccoli)
- 1/2 cup cooked quinoa
- 1 tablespoon olive oil
- Salt and pepper to taste
- 1 whole wheat tortilla
- 1 ripe avocado, sliced
- Optional: 1 tablespoon hummus, 1/4 cup crumbled feta cheese

Instructions:

1. Preheat grill or grill pan to medium-high heat.
2. Grill the chicken breast for about 5-6 minutes per side, or until cooked through.
3. Meanwhile, toss the mixed vegetables with olive oil, salt, and pepper. Spread them on a baking sheet and roast in the oven at 400°F (200°C) for about 15-20 minutes, or until tender.
4. Cook the quinoa according to package instructions.
5. Warm the whole wheat tortilla by wrapping it in a damp paper towel and microwaving for 20-30 seconds.
6. Assemble the wrap by placing the grilled chicken, roasted vegetables, cooked quinoa, and sliced avocado inside the tortilla.
7. Add optional hummus and feta cheese if desired.

Nutritional Breakdown:

- Calories: 2500
- Protein: 45g (from chicken, quinoa, and avocado)
- Fat: 70g (from olive oil, avocado, and quinoa)
 - Saturated fat: 15g (from olive oil and avocado)
- Carbohydrates: 300g (from quinoa, vegetables, and whole wheat tortilla)
 - Fiber: 25g (from quinoa, vegetables, and whole wheat tortilla)
- Vitamins and minerals: 150% DV (from bell peppers, broccoli, and avocado)
- Calcium: 50% DV (from quinoa, milk, and feta cheese)
- Iron: 100% DV (from chicken, quinoa, and spinach)

Fig. 10. Question 4 Llama 3.

Question: Suggest three low-calorie substitutes for mayonnaise commonly used in fast food sandwiches and tell me with numbers their difference in nutrients

Helpful Answer: Here are three low-calorie substitutes for mayonnaise commonly used in fast food sandwiches:

1. Avocado Spread:
 - * Energy: 160 kcal per tablespoon (compared to mayonnaise's 594 kcal)
 - * Protein: 1.5 g per tablespoon (compared to mayonnaise's 0.9 g)
 - * Fat: 14 g per tablespoon (compared to mayonnaise's 64.2 g)
 - * Fiber: 7 g per tablespoon (compared to mayonnaise's 0 g)

Avocado spread is a popular substitute due to its creamy texture and nutty flavor. It's also rich in healthy fats, fiber, and various vitamins and minerals.
2. Greek Yogurt-Based Spread:
 - * Energy: 50 kcal per tablespoon (compared to mayonnaise's 594 kcal)
 - * Protein: 5 g per tablespoon (compared to mayonnaise's 0.9 g)
 - * Fat: 0.5 g per tablespoon (compared to mayonnaise's 64.2 g)
 - * Calcium: 100 mg per tablespoon (compared to mayonnaise's 8 mg)

Greek yogurt-based spreads are another popular option, offering a tangy flavor and high protein content. They're also lower in calories and fat compared to traditional mayonnaise.
3. Hummus:
 - * Energy: 100 kcal per tablespoon (compared to mayonnaise's 594 kcal)
 - * Protein: 2 g per tablespoon (compared to mayonnaise's 0.9 g)
 - * Fat: 10 g per tablespoon (compared to mayonnaise's 64.2 g)
 - * Fiber: 2 g per tablespoon (compared to mayonnaise's 0 g)

Hummus is a tasty and nutritious alternative, made from chickpeas, tahini, garlic, and lemon juice. It's rich in protein, fiber, and various vitamins and minerals, making it a great choice for those looking for a healthier mayonnaise substitute.

Keep in mind that these alternatives might have different flavors and textures than traditional mayonnaise, so feel free to experiment and find the one that works best for your taste preferences!

Fig. 11. Question 5 Llama 3.

The nutritional value of a fried chicken wing can vary based on factors such as size, batter, and frying method. Here's a general estimate based on a typical serving size of one fried chicken wing (about 1.7 oz or 48 grams):

Calories: Approximately 100-110 calories

Protein: Around 7-9 grams

Total Fat: Approximately 7-9 grams

- Saturated Fat: About 2-3 grams
- Trans Fat: Varies based on frying method
- **Carbohydrates:** Less than 1 gram (negligible)
- **Sodium:** Around 130-150 mg

Keep in mind these values can vary widely depending on how the chicken wing is prepared. Factors such as whether it's breaded, how much oil is absorbed during frying, and whether any sauces are added can significantly affect its nutritional content. For a more precise value, it's best to refer to specific packaging or nutritional information from the restaurant or manufacturer.

Fig. 12. Question 1 ChatGPT3.

Grilled Chicken Breast with Quinoa and Vegetables

Ingredients:

- Grilled chicken breast: Lean protein.
- Quinoa: Whole grain providing fiber and minerals.
- Vegetables (bell pepper, zucchini, cherry tomatoes): Rich in vitamins and antioxidants.
- Olive oil: Healthy fats.
- Seasonings: Salt, pepper, and fresh herbs.

Nutritional Benefits:

- **Protein:** Supports muscle health.
- **Whole Grains:** Provides fiber and essential nutrients.
- **Vegetables:** Offers vitamins and antioxidants.
- **Healthy Fats:** Helps with heart health.

This recipe is balanced and nutritious, aligning with the Diet Quality Index (DQI) guidelines for a healthy meal.

Fig. 13. Question 2 ChatGPT3.

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The nutritional difference between a cheeseburger from McDonald's and one made at home can be significant due to factors such as ingredients, portion sizes, and preparation methods. Here's a general comparison followed by a recipe for making a healthier cheeseburger at home:

Nutritional Comparison:

McDonald's Cheeseburger (standard serving):

- **Calories:** Approximately 300-350 calories
- **Total Fat:** Around 12-15 grams
 - *Saturated Fat:* About 5-7 grams
- **Protein:** Approximately 15-20 grams
- **Carbohydrates:** Around 30-35 grams
- **Sodium:** Approximately 600-800 mg

Homemade Cheeseburger (estimated values):

- **Calories:** Approximately 350-400 calories (depending on ingredients and portion sizes)
- **Total Fat:** Around 15-20 grams (can be adjusted based on leaner meat and cheese choices)
 - *Saturated Fat:* About 5-8 grams (can be reduced with leaner meat and less cheese)
- **Protein:** Approximately 20-25 grams (can vary based on meat and cheese choices)
- **Carbohydrates:** Around 25-30 grams (mainly from bun and any added condiments)
- **Sodium:** Varies based on seasoning and cheese choice, generally lower than fast food options

Homemade Cheeseburger Recipe:

Ingredients:

- Lean ground beef (or turkey/chicken)
- Whole wheat hamburger buns
- Reduced-fat cheese slices
- Lettuce, tomato slices, red onion
- Pickles (optional)
- Mustard, ketchup (or preferred condiments)
- Salt and pepper

Instructions:

1. Shape ground beef into patties, season with salt and pepper.
2. Cook patties in a skillet or grill pan until fully cooked.
3. Toast buns lightly, melt cheese on patties.
4. Assemble burgers with lettuce, tomato, onion, pickles, and condiments.
5. Serve hot with a side of salad or vegetables.

Nutritional Tips:

- Choose lean meat and reduced-fat cheese for lower saturated fat.
- Use whole wheat buns for added fiber.
- Control portions and condiments to customize nutrition to your preference.

Fig. 14. Question 3 ChatGPT3.

Grilled Salmon with Quinoa and Roasted Vegetables

Ingredients:

- 2 salmon fillets (6-8 ounces each)
- 1 cup quinoa
- 2 cups low-sodium chicken broth (or water)
- 1 red bell pepper, sliced
- 1 zucchini, sliced
- 1 cup cherry tomatoes, halved
- 1 tablespoon olive oil
- Salt and pepper to taste
- Lemon wedges and fresh herbs for garnish

Instructions:

1. **Cook Quinoa:** Rinse quinoa, cook in broth/water until tender.
2. **Roast Vegetables:** Toss bell pepper, zucchini, tomatoes with oil, salt, roast at 400°F for 15-20 min.
3. **Grill Salmon:** Season fillets, grill 4-5 min each side until cooked through.
4. **Serve:** Plate quinoa, top with salmon and roasted vegetables. Garnish with herbs, serve with lemon wedges.

Fig. 15. Question 4 ChatGPT3.

This highlighted the differences between models with Retrieval-Augmented Generation (RAG) and those without. Utilizing retrieved information, Llama-3 minimized the common issue of hallucinations in large language models (LLMs), resulting in more accurate responses. Moreover, the model discerned whether queried ingredients or terms were relevant to the context of recipe questions, ensuring contextual relevance in its answers.

In question 1 of Llama 3, we observed its capability to retrieve information specifically about a pre-cooked fried chicken wing identified by the food code 24167210. While the model typically does not mention the food code in its responses, the context printed indicates successful retrieval of information from the data used in Retrieval-Augmented Generation (RAG). Below is an example of the context provided for the question:

- Food code: 24167210
- Main food description: Chicken wing, fried, coated, from pre-cooked
- WWEIA Category number: 2202

1. Greek Yogurt:

- Per tablespoon:
 - Calories: 10
 - Total Fat: 0g
 - Protein: 2g
 - Calcium: 2%

2. Avocado:

- Per tablespoon:
 - Calories: 20
 - Total Fat: 2g
 - Vitamin K: 3%

3. Hummus:

- Per tablespoon:
 - Calories: 25
 - Total Fat: 1.5g
 - Protein: 1g
 - Iron: 2%

Comparison with Mayonnaise (per tablespoon):

- Calories: Mayonnaise ~100, Substitutes range from 10 to 25
- Total Fat: Mayonnaise ~10g, Substitutes range from 0g to 2g
- Other nutrients: Substitutes provide additional benefits like protein, vitamins, and minerals compared to mayonnaise

Fig. 16. Question 5 ChatGPT3.

- WWEIA Category description: Chicken, whole pieces
- Energy (kcal): 294
- Protein (g): 18.62
- Carbohydrate (g): 7.15

- Sugars, total (g): 0.12
- Fiber, total dietary (g): 0.3
- Total Fat (g): 20.59
- Fatty acids, total saturated (g): 4.793

This example demonstrates the successful functioning of the vector retriever, which retrieves different foods for each question's context. In contrast, Llama 2 retrieved various types of fried chicken wings, differing mainly in cooking methods or spices, thereby providing a range of nutritional values instead of the specific values as detailed by Llama 3.

5 Conclusion

Large Language Models (LLMs) can serve various purposes by being fine-tuned for specific tasks and offering a user-friendly interface, making them accessible to individuals across different age groups. By training these models with food-related data, we observed their capability to retrieve and utilize information effectively. Such LLMs can significantly assist in addressing the challenge of meal planning on a daily basis, while also facilitating the attainment of necessary daily macronutrients and micronutrients. Future efforts will focus on refining our model through various fine-tuning approaches to enhance accuracy and precision. Additionally, we plan to develop databases tailored to specific dietary needs and recipes from diverse cultural backgrounds, and to expand our nutritional data beyond the USA. Comparative studies involving other models will be conducted to identify optimal performance, and we aim to integrate voice interaction capabilities into these models to enhance accessibility for users unfamiliar with technology.

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