



Personalized Healthy Anti-COVID Menu Generator Chatbot Based on Prolog

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Abstract- It is a healthy diet that creates conditions for human life, ensuring the optimal functioning of all processes in the body. Of course, a healthy diet cannot be a protection against the penetration of infection into the body, but it is the balanced and full-fledged nature of the diet that creates the conditions for the formation of a timely and adequate immune response. In order to help consumers in getting more balanced and healthy diet, we created a personalized Healthy Menu Generator Chatbot, based on Prolog Knowledge base. The user request is constructed by user in a subset of English Language by using Request Fragments from a list. Cross-translation of the user request and its execution in the Prolog Execution Environment is extensively covered in the paper.

Keywords— chatbot, personal advisor, healthy menu, menu generator, cross-translator

I. INTRODUCTION

Nutrition is one of the main factors affecting human health. A healthy diet has a multicomponent protective effect on health and the prognosis of a person's life as a whole, which justifies adherence to this diet in any conditions of existence. It is a healthy diet that creates conditions for human life, ensuring the optimal functioning of all processes in the body. Of course, a healthy diet cannot be a protection against the penetration of infection into the body, but it is the balanced and full-fledged nature of the diet that creates the conditions for the formation of a timely and adequate immune response [1-4]. Due to the worldwide spread of the infectious disease COVID-19 (COroNaVIrus Disease 2019) caused by the new SARS-CoV-2 coronavirus, the introduction of quarantine measures in many countries and the conditions of long-term isolation that have arisen in people, the problems that were noted earlier, but affected only certain groups of patients and therefore were not widely covered. However, at present they have become practically life-saving. At the current moment, the relevance of issues related to nutrition is due to two significant reasons:

- an increase in the risk of developing an infectious disease,
- a long stay of people at home.

Within the first block, recommendations on healthy eating were supplemented with the rules of personal hygiene, sanitary and hygienic processing of food products, technological conditions for food preparation, optimal temperature conditions for storing food, etc. products with a longer shelf life until direct compliance with the recommended composition, amount of food consumed and diet. The latter are aimed at controlling the development of macro- and micronutrient deficiencies and the prevention of alimentary-dependent risk factors for chronic non-infectious diseases, taking into account the concomitant isolation of restrictions on motor activity.

Therefore, in connection with the growing spread of the new coronavirus infection, experts from the World Health Organization and the nutritional communities began to supplement the recommendations on healthy eating with the rules that are relevant for the current moment, highlighting the necessary accents.

The experts place the next emphasis on the prevention of alimentary-dependent risk factors for chronic non-infectious diseases. The conditions of long-term isolation are often accompanied not only by a violation of the nature of the diet, but also by the regime, when the intervals between the main meals decrease, supplemented by “snacks,” “tea with sweets,” an increase in the portion of food consumed and, as a consequence, an increase in the energy load. diet, which, with reduced physical activity, contributes to the development of alimentary-dependent risk factors. Therefore, the emphasis of the recommendations is aimed at strengthening control over eating behavior: the consumption of an adequate amount of food, the absence of excess consumption of salt, added sugar, saturated fats and trans isomers of fatty acids, alcohol, adherence to the diet, as well as an adequate drinking regimen [2 -7].

Another emphasis that experts draw attention to is the risk of the formation of deficiency states caused by both a monotonous type of diet and rare exits from home. Experts point out the need for daily monitoring of the consumption of some nutrients.

First of all, it concerns the animal protein and vegetables, which are present in the diet is mandatory and is essential for the functioning of the immune system. The need for protein varies depending on the physiological state; on average, it is recommended not less than 0.83 g of protein per 1 kg of body weight, which is 58 g per day for an adult weighing 70 kg [5]. The second important point is the supply of vitamin D. The best source of vitamin D is the sun, but during quarantine or self-isolation it is difficult to get enough sunlight to meet the needs. Therefore, people who cannot go outside are advised to prioritize vitamin D-rich foods (salmon, sardines, eggs, liver, vitamin-fortified dairy products, UV-treated mushrooms) and consider taking vitamin D daily. The recommended intake of vitamin D is : 15 mcg / day for adults (over 18 years old), children (1-17 years old) and pregnant women; 10 mcg / day for children (up to 11 months). If you have access to an open window, garden or balcony, short periods (15-30 minutes) of daily sun exposure are recommended [5]. The British Dietetic Association recommends a dose of 10 mcg / day of vitamin D for adults. [3].

The possible problem of malnutrition in isolation among some groups of patients is considered in the recommendations of British colleagues [3]. Experts provide advice on the nature of nutrition and drinking regimen for patients with diabetes mellitus, celiac disease, ulcerative colitis, food allergies, for pregnant women and children [3]. Experts of the British Dietetic Association inform the population about incorrect information about dietary supplements (BAA) actively advertised during the spread of COVID-19 infection, drawing attention to the fact that taking these drugs can be hazardous to health, and strongly advise not to take new dietary supplements without doctor's prescription [3]. Experts emphasize that “no functional food or supplements will prevent you from becoming infected with COVID-19 / Coronavirus” and “no dietary supplement is able to “ boost ”the immune system above normal levels,” and argue evidence-based medicine that “a properly balanced nutrition contributes to the normal functioning of the immune system ”[2-4, 8].

"What kind of diet boosts immunity?" - the most frequent question that is now addressed to nutritionists around the world. Nutrient diversity is the basis of a protective diet. A diet high in dietary fiber, vitamins, minerals, probiotics and prebiotics continues to be a priority in maintaining health. This is a diet rich in vegetables, fruits, berries, nuts, seeds, lettuce greens, cereals (preferably whole grains), vegetable oils and dairy products, low in fat and adequate in protein. It is imperative to limit the consumption of salt, added sugar and trans-isomers of fatty acids, the content of which is very typical for products of deep technological processing, such as sausages, meat delicacies, sugary drinks, savory snacks, instant food [1, 3, 7, 9-11].

It is becoming increasingly clear that the development of a personal assistant is needed to advise consumers on how to eat as balanced a diet as possible so as to minimize the chance of having a bad illness.

Based on the review, we can conclude that foods that help lower blood sugar play a beneficial role. At the same time, foods that increase pH and alkalinity in the body should be recommended because, as is well known, an acidic environment is good for the development of bacteria and viruses.

In addition, a strategy should be used to maintain an optimal body weight - neither too high nor too low. After a thorough review, we considered that such an optimal strategy is "Zone" [13]. This method provides an opportunity for optimal balancing of the amounts of protein, carbohydrates and fats, adapted to personal weight, age, activity rate, neck and abdomen circumference, etc. sizes. A unit of measurement "zone block" has been introduced per unit amount of carbohydrates, fats and proteins, in which they are in an optimal ratio. Each person should eat a certain maximum amount of zone blocks per day to lose weight successfully or another minimum amount to gain weight successfully or an average amount to maintain their current weight if it is healthy.

If we combine the "Zone" methodology with other methods, such as restricting foods that increase blood sugar fluctuations and consuming mostly alkalizing foods that reduce the body's acidity, and we can formalize

the use of these strategies well enough to allow the use of means for computer generation of optimal menus, this would largely satisfy the objectives of current scientific work.

Therefore, we can set the following main goals of the present development, namely:

- Creation of an automated generator of a healthy menu, which will provide a balanced menu according to the methodology "Zone", which should include mainly alkalizing foods that do not fluctuate too much in blood sugar levels.
- Preference should be given to foods rich in fiber when possible;
- The user should be able to choose food products which:
 - does not want to combine;
 - does not want to participate in the menu;
 - wants to participate in the menu;
- The user should be able to enter a number of food blocks according to the "Zone" methodology, to which the generated menu should correspond.

It is worth noting that during the review we did not find many well-made software tools with the ability to generate custom health menus that combine more than one strategy. For example, it is full of mobile applications that in dialog mode help the user to "balance" the menu according to the "Zone" methodology, but we did not find automated menu generators using this methodology, or using other methodologies besides this one.

II. OUR APPROACH

Based on the review, we created a test prototype of a software system that is a chatbot implemented in languages and APIs: PHP 7, Python 3, PySwip (Python library that provides Prolog functionality), SQLite3 (used for The Knowledge Base with the Products, the Knowledge Base with the Prolog predicates for each product, the Knowledge Base with the general rules and facts in Prolog, as well as the knowledge base for the rules for cross-translating a Fragment from a request to a question to the Prolog execution environment).

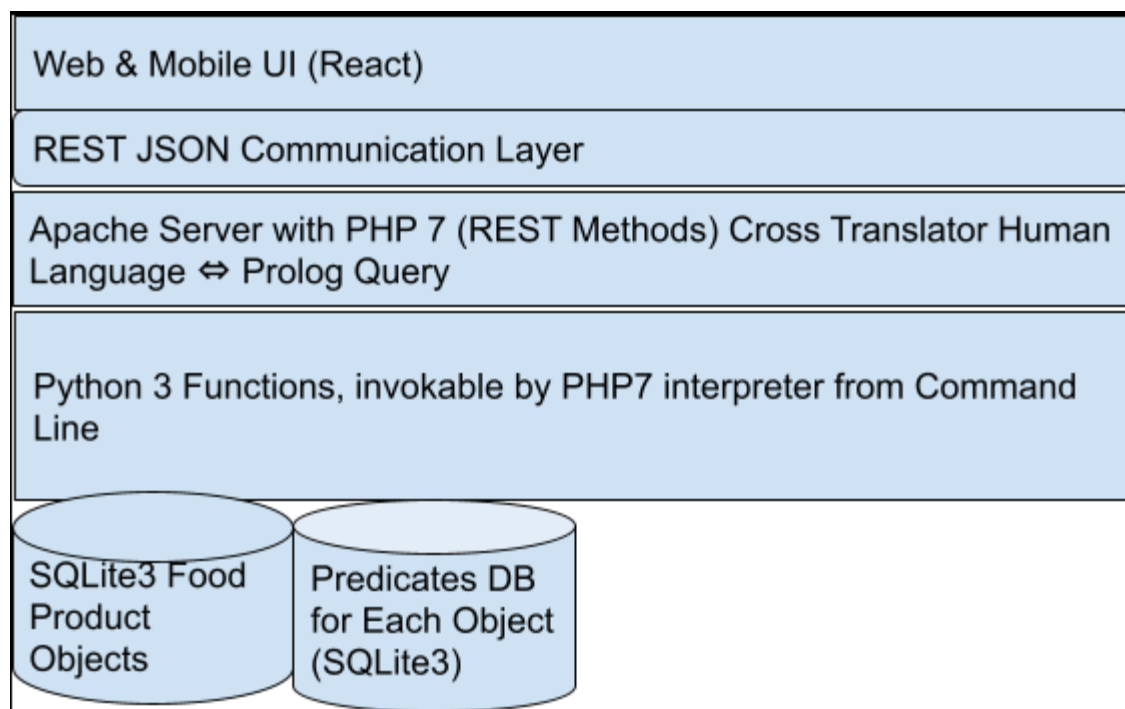


Figure 1. Block diagram of the software prototype

As shown in Figure 1, the architecture is flexible enough to allow the development of various UI environments and applications, including mobile and desktop applications, to consume the REST services provided by the Apache PHP server. The UI environment appropriately describes the templates by which the This list of user explanations is automatically generated based on the list of possible templates. Figure 2 shows an overview of the web-based user interface, which provides the user with a list of all possible query fragments that he can use to describe his query to generate a custom menu. The user must use each new query fragment on a new line of his query and some types of fragments can be used more than once, such as all but "Generate menu for... Zone blocks", because there is no way to set different values blocks according to the methodology "Zone" in the same user request.

Example Query Fragments (Use Each Fragment in New Line):

```

Generate menu for \s+(.*)\s*\ Zone Blocks

Exclude product \s+(.*)\s*\

Include product \s+(.*)\s*\

Do not combine \s+(.*)\s*\ and \s+(.*)\s*\

```

Your Query:

Figure 2. GUI of the chat bot, showing possible fragments of a user question

In this way, in a language that is intuitive and easy to use, the user can very easily construct his query.

PHP implements a cross-translator that translates a user request from a list of templates and rules for transformation to a question in the Prolog Knowledge Base, consisting of a system of rules and facts for each object (real food) in the database of food and logical an expression of predicates for each product compiled for the Prolog language.

```

4 $transform=[
5 "Generate menu for \s+(.*)\s*\ Zone Blocks "=>"num_blocks_eq($1, X_list).",
6 "Exclude product \s+(.*)\s*\ "=>"exclude($1, X_list).",
7 "Include product \s+(.*)\s*\ "=>"include($1, X_list).",
8 "Do not combine \s+(.*)\s*\ and \s+(.*)\s*\ "=>"no_combine($1, $2, X_list).",
9
10 ];
11

```

Figure 3. PHP associative array that specifies the rules for transformation in cross Translator

Figure 3 presents the rules by cross Translator, which is implemented in PHP and translated fragments of the application, each of which is a new line in consumer demand, to a question to the Prolog execution environment. It makes use of regular expression and replacement rules by using PHP `preg_replace` function iteratively.

Each of the objects in the Knowledge Base with its objects has a unique identifier that matches the name of its usage in the Prolog environment with which it participates in the rules and facts. In this way, the connection between the Knowledge Base with the objects and the specific rules and facts concerning the specific object in Prolog is ensured.

For each of the values in the associative array of Figure 3, there is a pre-implemented or corresponding rule or system of facts in the Prolog execution environment. The variable `X_list` is initialized with the current list of possible lists of products and their weights (i.e. possible solutions), which are subject to filtering at the respective step.

Here is how the execution of the user request is performed:

1. Prolog first executes the request for generating a user menu for a specific number of blocks according to the methodology "Zone"; It returns lists of lists of product identifiers, along with weights in grams for each product;
2. For each of the product lists, exclude this list, which does not include a product that came from the "Include Product" fragment;
3. If the user has specified a product in the fragment "Include Product", which is missing in the Knowledge Base of products, already during the phase of cross-compilation of the request to the Prolog question, an exception and error message will be generated to the user;

4. For each of the product lists, exclude this list, which includes a product that came from the "Exclude Product" fragment;
5. For each user fragment of a request of the type "Do not combine" excludes those from the lists in which there are both products cited in the user request;
6. If the list of product lists and their weights is not blank, return the first one.
7. If the list of 6. is empty, a message is displayed to the user that his request is unenforceable;
8. Product identifiers in the list, which is to be returned to the user, are replaced with user readable product names.

The Food Knowledge Base itself is pre-optimized by selecting plant products with higher amounts of fiber, as well as those that increase the body's pH and make the body environment more alkaline. Also excluded are products that are listed in the diet tables according to the "Zone" methodology as "bad carbohydrates" and "bad fats", which have too high energy value in the respective category.

Currently the menu generation is tested with a database with very few products with incomplete data for each of them. Further tests are needed with larger number of products and greater knowledge of rules and facts which product groups can be combined with other product groups and which cannot. For example, fish and yoghurt is a bad combination, but if this fact is not mentioned in the knowledge base, this combination can be returned to the user.

III. CONCLUSIONS

Objectives thus set out in the Introduction have been largely achieved. Thanks to the use of the first-order predicate logic engine Prolog, it became possible to create a quick and easy prototype of a custom menu generator.

Due to the overly generalized heuristic algorithms in Prolog, which return quite a lot of possible solutions to be filtered, it may be considered to improve the performance of the query result using other approaches, such as various simplex methods in Graph Theory, Multidimensional spaces, etc. Previous publications have presented a relatively efficient algorithm based on vector calculus and proximity finding in multidimensional spaces. The same strategy could be applied here.

Knowledge-base for products and facts and rules for them needs to be significantly extended by automatic scanning food product data across the internet by a linguistic crawler, which is going to be a matter of a further development.

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