AN APPLICATION OF CONVERSATIONAL SYSTEMS TO PROMOTE HEALTHY LIFESTYLE HABITS

ACCEPTED ARTICLE

David Griol, Zoraida Callejas
Dept. Software Engineering
Universidad de Granada
Granada, Spain
{dgriol, zoraida}@ugr.es

Fernando Fernández-Martínez
Infor. Proc. and Telecommunications Center
Universidad Politécnica de Madrid
Madrid, Spain
fernando.fernandezm@upm.es

Anna Esposito
Dept. of Psychology
Università Degli Studi Della Campania Luigi Vanvitelli
Caserta, Italy
anna.esposito@unicampania.it

This is an "accepted article" version in the authors employers website, corresponding to the paper:

D. Griol, Z. Callejas, F. Fernández-Martínez and A. Esposito, "An application of conversational systems to promote healthy lifestyle habits," *2022 IEEE Intl Conf on Dependable, Autonomic and Secure Computing, Intl Conf on Pervasive Intelligence and Computing, Intl Conf on Cloud and Big Data Computing, Intl Conf on Cyber Science and Technology Congress (DASC/PiCom/CBDCom/CyberSciTech)*, Falerna, Italy, 2022, pp. 1-6, https://doi.org/10.1109/DASC/PiCom/CBDCom/Cy55231.2022.9927835.

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ABSTRACT

Recent reports indicate the multiple benefits of adopting conversational systems for healthcare, providing automation of management tasks in overburdened healthcare systems, improved patient experiences, and better efficiency and productivity rates. In this paper, we describe a conversational system aimed at promoting healthy lifestyle habits related to nutrition and physical exercise. The system has been developed using Google's Dialogflow platform and the combination of different APIs and data repositories in the cloud. It has been integrated in the Facebook Messenger instant messaging platform. The results of the preliminary assessment of the system through a subjective questionnaire show the high degree of satisfaction of the users with the functionalities provided and the help offered to allow fulfilling the predefined objectives.

***K*eywords** Conversational systems, dialog systems, healthcare, healthy habits.

1 Introduction

The main goal of adopting a healthy life by means of doing regular exercise, having a healthy diet, and good rest is more and more widespread [1, 2, 3] as adequate nutrition and daily physical activity are necessary factors for optimal health. However, such objectives are not always easy to attain.

Conversational systems [4, 5, 6] and all the technology they encompass are experiencing a boom in recent years, with several studies indicating that the market for conversational interfaces will reach $24.9 billion by 2025 [7]. These systems can be defined as "those computer systems with which it is possible to communicate by having a conversation in natural language, either written or spoken" [5]. Conversational systems are currently used in a multitude of applications related to automatically provide information, question answering tasks and resolution of procedures with different complexity levels. Successful application domains include retail and e-commerce; travel and hospitality; banking, finance, and fintech; e-government; healthcare; media and entertainment; education and e-learning [4].

Conversational systems have a long history in healthcare [8]. On the one hand, they can be used for medical appointment management. In this way, patients can make an appointment by having a natural language conversation with an agent. On the other hand, new applications linked to the field of preventive medicine are appearing. Thus, systems are being developed that provide advice for acquiring healthy lifestyle habits such as regular exercise, a healthy diet, or the use of sunscreen [9]. Opportunities are also being created for self-monitoring of chronic diseases or recovery at home after hospital discharge. In this case, the systems can advise on how to perform exercises or activities aimed at recovery and also ask questions to assess the patient's situation and, if necessary, redirect the patient to his or her physician [10, 11].

In this paper, we present a conversational system oriented to those people interested in healthy lifestyle habits, both in the field of nutrition and physical exercise. The system has been developed using the Google's Dialogflow platform [1] and integrates different APIs offered by the Edamam platform[2] for the nutrition topics, a database built in Mongo with nutritional knowledge, a database built in Mongo with training routines, and another database built in Firebase to relate workouts and nutrition guidelines. In addition, the conversational system has been integrated into Facebook Messenger to facilitate the use and access by end users. A key challenge to develop the system has been the design of the conversation flow to provide a more natural and open conversation in terms of the different requests that users can make.

The remainder of the paper is as follows. Section 2 describes the benefits and related applications of conversational systems for healthcare applications. Section 3 presents the conversational system that we have developed to promote healthy lifestyle habits, their components, and main functionalities. Section 4 presents the result of the preliminary assessment of the conversational system by means of a subjective questionnaire. Finally, Section 5 presents the main conclusions and future research lines.

2 State of the art

As described in the previous section, computer programs using conversational functionalities are growing popular among healthcare institutions and organizations [12, 13, 14]. Current application domains include promoting physical activity, fruit and vegetable consumption, accessibility to online health information, among other outcomes. In the

[1] https://dialogflow.cloud.google.com/

[2] https://www.edamam.com/

coming few years, we can expect healthcare conversational systems and chatbots monitoring health status in real-time, automatically calling for assistance in case of an emergency, helping manage chronic conditions and mental health issue, proactively identifying symptoms, improving the treatment success rate, providing timely medical advice, etc.

There are a large number of applications for mobile devices that help their users to lead a healthy life: Endomondo, Sports Tracker, Runkeeper, Runbit, Fitbit, 8Fit, Fabulous, Skimble Personal Trainer, Freeletics, Misfit, Fitwell, MyFitnessPal, MyRealFood, Noom, Lose It!, etc. These apps help in specific aspects and activities related to healthy living. However, they usually require being very attentive to them, registering a lot of information, using calendars, etc. In addition, none of the applications allow conversational interaction, which makes them less user-friendly.

As for the existing conversational systems or chatbots already deployed in Facebook Messenger including Artificial Intelligence, the more completed ones are the following. Forksy[3] is a chatbot that helps users to improve their eating habits. It is available on Facebook Messenger as well as Telegram and Viber. At the beginning of the conversation, the chatbot explains its main functionalities. Later, it introduces itself and inquires about food intake. Although it works using buttons, the user can also provide inputs in natural language using an editor. The chatbot can also maintain simple and restricted conversations with the user. An interesting feature is that it complements the information by incorporating links to specific websites providing more detailed information, the meals to a personalized diary, etc. It is one of the most useful chatbots currently available with respect to nutrition guidelines.

Fitwell Coach[4] is integrated into the Fitwell app. It is a conversational agent that can be accessed by means of Facebook Messenger and provides ways to have a healthy lifestyle. The application initially displays images and provides a brief presentation. Then, it asks whether it is the first time using the system and asks a series of specific questions to guide the conversation. It also works with buttons and allows selecting among different options to continue the conversation. It is also able of sending reminders related to the previous interactions, ask if the user has completed the workouts, send jokes, etc. Fitwell gives advice according to the user's preferences and links to different resources on fitness, healthy living, etc. It also proposes different types of training according to the user's preferences. However, it is not able to answer questions referring to nutrition guidelines. Moreover, it only let users to inquire about a reduced set of restricted questions.

Daily Fitbot[5] is a chatbot integrated into Facebook Messenger that is able to send daily workouts that can be completed at home or outdoors. At the beginning of the interaction, the chatbot welcomes the user and makes a brief presentation of its main functionalities. It is able to send daily wellness-related guidelines, different workouts, links to videos where it teaches how to do these types of exercises, etc. However, the user cannot talk to the system directly. In addition, the system works through buttons, which greatly restricts the possibilities of users' interactions. In the same way as the Fitwell Coach chatbot, this detracts from the conversational aspect. Another feature of Daily Fitbot is that it does not personalize the workouts, i.e., it does not ask the user questions to what they prefer or suits their personal conditions.

FitCircle[6] is another of the most complete chatbots in this application domain. Its main functionality is to provide users with a range of five-minute workouts. As for the previously described chatbots, it uses buttons to guide the conversation. However, there is also the possibility for the user to write the messages. After answering a series of questions, this bot is able to send by email a personalized diet according to the responses provided in a questionnaire. As for training topics, it links to different five-minute workouts and explains all the exercises through small videos. It is able to maintain a simple conversation with the user. The bot also combines training and nutrition guidelines, although its conversational feature is not very well developed since the user must stick to what the chatbot asks.

HealthyBot[7] is a chatbot integrated into Facebook Messenger that provides advice for healthy living in relation to fitness, nutrition, supplements, mindfulness, etc. It does not personalize workouts or give information on specific nutritional scores. In addition, the user cannot write in a chat and they can only provide responses using buttons. Although it integrates a complete database, the interaction is not very user-friendly and does not offer user's customization.

As a conclusion of the study conducted on currently available assistants to promote healthy lifestyle habits, there are many dedicated applications for mobile devices that help users in healthy living guidelines. However, it is necessary to be very attentive to them, record a lot of information, use calendars, offer restricted ways for interaction, etc. In addition, none of the applications has a conversational behavior, which makes them less user-friendly. As for the currently available chatbots, besides the fact that they are very few and, although some of them provide a lot of information, they still do not allow the user to interact freely with the conversational assistant and they do not respond in a personalized way.

[3] https://getforksy.com/

[4] https://www.fitwell.co/

[5] http://www.themindfultechlab.com/daily-fitbot.html

[6] http://fitcircle.in/

[7] https://www.crunchbase.com/organization/healthybot

3 Developed conversational system

In this section, we describe the main architecture of the conversational system designed to promote healthy lifestyle habits, the main components, functionalities provided, and main decisions taken for the definition of the dialog flow.

3.1 Main components of the architecture

Figure 1 shows the main modules that make up the block diagram of the conversational system. As it can be observed, users make their requests to the system through the messaging platform chosen in the system integration (Facebook Messenger). The Dialogflow platform receives the user's information in natural language and processes it to select the intent corresponding to that request. Depending on the intent that has been activated, Dialogflow returns to the user the system response assigned to that intent. If the intent must perform any additional operation, Google Cloud Functions and Firebase are used to perform those operations. If one of the external services has the response that the system is looking for, it will return this information to Dialogflow, which will process it to send it to the user in an appropriate format. In addition, depending on the active intent, the system stores the information in one of the databases so that it can be accessed later if necessary.

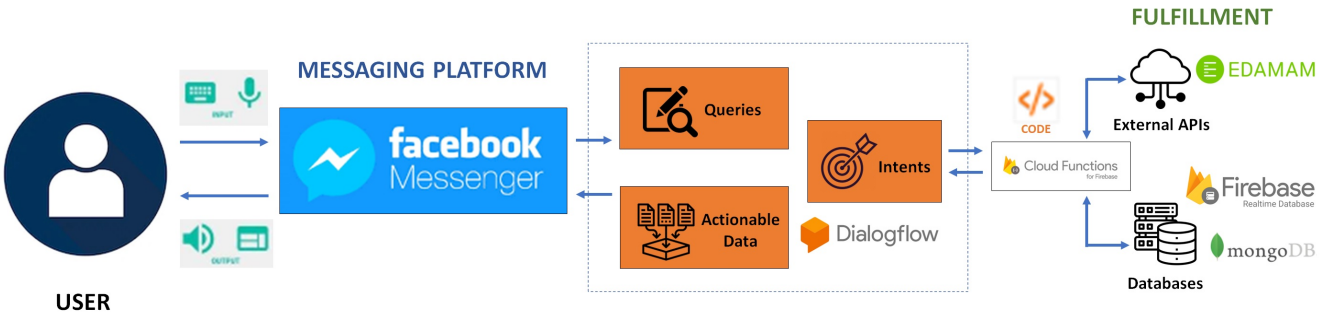

Figure 1: Main modules of the developed conversational application

Dialogflow is a Google service whose main purpose is to build conversational agents in a simple and practical way. In addition, for the connection with external APIs or databases, Dialogflow has a built-in online code editor, so it has not been necessary to use one external to the platform. This editor has been used to integrate Firebase Cloud Functions.

Cloud Firestore and Firebase have been used for data storage. With this, the data is stored in the cloud associated with a Google project. An additional database has been built and integrated with Mongo DB. This database is stored in the cloud thanks to the Atlas version of this platform and is used through Dialogflow's Fulfillment option. Google Cloud Platform brings together all the information associated with the Google Project ID: the conversational agent in Dialogflow, the Cloud Firestore databases, and even different statistics and analysis of system usage. Finally, the Facebook for developers utility has been used to integrate the conversational system into Facebook Messenger. Facebook has been used to create a page associated with the conversational agent in this social network.

3.2 Main functionalities and flow of the conversation

The specific objectives defined for the conversational system are:

- Identify food groups, calculate the caloric intake, and provide nutritional information.
- Inform about the caloric burning that the user has performed with a specific physical exercise.
- Offer different training routines that fit the user's needs.
- Make a summary of user's lifestyle and advise him/her accordingly.
- Maintain a small talk with the user.
- Build a database for each user to store all the information provided to allow later access.

Among the different ways Dialogflow offers to manage the flow of the conversation, the use of actions has been selected. An action is a value that is used when a specific intent is triggered. There can only be one action per intent and they are typically used in webhooks or third party services to decide the path of the conversation flow. Actions are

used to trigger the appropriate part of fulfillment that corresponds to the query that the user is requesting. The system integrates a total of 57 intents that are activated and combined according to the requests made by the users.

The conversation flow starts with a greeting from the user, which triggers the *Default-Welcome* intent to ask the user for his/her name. When the user responds, the user.name intent is triggered, which checks, through fulfillment and Firebase functions, whether the user is new or a previously registered user. If the system detects that the user is new, it will build a new document in the database with the user's name, send a response in the database with the user's name and a short presentation explaining the main functionalities of the conversational system. Then, it waits for a user's utterance to trigger the next intent.

If the system detects that the user is already registered, it generates a greeting in response and asks whether he/she needs to make a new query or wants to see the last summary that the system has stored in the database. In the first case, the system sends a search request in the user's database located in Firebase through the fulfillment. The user receives a summary of the last data collected by the system. Then, the system waits for a new request. In the second case, the system returns a default response that encourages the user to provide a new query. In addition, it reminds users that they can type 'help' to be provided with more detailed guidelines and tips. The conversational system then waits for a new request.

If the user's input is related to the help functionality, the conversational system activates the corresponding intent and provides a default answer from Dialogflow to guide the user on what the system is requiring at each moment of the interaction. If the user provides sentences such as can you repeat, I did not understand, etc., the system will activate the followup intent that has been configured. This followup rephrases the question that the user did not understand in order to continue the flow of the conversation. This type of intents have been defined several times throughout the dialog flow to contemplate similar responses to the one provided by user. In case the system does not understand what the user is asking for, the *Default-Fallback* intent is activated. It is an intent that is used in Dialogflow when the user's input does not activate any of the intents defined in the dialog model.

If the user makes training-related queries, first of all, the corresponding intent will be activated. In it, a default response is provided directly from Dialogflow with a training tip. After this intent, the system asks if the user wants more specific information. In this case, the system triggers intents and uses the contexts until it obtains all the necessary data to select a customized training routine in the Mongo database. To do this, the system asks for the type of training that the user wants to perform or the user wants the system to directly recommend a routine based on the requirements for training duration, level of difficulty, and body area where they want to focus the training. These values are stored in the database and can be modified by the user in subsequent interactions with the system. There is also the possibility for the user to directly make a training request providing some of the necessary parameters. For example, if the user says: *I want to do yoga for half an hour*.

To finalize the possibilities for exercise-related queries, it is also possible for the user to make a request about the calories burned after completing a specific type of exercise or sport. In this case, the system asks for the parameters related to the type of exercise, intensity, and duration. The user's response is stored in the user's Firebase database for possible further queries and a system response is generated.

Users can also make requests regarding nutrition guidelines. If the conversational system has not detected which foods or meals are to be searched in the databases and APIs to generate the system response, it will ask for them until it detects them and then change its intent. Nutrition and diet related data for food products is provided by the Edamam API. The API empowers its users with nutrition and diet data for generic foods, packaged foods and restaurant meals.

In addition, we have also considered for the definition of the dialog model the possibility that the user, after starting a conversation with the system, wanted to finish it and obtain a summary detailing the calories burned doing the exercises and the number of calories ingested during a day. The corresponding intent will return a brief summary including this information and, in addition, advices according to the results generated. Finally, the Small Talk functionality has been added to facilitate responses from the system to trivial conversations the system may have with the user. Several examples of the use of this functionality are as follows:

```
About the agent:
User: You are boring.
Agent: I am sorry. I will request to be
made more charming.
U: Are you busy?
A: I always have time to chat with you.
What can I do for you?
U: Are you hungry?
A: Hungry for knowledge
```

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Courtesy:
U: That is bad
A: I am sorry. Please let me know if
I can help in some way
U: Thank you!
A: Anytime. That is what I am here for

About user:
U: I am back!
A: Long time no see. What is up?
U: I do not want to talk
A: I understand. Hope we can chat
again soon.
```

A total of 9 entities enumerated in Table 1 has been defined to complete the information required by the set of intents previously described.

Table 1: List of entities defined for the conversational system

Entity	**Explanation**
Ingredient	Defined to store food or ingredients according to the values defined by the Edamam API.
Training	This entity defines the types of training for which the system can provide information.
Focus	This entity stores the area of the body where the user wants to focus their training.
Difficulty	It stores the level of difficulty of a training session.
Duration	It stores the duration of the training activity selected by the user.
Sport	It is used to identify the different types of physical activities.
Sys.person	This entity is used to detect the user name at the beginning of the conversation and, thus, to be able to access the Firebase database with the information about previous activities, queries and user's preferences.
Sys.unit-weight	It assists the system in calculating the calories consumed by a user according to the exercises completed. It stores the users' weight.
Sys.unit-duration	it is used to store how long the user has been performing the workout and calculate the calorie consumption.

4 Evaluation

We have already completed a subjective evaluation of the conversational system. To complete this assessment, we have designed a questionnaire that includes a total of 27 questions. This questionnaire has been answered by a total of 20 recruited users. First, each user interacted with the conversational system without a previous explanation about its use, so that it resembles a real situation in which a user wants to chat with the system after accessing the application the first time without any help. Later, the questionnaire has been provided to each of the users so that they can evaluate the complete set of functionalities that it provides, including the training part, the calorie count, the

summary provision, and the trivial conversations that they may have had with the chatbot. The questionnaire includes the following questions and possible responses:

General user information:

1. Sex (Female, Male, I prefer not to say)
2. Age (0 - 25, 26 - 50, 51 - 70, +70)
3. Experience in the use of mobile devices (1 = Very low, 5 = Very high)
4. Experience in the use of instant messaging applications (1 = Very low, 5 = Very high)
5. Experience using Facebook Messenger (1 = Very low, 5 = Very high)
   Conversation initiation:
6. Does the chatbot correctly recognize if you are a new user or have previously logged in? (1 = Never, 5 = Always) Training:
7. Does the chatbot match the training activities according to your preferences? (1 = Not at all, 5 = Perfectly)
8. Do you completely understand the summary of exercises in the workouts that the chatbot provides? (1 = Not at all, 5 = Perfectly).
9. Is the chatbot offering you alternatives to the workout when you do not like the one that it is suggested? (1 = Never, 5 = Always)
   Nutritional
10. Does the chatbot correctly interpret your requests about nutritional guidelines? (1. = Never, 5 = Always)
11. Does the chatbot correctly interpret the food or ingredients you provide? (1 = Never, 5 = Always)
12. Do you understand the chatbot responses about food-related queries? (1 = Never, 5 = Always)
    Exercise
13. Does the chatbot correctly interpret your queries about training information? (1 = Never, 5 = Always)
14. Does the chatbot correctly interpret the exercises or sports that you provide as input? (1 = Never, 5 = Always)
15. Do you understand the system responses when you ask for exercise-related queries? (1 = Never, 5 = Always)?
    Summary
16. Does the chatbot correctly interpret the request to obtain a summary with information of your previous interactions? (1 = Never, 5 = Always)
17. Is the summary information provided by the chatbot correct? (Correct, Incorrect)
18. Do you understand the chatbot responses when you ask for the summary information? (1 = Never, 5 = Always)
19. Is the summary information provided by the chatbot useful? (1 = Not useful at all, 5 = Very useful). Yes it is very useful)
    In general
20. Does the chatbot generally interpret the requests you make correctly? (1. = Never, 5 = Always)
21. In general, is the information returned by the chatbot understandable? (1 = Not understandable, 5 = Understandable)
22. Is the chatbot able to continue the flow of the conversation when you do not understand the questions or ask the system to repeat them? (1 = Never, 5 = Always)
23. How do you evaluate the duration of the interactions with the chatbot? duration, 5 = Short duration)
24. Do you know what to do at each point of the conversation? (1 = Never, 5 = Always)
25. Is the help option of any use? (1 = No, never, 5 = Yes, always)
26. Is the chatbot able to follow a trivial conversation? (1 = No, never, 5 = Yes, always)
27. Please provide an overall rating of the chatbot (1 = Not at all satisfied, 5 = Very satisfied)
28. What is missing, what would you improve?

Table 2 shows the results of the subjective assessment. The following key conclusions can be extracted from the evaluation results. The first one is that users agree that the system generally understands their queries correctly. They have found worse results when they require the system to repeat the information and in different cases in which they do not know what to do at each state of the dialog. Both are due to the system not providing enough information when explaining these situations. According to the users, the system was also able to follow a trivial conversation. The help functionality is, according to the surveyed users, quite useful. The overall score of the system has an average of 4.2 points out of 5.

It should also be noted that users initially found it difficult to understand the system functionalities. Since they had no prior information about what the conversational system is capable of doing, they had to complete several test interactions at the beginning to learn how it works and understand the main functionalities. However, after spending some time providing input sentences, testing the help section and asking for repetitions of the system responses, users achieved a good experience according to the answers provided in the questionnaire.

Regarding the suggestions provided by the users in the last question of the questionnaire, they mention the possibility of including additional languages, improving and expanding the food and ingredients database to enable a better understanding by the system, and reducing the response times of the system, especially when accessing several databases and APIs is required to generate the system response.

Table 2: Results of the subjective assessment

Table Head	**Table Column Head**		
	Avg. Value	***Max. value***	***Min. value***
Question 1	37.5% male - 62.5% female		
Question 2	0-25: 25%, 26-50: 60%, 51-70: 10%, +70: 5%		
Question 3	4.6	5	4
Question 4	4.7	5	4
Question 5	4.1	5	3
Question 6	5.0	5	5
Question 7	3.8	5	3
Question 8	4.0	5	3
Question 9	4.0	5	3
Question 10	3.6	5	3
Question 11	3.9	5	3
Question 12	4.5	5	4
Question 13	4.0	5	4
Question 14	4.3	5	4
Question 15	4.1	5	4
Question 16	4.4	5	4
Question 17	4.1	5	4
Question 18	4.6	5	4
Question 19	5.0	5	5
Question 20	4.1	5	4
Question 21	4.9	5	4
Question 22	4.1	5	3
Question 23	4.9	5	4
Question 24	3.8	5	3
Question 25	4.3	5	3
Question 26	4.0	5	3
Question 27	4.2	5	4

5 Conclusions and future work

This paper has described a practical conversational system to promote healthy lifestyle habits related to physical exercise and nutrition guidelines. These types of systems are increasingly being applied in e-health applications to improve efficiency, reduce costs, and support the tasks carried out by medical staff.

The developed conversational system uses technologies available in the Google Dialogflow platform to understand the queries made by the users, detect the provided entities and their corresponding values and design a dialog model based

on the selection of the intents defined in the system according to the information provided by the user and the result to the queries to the data repositories of the application. It also integrates different repositories and APIS to generate and store the system responses, previous interactions, and recommendations provided to the users. The system has been integrated into a Facebook social network page to also facilitate the interaction with their users.

The preliminary assessment of the conversational system by means of a subjective questionnaire show the positive evaluation results of the system functionalities, the correct understanding of the different functionalities, and a very positive assessment of the value-added functionalities, such as small talk or the provision of help.

As for future work, we would like to improve the dialog flow to reduce the failures of understanding and allow that users require the minimum of previous interactions to understand what the system can do. We also want to extend and improve the contents provided regarding training and complete nutritional information.

Acknowledgments

The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement no. 823907 (MENHIR project: https://menhir-project.eu) and the GOMINOLA project supported by the Spanish Ministry of Science and Innovation (PID2020-118112RB-C21 and PID2020-118112RB-C22, funded by MCIN/AEI/10.13039/501100011033).

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