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Recipe Bot: The Application of Conversational AI in Home Cooking Assistant

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***Abstract*—Conversational Artificial Intelligence (AI), which allows people to have human-like interactions with computers, has experienced a boom in recent years. A wide range of fields such as healthcare, finance, and retail have applied conversational AI in their websites to save efforts of completing easy tasks and provide voice interaction with end-users. It enables customers to find quick answers to frequently asked questions and service providers to save time to tackle more complex problems. This paper introduces the Recipe Bot, which is a conversational agent that provides matching recipes based on the information given by users. The intention of Recipe Bot is to help users get rid of unused ingredients in the fridge by providing related recipes. Recipe Bot allows users to input a specific dish name or provide a region, type, and/or ingredients of the food they would like to have, and then it returns a recipe list according to sorting and nutrients requirements given by users. The chatbot is built using Google Dialogflow platform to recognize the user's intentions and Spoonacular API to find recipes that match the search query. This paper discusses Recipe Bot's architecture, functionality, and inadequacies to be improved. It gives a detailed example of the interaction between the chatbot and a user, which demonstrates how the user interface will simplify the problem of finding a user-interested recipe.**

Keywords-conversational AI, cooking assistant, natural language processing, Google Dialogflow, machine learning

I INTRODUCTION

With the goal of producing natural human-to-computer interaction, Natural Language Processing (NLP) has been a game-changer in modern times. It allows people to employ computer programming in solving real-life problems, such as question answering and machine translation. The combination of NLP and Machine Learning (ML) develops systems that produce human-intelligent interactions. As with these technological advancements, people's expectation towards computer's problem-solving ability has become more demanding.

Machine learning, which has been developing rapidly in recent years, has granted computers the ability to learn without having to be explicitly programmed so that computers are able to learn from and make predictions on data [13]. As a subfield of machine learning, deep learning attempts to learn representation by using a hierarchy of multiple layers, which is the deep neural network that allows data to be passed and evaluated between the neuron nodes in highly connected ways [14]. Thus, it has the potential to even behave better than human intelligence at making decisions such as on movie rating prediction or approving loan applications [15]. In recent years, DL has been applied in conversational agents to reduce human labor. For example, IBM's Watson, Amazon's Alexa, and Apple's Siri are recent examples that employed deep learning and data-driven conversational agents. They are trained over a large amount of text corpus and are capable of understanding the content and finding out the correct answer even if the question proposed by users is phrased differently or incorrectly.

Chatbots are expected to handle 75-90% of healthcare and banking queries by 2022, which are thought to be the two industries that will benefit from chatbot technology the most due to their huge volume of human interactions, according to the study issued by analysis firm Juniper Research [17]. The average satisfaction rate of bot-only chats is 87.58%, two percent higher than human agents [18]. The reason why people show a preference towards chatbot is most because they can offer quick responses while being 7/24 available [19, 20].

The inflexibility in chatbots, however, is one of the issues that conversational AI has faced. Earlier chatbots may be unable to correctly answer all user questions or recognize the correct intent because their responses are designed with a certain set of instructions and they can only deliver answers for queries that are stored in a database. Currently, the main focus of chatbots is still simplifying the searching process—users can put vague or search queries to find what they are looking for in a website or application, just like a search engine [3]. The goal of this project is to create a more flexible dialog-based conversational user interface that accepts text and audio to help users find recipes. It will incorporate more fulfillments to handle user requirements. The platforms being used to build the project are Google Dialogflow and Spoonacular API.

II BACKGROUND AND OTHER RELATED WORKS

In 1950, Alan Turing developed the Turing Test, which tests whether a machine is capable of exhibiting undistinguishable human-like intelligence in interaction with humans. A machine that passes 70% of judges is thought to pass the test. Starting at that time, conversational AI had been under development. For instance, ELIZA [4], which was created in 1966 by Joseph Weizenbaum, and PARRY, which was created in 1972 by Kenneth Colby, opened up the gate of NLP computer programs that are capable of attempting the Turing Test [5].

Most of the earlier rule-based chatbots were designed to follow specific syntax analysis instead of truly understanding the context of the conversation [6]. A deviation from preset input syntaxes such as spelling and grammar mistakes would result in the chatbot not knowing what to respond to [5]. Besides, earlier chatbots are only capable of handling simple tasks such as checking weather since they can remember and

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act on the last sentence entered by users [10]. Only until recent years are ML-based chatbots invented and have the ability of Natural Language Understanding (NLU) and ML, and experienced a boom since then [5]. The major difference between these two prevailing models is that rule-based chatbots are designed to follow a predefined decision tree and keywords to help process the user queries while AI chatbots are understanding the conversation directly—they do not use keywords to trigger the intent [16]. ML-based chatbots have the ability to set up a background context of the user by processing the given information and therefore perform better at open-domain questions [8]. Moreover, the tolerance of grammatical errors in ML-based chatbots is also higher. Google Dialogflow uses the hybrid of the two models to do its intent matching—it allows the developers to predefine matching intents and uses ML to support automated entity expansion [7].

III RECIPE BOT

Recipe Bot is a chatbot that utilizes Google Dialogflow as the developing platform. Different from typical recipe websites that are flushed with ads and complex interfaces, it makes the process of searching recipes simpler by just asking users to answer a few questions and get all the required information about a dish. It provides two types of workflow: when users already have a dish in mind, it will return the specific recipes; when users have no idea about what to cook, it will recommend related recipes by asking users preferences of the food.

Recipe Bot incorporates the application programming interface(API) Spoonacular to find recipes for each request. Axios, a promise-based HTTP client, is also used to fetch the data from the recipe library in Spoonacular. Recipe Bot offers the Spoonacular user preferences, which then proposes a selection of recipes. The returned recipe list sorted by healthiness by default is returned to users—the higher the score, the more of your daily vitamin and mineral requirements are met, and the less unhealthy ingredients such as sugar and salt.

A. Features

Recipe Bot supports a wide range of services that are useful for a user to specify the requirements of the recipes and choose which recipe to be cooked. Below are its basic functions.

- *Identify requirements of recipes and preferences*: Recipe Bot has a user interface that allows users to enter their preferences into preset parameters. Parameters include: cuisine style (e.g. Chinese, American), ingredients to be included and excluded, dietary requirements (e.g. vegan, gluten-free), min/max nutrients of the dish (e.g. fat, calories, proteins), and specific dish name to be searched.
- *Show information of a recipe*: Recipe bot supports the feature of showing the summary of each recipe returned. The summary includes information such as preparation time, number of servings and price per serving, number of nutrients of a recipe.
- *Get random recipes*: Recipe Bot allows users to get completely random recommendations at any time by entering relevant phrases. For example, “give me a random recipe” would trigger the intent.
- Sort *the recipe list*: Recipes Bot allows users to sort the returned recipe list by the following options: healthiness, calories, and preparation time.

Recipe Bot allows text and voice interaction from front-end users to enter into the workflow and provoke intents in Dialogflow. Answers provided by users will invoke different intents, and according to the intent invoked, Dialogflow will trigger different sets of questions to fill values into required parameters.

B. Architecture

This section explains the overall architecture of Recipe Bot as shown in Figure 1. The detailed workflow involving intents and entities will be discussed in section 3.

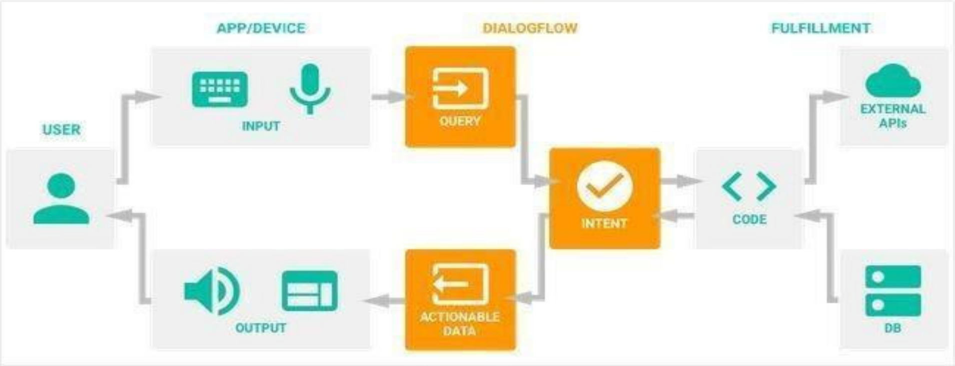

Figure 1 Google Dialogflow Agent architecture [11]

The natural language processing steps of Recipe Bot are handled by Google’s Dialogflow platform. Recipe Bot first accepts the front-end input format in either text or speech form. When the input is in audio form, Dialogflow will first perform speech-to-text before passing the text to the agent. After that, machine learning in Dialogflow will function—it will identify input queries to predict the hidden intention and map it to one of the predefined intents in Recipe Bot. According to the

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different intentions being called, different parameters that describe a user's preference will be filled. Named entity recognition incorporated in Dialogflow recognizes the intents, entities, and context of what a user says to extract the exact value from text [2].

After Recipe Bot receives all necessary inputs, the code in the inline editor of Dialogflow will initiate a webhook call to the external API—which is Spoonacular that gets used—to retrieve 10 topmost recipes related to the query. Then the response will be processed in the correct format—output can be generated in speech form by using the Cloud Text-to-Speech powered by DeepMind WaveNet if audio input was used—to be transmitted to the front-end user interface [12]. Recipe Bot interface can be integrated into websites, Alexa, Slack, Google Assistant, etc.

IV WORKFLOW

Built with Dialogflow, the designed technological process that takes place between Recipe Bot and a user follows Dialogflow's discipline. The workflow for such a conversation is illustrated below:

- *User: I have no idea what to cook.* From this phrase, Dialogflow identifies that the user needs some recommendations and the Food_Requirement intent will be triggered.
- *Recipe Bot: That's fine, let me help you! What regional food would you like to try?* The static response is predefined in Dialogflow to ask users to provide their preferences for searching the recipes.
- *User: Maybe Chinese?* The answer "Chinese" is matched with the entities Cuisine_Style described in Dialogflow and will be saved in the parameter Cuisine_Style for future queries.
- *Recipe Bot: Great choice! Do you have any other ingredients to be included or excluded? (Please enter "include" or "exclude" in front of your requirements.)* Recipe Bot then approaches Ingr_Preference intent to ask further questions regarding the requirements for the recipes.
- *User: Exclude mushroom. Include chicken.* With the help of keywords, Dialogflow will extract the correct values to put into Ex_Ingr and In_Ingr parameters.
- *Recipe Bot: Do you have any specific dietary requirements?* Recipe Bot then approaches to ask for unfilled parameters.
- *User: No.* Since the answer is "no", Recipe Bot will leave the value type as "undefined" and trigger the Sepcial_Req intent.
- *Recipe Bot: Gotcha ya! Do you have any other requirements described below for your recommended recipes? Please enter the typed requirement. 1. Sort by calories/healthiness/preparation time. 2. Restrict the min/max fat/calories/proteins of the dish.* The last piece of parameter value Recipe Bot needs is the Special_Req, and it will ask the user to fill in any requirements they want for the recipes returned.
- *User: Sort by healthiness.* The keyword "sort by" will enable Recipe Bot to understand that the parameter Sort_By should be filled with the value "healthiness". Since the keyword "restrict" is absent, the type of parameter Restrict will be undefined.
- Recipe Bot will take all the input received and send requests to the Spoonacular API to return a recipes list that satisfies all the requirements specified above.

A. Conversation building blocks

The building blocks of a designed conversation are intents and entities. After all the query parameters are received, the collected information will be passed between Dialogflow and Spoonacular using webhook. This subsection provides a description of major intents and entities, and programming of webhook to request the recipe list in Recipe Bot's design.

Intents: Intents refers to the intention of users' messages. Usually, it will match with one of the predefined intents, otherwise, a default fallback intent will be selected to respond to the user. To identify an intent, training phrases are added to help with machine learning. For example, "Tell me how to cook orange chicken" will be classified as NoRecommendation intent since the phrase "Teach me how to cook fried rice" was added as training phrases. Training phrases tell the bot how to recognize sentences as intents even if the phrase has not been predefined as one of the intents. The intents included in Recipe Bot are: NoRecommendation intent for searching a specific recipe, Food_Requirement for asking cuisine style, Ingr_Preference for asking ingredients to be included and excluded, Special_Req for asking requirements—such as sort by healthiness and restrict max calories—for the recipes.

Apart from these intents, a fallback intent is also created to handle the situation where the user input cannot be recognized as compatible with any one of the predefined intents. To prompt the user to enter correct phrasing, Recipe Bot will respond "I missed what you said. If you already have a dish in mind, please say 'yes'. If you need recommendations, please say 'no'" to guide users to give recognizable answers.

Entities: Entities are used to identify the parameter values so that essential information could be remembered. The entity defines the input type of a parameter. For instance, the parameter Cuisine_Style has the entity type Food_Location, which in it specified entries such as Chinese, American, and Japanese, etc. Hence, when the user input includes a specified entry, and a parameter is listed as to be filled, the value will be identified and extracted into the parameter. As previously described, some of the entities include ingredients, food location, diet, food type, sorting, and special requirements.

Webhook: Webhook is the part where external API is employed. It constructs the connection between Dialogflow and external database Spoonacular to make the response dynamic. The built-in Inline Editor is used to send requests to Spoonacular for recipes and their summary. Spoonacular will respond back with a JSON file that describes the recipe. Then,

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the webhook sends formatted responses back to the intent as fulfillment to show at the front-end user interface.

V CONCLUSION

In this paper, the author discusses chatbots and how they are interacting with people as technology advances with the development of Machine Learning. This paper will help people to understand the fundamental methodologies of constructing chatbots using Google Dialogflow as it introduces Recipe Bot's architecture, workflow, and building blocks. Recipe Bot is a chatbot that asks user's preferences through a chat-box and processes the information gathered to fetch recipe lists that match the request. It is augmented with the power of machine learning to identify user intents that are phrased differently. Apart from this, Recipe Bot has been proven to be useful in finding recipes that satisfy user's requirements.

However, there are still inadequacies of Recipe Bot that could be improved. First and foremost, users cannot modify the input they have entered earlier for now. If some words are mistyped or users change their minds, they have to start the conversation all over again and have a new request. The solution involves a more sophisticated coding in Dialogflow since three new intents should be created and directed. Besides, the response of Recipe Bot should be re-processed because the output text of the summary of recipes includes HTML coding and appears to be messy. Another aspect that Recipe Bot can be improved upon is that it could design meal plans for users to resolve their body weight concerns. This would involve asking the users for their weight and height to calculate their body mass index (BMI) and suggest recipes according to the number of nutrients they need.

According to the "Conversational AI Market" report published by MarketsAndMarkets, the global market size of conversational AI is expected to grow from $4.8 billion in 2020 to $13.9 billion by 2025 [9]. The major appliance of conversational AI is on service and advice as described in the "Conversational Business 2020" Study conducted by Aalen University, and most of the companies employing chatbots are business-to-business (B2B) [2]. The foreground for conversational AI is promising—with technological development, AI-based chatbots will be fed with an enormous amount of dynamic data and will learn the patterns to make themselves progressively robust and even become completely indistinguishable from humans. At the present, there are virtual assistants employed in websites or Apps of hospitals to assist people in identifying possible illnesses according to syndromes. With data training, virtual assistants will gradually secure the possibility to replace humans completely in providing assistance to people. Similarly, the author hopes to see Recipe Bot could be part of the intrepid concept of building a conversational agent that interconnects with all the steps related to preparing a meal, including making weekly meal plans, controlling body weight, buying groceries, following the instructions of cooking a recipe.

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