Designing a Chatbot for Diabetic Patients

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Abstract — Artificial Intelligence chatbot is a technology that makes interaction between man and machine possible by using natural language. In this paper, we proposed an architectural design of a chatbot that will function as virtual diabetes physician/doctor. This chatbot will allow diabetic patients to have a diabetes control/management advice without the need to go to the hospital. A general history of a chatbot, a brief description of each chatbots is discussed. We proposed the design of a new technique that will be implemented in this chatbot as the key component to function as diabetes physician. Using this design, chatbot will remember the conversation path through parameter called Vpath. Vpath will allow chatbot to gives a response that is mostly suitable for the whole conversation as it specifically designed to be a virtual diabetes physician.

INTRODUCTION

Chatbot or chatter robot is a technology that arises to be the way of human to interact with computer using natural language (spoken human language). There are a lot of chatbot nowadays that act such as an assistant for online shopping, website guidance and also a chatbot that just reply to whatever conversation the human had with them (a general knowledge chatbot). Although certain chatbot is being made to be function only for specific area of knowledge, the flow is still the same where one input from human will be against all knowledge base from chatbot. It was mostly like the search engine where user entered what they want to search and the engine will reply according to that search parameter. Although there is some used of a technique that will makes chatbot remember the previous conversation topic, but still it cannot makes chatbot to remember the whole conversation flow. As such, we propose an architectural design of a chatbot that will have the ability to remember the whole conversation flow to be used by diabetic patients for their daily diabetes control activities.

There was an effective usage of a chatbot in medical field proven by the success of VPbot, developed by Dr. Griffin Webber from Harvard University. VPbot has been particularly successful in Harvard Medical School’s Virtual Patient program, in which VPbot simulates patients that medical students can “interview” through a web-based interface. Not only the students who have used the Virtual Patient scored higher in exams, but also the Association of American Medical Colleges (AAMC) has chosen the Virtual Patient and VPbot to be the core of its new nation-wide MedEdPORTAL initiative [6]. What we want to propose in this paper is slightly different from VPbot where we want the chatbot to act as a virtual physician/doctor, not as a virtual patient as far as VPbot is concern. The two most referred chatbot, which is ELIZA (the first chatbot) and A.L.I.C.E (the most popular chatbot with record of three times winner for Loebner’s annual instantiation of Turing’s Test for machine intelligence [3]) along with VPbot will be discussed in order to generally understand the literature of chatbot technology as long as the used of chatbot in the medical field.

ELIZA

ELIZA, a first chatbot developed by Professor Joseph Weizenbaum from Massachusetts Institute of Technology (MIT) is desribed as a program, which makes natural language conversation with a computer possible. What is important for ELIZA is that the computer can read messages typed on the typewriter and respond by writing on the same instrument. Input sentence are analyzed on the basis of decomposition rules which are triggered by key words appearing in the input text. Responses are generated by reassembly rules associated with selected decomposition rules. The fundamental technical problems with ELIZA are: (1) the identification of key words; (2) the discovery of minimal context; (3) the choice of appropriate transformations; (4) generation of responses in the absence of key words; and (5) the provision of an editing capability for ELIZA “scripts” [7].

The fundamental technical problems with which ELIZA must be preoccupied are the following: (1) The identification of the “most important” keyword occurring in the input message; (2) The identification of some minimal context within which the chosen keyword appears, for example if the keyword is “you”, is it followed by the word “are” (in which case an assertion is probably being made); (3) The choice of an appropriate transformation rule and, of course, the making of the transformation itself; (4) The provision of mechanism that will permit ELIZA to respond “intelligently” when the input text contained no keywords; and (5) The provision of machinery that facilities editing, particularly extension, of the script on the script writing level [7].

A.L.I.C.E

A.L.I.C.E. (Artificial Linguistic Internet Computer Entity) first surfaced in 1995 and resulted from a collection of dialogue default responses collected by Wallace from books read, movies seen and life experiences, ostensibly from seemingly meaningless events. The aim of his creation, says Wallace, was to keep A.L.I.C.E. talking as long as possible without interacting humans realizing they were talking to a machine. A.L.I.C.E.'s content "comes directly from the effort to maximize dialogue length", which is the cost of conversation. A.L.I.C.E. is built to be a flexible technology [3].

A.L.I.C.E.'s knowledge about English conversation patterns is stored in AIML files. AIML or Artificial Intelligence Markup Language is a derivative of Extensible Markup Language (XML). It was developed by Dr. Wallace and the Alicebot free software community from 1995 onwards to enable people to input dialogue pattern knowledge into chatbots based on the A.L.I.C.E. open-source software technology [1].

AIML, describes a class of data objects called AIML objects and partially describes the behavior of computer programs that process them. AIML objects are made up of units called topics and categories, which contain either parsed or unparsed data. Parsed data is made up of characters, some of which form character data, and some of which form AIML elements. AIML elements encapsulate the stimulus-response knowledge contained in the document. Character data within these elements is sometimes parsed by an AIML interpreter, and sometimes left unparsed for later processing by a Responder [5].

VPBOT

Where A.L.I.C.E. is a modern ELIZA, the concluded distinctive between those two can be described as [2]:

- ELIZA – Keyword spotting and pattern-matching with 200 stimulus response pairs.
- A.L.I.C.E. – Case-based reasoning (CBS) for extraction of correct context of ambiguous words, random sentence generator, knowledge base (temporal, spatial, etc.), spell checker, and 45,000 stimulus response pairs.

Apart from ELIZA and A.L.I.C.E., there is VPbot, a SQL-Based chatbot for medical applications. VPbot, which stores 'language rules' in a relational data model. It shares many of the same features as A.L.I.C.E., but it is often easier to define new language rules in VPbot that with AIML. Whereas A.L.I.C.E. is designed to be able to produce generic responses to a wide range of topics, VPbot is best suited for a targeted topic of conversation. The VPbot algorithm accepts three input parameters, a *vpid*, *the current topic*, and a *sentence*. The *vpid* is a unique identifier for each VPbot instance. The topic is an optional parameter, which can be used to handle pronouns. Although the topic is an input parameter in the general VPbot algorithm, in the Virtual Patient implementation, the student can neither see the topic nor change it. It is simply a variable that the Virtual Patient stores internally and returns to the chatbot with the next question. Note that while the VPbot topic serves a purpose similar to that of the AIML <topic> and <that> tags, it is used differently in VPbot. The output of VPbot is a new sentence and a new topic. As with AIML, the output sentence can be dynamically constructed using parts of the input sentence; the database does not have to store every possible response [6].

Although VPbot uses SQL rather than AIML, there is a certain limit. As stated by Dr. Webber in his thesis, there are some limitations on what is possible with a single SQL statement, primarily because true recursion is not supported. However, in a restricted domain, such as a doctor-patient conversation, the full capabilities of AIML are not needed [6].

CHATBOT FOR DIABETIC

Diabetes disease yet cannot be cured by nowadays medical stature, but it can be properly manage in order for patients to have a healthy and active life. Three major components in managing diabetes are monitoring (blood glucose level), proper diet (by following dietitian advice) and patients/guardians motivation (to motivate diabetic to have the urge of managing their disease). The first component where patients need to continuously monitor their blood glucose level is usually done by close observation on an occurrence of an early symptoms of low blood glucose level. Those symptoms however is undetectable if patients is lack on knowledge about their disease [8]. Following that, patients needs to continuously go to the hospital in order to get a diagnosis result regarding those symtoms even if they are in secure control level of their disease. As such, we propose to develop a chatbot that will function as virtual diabetes physician to do a basic diagnosis on diabetic patients.

The process flow is that patient will have a regular chatting conversation using natural language with chatbot which will be question (ask by chatbot) and answer (input by patient) session. This session will continue until patient is successfully being diagnosed and then they will get their most suitable control advice for their diabetes condition. In order to clarify the diagnosis, chatbot will ask several sequence questions and those questions will be selected based on the answers given by the patient. This means chatbot need to know the whole conversation flow.

Referring to the literature of a chatbot, the flow of a chatting session is user enters an input, and chatbot will response. The logic of the process is like a search system where user input the searching parameter and the search engine will return a result regarding that parameter. It is likely a single flow process where previous input is not related with the current and future input. Thus, in chatbot technology, there is a way where chatbot can remember the previous conversation. By using “Wildcards” in AIML, chatbot will be able to “copy” some phrase/words that user input, and “paste” it in the response that will be given back to the user. AIML based chatbot also have the ability to “remember” the topic of a conversation (by using <that> and <topic> tag) that will makes the generated response remain in the same topic. Although those functions are really effective, it still does not allow chatbot to remember the whole conversation flow. As Abu Sawar and Atwell stated that the most common drawbacks of a chatbot is that they did not save the history of conversation and does not truly understand what the conversation is all about, it just gives user the response from the knowledge domain stored in the “brain” [1].

To fill the gap, we propose an architectural design that will make chatbot remember the conversation flow that later will be used to diagnose the patient. The key to that is by making chatbot know the path where patient takes in the questions and answers session. The path will be determined by analyzing parameter called “Vpath”. Fig. 1 shows the graphical description of how ViDi will determine Vpath.

In Fig. 1, the circle shape with “Q” inside represent the question ask by chatbot and the circle with “A” inside represent the answer input by patient. Fig. 1 shows the path that was taken by patient (represent by bold line and text) in three levels diagnosis session with the maximum questions for each level are nine (note that the actual session may take more levels, and the questions for each level maybe less than nine, depends on the actual physician diagnosis session that later will be discussed). For each level, patient will only be asked one question but if chatbot did not detect any keywords from the answer, several questions will be asked until the keywords is detected. Note that the level will only be increased when chatbot detected the keywords. The flow of process is described in Fig. 2. Keywords for each questions later will be determined by actual

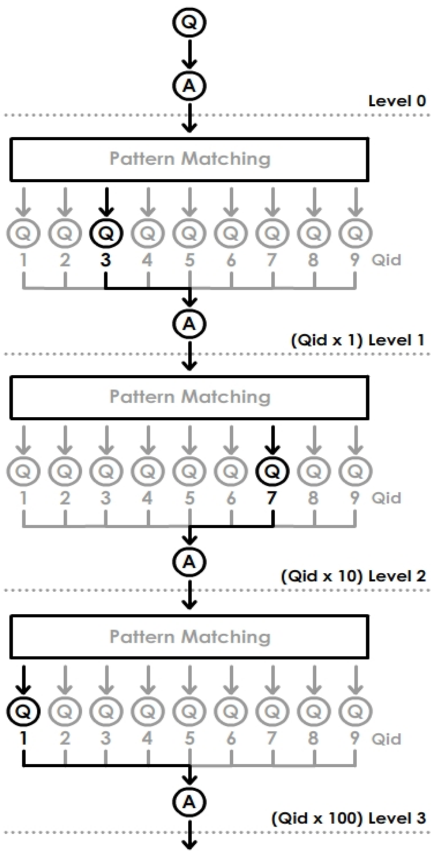

Fig. 1. A sample of path taken by patient

diabetes phsycian (note that one question can have more that one keywords and those keywords can be a full sentence, phrase or just a single word).

For the three levels diagnosis session (as shown in Fig. 1), the total probability of the possible path is 729 (9 * 9 * 9 = 729) with the Vpath value are 111, 112, 113, 114, 115, 116, 117, 118, 119, 121, 122, 123, 124, 125, 126, 127, 128, 129, 131, 132, 133, 134, 135, 136, 137, 138, 139, … until 991, 992, 993, 994, 995, 996, 997, 999. Although there is a 729 possible path that can be taken by patient in this session, the conclusion maybe not equal to 729 because the diagnosis can be flexible and also the total questions for each level can be less than nine. All those components will be determined when designing the session's questions and path with actual diabetes physician.

Each questions has their own value define by parameter called "Qid" and each Qid will be multiply by specific value for each level which is the value of increasing multiply 10 starting with 1 for level 1, 10 for level 2, 100 for level 3 and so on. Vpath is a total value of Qid referring to the path where the conversation takes place. In Fig. 1, the calculation for Vpath can be described as; Qid for level one is 3 (3 * 1), level two is 70 (7 * 10), and level three is 100 (1 * 100) and so the Vpath is 173 (3 + 70 + 100). As conclusion, Vpath is calculated by the value of Qid and Qid is a constant value of 1 to 9 according to question number. However, the total value of Qid for each level is different because different level have a different value for Qid multiplying process.

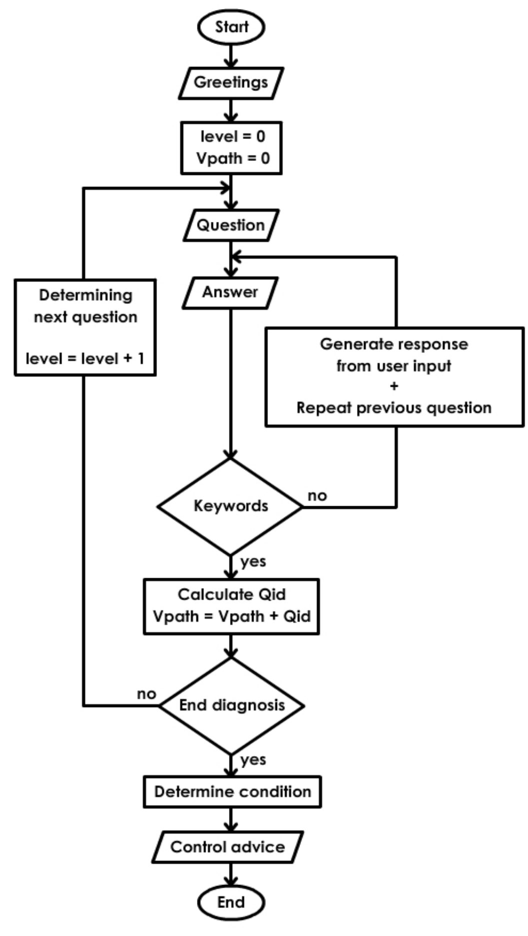

Fig. 2. Flow of process for patient conversation

PATTERN-MATCHING

For each level, a pattern-matching process will be done in order for chatbot to detect keywords from patient's input sentence. Several steps need to be done in the process and those steps are as follows:

- Receive input sentence from patient.
- Convert all alphabets into lower case.

- Separate words from sentence by dot “.”, comma ”,” and space “ “.
- Put all words into an array.
- Replace synonyms words according to the knowledge base (if any).
- Create an array of possible input to be match (sentence, phrase and words) by using Sequence Words Deleted (SWD) technique.
- Matching the array to “keywords” database one-by-one starting from the full sentence until for the each words (note that matching will based on level where the conversation is located).
- Exit all loop if matching were found.

Total possible input to be match after SWD process can be calculated by the Triangular Number equation, as in (1).

- m = Variable for matching
- n = Total words in input data

(1)

For example, if the total words of an input sentence are 5, then the total number of possible input to be match is 15. It can be described as shown in Table 1 (let say the input sentence is “Yesterday, my chest hurt badly”).

Table 1: Possible Input to be Match for 5 Words Input Sentence

No	Input Sentence				
	Word 1	Word 2	Word 3	Word 4	Word 5
1	yesterday	my	chest	hurt	badly
2	yesterday	my	chest	hurt	
3		my	chest	hurt	badly
4	yesterday	my	chest		
5		my	chest	hurt	
6			chest	hurt	badly
7	yesterday	my			
8		my	chest		
9			chest	hurt	
10				hurt	badly
11	yesterday				
12		my			
13			chest		
14				hurt	
15					badly

**No is refer to the number of possible input to be match*

CONCLUSION

This chatbot design is yet to be implemented but first, the questions and answers for virtual diabetes control diagnosis session must be designed with the actual diabetes physician. In this chatbot design, we proposed the used of Vpath, a way for chatbot to remember the conversation path. We also design the conversation to be controlled by chatbot rather than by user (likes any other chatbot program) by making the user remain to the conversation topic and not to enter any irrelevant input, and if they do, chatbot will response that the input was not understandable and keep repeating the previous question (with a good manner) until the keywords is detected. The suggestion also will be provided as guidance for patient in order to correctly answers the questions. Rather than just one response for one input, this design will allow chatbot to response to the whole conversation as it specifically designed to be a virtual diabetes physician for early symptoms diagnosis on diabetes control activities.

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