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Design a Facebook Messenger Chatbot for Course Counselling

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In view of that course counselling consumes much time and effort for teachers, we propose a chatbot on Facebook to relieve the loads while providing Q&A services with no limits in time and space. Employing Messenger API function of Facebook, we have developed a chatbot, who can answer students' questions via Facebook Messenger. As questions grow in number and varieties, the chatbot builds more capabilities and become more robust for all sorts of questions. Besides, a website is set up to collect data of Q&A and provides a statistical visualization on question profile. With this, teachers or TAs can easily understand students' learning status and barriers and thus adjust their teaching strategies or methods accordingly. An empirical testing on an initial course "Java Programming" has shown certain effectiveness and positive feedbacks from both students and teacher. More implementations on other courses are needed for fine tuning the solution.

Keywords: *facebook messenger, chatbot, data visualization, sentence similarity*

1. Introduction

A chatbot is a computer program that could interact with people via auditory or textual methods. In 1950, Alan Turing proposed the Turing Test[1], which stimulated Joseph Weizenbaum's interest in creating the first chatbot ELIZA. ELIZA could interact with people like a psychotherapist[2]. It could recognize certain keywords and patterns, and generate a response accordingly. ELIZA inspired a lot of chatbots after it, like ALICE, Mitsuku, SmarterChild, etc.

Currently chatbots are widely used as part of instant messaging platforms like Facebook Messenger, WeChat, and Line for entertaining purposes as well as B2C marketing and customer service[3]. Some Instant Messenger chatbots are able to provide users with news, weather reports, driving directions, movie times, stock quotes, and other information[4]. Companies like Domino's, Pizza Hut, Disney, Nerdify, Yamato's Line and Whole Foods have launched their own chatbots to increase end customer engagement, promote their products and services, and give their customers a more convenient ordering channel[5].

Since its launch by Mark Zuckerberg on February 2004 [6], Facebook has more than 2 billion monthly active users[7]. In April 2016, Facebook Messenger platform provides Receive and Send APIs that allow developers to create bots to interact with businesses[8]. These APIs support conversations with text and multimedia like images, gifs, videos, and so forth. Office Hours, email or other social media may provide options of channel for teachers or teaching assistants (TAs) to answer students' questions, which are usually common, routine, or similar, and some even repetitive and trivial. These communication processes usually consume much time and efforts and yet are limited to space and time. This paper is to propose a design of Facebook Messenger chatbot for course counselling services with no limits in time and space while relieving teachers certain communication loads. Also we like to examine its initial implementation on a course for correctness and usefulness.

The remainder of this paper includes an explanation of the core algorithm, a depiction of the system architecture, an initial experiment report for system effectiveness, and conclusion.

2. Technology

The key technology of a service chatbot lies in how to respond a user's request with an appropriate answer. Our solution for choosing an answer is based upon the similarities between the user's request and the sentences previously requested and stored in a Q&A database. The similarity between the two sentences is calculated by employing the cosine similarity for vector space model[9]. In the cosine distance metric, each sentence is represented as a vector in *m*-dimensional space (where *m* is the number of keywords in the vocabulary), and the weights on individual dimensions are determined by some weighting function. The weighting function used in this design is a simple word count function, which is based on the number of words the sentence contains.

Cosine similarity is a measure of similarity between two non-zero vectors of an inner product space that measures the cosine of the angle between them[9]. Given two vectors $\vec{a}$ and $\vec{b}$, the cosine similarity, cos(θ), is represented using a dot product and magnitude as

$$similarity = \cos(\theta) = \frac{\vec{a}\cdot\vec{b}}{||\vec{a}||_2||\vec{b}||_2} = \frac{\sum_{i=1}^{n} a_i b_i}{\sqrt{\sum_{i=1}^{n} a_i^2}\sqrt{\sum_{i=1}^{n} b_i^2}}.$$

The flowchart of retrieving the answer on a request is illustrated in Figure 1. A student sends a question to the chatbot via Facebook Messenger. The chatbot retrieves a built-in question with maximum similarity from the Q&A database. Two similarity thresholds, high_threshold and low_threshold, are set, where 0 < low_threshold < high_threshold < 1, and proper actions are decided on three conditions, as follows:

1. If the maximum similarity is greater than or equal to high_threshold, send a corresponding answer retrieved from the Q&A database.
2. If the maximum similarity is less than low_threshold, send the student a message "I don't understand what you said!" and log the question. The administrator or teacher can later view each un-answered question and add to the Q&A database with an appropriate answer. Next time, the chatbot would know how to answer the question. That is the "supervised learning."
3. If the maximum similarity is greater than low_threshold and less than high_threshold, retrieve the questions with similarity within the range, and send the student a hint with all possible questions listed for further references.

3. System Architecture

The system consists of two parts, the frontend and backend, as illustrated in Figure 2. The frontend takes charge of student/users' requests and responses via Facebook Messenger, i.e., the chatbot introduced above. An example of student-chatbot dialogue is shown in Figure 3.

The backend refers to a webpage designated for teachers or TAs to manage Q&A lists, query students' requests, make course announcements, and review students' question profile. Q&A list management typically includes append, delete, update, and query functions. Query function provides a drill-down feature for further examine students' questions. Figure 4(a)~(c) illustrates three views of student question profile where a teacher can easily review students' learning status, in terms of topic, individual, and time. With the understanding, a teacher can adjust his/her teaching strategies and methods accordingly.

4. Experiment

We examined the question log after the initial implementation on a course "Java programming" to verify the chatbot's effectiveness in the spring of 2017. For the first 100 questions, 61 are correctly answered with 16 responded incorrectly and 23 non-responded. While not very satisfactory, the initial result is acceptable and encouraging. With ongoing fine-tuning and accumulation of Q&A in number and variety, the chatbot promises to increase its effectiveness. What is more, participated students and teacher all reflected the system is highly interesting and useful. Further thorough evaluation is in progress in the new semester.

5. Conclusion

We have extended the application of chatbot in course counselling with system design and implementation by employing Messenger API function of Facebook. The chatbot can answer students' questions via Facebook Messenger. As questions grow in number and varieties, the chatbot builds more capabilities and become more robust for all sorts of question. Besides, a website is set up to collect data of Q&A and

provides a statistical visualization on question profile. With this, teachers or TAs can easily understand students' learning status and barriers and adjust their teaching strategies or methods accordingly. The initial result featuring simple design, low implementation and maintenance costs, and high (24/7) accessibility to students, is proven with certain effectiveness and usefulness, which promise to improve significantly after continuous fine-tuning and self-learning. Moreover, with its high mobility and scalability, any other course or even multiple courses can be applied, which, in together, promises to bring in more impacts on campus.

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Figure Caption

Fig. 1. Flowchart of chatbot.
Fig. 2. System architecture
Fig. 3. A Student-Chatbot dialog example on Facebook Messenger.
Fig. 4. Three views of student question profile on the website.

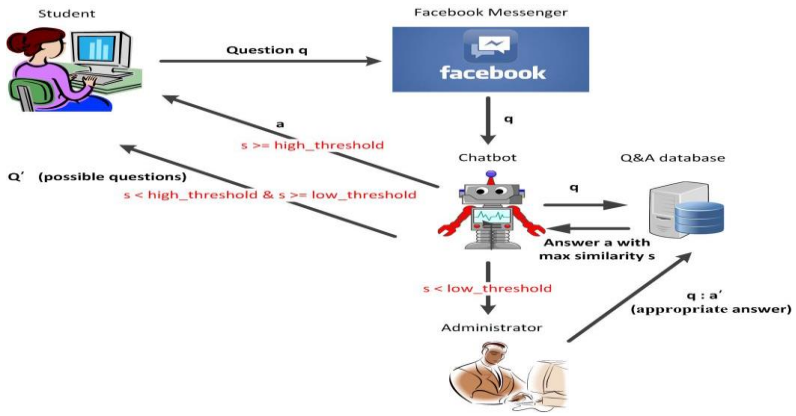


Fig. 1. Chou et al.

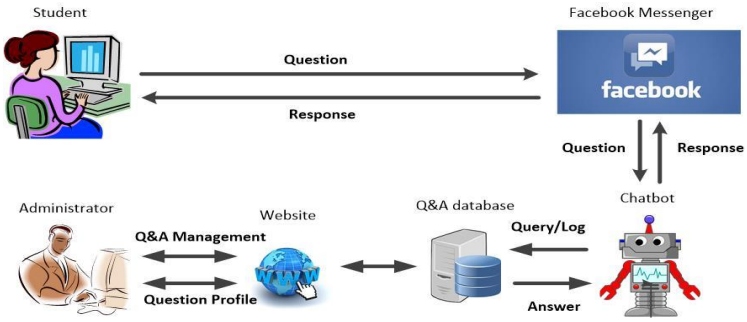


Fig. 2. Chou et al.

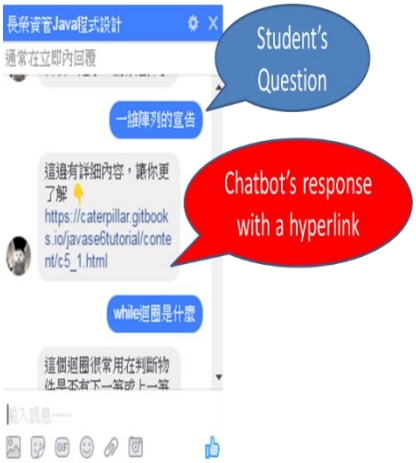
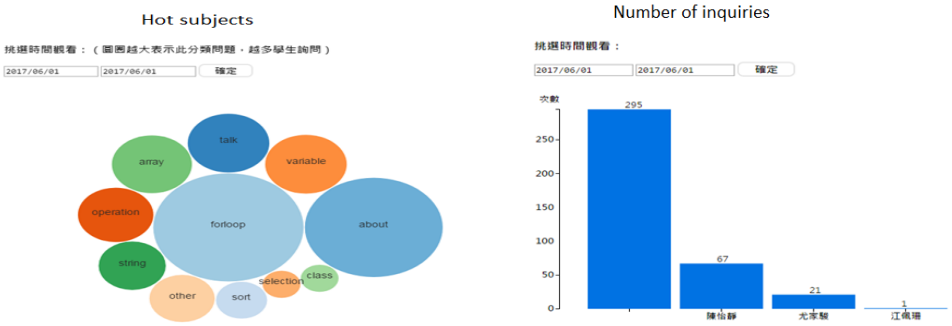


Fig. 3. Chou et al.



(a) Question profile based on topics (b) Questions profile based on individual students

(c)Question profile based on time

Fig. 4. Chou et al.