

Using a Multiplatform Chatbot as an Online Tutor in a University Course

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Abstract—Allowing students to ask questions in a university course is a crucial aspect of learning, which leads to increased learning effectiveness but also increased workload of the teaching staff. To reduce their workload, this paper presents the design of a chatbot for instantly answering students' questions on multiple common social platforms including Telegram, Facebook Messenger and Line. The chatbot can answer questions in natural language and commands. Once the teachers upload the necessary course-related information to an online database, the chatbot can answer questions on the course materials and course logistics (e.g., class schedule). The chatbot also supports a login system so as to provide answers according to different student profiles (e.g., schedule of their enrolled class and score dissemination). A survey on ten undergraduate computer science students showed that our chatbot can effectively act as an online tutor to reduce teachers' workload and will be a useful tool to be integrated into other e-learning platforms.

Keywords—chatbot, online tutor, multiplatform, natural language processing, innovative pedagogy

I. INTRODUCTION

Allowing students to ask questions is a crucial aspect of learning, which leads to increased learning effectiveness [1, 2]. Questioning is embedded in the thinking process of critical thinking, creative thinking, and problem solving [3]. By asking questions, students can improve their study skills, problem solving skills, and have better retention of course materials [2]. Yet when students get older, they tend to ask fewer questions in classroom because they do not want to call attention to themselves. Some teachers do not encourage students to ask questions [4], when most questions are factual, procedural, and closed in nature [5]. One reason why some teachers discourage students to ask questions is the increased workload imposed. Obviously, such workload becomes even more unmanageable for Massive Online Open Courses (MOOCs).

To this end, education researchers and practitioners have studied using chatbot in education. Heller et al. [6] developed a chatbot called Freudbot for psychology students to emulate a conversation with the famous late psychologist Sigmund Freud. Their work indicated that chatbots would be a promising teaching and learning tool in distance and online education. Nenkov et al. [7] discussed how to apply artificial intelligence technologies to the Learning Management Systems (LMS), Moodle, and showed a simple chatbot in Facebook Messenger that lets students to answer questions of an online test in Moodle. One of the difficulties in applying chatbots in education as identified in [7] is that students tend to use the social networking platform they used to use and are reluctant to switch another social networking platform for the chatbot. Molnár and Szűts [8] presented a review on the development of chatbots and their applications in education.

They presented the possibility of developing a chatbot-based teaching assistant in Facebook Messenger, yet there is no prototype built in their work. Verleger and Pembbridge [9] developed an AI-based chatbot named EduBot for an introductory programming course on MATLAB. The chatbot has an initial knowledge database with common MATLAB functions. When a student asks a question without an answer in the knowledge database, the course teacher will receive an email asking for a manual response to the student as well as an update to the knowledge database. Responses to one student's question can also be shown to all students. However, due to the high frequency of "no answer found", most students became disengaged and decided to switch to search their answers from other online resources, e.g., Google search engine. Murad et al. [10] developed a chatbot called LenoBot to answer questions on course materials of several Information System Engineering courses. LenoBot allows students to directly learn the course materials through the chatbot without the need to download the lecture notes, and students can view other students' conversation history as additional learning material. Yet this work did not include an evaluation on LenoBot.

Contrary to the chatbot design in [9, 10], this study aims to provide personalized learning experience to the students. We present the design of a chatbot called Infobot for an introductory networking course in a university in Hong Kong, which can instantly answer students' questions on multiple common social platforms including Telegram, Facebook Messenger and Line. Infobot can answer questions on course materials and course logistics (e.g., class schedule and venue). To support personalized learning, a login system is included such that students can get specific schedule of their enrolled classes for tutorial and their scores of coursework. The knowledge base is an online database in Firebase (firebase.google.com). Teachers can import chatbot knowledge to the database through the web interface of Firebase, uploading a data file (in JSON format) to Firebase, or via Infobot directly. A survey on ten computer science undergraduates showed that Infobot can satisfactorily provide the services of the course tutor and will be a useful e-learning tool, e.g., for MOOCs.

II. DESIGN OF THE CHATBOT

Our chatbot Infobot is mainly built on the free cloud service DialogFlow (dialogflow.com), which is an end-to-end, natural language understanding platform working with two components: an inference engine and a knowledge base. DialogFlow's inference engine can extract useful information from students' questions, e.g., *intents* and *entities*. As the same question may be asked in different wordings, DialogFlow uses machine learning for training to identify the same intent with different wordings, while basic support to identify common intents is also provided by default without any training data.

Knowledge base. We use an online database in Firebase as the knowledge base. Teachers can format the course materials as structured data and import them to Firebase easily, e.g., using Firebase's web interface (Fig. 1), uploading a data file in JSON format using a JavaScript program, or via the chatbot interface in Infobot (Fig. 2).

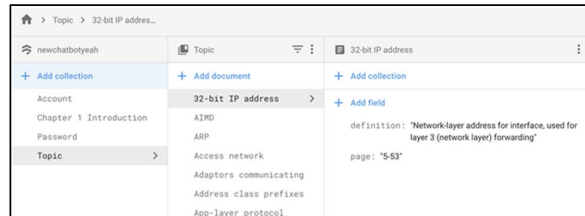


Fig. 1. Importing course materials in Firebase's web interface.

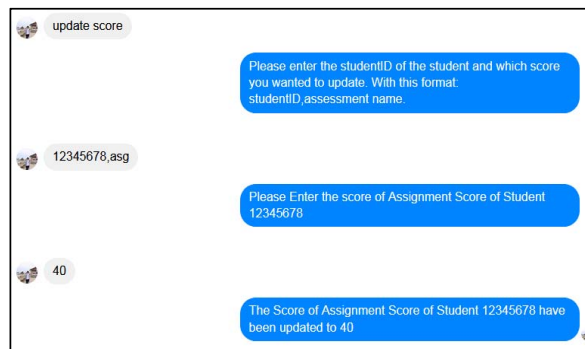


Fig. 2. Updating student assignment score in knowledge base via Infobot.

Multiple social platforms. Infobot has its own web server to connect different online components, so it can support the chatbot functions in its own web interface or on different social platforms with a programming API, e.g., Telegram, Facebook Messenger, and Line (see Fig. 3 & 4). Therefore, students will not be reluctant to use Infobot due to their habit of using a particular social platform as shown in [7].

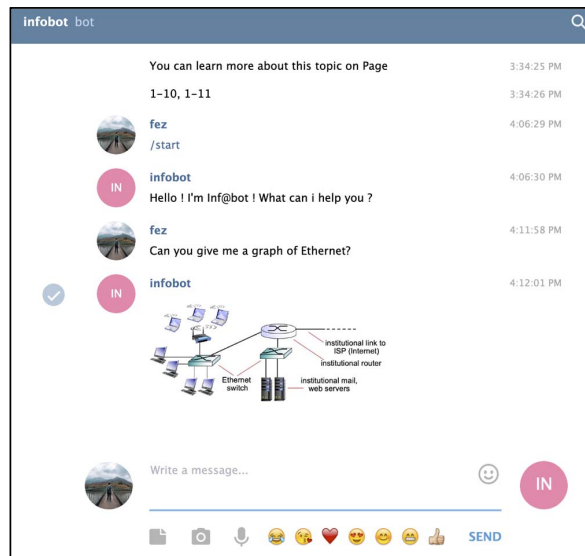


Fig. 3. Infobot in Telegram.

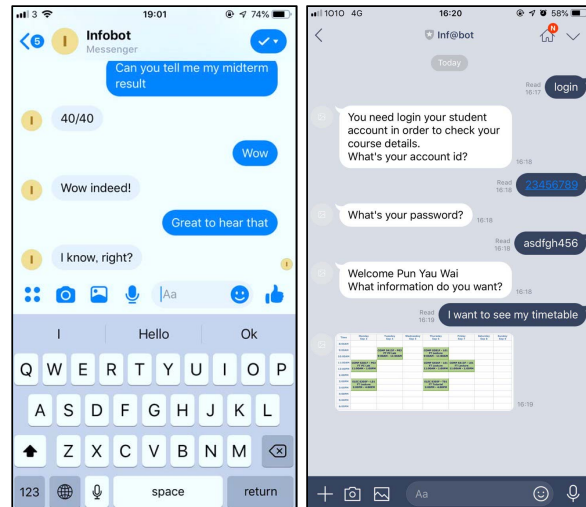


Fig. 4. Infobot in Facebook Messenger (left) and Line (right).

A. Question Handling

Infobot supports inputs in different forms, including term, natural language, command, and multiple choices.

Term. Users (including students and teachers) may perform a function by inputting its name, e.g., the term “login” in the above Fig. 4 (right). As shown in Fig. 5, students may also ask for information about a term, e.g., “FTP”, and obtains a brief information about it and a pointer to the course material for more details (e.g., “2-46” refers to lecture notes 2 page 46).

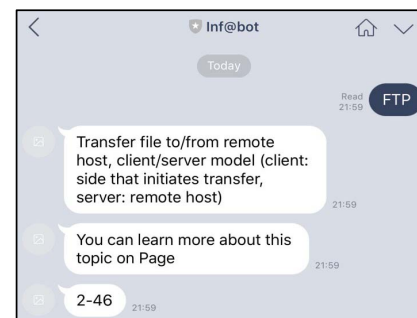


Fig. 5. Example of a question in a single term.

Natural language. Users may also input a complete sentence (see Fig. 4 & 6). In Fig. 6, the student's question is “Can you give me the definition of protocol?”. DialogFlow's inference engine identifies “definition of” as the intent and “protocol” as the entity, which then allows Infobot to retrieve the required information from the knowledge base and then return it as an answer to the users.

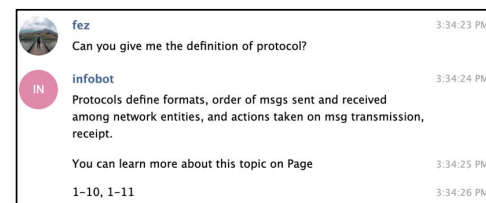


Fig. 6. Example of a question in natural language.

Command. Infobot supports several short commands (beginning with “/”) which are defined by the developers. For

example, the command “/start” allows the users to restart the conversation with Infobot (see Fig. 3).

Multiple choices. Some questions may trigger answers in multiple choices format, where the choices are buttons that the user can select. Fig. 7 below shows a multiple-choice question in a self-test, in which the user can press the button to select the answer or type it in the textbox. Another possible scenario is that when a student asks for information of a term that appears in multiple locations of the course materials, Infobot will return a *follow-up question* in multiple choices asking the student to select a specific part to look into (e.g., an equation, a graph/diagram, definition).

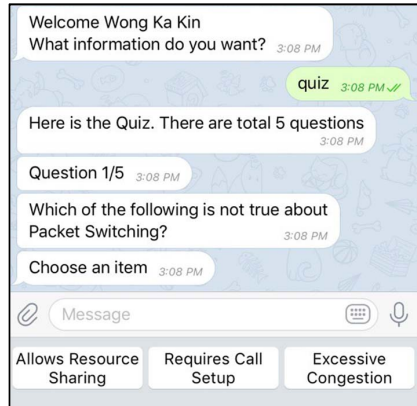


Fig. 7. Example of a user input in multiple choices.

If Infobot is unable to return an answer for a question, it will ask the student to send an email to the teachers.

B. Supported Functions

Importing and managing knowledge base. As mentioned before, teachers can import and manage course materials in the Firebase database using the web interface of Firebase (Fig. 1), uploading a data file using a JavaScript program, or via Infobot itself (Fig. 2). The Firebase database also keeps user account information, including their names, student ID, password, assigned tutorial group and scores for different coursework, and whether the user is an administrator (i.e. a teacher). This information will be useful to the login function and to provide personalized learning.

Infobot is designed to provide the following functions that a course tutor would normally offer to the students.

Answering course logistics information. The Firebase database also keeps course logistics information, including course information (course aim and learning outcomes), class schedules and venues of different tutorial groups, teachers' contact, examination date and details, and due dates of different coursework. Students may login with his account and then ask for the timetable diagram of his/her tutorial group (see Fig. 4 (right)), ask the score of his/her mid-term test (see Fig. 4 (left)), or ask for the venue of the lectures (Fig. 8).



Fig. 8. Example of answering course logistics information.

Answering questions on course materials. When a student asks a question on the course materials, the returned answer may be a term definition (Fig. 5 & 6), a diagram/figure (see Fig. 3), an equation or a follow-up question in multiple choices. A pointer to the course materials for more details may also be returned (see Fig. 5 & 6).

Taking a self-test. Students can take a self-test (quiz) in multiple-choice questions created by the teachers (see Fig. 7). We believe that self-tests can increase students' retention of course materials and help identify weakness in their study.

III. PRELIMINARY EVALUATION

Participants and Setting. To confirm that our chatbot Infobot can effectively act as an online tutor, we invited 10 undergraduate students taking the introductory networking course of this study to use Infobot for 15 minutes and then complete a survey individually. All participants are final year students major in computer science. They also participate in a focus group interview.

Result. The survey used a 5-point Likert scale (1: disagree, 2: partially disagree, 3: neutral, 4: partially agree, 5: agree). Table I shows the items in the survey and the percentage of participants selecting each point in the Likert scale.

TABLE I. SURVEY RESULT

Item	1	2	3	4	5
1. Infobot helps me to solve problems in real-time.	0%	0%	0%	40%	60%
2. The self-test offers a quick recap on course materials.	0%	0%	0%	30%	70%
3. Infobot can answer my questions correctly.	0%	20%	0%	10%	70%
4. Infobot can help reduce my study time.	0%	10%	0%	30%	60%
5. Infobot is a quick tool for checking coursework scores.	0%	0%	0%	0%	100%
6. Infobot is easy to use.	0%	0%	0%	30%	70%
7. Infobot has an attractive user interface.	0%	20%	10%	60%	10%
8. Infobot is an effective tool as an online tutor.	0%	10%	20%	60%	10%

IV. DISCUSSION AND CONCLUSION

In the preliminary evaluation, survey items 1 to 5 correspond to user satisfaction on Infobot's functionality. A majority (at least 80%) of participants agree that Infobot is a useful tool in their learning, which facilitates real-time problem solving and provides a quick recap on course materials. In particular, all of them strongly agree that Infobot is a quick tool for checking their coursework results. Yet, two participants found that Infobot may return an incorrect answer to their questions, which lead to unnecessary extra time in their study.

Survey items 6 and 7 correspond to the user satisfaction on the user interface. As expected, all participants agreed chatbot is a tool easy to use. However, two participants do not like the user interface of Infobot. They complained that the display region of the chatbot is too small that some information is incorrectly formatted due to displacement of words. In survey item 8, 70% of participants agree that Infobot is an effective tool as an online tutor.

This paper presented the design of a chatbot called Infobot for instantly answering students' questions on multiple

common social platforms including Telegram, Facebook Messenger and Line. Infobot can answer questions in natural language and commands. Once the teachers upload the necessary course-related information to an online database, Infobot can answer questions on the course materials and course logistics (e.g., class schedule). The chatbot also supports a login system so as to provide answers according to different student profiles (e.g., schedule of their enrolled class and score dissemination). In the preliminary evaluation, majority of participants agree that Infobot can effectively act as an online tutor. This will help reduce teachers' workload and will also be a useful tool to be integrated into other e-learning platforms with many students, e.g., MOOCs.

Limitations and Future Work. A limitation of this study is that the number of participants in the evaluation is low. Though a focus group interview has been performed, limited information is obtained from these participants. A future work is to perform a more thorough evaluation on Infobot with a larger size of participants and also with an analysis of response accuracy. Other future work directions include improving the user interface of the chatbot, and improving the natural language understanding model by replacing DialogFlow with a deep learning model trained on a large amount of students' questions and tutors' responses, e.g., in course forum.

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