Developing a Chatbot for College Student Programme Advisement

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Abstract— **Elective course selection often challenges students to make decisions concerning their academic interests and other practical issues such as graduation plan, class scheduling, and difficulty of course content. Conversations with academic advisors and peers are usually considered as a useful process for obtaining official and informal information, rearranging priorities, and making compromise in the decision. The paper describes the design and development of a conversational agent called EASElective for elective course selection. EASElective is designed to complement existing academic advising services with an online natural language interactive interface that will support a conversation on topics from basic official course data to informal students' opinions. The major design components of EASElective include intent detection, routines for conversation management, dialogue design, sustainable students' opinion collection and analysis, and course information management. The paper also describes a study on the perceived usefulness of EASElective. The findings were found to be largely positive and EASElective has unique functions and characteristics when compared to other conventional academic advising services.**

Keywords—academic advising, conversational agents, chatbots, cloud computing, elective course selection

I. INTRODUCTION

Academic advisement has been widely regarded as an essential student support service in higher education. Student advisement typical refers to services supporting course selection, general mentorship, and career planning. Giving college students timely and relevant advice is known to positively influence student retention, progression, and graduation. Academic advisement provides many institutional benefits, including increased student loyalty [1] and prospective student recruitment [2].

Conventional forms of academic advisement require students to schedule appointments with their designated advisor, who is typically a professor that is familiar with the curriculum and potential career trajectories. However, college professors are required to participate in many other roles and responsibilities that rank higher than student advisement in their personal performance evaluation. Additionally, modern financial constraints are stimulating trends of higher student-to-instructor ratios at many higher education institutions. These related phenomena describe a critical issue that will become increasingly problematic if solutions are not identified. Thus, automation has been proposed as a beneficial mean of mitigation the issue of student advisement. The appropriate integration of technological solutions can support both students' advisement processes, as well as prioritize the efficiency of professors' time toward more significant advisement issues and other important scholarly responsibilities. [4, 5].

Typical academic programmes adopt a semi-structured core-elective curriculum that challenges students to make decisions on course selection. Previous research showed that students consider several sources of advice and combine with their preferences in choosing their electives. Some students look at career prospect and relevance of the courses but others place more emphasis on more practical factors such as difficulty, teaching evaluation, and even instructors' rapport with students [6-8]. Therefore, peers are often found to be the main source of advice that can offer their perceptions on these factors, rather than academic advisors and faculty members [6]. Recognizing that students tend to believe that their peers are more aware of their personal situations, and these perceptions have encouraged institutions to develop peer advisement programs[9]. Peer advisors may be regarded as more approachable and realistic, and they can boost the credibility of the faculty if they give the same advice [9].

A. Project Aim

The Bachelor of Computing with Honours in Internet Technology programme at the Open University of Hong Kong poses final year students with an annual course selection dilemma. The final year curriculum requires students to take 6 specialization courses from 10 to 12 wide-ranging choices. In making this difficult decision, some students have better access to advice than others. The course titles, course description and general course information are universally available, but the more personalized and sensitive information is often difficult to obtain. For many students, scheduling a consultation with their faculty advisor may be too intimating to pursue. Additionally, much time and effort is needed to seek relevant information through their peer networks.

Therefore, in response to these issues, this paper reports the outcomes of our project on developing a chatbot for elective course advisement. The chatbot, EASElective, was designed to satisfy the following advisement requirements.

1. Universal and all-time access to advising service

Typical students nowadays are used to 24-hour online access and they have the same expectation on advising service.

978-1-5386-7209-9/18/$31.00 ©2018 IEEE
DOI 10.1109/ISET.2018.00021

2. Interactive interface

Using a conversational interface can increase users' attention and customize information if needed. It should provide better user engagement.

3. Official information

Providing students with official information, such as, course description, is proven helpful for students to understand about the courses.

4. Peers' opinions

Students like to know about the thoughts of their senior peers, which have gone through the courses and able to provide opinions, such as, teaching staffs' characteristics and other perception about the course.

5. Analysis of possible course selections

Possible course selections will be provided as advice for students to consider and adapt.

6. Recommendations

After the consultation, personalized recommendations will be provided. Students can refer to this recommendation for making their own decisions.

The chatbot to be presented in this paper, EASElective, was developed for resolving the problem providing elective course advising. It can offer different aspects of information and recommendations when students are making decision of course selection. Since chatbots are basically virtual robots they can serve many students at the same time and at any time of the day. It can simultaneously have conversations with thousands of people. Our chatbot can provide different aspect of information such as official information and peers' opinions.

II. Review of IT Solution for Course Advising

The approach of developing online computational advising services has proven effective in resolving intricate situation surrounding academic advising for tertiary institutions. Such approach can offer around-the-clock service to large number of users. The online advising systems reported in the literature are mostly concerning with programme planning and course selection [10-13]. They were found successful in catering for most help-seeking cases, leaving more time for faculty and peer advisors to deal with the students needing more personal interactions [13]. Some of these systems can also check graduation status [10], make course recommendations based on past academic performance [11], review scholarship eligibility [12], and handle complaints [14]. These systems mainly employ a form-based interface for information gathering and dissemination, and are available as a web application, web service, or a standalone application.

Academic advising, however, has a conversational aspect in addition to the information exchange aspect. A student can be benefited from talking to an advisor to sort out the real concerns before knowing the kind of information needed. Developing virtual academic advisors as conversational agents or chatbots should significantly advance the level of advising services to students. Chatbots have been successfully applied to trouble-shooting call centers [16]. The natural language dialogue interface is the medium for working out the problem of users and suggesting advice to resolve the problem. According to the authors, Albert was claimed to be the first-known conversational based academic advising system [15]. The system provides a web-based interface for students to enter past academic records and to receive recommendations to complete the programme. Albert has an academic advising knowledge base and an expert system for making responses on academic planning. To make correct responses, the system employs typical Natural Language Processing (NLP) techniques in extracting keywords and detecting ambiguity. Performance in making precise responses was found to be satisfactory (80% accuracy and F1 measure of 0.81). Users were initially found to be reluctant in using the system. Overall there were mixed comments with some students welcomed the new approach while others deterred by technical and design problems, which could be overcome as the technology advances and better understanding on how to design academic advising chatbots.

In the era of instant messaging, text-based online conversation is well accepted by university students. Forward-looking institutions have already moved academic advising onto Social Networking Sites (SNS) like Facebook [17]. Students were found to like this approach and to show willingness to text with academic advisors. As Facebook, Telegrams, and other SNS support chatbot services, and the maturity of cloud-based conversation management and NLP technologies, developing academic advising chatbots is never easier. The key for success is however finding the suitable split of work between human and virtual academic advisors, so that students will receive the advising service most suitable to their personal needs.

III. Methods

This project followed the build-and-test methodology. We built a prototype system named EASElective for those who are studying computing. The functional requirements are listed as follow:

- Provide course information
- Provide students' opinion
- Analysis of possible selections
- Provide recommendation
- Collect students' opinions

The major components of EASElective include the following:

- Intent detection
- Conversational design with routines
- Dialogue design
- Bootstrapping and sustaining student opinions
- Course information management.

A. Intent Detection

The aim of intent detection is to deduce the need of the user from their input natural language. In this component the input sentences are analyzed with typical natural language processing (NLP) techniques. The possible outcomes of the analysis include:

- The courses to discuss.
- The course attributes to discuss.
- Related topical keywords and concepts.
- The input cannot be recognized.

B. Conversation Design with Routines

Conversational design for chatbots means devising a sequence of dialogues to achieve a particular objective which may include:

- Extract the intention of users
- Provide information in a structured manner
- Handle interrupts and other exceptional situations in the conversation.

Routines are programming entities that define a conversation. A routine has a number of steps and as the conversation goes on, the routine will move from one step to the next based on pre-defined conditions. For example, a typical routine will work out the interested course of a user and subsequently find out the course attributes that the user wants to know. The system has built-in a number of routines, each serving different purposes. A user can change topic half way through a routine, and in such case, the system would start another routine asking for confirmation of changing topic, and if it is so, push the conversation into a stack and start a new one. Later on, the previous conversation can be pulled out and resumed. Fig. 1 shows a short routine with just three steps. The circles contain computation logic and the edges are conditional. Typical routines have more than 8 steps.

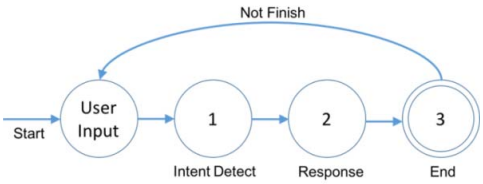

Fig. 1. A three-step conversation routine

C. Dialogue Design

Dialogue is an interface for the communication between the chatbot and users. The objective is to make the conversation efficient, unambiguous, and error-free. The system will sometimes restrict the input form to buttons when the conversational situation has a few possibilities. Of course, the system will allow text input most of the time.

D. Bootstrapping and Sustaining Student Opinions

One design feature of EASElective is to reuse user input concerning opinions on courses for providing advice to other users. There are pre-defined routines that would start a conversation to ask for user's opinion when the user has completed a course. The responses will be saved and relevant student opinion information will be extracted with NLP techniques at the end of the day. Afterwards, the analysis results will be archived in a database for future use.

However, at the beginning there is no prior user input. In our case, we bootstrapped the system by administering a questionnaire to existing students for their opinions.

E. Course Information Management System

The course information management system is designed to organize and store any information related to courses. The types of information include:

- Official course information including course titles, course description, schedule, instructor, and so on.
- Official advice about taking this course.
- Student opinions about the course and its attributes such the instructor, the course materials, the ratings, the major techniques covered in the course.

There is a web administrator page serving as the course information management platform for managing the data in the database. It is expected that the system administer is the programme leader who will update the information and moderate students' opinions.

IV. Results

A. Implementation Notes

Server-side technologies including node.js, PHP, RESTful, JSON, MongoDB and MySQL were used to build the chatbot system. Fig. 2 describes the major components and how they can work together.

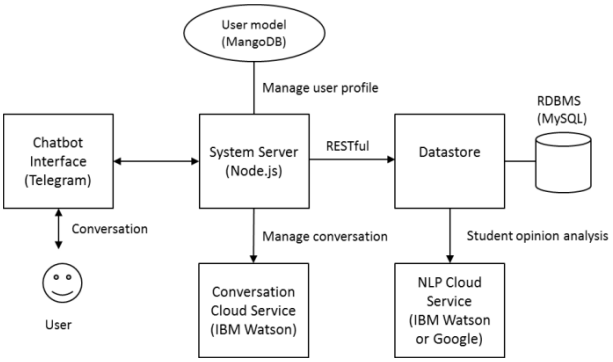

Fig. 2. Major components of the chatbot system

The chatbot system has three major parts: the chatbot interface that may run on a webpage or a messaging tool such as Telegram, the system server where business logic is implemented, and the datastore that manages the course information and analyze student opinions. The parts are connected via RESTful as the middleware. The system engages two cloud services for specialized functionality. The IBM Watson Conversation is used for the intent detection and conversation management, and another cloud based NLP tool is used for text analysis. In addition, an administrator website was developed for managing the cloud-based database.

B. Chatbot Operations

Fig. 3 illustrates the chatbot in operation. EASElective is the name of the chatbot which simulates a senior peer who have gone through the elective courses before and learned about the courses.

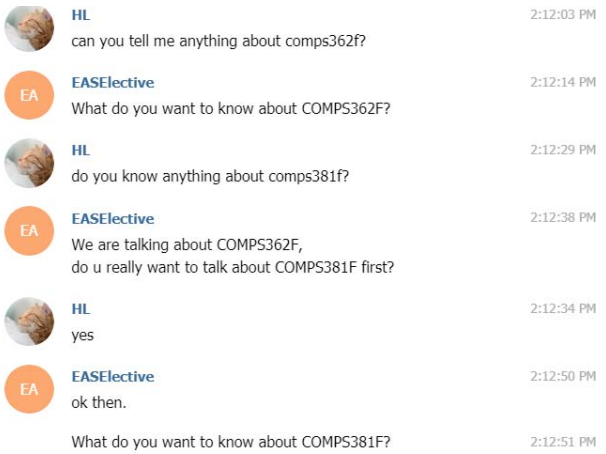

Fig. 3. A routine that directs the conversation asking for student opinions on the course COMPS362F. A routine that handles the user changing the desired course that eventually switch to another routine and back.

C. Student Perceptions

A user perception study based on a questionnaire was carried out to measure the effectiveness of the chatbot solution. In particular, a comparison was made with four alternatives of course advising: programme booklet, website, programme leader, and peers. The subjects were recruited from the fulltime computing programme in the authors' university. Each subject was briefed on the purpose the chatbot system and simple instruction on how to start and the available functions. Then the subjects were given freedom to use the system for up to half-an-hour. Finally, they were asked to fill in the questionnaire.

D. Overall Student Evaluation

The majority of subjects preferred to ask friends for course information. About 22% prefer to ask the program leader. Only a few subjects reported using programme booklets and official websites.

Table 1 below shows the whether the subjects agreed that EASElective is more preferable and convenient than the four alternatives. Items 1-8 refer to the convenience and preferability; meanwhile items 9-12 represent the performance of the chatbot. It was found that many of them preferred the programme booklet and the website more than the chatbot. Table 2 shows that the performance of the chatbot was found to be acceptable.

TABLE 1. Scores indicating whether EASElective is more preferable and more convenient than the alternatives

Items	Mean (SD)
Q1. EASElective informs better than Booklet	2.6 (1.1)
Q2. EASElective informs better than OUHK Website	2.6 (1.3)
Q3. EASElective informs better than Programme Leader	3.2 (1.3)
Q4. EASElective informs better than Peers	3.5 (1.4)
Q5. EASElective more convenient than Booklet	2.5 (1.4)
Q6. EASElective more convenient than OUHK Website	2.7 (1.4)
Q7. EASElective more convenient than Programme Leader	3.3 (1.2)
Q8. EASElective more convenient than Peers	3.6 (1.4)
Q9. The response time is acceptable	3.2 (1.2)
Q10. The system is easy to use	3.4 (1.4)
Q11. The dialogue is clear to understand	3.1 (1.1)
Q12. The response is accurate	3.1 (1.3)

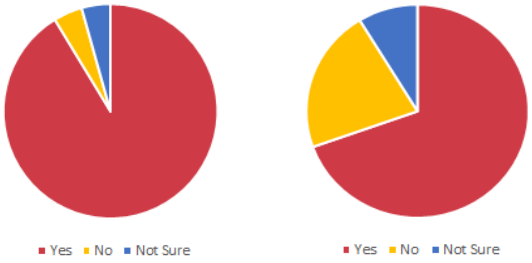

Fig. 4. The overall perception of the chatbot system. (left) should the system be made available to computing students and (right) would you recommend this system to others?

The subjects include final year students (n=14) and non-final year students (n=9). Final year students had gone through two rounds of elective course selection and they should know more about the type of course advising required. Table 3 compares the perception of final year students and non-final year students. Generally, final year students have more positive perception and the differences in Q2, Q4, Q7, and Q8 were found to be statistically significant according to Student's t-test. Fig. 7 clearly shows the average score for Q1 to Q4 is higher among final year students.

TABLE 2. Comparison between final year students and non-final year students students and the results of Student's t-test.

Items	Final year students Mean (SD)	Non final year students Mean (SD)	Mean Diff	t	df	Sig
Q1.	2.8 (0.67)	2.5 (1.3)	-0.3	-0.5	21	0.558
Q2.	3.4 (1.2)	2.1 (1.0)	-1.4	-2.8	21	0.01**
Q3.	3.8 (1.0)	2.9 (1.4)	-0.9	-1.7	21	0.102
Q4.	4.6 (0.5)	2.8 (1.4)	-1.8	-3.6	21	0.002**
Q5.	3.1 (1.4)	2.1 (1.4)	-1.0	-1.6	21	0.118
Q6.	3.4 (1.0)	2.3 (1.3)	-1.1	-2.0	21	0.054
Q7.	4.1 (0.8)	2.8 (1.3)	-1.3	-2.8	21	0.010**
Q8.	4.4 (0.7)	3.1 (1.5)	-1.3	-2.6	21	0.018**

V. Discussion

This study revealed that the chatbot system was seen as a novelty, something nice-to-have but not something to rely upon yet. The findings considered the chatbot available anytime and anywhere. It was regarded as better than the programme leader and peers probably because they were not as readily available as online services, which included programme booklets and website. Concerning the performance in general, the majority of subjects considered the chatbot easy to use. Close to half of them were satisfied with its response time, dialog and accurate response.

It was not a surprise that there was a significant difference between final year students and non-final year students in their perception of the chatbot system. Final year students were more experienced in choosing electives, and they knew more what they wanted to know. They regarded that the chatbot system was on-par with the programme booklet and website, and much better than the programme leader and their peers. It would be useful to know why their peers were regarded so low, which is in contrary with previous research.

For those who would not recommend the chatbot system, their additional comments included not using Telegram (the instant messaging system used in the prototype), the response time was too slow, the interaction was not efficient. The last point was a valid comment commonly associated with chatbots. It would be faster to search the programme website for information but chatbot could provide advanced functions like doing analysis and making recommendations.

It was also interesting to find out that the subjects though the chatbot provide less information than programme booklet. In fact, all information provided by the booklet could be found in our system database. A few reasons are suggested as follows. Students did not know what they want to know. They had to ask explicitly for information with the chatbot, whereas they could browse a booklet to know what are available. Thus, it resulted in the subjects thinking that they were not better informed by the chatbot.

VI. CONCLUSION

Academic advising, in particular course selection advising, has become an important component of student support. A faculty member, acting as academic advisor, is now seen as the window for cultivating student engagement with the university. As the student population becoming more and more diverse, there are genuine needs for more such windows, each of which is dedicated for certain need or designed for certain requirements. The development of academic advising chatbots should be an important endeavor to achieve such a new model of comprehensive advising services. The chatbots, together with faculty advisors, administrative advisors, and counselors, will contribute to the services with their uniqueness.

There are a number of limitations to the study. As discussed above, the period of interaction with a chatbot needs to be longer before the users learn how to interact with it more efficiently. In addition, the usage pattern was neither pre-defined nor recorded, and therefore unable to gauge user behavior for interpretation of their responses. The next study should be based on more long-term use of an operational system, preferably over 1-year period.

In summary, the chatbot technology demonstrated ample potential for course advising based on our experience and the user perception evaluation. The chatbot is capable of giving precise responses to users asking for official course information and student opinions. At present, the functions on course advising and recommendation are rather basic. The next stage of development will focus on two directions. First, we will investigate a more effective manner for students to obtain official information through the chatbot interface, due to the findings that students found the course website and booklet more preferable to use. Two issues will be investigated which include how to allow students to indicate their intent in a conversation and how to better style the course information. Second, we will investigate on building in more analysis and recommendation functions. Students will receive several versions of recommended course sets according to their preferences and constraints.

ACKNOWLEDGEMENT

We are very grateful to Ms. Katie Shu and the Katie Shu Sui Pui Charitable Trust – "We can Fly" programme for sponsoring the trip to attend the conference and present this paper. Also, we are grateful that IBM bluemix provided the cloud service.

REFERENCES

[1] J. C. B. Vianden and, P. J. Barlow, "Strengthen the Bond: Relationships Between Academic Advising Quality and Undergraduate Student Loyalty," NACADA Journal, vol. 35, no. 2, pp. 15–27, 2015.

[2] K. M. Elliott and, M. A. Healy, "Key Factors Influencing Student Satisfaction Related to Recruitment and Retention," Journal of Marketing for Higher Education, vol. 10, no. 4, pp. 1–11, 2001.

[3] B. N. Matta, J. M. Guzman, S. K. Stockly and, B. Widner, "Class Size Effects on Student Performance in a Hispanic-Serving Institution," The Review of Black Political Economy, vol. 42, no. 4, pp. 443–457, 2015.

[4] N. Werghi and, F. K. Kamoun, "A decision-tree-based system for student academic advising and planning in information systems programmes," International Journal of Business Information Systems, vol. 5, no. 1, p. 1, 2010.

[5] L. Keston and, W. Goodridge, "AdviseMe: An Intelligent Web-Based Application for Academic Advising," International Journal of Advanced Computer Science and Applications, vol. 6, no. 8, 2015.

[6] R. Kerin, M. Harvey and, N. F. Crandall, "Student Course Selection in a Non-Requirement Program: an Exploratory Study," The Journal of Educational Research, vol. 68, no. 5, pp. 175–177, 1975.

[7] M. W. Pass, S. S. Mehta, G. B. Mehta, "Course selection: student preferences for instructor practices", Academy of Educational Leadership Journal, vol. 16, no. 1, pp. 31- 38, 2012

[8] M. W. Hayes, J. Prus, "Student use of quantitative and qualitative information on Ratemyprofessors", College Student Journal, vol. 48, no. 4, pp. 675–688, 2014.

[9] C. Andre, J. Deerin, and, L. Leykum, "Students helping students: vertical peer mentoring to enhance the medical school experience," BMC Research Notes, vol. 10, no. 1, Feb. 2017.

[10] L. Keston and, W. Goodridge, "AdviseMe: An Intelligent Web-Based Application for Academic Advising," International Journal of Advanced Computer Science and Applications, vol. 6, no. 8, 2015.

[11] O. Daramola, O. Emebo, I. Afolabi, and, C. Ayo, "Implementation of an Intelligent Course Advisory Expert System," International Journal of Advanced Research in Artificial Intelligence, vol. 3, no. 5, 2014.

[12] G. C. B. Engin, B. Aksoyer, M. Avdagic, D. Bozanlı, U. Hanay, D. Maden and, G. Ertek, "Rule-based Expert Systems for Supporting University Students," Procedia Computer Science, vol. 31, pp. 22–31, 2014.

[13] K. Hingorani and, N. Askari-Danesh, "Design and development of an academic advising system for improving retention and graduation". Issues in Information Systems, vol. 15, no. 2, pp. 344-349, 2014.

[14] E. Afify and, M. Nasr, "A Proposed Model for a Web-Based Academic Advising System". International Journal of Advanced Networking and Applications, vol. 9, no. 2, pp. 3345-3361, 2017.

[15] E. M. Latorre-Navarro and, J. G. Harris, "An Intelligent Natural Language Conversational System for Academic Advising," International Journal of Advanced Computer Science and Applications, vol. 6, no. 1, 2015.

[16] C. Thorne, "Chatbots for troubleshooting: A survey," Language and Linguistics Compass, vol. 11, no. 10, 2017.

[17] P. Amador and, J. Amador, "Academic advising via Facebook: Examining student help seeking," The Internet and Higher Education, vol. 21, pp. 9–16, 2015.