Emobot: Emotional chatbot

Vishal Chaudhary, Bastin Headmon Gomez

{*v3chaudh, bgheadmo*}*@uwaterloo.ca*
David R. Cheriton School of Computer Science
University of Waterloo

***Abstract*—Chatbots are computer programs that interact with users using natural languages and are built to mimic human conversation, entertain users, and many other applications in fields such as education, information retrival, business, and e-commerce [1]. Analysing the sentiment associated with the chats and replying accordingly greatly increases the utility of chatbots, since knowing the sentiment associated with the text would help in forming better responses.**

Sentiment analysis in itself is an important research area in Affective computing, which has many applications such as, to analyze the sentiments in the reviews of consumer products and services, to examine the sentiments associated with publicly traded companies in financial markets [2] et. al.

We present *Emobot*, an emotional chatbot that analyses the emotions and sentiments associated with the user chat text, then responds accordingly. On receiving a chat text, the emobot finds out the EPA (Evaluation, Potency and Activity) [3] values for the entire sentence by analysing the words in the sentence and sends the chat text to a number of hand-selected chatbots. Once Emobot receives the response from these bots, it selects the most affective (emotionally close) response based on their effective EPA values. This response is then presented to the user as Emobot's reply.

Keywords—Sentiment analysis, emotional chatbot, affect control theory, evaluation potency activity.

I. Introduction

It is very important to make chatbots to be able to analyse sentiments and emotions contained in the user text since chatbots can be used in a variety of situations [1]. A lot of research and development is happening in the field of sentiment analysis [4]–[7]. Many commercial products are making use of this and it is playing an important role in understanding user's opinion more efficiently [8]. Scope of usage of this information range from e-commerce websites to get an in-depth understanding of user's opinion about the product, to making artificially intelligent products that use voice recognition and in different kinds of battle emulators as well to understand the thought process of soldiers in crisis situations [4], [9], [10].

A number of large technology companies are working on developing chatbots. For instance, Facebook's chatbot [11] and Microsoft's Cortana-powered chatbot for Skype and its developer framework [12]. Kik is offering a chatbot store[1] which allows different companies to talk to users via bots.

Sentiment analysis tools that are currently available calculate the sentiment values for a full piece of text as a whole and produce a sentiment value and say that it was either positive or negative. They do not perform analysis on a detailed level. This approach lead to loss of significant information. For example, a negative statement expressed sarcastically should be considered as more positive if it is made among many positive statements. Also, if it has emoticons, they should also be taken into account to understand the user's sentiment behind writing that statement. Current tools are unable to identify this as they work on the macro level rather than on the micro level [13].

In this project, we have attempted to achieve the following objectives:

1) Implement an emotional chatbot which has a Java Swing-based[14] graphical user interface (GUI) which can be used to perform chat sessions.
2) Implement the logic for removing stop words, which are words that occur so frequently that they create a noise [15], [16].
3) Implement the logic for calculating the EPA [3] values for a sentence from the EPA values of the relevant words. We make use of Interact data[2] and OpenNLP [17].
4) Implement backend REST services which can be used to interact with third-party chatbots.
5) Implement the logic for invoking the REST services to get responses from third-party chatbots and calculating the most affective (emotionally close to user's message) response out of all received responses, based on their effective EPA score.
6) Evaluate with experiments to find if Emobot is able to provide the most affective response in the chat sessions.

In section II, we describe the methodology used in Emobot along with various third-party chatbots and the terminologies used. We list some related work in section III. Then we describe our frontend and backend implementation in detail in section IV. In section V, we describe our evaluation setup and evaluation results. Then we list some threats to validity for Emobot in section V-B. Finally, we conclude the paper with some future work in section VI.

[1] https://bots.kik.com/

[2] http://www.indiana.edu/~socpsy/ACT/data.html

II. Methodology

A. Terminologies used

Below are some terminologies used in the paper repeatedly:

1) A.L.I.C.E.[3](Artificial Linguistic Internet Computer Entity): It is an award-winning free natural language artificial intelligence chatbot. Alicebot and AIML are open source softwares.
2) AIML[4] (Artificial Intelligence Markup Language[5]): It enables people to input knowledge into chat-bots based on the A.L.I.C.E free software technology. AIML was developed by the Alicebot free software community during 1995-2000. It was originally adapted from a non-XML grammar also called AIML, and formed the basis for the first Alicebot, A.L.I.C.E., the Artificial Linguistic Internet Computer Entity.
3) EPA: EPA stands for Evaluation, Potency, Activity. Evaluation/valence, Potency/control, and Activity/arousal are the basis vectors of affective space, that can be used to measure the semantic differential [3].

B. Overview

Emobot is a chatbot that replies to the user's message with affective tit-for-tat response. To provide a tit-for-tat response, Emobot uses EPA vectors distance formula, to make sure that response is affectively (emotionally) closest to user's message/question.

Constructing a sentence as a response is a whole different research in itself and hence we did not implement the sentence construction module in the Emobot. Instead, we used 5 different chatbots and used them to extract 5 different responses. Then, to send a response to user as a reply to his/her message, Emobot picks the most affective (emotionally close) response amongst all 5 responses. In this way, we were able to concentrate more on affective part of the response than the response itself.

Each of these 5 chatbots was implemented with a primary objective. Few chatbots try to answer "what", "when", "where" questions, some try to provide a general reply using simple natural language processing techniques. To cover a variety of responses, we used 5 different chatbots that were implemented with different objectives. Below is the list of these 5 chatbots:

1) Eliza Bot[6]: A bot modeled after the 1966 ELIZA chatbot. ELIZA was written at MIT by Joseph Weizenbaum between 1964 and 1966. She attempts to simulate a Rogerian psychotherapist.
2) Alice Bot[7]: A bot that uses the ALICE AIML set from the A.L.I.C.E. (Artificial Linguistic Internet Computer Entity) foundation. It is an award-winning free natural language artificial intelligence chat robot.
3) Brain Bot[8]: A chat bot created to become the most intelligent chatbot on the Internet. It can answer any "what is" question by looking up the answer directly on the Internet.
4) Program-O Bot[9]: A chatbot[10] implemented in PHP, MySQL & AIML and XML/JSON responses or just plain HTML. It has a massive community of users and supports foreign languages as well.
5) Personality Forge Bot[11]: Personality Forge Bot, an advanced artificial intelligence chatbot which can be modified as per need for creating new chat bots. We used the default implementation available from the website.

All of the above mentioned chatbots, have different objectives behind their implementation. When a user sends a message/question, Emobot send that message to all 5 chatbots and gets 5 separate responses. Emobot then selects one response based on EPA distance calculation with respect to the EPA value of the user's message. Moreover, user can also use Emobot interface just to interact with any of the 5 chatbots separately.

For calculating EPA value of a message (that is coming from the user or from any chatbot), Emobot uses OpenNLP for parsing the message/sentence and get a list of verbs or behavioral components. Then it uses WordNet for removal of stop words. Next, Emobot uses Interact to evaluate the EPA values of the whole sentence. In the next section, we talk about some related work in the area of chatbots and sentiment analysis.

III. Related Work

EHebBy is an evocative humorist chatbot and is said to have a sense of humor and it can both generate humorous sentences and recognize humoristic expressions introduced by the user during a dialogue [18]. Humor evokes emotions and this is very close to a chatbot that can understand and express emotions. It uses ALICE framework similar to one of the chatbots that we are using for Emobot. Our bot differs from this in the sense that we use multiple chatbots and make use of affect control theory to decide on the most affective response to be given back to the user.

In [19], the authors talk about chatbots that can generate puns by searching in the internet and using the Nakamuras Emotion Dictionary. Although the authors have talked about the detecting emotional load from text, not much details are given in the paper and experimental results are missing which could have proven their claims. Although it seems like an interesting work, we cannot compare it with ours because of lack of details.

In [20], authors implemented a chatbot named Botcom that is an embodied conversational agent (ECA). In this paper, authors emphasized on visualization of the synthetic character that was a result of several approaches to graphical realization. Also, they focused on usage of fast emotion generation and described this module from the architectural and theoretical perspective.

[3] http://www.alicebot.org/about.html

[4] http://www.alicebot.org/aiml.html

[5] www.pandorabots.com/pandora/pics/wallaceaimltutorial.html

[6] www.masswerk.at/elizabot/

[7] www.alicebot.org/about.html

[8] www.botlibre.com/BrowseServlet?browse=Brain+Bot

[9] www.program-o.com/

[10] github.com/Program-O/Program-O

[11] www.personalityforge.com/

In a study conducted in 2004, to demonstrate the usage of chatbots in teaching foreign languages [21], users were asked to interact with an online human-computer dialog system using natural language and try to learn a foreign language. Experiment indicated that dialogs between humans and computers were very short because most of the time computers replied with responses that were irrelevant to the topic and context. Also, at times, the program could not understand the language at all. Authors concluded that this kind of system that follows keywords or pattern-matching mechanism, cannot work as a teaching assistant program in foreign language learning.

IV. Software Implementation

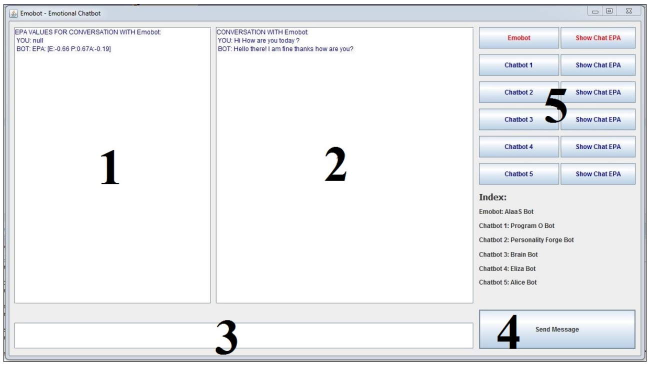
In this section, we will be explaining the implementation of Emobot which includes the frontend part and the backend part. We have divided this section into two namely:

1) Emobot frontend implementation: The frontend consists of a graphical user interface and the frontend logic of the Emobot. More details provided in section IV-A.
2) Emobot backend implementation: The backend consists of the application server which hosts the RESTful services for the Emobot frontend that accesses the functionality of third-party chatbots. Different third-party chatbots are used in our implementation and their significance in Emobot is also discussed. More details provided in section IV-B.

A. Frontend Implementation

Emobot frontend is written using Java Swing[12] and graphs are built using JFreeCharts library[13]. The frontend will be communicating with a set of RESTful services, deployed in a backend server, which is responsible for responding to the user's messages. For the purpose of making the installation easier, we deployed our frontend on a JNLP[14] server. By that, anybody can launch the frontend just with the access to a URL. Refer section VIII for details.

Java Swing provides a simple, clean and smooth user interface to interact with the Emobot. Java Swing was introduced as a superior set of components to AWT (Abstract Window Toolkit)[15], to provide a better graphical user interface for Java programs. Fig. 1 shows the user interface of Emobot, developed using Java Swing. In that figure, portion marked as number 3 represents the text box (say chatting text box) where the user types in messages and sends using the "Send Message" button (marked by number 4). Portion marked by number 1 shows the EPA values for each corresponding message in the chat window (marked by number 2). So, for every message (by user or by Emobot) in the chat window, the EPA will be printed on the screen marked by number 1. Portion marked by number 5 represents various buttons that the user can use for navigating between different chatbots.



Emobot - Emotional Chatbot

EPA VALUES FOR CONVERSATION WITH Emobot:
YOU: null
BOT: EPA: [E:-0.66 P:0.67A:-0.19]

CONVERSATION WITH Emobot:
YOU: Hi How are you today ?
BOT: Hello there! I am fine thanks how are you?

Index:
Emobot: AlaaS Bot
Chatbot 1: Program O Bot
Chatbot 2: Personality Forge Bot
Chatbot 3: Brain Bot
Chatbot 4: Eliza Bot
Chatbot 5: Alice Bot

Fig. 1: User Interface of Emobot

Emobot has a set of buttons, that helps the user to interact with Emobot in different ways. Either user can use Emobot itself (by clicking on Emobot button) for a conversation or else can interact directly with the other 5 chatbots (by clicking on buttons Chatbot 1 to Chatbot 5) in the Emobot interface. These 5 chatbots included in the Emobot interface were selected based on their differences in the objectives behind their implementation.

Chatting text box, chat windows, 'Send Message' button and all the other components on the Emobot user interface are shared by all 6 bots (except respective set of chatbot buttons). Out of 6 bots (Emobot and other 5 chatbots), any active chatbot is shown in red color font on the button and the rest are shown using dark blue colour. So, at any given time, contents in chat windows would correspond to the active chatbot shown in red color.

Emobot uses 5 other chatbots to construct the response. User enters a message in the input text box provided at the bottom of Emobot user interface and sends this message to the backend server using a RESTful GET request. Backend server then sends 5 individual requests to various chatbots to get separate responses from each chatbot. Once the server receives all the responses from each of these 5 chatbots, it uses OpenNLP [17], Wordnet [22] and Interact [23] to determine the most affective (emotionally close) response to the user's message.

Emobot uses EPA values to determine the emotional strength of the message and its responses. For EPA calculation, we restricted Emobot to consider only the behavioral EPA and excluded actor EPA and object EPA. There were two main reasons behind this approach. First, we wanted to concentrate on only one component for our research and behavioral EPA was a clear winner against actor EPA and object EPA. Behavior or action provides more information about the emotion involved in the message, than the identity of the actor or object. Second, in the scenario of a user and a chatbot, the significance of the identity/role of the user is not high and hence can be excluded.

Since the focus of Emobot is only on behavioural EPA, backend server creates a copy of the user's message. Then, the server cleans this message copy using Wordnet dictionary, removes stop words and a filtered string is obtained. Then, using OpenNLP, the message is parsed and the verb (action

[12] https://docs.oracle.com/javase/7/docs/technotes/guides/swing/

[13] http://www.jfree.org/jfreechart/

[14] https://docs.oracle.com/javase/tutorial/deployment/deploymentInDepth/jnlp.html

[15] http://docs.oracle.com/javase/7/docs/technotes/guides/awt/

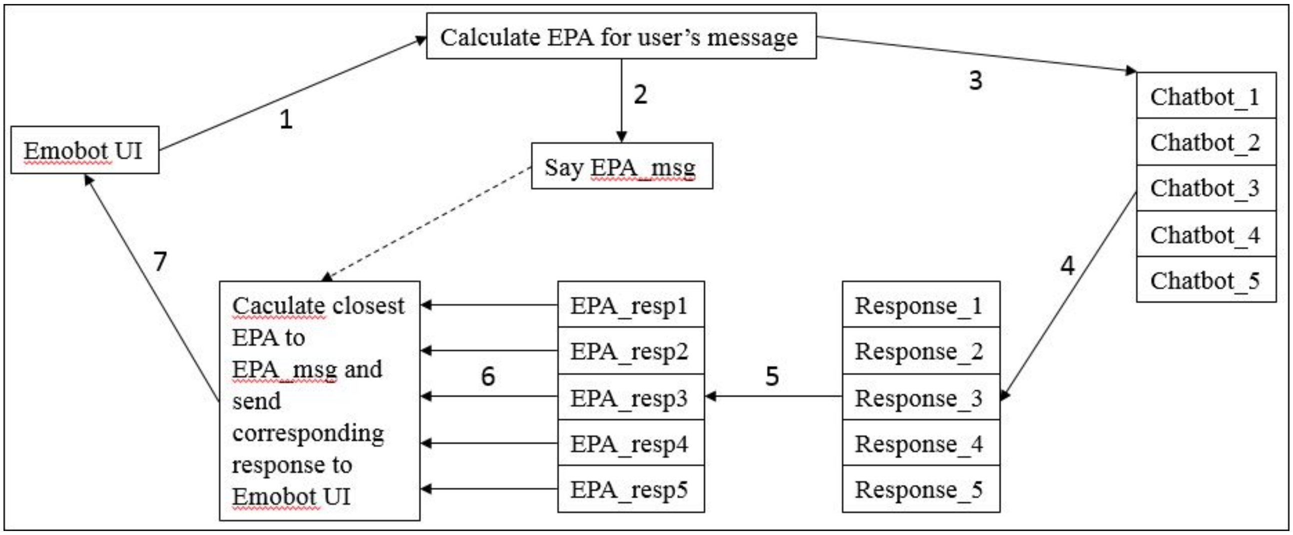
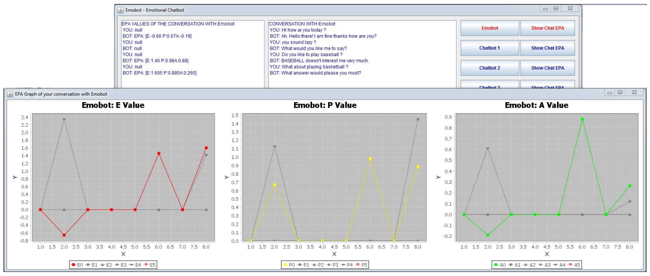


Fig. 2: Flow chart of Emobot

or behavioral) component of the message is obtained. Using this verb component, server connects with Interact module to get an EPA value (say EPA_msg) for the message as shown in Fig. 2.

Now, server takes another copy of the original message (as received from the user) and sends it to 5 chatbots to get 5 separate responses from respective chatbots. Once, backend server receives all 5 responses, EPA value is calculated for each response message using the the same process as explained earlier (i.e. parsing, stop word cleaning, EPA value calculation using Interact). An algorithm collects only non-null EPA values out of EPA values for all 5 chatbot responses. Then the algorithm finds the closest EPA value to our user's message EPA value (i.e. EPA_msg) and corresponding response is then sent to user's screen as the response of the Emobot. As discussed earlier, Emobot constructs a response for the user's message from one of the 5 chatbot's response, but user thinks that he/she is interacting with the Emobot.



EPA VALUES OF THE CONVERSATION WITH Emobot:
YOU: null
BOT: EPA: [E:-0.66 P:0.67A:-0.19]
YOU: null
BOT: null
YOU: null
BOT: EPA: [E:1.46 P:0.98A:0.88]
YOU: null
BOT: EPA: [E:1.605 P:0.885A:0.265]

CONVERSATION WITH Emobot:
YOU: Hi how ar you today ?
BOT: Ah. Hello there! I am fine thanks how are you?
YOU: you sound lazy ?
BOT: What would you like me to say?
YOU: Do you like to play baseball ?
BOT: BASEBALL doesn't interest me very much.
YOU: What about playing basketball ?
BOT: What answer would please you most?

Fig. 3: Result graphs

After user has finished interacting with Emobot, he/she can click on 'Show EPA graph' button to see a line graph of all the EPA values obtained from all the 5 chatbots as shown in Fig. 3. These charts are created using JFreeChart library and gives an overview of how Emobot chose one particular response out of 5 responses from the 5 chatbots. Out of 5 responses, response selected by Emobot as its response is shown in colors (red for E value, yellow for P value and green for A value) whereas other 4 responses are shown in gray colour.

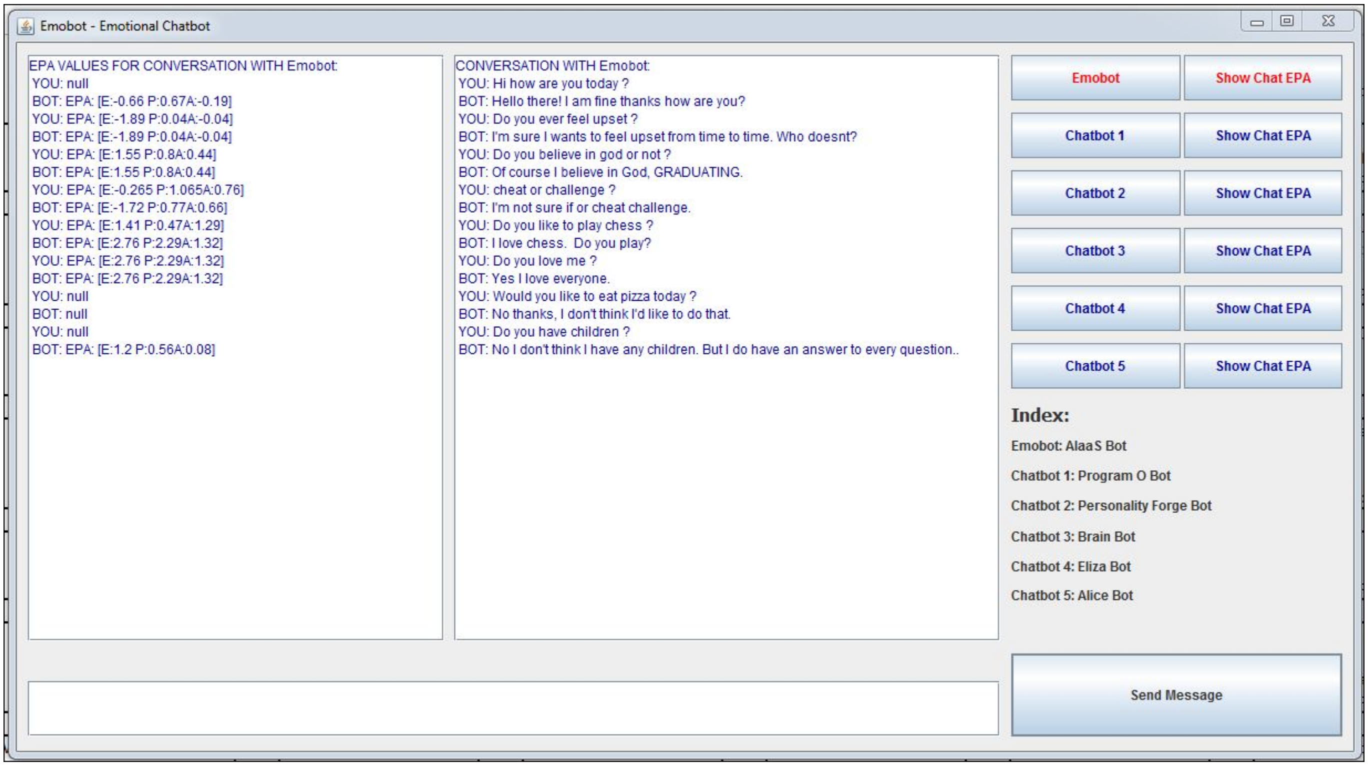
B. *Backend implementation*

The backend implementation was done using Ruby on Rails web framework. We created wrapper REST services which could be used by the frontend. These REST services wrap the invocation of the 5 chatbots that we use in Emobot. The REST services receive the user's chat text from the Emobot frontend when the user types in and press the "Send Message" button. The received text is passed on to the 5 chatbots one-by-one and responses are received from them. These responses are processed as explained earlier in section IV-A. Processed responses are compared with the input text to select the best response for the user which along with the EPA values are send back to the frontend and printed as the Emobot's response. During development, we tested the functionality by locally deploying the services on an instance of WEBrick[16] server which comes along with the Ruby on Rails installation. Later when we had to integrate with the frontend, we deployed the services on an instance of Heroku[17], which is a cloud platform-as-a-service (PaaS) that supports several programming languages. This way, when the frontend is launched using JNLP[18] on the user's personal computer, it will interact with the REST services which is deployed on Heroku.

V. Evaluation

For the evaluation of Emobot, we made few assumptions to execute a controlled experiment.

[16] http://ruby-doc.org/stdlib-2.0.0/libdoc/webrick/rdoc/WEBrick.html
[17] https://www.heroku.com/
[18] http://www.oracle.com/technetwork/java/javase/overview-137531.html



```
EPA VALUES FOR CONVERSATION WITH Emobot:
 YOU: null
 BOT: EPA: [E:-0.66 P:0.67A:-0.19]
 YOU: EPA: [E:-1.89 P:0.04A:-0.04]
 BOT: EPA: [E:-1.89 P:0.04A:-0.04]
 YOU: EPA: [E:1.55 P:0.8A:0.44]
 BOT: EPA: [E:1.55 P:0.8A:0.44]
 YOU: EPA: [E:-0.265 P:1.065A:0.76]
 BOT: EPA: [E:-1.72 P:0.77A:0.66]
 YOU: EPA: [E:1.41 P:0.47A:1.29]
 BOT: EPA: [E:2.76 P:2.29A:1.32]
 YOU: EPA: [E:2.76 P:2.29A:1.32]
 BOT: EPA: [E:2.76 P:2.29A:1.32]
 YOU: null
 BOT: null
 YOU: null
 BOT: EPA: [E:1.2 P:0.56A:0.08]
```

```
CONVERSATION WITH Emobot:
 YOU: Hi how are you today ?
 BOT: Hello there! I am fine thanks how are you?
 YOU: Do you ever feel upset ?
 BOT: I'm sure I wants to feel upset from time to time. Who doesnt?
 YOU: Do you believe in god or not ?
 BOT: Of course I believe in God, GRADUATING.
 YOU: cheat or challenge ?
 BOT: I'm not sure if or cheat challenge.
 YOU: Do you like to play chess ?
 BOT: I love chess.  Do you play?
 YOU: Do you love me ?
 BOT: Yes I love everyone.
 YOU: Would you like to eat pizza today ?
 BOT: No thanks, I don't think I'd like to do that.
 YOU: Do you have children ?
 BOT: No I don't think I have any children. But I do have an answer to every question..
```

Index:

Emobot: AlaaS Bot

Chatbot 1: Program O Bot

Chatbot 2: Personality Forge Bot

Chatbot 3: Brain Bot

Chatbot 4: Eliza Bot

Chatbot 5: Alice Bot

Fig. 4: Emobot Evaluation

1) As already mentioned in the previous section, we focused only on behaviour EPA and excluded actor EPA and object EPA.
2) User is always the first speaker and Emobot just replies to his/her message. We assumed this because we are using 5 other chatbots to construct Emobot's response. If first speaker rights are given to the Emobot, we might get 5 different messages with 5 different contexts. To control this conversation and keep it within a particular context, user first asks the question and Emobot responds to that question.
3) If all the 5 responses do not give any EPA value (i.e. they give null EPA values), we take Alicebot's response. Reason behind this is that AliceBot's credibility is very high and a lot of research has been done on AliceBot in the past which makes it a very strong contender to be selected as the default chatbot.
4) Since, this is the first chatbot of its kind that works on Affect Control Theory (ACT), we cannot compare it with any other chatbots. Our motivation for this evaluation study is to check if it works as claimed or not. But, the EPA graph in figure 6 shows a good comparison of Emobot with the other 5 chatbots.

A. Evaluation Setup

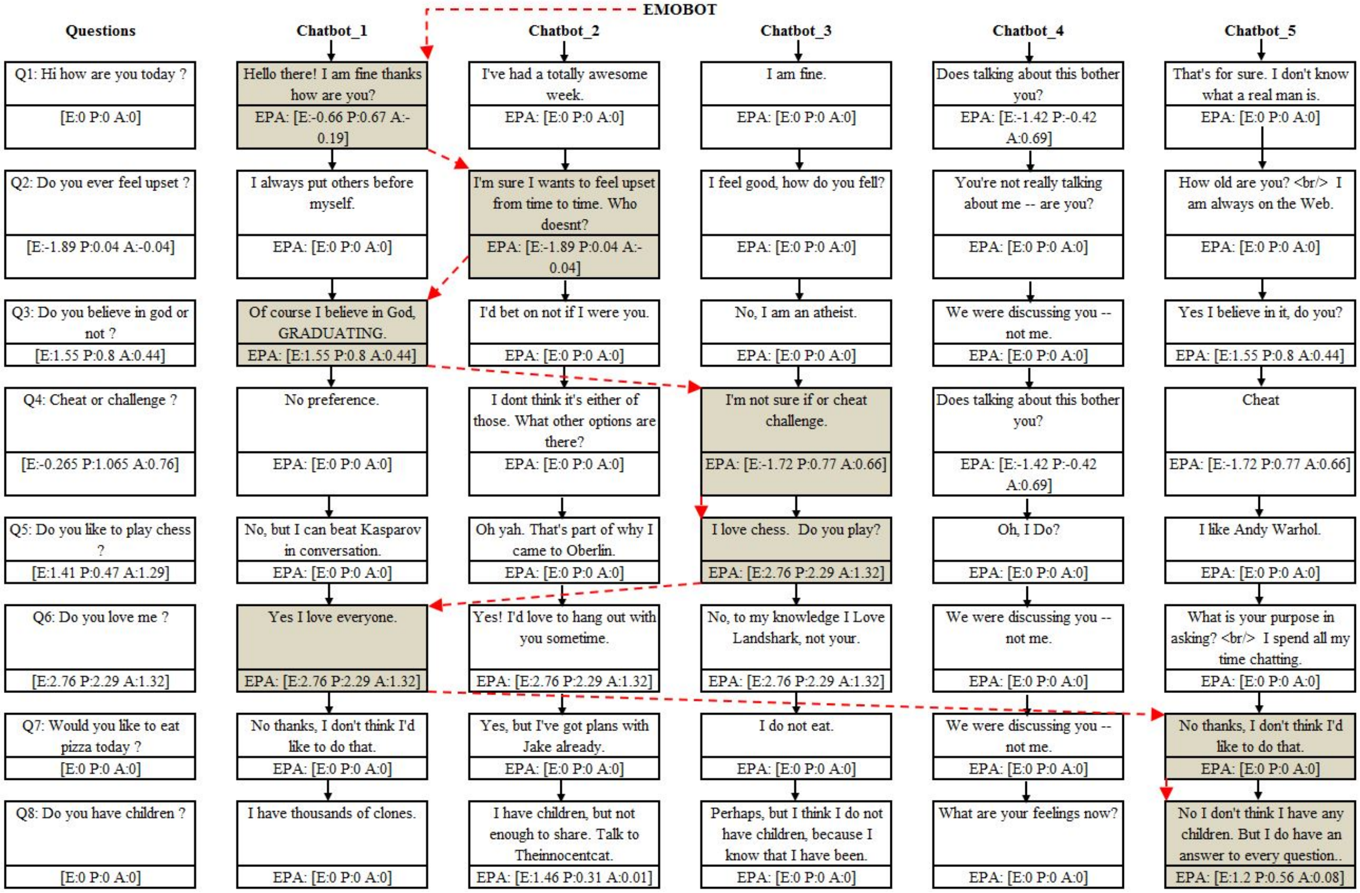
As mentioned above, this evaluation is carried out to check if the Emobot always picks the most affective (emotionally close) response out of all 5 responses. So, the experiment setup includes a list of questions to be asked to the Emobot and collect all the responses. Then, EPA values of user's message and all 5 responses are calculated. Emobot then selects the emotionally closest response to the user's message based on EPA values.

Questionnaire used for the evaluation consists of following questions:

1) Question 1: Hi how are you today?
2) Question 2: Do you ever feel upset?
3) Question 3: Do you believe in god or not?
4) Question 4: Cheat or challenge?
5) Question 5: Would you like to play baseball today?
6) Question 6: Do you love me?
7) Question 7: Would you like to eat pizza today?
8) Question 8: Do you have children?

For evaluation, above mentioned questionnaire was used. Fig. 4 shows Emobot interface after the evaluation was completed. Fig. 5 shows different replies given by all 5 chatbots for each question in the questionnaire. For every question on the left hand side, there are 5 responses each from the 5 chatbots. Each chatbot's response for the questionnaire is shown from top to bottom linked with black coloured solid arrows. Emobot responses are shown using gray color highlighted boxes linked by red dotted lines. Emobot selected the most affective (emotionally close) response to the user's message.

After the evaluation was completed, an evaluation graph was



Questions	Chatbot_1	Chatbot_2	Chatbot_3	Chatbot_4	Chatbot_5
Q1: Hi how are you today ? [E:0 P:0 A:0]	Hello there! I am fine thanks how are you? EPA: [E:-0.66 P:0.67 A:-0.19]	I've had a totally awesome week. EPA: [E:0 P:0 A:0]	I am fine. EPA: [E:0 P:0 A:0]	Does talking about this bother you? EPA: [E:-1.42 P:-0.42 A:0.69]	That's for sure. I don't know what a real man is. EPA: [E:0 P:0 A:0]
Q2: Do you ever feel upset ? [E:-1.89 P:0.04 A:-0.04]	I always put others before myself. EPA: [E:0 P:0 A:0]	I'm sure I wants to feel upset from time to time. Who doesnt? EPA: [E:-1.89 P:0.04 A:-0.04]	I feel good, how do you fell? EPA: [E:0 P:0 A:0]	You're not really talking about me -- are you? EPA: [E:0 P:0 A:0]	How old are you? <br/> I am always on the Web. EPA: [E:0 P:0 A:0]
Q3: Do you believe in god or not ? [E:1.55 P:0.8 A:0.44]	Of course I believe in God, GRADUATING. EPA: [E:1.55 P:0.8 A:0.44]	I'd bet on not if I were you. EPA: [E:0 P:0 A:0]	No, I am an atheist. EPA: [E:0 P:0 A:0]	We were discussing you -- not me. EPA: [E:0 P:0 A:0]	Yes I believe in it, do you? EPA: [E:1.55 P:0.8 A:0.44]
Q4: Cheat or challenge ? [E:-0.265 P:1.065 A:0.76]	No preference. EPA: [E:0 P:0 A:0]	I dont think it's either of those. What other options are there? EPA: [E:0 P:0 A:0]	I'm not sure if or cheat challenge. EPA: [E:-1.72 P:0.77 A:0.66]	Does talking about this bother you? EPA: [E:-1.42 P:-0.42 A:0.69]	Cheat EPA: [E:-1.72 P:0.77 A:0.66]
Q5: Do you like to play chess ? [E:1.41 P:0.47 A:1.29]	No, but I can beat Kasparov in conversation. EPA: [E:0 P:0 A:0]	Oh yah. That's part of why I came to Oberlin. EPA: [E:0 P:0 A:0]	I love chess. Do you play? EPA: [E:2.76 P:2.29 A:1.32]	Oh, I Do? EPA: [E:0 P:0 A:0]	I like Andy Warhol. EPA: [E:0 P:0 A:0]
Q6: Do you love me ? [E:2.76 P:2.29 A:1.32]	Yes I love everyone. EPA: [E:2.76 P:2.29 A:1.32]	Yes! I'd love to hang out with you sometime. EPA: [E:2.76 P:2.29 A:1.32]	No, to my knowledge I Love Landshark, not your. EPA: [E:2.76 P:2.29 A:1.32]	We were discussing you -- not me. EPA: [E:0 P:0 A:0]	What is your purpose in asking? <br/> I spend all my time chatting. EPA: [E:0 P:0 A:0]
Q7: Would you like to eat pizza today ? [E:0 P:0 A:0]	No thanks, I don't think I'd like to do that. EPA: [E:0 P:0 A:0]	Yes, but I've got plans with Jake already. EPA: [E:0 P:0 A:0]	I do not eat. EPA: [E:0 P:0 A:0]	We were discussing you -- not me. EPA: [E:0 P:0 A:0]	No thanks, I don't think I'd like to do that. EPA: [E:0 P:0 A:0]
Q8: Do you have children ? [E:0 P:0 A:0]	I have thousands of clones. EPA: [E:0 P:0 A:0]	I have children, but not enough to share. Talk to Theinnocentcat. EPA: [E:1.46 P:0.31 A:0.01]	Perhaps, but I think I do not have children, because I know that I have been. EPA: [E:0 P:0 A:0]	What are your feelings now? EPA: [E:0 P:0 A:0]	No I don't think I have any children. But I do have an answer to every question.. EPA: [E:1.2 P:0.56 A:0.08]

Fig. 5: Evaluation Questionnaire

obtained by clicking 'Show EPA Graph' button for Emobot as shown in Fig.6. In this graph, the colors red, yellow and green are used to represent E, P and A values of the Emobot respectively. Rest all gray coloured lines represent other 5 chatbot's EPA values. Each dot on the line graphs represent a E, P or A value of a particular question (in total 16 dots in each graph for 8 set of questions and answers).

As seen in all 3 graphs in Fig. 6, every second dot is the most affective (emotionally closest) to the previous dot which represents Emobot's nature of affective tit-for-tat behaviour.

B. *Threats to Validity*

1) Irrelevant/Repeated responses: As Emobot uses 5 other chatbots at the backend to construct the response, there are good chances of getting an invalid, vague or irrelevant response (but might have a non-null EPA value) from all the chatbots and in that case Emobot's response will not make much sense.

2) Null EPA value responses: Many a times, chatbots do not have any significant behavioural component in their response, for which, Interact can provide an EPA value. In those cases, it becomes really difficult to choose one response as Emobot's response, out of all 5 different responses.

VI. Conclusion

It is important for chatbots to analyse the sentiment associated with chats as it greatly increases their utility and helps in forming better responses and thus engaging the user much more. We presented Emobot, which is an emotional chatbot, and its various characteristics and its implementation detail. We also conducted experiments that show the effectiveness of our method. Emobot uses affect control theory to decide on the right response to be given back to the user.

A. *Future Work*

1) Sentence structuring: Emobot currently is dependent on 5 other chatbots to provide responses for a particular message. We would like to remove this dependency and create our own sentence structuring mechanism so that Emobot can analyse the message and generate an affective (emotionally close) response on its own.

2) Include stemming as a part of processing text: Currently, Emobot works with present perfect tense only. This is because Interact dictionary has only present perfect behaviours for which EPA values are available. For example: 'playing' might not provide a valid EPA value, but 'play' would provide a

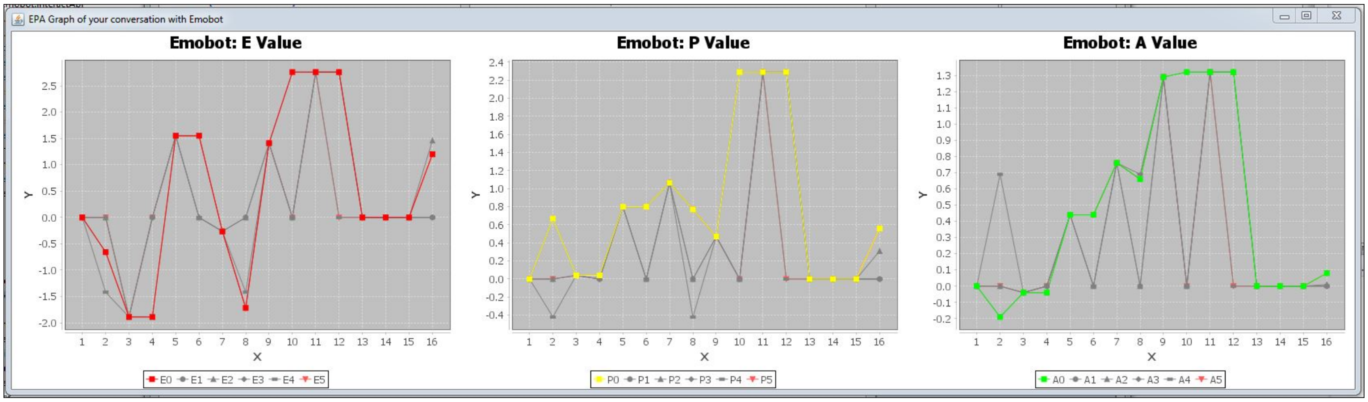


Fig. 6: Emobot Evaluation Graph

value. It is chatbot's responsibility to fetch the present perfect verb from the message and pass it to Interact to get exact EPA value. We would like to strengthen Emobot by applying stemming[19] process before we obtain the EPA value for non-present perfect verbs.

3) Ensure participation of all behaviours: Emobot relies on Interact to provide EPA values. But Interact does not cover all kinds of behaviours. So, if a behaviour is not covered in Interact, we would like to use some third party APIs (like WordsApi[20] and Big Huge Thesaurus [21]) to get other synonyms of that word and check if EPA values for those synonyms are available. This would make ensure that Emobot would not exclude any valid behaviour from the message.

4) BayesACT [24] integration: We would also like to integrate Emobot with BayesACT which provide different results as it is probabilistic and uses total derivative. Also, it can help in detecting behaviours in a context rather than as a standalone one.

5) Effective usage of emoticons: Incorporating emoticons in our chat interface. This helps in getting additional information about the emotion felt by the user along with his text input.

VII. Acknowledgments

We would like to thank Dr.Jesse Hoey, for sharing his in-depth knowledge of Affective computing with us and for his valuable suggestions during the implementation of Emobot.

We would also like to thank Alexandra Vtyurina, a PhD candidate at the University of Waterloo for her suggestions and insights in the area of semantic analysis and chat bots.

VIII. Availability

Emobot is a JNLP-based software and can be accessed using the below hyperlink. Please make sure to add the target URL of the below hyperlink to the exception site list in the Java console.

http://goo.gl/RF6rkr

[19] http://nlp.stanford.edu/IR-book/html/htmledition/stemming-and-lemmatization-1.html

[20] https://www.wordsapi.com/

[21] https://words.bighugelabs.com/api.php

References

[1] B. A. Shawar and E. Atwell, "Chatbots: are they really useful?" in *LDV Forum*, vol. 22, no. 1, 2007, pp. 29–49.

[2] R. Feldman, "Techniques and applications for sentiment analysis," *Communications of the ACM*, vol. 56, no. 4, pp. 82–89, 2013.

[3] C. E. Osgood, "Studies on the generality of affective meaning systems." *American Psychologist*, vol. 17, no. 1, p. 10, 1962.

[4] B. Pang and L. Lee, "Opinion mining and sentiment analysis," *Foundations and trends in information retrieval*, vol. 2, no. 1-2, pp. 1–135, 2008.

[5] A. Kumar and T. M. Sebastian, "Sentiment analysis on twitter," *IJCSI International Journal of Computer Science Issues*, vol. 9, no. 4, pp. 372–373, 2012.

[6] W. Chamlertwat, P. Bhattarakosol, T. Rungkasiri, and C. Haruechaiyasak, "Discovering consumer insight from twitter via sentiment analysis." *J. UCS*, vol. 18, no. 8, pp. 973–992, 2012.

[7] A. Kumar and M. S. Teeja, "Sentiment analysis: A perspective on its past, present and future," *International Journal of Intelligent Systems and Applications*, vol. 4, no. 10, p. 1, 2012.

[8] S. Baccianella, A. Esuli, and F. Sebastiani, "Sentiwordnet 3.0: An enhanced lexical resource for sentiment analysis and opinion mining." in *LREC*, vol. 10, 2010, pp. 2200–2204.

[9] E. Cambria, B. Schuller, Y. Xia, and C. Havasi, "New avenues in opinion mining and sentiment analysis," *IEEE Intelligent Systems*, no. 2, pp. 15–21, 2013.

[10] R. Shilling, M. Zyda, and E. C. Wardynski, "Introducing emotion into military simulation and video game design america's army: Operations and virte." in *GAME-ON*, 2002.

[11] Techcrunch, "Bots on Messenger," http://techcrunch.com/2016/04/12/agents-on-messenger/, april 12, 2016.

[12] Geekwire, "Cortana-powered chatbot for Skype," http://www.geekwire.com/2016/microsoft-introduces-cortana-powered-chatbot-for-skype-opening-up-framework-to march 30, 2016.

[13] P. Gonçalves, M. Araújo, F. Benevenuto, and M. Cha, "Comparing and combining sentiment analysis methods," in *Proceedings of the first ACM conference on Online social networks*. ACM, 2013, pp. 27–38.

[14] R. Eckstein, M. Loy, and D. Wood, *Java swing*. O'Reilly & Associates, Inc., 1998.

[15] A. Rajaraman, J. D. Ullman, J. D. Ullman, and J. D. Ullman, *Mining of massive datasets*. Cambridge University Press Cambridge, 2012, vol. 1.

[16] W. J. Wilbur and K. Sirotkin, “The automatic identification of stop words,” *Journal of information science*, vol. 18, no. 1, pp. 45–55, 1992.

[17] “Apache opennlp,” https://opennlp.apache.org/.

[18] G. Pilato, A. Augello, G. Vassallo, and S. Gaglio, “Ehebby: An evocative humorist chat-bot,” *Mobile Information Systems*, vol. 4, no. 3, pp. 165–181, 2008.

[19] R. Rzepka, W. Shi, M. Ptaszynski, P. Dybala, S. Higuchi, and K. Araki, “Serious processing for frivolous purpose: a chatbot using web-mining supported affect analysis and pun generation,” in *Proceedings of the 14th international conference on Intelligent user interfaces*. ACM, 2009, pp. 487–488.

[20] G. Tatai, A. Csordás, A. Szaló, and L. Laufer, “The chatbot feeling–towards animated emotional ecas,” in *Progress in Artificial Intelligence*. Springer, 2003, pp. 336–340.

[21] J. Jia, “The study of the application of a web-based chatbot system on the teaching of foreign languages,” in *Proceedings of SITE*, vol. 4, 2004, pp. 1201–1207.

[22] A. Miller, “Wordnet: a lexical database for english communications of the acm 38 (11) 3941,” *Niemela, I*, 1995.

[23] “Interact,” http://www.indiana.edu/∼socpsy/ACT/interact.htm.

[24] J. Hoey, T. Schroder, and A. Alhothali, “Bayesian affect control theory,” in *Affective Computing and Intelligent Interaction (ACII), 2013 Humaine Association Conference on*. IEEE, 2013, pp. 166–172.