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Emotion Based Chatbot Using Deep Learning

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***Abstract*—The use of chatbots has been evolving rapidly in numerous fields in recent years which includes Education, Marketing, Health Care, Entertainment, etc. Chatbots utilise the technology of Artificial Intelligence (AI) to mimic human conversation. It is like a virtual assistant that is able to assist in conversation, answering questions, getting directions in the area of knowledge they are designed under. Chatbot can reduce customer service cost and handle multiple users at a time which makes it become more popular. But yet to accomplish a task in detecting and identifying emotion from users the chatbot interacts with. To address this issue, this paper provides a design of a chatbot, in which the chatbot is able to identify the user's emotional status through the text provided by the users through the communication and then provide suggestions according to the input given. The emotion detection model will be trained using Artificial Neural Networks (ANN) and supervised learning. This chatbot is proposed to be used by i-CATS University College to help in the Marketing department to automate the process of answering FAQs and inquiries. However, a full chatbot implementation that replies to human queries is suggested that this research paper should shows to indicate how effective the chatbot can be. It is also suggested that strong implementation of chatbot must be considered for the improvement of this research in the future.**

Keywords—chatbot, emotion detection, artificial intelligence, artificial neural network, supervised learning.

I. Introduction

Artificial Intelligence (AI) is becoming more integrated into human daily lives. The ability for AI to detect and provide response according to user's emotions and feedback is an example of good Human Computer Interaction (HCI) [1]. Web services have been drastically increased and the needs for support services such as live chat and phone are on the raise [2]. It becomes unrealistic for humans to entertain each enquiry as the number of services increases.

The advancement of AI empowered chatbot as an alternative solution to provide customer services. According to Lexicon, chatbot is defined as "A computer program designed to simulate conversation with human users, especially over the internet" [3]. Chatbot was created with the intention of reproducing a clever discussion with humans through their understandable language. It is currently used in many web clients to disseminate information upon request or learning purposes [3]. Chatbot held a lot of good promises like servicing multiple users simultaneously and the response speed [4]. It becomes particularly useful in the education sector in responding to users' enquiries on the web domain. Chatbot is suitable in responding to most frequently asked questions for instances such as course related information.

To understand and perceive human emotion is a difficult task because of the versatility and ambiguity [5]. Chatbot detects users' emotion through the input texts. Research on emotion detection from texts has been done over the years and shows optimistic results. Text is still the most commonly used as a form of communication on social media and web services [6]. The ability for chatbot to recognize and respond according to users' emotion will further improve its interactivity. Emotion detection by chatbot plays an important role in determining its success or failure in delivering customer service.

The paper is divided into four sections. Second II section will describe the literature review on chatbots with emotion detection. Section III elaborate on the research methodology including the system overview, technology used, formula and comparison between similar chatbots available. Section IV depicts the conclusion with possible future work.

II. Literature Review

The relationships between chatbot and human are interesting. It is important for human to maintain and develop relationships between each other as to carry out social lives. Chatbot enhanced with the technology of Artificial Intelligence (AI) would allow them to talk and have conversation like human's conversation. With the Neural Network behind of AI, the chatbot is able to learn and improve on accuracy in having better conversation quality with human. In this section, a brief clarification of review will be carried out on previous works, especially on technology used. This section will also discuss about existing similar system on the market and comparation between those system to find out some of the suitable features for proposed system.

Chatbot is a software agent, known with the capability to mimic human conversation [12] and provide services and information through the users via input of text, voice, image, etc. Chatbot also find beneficial in applications of numerous fields such as in Education, Marketing, Health Care, Entertainment, etc. Chatbot is made instantly available for and without any needs of installation. Due to the digital developments and growing competition, users would spend more time on digital environment and companies or organizations would always be challenging to attract and retain more customers [17]. These users that spend time on digital environment would be looking for faster feedback in less time and expect to be able to reach a company or an organization at anywhere and anytime, despite of the where being and time [17]. The answer in respond to this digitization and maintain customers' satisfaction is by implementing chatbot.

There are different ways a chatbot can perform communication and for this paper, the chatbot will be developed as rule-based chatbot. A rule-based chatbot is developed in a manner that it works on certain rules. When the input pattern from user does not match with the predefined rule of the chatbot, then the chatbot system will be inefficient to answer the question [20]. Rule-based chatbot can handle simple questions and yet crucial to manage complex questions.

Using chatbot in marketing can help in improving customers' satisfaction in which the chatbot able to provide fast response in less time and accessible at anywhere and anytime. Thus, chatbot provides fast turnaround at almost all customers that demand feedback at the same time. They can answer questions by providing response of information by pulling data from database, promote products and services, arrange appointments, etc [13]. The usage of chatbot may differ due to the goals and objectives. This paper will be focusing on using chatbot for marketing purpose and according to study [15], companies or organizations should not look at chatbot simply as a channel for advertising as they should focus more on the service aspect of the chatbot in communication. The chatbot need to be helpful and useful in communication as to serve the users or consumers in getting the answer they need. From the study [16], they find out that the key quality dimension in communication with chatbot are accuracy, credibility and competence. The accuracy here refers to the precision of information provided by the bot, credibility refers to the trustworthiness of chatbot and competence refers to the ability of chatbot in complete their task efficiently. These key quality dimension may differ among users or consumers as they might have different levels of communication quality as they could be from different field of knowledge.

Detecting emotional state and expression of a person through text or sentence written by the person seems to be challenging yet necessary as most of the time, an individual does not just express their emotion through textual expressions by using emotion words but also through the interpretation of the meaning of concepts and interaction of concepts which are described in the text document [19]. Emotion expressed from a person can be identified as anger, sadness, happiness, fear, surprise and so on.

The trend of detecting emotion through textual expression strikes the attention of many researchers. From the study [19], there were few emotion detection techniques which are Keyword Spotting Technique, Lexical Affinity Method, Learning-based Methods and Hybrid Methods. Emotions provide observers with information of a person's emotional state and comfort [11]. For this paper, the chatbot will be implemented with focus on marketing department, and the chatbot will comes with live chat feature embedded with emotion detection via text input and the emotion detected will only be available to view by the marketing department staff. With the emotion detected, the marketing department staff will be provided with a set if suggestion for the live chat session. Thus, it is important for marketing department to know the current emotion state of the users or consumers through the chatbot as to be able to provide them with the optimal services based on the identified emotions expressed in order to meet their needs. Being able to address the issues faced by users or consumers would be a key matter as being stuck on a question or getting slow feedback during inquiries would lead to frustration [14].

In order to improve accuracy of detecting emotion from text input, a set of labelled data is used to apply machine or deep learning. To perform machine or deep learning on the data set, Artificial Neural Networks (ANN) and supervised learning will be applied. The data set used consists of sentences labelled with respective emotion. Then from the trained system, which is the chatbot, will be able to detect the emotion from users or consumers text input. From the study by [18], text-based emotion detection uses AI and make use of the Natural Language Processing (NLP) to help computers to understand and produce output of text in the form of human language. NLP combines the techniques in human language and computation in order to help the computers to understand. The reason this paper focus on using textual expression is due to text data has gained enormous popularity since the emergence of Web 2.0 and social media. From the study by [10], textual data follows a logical order, in which the arrangement of words in a sentence has their relation. Therefore, the Bi-directional Encoder Representations from Transformers (BERT) is one of the transformer-based models researched for text-based emotion detection.

III. Methodology

This section will cover structure of chatbot flows designed with rule-based technique, data mining algorithm for emotion detection and structure of reply suggestions based on detected emotions.

The rule-based chatbot is designed to help customers or students of i-CATS University College to solve their problems or questions, the chatbot can answer most of the questions about the university college with helpful information. The emotion detection is implemented into the chatbot to help marketing staff of i-CATS University College to reply with a suitable sentence while doing live chat with customers or students. The emotion of each message sent by customers or students will be detected and assigned with either one from happy, angry, sad, fear, and surprise. The detected emotion will then show to marketing staff, and based on the detected emotion, the application will provide a set of reply suggestions to marketing staff. Marketing staff can click on the suggestion to perform a quick reply or reply by themselves based on the received message and detected emotion.

A. Rule-Based Chatbot

The automated responses of chatbot are designed and built with rule-based technique. With rule-based technique, the chatbot will give a related response according to the option selected or message sent by the user. According to [9], a rule-based chatbot is using decision-tree structure to process conversations like a flow chart in which customers or students can select an option from the chat flow and the chatbot will reply them with a helpful message that can solve their problems.

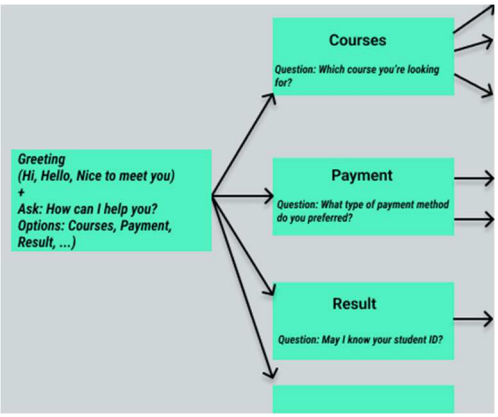

Fig. 1. Structure of Chatbot Flows

Fig. 1 shows the structure of chatbot flows. The flows are designed with decision-tree structure that combined with root node, decision node, and leaf node. The greeting message in Fig. 1 represents the root node of Chatbot Flows, it will be sent to users when users open the chat window. The question "How can I help you?" and options will be sent along with the greeting message as an initial message of the chatbot. The options will be the leaf nodes of the root node and the users can select one of them, once users selected one of them then the chatbot flow will proceed to the linked next flow and reply or question with the predefined questions or replies. This process will continue until there is no leaf node or child node anymore. The chatbot will stop or reset when there is no more leaf node or child node.

B. Emotion Detection

For this project, five types of emotions are chosen to be detected by the chatbot, which are angry, sad, happy, fear and surprise. For the purpose of emotion detection training, two dataset collection was gathered from two sources which are Classify Emotions in text with BERT [7] and Multi-Class Text Emotion Analysis [8]. The datasets from these two sources are then be filtered and combined to get 2500 number of messages for representation of each emotion, which are become a dataset collection that consists of 12500 messages at the end. Also, all the messages in the training data consist of 5 to 15 words to prevent the training bias toward certain emotions.

For the testing purpose, a total of 2000 testing data which consists of random chosen data from the training dataset and also messages manual input by testers, will be used as test data for testing purpose. Data from training dataset is used to test the accuracy of emotion detection as if the result from the output trained chatbot is different from training data meaning the emotion detection is not accurate so it has no reason to continue with manual input testing from tester. The chatbot will receive messages as user input and generate output of the emotion detected from the user input.

C. ANN Model for Emotion Detection

Artificial Neural Network Model was chosen as the training method that was used for the emotion detection of the chatbot. To train the dataset, first the input messages will be processed and converted into 512 bytes. And the possible output for the emotion detection is five which are angry, happy, sad, fear and surprise. Which means 512 input shapes for the input layer and 5 classes for the output layer are obtained. The sample data used for training is 12500. By using these data, estimation for the number of nodes in hidden layer can be done so using the following formula:

$$n_h = \frac{N_S}{(\alpha*(N_i+N_O))} \qquad (1)$$

From this formula, number of hidden node = number of sample data / c (can be any number between 2-10) * (number of input nodes + number of output nodes). The study used 5 as the number of c for this formula. So, the result will be: hidden node = 12500 / 5* (512+5), hidden node = 4.83 and round off becomes 5, so there will be 5 hidden nodes for the training method.

Once the number of hidden nodes has been estimated, the training of emotion detection can be started. The converted input messages which are in a 512 bytes array will be used as input layer and a 5 bytes data that represents different emotions will be the output data from the emotion detection. Table below shows different emotions and their byte data representation.

TABLE I. DIFFERENT EMOTIONS REPRESENTED WITH DIFFERENT BYTE DATA

Emotion	Bytes of data
Happy	10000
Angry	01000
Sad	00100
Fear	00010
Surprise	00001

The model had been trained using TensorFlow with a method call categorical cross entropy, with a batch size of 32 and 200 epochs. Categorical cross entropy is a loss function that can be used for multi-class classification problem and it is suitable to use for task that need to identify one of the many possible output that for the input , which is suitable for this project because this project require to detect which output, which is one out of five emotion, is suitable to represent the input, user messages.

D. Testing for Emotion Detection

The emotion detection had run a few tests to validate the accuracy of output. For the testing purpose, 2000 testing data that consists of different messages that represent different emotions, have been prepared by both tester manual input and from the gathered dataset. The threshold of emotion detection was set to 0.6 for the testing purpose. The testing was done by passing the test data to the trained model and analyzing the output which is the list of messages and detected emotion. Array with size of 5 will be generated for each message, and depending on which position in the array have value greater than 0.6, the emotion will be identified and shown as output. If 1st position is greater than 0.6, then the output will be happy, if 2nd position is greater than 0.6, then the output will be angry, if 3rd position is greater than 0.6, then the output will be sad, if 4th position is greater than 0.6, then the output will be fear, if 5th position is greater than 0.6, then the output will be surprise.

E. Testing for Emotion Detection

The following result was produced from the testing of emotion detection:

TABLE II. RESULTS OF TESTING ON EMOTION DETECTION

Emotion	Total	Total
Happy	743	687
Angry	308	272
Sad	646	570
Fear	218	182
Surprise	85	67

From this testing result, the emotion detection has an overall of 88.9% accuracy, for more detail, 92.4% for happy, 88.3% for angry, 88.2% for sad, 83.4% for fear and 78.8% for surprise. From this result, it can be concluded that happy has the highest accuracy while surprise has the lowest accuracy. This is probably because the number of testing data is different.

F. Reply Suggestion

The reply suggestions are predefined and stored in the database, each reply suggestion will be linked with one emotion. After detecting the emotion of the received message, the system will store the message by linking with the emotion. And the emotion will be shown to marketing staff of i-CATS University College in a form of emoji that is rendered at the right-bottom side of the message bubble. The reply suggestions that are linking to the emotion of the latest received message will be shown to marketing staff as quick reply buttons, they can click on one of them to perform a quick reply or typing by themselves.

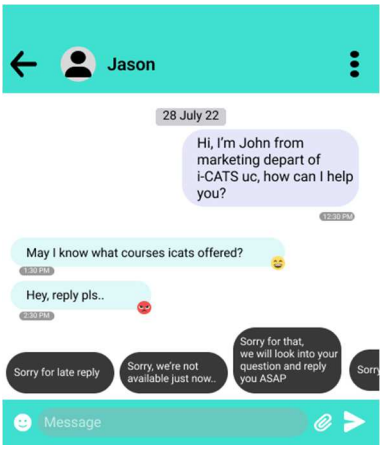

Fig. 2. Structure of Chatbot Flows

Fig. 2 shows the sample of reply suggestions that shows according to detected emotion.

IV. CONCLUSION

The chatbot designed with rule-based technique can answer most of the questions asked by customers or students on the website and Facebook Messenger. The rules are predefined and set by the marketing department of i-CATS University College, with the rules the chatbot can have automated responses that send to customers or students according to the selected topic or received message. The emotion detected from the received message will help the marketing department to decide the message to reply when the live chat between sender and marketing department is started.

The reply suggestions are gathered and generated through the interview section with marketing staff and each suggestion is linked with an emotion. With those reply suggestions that are linked to each emotion, marketing staff will be able to choose a helpful and suitable message to perform a quick reply.

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