Chatbot for Monitoring Mental Health and Personality Trait Identification

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Abstract: AI Chabot or conversational agents are application that mimics human communication. They can entertain, motivate and actively engage people. An important concern faced by most people is stressed disorders. These disorders can include OCD and posttraumatic stress disorders. Most affected category of people is the employees and students. In order to prevent this, counseling is provided. It is done by the HR managers in IT companies and by the teachers to the students or by professionals. But most people are not open to the specialists and feel more uncomfortable during this process of expressing their feelings. This process can be made simple by using a Chatbot. This Chatbot communicates with the people, identifies their traits and provides their sentiment scores to an authorized person. There are three key modules in the development process. First is the Sequence-to-Sequence model. This model consists of an encoder and a decoder. The received input text is converted to tokens and each token is identified with a random number, which is common for the same tokens. The second module is the sentiment analysis which is used in identifying the emotions of a person. The sentiment score is generated for the users. The traits of the person are identified from the chat logs. A RNN (Recurrent Neural Network) is built to identify the trait of the person from the pre-defined 16 types of personality traits. The multi-class classifier's output can be combined with the sentiment score to truly identify the characteristics of the users.

Index Terms: Chatbot, Sequence-to-Sequence, Multi-class classifier and Sentiment Analysis.

I. INTRODUCTION

A neural network can be thought of as a differential function (f(x)), that takes x as input and produces y as output. The Recurrent Neural Networks (RNNs) is majorly used for text based processing. RNN are networks with loops, in which the output of each step is based on the information passed to it from the previous steps (similar to how humans think). Many variants of RNNs exist such as the Vector-Sequence Model (E.g. Image captioning), Sequence-Vector Model (E.g. Sentiment Analysis) and the Sequence-Sequence Model (E.g. Machine Translation). Google's voice search and Apple's Siri are example of two products that makes use of RNN (Recurrent Neural Networks).The input to the system is text or chat. The input sentence is converted to vectors using vocabulary of words. These vectors are fed to the networks so that the machines can understand. In this paper the Sequence-to-Sequence Model [4] which has succeeded in language translation, is implemented for developing the conversational Chatbot[15]. It consists of an encoder and decoder. The encoder converts the sentence into encodings.

The encodings are passed to the decoder. The encoder-decoder network consists of multi-layered LSTM (Long Short-Term Memory) blocks[10]. It is nothing but an extension to RNN, which includes a memory component. This memory can be seen as a gated cell, where gated means that the cell decides whether or not to store or delete information. There are three gates in an LSTM: the input gate, output gate and the forget gate. GRU (Gated Recurrent Units) aims to solve the vanishing gradient problem and also two additional gates compared to LSTM, the update and reset gate.

Attention mechanism [5][6] which selectively focuses on the input sentences is used to improve the performance. A neural network with an attention mechanism included can understand what "it" is referring to. That is, it knows how to disregard the noise and targets only on what's relevant .The decoder is not overloaded with irrelevant information (output of all time steps).The weighted average of only corresponding word representations is fed to the decoder. The Chatbot identifies the current state of a person by identifying the emotions.

The sentiment analysis has mainly three categories (i) Positive, (ii) Negative and (iii) Neutral [1][13] .The results are finally analyzed and the sentiment score is generated.16 types of personality traits are pre-defined. The replies of the users are passed to a RNN .The traits are classified by the network. These traits and sentiment scores can be useful in many ways. They can be used in the recruitment process and identifying the characteristics of a person. Users can also know their traits and choose their career path accordingly. The list of traits is discussed later.

II. RELATED WORKS

There are many Chatbots available for a different purpose. Chatbots are used as purchase assistants, shopping assistants, and tour assistants. They also can provide companionship and customer services and helpdesk troubleshooting [15]. There are many types of Chatbot available used for medical purposes [7]. Tourism is one of the necessary areas where Chatbot has to be implemented. Chatbots also find wide applications in e-commerce websites. In [12] study has been done as to how chatbots can digitally assist people to select their goods. All these are primarily retrieval based chatbots. These are the motivation [15] that provides us a good idea of making a Chatbot that is useful to the people. Speech input can also be given to the Chatbot[3].

Many interesting applications of RNN exists [2][9][10].In [10] Bi-directional RNN model is used for extractive summarization. In our work RNN's are used to achieve three different tasks: Chatbot

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response, Sentiment analysis and trait identification of the user replies. Our bot has been trained from the Reddit comments, divided based on relevant sub-reddits. The bot can have characteristics such as nerd, funny, geek, general, positive, and intellectual. The bot can be constructed in any flavor. In this paper, we have included the general end-to-end approach to sequence learning[4]. Their work uses a multi-layered Long Short-Term Memory (LSTM) [10] to map the input sequence to a vector of a fixed dimensionality, and then another deep LSTM to decode the target sequence from the vector. The main result is that on an English to French translation task from the WMT'14 dataset. Sentiment analysis [1][13] deals with identifying and classifying opinions or sentiments expressed in the source text. Social media [1] is generating a vast amount of sentiment rich data in the form of tweets, status updates, and blog posts. Sentiment analysis of this user-generated data is very useful in knowing the opinion of the crowd. So we have adopted sentiment analysis to understand the user's psychological orientation. Sentiments of a person are not alone enough to understand the nature of a person. The different traits of a person are referred from The Myers and Briggs Foundation [14].The characteristics of each type can be understood from [11].A multi-class classifier is used to predict the output class.

II. PROPOSED SYSTEM

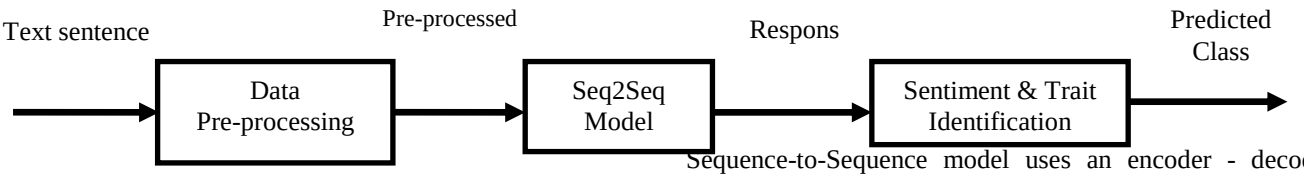

Fig 1.1 System Architecture

The architecture of the proposed system is given in Fig 1.1.The input to the system are sentences/chats which are converted to vectors for training the network.

A.Data Pre-processing

User comments from Reddit discussion forum are used as a dataset for the Seq2Seq model [4]. The comments are converted to questions and reply. Then the punctuation and other non-English characters are removed and the words are tokenized. The frequency count of all the words is calculated and a vocabulary of most common words is created. The vocabulary contains 10,000 words. Using the vocabulary the text is encoded into numbers, these encodings are given as input to the neural network. The input of the Chatbot can be in the form of text. First, the vocabulary is compiled containing all the words that needs be modeled. Seq2Seq vocabularies contain four special tokens.

<PAD>-The processing is done in batches. The input in the batches should be of same length so that the networks can process. The shorter inputs are padded.

<EOS>-It tells the decoder when the sentence ends

<UNK>-This token is used to ignore words that don't appear frequently. The words are replaced with <UNK>

<GO>-It tells the decoder when to start to generate the output. It is the input to the first time step.

The algorithm and a sample output are given below.

Algorithm TextEncoding:

Input: Sentence s_i

Output: Encoded Format of sentence e

{

get the input s_i

create a vocabulary, v with index i

for each s_i

convert the s_i into encoding e_i

Generate e

end

}

INPUT	*OUTPUT*
"The Sky is Blue"	[1430, 3450, 2132, 2346]

B. Modeling the Bot

The output of the data processing is passed into the Seq2Seq model. In this process, the input will be the encoded text, e and output will be the response, r. The algorithm is given below

Sequence-to-Sequence model uses an encoder - decoder architecture to create vector representation of the data and use them to generate text mappings. If the process learns a connection between the layers, then the weights will be updated. Let us go through the example. The encoded sentence will be in the form [1430, 3450, 2132, 234]. The Chatbot reads the encoding and stores the result and tries to learn from those encodings. Finally, it generates the result and put forth the reply to the user. Fig 1.2 depicts the process of response generation. It is a very useful model for time-series and sequential data. RNN with LSTM units is created, which is specifically used for modeling of the bot. This network can be tuned for better performance and accuracy using the BLEU score.

In cases where it is required to predict the next word of a sentence, the previous words are required and hence there is a need to remember the previous words. Thus RNN came into existence, which solved this issue with the help of a Hidden Layer. The most important feature of RNN is Hidden state, which remembers some information about a sequence. The input of the previous time step is also included with the input of the current state, thereby preserving a relationship between the previous and the current state. The equation for the current state can be given by (1)

$$c_t = g(c_{t-1}, x_t) \quad (1)$$

where c_t is the new state, c_{t-1} is the previous state and x_t is the current input.

Softmax function takes an N-dimensional vector of real numbers and transforms it into a vector of real number in range (0, 1) which adds unto 1.The activation function for any layer p_i is given by(2)

$$p_i = \frac{e^{a_i}}{\sum_{k=1}^{N} e_k^a} \quad (2)$$

where a is the input vector to the i^{th} layer. $a=[a_1,a_2\ldots..,a_N]$. Negative softmax sampling is used, so that instead of changing all of the weights during each iteration only *K* of them is taken. This increases the computational efficiency

Algorithm **Seq2Seq**:

Input : Encoded Text, e

Output :Text mapping, r

{
  for every e
    convert every e into batch b
    Pass every b into encoder and decoder
    Update the weights w
    Use the trained embedding to generate r
Output r
}

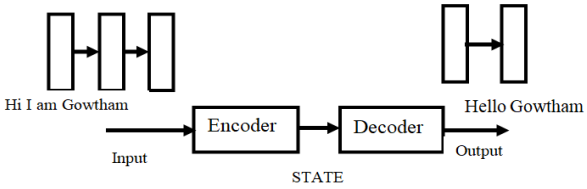

Fig.1.2 Sequence-to-Sequence Model

C.Sentiment Analysis and Identifying Traits:

The sentiment analysis model is built and trained using the Amazon review dataset. The dataset is split into training, validation and testing. The model generates a sentiment score between 0-1 .Initially the sentence is tokenized and pre-processed (stop words, punctuation removal).The pre-processed text is appended with all necessary paddings. The vocabulary is then built based on the frequency of the words. The chats are fed to the network. The network learns through the iterations to increase the probability of the predicted class. Fully connected network is used and dropout is used to prevent over-fitting of the network. The similar procedure is followed for traits identification. Table 1.1 shows the 16 personality classes referred from [14].

Table 1.1-Personality Traits

Class_Name	Traits
INTJ	Architect
INTP	Logician
ENTJ	Commander
ENTP	Debater
INFJ	Advocate
INFP	Mediator
ENFJ	Protagonist
ENFP	Campaigner
ISTJ	Logistician
ISFJ	Defender
ESTJ	Executive
ESFJ	Consul
ISTP	Virtuoso
ISFP	Adventurer
ESTP	Entrepreneur
ESFP	Entertainer

IV. EXPERIMENT AND RESULTS

The work contains three modules .Generating the response for the users' chat .Sequence-to-sequence model is used for modeling the dialogue system. The Chatbot is trained based on the Reddit comments. The accuracy of the bot can be increased by training them with large datasets. The parameters of the RNN were chose to maximize the computation efficiency. Bucketing technique is used during pre-processing, when the length of the sentences are very large. Gradient clipping is used to avoid the vanishing gradient problem. The learning rate is set as 0.1. Softmax is used as the activation function. The number of units was set to 128. Table 1.2 shows a snapshot of the conversation with the bot. Testing with the real-time data is a good validation measure. The bot was able make a reply within the context, though it was not perfectly correct. Overall performance of the Chatbot was satisfactory. Given large datasets and GPU architecture the bot can perform well. Amazon reviews dataset was used to generate the sentiment analysis model. Table 1.3 shows the result of this phase. Many literatures are available in the genre of sentiment analysis which the readers can refer to. For traits identification the mbti-myers-briggs personality type dataset was used. The chatlogs are provided as input to this phase. Table 1.4 shows the results obtained. Table 1.5 shows the overall summary of our work.

Table 1.2 Talking to the Chatbot

Bot	User
RoboHR friendly assistant you can talk to.	
	hi
hi what up	
	What is your name
William say say your name	
	bharth
Well	

Table 1.3-Output of Real Time Sentiment Analysis

Replies	Sentiment scores
I love to eat oranges	0.99
I like this model	0.67
I don't like hdfs	0.007
I do like people	0.7357

Table 1.4-Output of Trait Identification

Sample Chat	Predicted Class
I love music and songs and will love to wander outside. People are good and I do talk to some but very rarely I like to play games and read I like to read a lot. I am curious and love to work on interesting things I may easily lose interest sometimes. I love my lone time I play games and work with my laptop. Always interested in computers I love to have debates and argue and am more fearless and have genius intellect.	INTP-Logician

Table 1.5-Modules and their corresponding outcomes

Module	Outcome	Dataset
Seq2Seq	Chatbot with responds based on the replies of the user	Reddit comments divided based on relevant sub-reddits Metrics: Real time relevancy test
Sentiment Analysis	A model to say user reply is positive or negative	Amazon reviews dataset 17,900 lines divided into training, validation and testing Metrics: Accuracy (82% on final test data)
Traits Identification	A multi class classifier to detect personality of people from their chats	mbti-myers-briggs personality type dataset Metrics: Accuracy (80% on final dataset)

V. CONCLUSION AND FUTURE WORK

Chatbots are a great tool to digitally assistant people. The proposed work tries to explore the power and usefulness of RNN. Optimization has been kept in mind while designing the networks. The system takes chats as input, gives a suitable response. From the chatlogs the traits and the opinions of persons are identified. The model has attained considerable accuracy. Separate logs for each user can be created and graphical displays can be done to understand his/her behavior which could be of used therapeutically.

The Chatbot can be further enhanced by including the sentiment scores and traits in the response of the bots. It can also look for patterns that may be out of human scope and gradually learn more every day through its daily interactions. Reinforcement learning can be combined with the response generation process further enhancing the accuracy of the bot. We are working in this direction and this is the primal target of all our future works.

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