CareBot: A Mental Health ChatBot

Publisher: IEEE | Cite This | ⬇ PDF

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Abstract:
A large number of students face some sort of mental health illness such as depression, anxiety, stress, etc. Due to the lack of willingness or financial ability many students do not visit a college counsellor or seek professional help. The proposed system aims to ease this problem by providing a chatbot to students that would provide the required support similar to a counsellor or therapist. Recent use of technology in aiding with Mental Health recovery has proven to be highly effective in terms of machine learning. The method involves surveys, questionnaires, data analysis and natural language processing. The aim is to build an online platform through which the tool will function.

SECTION I.
Introduction

Students of the age 15-25 and studying in Indian institutions are generally under a lot of stress or suffer from poor mental health due multiple reasons such as- the method of education, the expectations of family and friends and the lack of communication of this stress between each other or their superiors. This lack of communication stems from social stigma that mental health isn't real or isn't very important, due to this stigma students don't bring this problem to the attention to their superiors, parents/family, or to professionals on campus or otherwise. Regardless of this stigma light is now being shone on the importance of mental health and stress in students, however, even with the current breaks in the social stigma students still find it difficult to seek help as they do not want their problems to be out in the open so to speak. To deal with this a chatbot is to be put into action. The chatbot will provide the students with the means to let out their worries and talk about their issues in complete anonymity if they wish to do so.

By implementing a chatbot the need for a second party was cut out, to whom the students would need to vent their issues out to, which essentially removes one of the biggest hurdles that these students face. The chatbot will run on the Transformer model [1] and will be trained using current mental health datasets through which the chatbot will create effective suggestions/conversation to the problems and questions posed by the users/students. The method of suggestive treatment is based on the PHQ-9 mental health questionnaire and the user's input [2].

SECTION II.
Methods

A. Mental Health Questionnaire

Users will fill out the PHQ-9 mental Health Questionnaire, which objectively determines severity of initial symptoms of depression and WHO-5 that are questionnaires recognized by the WHO as a way to gauge the mental health of an individual, on a scale from 0-10, 0 being mentally healthy and 10 being mentally unhealthy(severe) [2] [3].

B. Conversation with the Chatbot

The Chatbot will ask the student/user for the problems that they believe they are facing [4] [5]. The reasoning behind this that the student will get a sense of fulfilment when the problems they consider the most problematic are tackled. This method works similarly to positive reinforcement and encourages the user to continue working on themselves. Figure. 3 illustrates this process.
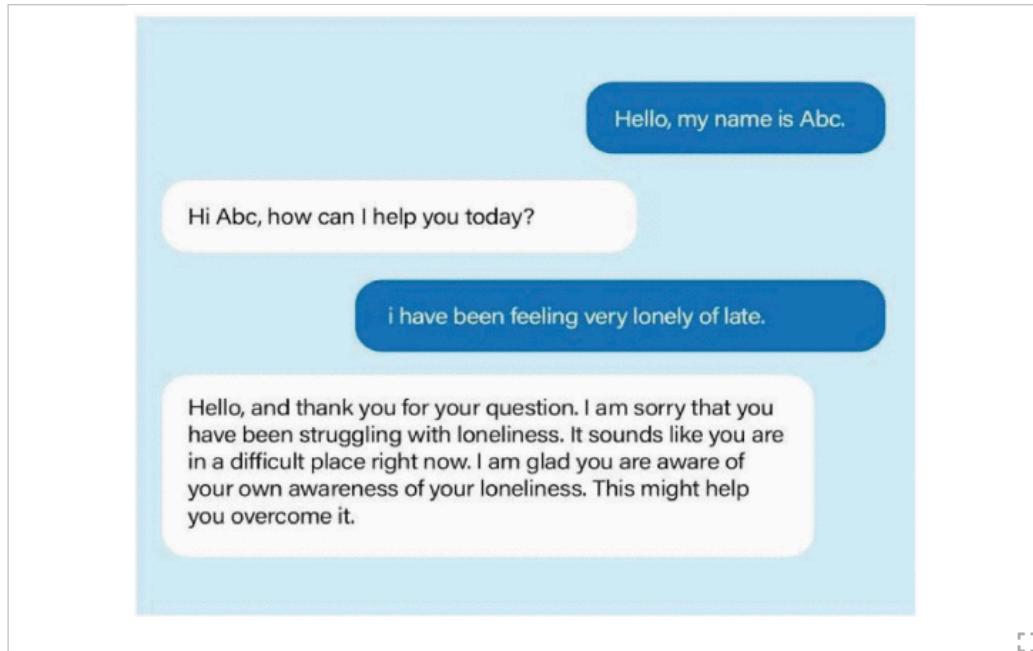
Fig. 1.
Design of chatbot interface

C. Suggestive Treatment

The user will be suggested a few small tasks or micro interventions that would reflect the problem they would like to tackle first [5]. These small suggestions include taking a few minutes to meditate, reflecting on the good things in their lives, taking a break from work to have some alone time to relax, going out to meet friends or family and to have a change in scenery, etc. Small tasks to improve their mood slowly but steadily. The method also includes not providing interventions when the subject is in a positive mood so as to not interrupt good moods.

D. Transformer Model

The Transformer Model architecture that has been selected to train the chatbot and works entirely on the principle of Self- Attention [1]. It is preferred over a Recurrent Neural Network or Convolutional Neural Network as it offers superior quality of results. Unlike an RNN, which scans a given input from left to right, it can accept the entire input at once. Another reason why this model is selected is because recurrent layers require sequential operations. Hence speaking of complexity, Self-Attention mechanisms work well. The attention mechanism in the Transformer is interpreted as a way of computing the relevance of a set of values(information) based on some keys and queries [1]. The output is computed as a weighted sum of the values, where the weight assigned to each value is computed by a compatibility function of the query with the corresponding key. The attention function is a mapping of a query and a set of key and value pairs to an output [9].

The architecture is primarily made up of an encoder-decoder system like other traditional systems. The initial inputs to the encoder are the embeddings of the input sequence, and the initial inputs to the decoder are the

embeddings of the outputs up to that point [1]. The transformer also achieves better BLEU scores as compared to previous state-of-the-art models [1].

This architecture would be modified to suit the requirements of the project and the dataset will be split into training and testing data (following an 80-20 format). For this project, DialoGPT, a tunable conversational neural model created by researchers at Microsoft, has been selected. The model is trained on 147M multi-turn dialogue from Reddit discussion thread [9]. The DialoGPT package also contains an open-source training pipeline (data extraction/preparation and model training/evaluation) built upon the Huggingface PyTorch transformer which will be used to import the libraries [10]. The pre-trained model will then be fine-tuned with the training dataset in order to achieve an acceptable result.

E. Dataset

The current dataset being used to fine tune the DialoGPT model consists of data scraped from Counselchat. This data includes questions each with a tag related to the illness or problem the question covers/rotates around.

Fig. 2.
Dataset

Each question has multiple answers acquired from multiple verified therapists; this helps in diversifying the responses for each question posed to the chatbot. The DialoGPT model however is a conversational model trained on a conversational training set. This dataset does not include multiple lines of conversation and hence reduces the context for each response. By producing columns for question type, question, illness and answer, the required context can be generated for the fine-tuning response text generation.

F. Topic Extraction

A survey was conducted to get a better understanding of what constitutes a mental health problem and to get better insights of what students go through in their daily life.

The first 3 fields consisted of basic information to be filled about the individual and the last field to be filled was set as an open-ended text field. The question specified was "Please mention any and all sources of mental stress/anxiety/depression that you are facing as a student as well as in your life". The question was thus framed in order to capture a psychological picture of the students mind and to compare the problems and issues that a student faces both within the walls of their college and beyond. The responses were visually analyzed using Tableau Public. The idea of giving an option to not specify gender was given to identify the number of people who are not comfortable with sharing a part of their identity. This could translate to the fact that these respondents are not comfortable with sharing their problems with someone who they know. Searching for the term "depression" resulted in finding 4 occurrences. The age group that uses this term in their response was between 17-21 years. The term "depression" is most commonly associated with mental health issues but it resulted in the least count of occurrences compared to the other terms that were searched. Depression itself is a rather large umbrella term which consists of different types. However, since being under depression is stigmatized in society, people refrain from using it to describe their mental state. Also, the term

"depression" is used to describe the most severe form of feeling low and having lack of purpose, which explains why it was not used as much.

The term "anxiety" was searched next and resulted in 15 occurrences. Again, it is observed that the anxiousness is expressed freely as compared to depression. This could be due to the nature of anxiety. Being anxious at times is perfectly normal and it can happen to anyone. Although some people suffer from anxiety attacks, this number is much lower compared to general anxiety. Nevertheless, it is a situation that is undesirable to have at any time. The next term searched was "stress". The number of occurrences, '16', was very close to that of "anxiety". This result shows how often these terms are used and also the relationship between them. Stress and anxiety are almost synonymous with each other and people often use one of these terms in place of the other. But they have different meanings. The reason why they are so closely linked could be due to the fact that anxiety can be caused due to stress, hence the misunderstanding. Another term used quite frequently was "exams". As compared to the previous terms that were explored, this term stands out. This is simply because it is not a word that is associated with mental health problems. However, since the current demographic consists of students, this term is thrown frequently.

By observing the graph based on the "Exams" keyword, there have only been answers from students between the ages of 20 and 21. This result could be due to the fact that students from this age group are usually in their final / senior year of college and hence the pressure of exams is imminent. Such deductions can be inferred from the given graphs in Figure. 4.

This analysis has proven to be helpful in understanding the users who would be using this tool. While developing the model, these terms can be used as parameters and the data gained from this can be transformed into a weighted value. Since the targeted demographic is students, focusing on these terms instead of the broader topic of "Mental Health" in general would make the system more efficient.
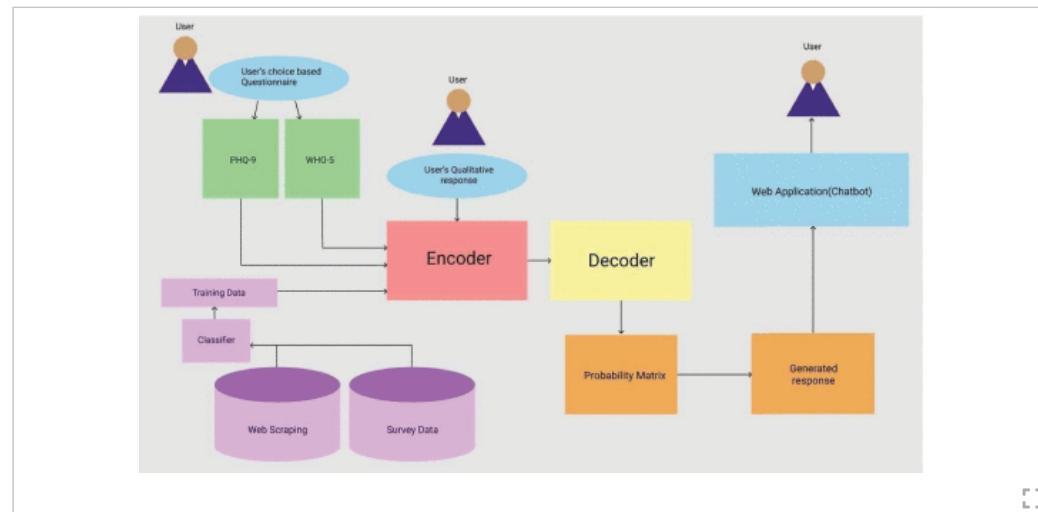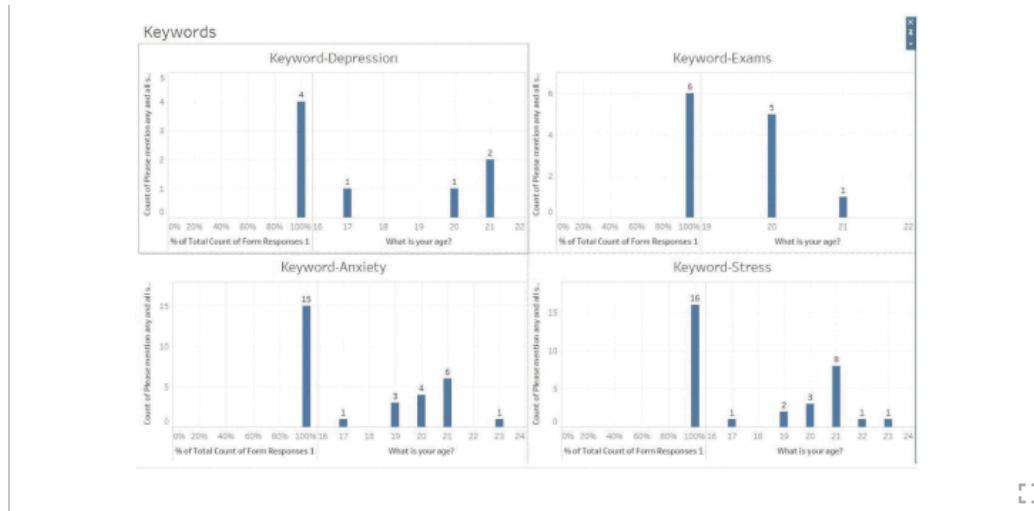
Fig. 3.
Basic Architecture

Fig. 4.
Most common topics found in qualitative responses

SECTION III.
Algorithm

1 Users will fill the PHQ-9 questionnaire.

2 Users will fill the WHO-5 questionnaire.

3 Chat bot asks the user to describe their problem.

4 User types in the text field to address the chat bot.

5 Chat bot replies to the user based on the input given by the user.

6 While User does not end conversation

a) IF User ends the conversation:

i) Exit

b) Else

i) User enters input in the text field

ii) Chatbot replies back to the user.

7 Exit

SECTION IV.
Results

Evaluation of natural language generation chatbots can prove to be a challenge considering the fact that each generative task varies as per the situation. While it is arduous to find relevant metrics to evaluate these models, methods for comparing texts do exist. For this system, perplexity will be used to evaluate the models and represent the performance of these models. Using this method, the model should ideally assign high

probabilities to real, factual sentences and lower probabilities to sentences that are syntactically incorrect. Hence, perplexity itself should be at its lowest for the best performing model.

$$PP(W) = \sqrt[N]{\frac{1}{P(w_1, w_2, \ldots, w_N)}}$$

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Here P represents the probability of words of the test set, which is inversed and normalised to get the perplexity

TABLE I Results On Language Modelling On Dataset with Perplexity

Model	Perplexity
LSTM	43.5
RNN	34.2
DialoGPT-small	27.6
DialoGPT-medium	19.8

From Table 1, it is observed that using DialoGPT's transformer model will demonstrate higher perplexity followed by Recurrent Neural Networks and Long-Short Term Memory Networks. While the DialoGPT pre-trained model is complex and takes sufficiently more time to finetune, it yields better results as a result of parallelization which is evident in transformer-based architectures.

Responses generated by each of the models were subjected to testing by human participants. The participants consisted of 100 college students, who were given a list of questions followed a response each, and were asked to give a comparison between the generated replies. Around 63% of the participants preferred the response generated by DialoGPT followed by 22% for LSTM and 15% for RNN. Explanations provided by these participants to assert their decisions show that they preferred responses that had a more human-like feel to them and also responses that showed a higher range of empathy.

From the above results, it was decided that the DialoGPT model would be the best model for this system. While advanced models of DialoGPT are available for use, they consume significantly higher resources, which is not feasible. It is suggested that these higher-level models would produce more accurate results.

SECTION V.
Discussion

The reason a chat bot was chosen as the method of communication over other means such as online questionnaires, google forms and personal communication comes from the results obtained in various research papers where communication with a chat bot received more accurate results over others [5] [6] [7] [8].

This tool has been idealized in order to bridge the gaps presented in former studies. Gaps like inability to converse with the subject, inability to receive feedback on the subject's mood and inability to compel the subject to continue with self- improvement or seek professional help.

This chatbot cannot be a real substitute for a psychologist or a mental health professional, if the need for professional help comes up on any particular case the tool will prompt the individual to seek it out. However, the intent is to create a tool to offer a decent amount of closure and to give a feeling to the users that their problems are being heard. Often, the mental health of students can drastically decline if they do not have someone to speak to. Even the simple act of listening and responding can change the student's attitude towards that problem, and they feel empowered.

In further versions the implementation of a virtual therapist may be possible to dive deeper into the more complex deep leaning aspect of the tool. The chatbot could be fitted with a text-to-speech converter that would make the process that much more lifelike or human, allowing the user to speak to the bot rather than converse in textual conversation through the help of a speech-to-text converter on the input side of the chatbot.

SECTION VI.
Conclusion

The purpose of this project is to bring a solution to the table, to solve the problem of rising mental health issues that students face. To tackle the problem, it was necessary to get raw input from the students itself through means of a survey form. Analysis of that data, gave some important information regarding the various terms that are associated with mental health problems among students and the relationship between these words.

Consulting with a psychologist from the field also gave important insight on what methods should be adopted to test the users and how these methods should be evaluated. Further research into these methods have shown that these encompass most of the parameters that are to be tested which resulted in the medically approved questionnaires being selected to initially analyze the user.

Training a regular feed forward network with a simplified version of the dataset gave results which provided understanding of the working of the model but also revealed that it might not be capable of handling all types of queries, which prompted the selection of the Transformer model as the proposed architecture. This would work well with the available dataset as it is able to handle greater complexities.

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