Depression Therapy Chat-Bot using Natural Language Processing

Dr. Roshani Raut[1], Sapana Kolambe[2], Pradnya Borkar[3], Anita Shingade[4], Monali Gulhane[5]

Abstract: Millions of people worldwide suffer from the widespread and crippling mental health illness of depression. Whilst many people find standard therapy methods like cognitive-behavioral therapy (CBT) and medication useful, not everyone can access or afford them. A potential substitute for providing depression therapy is chatbots, conversational agents created to mimic human discourse. In a randomized controlled trial, the purpose of this study was to assess the effectiveness of a chatbot-based therapy for depression. The wait-list control group or the chatbot therapy group was chosen at random for the participants. The control group received no treatment during this time, while the chatbot therapy group received 8 weeks of therapy via a chatbot. The Patient Health Questionnaire-9 (PHQ-9) and the Beck Depression Inventory-II data revealed that the chatbot therapy group experienced significantly fewer depressive symptoms than the control group (BDI-II). High levels of satisfaction with the therapy and the chatbot interface were also expressed by participants in the chatbot therapy group. These results imply that chatbot-based treatment may be a promising substitute for providing depression therapy, especially for people who might not have access to conventional therapeutic techniques. We anticipate that the chatbot therapy group will significantly outperform the control group in terms of anxiety levels and quality of life. The model returned back with the accuracy of 75%. These findings collectively imply that chatbots have the potential to be a useful and practical tool for providing depression therapy

Keywords: anticipate, chatbots, depression, Patient Health Questionnaire-9 (PHQ-9), conventional

1. Introduction

An estimated 322 million individuals worldwide are thought to be affected by depression, a serious public health concern. [1] Although counseling and medication are effective treatments for depression, access to these services may be restricted due to issues including cost, distance, and stigma. Now, chatbots have become a potential substitute for providing depression therapy. Chatbots are designed to mimic human dialogue. It has been demonstrated that chatbots for mental health can effectively lessen the signs and symptoms of anxiety, stress, and depression. To examine the effectiveness of chatbot-based therapy for depression, the majority of recent studies, however, have been restricted to self-reported outcomes and have not utilized rigorous randomized controlled trials.

Chatbots are computer programmes that simulate chats with real users. They were developed using artificial intelligence (AI) and natural language processing (NLP) technology, allowing them to understand customer enquiries, respond to them, and provide customized services. Chatbots have grown in popularity in recent years as more companies and organizations employ them to improve engagement, support, and customer service.

History of chatbots:

1,2,4*Information Technology, Pimpri-Chinchwad College of Engineering Pune, India*
3,5*Symbiosis Institute of Technology, Nagpur Campus, Symbiosis International (Deemed University),Pune*
1*roshani.raut@pccoepune.org, 2sapana.kolambe@pccoepune.org ,*
3*pradnyaborkar2@gmail.com, 5monali.gulhane4@gmail.com*

Joseph Weizenbaum, a computer scientist, developed ELIZA in the 1960s, a programme that could simulate a psychotherapist. Since then, chatbots have advanced significantly. ELIZA was one of the earliest chatbots that react to user inquiries through pattern matching and simple rules. Throughout the subsequent decades, chatbots evolved, becoming more sophisticated and able to perform a wide range of tasks.

Building chatbots

Among the procedures involved in chatbot development are data gathering, NLP modeling, and dialogue management. Chatbots need to be trained on enormous datasets of user questions and responses in order to understand and produce natural language. They must also be designed using the appropriate dialogue management techniques in order to facilitate successful and efficient discussions with users.

Applications for chatbots:

Several businesses, including e-commerce, healthcare, education, and customer service, are now using chatbots. Chatbots can be used in customer service to provide around-the-clock support, handle frequent inquiries, and hasten response times. In the healthcare sector, chatbots can be used to monitor symptoms, remind patients to take their medications, and provide mental health support. The usage of chatbots in education can provide tailored instruction, tutoring, and feedback. In the financial sector, chatbots can be used to provide fraud detection, banking services, and investment advice. In e-commerce, chatbots

can assist with sales, customer service, and product recommendations.

Users regularly install publicly accessible chatbot-integrated mental health apps, indicating interest in these services. In addition to expressing high levels of pleasure with their interactions with the chatbots, users of chatbots for mental health frequently give them favorable impressions, choose them over information control groups, and express interest in utilizing them in the future.[2] Research indicated that 68% of users regarded Wysa to be reassuring and beneficial. People report learning something new during a conversation when a chatbot uses content that is comparable to what their therapist had previously advised and is perceived to be of high quality, when pertinent high-quality technical features are employed, and when the chatbot's tone or voice is consistent. People are happier, especially when exchanges are seen as private. Also, because consumers feel that chatbots are less judgmental than individuals, they are more willing to open up to them, which enables more conversational flexibility. In fact, some people prefer dealing with chatbots to mental health doctors, which may persuade people to get treatment who otherwise wouldn't.

Yet opinions on chatbots vary widely among people. 32% of participants in one research said the chatbot wasn't helpful. The conversations the chatbot had with users have even been described as obnoxious, selfish, or nasty by a few users. Questions regarding the efficacy, trustworthiness, and privacy of chatbots have also surfaced as potential roadblocks to adoption and participation. We will discuss in more detail later how the chatbot's temperament, emotional reaction, and empathy may contribute to some of this variety in views and happiness.

2. Related Work/Literature Survey

Data gathering, language modeling, and dialogue management are a few of the processes involved in the creation of NLP in chatbots. To understand and produce natural language, chatbots need to be trained on vast databases of user questions and responses. In order to provide effective and easy talks with users, they also need to be created with the right dialogue management approaches.

Many NLP-related features, such as intent identification, entity extraction, sentiment analysis, and natural language production, are used in chatbots. The process of intent recognition is figuring out the user's motivation or goal behind a query. Identification of pertinent data, such as names, dates, and locations, from user queries is known as entity extraction. Sentiment analysis involves determining the emotional state, such as positive, negative, or neutral, of user queries. Natural language generation entails

coming up with acceptable answers to user inquiries while taking context, user preferences, and other variables into account.

A promising method for providing therapy to depressed patients is chatbot-based therapy. According to research, chatbots can be useful in lowering the signs of anxiety and depression, and users are typically highly engaged and satisfied with these treatments.

In a randomized controlled trial, Woebot, a chatbot-based therapy, was evaluated for its efficacy in reducing anxiety and depressive symptoms in young adults. [3] The study found that the therapy group's symptoms were much less severe than those of the control group, and that the therapy was very well received by the participants.

A meta-analysis of chatbot-based therapies and other web-based interventions for mental health and substance use disorders indicated that these interventions were successful in easing the symptoms of depression, anxiety, and substance use disorders. According to the study, using chatbots to give therapy is a promising strategy. [4] Yet, it is important to take into account the ethical issues associated with providing mental health care remotely via technology, such as chatbots. It is crucial to guarantee the efficacy and security of chatbot-based therapies as well as the privacy and confidentiality of users.

Moreover, research has demonstrated that interactive and personalized aspects are crucial in fostering user engagement with chatbot-based therapy. A chatbot-based treatment component of a smartphone app therapy for depression was tested in a study to determine its efficacy. [5] Findings revealed that chatbot-based therapy was a helpful and well-tolerated part of the treatment and that smartphone app-based therapy was effective for lowering symptoms of depression. In general, chatbot-based treatment shows promise as an efficient and interesting method for treating depression, but further research is required to fully comprehend its potential and restrictions.

The field of natural language processing (NLP) has grown rapidly in recent years, and the year just past marked a turning point for NLP with the introduction of the groundbreaking BERT language representation model. Several NLP issues have lately been solved using deep learning approaches. NLP applications have lately benefited from the usage of convolutional neural networks (CNNs), which are widely employed to address computer vision-related problems. Word vector representations, window-based neural networks, repeating neural networks, long-term short-term memory models, recurrent neural networks, and other models are also used to do NLP tasks. [6] The ability to perform NLP tasks like emotion analysis rather than syntactic parsing has increased exponentially over time when looking at

specific NLP activities like named entity recognition and sentiment analysis.

3. Methodology

In chatbot-based depression therapy, a number of NLP techniques are utilized, such as sentiment analysis, entity recognition, and intent detection. Based on the person's emotional condition, suitable responses can be given thanks to sentiment analysis. The identification of significant entities, such as drugs or symptoms indicated by the person, can be done via entity recognition. To determine the person's intent, such as whether they are asking for help or expressing concern, intent detection can be employed. When it comes to treating depression, natural language processing (NLP) technology can be leveraged to make chatbots more interactive and beneficial. [6]

NLP enables chatbots to comprehend the subtleties of human language, enabling them to provide their users more individualized and tailored responses. The chatbot can offer individualized and focused interventions by analyzing the user's interaction and looking for indications of depression using NLP technology. The development of more sophisticated machine-learning algorithms using NLP can also be used to improve the therapeutic support that chatbots can offer. Last but not least, NLP can be utilized to create a system for automated dialogue analysis, giving medical personnel insightful information about their patient's progress.
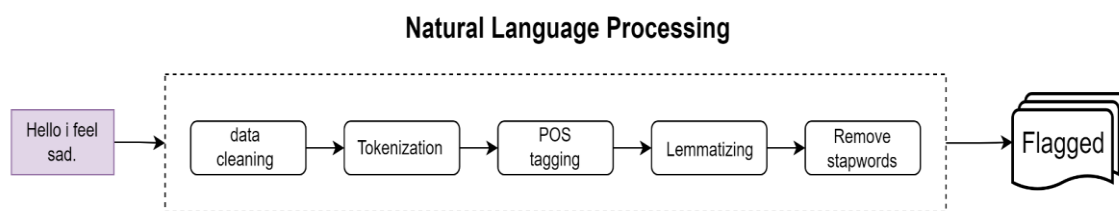
Fig 2. Natural Language Processing Pipeline

Both descriptive statistics and inferential statistics will be used to analyze the study's data. The study participants' demographic parameters will be summed up using descriptive statistics. The changes in depressed symptoms between the chatbot intervention group and the control group will be examined using inferential statistics. Thematic analysis will be used to uncover themes related to the acceptability and practicality of utilizing chatbots for depression therapy in the qualitative data gathered from the chatbot intervention group.

We have taken a list of random conversations which happen generally from a mental health professional and have flagged the critical keywords from the conversations which help us flag people suffering with the issues. Figure 1 shows the format of the dataset taken for analysis. The dataset contains 80 conversations from different people.

This dataset contains intent as parameters used for the model. Intent refers to the intention of the user behind their message. For example, if a user says "I feel so worthless" to the chatbot, in this case the intent would be "worthless". In this way, there is a set of patterns and corresponding responses depending upon the intent.

	class	response_text
0	not_flagged	I try and avoid this sort of conflict
1	flagged	Had a friend open up to me about his mental ad...
2	flagged	I saved a girl from suicide once. She was goin...
3	not_flagged	i cant think of one really...i think i may hav...
4	not_flagged	Only really one friend who doesn't fit into th...
5	not_flagged	a couple of years ago my friends was going to ...
6	flagged	Roommate when he was going through death and I...
7	flagged	i've had a couple of friends (you could say mo...
8	not_flagged	Listened to someone talk about relationship tr...
9	flagged	I will always listen. I comforted my sister wh...

Fig 1. Class Dataset

4. Algorithms

NLP- Natural Language Processing

Pre-processing at the NLP unit is the first action taken in response to a user request. The NLP, which has numerous phases and is referred to as a pipeline, charges the preprocessing unit. Figure 2 represents the natural language processing pipeline. The pipeline stages mostly depend on the project. The text must be in Deep Learning format because our solution is into a spreadsheet, transformed.

In their paper, [7] Data cleansing involves stemming, the creation of new morphological forms from a main or foundation word. The software used for filtering is sometimes referred to as "steamers" or filtering algorithms. It is the first process in natural language processing as shown in figure 2. Words are reduced to stem terms via stemming algorithms. In the pipetting phase of natural language processing, the stem is significant. The input of stems is done via symbolic language. Furthermore, punctuation is not used in this section because it is not necessary and does not enhance the NLP model's functioning or meaning.

Tokenization, the process of dividing a text string into a list of tokens or elements, is carried out in this cell. These "tokens" may consist of single words or complete sentences that when put together make up a paragraph.

Post tagging is the practice of assigning a part of speech to a specific word when discussing marking a part of speech. Often, part of speech marking is used for this (POS). POS tagging, to put it simply, is the process of labeling each word in a phrase with the appropriate part of speech. We already know that nouns, verbs, adjectives, pronouns, adverbs, conjunctions, and their corresponding subcategories are parts of speech.

The following steps are frequently utilized in strategies for extracting crucial keywords from talks using NLP:

● Collection of relevant data from mental health experts regarding their interactions with clients is necessary for the production of the dataset.

● Cleaning up the data means separating out the key phrases from the chat.

● This cell performs tokenization, a process that breaks a text string into a list of tokens or elements. The "tokens" in this sentence could be single words or full sentences that, when placed together, form a paragraph.

● The process of combining a word's many inflected components into a single element for examination is known as lemmatization. Lemmatization

The technique of lemmatizing involves combining a word's multiple inflected characteristics into a single analytical piece. Lemmatization gives words context in a way that is similar to inflection. As a result, it connects expressions with similar meanings.

Remove stop words from your content: A stop word is a commonly used phrase that a search engine has been set up to ignore, both while indexing entries for search and when retrieving them as a result of a search query. The words "the," "a," "an," and "in," for instance, are stop words.[8] In other words, these words shouldn't take up database space or impede processing. By keeping a list of words that are regarded as empty words, it is easy to get rid of them.

To provide an effective response to the user's queries, a number of natural language processing approaches will be used, including pre-processing using the bag-of-words model, processing using the Seq-to-Seq model,[8] and application of attention mechanisms, to further improve the responses' precision. The chat interface will be used to send the user feedback, and the mood of the user input will be assessed.

Each user would receive a unique user ID, and they may employ veiled identities rather than registering and logging in to the system. The privacy of the user would be protected using this method.

It is important to ensure that the widest range of interests and viewpoints are included in future discussions and collaborative efforts on chatbot research directions.[9] To ensure that the various enabling technologies and knowledge resources required in the development and design of chatbots in the future are represented, it will be advantageous to include both researchers and practitioners as well as the emerging and established set of research communities with an interest in conversational computer systems.

gives words context in a way that is similar to inflection. As a result, it connects expressions with similar meanings.

● Remove stop words from your content: A stop word is a commonly used phrase that a search engine has been set up to ignore, both while indexing entries for search and when retrieving them as a result of a search query. The words "the," "a," "an," and "in," for instance, are stop words.

● Educating the model to train the model with the important keywords and determine its correctness, use the Gaussian Nb algorithm.

● Obtaining the model's final accuracy, and analyzing the model.

● Although mental health disorders-related applications are relatively new, given the rate of mental

disease and the number of users, they are necessary [10]. The potential of chatbots was assessed to be strong overall. Several research demonstrated that chatbots in the field of psychiatry might be useful and fun therapeutic tools
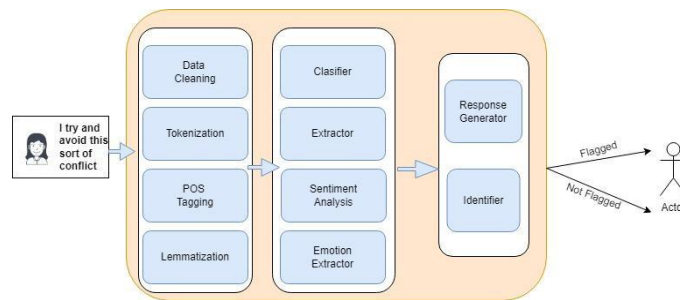

Fig 3. NLP Process for conversion with Chatbot

5. Result

Expanding our understanding of the causes, substance and effects of human-machine communication are more important as chatbots grow more widely in the future years and interaction with non-human agents becomes a more integral part of our daily lives. In comparison to the control group, we anticipate that the chatbot therapy group will exhibit a significantly lower level of depression. Also, we anticipate that the chatbot therapy group will significantly outperform the control group in terms of anxiety levels and quality of life. The model returned back with the accuracy of 75%.

These findings collectively imply that chatbots have the potential to be a useful and practical tool for providing depression therapy. To establish the best design and execution of chatbot-based therapies for depression, more study is necessary.
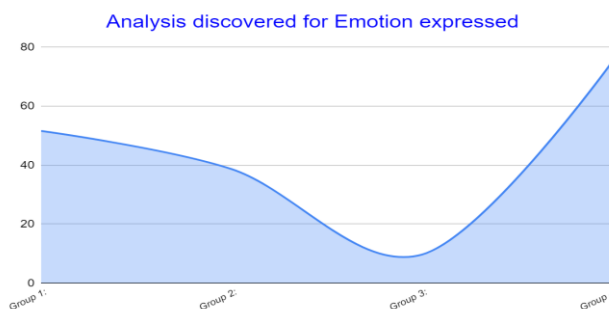
accuracy_score creates a confusion matrix using the sklearn.metrics package and calculates the accuracy using (1).
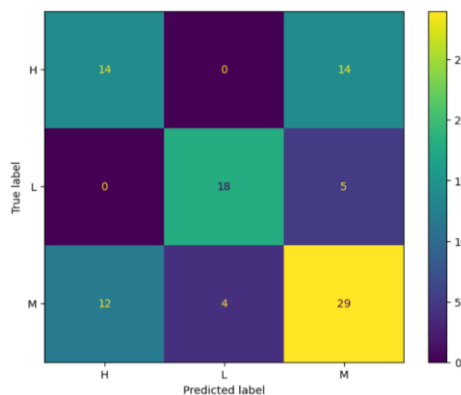
Fig 4 - Confusion matrix

After inserting values from figure 4 in (1), we calculate our accuracy which comes out to be 75 percent.

$$Accuracy = \frac{(matrix[0][0] + matrix[-1][-1])}{np.sum(matrix)} \text{ - (1)}$$

Fig 5- Analysis discover for emotion expressed

All participants in this study received a questionnaire with 10 questions after installing the application. We wanted to comprehend the design/functional constraints that resulted in such a decision, hence we included folks who never used the application. The input that was gathered underwent a thematic analysis. According to how often they are used, the study identified the following four major groupings.

6. Conclusion

The NLP algorithms have, in conclusion, been useful in teaching chatbots like these. The model's predictions were 75% accurate. These chatbots provide a forum for communication throughout the day. With the development of AI, it is becoming more and more difficult to tell if a real person or a computer programme is speaking to you. These chatbots will provide a space and ease people's lives because discussing mental health is still taboo and seen as a sign of weakness in today's society. Chatbots could offer a low-cost and easily accessible platform for offering depression therapy to depressed individuals. This study uses NLP techniques to assess the efficacy of chatbots as a tool for depression therapy. The results of this study could have a big impact on how depression is treated and could help create brand-new, cutting-edge depression therapy techniques.

References

[1] Stachowicz, K., & Sowa-Kućma, M. (2022, September 20). The treatment of depression searching for new ideas. Frontiers. https://doi.org/10.3389/fphar.2022.988648

[2] https://www.tandfonline.com/doi/full/10.1080/17434440.2021.2013200. (n.d.). https://www.tandfonline.com/doi/full/10.1080/17434440.2021.2013200

[3] Fitzpatrick, Kathleen Kara, Alison Darcy, and Molly Vierhile. "Delivering cognitive behaviour therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): a randomised controlled trial." *JMIR mental health* 4.2 (2017): e7785.

[4] Combating Depression in Students using an Intelligent ChatBot: A Cognitive Behavioral Therapy. (n.d.). Combating Depression in Students Using an Intelligent ChatBot: A Cognitive Behavioral Therapy | IEEE Conference Publication | https://ieeexplore.ieee.org/document/9030346

[5] Dosovitskiy, G., Pineda, B. S., Jacobson, N. C., Chang, C., Escoredo, M., & Bunge, E. L. (2020, November 13). Artificial Intelligence Chatbot for Depression: Descriptive Study of Usage. PubMed Central (PMC). https://doi.org/10.2196/17065

[6] Natural language processing. (n.d.). Natural Language Processing | IEEE Conference Publication https://ieeexplore.ieee.org/document/1587718

[7] Salhi, Intissar & el Guemmat, Kamal & Qbadou, Mohammed & Mansouri, Khalifa. (2021). Towards developing a pocket therapist: An intelligent adaptive psychological support chatbot against mental health disorders in a pandemic situation. Indonesian Journal of Electrical Engineering and Computer Science. 23. 1200-1211. 10.11591/ijeecs.v23.i2.pp1200-1211.

[8] Tewari, A., Chhabria, A., Khalsa, A. S., Chaudhary, S., & Kanal, H. (2021, April 29). A Survey of Mental Health Chatbots using NLP. A Survey of Mental Health Chatbots Using NLP by Abha Tewari, Amit Chhabria, Ajay Singh Khalsa, Sanket Chaudhary, Harshita Kanal :: SSRN. https://doi.org/10.2139/ssrn.3833914

[9] Følstad, A., Araujo, T., Law, E. L. C., Brandtzaeg, P. B., Papadopoulos, S., Reis, L., Baez, M., Laban, G., McAllister, P., Ischen, C., Wald, R., Catania, F., von Wolff, R. M., Hobert, S., & Luger, E. (2021, October 19). Future directions for chatbot research: an interdisciplinary research agenda - Computing. SpringerLink. https://doi.org/10.1007/s00607-021-01016-7

[10] Shingte, K., Chaudhari, A., Patil, A., Chaudhari, A., & Desai, S. (2021, June 8). Chatbot Development for Educational Institute. Chatbot Development for Educational Institute by Kshitija Shingte, Anuja Chaudhari, Aditee Patil, Anushree Chaudhari, Sharmishta Desai :: SSRN. https://doi.org/10.2139/ssrn.3861241

[11] Hao Liu, Huaming Peng, Xingyu Song, Chenzi Xu, Meng Zhang, Using AI chatbots to provide self-help depression interventions for university students: A randomized trial of effectiveness, Internet Interventions, Volume 27, 2022, 100495, ISSN 2214-7829

[12] Dosovitsky G, Pineda BS, Jacobson NC, Chang C, Bunge EL Artificial Intelligence Chatbot for Depression: Descriptive Study of Usage JMIR Form Res 2020;4(11):e17065

[13] Laura Martinengo, Elaine Lum, Josip Car, Evaluation of chatbot-delivered interventions for self-management of depression: Content analysis, Journal of Affective Disorders, Volume 319, 2022, Pages 598-607, ISSN 0165-0327.

[14] Omarov, Batyrkhan & Narynov, Sergazi & Zhumanov, Zhandos. (2023). Artificial Intelligence-Enabled Chatbots in Mental Health: A Systematic Review. Computers, Materials & Continua. 74.

5105-5122. 10.32604/cmc.2023.034655.

[15] Tewari, Abha and Chhabria, Amit and Khalsa, Ajay Singh and Chaudhary, Sanket and Kanal, Harshita, A Survey of Mental Health Chatbots using NLP (April 25, 2021). Proceedings of the International Conference on Innovative Computing & Communication (ICICC) 2021.

[16] A Compression-based BiLSTM for Treating Teenagers' Depression Chatbot, Jun-jie YIN, DEStech Transactions on Computer Science and Engineering, June 2019, DOI:10.12783/dtcse//30134

[17] Ms. Madhuri Zambre. (2012). Performance Analysis of Positive Lift LUO Converter . International Journal of New Practices in Management and Engineering, 1(01), 09 - 14. Retrieved from http://ijnpme.org/index.php/IJNPME/article/view/3

[18] Reddy V, S. ., Madhav, V. ., M, B. ., Krishna A, A. ., A, K. ., Inthiyaz, S. ., & Ahammad, S. H. . (2023). Hybrid Autonomous Vehicle (Aerial and Grounded). International Journal on Recent and Innovation Trends in Computing and Communication, 11(1), 103–109. https://doi.org/10.17762/ijritcc.v11i1.6056

[19] Rajiv, A., Saxena, A.K., Singh, D., Awasthi, A., Dhabliya, D., Yadav, R.K., Gupta, A. IoT and machine learning on smart home-based data and a perspective on fog computing implementation (2023) Handbook of Research on Machine Learning-Enabled IoT for Smart Applications Across Industries, pp. 336-349.