A picture containing logo

Description automatically generated 

Final Production Project Report

On

Sentiment-based Chatbot using Machine Learning for mental health

**Submitted to:**

**The British College**

**Supervisor:** Sukant Kumar Sahu

**Submitted by:**

**Name:** Ekata Ghimire

**TBC ID:** 6091

**LBU ID:** 77216096

**Course:** BSC (Hons) Computing

**Level:** 6

**Year:** 2019-2023

**ABSTRACT**

It is crucial to maintain good mental health for the sake of one's overall wellbeing. Self care is important so this project explores the possibilites of the chatbot in self care. The intention behind this project is to introduce a study on a sentiment-analyzed chatbot that aims to provide solutions to mental health issues and to address the stigma, taboo surrounding it. It would be done by creating a chatbot that can analyze the sentiment of the user and provide non-judgmental responses. The study uses NLP and the NLTK toolkit to analyze the sentiment of the user's input and provide appropriate responses. The study aims to benefit individuals who may be hesitant to discuss their mental health issues due to stigma or fear of judgment. The report also discusses future development possibilities in this area, which could benefit those interested in chatbot development or mental health technology.

keywords

Natural Language Processing(NLP), Natural Language Toolkit(NLP), chatbot, mental health

**LETTER OF DECLARATION**

I hearby decleare that the work presented in this project report has been done by myself under the supervision of Sukant Kumar Sahu Sir and has not been submitted elsewhere for any examination.

All sources of information have been specifically acknowledged by refrences to authors or institutions.

Date: Name:Ekata Ghimire

LBU ID: 77261096

**Table of Contents**

**Table of tables**

**Table of Figures**

**Introduction**

Experiencing a situation where you are unable to articulate the source of your stress and unable to communicate that you are being troubled can have a negative impact on your mental well-being. It is crucial to have someone with whom you can discuss your mental state without the fear of being criticized or judged. A growing sector of concern is Mental Health in Nepal as well. (Asim, M., van Teijlingen, E. and Sathian, B., 2020). Due to the prevelances of different stigma and taboo around mental health indivudals who experience anxeity, stress and depression are not able to seek help.

With the **ongoing technological revolution** and the ubiquitous presence of the internet, the healthcare sector is witnessing numerous upgrades and enhancements.

The **problem** at hand is the prevalence of stigma and taboos surrounding mental health, which prevent individuals experiencing anxiety, stress, and depression from seeking help.

This chatbot can help those who lack access to conventional mental health resources or who are reluctant to seek assistance because of the stigma associated with it by offering them useful materials. It can be accessed by anyone who has access to the internet as good mental health is everyone’s right.

**The aim of this project** is to create a chatbot using Machine Learning that can provide emotional support and guidance to the users.

I**ts main objective** is to improve mental health awareness and reduce stigma around it. This project will include chatbot development, testing and effectiveness evaluation in promoting positive mental health outcomes by making resources and information more available. This also can be considered as a form of self-care. In general, the term "self-care" refers to the actions and practices that individuals undertake to take care of their own well-being or to manage a mental health condition without professional assistance, using sources like online resources or guidance from caregivers (Moilanen J, et al.,2023). This project will add to the existing research on the relationship between mental health and technology, which has previously been done. It also may encourage more research and development in this field.

This sentiment based chatbot is the technology that will analyse their problems through text which would be using the natural language Processsing(Abdellatif, A. et al., 2022) and Machine learning algorithms(Naufaldi, M. et al., 2021) to provide the valid responses.

**Functional and Non-functional Requirements:**

|  |  |
| --- | --- |
| **Functional Requirements** | **Moscow** |
| NLP ability to translate user input and appropriate response generations. | C |
| Evaluating the emotional state of the user using the Sentiment analysis algorithm. | M |
| ML to learn from user interactions | M |
| Protect the sensitive data user. | S |
| Chatbot should be able to provide instructions as per user’s mental health. | S |
| For wellness practice the chatbot could have the ability to recommend proper recommendations. | C |

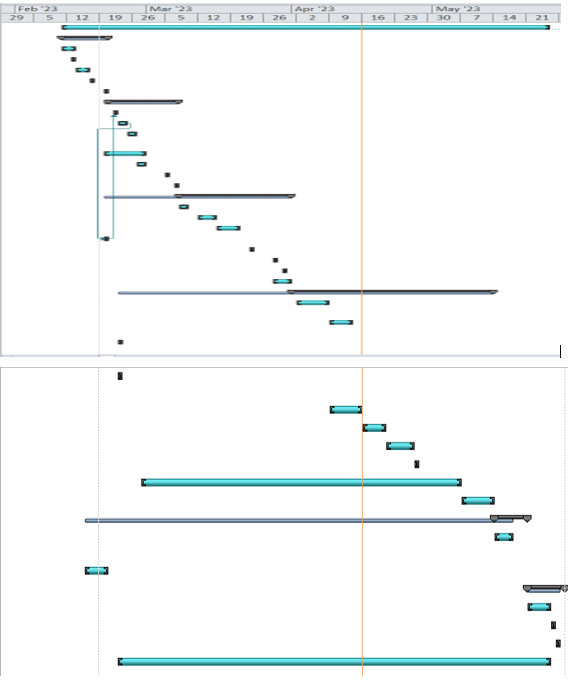
|  |  |
| --- | --- |
| **Non-Functional Requirements** | **Moscow** |
| Sensitive information must not be leaking. | M |
| Simple and easy-to-use user interface | S |
| Accurate response to the questions asked. | M |
| Product validation and completely tested | S |

**Project Timeline:**

**Graphical user interface, table, Excel

Description automatically generated**

**Gantt chart**

****

**Timeline**

**Graphical user interface, application

Description automatically generated**

**Review of Literature**

The COVID-19 pandemic has resulted in a significant impact on the mental health of people globally, with depression and anxiety rates increasing by more than 25% during the first year. Younger people aged 20-24 years have been more affected than older individuals (Mental Health and COVID-19: Early evidence of the pandemic's impact: Scientific brief, 2022).

Mental health conditions affect a considerable portion of the world's population, with 29% of individuals experiencing them in their lifetime. Depressive 25% of adults and 10% of children are affected, with depressive and anxiety disorders being the most common. In 2017, 322 million individuals suffered from depressive disorders, and 264 million suffered from anxiety disorders globally (Arulnathan et al., 2023).

There is a global shortage of human resources to provide mental health services, with developed countries having nine psychiatrists per 100,000 individuals, while developing countries only have one psychiatrist per ten million people. The World Health Organization (WHO) reports that only 45% of people in developed countries and 15% in developing countries have access to psychiatric services.

A substantial number of students experiencing symptoms of mental health problems do not seek help, and those who do, often seek it too late. Several chatbots have been introduced to the world, and their effectiveness can be gauged by analyzing research studies.

**Mental Health by WHO**

The definition of mental health, as established by the World Health Organization (WHO), is "a state of wellbeing in which the individual realizes his or her abilities, can cope with the everyday stresses of life, can work productively and fruitfully, and can make a contribution to his or her community."

**Chatbot in mental health:**

The delivery of mental health services is hampered by a global shortage of human resources. While developed countries have nine psychiatrists per 100,000 people, developing countries have just one psychiatrist per ten million individuals. The World Health Organization (WHO) estimates that access to psychiatric services is available to 45 percent of people in developed countries and 15 percent of people in developing countries. (Arulnathan et al., 2023)

So, several chatbots have been developed to help individuals cope with symptoms of depression and anxiety. A systematic review has identified 41 different chatbots for mental health across 53 studies. (Arulnathan et al., 2023) Of these chatbots, 43 percent were implemented in the United States of America. The first chatbot, known as ELIZA, was originally developed for psychology, and allowed users to input text to simulate a conversation with a Rogerian psychotherapist. Some of the chatbots that prevail in supporting mental health condition are: Webot, Wysa , SERMO, XiaoE. The detailed description on them are as follows:

**Woebot:**

**Title of the research paper:**

**Author name:**

One such chatbot is Woebot, which uses cognitive-behavioral therapy (CBT) strategies to assist users (Meadows et al., 2020). CBT was originally designed for treating mild to moderate depression, but it is now being used to treat other mental disorders like anxiety disorders, bipolar disorders, panic disorders, and post-traumatic disorders. The fundamental assumption of CBT is that mental disorders emerge and persist because of distorted cognition such as thoughts and attitudes (Arulnathan et al., 2023). It is an effective tool for assisting individuals with symptoms of depression and anxiety. It is not clear which psychological evidence the system is based on. Despite this, in a study comparing Woebot users to individuals who read a self-help book, Woebot users had a reduction in their symptoms (Meadows et al., 2020). Overall, existing research suggests that chatbots, such as Woebot, can be effective tools for assisting individuals with symptoms of depression and anxiety. Further research is needed to understand the limitations and potential benefits of chatbots in mental health care.

**Advantage**

Woebot allows users to enter their emotions by selecting terms from a list of suggestions. However, this limits the user's ability to comprehensively express their emotions and feelings. Users had a reduction in their symptoms compared to those in the information control group (Meadows et al., 2020).

**Limitation:**

Woebot can feel robotic or impersonal, and the chatbot may not be able to respond to complex issues or emergencies.

**Wysa**

**Title of the research paper:**

**Author name:**

Wysa is a chatbot designed to support the relief of anxiety, depression, and stress, with mindfulness meditation exercises integrated into the app. (Alfonso 2020)

The authors of the study identified Wysa as one of 41 different chatbots in mental health, mainly implemented as rule-based and standalone software (Arulnathan et al., 2023). Two-thirds of the users perceived the app as positive, finding the conversation with Wysa helpful and stimulating.

Overall, the literature suggests that Wysa is an effective chatbot for supporting mental health by offering mindfulness exercises and tracking moods, detecting negative emotions, and providing resources for seeking professional help if necessary (Arulnathan et al., 2023).

**Advantage**

It Provides a mood tracker and can detect negative moods, suggesting a depression test and recommending seeking professional help if necessary (Arulnathan et al., 2023). Research from Arutlnathan discovered wysa improves users' moods, with frequent users having a higher average improvement than occasional users.

**Limitation:**

The chatbot can sometimes provide generic or unhelpful responses. There also has been the issue with the security with this chatbot.

**SERMO:**

**Title of the research paper:**

**Author name:**

SERMO is a chatbot that integrates natural language processing (NLP) and emotion analysis techniques to determine user emotions automatically. There are two basic procedures: lexicon-based or machine learning-based methods for analyzing emotions in text. SERMO is one of the first applications that supports emotion regulation and processing German natural language. The chatbot was created utilizing the Syn. Bot framework, and it differs from other available systems by incorporating natural language processing (NLP) and emotion analysis methods (Arulnathan et al., 2023).

**Advantage:**

Integrates NLP and emotion analysis techniques to determine user emotions automatically. The architecture comprises a recurrent neural network with GRU cells and an attention mechanism.Available in multiple Languages (Arulnathan et al., 2023).

**Limitation:**

Since it is the first mental health chatbot using sentiment analysis in German Language it is quite effective.

**XiaoE:**

**Title of the research paper:**

**Author name:**

XiaoE is an unguided CBT-based chatbot designed for depression. It can be used for screening, prevention, and self-assistance for depressive symptoms through fully automated intelligent interactions with users via text, image, and voice (He et al., 2022). The technology of XiaoE is based on natural language processing (NLP) and deep learning, and the entire chatbot dialogue system was constructed through the open-source framework RASA (He et al., 2022). The goal of developing XiaoE is not to replace human therapists but to provide convenient self-help intervention for users who are unable to receive immediate mental health services. It can also function as an auxiliary tool for traditional psychological counseling and treatment, including campus and epidemic-related counseling, adolescent mental health screening and diagnostics, automated CBT-based chatbot interventions, intelligent multiturn conversations, artificial psychological counseling, and "tree hole" (a place to share thoughts and secrets) (He et al., 2022). XiaoE demonstrated a special ability to build relationships with users, increase engagement, and improve the user experience during the therapeutic process.

**Advantage:**

It is feasible, engaging, and effective digital intervention for college students with depressive symptoms [Study with college students]. It demonstrated a special ability to build relationships with users, increase engagement, and improve the user experience during the therapeutic process (He et al., 2022).

**Limitation:**

It is challenging to swiftly implement the intervention in real clinical practice.

**Building Trust in chatbot:**

Skjuve et al.'s (2021) research indicates that the chatbot's human-like behavior affects individual participants' trust. We argue that improving the chatbot's (perceived) security and integrity will aid in designing more effective mental health chatbots, based on our findings. Tolmeijer et al.'s (2021) work suggests that trust develops gradually, with the initial trust impression having a significant anchoring effect on users. Chatbot behavior and human-like qualities are critical factors in developing trust in mental health chatbots (Moilanen et al., 2023). There is evidence that the user's personality influences how trust is formed between the user and the chatbot, with trust primarily affected by personal experiences, perceived reliability, and presentation of results.

Tabular Comparison of Different Types of Chatbot:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Chatbot** | **Type of Therapy** | **Key Features** | **Study Findings** | **Effectiveness** | **limitations** |
| Woebot | Cognitive-behavioral therapy (CBT) (Meadows et al., 2020) | -Allows users to enter their emotions by selecting terms from a list of suggestions. (Arulnathan et al., 2023) | - Users had a reduction in their symptoms compared to those in the information control group (Meadows et al., 2020).  - Further research is needed to understand the limitations and potential benefits of chatbots in mental health care. | - Effective tool for assisting individuals with symptoms of depression and anxiety. | Woebot can feel robotic or impersonal, and the chatbot may not be able to respond to complex issues or emergencies. |
| Wysa | Mindfulness exercises, mood tracking, detection of negative moods, and resources for seeking professional help(Alfonso 2020). | - Provides a mood tracker and can detect negative moods, suggesting a depression test and recommending seeking professional help if necessary. (Arulnathan et al., 2023) | - Effective in improving users' moods, with frequent users having a higher average improvement than occasional users [Study with 129 participants] (Arulnathan et al., 2023).  - Further research is needed to understand the limitations and potential benefits of Wysa and other chatbots in mental health care. | - Positive feedback from two-thirds of the users, finding the conversation with Wysa helpful and stimulating (Arulnathan et al., 2023). | The chatbot can sometimes provide generic or unhelpful responses.   -There also has been the issue with the security. |
| SERMO | Emotion analysis using natural language processing (NLP) (Arulnathan et al., 2023) | - Integrates NLP and emotion analysis techniques to determine user emotions automatically.  - The architecture comprises a recurrent neural network with GRU cells and an attention mechanism.  - Available in multiple Languages. (Arulnathan et al., 2023) | - One of the first applications that support emotion regulation and processing German natural language.  -Machine learning-based approaches are based upon labeled training data and could consider the context.  Prominent examples for algorithms are Naive Bayes and  Support Vector Machines. (Arulnathan et al., 2023)  - Further research is needed to understand the limitations and potential benefits of SERMO and other chatbots in mental health care. | - Since it is the first mental health chatbot using sentiment analysis in German Language it is quite effective. | - Chatbot responses feel repetitive or unhelpful. |
| XiaoE | Cognitive-behavioral therapy (CBT) (He et al., 2022) | - Designed for depression, screening, prevention, and self-assistance for depressive symptoms through fully automated intelligent interactions with users via text, image, and voice.  - Based on natural language processing (NLP) and deep learning, and the entire chatbot dialogue system was constructed through the open-source framework RASA (He et al., 2022).  - Created, discussed, and supervised by a psychologist panel led by several experienced clinical and counseling experts from schools and hospitals. | - Feasible, engaging, and effective digital intervention for college students with depressive symptoms [Study with college students].  - Significant short-term and long-term effectiveness that remained robust after sensitivity analysis (He et al., 2022).  - Further evidence is needed to verify the long-term effectiveness via trials replicated with a longer dose, as well as exploration of its greater efficacy compared with other active controls. | It demonstrated a special ability to build relationships with users, increase engagement, and improve the user experience during the therapeutic process (He et al., 2022). | -It is challenging to swiftly implement the intervention in real clinical practice |

Fig 1: Tabular comparison of different mental health chatbots

**Use of sentiment analysis in the Chabot:**

In a study conducted by Elcholiqi et al. in 2020, data is collected through natural language processing (NLP) to gain a better understanding of the patient. This collected information helps the program to accurately detect and respond to the patient's emotional needs, providing personalized resources, self-help guidance, and support related to their concerns. Another study by Hsu and Liao in 2022 proposes a framework called the Sentiment Analysis and Machine Learning Recommendation Framework (SAMLRF), which integrates sentiment analysis and customized recommendations using a machine learning approach. This framework consists of five modules: data preparation, sentiment analysis, recommendation, human-machine interaction, and cloud computing. Chatbots can be developed using rule-based sentiment analysis, machine learning-based sentiment analysis, or hybrid approaches that combine both methods.

**Ethical Considerations for sentiment-based Chabot**

Mental health is a complex and often misunderstood topic that requires a high degree of empathy to fully comprehend. As human beings, we sometimes struggle to empathize with others and understand what they are going through. It is crucial to develop a chatbot that can converse with users in a human-like manner with a high level of empathy, attempting to understand their feelings and emotions.

However, it is important to note that chatbots should not be used as a substitute for clinical treatment or medication. Rather, they should provide mindful and alternative solutions to the users' problems while recommending that they seek professional help from a psychiatrist if the chatbot's sentiment analysis suggests that their condition is serious (Arulnathan et al., 2023).

The chatbot should be designed to create a safe and non-judgmental space for users to share their concerns and feelings, and provide personalized resources and support related to their specific concerns. Through sentiment analysis, the chatbot can detect the user's emotional state and respond accordingly with appropriate and helpful recommendations. The chatbot can offer self-help guidance, coping strategies, and tips to manage symptoms, as well as provide links to relevant resources such as helplines and support groups.

Overall, the aim is to develop a chatbot that can assist individuals struggling with mental health issues by providing them with a supportive and empathetic virtual environment that can help them navigate their emotions and provide them with the necessary resources to seek professional help if needed.

**Research Methoology**

**Hardware and software specifications**

Data analysis

**Name of the bot:**

**Title of the research paper:**

**Author name:**

Intro

**Advantage**

**Limitation:**

**Bibliography**

1. Asim, M., van Teijlingen, E. and Sathian, B., (2020). “Coronavirus Disease (covid-19) and the Risk of Post-Traumatic Stress Disorder: A Mental Health Concern in Nepal, Nepal journal of epidemiology”*,* 10(2), pp. 841–844. doi: 10.3126/nje.v10i2.29761
2. Abdellatif, A. et al. (2022) “A Comparison of Natural Language Understanding Platforms for Chatbots in Software Engineering,” IEEE Transactions on Software Engineering, 48(8). doi: 10.1109/TSE.2021.3078384.
3. Naufaldi, M. et al. (2021) “2021 International Conference on Ict for Smart Society (iciss),” in Coby: Covid-19 Telegram Chatbot by Employing Machine Learning Algorithms. IEEE, pp. 1–7. doi: 10.1109/ICISS53185.2021.9533198.
4. Moilanen J, van Berkel N, Visuri A, Gadiraju U,van der Maden W and Hosio S (2023) "Supporting mental health self-care discovery through a chatbot." Front. Digit. Health 5:1034724. doi: 10.3389/fdgth.2023.1034724
5. Skjuve , M., Folstad, A., Fostervold , K., Brandtzawg, P.,( 2021)"My Chatbot Companion - a Study of Human-Chatbot Relationships." International Journal of Human-Computer Studies, Volume 149, 102601, ISSN 1071-5819, <https://doi.org/10.1016/j.ijhcs.2021.102601>.
6. Meadows, R., Hine, C.,Suddaby , E., "Conversational agents and the making of mental health recovery" (2020) Digital Health Volume 6: 1–11, Article reuse guidelines: sagepub.com/journals-permissions, DOI:10.1177/2055207620966170journals.sagepub.com/home/dhj
7. Arulnathan, A., Vaaheesan, S. and Denecke, K. (2021) “A Mental Health Chatbot for Regulating Emotions (sermo) - Concept and Usability Test,” IEEE Transactions on Emerging Topics in Computing, 9(3), pp. 1170–1182. doi: 10.1109/TETC.2020.2974478.
8. Alfonso, S., (2020) "AI in mental health", Current Opinion in Psychology, Volume 36, Pages 112-117, ISSN 2352-250X,https://doi.org/10.1016/j.copsyc.2020.04.005.
9. He,Y., Yang, L., Zhu, X., Wu , B., Zhang, S., Qian, C., Tian, T. (2022) " Mental Health Chatbot for Young Adults With Depressive Symptoms During the COVID-19 Pandemic: Single-Blind, Three-Arm Randomized Controlled Trial." J Med Internet Res. ;24(11):e40719. doi: 10.2196/40719. PMID: 36355633; PMCID: PMC9680932.
10. Gifu , D., Popc, E., (2022) ,"Smart Solutions to Keep Your Mental Balance" , Peer-review under responsibility of the scientific committee of the 9th International Conference on Information Technology and Quantitative Management
11. Abidah Elcholiqi and Aina Musdholifah (2020) “Chatbot in Bahasa Indonesia Using Nlp to Provide Banking Information,” 14(1), pp. 91–102. doi: 10.22146/ijccs.41289.
12. Hsu, h., and Liao, A., (2022) "Sentiment-based Chatbot using Machine Learning for Recommendation System",Department of Computer Science and Information Engineering National Formosa University, DOI: https://doi.org/10.21203/rs.3.rs-1468604/v1