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Chatbot Delivering Cognitive Behavior Therapy for Mental Health using NLP

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A virtual remedy for individuals experiencing anxiety and despair is provided by the mental health bot, an online platform for mental health interactions. The platform's goals are to link patients with qualified providers who can offer support and direction, as well as to offer thorough information on these illnesses and their therapies. The core component of a mental health bot is a chatbot that leverages cutting edge AI algorithms to offer patients individualized, sympathetic support. The chatbot can assist patients in managing their symptoms, enhancing their well-being, and gaining access to the resources they require to lead satisfying lives because it has been trained in a variety of therapeutic approaches. Additionally, the website gives users access to a peer and medical professional network, enabling them to interact with people who can relate to their challenges and offer support. Anyone suffering from anxiety or depression can easily and conveniently get access to high-quality mental health treatment from the comfort of their own home with Mental Health Bot.

Introduces a novel approach to enhancing mental health care through the implementation of a chatbot that integrates cognitive behavioral therapy (CBT) and remote health monitoring, facilitated by natural language processing (NLP) and artificial intelligence (AI). Additionally, the Al component empowers the chatbot to offer tailored treatment recommendations based on user interactions. Accessible through smartphones and other devices.

Keywords: Artificial Intelligence (AI), Cognitive Behavioral Therapy (CBT), Face recognition (using Computer Vision - CV), Mental Health Bot, Natural Language Processing (NLP), Therapies, Tailored treatment recommendations.

1. INTRODUCTION

Globally, mental health is a critical issue, and as technology advances, there is growing interest in using chatbots to offer mental health care. This study presents a unique chatbot system that uses artificial intelligence (AI) and natural language processing (NLP) to provide remote health monitoring and Cognitive Behavioral Therapy (CBT) to people with mental health problems. By providing evidence-based treatment in real-time, the chatbot seeks to offer mental health care that is easily accessible, reasonably priced, and convenient. This study explores the chatbot system's efficacy in mitigating anxiety and depression symptoms, as well as its potential for long-term mental health outcome monitoring. The most serious issues in human existence, such as stress, anxiety, and depression, are the result of poor lifestyle choices and unhealthy habits that are wreaking havoc on people's lives and separating them from a calm and comfortable state of mind. According to the study, this causes a quick decline in a person's emotional stability, which gives rise to symptoms

including peritraumatic distress, bipolar illness, hypertension, brain fog, and brain weariness. Cognitive behavioral therapy is the most effective way to address these issues. The aim of this study is to make it easily accessible and free of cost. Human-to-human communication has declined because of mental health disorders, making it crucial to monitor brain health and give humanity an immediate remedy.

Chatbots are computer programs that have human-to-human conversations. It operates by utilizing a method known as Natural Language Processing (NLP). Natural Language Generation (NLG) and Natural Language Understanding (NLU) are the two stages of NLP.NLU (also known as an intent) facilitates comprehension of the user's dialogue [9]. NLU "cleans" the intents, meaning it eliminates all superfluous words and extracts only the strongest words—that is, the words that are most appropriate for eliciting responses—from the intent. then, these potent terms are categorized into entities, which can then be processed and employed in the process of generating responses. Dialog Flow does this by using a rule-based grammar matching method.

NLG aids in producing the appropriate response for the stated purpose. It selects the optimal response from a range of created responses based on the entities supplied. The best answer is produced using machine learning (ML) algorithms for the specified intent. The user is then responded to in a dialogue using this response.

2. LITERATURE SURVEY

The existing chatbot systems exhibit limitations in terms of personalization, handling complex cases, and reliance on human intervention. The studies reviewed the effectiveness of these chatbots in various mental health contexts, including depression, anxiety, and suicidal ideation.

[1] Abd-Alrazaq, A.A., Alajlani, M., Alalwan, A.A., Bewick, B.M., Gardner, P. and Househ, M., 2019.This paper provides importance of chatbots, main features of chatbots and their potential uses. And also informed the future research about the gaps of the previous literature.

[2] Tewari, Abha and Chhabria, Amit and Khalsa, Ajay Singh and Chaudhary, Sanket and Kanal, Harshita, 2021. This paper highlights the growing significance of NLP-driven mental health chatbots as a supplement to traditional services, proposing the "Mental Ease" application for this purpose. However, it lacks specific methodological details, outcome results, and ethical considerations while addressing potential advantages in improving mental health accessibility.

[3] Fitzpatrick KK, Darcy A, Vierhile M. The study shows conversational agents' potential for delivering effective CBT-based self-help to college students with anxiety and depression symptoms, with reduced depression symptoms. However, it needs more in-depth exploration of limitations and long-term trail.

[4] Giovanni Almeida Santos, Guilherme Guy De Andrade, Geovana Ramos Sousa Silva, Francisco Carlos Molina Duartz, João Paulo Javidi Da Costa, And Rafael Timóteo De Sousa,The proposed conversation-driven approach for chatbot management offers a promising methodology to enhance chatbot performance and user satisfaction. Further research is encouraged to validate its effectiveness and explore its broader applications.

3. Proposed System

The proposed chatbot system address various life problems and provide a safe and non-judgmental space for users to share sensitive information. This NLP-based model seeks to alleviate mental health challenges, enhance emotional well-being, and contribute to an improved quality of life for users. The integration of deep learning and NLP techniques empowers these chatbots to understand natural language and offer personalized responses. This capability

plays a pivotal role in their effectiveness and user acceptance. Chatbots equipped with sentiment analysis, and other NLP tools have been instrumental in identifying individuals at risk of suicide, providing appropriate support, and reducing symptoms of depression and anxiety. The dataflow diagrams shows the flow of the proposed system.

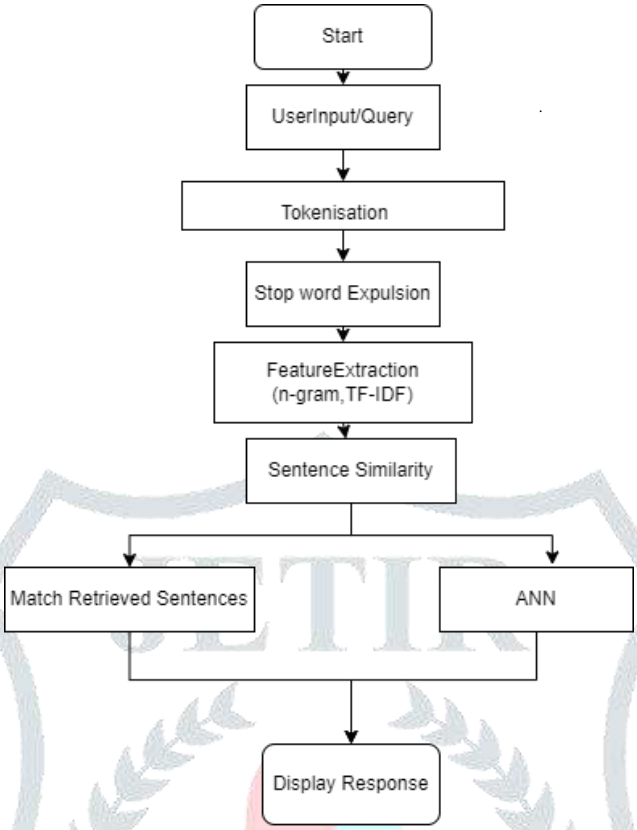

Figure 3.1: Data flow diagram

3.1 Algorithms

- **TF-IDF Calculation**
  - **Term Frequency (TF):** Measures the frequency of a term (word) within a document. It quantifies how often a term occurs in a document, is calculated in equation (1),

$$TF(t,d) = \frac{Number\ of\ times\ term\ t\ appears\ in\ document\ d}{Total\ number\ of\ terms\ in\ document\ d} \quad (1)$$

  - **Inverse Document Frequency (IDF):** Measures the rarity of a term across the corpus. It provides a weight to the terms that are less common in the entire corpus but occur frequently in specific documents, is calculated in equation (2),

$$IDF(t,D) = \log\left(\frac{Total\ number\ of\ documents\ in\ the\ corpus\ N}{Number\ of\ documents\ containing\ term\ t}\right) \quad (2)$$

  - **Calculation of TF-IDF:** The TF-IDF score for a term t in a document d is calculated in equation (3), by multiplying the TF and IDF values:

$$TF-IDF(t,d,D) = TF(t,d) \times IDF(t,D) \quad (3)$$

- **ANN Algorithm**

Step 1: Initialize the neural network parameters and architecture

Initialize the number of input nodes (features)

Initialize the number of hidden layers and nodes in each hidden layer

Initialize the number of output nodes (classes or predictions)

Randomly initialize the weights and biases for each connection in the network

Step 2: Define the Activation Function

Define the activation function for the neurons (sigmoid)

Step 3: Define the Training Algorithm (Backpropagation)

For each epoch or iteration:

Loop through the training dataset:

Forward Propagation:

Compute the weighted sum of inputs and weights for each neuron in each layer

Apply the activation function to the weighted sum to get the output of each neuron

Calculate the error (the difference between predicted and actual output)

Backpropagation:

Adjust the weights using the calculated error and gradients to minimize the error

Update weights and biases using the gradient descent or other optimization algorithms.

Step 4: Define the Prediction/Testing Process

- After training, use the learned weights and biases for forward propagation to predict outputs for new or unseen data.

- Evaluate the performance of the network using a separate test dataset

Step 5: Model Evaluation and Optimization

- Assess the model's performance, accuracy, and loss on training and validation datasets

- Perform hyperparameter tuning, adjust the network architecture, or optimize the learning process based on evaluation results

- Repeat training and evaluation steps until a satisfactory performance is achieved

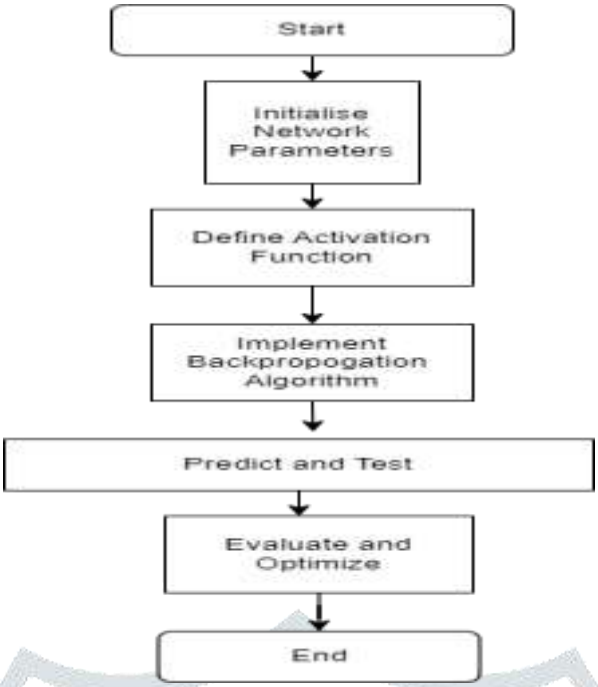

Figure 3.2. ANN Flow chart

4. RESULTS

The input text will be tokenized through tokenization process and base words are taken by performing stemming/lemmatization process. Also, steps include converting all the text into lowercase, remove common English words which doesn't contribute much to the context of the sentence called Stop word expulsion, eliminating various forms of punctuation. The root words are extracted using feature extraction techniques N-Gram and TF-IDF on the pre-processed text. These make the processed text ready for tasks like sentiment analysis, text classification, and natural language processing. The sentence similarity index results as mapped, then the corresponding response will be given as the output. If the sentences aren't mapped exactly then the system uses cosine similarity to map the nearest possible query sentence to the pre-processed text and return output from the response of sentence that is most like the input query.

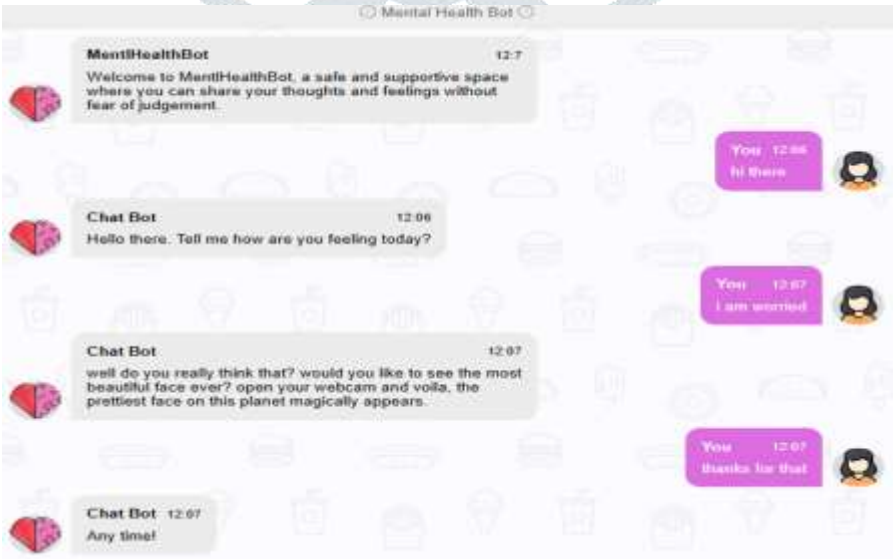

Figure. 4.1. Screenshot of UI

The chatbot is built using ANN, and the results showed with an accuracy of 81.3% in below figure 4.

```
Epoch 1/200
57/57 [==============================] - 1s 2ms/step - loss: 4.8533 - accuracy: 0.0353
Epoch 2/200
57/57 [==============================] - 0s 2ms/step - loss: 4.7816 - accuracy: 0.0353
Epoch 3/200
57/57 [==============================] - 0s 2ms/step - loss: 4.6802 - accuracy: 0.0565
```

```
Epoch 197/200
57/57 [==============================] - 0s 2ms/step - loss: 0.7382 - accuracy: 0.7668
Epoch 198/200
57/57 [==============================] - 0s 2ms/step - loss: 0.6393 - accuracy: 0.7739
Epoch 199/200
57/57 [==============================] - 0s 2ms/step - loss: 0.8790 - accuracy: 0.7562
Epoch 200/200
57/57 [==============================] - 0s 2ms/step - loss: 0.7562 - accuracy: 0.7668
model created
```

Fig. 4.2. Training of chatbot on intents. json with ANN model

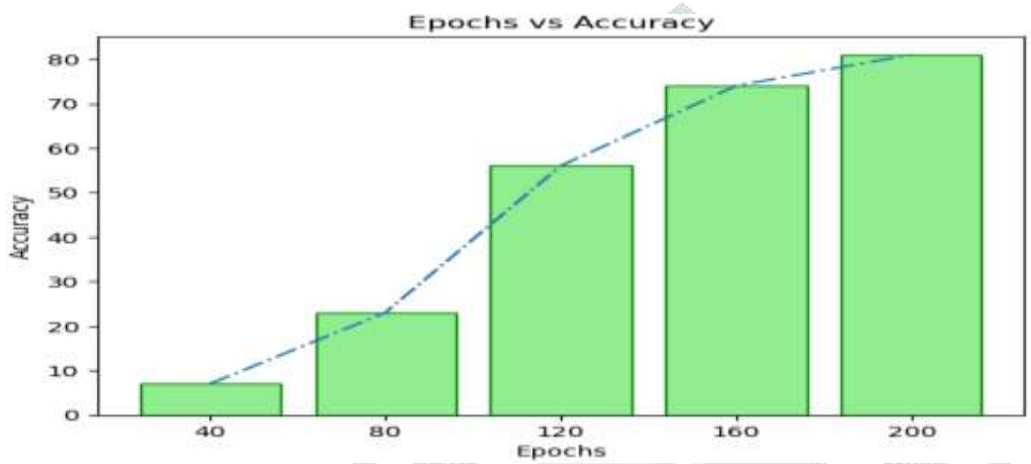

Fig. 4.3 Epochs vs Accuracy

5. CONCLUSION

The presented work formulates a sophisticated mental health chatbot create intelligent, flexible and scalable mental health chatbots aimed at providing seamless and personalized support to users who are taking on mental health issues that are den in Neo-inclusive -must include technical solutions with important modules such as pre-processing, feature extraction, and training modules based on Artificial Neural Networks (ANN), which is especially important in times of high sensitivity, and removes barriers associated with traditional funding mechanisms.

1. REFERENCES

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