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NeuroSafe-Advancing Mental Health using AI, ML and Blockchain

Parth Gujarathi
Department of Computer Engineering
Sardar Patel Institute of Technology
Mumbai, India
parth.gujarathi@spit.ac.in

Kartik Menon
Department of Computer Engineering
Sardar Patel Institute of Technology
Mumbai, India
kartik.menon@spit.ac.in

Jai Patel
Department of Computer Engineering
Sardar Patel Institute of Technology
Mumbai, India
jai.patel@spit.ac.in

Aparna Halbe
Department of Computer Science and Engineering
Sardar Patel Institute of Technology
Mumbai, India
aprana_halbe@spit.ac.in

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***Abstract*—This study offers a novel platform for mental health support that incorporates state-of-the-art technology to improve user experience. The platform analyzes user journals using BERT-based emotion analysis, and it generates weekly reports that show emotional trends. By utilizing blockchain technology, individuals can grant and withdraw therapist access as needed, while also ensuring safe record-keeping. Therapists can promote cooperative and private treatment by safely uploading session recordings to the blockchain. Real-time help is provided via a generative AI-based chatbot that makes use of LSTM and Seq2Seq architectures, and peer interactions are facilitated by a community chat app. The platform's usefulness is demonstrated by the results, and user feedback validates its influence on mental health assistance. This project creates a user-centric framework that integrates blockchain security, emotion analysis, and AI-driven interactions to provide a holistic approach to mental health.**

Keywords — BERT, LSTM, seq2seq, blockchain, ethereum

I. Introduction

The convergence of cutting-edge technologies has opened up new avenues for creative approaches to mental health treatment, catering to the intricate and subtle aspects of personal wellbeing. This study presents a comprehensive mental health platform that incorporates these cutting-edge technologies, such as a generative AI-driven chatbot, blockchain technology for safe record-keeping, and BERT-based emotion analysis. Our initiative intends to offer a comprehensive and user-centric strategy to support people in their journey toward mental well-being. Mental health is a multifaceted area.

There is an increasing need for individualized and easily available interventions as mental health is becoming more and more recognized as important. Conventional approaches frequently don't capture the nuances of emotional experiences well enough, nor do they provide the flexibility required for customized care. Our technology uses a sophisticated emotion analysis model based on BERT to overcome these issues, enabling users to write and express themselves while getting weekly individualized reports that visually represent their emotional states.

In order to provide mental health care in a secure and transparent manner, our platform uses blockchain technology. Security and privacy are of the utmost importance. Users are in charge of their data and can provide or take away access to therapists as needed. In response, therapists can safely upload their session notes to the blockchain, fostering a private, cooperative setting for efficient treatment.

Additionally, our approach acknowledges the value of community involvement in mental health. With the help of a community chat app, users can engage with one another, exchange stories, offer assistance, and create a feeling of community. In addition to the collective assistance, a chatbot driven by generative artificial intelligence and utilizing LSTM and Seq2Seq architectures provides real-time communication, guaranteeing that users can obtain prompt assistance anytime they require it.

Thus, this project intends to provide a user-centric, inclusive platform that caters to the individual needs of each user, in addition to advancing the technology landscape of mental health assistance. By using state-of-the-art technologies, our platform aims to transform mental health assistance by offering a more individualized, safe, and cooperative method of promoting well-being.

II. Literature Review

It was crucial for us to learn from and research previous research in this area before we got started in order to draw inspiration and improve upon it. We studied various research methods on the individual technologies available so that we could improve upon them and create a full fledged application using the aforementioned technologies

The study [] by T. Ananthakrishna and colleagues gave us significant insights into a variety of methods to process and analyze textual data, which helped us to better comprehend

the application of natural language processing in the detection of stress. The goal of this study was to develop models for the identification of user attitudes and emotions, which might then be applied to stress management, and to categorize textual data into five different emotional categories. The LDA algorithm was also employed in the paper to give detailed data visualization and to analyze user tweets. The research underscored the importance of data visualizations in achieving a thorough comprehension of the information. The number of subjects in the extracted tweets and the frequency of a word in a certain topic were ascertained using LDA.

We then looked at RR Baheti and S Kinariwala's paper [ ]. This study presented a method for spotting signs of tension and relaxation on social media sites, especially Twitter. The TensiStrength framework, a lexicon-based technique for identifying textual stress intensity, was utilized in the study together with a dataset from Twitter. Using this paradigm, the tweets were categorized into stress levels ranging from -5 to +5. It estimated the stress level by analyzing the sentiment of a user's tweet. However, this paper's accuracy—which was only 68

Next we studied a paper [] written by Prabod Rathnayaka and his colleagues, which introduced a BA-based AI chatbot. It was designed as a series of chatbot capabilities that can be grouped into three main categories: (1) personalized conversation, (2) emotional support, and (3) remote mental health monitoring.The study also included three experimental studies to evaluate the functionality and use of the chatbot.The authors suggested that the chatbot had the potential to provide personalized and accessible mental health support to individuals who may not have access to traditional mental health services.It was challenging to compare the efficacy of the chatbot to other types of mental health care because the study lacked a control group.

The paper A Blockchain-Enabled Framework for mHealth Systems by Dragos Daniel Taralunga and Bogdan Cristian Florea proposes a framework that addresses security, data integrity, and data provenance challenges. The document details the creation, execution, and application of a blockchain network and its corresponding smart contract. This process encompasses the generation of information and its merging with the InterPlanetary File System (IPFS). The implementation incorporates a two-way functionality, enabling continuous uploading and monitoring of data from various origins by both medical professionals and patients. This involves the uploading of data on IPFS, storing references in the smart contract on the Ethereum blockchain, and employing an interface for doctor-patient interactions. The paper highlights the significant benefits of integrating blockchain into healthcare. In contrast to a conventional client-server digital health system, which is vulnerable to data breaches and server failures, a decentralized peer-to-peer network eliminates centralization, providing owners with full control over their records. The distributed nature of the blockchain also enhances the system's fault tolerance.

The paper Blockchain Technology for Healthcare: Facilitating the Transition to Patient-Driven Interoperability by William J. Gordon, Christian Catalini emphasizes the shift from institution-driven interoperability towards patient-centered interoperability, in which health data exchange is patient-mediated and patient-driven. Interoperability pertains to the system's capability for data upload and access from diverse sources, such as a doctor and a hospital. Blockchains facilitate a centralized and shared mechanism for managing authentication and authorization rules related to data. The data custodian (e.g., the patient) is clearly identified on the blockchain, allowing them to designate access rules and permissions for their data, simplifying sharing. As patients increasingly take control of their health data, a primary step involves consolidating all their clinical data, often achieved by establishing API connections to systems containing the desired data. Blockchain's utilization of public-key infrastructure (PKI) establishes a centralized identification method—a person's public key—that can link the patient's records across various institutions.

III. Proposed Methodology

We present a ground-breaking platform that has the potential to completely transform the mental health support market in response to the growing demand for creative and easily accessible mental health solutions. Using state-of-the-art technology, this suggested system takes a user-centric and comprehensive approach to mental health. Through the seamless integration of advanced emotion analysis, a cutting-edge generative AI chatbot, and secure blockchain-based record-keeping, this system seeks to offer an unparalleled degree of individualized and safe mental health care to both users and therapists.

Emotion Anaysis: Emotion analysis is one of the most important features of our project. Leveraging state-of-the-art models like BERT (Bidirectional Encoder Representations from Transformers), this project utilizes users' journal history to analyse the user's emotions and keep track of them in the form of reports.

BERT is a deep learning architecture widely used for natural language processing tasks, including text analysis. BERT is a pre-trained language model that is capable of generating high-quality contextualized word embeddings. Unlike traditional word embeddings, which are based solely on the context of individual words, BERT takes into account the entire context of the input sentence or text. BERT can be specialized for a particular task like text classification and sentiment analysis, etc. It appends a task-specific output layer to its pre-trained model and then trains the entire network on the given labeled dataset. As a result, the model adapts to the specific characteristics of the target task and provides enhanced performance on many NLP benchmarks.

To train the BERT model on emotion analysis, we had taken a labelled dataset on various types of texts and each text is labelled based on the emotion it shows. These emotions are joy, love, anger, fear and surprise. Now these texts are cleaned to remove any types of HTML tags, accents or any stopwords. Stopwords are commonly used words in natural

language that are often filtered out or removed from text during text preprocessing in natural language processing (NLP) tasks. These words are considered to have little or no significant meaning or contribution to the overall understanding of the text. After cleaning the dataset, we tokenize each text using BertTokenizer into token IDs as inputs in a BERT model should contain only tokens. Now, the dataset is split into 3 datasets: training dataset, testing dataset, and validation dataset. These 3 datasets must be converted into Tensor as input to the BERT model is fed in the form of vectors. To improve speed and efficiency of the model, the training dataset is split into batch of size 32. Then, we trained the BERT model on the training dataset and loss is calculated for each epoch. Finally we tested the model on our testing and validation dataset and calculated the accuracy of the model.

By harnessing the contextual understanding and representation learning capabilities of BERT, this project is able to decode nuanced emotional nuances encapsulated within personal journal entries. The utilization of users' historical journal data serves as a rich source for training and fine-tuning BERT-based models, enabling the development of robust and personalized emotion analysis frameworks. This research endeavors to not only classify emotions but also comprehend the intricacies of emotional transitions and patterns over time, thereby contributing to advancements in personalized emotional understanding and mental health assessment.

Generative AI-based chatbot: Our mental health platform's generative AI chatbot uses an advanced approach based on sequence-to-sequence (Seq2Seq) architecture and Long Short-Term Memory (LSTM) models. This section offers a thorough analysis of the chatbot's technique, illuminating the subtleties of its creation and training procedures.

Encoder-Decoder Structure: The encoder-decoder structure of the chatbot is based on a Seq2Seq model. This arrangement is essential for comprehending a conversation and coming up with contextually appropriate answers. While the decoder creates the output sequence (the chatbot's answer), the encoder examines the input sequence (the user's message).

LSTM Models: To get over the drawbacks of conventional recurrent neural networks (RNNs), Long Short-Term Memory (LSTM) models are used in the encoder and decoder. Long-range relationships within the sequence are efficiently captured by LSTMs, enabling the chatbot to recognize and produce logical responses even during drawn-out and intricate talks.

Tokenization and Embedding: Tokenization divides the text data into manageable chunks for processing. Following that, a continuous vector space is filled with these tokens to create a representation that captures the semantic links between words. For the chatbot to understand the context and meaning of the input sequence, this phase is essential.

Training of the Encoder: As the encoder is exposed to input sequences, its LSTM layers pick up contextual information through encoding. The input sequence is converted during the encoding process into a fixed-length context vector that captures the main ideas of the user's message.

Decoder Training: The decoder is simultaneously trained to produce replies according to the context vector that has been encoded. Iteratively building the response one step at a time, the LSTM layers of the decoder learn to predict the next token in the sequence.

Attention Mechanism: An attention mechanism is added to improve the chatbot's capacity to pay attention to particular segments of the input sequence when producing responses. The replies are more contextually coherent and context-aware thanks to this approach, which enables the model to concentrate on pertinent areas of the context vector.

Hyperparameter tweaking: To maximize the chatbot's performance during training, careful hyperparameter tweaking is required. To achieve a compromise between accuracy and efficiency, parameters including learning rate, batch size, and model architecture are changed iteratively.

The methodology of the generative AI chatbot is essentially a combination of attentive mechanisms, continuous learning paradigms, and sophisticated neural network structures. The objective of this chatbot is to provide consumers with a mental health platform that is sympathetic, contextually aware, and supportive by deciphering the intricacies of conversational dynamics.

Blockchain Based Record Management: In this research paper we also explore the integration of blockchain technology into a health record management system to enhance data security, integrity, and user authenticity. The system employs a decentralized and tamper-resistant ledger to store health records, ensuring transparency and trust in the healthcare data ecosystem. Digital health records have become integral to modern healthcare, but challenges such as data security breaches, integrity issues, and concerns about user authenticity persist. This paper explores the use of blockchain technology as a means to overcome these challenges. We aim to achieve the following objectives:

To identify and analyze the challenges in current digital health record systems.

To propose a blockchain-based solution for mitigating these challenges.

To evaluate the effectiveness of the proposed system in addressing identified issues.

The proposed health record management system is architecturally designed to leverage the synergy of Ethereum framework and the InterPlanetary File System (IPFS). Ethereum smart contracts play a pivotal role in facilitating the secure storage and retrieval of health record references, while IPFS is integrated for decentralized and efficient storage of the associated data.

General System: The main features of the proposed health framework are:

Patient/doctor identity: Registration within the framework is a requisite for both patients and doctors, with their identity and privacy meticulously managed by a blockchain smart contract.

Patient/doctor association: Each patient has the flexibility to engage with multiple doctors of diverse specialties. The coordination of patient management is overseen by a blockchain

smart contract, empowering patients with control over their medical data.

Data immutability: Hashing and the inherent properties of the blockchain network guarantee the immutability and integrity of the data.

IV. Results

Promising results from the empirical examination of the essential elements of the mental health platform demonstrate advances in emotion analysis, chatbot training, and blockchain integration.

Emotion Analysis:

Two distinct models were used to test the emotion analysis module, which is essential for comprehending and reacting to user sentiments: CNN and BERT. With a remarkable 96 percent accuracy rate in identifying user emotions, BERT showed remarkable precision. Conversely, CNN fared well as well, hitting a respectable 92 percent accuracy rate. The comparative analysis demonstrates how well BERT captures the subtleties of user expressions in relation to mental health.

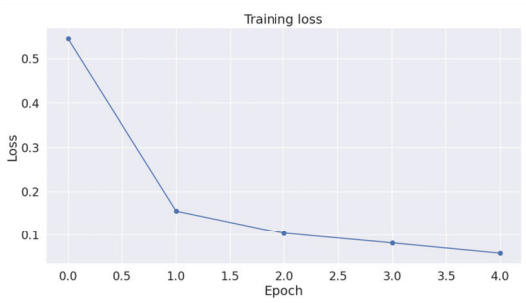

Fig. 1. Training Loss

Generative AI-based Chatbot:

With 350 training epochs, the chatbot—which used a Seq2Seq architecture with LSTM—achieved a remarkable 95 percent accuracy. This highlights the chatbot's capacity to produce contextually appropriate answers, offering consumers a helpful and conversational interface. The high training accuracy shows how well the model can comprehend and imitate human-like interactions.

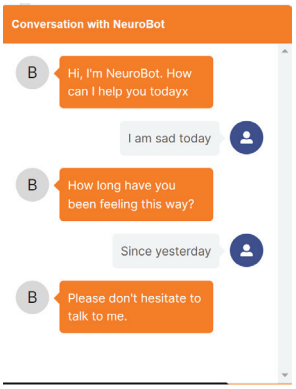

Fig. 2. Chatbot

Blockchain Integration:

The system's durability and effectiveness were demonstrated by the successful integration of a local blockchain. The speed with which mining tasks—a crucial component of blockchain operations—were completed in a matter of seconds indicated the responsiveness of the platform. Nevertheless, it's interesting to notice that reports took five to ten seconds to upload to the InterPlanetary File System (IPFS). It's possible that this delay can be optimized further to improve the user experience in general.

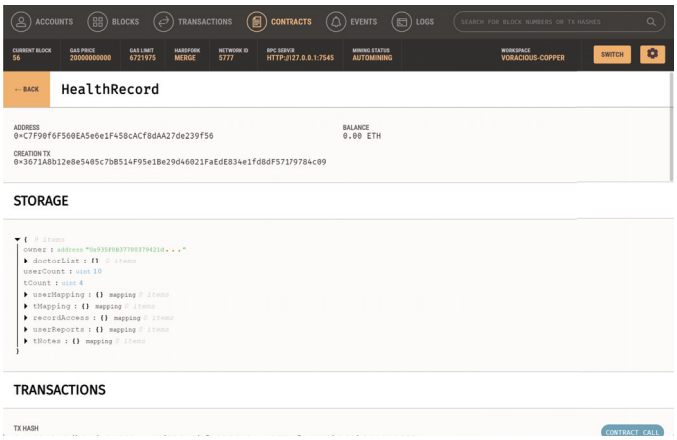

Fig. 3. Blockchain

Implications and Considerations:

The outcomes validate the platform's dedication to utilizing state-of-the-art technologies to assist with mental health. Because of BERT's remarkable accuracy in emotion analysis, customers are guaranteed to gain highly individualized and detailed insights into their emotional states. The accuracy of the chatbot's training indicates that the platform can offer users a helpful and accommodating conversational experience.

Even though the blockchain integration proved effective for mining activities, more research is necessary due to the upload latency on the IPFS. In the future, efforts might concentrate on improving the IPFS integration to speed up uploads and improve system performance in general.

V. Conclusion

This research has provided a comprehensive platform that combines cutting-edge technology to produce a dynamic and user-centric solution in the ever-evolving field of mental health support. A complex mental health ecosystem is established by the combination of blockchain security, generative AI-driven interactions, and BERT-based emotion analysis.

The platform's achievement of 96 percent accuracy in emotion analysis highlights the effectiveness of applying cutting-edge natural language processing methods. Users gain a comprehensive awareness of their emotional states by utilizing BERT, which opens the door to individualized interventions and assistance.

The platform's partnership with therapists adds a new level of complexity to mental health treatment. The platform em-

powers customers and therapists with an easy-to-use booking system, real-time chat app interactions, and comprehensive appointment logs. Therapists' access to computerized prescription writing and appointment scheduling tools supports an all-encompassing, user-centered approach.

The combination of Next.js, Tailwind CSS, Node.js, Express.js, Flask, and Python in the underlying technology stack exemplifies the adaptability needed to create a mental health platform that is secure, responsive, and modular. Socket.io facilitates real-time communication within the chat app, giving user interactions an extra degree of immediacy.

Future-focused recommendations for ongoing development and enhancement have been provided, with a focus on topics like wearable data integration, customized treatment plans, and multimodal emotion analysis. The platform's focus on promoting a diverse and supportive community is further evidenced by its commitment to security, accessibility, and inclusivity.

In summary, this study highlights the importance of a comprehensive and team-based strategy while also making a technological contribution to mental health support. Through the integration of state-of-the-art technology and the knowledge of mental health specialists, we see a future in which mental health services are not only safe and easily available, but also highly individualized and compassionate. This platform seeks to be a steady companion on the path to mental well-being, offering consolation and assistance to those who require it.

REFERENCES

[1] Baheti, R.R. and Kinariwala, S. Detection and Analysis of Stress using Machine Learning Techniques, International Journal of Engineering and Advanced Technology (IJEAT), Volume-9, 2019

[2] Thilagavathi P, Pushkala P, Suresh Kumar. A and Yamini P, Detecting Stress based on Social interactions in social network, International Journal of Engineering, Research and Technology(IJERT), 2018

[3] Priya A, Garg S, Tigga N.P, Predicting Anxiety Depression and Stress in Modern Life using Machine Learning Algorithms, Procedia Computer Science, Volume 167, 2020

[4] Dham V, Rai K, Soni U, Mental Stress Detection using Artificial Intelligence Models, International Conference on Mechatronics and Artificial Intelligence, Volume 1970, 2021

[5] M. Pacula, T. Meltzer, M. Crystal, A. Srivastava and B. Marx, "Automatic detection of psychological distress indicators and severity assessment in crisis hotline conversations," 2014 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2014

[6] Ali M.M, Hajera S, Psychological Stress Detection from Social Data using a Novel Hybrid Model, International Journal of Intelligent Systems and Applications in Engineering(IJISAE), 2018

[7] Rastogi A, Liu Q, Cambria E, Stress Detection from Social Media Articles, Department of Electrical Engineering, Indian Institute of Technology Indore, India, School of Computer Science and Engineering, Nanyang Technological University, Singapore

[8] Nijhawan, T., Attigeri, G. Ananthakrishna, T. Stress detection using natural language processing and machine learning over social interactions. J Big Data 9, 33 (2022).

[9] Guntuku S.C., Buffone A, Jaidka K, Eichstaedt J, Ungar L.H, Understanding and Measuring Psychological Stress Using Social Media, University of Pennsylvania, Nanyang Technological University, 2019

[10] KWilliam J. Gordon, Christian Catalini, "Blockchain Technology for Healthcare: Facilitating the Transition to Patient-Driven Interoperability", Computational and Structural Biotechnology Journal, Volume 16, 2018, Pages 224-230

[11] Taralunga DD, Florea BC. "A Blockchain-Enabled Framework for mHealth Systems". Sensors (Basel). 2021 Apr 16;21(8):2828. doi: 10.3390/s21082828. PMID: 33923842; PMCID: PMC8073055.