Mental Health Companion

Aniket Barke[1], Akshat Gawali[2], Shreya Hire[3], Kinjal Rayate[4], P. N. Pathak[5]

[1,2,3,4] *B.E Computer Engineering Students,Loknete Gopinathji Munde Institute of Engineering Education & Research (LOGMIEER), Nasik*
[5] *Assistant Professor, Dept. of Computer Engineering ,Loknete Gopinathji Munde Institute of Engineering Education & Research (LOGMIEER), Nasik*

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Abstract – *This research endeavors to address the critical challenge of timely identification and intervention in mental health disorders, particularly depression. Utilizing self-reported symptoms obtained through survey responses, alongside essential demographic and personal data, we aim to develop a predictive model for the early detection of mental health issues. The dataset, comprising diverse survey responses, provides a comprehensive understanding of participants' mental well-being. Employing advanced machine learning techniques, we seek to uncover patterns that can contribute to an effective prediction model.*

The ultimate aspiration is to empower healthcare practitioners with a sophisticated tool that enhances the overall efficacy of mental health interventions. By navigating the complexities of mental health identification, our research underscores the importance of proactive measures, striving for a paradigm shift towards a more comprehensive and timely approach to mental healthcare. Through systematic testing and model selection, we aim to pave the way for a transformative tool that can positively impact public health by enabling early detection and intervention.

***Key Words:* Mental Health Prediction, Depression, Random Forest Classifier, Decision Tree Classifier, Gaussian Naive Bayes, K-Nearest Neighbors, Machine Learning, Classification, Anxiety, Stress, Mental Health.**

1. INTRODUCTION

Modern lifestyle often takes a toll on people's mental well-being, leading to conditions like depression and mental anguish. Depression, a pervasive mental disorder, profoundly impacts individuals' cognitive and emotional processes. Tragically, suicidal thoughts frequently accompany depression, contributing to the alarming statistic of nearly 800,000 suicides annually .

Recognizing the profound impact of mental health disorders, it becomes imperative to adopt a holistic approach to address the stress they induce. Furthermore, depression can significantly affect an individual's socioeconomic status, as those afflicted may struggle to maintain their usual levels of functioning and productivity. Social withdrawal is a common symptom of depression, further isolating individuals from their support networks . Fortunately, effective interventions such as counseling and psychiatric treatments offer hope in combating depression and alleviating its debilitating effects.

The World Health Organization (WHO) recognizes depression as a significant global health issue, underscoring the critical need for effective detection and intervention strategies. Given the complexities of mental health disorders, there is a growing demand for innovative tools to support mental health professionals in delivering timely and accurate diagnoses.

This research seeks to meet this demand by developing a tailored predictive model to assist in the early identification of depression. Mental well-being is crucial for our overall health, impacting our daily emotions, thoughts, and behaviors. However, identifying early signs of mental health issues, particularly depression, can be challenging, often leading to delayed or inadequate treatment. This study addresses this challenge by introducing a predictive model designed to detect early indicators of depression. By analyzing data from the Depression, Anxiety, and Stress Scale (DASS-42) questionnaire and the Ten-Item Personality Inventory, the model aims to provide a comprehensive tool for early detection and intervention.

By harnessing the power of technology, our web-based tool aims to provide a seamless and accessible platform for individuals to assess their mental health status. Through user-friendly survey interfaces, participants can conveniently report their symptoms, offering valuable insights into their mental well-being. Coupled with essential demographic and personal data, this comprehensive dataset serves as the foundation for our predictive model.

2. RELATED WORK

Comparative Analysis of different Algorithms to predict depression: K. S. Sudhishna, C. Sanjay Kumar, B. S. Kishore and A. Arun[1], examine the effectiveness of three algorithms—Logistic Regression, Multinomial Naïve Bayes, and Support Vector Machine in predicting depression using data from social media platforms and wearable technology. The accuracy of machine learning models relies on the quality of training data, which can be challenging to obtain reliably for depression forecasting due to potential incompleteness, errors, or biases. Various metrics, including precision, recall analysis, and F1-score comparison, are used to assess algorithm effectiveness. By training these models on datasets and evaluating them based on accuracy and sensitivity rates, the study aims to identify the most effective algorithm for depression prediction.This research contributes valuable insights into the application of machine learning in mental health analysis, paving the way for improved diagnostic tools and interventions in depression management.

Mental Health Chatbot Delivering Cognitive Behaviour Therapy and Remote Health Monitoring Using NLP And AI: Komal Rani, Harshit Vishnoi, and Manas Mishran [2], is a mental health interaction portal that provides a virtual solution for individuals suffering from anxiety and depression. The platform offers comprehensive information on these conditions and their treatments, connecting patients with trained professionals who can provide support and guidance. At the heart of Saarthi is a chatbot, which utilizes advanced AI algorithms to deliver personalized and empathetic support to patients. Trained in various therapeutic techniques, the chatbot helps patients manage their symptoms, improve their well-being, and access the resources they need to live fulfilling lives. Saarthi also provides access to a community of peers and medical professionals, enabling patients to connect with others who understand their struggles and offer support. With Saarthi, patients can access quality mental health care from the comfort of their own homes, making it a convenient and accessible solution for anyone struggling with anxiety and depression.

Neural Network Based Model for Predicting Psychological Conditions: Guo, Y., Friston, K., Aldo, F., Hill, S., Peng, H.[3] Preventive care attempts to inform individuals and clinicians of potential complications or conditions a patient might encounter. With the recent interest on leveraging big data in the healthcare domain to better design data-driven models for preventive medicine and the increased awareness of the long-lasting effects of concussions, being able to predict psychological conditions postconcussion can have a paramount effect on mild traumatic brain injury patients. We present a neural network model that can predict the likelihood of developing psychological conditions such as anxiety, behavioural disorders, depression, and posttraumatic stress disorder. We analysed the effectiveness of our model against a dataset of 89,840 patients. Our results show that we can achieve accuracies ranging from 73% to 95% for each of the clinical conditions under consideration, with an overall accuracy of 82.35.

Chiong, Raymond, Budhi, Gregorius Satia, and Dhakal, Sandeep [4], have explored the potential of using machine learning to detect signs of depression in social media users, even when explicit keywords such as 'depression' or 'diagnosis' are absent from their posts. Through various text preprocessing and feature extraction methods, coupled with machine learning classifiers, the study aims to establish a generalized approach for depression detection using social media texts. By analyzing labeled Twitter datasets for training and testing, along with additional datasets from platforms like Facebook, Reddit, and electronic diaries for validation, the research demonstrates the effectiveness of detecting depression through social media texts, even in the absence of specific keywords.

Research on Depression Recognition Using Machine Learning from Speech: Daimin Shi, Xiaoyong Lu, Yang Liu, Jingyi Yuan, Tao Pan, and Yanqin Li [5] Recent studies have shown that speech is a good indicator of depression, giving us a motivation to perform depression diagnosis using speech to create an objective measure. This paper studies the use of state-of-theart machine learning (ML) models including ensemble in predicting depression severity using audio features after optimizing the data. We collect the audio data from Northwest Normal University and the classic paradigm of psychological self-reference effect (SRE) is used. In the task of vocabulary reading, the SVM model achieved very good performance. In the task of image description, the DT model was better than other models. The results are better than other state-of-the-art models. In the future, we aim to further verify the model's correctness and create an autonomous agent that could help depressed patients.

3. DATASET

The dataset used in this project was collected through an online version of the Depression Anxiety Stress Scales (DASS), Individuals were encouraged to participate in the survey to receive personalized results. Those who agreed to participate in a short research survey and consented to their responses being used for research purposes were included in the dataset. Data collection occurred between 2017 and 2019. The survey consisted of questions related to mental health symptoms, including depression, anxiety, and insomnia, as well as demographic information such as age, gender, education level, and ethnicity. Participants rated the frequency of experiencing specific symptoms over the past week using a 4-point rating scale. Additionally, participants completed the Ten Item Personality Inventory and a vocabulary recognition task. Technical information such as country of connection, screen size, and source of survey access was also recorded. Overall, the dataset provides a comprehensive snapshot of individuals' mental health status, personality traits, and demographic characteristics, making it suitable for analyzing and predicting mental health disorders using machine learning techniques
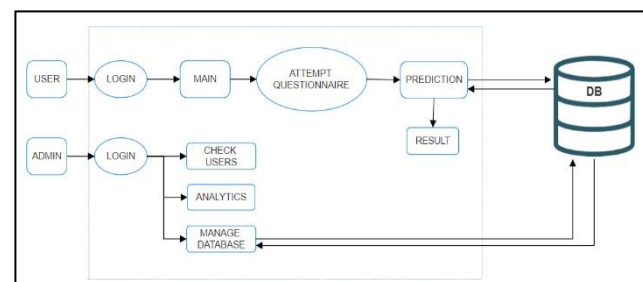
4. METHODOLOGY

System Architecture:

Fig 1: System Architecture

The Mental Health Companion project is structured around a client-server architecture, with distinct modules for users and administrators. The user module encompasses the front-end application, offering features such as registration, login, dashboard, questionnaire completion, result retrieval, suggestions, and journaling. This module communicates with the back-end server through HTTP requests and relies on a centralized database to store user data, questionnaire responses, and other relevant information. On the other hand, the admin module comprises an admin panel accessible to authorized personnel, providing functionalities for user management, analytics, database administration, and contact management. Communication between modules occurs via HTTP requests, ensuring seamless interaction and data exchange. Additionally, the architecture prioritizes scalability to accommodate a growing user base and implements robust security measures such as encryption, authentication, and authorization to safeguard sensitive data. Overall, the architecture is designed for reliability, scalability, and security to support the effective operation of the Mental Health Companion platform.

i. Frontend Interface: The frontend interface is developed using HTML, CSS, and JavaScript, providing a user-friendly interface for users to interact with the application. It includes pages for user registration, login, dashboard, questionnaire attempt, journaling, and accessing suggestions.

ii. Backend Server: The backend server is implemented using Flask, a Python web framework. It handles user authentication, data processing, and communication with the machine learning model. The server manages user sessions, processes requests from the frontend, and interacts with the database.

iii. Database Management: The application uses a relational database management system (RDBMS) such as MySQL or PostgreSQL to store user data, questionnaire responses, journal entries, and other relevant information. The database ensures data persistence and integrity.

iv. Machine Learning Model: The core component of the system is the machine learning model trained to predict mental health conditions based on questionnaire responses. The model is backend server. It processes user inputs, generates predictions, and provides insights to users.

v. External APIs: The application may integrate with external APIs for additional functionalities such as sending messages to doctors, accessing resources for mental health support, or fetching latest research articles related to mental health.

vi. Admin Panel: An admin panel is included for administrators to manage user accounts, view analytics, monitor system performance, and perform other administrative tasks. It provides insights into user interactions and helps in improving the application over time.

5.1 RESULTS AND IMPLEMENTATION

A. Results Analysis for Random Forest Classifier:

a. Random Forest Confusion Matrix:

	precision	recall	f1-score	support
Extremely Severe	0.97	0.98	0.98	2645
Mild	0.86	0.69	0.77	750
Moderate	0.87	0.93	0.9	1425
Normal	0.94	0.97	0.96	1796
Severe	0.91	0.88	0.89	1331
accuracy			0.93	7947
macro avg	0.91	0.89	0.9	7947
weighted avg	0.92	0.93	0.92	7947

b. Random Forest Classification Report

	Extremely Severe	Mild	Moderate	Normal	Severe
Extremely Severe	2597	0	0	0	48
Mild	0	520	113	117	0
Moderate	0	40	1323	0	62
Normal	0	47	0	1749	0
Severe	82	0	83	0	1166

c. Random Forest Metrics

Accuracy	0.925506
Precision	0.92454
Recall	0.925506
F1 Score	0.923888

B. Findings and Reasons for Choosing Random Forest Classifier:

- Accuracy Comparison:

  - Random Forest Classifier: 92.55%
  - Decision Tree Classifier: 79.84%
  - Gaussian Naive Bayes Classifier: 87.47%
  - K-Nearest Neighbors Classifier: 88.95%

Random Forest outperforms all other classifiers in terms of accuracy, providing the highest accuracy score of 92.55%. This indicates that Random Forest is more effective in correctly predicting depression severity levels compared to the other classifiers.

- Precision, Recall, and F1-Score:

  o Random Forest Classifier demonstrates balanced precision, recall, and F1-score across all classes, ensuring both high correctness of positive predictions (precision) and the ability to find all positive instances (recall).

  o Decision Tree Classifier exhibits lower precision, recall, and F1-scores compared to Random Forest, especially for the "Mild" and "Severe" classes.

  o Gaussian Naive Bayes Classifier shows relatively high precision but lower recall for the "Mild" class, indicating that it may miss some instances of this class.

  o K-Nearest Neighbors Classifier performs reasonably well but shows slightly lower precision and recall for some classes compared to Random Forest.

- Complexity and Overfitting:

  Random Forest Classifier, being an ensemble model, is less prone to overfitting compared to Decision Trees, as it aggregates predictions from multiple decision trees.

  Decision Tree Classifier, being a single decision tree, may tend to overfit the training data, resulting in lower generalization performance.

- Robustness to Outliers and Irrelevant Features:

  Random Forest Classifier is robust to outliers and noise in the data due to its ensemble nature, which averages out the impact of individual trees.

  Decision Tree Classifier may be sensitive to outliers and irrelevant features, potentially leading to less robust predictions.

- Computational Efficiency:

  Random Forest Classifier is generally more computationally efficient compared to K-Nearest Neighbors Classifier, especially as the dataset size increases.

  Decision Tree Classifier can be computationally expensive to train and evaluate, particularly for large datasets, due to its hierarchical nature and potential for overfitting.

5.2 Web Implementation

The web tool mainly consists of two main modules which are "User Panel" and "Admin Panel". The User Module of the Mental Health Companion platform offers individuals seeking mental health support accessible tools and resources for self-assessment, providing personalized experiences, confidentiality, and trust in a supportive community environment. On the other hand, the Admin Module equips administrators with tools for managing and overseeing platform operations, ensuring smooth functioning and user support, offering benefits such as control and oversight, data analytics for decision-making, efficient database management, user support, and scalability for growth and adaptation.

- **User Module**:

  The User Module empowers individuals seeking mental health support with accessible tools and resources for self-care, self-assessment, and community interaction.

- **Main Page:**

  The Main Page of the Mental Health Companion serves as the entry point for users, offering options to sign up or log in. It provides easy access to essential features like the dashboard, questionnaire attempts, and result output. Users can also explore additional information through links to About Us or Contact Us pages, fostering engagement and connection with the platform.

- **Registration:**

  Registration allows users to create accounts on the Mental Health Companion platform. Users input essential details like username, email, and password, ensuring secure authentication for accessing resources and tools.

- **Login:**

  Login enables registered users to access their accounts on the Mental Health Companion platform securely.

- **Dashboard:**

  The dashboard serves as a central hub for users on the Mental Health Companion platform, offering various options to enhance their mental well-being journey. Users can access features such as "Attempt a Test" to evaluate their mental health status through comprehensive assessments. Additionally, they can receive personalized "Suggestions" based on their test results and individual needs. The dashboard also provides access to "Profile Settings," allowing users to update their personal information and manage contact details via the "Contact Info" section. For those seeking professional support, the "Doctors" feature enables users to connect with healthcare professionals. Test results, once completed, are conveniently displayed within the dashboard, providing users with valuable insights into their mental health status and progress.

- **Attempt Questionnaires:**

  "Attempt Questionnaires" enables users to assess their mental health by completing structured questionnaires. This feature provides valuable insights into users' emotional well-being, aiding in self-awareness and facilitating informed discussions with healthcare professionals.

- **Result Output**

  "Result Output" offers concise summaries of users' questionnaire responses, delivering insights into their mental well-being. It highlights key findings and potential

areas for improvement, empowering users to make informed decisions about their mental health.

- **Suggestions:**

"Suggestions" offers tailored recommendations derived from users' questionnaire responses. It provides practical guidance and resources aimed at assisting users in addressing particular areas of concern and enhancing their mental well-being.

- **Journaling:**

"Journaling" provides users with a private space to record thoughts, emotions, and experiences. It aids in self-reflection, emotional expression, and tracking mental health progress. Users can set goals, identify patterns, and gain insights into their well-being.

6. Conclusion and future scope:

In conclusion, the Mental Health Companion project offers a comprehensive solution for individuals seeking support and resources for mental well-being. Through its user-friendly interface and intuitive features, users can easily access tools for self-assessment, receive personalized suggestions, and engage in journaling activities to track their progress. The administrative panel empowers administrators to manage user accounts, analyze data, and ensure the smooth functioning of the platform. With a scalable and secure architecture, the Mental Health Companion project is well-equipped to adapt to the needs of its users while prioritizing their privacy and security. Overall, the project aims to make a positive impact on mental health by providing accessible and effective support to individuals worldwide.

It holds promising potential for future enhancements and expansions. One avenue for future development involves integrating advanced machine learning algorithms to enhance the accuracy of mental health assessments and personalized recommendations. Additionally, incorporating features such as real-time chat support with mental health professionals or peer support groups can further enhance user engagement and support. Expanding the platform's reach by offering multilingual support and customizing content to cater to diverse cultural backgrounds can also broaden its impact. Furthermore, forging partnerships with mental health organizations, healthcare providers, and educational institutions can facilitate outreach efforts and foster collaboration in promoting mental well-being. Continual updates and iterations based on user feedback and emerging research in mental health will ensure that the Mental Health Companion remains relevant and effective in addressing the evolving needs of its users.

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