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SmartHealthBot: A Sustainable AI Chatbot for Health Equity and Digital Innovation

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Abstract: ***In many areas where there is little infrastructure available to deliver timely and reliable healthcare, users can remin an opportunity to use SmartHealthBot - an AI-powered healthcare chatbot providing real-time, individualized assistance, driven by artificial intelligence and deep learning. This utilizes natural language processing to interpret user symptoms provided via either voice or text format, allowing users' interactions to be user friendly and inclusive. It leverages a hybrid methodology combining the advantages of both artificial neural networks and Naive Bayes classification, providing the ability to predict disease based upon a user's reported symptoms. Specifically, artificial neural networks (ANNs) are used to model the complex interrelationships between symptoms, while Naive Bayes classification provides for the rapid identifying of likely symptom groups. Further, through its use of sentiment analysis, it provides its users with mental health monitoring capabilities, including providing stress relief suggestions and motivation, as well as recommendations for enhancing diet and preventing illness, thereby supporting sustainable healthcare that encourages prevention. SmartHealthBot provides a rich analytics dashboard that assists the user in visualizing the trends and interactions of their symptoms, gaining greater insight into themselves.***

I. INTRODUCTION

Conventional healthcare methods are reliant on face-to-face consultations creating delays in diagnosis due to not having access to complete medical records. Due to having a stigmatized view overall, and/or having little to no awareness of their mental health symptoms, many people do not seek out timely mental health care when they need it [1], [3].

The evolution of the healthcare industry has been drastically altered through AI with predictive diagnosis, intelligent health monitoring, and decision-support capabilities [4]. The combination of Machine Learning and Natural Language Processing technology now allows for the analysis of large amounts of medical data in addition to understanding human language. This has shifted healthcare from a reactive model to a preventive model that focuses on the early detection of illness and managing wellness [2], [3].

AI chatbots for healthcare have been proven to help patients assess their symptoms, provide direction on what type of care would be better suited for their situation, and educate them about different types of medicine [6], [7]. Their significance was most evident during the COVID-19 pandemic when AI-based self-assessment tools were created and implemented to relieve the overload on the healthcare system and improve the accessibility to mental health care [6].

To solve these problems, SmartHealthBot has combined mental health monitoring, predictions of diseases, and personalised lifestyle recommendations into a single platform. Unlike the typical rule-based systems, SmartHealthBot leverages Artificial Neural Networks (ANN) as well as Naive Bayes classifiers to provide an accurate prediction of diseases based on symptoms [2], [5]. The use of NLP improves interaction through text and voice, leading to greater accessibility and usability in healthcare systems [3]. SmartHealthBot also features sentiment analysis, allowing for a more accurate assessment of how someone feels emotionally and provides motivational support for people in that respect [1]. Personalised diet recommendations, secure health record management, and analytical

II. METHODOLOGY

In the SmartHealthBot project, the modeled design and development of the chatbot integrate a scientific approach based on machine learning and conversational AI. In the project, the preprocessing of the data takes into account the division of the data into a training set and a testing set. A structured set of data on various diseases along with their respective symptoms is extracted. There are no missing, repeated, or flawed data points, which are removed by the preprocessing functions. As the symptoms are of the category type, the encoding is carried out to convert the symptoms into numerical form.

For the prediction problem, two models have been developed: the Artificial Neural Network (ANN) Model and the Naïve Bayes Classifier Model. Even though the ANN model works best in modeling the symptoms and diseases complex relation, the Naïve Bayes model works best since it provides fast and easy computation of probabilities.

The performance of the models will be measured using the accuracy, precision, recall, and F1 score metrics. The best performing model will be implemented in the chatbot system using Natural Language Processing in order to enable text and speech conversations with the system. The system will also enable the storage and retrieval of Health Information.

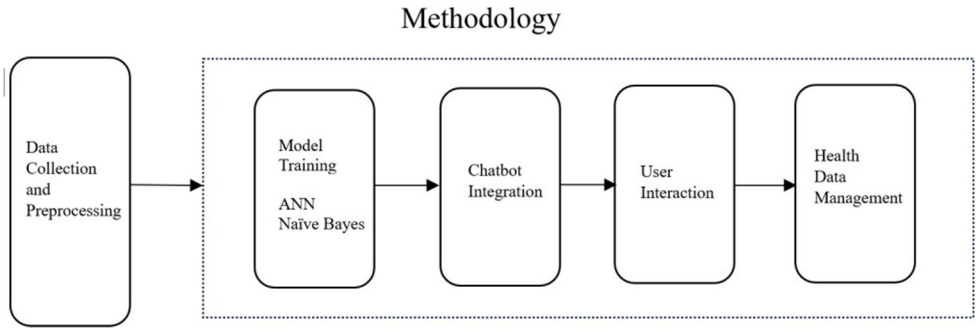

Figure 2.1. Methodology

III. ARCHITECTURE

The SmartHealthBot system combines the strengths of various modules: its NLP component, predictive models, and recommendation components.

A. Preprocessing Techniques

- Data Cleaning & Standardization: Handle duplicates, standardize disease names
- Encoding: Symptoms are converted to numerical vectors
- NLP Processing: Tokenization, lemmatization, stop-word removal.
- Vectorization & Normalization: TFIDF and MinMax scaling for normalized inputs.
- Train-Test Split & Balancing: Done at the rate of 80:20 with oversampling

B. Model Development

For disease prediction, Artificial Neural Networks (ANN) and Naïve Bayes were used to analyse symptoms and identify key patterns for accurate healthcare classification

- Artificial Neural Network (ANN): The ANN model employs ReLU-activated layers with a Softmax output to predict disease probabilities, achieving a prediction accuracy of 96%.
- Naïve Bayes: Naïve Bayes assumes conditional independence among symptoms and uses a multinomial variant suited for categorical medical data to quickly compute disease probabilities. It is lightweight, fast, easy to interpret, and achieves an accuracy of 78%.

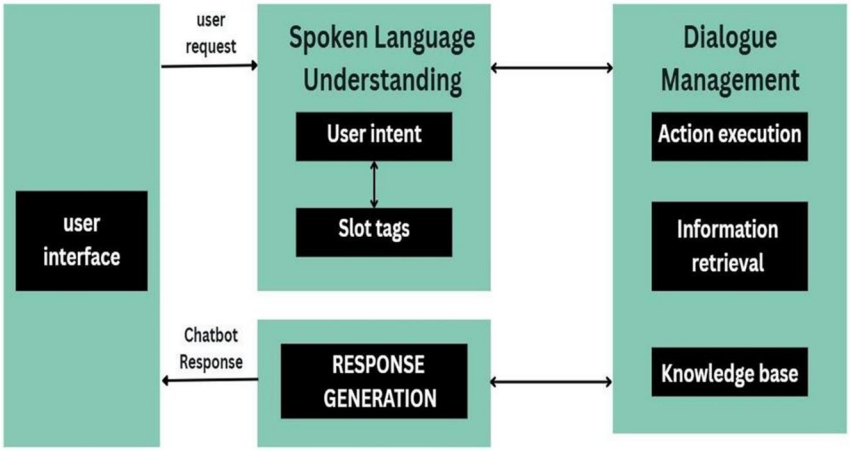

Figure 3.1. Architecture of the System

IV. IMPLEMENTATION

A. *Dataset*

SmartHealthBot uses two open-source medical datasets from Kaggle for prediction and recommendation.

1) Disease and Symptoms Dataset

- This dataset has 4,920 patient records with 17 symptom attributes and one disease label.
- Each symptom is converted to a binary format for efficient machine learning processing.
- This dataset helps the ANN and Naïve Bayes models learn the relationships between symptoms and diseases accurately.

2) Precautionary Dataset

- This dataset includes 41 diseases, each with four precautionary measures.
- Each record offers disease-specific guidance for prevention and recovery.
- This dataset improves the recommendation system by giving meaningful health advice.

B. *Algorithm - Artificial Neural Network*

The proposed work uses an Artificial Neural Network (ANN) that processes binary symptom inputs to predict diseases by capturing non-linear relationships as shown in figure 4.1. The ANN consists of an input layer, multiple ReLU-activated hidden layers, a dropout layer to prevent overfitting, and a Softmax output layer for disease probability prediction. The model is trained using the Adam optimizer with a cross-entropy loss function and evaluated using accuracy, precision, recall, and F1-score.

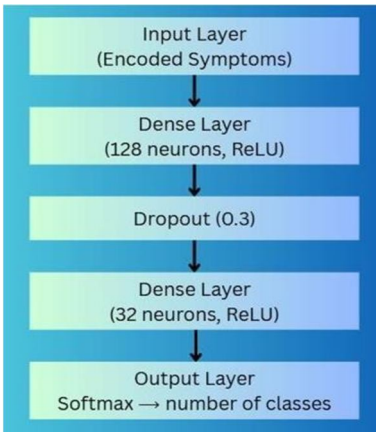

Figure 4.1. ANN architecture

C. *Algorithm – Naive Bayes*

The project uses a Naïve Bayes probabilistic classifier to predict diseases from encoded symptom data. Symptoms are converted into numerical feature vectors, and the model learns class-wise probability distributions to identify the most likely disease. A multinomial Naïve Bayes variant is selected for its efficiency in handling categorical symptom data.

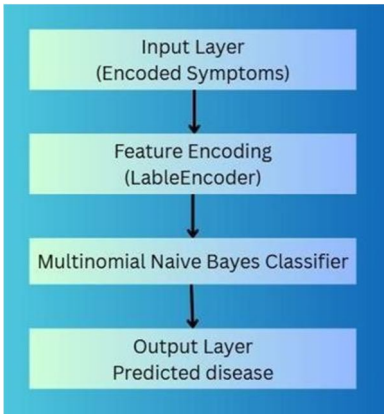

Figure 4.2. Naïve Bayes architecture

V. RESULTS

The implementation of our healthcare chatbot system has produced comprehensive results across multiple aspects of the model.

1) ANN model results: The proposed model achieved 96% accuracy, as shown in table 5.1 with high precision and recall, effectively identifying complex disease patterns and consistent health predictions suitable for real-world applications.

Table 5.1. ANN Model Results

Disease	precision	recall	f1-score	support
(vertigo) Paroxysmal Positional Vertigo	0.91	0.94	0.92	32
AIDS	0.91	1	0.95	39
Acne	0.97	0.83	0.89	41
Alcoholic hepatitis	1	1	1	36
Allergy	0.73	1	0.84	35
Arthritis	0.92	0.92	0.92	36
Bronchial Asthma	1	1	1	44
Cervical spondylosis	0.93	0.88	0.9	32
Chicken pox	1	1	1	35
Chronic cholestasis	1	1	1	30
Common Cold	1	1	1	31
accuracy			0.96	1476
macro avg	0.96	0.96	0.96	1476
weighted avg	0.97	0.96	0.96	1476

2) Naive Bayes Results: The model achieved a baseline accuracy of 78.12%, establishing a strong foundation for disease prediction and analysis.

Disease	precision	recall	f1-score	support
(vertigo) Paroxymsal Positional Vertigo	0.69	0.75	0.72	32
AIDS	0.69	0.56	0.62	39
Acne	0.56	0.78	0.65	41
Alcoholic hepatitis	1	0.94	0.97	36
Allergy	0.55	0.97	0.7	35
Arthritis	0.53	0.72	0.61	36
Bronchial Asthma	1	0.7	0.83	44
Cervical spondylosis	0.85	0.88	0.86	32
Chicken pox	0.9	1	0.95	35
Chronic cholestasis	0.67	0.67	0.67	30
Common Cold	0.94	1	0.97	31
accuracy			0.78	1476
macro avg	0.8	0.78	0.78	1476
weighted avg	0.81	0.78	0.78	1476

Table 5.2. Naïve Baes Results

3) User Interface: The user is first acquainted with home page depicted in figure 5.1, where the user enters the existing username and password, then the details are checked from the database.

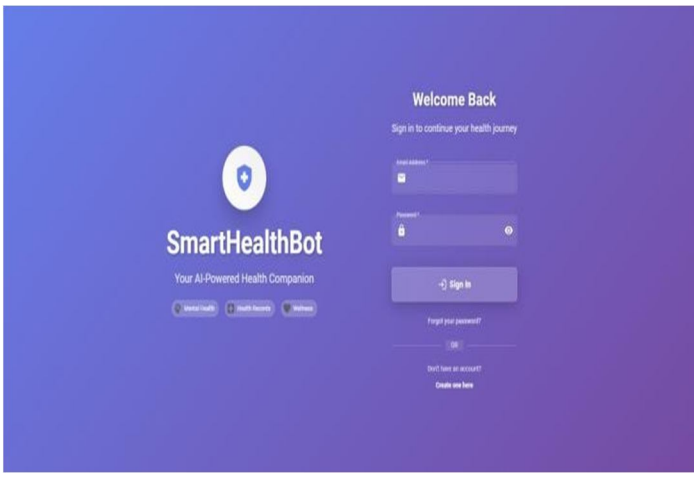

Figure 5.1. Login Page

4) SmartHealthBot Page: The figure 5.2 shows primary SmartHealthBot website page which allows users to tell us about their health and use the information to triage possible conditions based on symptoms.

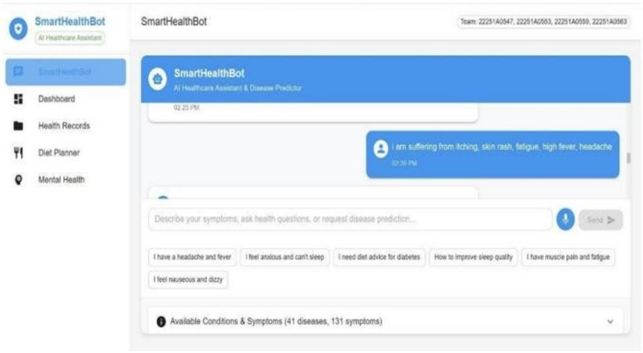

Figure 5.2. Chatbot

5) Dashboard: The SmartHealthBot summary page in figure 5.3 displays the overall health status, the risk level for numerous diseases, the trends regarding symptoms over time, mood and nutritional compliance through visual analytics.

Figure 5.3. Dashboard

6) Diet Planner: The Diet Planner within SmartHealthBot will generate personalized diets for users with specific medical conditions and preferences on how they eat as shown in figure 5.4.

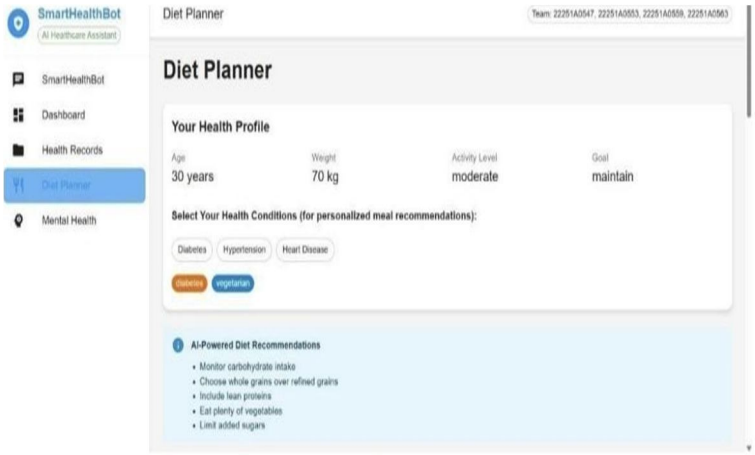

Figure 5.4. Diet Planner

7) Mental Health: The Mental Health Module of SmartHealthBot, in figure 5.5, includes mood Tracking, emotion Trend Analysis, Risk Level Assessment, and Daily Wellness Activity Suggestions to help users Manage Stress.

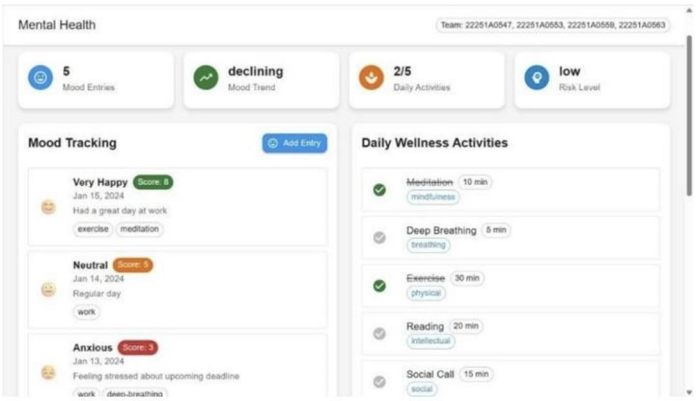

Figure 5.5. Mental Health Tracking Page

VI. CONCLUSION

This project provides Intelligent Medical Assistance through an Interactive Chatbot that Analyses User Input Symptom Data and Predicts Possible Illnesses. This project is highly beneficial for patients because it uses Artificial Neural Networks (ANN), and the Naive Bayes method of Probabilistic Reasoning, giving users reliable predictive power to analyze Disease Symptoms and Recommendations. Because of this, SmartHealthBot uses AI algorithms for Deep Learning accuracy and Probabilistic Reasoning for Reliable Predictive Power, resulting in meaningful and useful recommendations for patients.

SmartHealthBot combines Natural Language Processing (NLP) technology with user communications to provide more engaging conversations between patients and the healthcare system. In addition, SmartHealthBot has additional useful modules such as Diet Planning, Mental Health Support, and Health Records Management, which promote holistic health. SmartHealthBot provides a Personalised Healthcare Experience for Every User by generating Dietary Recommendations according to their Lifestyle Preferences, Evaluating Users' Emotional States through Sentiment Analysis, and Saving Users' Medical History.

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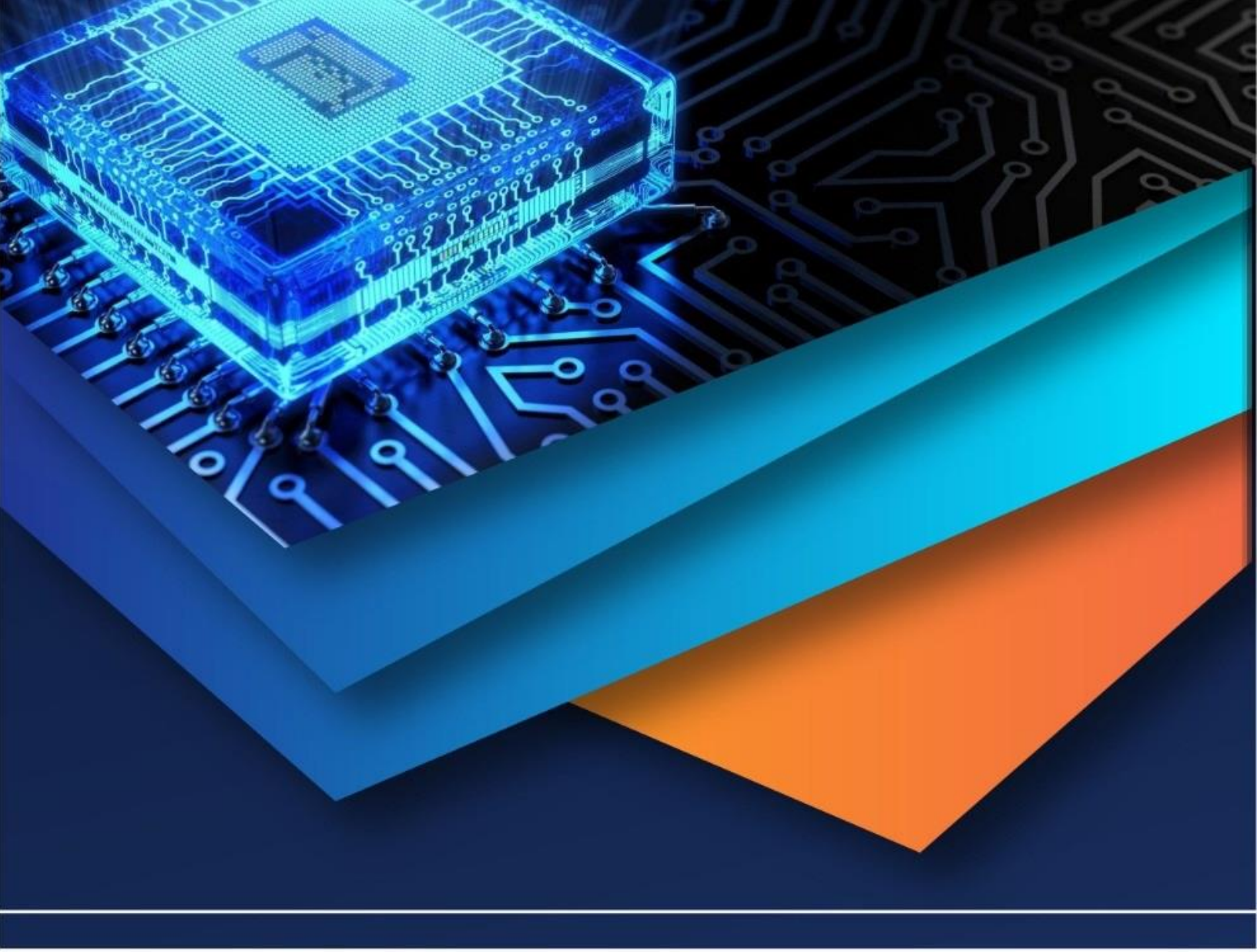

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