An Innovative Emotion Recognition and Solution Recommendation Chatbot

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***Abstract*—The proposed chatbot for emotion recognition and solution recommendation system is a web-based application that aims at helping people to handle their emotions without any external assistance. In today's world, pressure and stress on the professional front, insecure relationships, and other factors produce a lot of mental turmoil, which many prefer not to discuss with others. The proposed system simulates a one-on-one interaction of the user with the chatbot through images, category selection, and text data describing the mood of the person. The user's text description of emotion is analyzed using a variety of machine learning algorithms and parameters, with Random Forest proving to be the most precise in recognizing emotion with accuracy and F1 score of 97.55 and 0.969, respectively. This facilitates recognizing subtle and hidden emotions to recommend better ways of handling the emotions. The proposed chatbot uses state of art technology to analyze the mood of the user using multiple inputs and recommends different ways of controlling the emotion.**

Keywords—chatbot; emotion recognition; natural language processing; recommendation system; machine learning; web-based application; sentiment analysis; text classification

I. INTRODUCTION

Artificial intelligence (AI) is the ability of a computer chatbot to accomplish activities that are commonly performed by humans and are associated with human intelligence [1]. A chatbot is an application that uses AI and Natural Language Processing (NLP) to understand the users and simulate a human-like conversation over the internet, forums, tablets, and message applications. In chatbots, Machine Learning (ML) and NLP are used along with AI mechanisms to provide an interactive environment to the user [2]. NLP plays a major role in making the chatbots accept input questions, analyze the received text, and respond by generating the output text. NLP allows computers to derive meaning from user input. In case of chatbots, it evaluates user input and then generates replies based on contextual analysis, much like humans.

A. Types of Chatbots

In general, chatbots can be classified into rule-based chatbots and conversational chatbots. Rule-based chatbots operate within some pre-defined rules and are limited in their scope of activity. These rules are used to train the chatbots, develop a response system, and help the chatbot to get an idea about the questions. In rule-based chatbots, the questions are mapped to the corresponding response that will be given as output. Conversational chatbots rely on NLP to extract information from user's text and respond with the most appropriate replies. They use AI to improve the accuracy of the response over time [3]. Chatbots are widely used for different business applications like flight booking and FAQ agents [4].

B. Emotions and Need for Psychotherapy

Emotions are how the brain interprets body feelings based on previous experiences. Almost everyone experiences diverse emotions such as joy, anger, fear and so forth. They have a significant impact on how individuals think and act. Despite its importance on a person's overall health, nearly two-thirds of the population with mental health problems never seek treatment, and one out of every four people are likely to experience mental or neurological issues at a certain point in life. Many do not receive treatment for various reasons, including lack of availability of assistance or increasing need for counselling and hesitance in discussing the issue. Not reaching out for help may further worsen the situation leading to suicidal and self-harm tendencies, but not everyone can afford the time or money for professional help

[5]. As a result, research based on emotions has expanded in the last two decades, with contributions from a wide range of fields such as psychology, medicine, sociology of emotions, and computer science [6].

C. Related Work

Several existing models adopted the concept of chatbot in psychotherapy and the medical industry to cure different health conditions. Some of the previous approaches are discussed below.

A study is conducted on different techniques to detect emotions through sentiment analysis, voice-based and video-based emotion analysis. This study proves that the classification of emotions is more precise through the preprocessing of text [7]. A chatbot is developed using SAT counselling method. This method uses visual stimuli to identify unrecognized feelings and emotions of the user. The digital SAT counselling method is used to provide a self-guided mental healthcare application without a counsellor's guidance using the system [5]. Another model is developed using different entities created inside an intent where these entities focus on reacting to different situations. The entities considered in this model are personal loss, relationship issues, career and education related problems. The model uses supervised learning to generate responses based on user's input [8].

The development of MOST, an interactive social media-based platform for mental health recovery, is discussed in this study. The Horyzons website, powered by MOST, is the basis of the case study. It highlights the project's objective and the basic features along with the web application's interface. Based on the content viewed, the system gives automated suggestions [9]. A research examines the design and development of a chatbot for a clinical psychology study. A discussion is held on the different types of chatbots and NLP methods. The paper also examines the design and architecture of PlyBot, which is used as a case study [10]. In order to address the mental consequences of the pandemic, a chatbot is created that uses a sequential attention mechanism and considers human emotion detection. During the COVID-19 pandemic, the idea is to aid those suffering from mental issues by gradually understanding the causes [11].

Another technique focuses on identifying the possibility of self-harm based on the user's text inputs, indicating that the users have suicidal thoughts or a proclivity to hurt themselves. The idea is to develop a self-harm classifier that can recognize texts implying self-harm and offer suggestions for suppressing negative emotions [12]. A survey is held on the different techniques used to design chatbots like parsing, pattern matching, AIML, chat script, Markov Chain, and relational database (RDB). It emphasizes the similarities and differences between different techniques. The survey concludes that there is no best technique or a common way for building a chatbot [13]. A prototype version is developed that detects the emotion expressed on a face automatically. Thus, to categorize the universal emotions, a neural network based approach integrated with image processing is implemented. The prototype system receives colored frontal face snapshots as input. After face recognition, a feature point extraction approach is applied to extract a collection of selected feature points. Finally, after processing the retrieved feature points, a series of values is supplied as input to the neural network in order to detect the emotion represented [14].

An individual's emotions and mental state can be recognized based on the given input text. Therapy can be made more efficient if the user's situation is known, which is identified using category selection in the proposed approach. This helps the user interaction to be more engaging and personalized. The proposed model provides more authentication regarding the user's emotions by using images to identify unsaid and hidden emotions.

II. Proposed Methodology

The primary goal of the proposed model is to handle human emotions using NLP techniques and ML algorithms. After a rigorous and thorough analysis of the previous approaches, we have come up with an approach to this problem. To enable a conversation with the user, a chatbot is created. The proposed model provides authentication regarding the emotions of the user through images and text. The text obtained through the chatbot is used to recognize the feelings of a person, whether he is angry, fearful, or happy. To ensure an accurate analysis, the images selected by the user are used to recognize the user's hidden emotions. At the same time, the cause of the user's emotion is also identified by asking the user to select from a set of categories. After recognizing the emotion and the reason behind it, the chatbot recommends the corresponding solution, as shown in Fig.1. It works as a therapist by displaying various solutions in the form of quotes, audio and videos pertaining to a particular class of emotion to assist the user. In case the system detects multiple emotions in the user, the chatbot displays solutions for all the emotions that are detected.

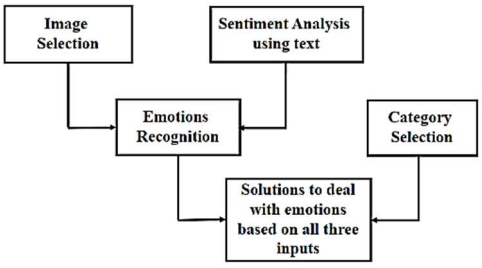

Fig. 1 Functional flow of the proposed model

The various modules of the proposed model are shown in detail in Fig.2. It is categorized into two parts, i.e., the front end and the back end. The front end comprises image selection, description box, category selection, and a system to display solutions based on the inputs. Classification is the most vital module of any recognition system [15]. In the proposed model, image and text classification are performed to recognize the user's emotion. The back-end deals with the

classification of emotions based on image selection and text input, as well as recommends the user with various ways to control emotions.

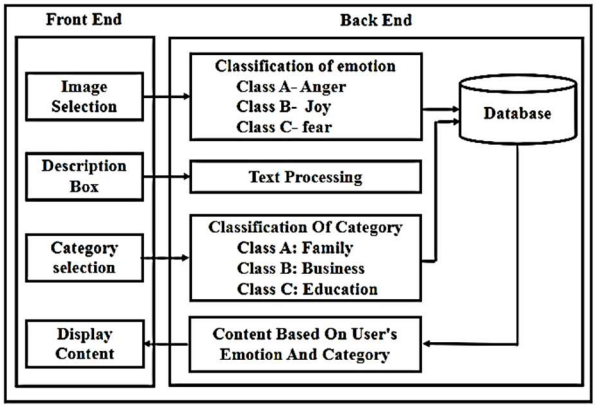

Fig. 2 System Architecture

According to the user's emotions, the front-end receives various forms of inputs. In order to classify the user's emotions accurately, the model integrates three different techniques: image selection, sentiment analysis, and category selection. The main steps involved in the flow of the application are illustrated in Fig.3.

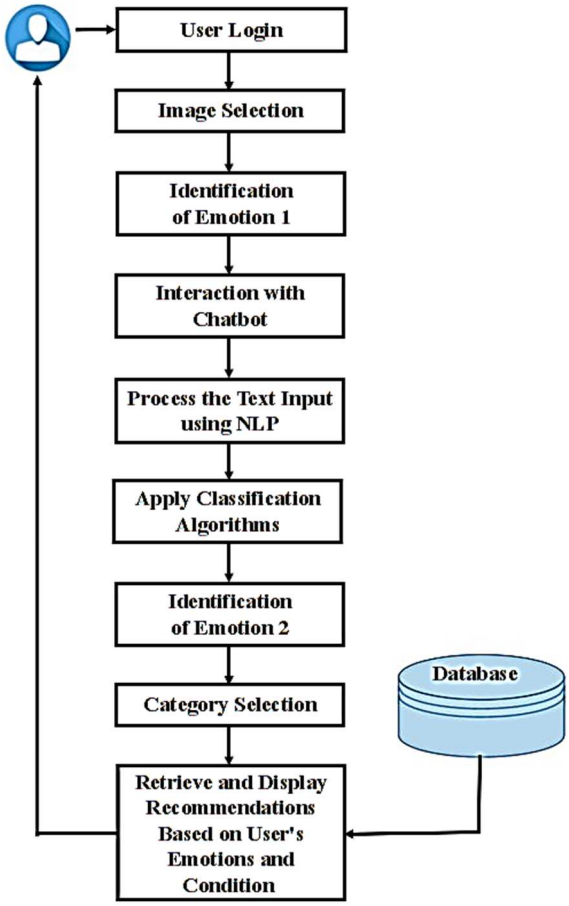

Fig.3. The steps involved in emotion recognition and solution recommendation system

Image selection is an unconventional technique that uses visual stimuli. The purpose of using image selection is to quickly identify unrecognizable feelings, and it also helps get an insight into the user's hidden emotion. The model uses nine different static images which represent three different classes of emotions: joy, fear, and anger. Once the user selects an image, the corresponding emotion is identified.

The description box takes input from the end-user in the form of text. The text received is preprocessed using functions such as tokenization, stemming, lemmatization, stop word removal and Term Frequency - Inverse Document Frequency (TD-IDF). The NLP functions convert the text into computer language and TF-IDF, which assigns a value to a term according to its importance and makes it easy to find the most significant parts of the text. Once the input text is narrowed down to the essential keywords, it is demonstrated among five different classifiers to determine the algorithm that provides the best accuracy.

The K-Nearest Neighbors (KNN) algorithm classifies data by identifying K nearest matches in the data and then predicting by using the label of closest matches. The value of k (n_neighbors) is set to 13. The Euclidian distance metric is utilized as it gives the shortest distance between observations. Neural networks are systems made up of linked nodes that function similarly to neurons in the human brain. Multi-layer Perceptron (MLP) is used for classification, which relies on an underlying Neural Network to perform the task. The number of hidden layers used is one, and the number of neurons is calibrated to the default value of 100. The ReLU function is used as an activation function combined with the Adam solver. The learning rate for Adam solver is 0.001, and the value of alpha (regularization term) is 0.0001. The values of beta_1 and beta_2 (exponential decay rates of moment vector) are 0.9 and 0.999, respectively, for the Adam solver.

The Random Forest algorithm uses several decision trees to classify different subsets of a dataset. The average is used to increase the dataset's predictive accuracy. In this project, the number of trees used is 100. The splitting criterion used is "Gini", which stands for Gini impurity. The Naïve Bayes algorithm is based on posterior probability. Bernoulli classifier is used in the model, which is suitable for discrete data and is helpful to find whether a particular word has occurred in a given text. Support vector machines (SVM) are supervised learning models with associated learning algorithms that analyze data for classification and regression analysis. Linear Support Vector Classifier (SVC) is used to fit the data provided so that a "best fit" hyperplane is returned, categorizing the data. When the model is trained using several algorithms, it is discovered that Random Forest has an accuracy of 97.55%, while Naïve Bayes, Neural Network, SVM, and KNN algorithms exhibited 93.65%, 94.95%, 95.96%, and 82.42% accuracies, respectively.

In addition to image selection and emotion detection through user's text, a list of options is displayed for category selection. The entities considered for categories are Family,

Business and Education. Upon selecting the category, all the three inputs are combined, i.e., emotion detected through image, text and category which is the root cause for the user's emotional state. This combinational input is mapped with the corresponding solution and is displayed.

The chatbot works as a therapist by displaying the appropriate content to uplift the user's mood. A few examples of combinational inputs as well as recommendations are shown in TABLE I. For instance, if the user inputs are classified as Joy for image selection, Joy for text description and Business for category selection, the chatbot displays solutions such as quotations and videos to maintain and boost the user's mood. In case the system detects multiple emotions in the user, i.e., if image selection and text analysis classify the user's emotion into different classes, then the chatbot prescribes content related to all the detected emotions. For example, suppose the user inputs are classified as Anger for image selection, Fear for text description and Education for category selection, then the chatbot suggests content to assist the user to calm down and overcome fear related to education.

TABLE I. SAMPLE USE CASES OF THE CHATBOT SYSTEM

Use Cases	**User Inputs**			**Solutions recommended by chatbot**
	Image Selection	***Text input***	***Category selection***	
Case 1	 **(Joy)**	REI did offer me the job today as well. Can't believe how exponentially joyous I feel...!!! **(Joy)**	Business	Quote: Success is not the key to happiness. Happiness is the key to success, If you love what you are doing, you will be successful. Link: https://youtu.be/8aRor905cCw
Case 2	 **(Anger)**	I went on an amazing trip to Paris with my family. I enjoyed a lot, and I am very happy, but my sister couldn't make it. **(Joy)**	Family	Quote 1: Family where life begins and love never ends. Quote 2: In a family, you may get angry…. you may shout at others and you may even say things that can hurt...but what makes people come together as family is understanding and trust, concern for each other's happiness and making things right.... Link: https://youtu.be/OnKl3g3NGDk
Case 3	 **(Fear)**	I am terrified that my current project might declined due to my teammate's fault. **(Fear)**	Business	Quote: Do not fear mistakes. You will know failure. Continue to reach out. Link 1: https://youtu.be/XbxNtPiCBK8 Link 2: https://youtu.be/eBSeCp__xhI
Case 4	 **(Anger)**	I am afraid for my semester exams that start next week. I have not prepared anything and there is a lot to study. **(Fear)**	Education	Quote 1: Don't let your fear of failure stop you from realizing your dreams. Quote 2: Frustration, although quite painful at times, is a very positive and essential part of success.
Case 5	 **(Anger)**	It is frustrating that my brother is always yelling at me and taking me for granted. **(Anger)**	Family	Quote: Family is the best thing you could ever wish for. They are there for you during the ups and downs and love you no matter what. Link: https://youtu.be/CAz9aYvR98k
Case 6	 **(Joy)**	I am frightened to give my science presentation tomorrow in front of everyone, but I am also thankful for the opportunity. **(Fear)**	Education	Link 1: https://youtu.be/biICdssHQb8 Link 2: https://youtu.be/d9gwmyPMByM

III. Analysis And Results

Various algorithms have been used to train the model and classify the text description given by the user. Each algorithm is fine-tuned by changing the parameters of different levels. The dataset Emotions is downloaded from Kaggle [16], which contains 2828 observations for training the model and 694 observations for testing the model.

The 'n neighbors' parameter is a tuning parameter(K) used in KNN algorithm. As selecting the best K value is essential, the model is trained and tested for K values ranging from 5 to 17. It is observed from Fig. 4 that the least accuracy obtained is 74.06% at K=5, and the highest accuracy 82.42% is obtained at K=13, whereas the precision, F1 score and recall are 82.42%, 0.8124, 0.8184 and 0.8420, respectively.

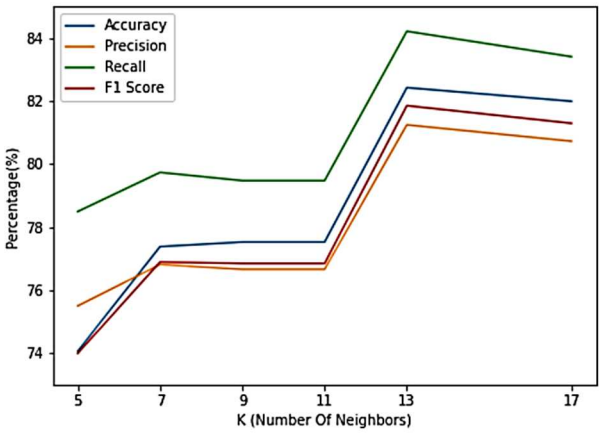

Fig.4. Graph for accuracy, precision, recall and F1 score for different k-neighbor values

In the neural network algorithm, two types of solvers have been taken into consideration, i.e. Adam solver and Stochastic gradient descent (SGD) solver. Both of these solvers are combined with various activation functions such as ReLU, identity, logistic and tanh. It is found that Adam solver outperforms when compared to SGD solver, as shown in Fig.5. The highest accuracy for the Adam solver was obtained with the ReLU activation function, which is calculated to be about 94.66%, as shown in Fig.6. The computed precision, F1 score, and recall for this combination are 0.9426, 0.9309, and 0.9362, respectively.

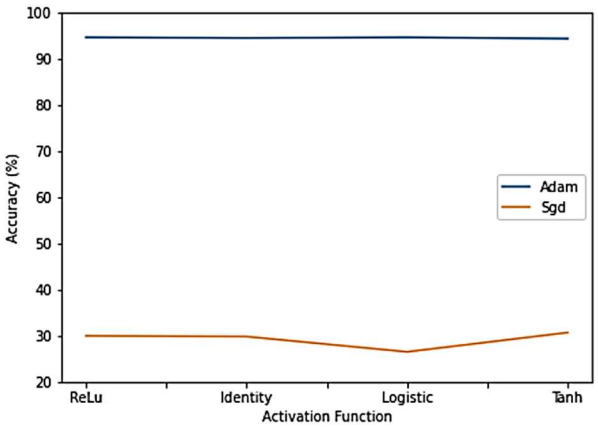

Fig.5. Accuracy graph for Adam Solver vs SGD Solver

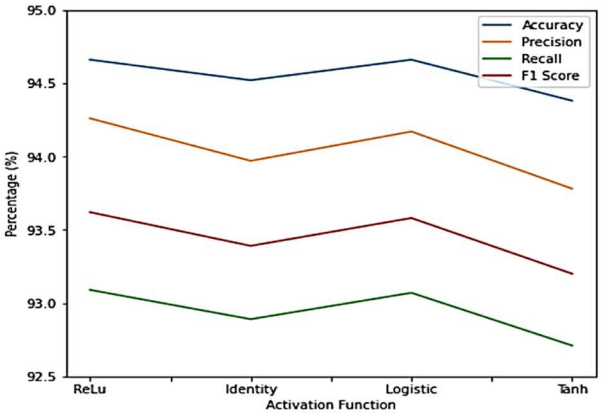

Fig.6. Adam solver accuracy, precision, recall and F1 score for different activation functions

The 'n estimators' parameter specifies the number of trees that will be considered before taking the prediction averages. To get the best accuracy in Random Forest algorithm, the model is trained with several number of trees ranging from 10 to 150. Another significant parameter is the splitting criterion, which is a function that determines the quality of a split. The two splitting criteria considered for experimenting are Gini and entropy. As shown in Fig.7, the Gini criterion is chosen as it gives the highest accuracy of 97.40% when compared to entropy, which gives an accuracy of 96.97%. The highest accuracy is attained for 100 trees, as shown in Fig.8, and the simulated results for precision, F1 score, and recall are 0.9691, 0.9672, and 0.9672, respectively.

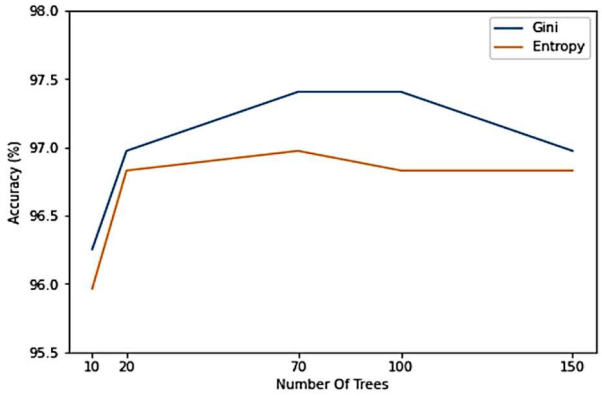

Fig.7. Accuracy graph for Gini vs Entropy splitting criterion

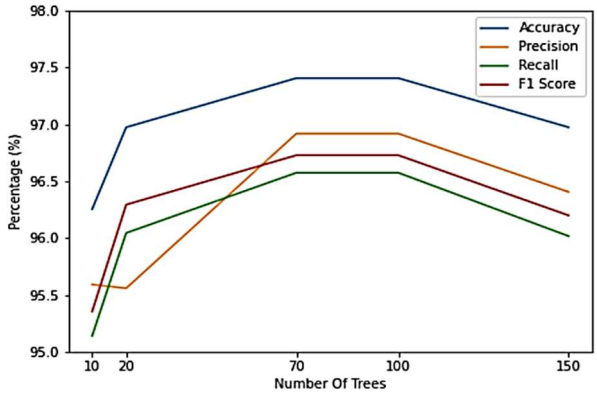

Fig.8 Gini graph of accuracy, precision, recall and F1 score for different number of trees

Accuracy and F1 score are considered to evaluate the results. The accuracy is the primary performance measure, and the F1 score is the secondary measure. The performance metrics of various algorithms used in this study for sentiment analysis using text are compared in TABLE II. It can be noticed that among all the algorithms, Random Forest has outperformed with the highest accuracy of 97.55% and F1 score of 0.9692, whereas KNN has achieved the lowest accuracy of 82.42% and F1 score of 0.8184. As an outcome, the Random Forest algorithm has been selected.

TABLE II. PERFORMANCE METRICS OF DIFFERENT ALGORITHMS

Algorithm	Precision	Recall	F1-Score	Accuracy (%)
Naïve Bayes	0.929	0.924	0.925	93.65
Neural Networks	0.947	0.934	0.940	94.95
Support Vector Machine	0.956	0.947	0.951	95.96
Random Forest	0.970	0.968	0.969	97.55
K-Nearest Neighbors	0.812	0.842	0.818	82.42

Different existing models and the features that they have considered are shown in TABLE III. The existing models are mostly based on either sentiment analysis using user's text input or category selection. Whereas the proposed model includes the combined features of image selection, text input and category selection which makes it unique and robust compared to other existing chatbots.

TABLE III. COMPARISON BETWEEN EXISTING APPROACHES AND THE PROPOSED APPROACH

Existing System	Features Considered
Pranav Kapoor, Pratham Agrawal, Zeeshan Ahmad [8]	Text input and Category selection
Abubakr Siddig, Andrew Hines [10]	Text input
Intissar Salhi, Mohammed Qbadou, Kamal el Guemmat, Khalifa Mansouri [11]	Text input
Proposed Approach	Image selection, Text input and Category selection

IV. CONCLUSION

A chatbot is developed to provide a platform for individuals to interact and solve their mental health concerns. AI has successfully been applied to detect the emotions of the user through images and text. It analyses the information provided by the user and recommends a solution according to the individual's mental state. The Emotions dataset has been trained and tested using various machine learning algorithms and parameters that analyzes the user's text description of emotion. Random Forest excelled when compared to other algorithms, giving the best accuracy and F1 score of 97.55% and 0.9692, respectively, while KNN has the least accuracy and F1 score of 82.42% and 0.8184. As a result, the Random Forest algorithm is chosen.

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