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Comparative Study On Sentiment Analysis Detection Through The Machine Learning Techniques

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ABSTRACT
The capacity of the human brain is expanding at a rapid rate along with human civilization, which ultimately results in psychological health problems affecting everyone from elementary school children to working professionals. Compared to physical health, mental health is the subject that today's age is least concerned about. Sentiment analysis is one of several approaches that have been created recently to evaluate and track a person's mental health. The scientific community is investigating the potential applications of sentiment analysis (SA) in several fields like customer reviews, movie ratings, and political fields like exit poll prediction from tweets, etc. Natural language processing (NLP) methods are used to excerpt particular information from the text and assess if the attitude communicated is good, negative, or neutral. It entails the automated extraction of subjective information from textual material using algorithms, followed by the classification of that information into categories like positive, negative, or neutral information.
However, the early-stage sentiment analysis to achieve optimized accuracy, several pieces of research are being conducted in the extent of AI and machine learning. With a focus on the dimension of AI and its subfields, such as ML, for early stage recognition of issues related to mental health with enhanced accuracy, this study presented an effective review of the previous researches and concluded the summary of the implementation of AI for the sentiment analysis. Therefore, using AI-based technology to expedite the developing phase for overall sustainable growth, this would not only improve the problem of human mental health but also provide an excellent strategy for a country to flourish.

Keywords: *Mental health, Machine learning (ML), Sentiment analysis, AI, Natural language processing (NLP).*

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I. INTRODUCTION

Sentiment refers to the emotional tone, attitude, or feeling expressed by an individual towards a particular topic, product, or service. Sentiment can be positive, negative, or neutral, and it can be expressed through language, facial expressions, body language, or other non-verbal cues. In the context of sentiment analysis, sentiment is typically measured and analyzed through text data, such as social media posts, online reviews, and customer feedback. Sentiment analysis algorithms use natural language processing and machine learning techniques to determine the emotional tone and sentiment expressed in the text data. For example, a positive sentiment may be expressed through words like "amazing," "fantastic," or "great," while a negative sentiment may be expressed through words like "terrible," "disappointing," or "awful." Neutral sentiment may be expressed through words that are neither positive nor negative, such as "okay," "alright," or "fine." Overall, understanding sentiment is important because it can provide insights into the attitudes and emotions of individuals towards a particular topic, product, or service. This information can be used to improve decision-making, develop marketing strategies, and enhance customer satisfaction.

Sentiment analysis, also known as opinion mining, is the process of using natural language processing, text analysis, and computational linguistics techniques to extract subjective information from text data. It involves analyzing and categorizing text data to determine the sentiment or emotion expressed by the writer.

The importance of sentiment analysis lies in its ability to provide insights into the opinions, attitudes, and feelings of customers, stakeholders, and the general public towards a particular product, brand, or topic. By analyzing social media posts, online reviews, and customer feedback, businesses can gain valuable insights into

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the sentiment of their customers, which can help them improve their products and services, develop effective marketing strategies, and enhance customer satisfaction.

Artificial intelligence (AI) and machine learning (ML) play a crucial role in sentiment analysis. AI and ML algorithms are used to analyze large amounts of text data and identify patterns and relationships between words and phrases that indicate positive, negative, or neutral sentiment. These algorithms can also learn from new data and adjust their analysis based on the patterns they find. AI instructs computers on how to act intelligently. ML trains the system to carry out intelligent actions that can gain knowledge through experience. NLP trains the system to carry out intelligent actions that are able to pick up on past experience and comprehend human language. NLP is a component of AI and works in tandem with machine learning as shown in fig [1]. It deals with the preparation of data input by a human in a language that is spoken outside of the computer's immediate operating system. Sentiment analysis is the act of examining written material to find and categories hidden thoughts and to ascertain if the author has a good, negative, or neutral attitude towards the subject. [1]

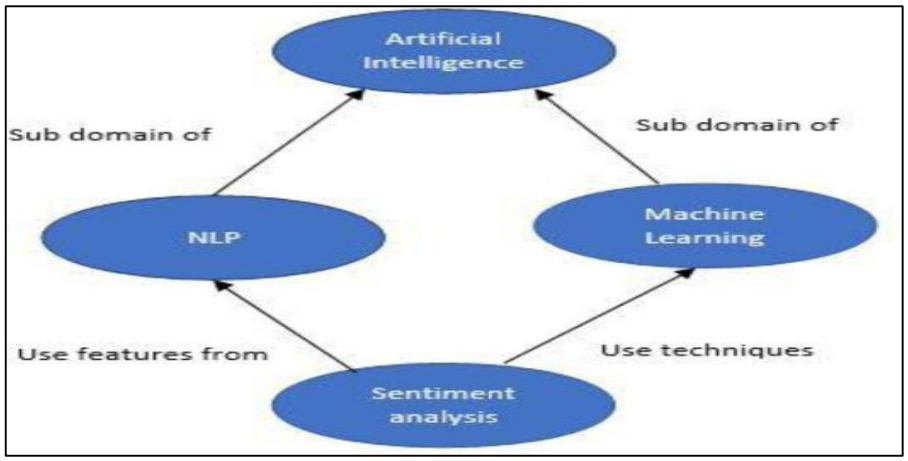

Figure 1 AI and Sentiment Analysis

Emotion analysis is a sub-field of NLP that includes the use of machine learning algorithms to classify the sentiment of a given text. A standardised platform is created to help psychiatrists diagnose patients using NLP methods and sentiment analysis [2]. These algorithms are trained on a large corpus of text data that has been labeled with sentiment information, such as movie reviews or social media posts. The algorithm may be used to categories the sentiment of fresh, unread material after it has been taught. This research included all artificial intelligence mathematical models that are contributing to improvements in human mental health by performing sentiment analysis. In the many branches of AI, including ML, DL, and NLP, there are several algorithms that may be found [3]. In this study, we'll review pertinent studies in the field of sentiment analysis, followed by discussions of artificial intelligence methods for spotting mental health issues, the study's findings and conclusions, as well as potential extensions and references.

II. RELATED WORK

There are various ML models have been created by researchers for the early identification of mental stress and sentiment analysis. Surveys, voice recognition, emotion detection, social media data, and wearable sensors have all been used in various ways to predict stress. For instance, a novel approach, semantic orientation with WordNet, was presented by Gautam and Yadav [4] after working on three fundamental techniques, NB, ME, and SVM. To train and classify data using NB and SVM, researchers employed Python and the Natural Language Toolkit (NLTK). A dataset of 19340 bytes was utilised, of which 1000 bytes were used for testing and 18340 bytes were used for training. Moreover, using a lexical-based and machine learning approach, Alvaro Ortigosa et al. [5] suggested a sentiment analysis technique for Facebook messages and investigated its use for e-learning. The results obtained through this approach show that it is feasible to perform sentiment analysis in Facebook with high accuracy (83.27%). In the context of e-learning, it is very useful to have information about the users' sentiments available Performance of ME and KMC was examined by Hamzah and Widyastuti [6]. The results indicated that, on average, KMC performed with 3% more accuracy than ME. As we discussed earlier that the public opinions are also one way to analyse the sentiments of a human being so in this continuation, In the analysis of 2000 text opinions, KMC was 25 ms quicker than ME. Orestes Appel et al. [7] suggested sentiment analysis at the sentence level, which used a hybrid approach that combines lexicon, fuzzy sets, and NLP approaches to estimate the semantic polarity. Three distinct data sets are subjected to the suggested hybrid approach, and the outcomes are compared to those attained using the Naive Bayes and Maximum Entropy procedures. When the

latter are used separately, it is shown that the proposed hybrid strategy is more accurate and exact than both Naive Bayes and Maximum Entropy procedures.

Kurniawat and Pardede [8] evaluated acceptable qualities from input texts using particle swarm optimisation (PSO), information gain methods, and SVM classifier. It is suggested that the classifier be a support vector machine (SVM) and that the most acceptable qualities from texts be selected using particle swarm optimisation (PSO) and information gain. In preparation for the governor's election in West Java, they create a sentiment analysis system. 94.80% accuracy and an area-under-curve (AUC) value of 0.98 are achieved by our suggested system, according to the experimental data. As a comparison between utilising PSO and Information Gain and not using it, the findings likewise demonstrate significant benefits. Several research studies have been discovered in the literature in recent years. The study of Jiangtao Qiu et al. [9] is one of them that predicts the ratings of nonrated Yelp reviews based on their feelings. The evaluations rely on the sentiment of the aspects and the quantity of favourable and unfavourable aspects of the review. The feelings are analysed at the aspect level. Multi-domain adversarial neural networks were created for text categorization by Ding et al. [10]. Private and shared features were separated from one another using orthogonal constraints and multi-domain adversarial training procedures. This increased the performance of the source and destination domains.

III. ROLE OF ARTIFICIAL INTELLIGENCE IN SENTIMENT ANALYSIS

Artificial intelligence (AI) plays a significant role in sentiment analysis, as it allows for the processing and analysis of large amounts of text data in a quick and efficient manner. Artificial intelligence (AI)-based sentiment analysis algorithms extract subjective information from text data and evaluate the sentiment conveyed by the author using natural language processing (NLP), machine learning (ML), and deep learning (DL) approaches. NLP techniques are used to analyze the syntax and semantics of the text data, such as identifying parts of speech, parsing sentence structure, and understanding the meaning of words and phrases in context. ML and DL techniques are used to train sentiment analysis models to distinguish configurations and learn from data, allowing for the accurate identification of sentiment in new and previously unseen text data. AI-based sentiment analysis algorithms can also be customized and trained for specific industries, languages, and sentiment categories, allowing for more accurate and relevant analysis. For example, sentiment analysis models can be trained to recognize the sentiment expressed in product reviews or social media posts related to a specific brand or industry, such as the hospitality or healthcare industry. There are several algorithms available under the different categories of AI and its subfields such as ML, DL, NLP. The following is a discussion of machine learning algorithms, broken down into the categories of reinforcement learning, unsupervised learning, semi-supervised learning, and supervised learning [3].

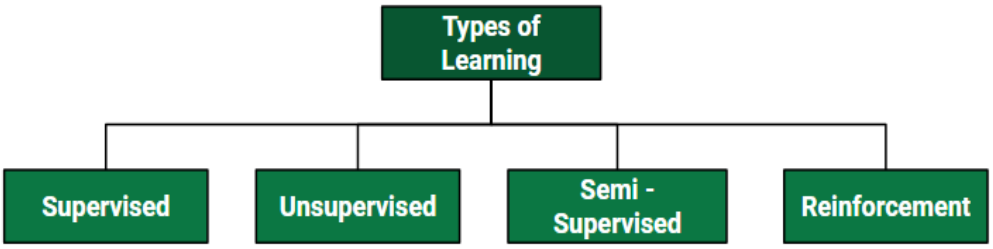

Figure 2 Kinds of Machine Learning

A. SUPERVISED MACHINE LEARNING

The kind of Machine learning in which, an algorithm learns from labelled data when it is subjected to supervised machine learning. Data that has been labelled is information that has already undergone human categorization or classification, with each data point having a corresponding label or result. With the help of supervised learning, an algorithm can anticipate the output labels for brand-new, unforeseen input data by learning a mapping between the input characteristics and the appropriate output labels. Numerous applications, such as fraud detection, speech recognition, image classification, and natural language processing, benefit from the usage of supervised learning methods. Unsupervised learning techniques include decision trees, random forests, support vector machines, neural networks, and k-nearest neighbours. A training set and a validation or test-set are created from the labelled data in order to train a supervised learning algorithm. The algorithm is tested or assessed on the validation or test set after being trained on the training set. The objective is to create a model that does not over fit to the training data but instead generalises effectively to new, unexplored data.

B. UNSUPERVISED MACHINE LEARNING

This type refers to a sort of machine learning in which the algorithm picks up on patterns and connections in data without being explicitly taught on labelled data. Unsupervised learning algorithms receive input data without any associated output labels or results, in contrast to supervised learning. Without any previous understanding of what these patterns may be, the algorithm then learns to uncover significant patterns and correlations within the data. Numerous tasks, including clustering, anomaly detection, dimensionality reduction, and others, may be accomplished using unsupervised learning methods. Principal component analysis (PCA), generative adversarial networks (GANs), and k-means clustering are a few well-liked unsupervised learning approaches. To train an unsupervised learning system, data sets called a learning set and a validation or test set are often produced. The algorithm is then trained on the training set to find correlations and patterns in the data, and its performance is assessed on the validation or test set. In order to do tasks like visualisation, anomaly detection, or feature extraction, it is necessary to establish a model that can locate significant patterns and correlations in the data.

C. SEMI SUPERVISED MACHINE LEARNING

Semi-supervised machine learning is a technique for machine learning that falls somewhere in the between of supervised and unsupervised learning. The method for semi-supervised learning is trained on a mixture of tagged and unlabeled data. This may be helpful if getting labelled data is difficult or costly but there is still some labelled data available that can aid in the learning process. Using labelled data to direct the learning process and then generalising the acquired patterns to unlabeled data is the fundamental concept behind semi-supervised learning. This enables the algorithm to learn from the supplied data more effectively and perhaps enhance its performance in comparison to utilising solely supervised or unsupervised learning. Co-training, self-training, and multi-view learning are a few of the well-liked semi-supervised learning methods. In co-training, the algorithm learns from multiple views of the data, where each view provides different features or perspectives on the data. In self-training, the algorithm initially learns from the labelled data and then uses the predicted labels to train on the unlabelled data. In multi-view learning, the algorithm gains knowledge from a variety of data sources, each of which offers further knowledge about the data. Numerous practical applications, including voice recognition, picture classification, and natural language processing, may benefit from semi-supervised learning.

D. REINFORCEMENT MACHINE LEARNING

Reward signal maximisation is the goal of the machine learning technique known as reinforcement learning, which instructs an agent how to make a sequence of decisions in a certain environment. A reward signal and a new state are produced as a result of the agent's activities when it interacts with the environment. In order to optimise long-term gain, the agent seeks to learn a policy—a mapping from states to actions. Reinforcement learning is inspired by the way animals learn through trial and error, and it has been used to solve a wide range of complex tasks, such as playing games, controlling robots, and managing resources in complex systems. The key components of a reinforcement learning system are the agent, the environment, and the reward signal. The agent selects actions based on its current policy, which is updated over time based on the feedback it receives from the environment in the form of rewards. The environment defines the rules of the task and determines the next state based on the agent's action. The reward signal provides feedback to the agent on the quality of its actions. The actor-critic approach, policy gradients, and Q-learning are a few of the well-liked reinforcement learning algorithms. These algorithms use a variety of techniques to discover the best course of action, including value-based methods that quantify the worth of each condition or action and policy-based methods that directly improve the policy. Numerous real-world uses exist for reinforcement learning, including resource management in data centres, autonomous driving, and recommendation systems.

Moreover, the machine learning technique the advance technology of deep learning along with the neural network and NLP also participating in the effective prediction and analysis of sentiment at early stage to improvise the mental health of human being. The brief description of these technologies are as follows

E. DEEP LEARNING AND NEURAL NETWORK

Artificial neural networks, a branch of machine learning that is based on deep learning, are modelled after the structure and operation of the human brain. In order to build hierarchical representations of the input data, deep learning algorithms use numerous layers of linked neurons. Deep learning algorithms can now recognise intricate patterns and connections in data that could be difficult or impossible to detect using previous machine learning methods. Layers of linked nodes, or "neuron," make up artificial neural networks. Each neuron takes in information from other neurons and calculates a weighted sum of that information, which is then applied to an activation function to create an output. The results of one layer of neurons provide inputs to the subsequent layer, establishing a hierarchical chain of computations that increasingly converts the incoming data into a more abstract representation.

Deep learning has transformed several industries, including computer vision, natural language processing, and voice recognition, and it has attained cutting-edge performance on a wide range of difficult problems. Popular deep learning designs include generative adversarial networks (GANs) for producing fresh data, recurrent neural networks (RNNs) for sequential data, and convolutional neural networks (CNNs) for processing images. In most cases, stochastic gradient descent is used to train deep learning models, which requires gradually adjusting the weights of the neural network to minimise the discrepancy between the predicted and actual outcomes, or loss function. Deep learning models may achieve impressive accuracy and generalisation performance on a variety of tasks, but the process of training them can demand significant quantities of labelled data and processing resources.

F. NATURAL LANGUAGE PROCESSING (NLP)

Natural language processing (NLP), a field in computer science and AI, attempts to enable computers to interpret, analyse, and generate human language. In natural language processing (NLP), algorithms and machine learning techniques are used to analyse and analyse text, audio, and visual input. Applications for NLP include sentiment analysis, chatbots, language translation, and voice recognition. Named entity recognition, sentiment analysis, language modelling, and part-of-speech tagging are a few common NLP approaches.

By identifying the part of speech that each word in a sentence, such as a noun, verb, adjective, or adverb, belongs to, part-of-speech tagging may identify the grammatical structure of a phrase. Named entity recognition is the process of identifying and categorising named entities, such as people, locations, and organisations, in a text. Sentiment analysis seeks to establish the emotional tone of a text, including whether it is positive, negative, or neutral. For purposes like voice recognition and machine translation, language modelling entails estimating the probability of a word sequence in a language. Machine learning methods like support vector machines, decision trees, and neural networks are often used to develop NLP approaches. These algorithms discover patterns and correlations in the data by training on large datasets of tagged text data; they may then be used to predict the behaviour of incoming text data. With the emergence of social media and other digital technologies, NLP has risen in importance as the volume of natural language data produced by people has increased quickly. NLP has the promise of revolutionising a wide range of industries and altering how humans interact with technology by allowing computers to comprehend and interpret human language.

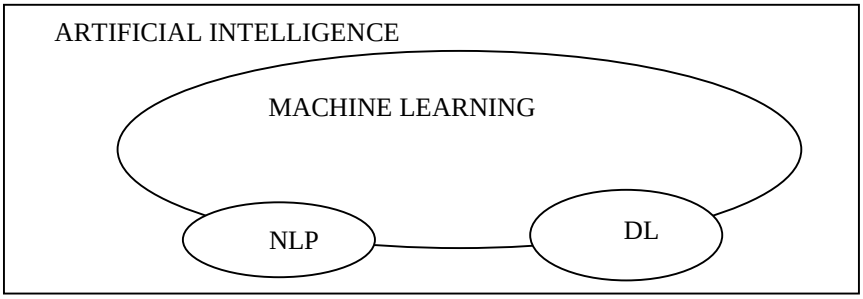

Figure 3 AI and its sub fields

In this study we have reviewed the previous literature and machine learning models for the sentiment analysis and make the comparison of these models based on their accuracy and efficiency, which are as follows. The detailed reviewed summery of the literature for the sentiment analysis using machine learning approach in formation of the tables (Table 1) is given below.

Summary Table of Reviewed Articles with ML Methods used to analyze Sentiment Analysis, Dataset, and Methodology& Accuracy Evaluation

Sr. No	Authors	Purpose of Study	Dataset	ML technology/Methodology	Result/Accuracy
1.	Rani, S., & Kumar, P. [11] (2017)	System for analysing tweets using rules-based sentiment	500 Tweets and 200 English Sentences	Rule-based Sentiment Analysis	500 tweet recordings with an accuracy of 86% and 200 English phrases with an accuracy of 94%.
2.	Kurniawati, I., & Pardede, H. F. [12] (2018)	Using a hybrid method that combines information acquisition with particle swarm optimisation, features are chosen for SVM-	Not mentioned	PSO with SVM classifier	The SVM's accuracy increased by 94.8%.

		based sentiment analysis.			
3.	Idrus, A., & Brawijaya, H. [13] (2018)	Using the naive bayes classifier technique and particle swarm optimisation, sentiment analysis of state official news in online media is conducted based on public opinion.	200 comments online news portal readers	Naïve Bayes classifier	With PSO, accuracy rose to 76% of NB.
4.	Kristiyanti, D. A et. al. [14] (2018)	Using SVM and the Nave Bayes algorithm to analyse public sentiment on Twitter, we analyse the sentiment of the 2018–2023 West Java Governor Candidate.	800 tweets.	SVM and Naïve Bayes	Before using SVM and NB, the 2-gram technique is applied. NB excelled with the best accuracy of 94% while SVM achieved the highest accuracy of 75.5%.
5.	Doan Son, et. al. [15] (2018)	Using natural language processing (NLP), extracting causes linked to mental health from tweets	24 Million Tweets	Natural language processing (NLP)	Insomnia 73.81 %, 88.10 % Stress 96.94%, 82.65% Migraine 56.10% ,85.37% Micro-average 74.59% ,92.27%
6.	Du, Y. et.al. [16] (2019)	a new hybrid neural network based on capsules for sentiment classification	short text review datasets	Capsule-based hybrid neural network	82.55% accuracy is attained in movie reviews.
7.	Rahat, A. M. et.al. [17] (2019)	A comparison of the Naive Bayes and SVM sentiment analysis-based algorithms using the review dataset	10000 Tweets	SVM and Naive Bayes	SVM offers accuracy of about 83% while Naive Bayes offers accuracy of 77%.
8.	Hemalatha, S., & Ramathmika, R. [18] (2019)	Yelp Review Sentiment Analysis Using Machine Learning	16,000 reviews	Logistic Regression, Multinomial Naive Bayes, Bernoulli Naive Bayes, Linear SVC (Support Vector Clustering), and Naive Bayes	Naive Bayes, Multinomial, 79.12 78.92 Naive Bayes Logistic Regression Bernoulli Naive Bayes 73.22 75.32 Proposed 78.44 Linear SVC (Support Vector Clustering)
9.	Chawre et al. [19] (2020)	Proposed Design for a Stress Detection Methodology Using Social Media Networks.	Facebook posts	SVM, TSVM, Naïve Bayes, Random forest Decision Tree, D-Tree ,Adaboosted.	84% (extract post) 82% (classify post) 77.5% 73.8% 72.5% 67%
10.	Biswal, S. et.al. [20] (2022)	Aspect-level Sentiment Analysis Using Learning Classifiers Over Review Text Dataset	50000 files of benchmark review text datasets	SVM, ANN, CNN	SVM 86.30% ANN 88.90% CNN 91.10%

IV. FINDING AND DISCUSSION

Recent years have seen tremendous advancements in sentiment analysis research, due to the creation of cutting-edge machine learning algorithms like deep neural networks, tools for natural language processing, and massive datasets. The creation of more precise and effective algorithms is one of the research fields in sentiment analysis that offers the greatest promise. Traditional sentiment analysis methods relied on manual feature engineering and rule-based approaches, which were time-consuming and limited in their accuracy. However, recent advances in machine learning, particularly in deep learning, have enabled sentiment analysis algorithms to automatically learn features from the input data, significantly improving their performance. In earlier studies, a variety of machine learning methods were used for sentiment analysis. Some of the most popular machine learning sentiment analysis algorithms are listed below:

- **Naive Bayes**: For text classification applications, such as sentiment analysis, Naive Bayes is an effective probabilistic technique. It is computationally simple and straightforward to implement since it assumes that

every word in the text is independent of every other word. Numerous research on sentiment analysis have used naive Bayes, and in many of these situations, the results have been promising.

- **Support Vector Machines (SVM):** SVM is a powerful algorithm that has been used successfully in many machine learning tasks, including sentiment analysis. It works by finding a hyperplane that separates the positive and negative classes in the data. SVM can handle high-dimensional data and has shown good performance in several sentiment analysis studies.
- **Random Forest:** The Random Forest ensemble learning approach employs many decision trees to improve accuracy. Many sentiment analysis studies, particularly those that concentrate on social media analysis, have employed it. Random Forest can tolerate erratic data and often performs well.
- **Recurrent Neural Networks (RNN):** RNN is a type of deep learning algorithm that has been used successfully in many natural language processing tasks, including sentiment analysis. RNNs can capture the sequential nature of text data and have shown good performance in several sentiment analysis studies.
- **Convolutional Neural Networks (CNN):** CNN is another kind of DL algorithm that has been used for sentiment analysis. It works by convolving filters over the input data and can learn hierarchical features from the data. CNNs have shown good performance in several sentiment analysis studies, particularly in the domain of product reviews.

In summary, there is no single "best" machine learning algorithm for emotion analysis. The prime of algorithm be subject to on the explicit problem and the available data. Researchers often compare the performance of multiple algorithms to determine the most effective approach for a particular task. The results of a thorough evaluation of all previously published, relevant work were presented in table 1 for this research. The magnitude of the massive dataset that is fed into the system determines how accurate it is. In order to make conclusions, datasets are acquired over time. The prediction model analyses give onset alerts in the event that there are any irregularities. The health industry uses SVM as a common machine learning (ML) strategy. Naive Bayesian has shown to be very accurate in several cases while analyzing Facebook status updates. Hybrid classifiers perform better overall than conventional classifiers and outperform them when it comes to the f-measures used for sentiment analysis.

V. CONCLUSION AND FUTURE EXTENSION

In conclusion, popular machine learning (ML) techniques in the fields of sentiment analysis and mental health include SVM. In certain cases, Naive Bayesian is quite accurate when analyzing tweets and Facebook posts. In terms of inclusive performance and the f-measures used for sentimentality analysis, hybrid classifiers beat standard classifiers. As the demand for sentiment analysis continues to grow across various domains, further research in this area will be essential to ensure that these models are robust, reliable, and unbiased. Future researchers will have the opportunity to utilize the use of this study to more easily determine the best machine learning strategy for sentiment analysis based on the parameters chosen in this study. Sentiment analysis using AI has significant potential for future growth and innovation. With the development of more advanced AI techniques and the growing demand for sentiment analysis across different domains, there are exciting opportunities for researchers and businesses to develop more accurate, efficient, and personalized sentiment analysis models using the hybrid approach of deep Neural Network (NN) and natural language processing (NLP).

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