



MACHINE LEARNING TO PREDICTING DEPRESSION LEVEL IN SOCIAL MEDIA DATA LIKE TWEETS

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ABSTRACT

One of the most significant distinctions between today's youth and young adults and previous generations is that they spend far less time connecting with people in person and far more time connecting electronically, primarily through social media. The rise in depression, according to some experts, is proof that social media users are less emotionally content. Twitter has become the most popular social media tool for users to communicate information in real time through tiny messages known as tweets. Depression is a prevalent long-term illness. Due to limited detection procedures, it frequently goes unnoticed, resulting in major consequences for public and personal health. Depression is a big worry that is becoming more prevalent by the day. Depression can have a variety of reasons, but the most common is mental disease. Many people suffer from depression, yet only a small percentage of them seek treatment. The goal of this research is to apply machine learning approaches to detect a possible depressed Twitter user's tweet. We used variables collected from a user's behaviours within tweets to train and test classifiers to distinguish whether a person is depressed or not. On a scale of 0-100 percent, classification machine algorithms are used to train and classify it in different stages of depression. Also, data was collected in the form of tweets, which were categorised into whether the person who tweeted was depressed or not using Machine Learning classification algorithms. Early detection of depression or other mental diseases using a predictive technique.

KEY WORDS: Twitter, Machine Learning (ML), Depression, Social Media, Tweets.

INTRODUCTION:

For many people dealing with mental illness, social media has become an important part of their lives. Individuals can interact with others inside a virtual network (such as Facebook, Twitter, Instagram, Snapchat, or LinkedIn) and share, co-create, or exchange various forms of digital content, such as information, messages, images, or videos, via social media.

Humans are social creatures that require the company of others in order to advance in life. As a result, while being socially linked with other people might reduce stress, worry, and melancholy, a lack of social connection can put one's mental health at risk. Depression is a prevalent mental condition that can lead to suicide. It is also a primary cause of disability worldwide. Every year, it is estimated that more than 300 million people worldwide suffer from depression. Depression is typically diagnosed using face-to-face clinical depression criteria. However, in the early stages of depression, 70% of individuals would not seek medical help, which could lead to their illness progressing.

People are increasingly turning to social media platforms to express their innermost feelings, wants, and opinions on societal issues. The postings on these sites are done in a naturalistic manner, which eliminates the manipulation that frequently occurs in self-reported depression questionnaires. We came to the conclusion that social media may be used to record a person's current state of mind, and that it can even be used to depict sentiments of worthlessness, guilt, helplessness, and self-hatred that are common in clinical depression. We test the idea that word vectorization from social media might be used to build statistical models to detect and even predict Major Depressive Disorder, complementing and extending established approaches to depression diagnosis.

Social media is ubiquitous, allowing people to express themselves, stay connected, and stay in touch with friends and acquaintances all over the world. Users' mental health and social media use can be linked in three different ways:

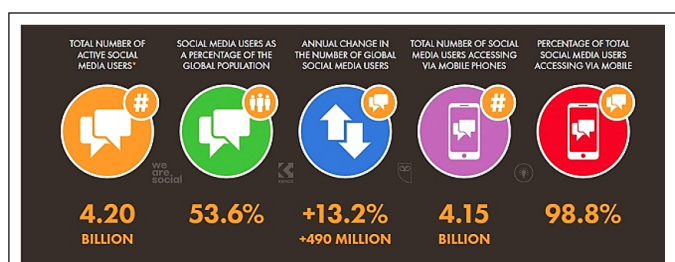
- *Social media anxiety disorder:* An active social media user with an addictive pattern, who is distressed by negative interactions and social comparisons on social networking sites affecting self-esteem and mental wellness.
- *Anxious Depression social media verbalization:* An active social media user who uses social media postings as an outlet to share feelings in a non-threatening atmosphere
- *Social Anxiety:* A passive social media user with no engagement and is comfortable with virtual connections rather than real interaction.

Though feelings are difficult to explain, online self-expression allows a mental state to be translated into a physical form. In active extroverts who express and share their internal restlessness, social media can aid in the pre-diagnosis of a clinical mental health problem such as anxiety, depression, or anxious depression. According to studies, people suffering from a variety of mental illnesses, such as depression, psychotic disorders, or other severe mental illnesses, use

social media platforms at similar rates as the general population, with use ranging from about 70% among middle-aged and older people to upwards of 97 percent among younger people. Other research has indicated that many of these people with mental illnesses use social media to discuss their personal experiences, seek information about their mental health and treatment options, and provide and receive support from others who are dealing with similar issues.

SOCIAL NETWORK ANALYSIS:

The process of finding and recognising the relationships and data flow between people, groups, organisations, computers, and other related information entities is known as social network analysis. The network nodes are the groups and people, while the links represent the connections between them. It analyses human relationships using visual and quantitative methods. Researchers use the idea of degrees to calculate the activity of a network for a node, which is the total number of connections a node has directly. One or a few nodes known as central nodes identify a centralised network. If the network fractures quickly into unconnected sub-networks, central nodes are harmed or deleted. It has the potential to become a single point of failure. When a well-connected hub is removed or disabled, a centralised system can fail. Nodes with a high degree of centrality are referred to as hubs.



Source: WeAreSocial/Hootsuite

Figure 1: Social media use around the world, Jan 2021

TWITTER:

Twitter is a prominent social networking website that allows users to send short messages (tweets) of up to 140 characters. Retweeting (reposting other users' tweets to one's own feed), reacting to tweets, and following other users' Twitter feeds allow users to communicate and network socially. Hashtags are used in tweets to identify a theme and allow other users to see messages with the same hashtag that are relevant to them. On Twitter, almost 6,000 tweets are sent every second, equating to over 350,000 tweets every minute, 500 million tweets per day, and around 200 billion tweets per year. Consumers (35%) were the most common users tweeting about depression, followed by individuals (unspecified) (27%), organisations (25%), health professionals (9%), and mental health advocates (9%). (3 percent).

The majority of tweets about depression were about consumer resources (34 percent; 2,011 tweets) or offered services or products for those who are depressed (20 percent; 1,201 tweets). The remaining tweets described personal experiences with depression (16 percent; 977 tweets), promoted depression awareness (15 percent; 917 tweets), linked to depression-related news media articles (6 percent; 354 tweets), reported research findings (5 percent; 311 tweets), or described an individual's opinion or view (2 percent; 136 tweets). # depression was accompanied by the hashtags # anxiety, # mental health, # bipolar, # stress, and # suicide the most.

TWITTER USAGE STATS AND FACTS:

Twitter is considered as one of the mainstream Social Media accounts, alongside Facebook and Instagram and it has a large user base from all over the world. Here is a list of Twitter usage stats:

- Worldwide, Twitter has over 336 million monthly active users and 100 million daily active users.
- 23% of the Internet population is said to be on Twitter.
- Top 5 countries on Twitter accounts for 50% of overall Tweets.
- 2 billion Queries are served by Twitter daily.
- 83% of the World's Leaders have Twitter accounts.
- There are 24.6% verified Journalists on Twitter.
- Twitter now can handle 18 quintillion user accounts.
- Current ad revenue of Twitter is \$545 million, 88% of which came from mobile advertising.
- Every second, on average, around 6,000 tweets are tweeted on Twitter, which corresponds to over 350,000 tweets sent per minute, 500 million tweets per day and around 200 billion tweets per year.

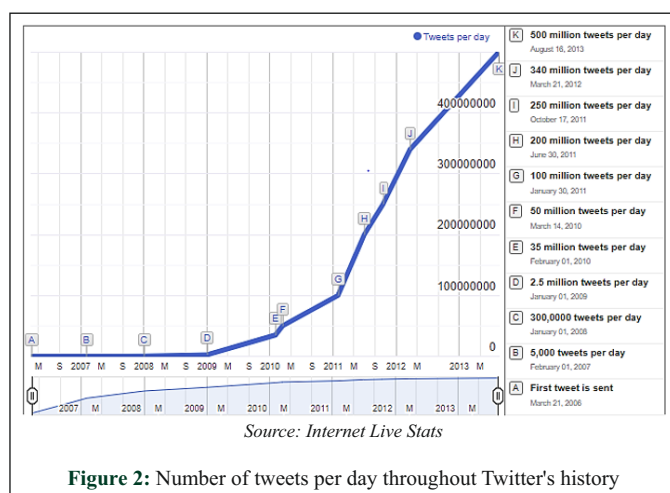


Figure 2: Number of tweets per day throughout Twitter's history

TWITTER INDIA STATISTICS:

India has been a participant in the Twitter game since its inception and is an avid contributor to Tweets. In India, over 34 million people used Twitter in 2019. In 2013, the country had only 11.5 million subscribers, a rise of 22.5 million in only six years. This demonstrates that India's total Twitter users are increasing at an exponential rate. As a result of this statistic, India is an important market to target for Twitter marketing initiatives.

Taylor Swift was named the most influential Twitter user in 2019, followed by Donald Trump. On Twitter, Indian Prime Minister Narendra Modi has 65 million followers. The third most influential Twitter user is Narendra Modi.

38.5% OF TWITTER USERS ARE AGE 25 TO 34:

38.5% of users are between the ages of 25 and 34 while a further 20.7% are age 35 to 49. This means the bulk of Twitter's user base is in the 25 to 49 age range.

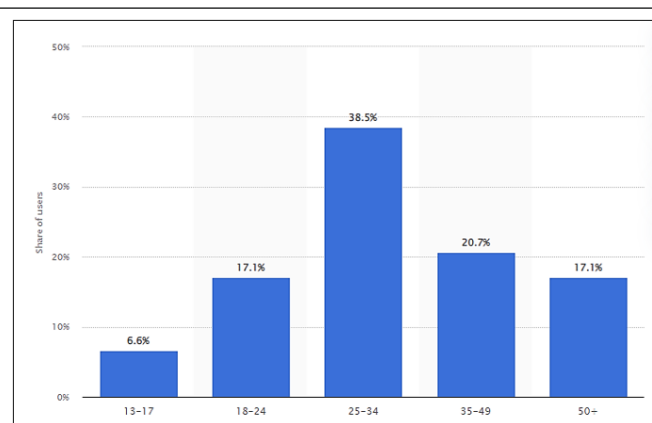


Figure 3: Distribution of Twitter users worldwide as of April 2021, by age group

DEPRESSION:

A medical disorder that affects your feelings, thoughts, and actions. Depression manifests itself in a variety of feelings such as sorrow and a loss of interest in previously appreciated activities, all of which can impair your capacity to function at work and at home. "It affects one in every 15 adults (6.7 percent) in any given year," according to the American Psychiatric Association. Depression has an impact on people. In their lifetime, one-sixth of persons (16.6 percent) will encounter." According to research, women are more prone than males to suffer from depression. In their lives, one out of every three women will have serious depression symptoms. When first-degree relatives (parents/children/siblings) suffer from depression, there is a significant possibility of inheriting. A depressive episode lasts at least two weeks and is marked by a depressed mood (feeling sad, irritated, or empty) or a loss of pleasure or interest in activities for the majority of the day, practically every day. Poor focus, feelings of excessive guilt or low self-worth, hopelessness about the future, thoughts of dying or suicide, disrupted sleep, changes in food or weight, and feeling especially weary or low in energy are all possible symptoms. According to the World Health Organization's (WHO) Mental Disorders Fact Sheet from January 2020, more than 264 million individuals of all ages worldwide suffer from depression. During the COVID-19 pandemic, there was also a high prevalence of mental health disorders, according to recent data. Even though there are effective therapies for depression, only a small number of people have gotten them. Inadequate therapy can result in impairment, psychotic episodes, self-harming impulses, and suicide.



Source: https://twitter.com/mohfw_india/status/1011454002318340096

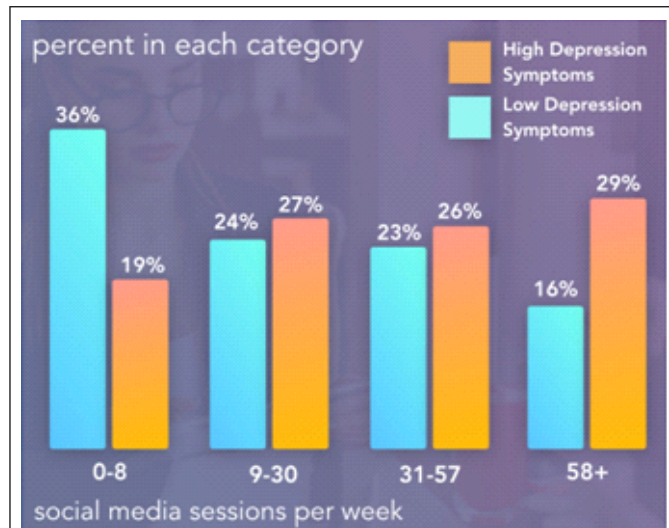
Figure 4: Snapshot of Ministry of Health on Twitter

DEPRESSION DETECTION:

Depression is one of the most common mental health issues that people confront around the world. According to studies, less than half of persons with this emotional condition received mental health treatment. People use social media to share their feelings and views with friends and family. "Depression affects an estimated one in 15 adults (6.7 percent) in any given year," according to the American Psychiatric Association. One in every six people (16.6%) will suffer from depression at some point in their lives. Depression can strike at any age, but it is most common in late adolescence and early adulthood. Women are more prone to suffer from depression than males. According to some research, one-third of women will have a significant depressive episode over their lifetime." According to a recent regime poll, 30 percent of India's 103 million adults over the age of 60 show signs of depression. It is estimated that 8.3 percent of the older population in the country suffers from serious depression. This means that one out of every 12 senior persons in the country suffers from depression. The prevalence statistic is ten times higher than the self-reported diagnosed depression rate of 0.8 percent in the older population, indicating the burden of undiagnosed cases, according to the survey. Depressive symptoms are seen in 26% of adults between the ages of 45 and 59.

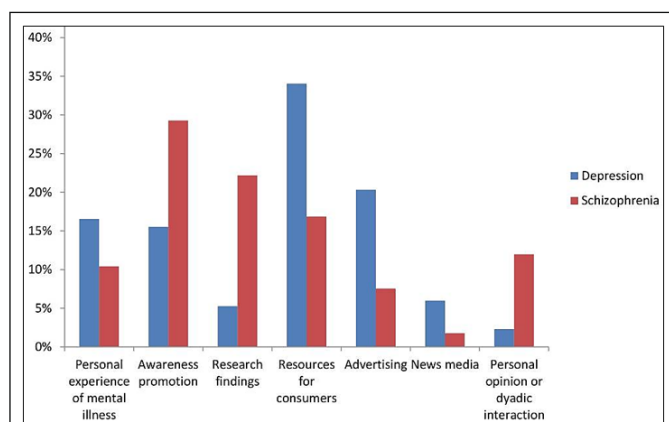
THE FACTS ON SOCIAL MEDIA AND DEPRESSION:

- Social media has never been more popular, with more than half of the world's population active on these networking sites that roll out nonstop news, much of it negative.
- A Lancet study published in 2018 found that people who check Facebook late at night were more likely to feel depressed and unhappy.
- Another 2018 study found that the less time people spend on social media, the less symptoms of depression and loneliness they felt.
- A 2015 study found that Facebook users who felt envy while on the networking site were more likely to develop symptoms of depression.



Source: <https://www.statista.com/chart/19262/impact-of-social-media-on-mental-health/>

Figure 5: Social media and depression



Source: https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.html?title=Click%20on%20image%20to%20zoom&p=PMC3&id=4217192_peerj-02-647-g001.jpg

Figure 6: Social Media and Depression

TWEETS ABOUT DEPRESSION AND ANXIETY:

All tweets sent by Twitter users who took part in this study during a 200-day period were analysed to see if there were any changes in communication regarding depression and anxiety between the two groups. All tweets containing the terms "depression", "depressed", "anxiety", and "anxious" were detected and extracted. Our goal was to record all of the conversations in our sample that used these exact phrases. These key words were chosen to boost our confidence that the Twitter users were talking about sadness or anxiety in their interactions.

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PRELIMINARY REVIEW:

Survey was conducted on various papers from different research areas which include:

- Data analysis.
- Social media analysis.
- Natural language processing.
- Sentiment analysis.
- Depression detection.

DATA COLLECTION AND DATA SET DESCRIPTION:

Tweets indicating depression were retrieved using the Twitter scraping tool TWINT using linguistic markers indicative of depression.

Command line: `twint -s "depression" since 2019-07-20 -o depression CSV`

- Depressed
- Depression
- Hopeless
- Lonely
- Suicide
- Antidepressant
- Antidepressants

These Tweets proved to contain lexical features strongly indicative of depression and were ideal for training an efficient and robust classifier.

STATISTICAL FRAMEWORK:**MACHINE LEARNING MODELS:**

We used supervised machine learning classifiers to distinguish between the observations of impacted and healthy sample members. Classifiers were trained on a random sample of 70% of all observations before being tested on the remaining 30%. A 1200-tree Random Forests classifier performed the best out of several possible methods. Random Forests hyperparameters were optimised using stratified five-fold cross-validation, and final accuracy ratings were averaged over five separate randomised runs. Details about optimization can be found in Section III of the Supplementary Information. General practitioners' unassisted diagnostic accuracy rates reported in Mitchell, Vaze, and Rao (MVR) and Taubman-Ben-Ari et al. (TBA) are used as informal benchmarks for depression and PTSD, respectively. Precision, recall, specificity, negative predictive value, and F1 accuracy scores are reported, and general practitioners' unassisted diagnostic accuracy rates reported in Mitchell, Vaze, and Rao (MVR) and Taubman-Ben-Ari et al. (TBA) are used as informal benchmarks for depression and PTSD, respectively. Precision, recall, specificity, negative predictive value, and F1 accuracy scores are reported, and general practitioners' unassisted diagnostic accuracy rates reported in Mitchell, Vaze, and Rao (MVR) and Taubman-Ben-Ari et al. (TBA) are used as informal benchmarks for depression and PTSD, respectively. Precision, recall, specificity, negative predictive value, and F1 accuracy scores are reported, and general practitioners' unassisted diagnostic accuracy rates reported in Mitchell, Vaze, and Rao (MVR) and Taubman-Ben-Ari et al. (TBA) are used as informal benchmarks for depression and PTSD, respectively.

MACHINE LEARNING TECHNIQUES:

Machine Learning is the process of teaching a machine to make accurate predictions while feeding data. It demonstrates how an algorithm learns to make increasingly accurate predictions. Supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning are the four primary methodologies used in machine learning.

PROBLEM STATEMENT:

User depression levels are sorted into different levels using machine learning algorithms such as Naive Bayes on user supplied content.

NAIVE BAYES CLASSIFIER:

The Naive Bayesian classifier is commonly used. All of the features are fed straight into the classifier, which determines whether or not the user is sad. Naive Bayes is a machine learning technique based on the Bayes theorem and the assumption of independent features. It is a family of theorems based on the same idea, rather than a single theorem. The key assumption of the naive Bayes algorithm is that each characteristic contributes equally and independently to the output. The Bayes theorem is the mathematical expression for the likelihood of an event occurring given the chance of another event already occurring.

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Where A and B are occurred and occurring events respectively.

LITERATURE REVIEW:

Over the last decade, the use of social media platforms has rapidly increased, with current surveys estimating that 90% of internet teens and young adults in the United States utilise social networking sites. Twitter is one of the most popular social networking services, with 19% of internet American adults using it. In

fact, Twitter is used by 35% of internet users aged 18 to 29, and it was dubbed the "most important social media network" by American teenagers in a 2013 market research report. Furthermore, according to the most recent data from a 2014 Pew Research Center survey, 23 percent of online adults now use Twitter, a 5 percent rise from 2013. Twitter is a microblogging service that allows users to post short updates of less than 140 characters. These "tweets" are then viewed by a network of "followers" who have chosen to follow the account of the user.

Twitter's popularity has soared, especially among teens and young adults, due to the simplicity with which it allows users to connect with a huge audience of acquaintances and strangers. Indeed, Twitter differs from other popular social media sites such as Facebook in that Twitter users prefer to keep their posts public, whereas Facebook profiles frequently use privacy settings. Adults aged 55 to 64 are now the fastest increasing demographic on Facebook, and as a result, many teenagers believe it has a significant adult presence. The majority of Twitter users, on the other hand, are young (66 percent are 25 years old and under). Twitter is more popular among girls than boys among teen Twitter users, according to demographic data (37 percent versus 30 percent). Furthermore, African American teenagers utilise Twitter more than their Caucasian peers (45 percent versus 31 percent). Because there is less involvement or supervision from older adults/parents on Twitter in general, young Twitter users can feel free to publicly chat with friends and acquaintances about nearly anything, even matters that are normally private, such as mental illness.

Depression is a stigmatised disorder, and many people regard their struggle with such symptoms as "private affairs" and/or refuse to seek therapy for fear of being labelled as a psychiatric patient. Furthermore, self-harm, which is defined as intentional self-poisoning or self-injury, regardless of the motive or extent of suicidal intent, is a serious public health issue among young people. Suicide risk is also increased by thoughts of self-harm, which are significantly linked to mental diseases, particularly Major Depressive Disorder (MDD).

Because Twitter only allows users to publish 140-character messages, the richness of content might be limited. This limited the amount of information users could share about their melancholy, and as a result, all of the causes of the Tweeter's despair were rarely included in the tweets we looked at. The study's findings are based on a random sample of 2,000 depression-related tweets received over the course of a 24-hour period. As a result, examining more tweets over a longer period of time may yield more comprehensive results. Popular phrases such as "sad," "unhappy," and "miserable" were not monitored because they are frequently used to describe transient emotions or moods and would have likely created a large number of insignificant tweets. However, a longer list of keywords to track could have resulted in more thorough results. We are unable to draw any conclusions regarding the kind of people who are willing to freely discuss personal information about depression online vs those who do not choose to socialise in this manner. For example, some people with depression are likely to suffer from social anxiety and use Twitter to socialise because they feel less anxious when communicating online than when they connect IRL. Finally, because Demographics Pro infers demographic features of Twitter users, it's likely that the inferred characteristics of the Tweeters do not represent the actual Twitter users in our sample of tweets, even though their methods are regarded to be accurate. Similarly, the "average Twitter user" comparison group is limited to the United States and Canada and does not quite match our sample of Tweeters; the majority of our Tweeters (78%) are from the United States and Canada, while 9% are from the United Kingdom, and 13% are from another nation.

With the rise in social media usage and the high level of self-disclosure on these platforms, efforts to detect depression using Twitter data have grown. According to Park et al., depressed Twitter users are more likely than healthy users to post tweets with negative emotional emotions. De Choudhury et al. have discovered that depressed signals can be detected in tweets written by those who have major depressive illness. Various variables have been utilised to diagnose depression from Twitter data thus far. De Choudhury et al. gathered more than 2 million tweets from 476 people who were clinically depressed and used Twitter. To create a classifier that provides estimates of the likelihood of depression, they examined behavioural factors related to social engagement, emotion, language and linguistic styles, ego network, and mentions of antidepressant medicines. They used these distinct characteristics to create an SVM classifier that can accurately predict the likelihood of depression by 70%. Tsubawa et al. discovered that word frequency and topic modelling are important elements for the prediction model. They got 69 percent classification accuracy using the radial kernel SVM classifier in predicting depression in 81 of the 209 participants who filled out a questionnaire. Furthermore, Reece et al. identified predictive variables for evaluating the effect, linguistic style, and context from users' tweets, developed models employing these features, and successfully distinguished between sad and healthy contents using supervised learning algorithms. The CESD scores were based on the identification of depressive users, and data was obtained from 105 of the 204 sad users. When compared to other study findings, the best classifier performance was found using a 1200-tree random forest classifier, which increased the precision to 0.866. For better depression diagnosis, Nadeem et al. used the bag-of-words approach, which uses word occurrence frequencies to quantify the content of a tweet measured on a document level. They tested four binary classifiers: the linear SVM classifier, the decision tree (DT), the Naive Bayes (NB) algorithm, and the logistic regression approach, and discovered that

the NB algorithm outperformed the others with an accuracy of 81 percent and precision of 0.86. They used a corpus of more than 2.5 million tweets collected online via CLPsych 2015 Shared Task organisers from users who reported they were sad (326) or had PTSD. Nadeem et al., Coppersmith et al., and Mowery et al., on the other hand, looked at sentiment analysis as a feature for detecting depression from Twitter data. According to Jamil et al., using sentiment analysis in conjunction with the percentage of depressed tweets improves the precision and recall 3 of diagnosing depression. The classifier was trained using SVM on 95 users who declared their own depression (which accounted for 5% of the study participants, while the remaining 95% were healthy users), yielding a recall of 0.875 and precision of 0.775. De Choudhury et al. and Jamil et al. took advantage of the advantages of depressed people's tweets to extract attributes that improved detection accuracy. De Choudhury et al. created a depression lexicon comprising phrases that are likely to emerge in online postings from people talking about depression or its symptoms. Jamil et al., on the other hand, employed the percentage of depressive tweets, as well as self-indications of depression, to determine whether a user should be excluded from the training set, and discovered that this feature improved the model's accuracy.

CONCLUSION:

Depression is a global health issue with an alarmingly high prevalence. The prevalence of social media addiction has also increased, with teenagers and young people being the most affected. People's health is being harmed by mental stress, and they are becoming more susceptible to diseases, hence it is critical to monitor stress levels. We utilised the Naive Bayes Algorithm to detect people's stress levels because it had the highest accuracy on the data. The project's final goal was to create a web application that could predict the severity of depression.

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