The Detection of State of Mental Health Using Recurrent Neural Networks

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ABSTRACT

In the recent days, the number of people affected by Mental Depression Disorder (MDD) is on the rise with age, occupation related stress levels and several other factors. Depression has been identified as the main cause behind various diseases in individuals. In most cases, mental depression disorder is diagnosed with the help of counselling given by psychiatrists. However, even after the counselling and clinical diagnosis, the symptoms of depression persist. Social stigma associated with depression results in reluctance on the part of individuals to consult psychiatrists to diagnose mental illness. Also the existing techniques or methods do not guarantee accurate prediction of the level of depression. In order to overcome these problems, a new emotional model is designed to analyze the depression in individuals. A set of questionnaires called Personal Survey Questionnaire (PSQ) is framed to collect responses from the tweeters to understand about their mindset and depression level. Based on the PSQ answers, E-Ranking is calculated and compared with the polarity value generated by the PSQ answers. The performance of the proposed questionnaire-based model is compared with seven existing model based on parameters such as estimate and P-Value.

Finally, the Recurrent Neural Network (RNN) is combined with Rule Based model (RB) to define the level and symptoms of depression. The blended RNN is compared with NLP process (Nature Language Processing) and it is proved that the Hybrid RNN and RB models give the best classification model for depression analysis.

1. INTRODUCTION

1.1 OVERVIEW

Mental depression, clinically known as Mental Depression Disorder (MDD), is a weakening ailment experienced by people all around the world. As per the latest measurement accessible from WHO (World Health Organization), in 2015, in excess of 300 million individuals overall experience the ill effects of MDD, an expansion of over 18% from 2005. In the United States (US), there are over 16 million individuals (6.7% of US grown-up population) with at any rate one significant incident in a given year.

WHO has identified that there is a strong association between misery and different kinds of diseases, for example, diabetes and coronary failure. Sadness causes considerable languishing among patients and

families. Likewise, the nearness of MDD places an individual in comorbid conditions, for example, tension issue, eating disorders, anxiety disorders, and substance abuse. Over 90% of the individuals who experience the ill effects of depression. Perceiving the seriousness and outcomes of this psychological maladjustment, WHO (World Health Organization) has begun a battle, "How about we talk?" with an objective for individuals with discouragement to look for and find support.

With significant rise in mental health issues all over the world, the Centre for Disease Control and Prevention (CDC), located in United States of America (USA) reported that "constantly in 2020, mental depression will be the subsequent driving reason for incapacity, all through the world" (CDC, 2013). Mental depression can even induce problems like viciousness and suicide. Most of the individuals with mental issue regularly go undiscovered and untreated. So, there is an increasing need to analyse and treat such sort of malady. The social life of an individual can be utilized as an indicative parameter to analyse his/her brain science. For example, long range informal communication sites such as Twitter can be used to define ones' mental state. A mental depression can be defined as a health condition that

changes a person's thoughts, feelings, and/or behavior (or all three) and causes the person to experience distress and difficulty in functioning. As with many diseases, mental illness is severe in some cases and mild in others. Individuals who have mental illness don't necessarily look like they are sick, especially if their illness is mild. Other individuals may show more explicit symptoms such as confusion, agitation, or withdrawal. Mental illness includes depression, schizophrenia, Attention Deficit Hyperactivity Disorder (ADHD), autism, and obsessive-compulsive disorder. Each illness alters a person's thoughts, feelings, and/or behaviors in distinct ways.

1.2 EMOTIONAL ANALYSIS TASKS IN SOCIAL MEDIA SITUATIONS

Nowadays social life is the key stage for the examination to dissect and anticipate the ecological circumstances and furthermore think about the individual musings and assessments. The use of social life is expanded in this 21st century by various network of individuals everywhere throughout the world. Online networking stage is utilized to impart the insight and conduct the person, by which gigantic corpus can be gathered related with the individual contemplations which they think in their mind on their present circumstances. The post which broadcasted by the client is divided by their assortment of burdensome and nervousness contemplations about film, game, individual, governmental issues, about items, restorative and so forth.

Social media generates a wealth of opinion data that provides an opportunity to understand and mine users' perspectives on specific topics. Researchers are also beginning to pay attention to people's emotions and opinions in social media situations. Several scholars extract and predict many practical problems, such as product opinions, stock earnings, political election results, etc. by analyzing people's statements on social platforms. At the heart of these studies is the analysis of the emotions (opinions) expressed by users on social platforms, i.e. emotional analysis. Emotion analysis is an active research field, the motivation of which is to improve the automatic recognition results of emotional expression. The use of social platforms by individuals to share personal opinions and experience information produces a lot of valuable data for research. Although many scholars are committed to the development of cutting-edge emotional analysis technology and applications, no one has yet systematically investigated and summarized these research results. Therefore, it is necessary to organize the relevant literature, explore the research results and challenges of emotion analysis in the existing social media situation, and provide guidance for the follow-up research.

1.3 PROBLEM STATEMENT

The purpose of this research is to conduct a comprehensive survey and analysis of these issues and to help understand the study of emotional depression in the context of social media.

1.4 EMOTIONAL CLASSIFICATION

Emotional classification, also known as emotional polarity classification, is the most common task in emotional analysis. It is based on the assumption that the opinion in the target text is about an aspect or attribute of an entity or the entity itself, and that the opinion can simply be divided into two opposite emotional polarities, or that it is positioned to be measured on a continuous variable between the two emotional polarities. Therefore, emotions are divided into three main categories: positive, negative, or neutral. In order to express the intensity of emotion, different measures are used. For example, the commonly used measurement range is between -1 and 1, where -1 represents the maximum negative emotion, 1 represents the maximum positive emotion, and 0 represents neutral attitude. Other studies have divided emotional ratings into 5, with 0 as maximum negative and 4 as maximum positive. However, Thelwall and others believe that both positive and negative emotions can coexist, and proposed an algorithm to measure both the emotional polarities at the same time, indicating that there are both positive and negative values in the emotional classification to express the emotional intensity.

## 2. RELATED WORK

2.1 DEPRESSION ANALYSIS

Depression is one of the most common mental disorders that affects 121 million people worldwide. It is estimated by the World Health Organization that depression will be the second major disability causing disease in the world by 2020. Reviewed the studies related to the problem and looking at how depression is reflected in communication behavior. Among the wide range of communication activities, this study focuses on the activities that take place within social networking sites. The aim of this

research is to conduct a comprehensive survey and analysis of these issues and to help understand the study of emotional analysis in social media contexts.

Each social media, such as Twitter, Instagram, and Facebook, has different characteristics and functions. Although the specific operation methods are different in each of these social media sites, it can be seen that they provide a common experience in a wide range. According to Burke, Kraut, & Marlow's classification Burke et al. (2011), possible actions in social network services can be generalized into three categories. The first is to broadcast a message so that an unspecified number of people can see it. The second is to communicate with individuals directly connected by following or making friends. Direct communication can be divided into receiving messages or communication actions from others and giving them to others. The third action involves only reading messages posted on the networking service (passive consumption). Among the above three types of behavior, passive message consumption is not identified as a practical interpersonal communication behavior. This study aims to focus on communication behavior in which the exchange of behavior is visible, thus excluding the behavior of passive message consumption. Existing studies also focus on communication behavior other than message consumption.

2.2 DEPRESSION AND INTERPERSONAL COMMUNICATION

Studies looking at behaviors caused by high levels of depression have been carried out in many cases in people with depression. Although high depression does not necessarily result from a psychopathological state of depression, the behavioral aspects of depression provide clues about the behavior of people with high depression.
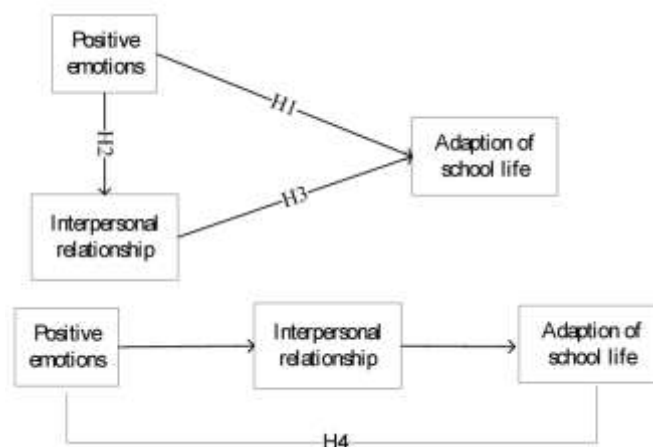
Depression is a mental illness that significantly affects a person's functional ability due to emotional, physical and cognitive changes that include sadness, emptiness and extreme mood swings. According to the diagnostic criteria of DSM-5, people with depression lose interest in almost every activity, have difficulty thinking or concentrating, feel overwhelmed, or feel unimportant. Depressed patients generally lose motivation in activities and do not feel happy in social interactions (Sperry, et al. 2014).

The study carried by Joo et al. (2019) analyses depression-related posts on Facebook, a social network service, to identify topics that are mostly discussed within it. Specifically, the users' discussion about depression on Facebook which has features such as ease of access, openness and anonymity is being looked at. For this study, a natural language processing-based data analysis framework, including the overall process from Facebook data collection to main control extraction is implemented. Using the

framework implemented, the study collected and analyzed 885 posts made in the last year from Facebook's largest user group discussing depression. It was combined with an automated technique and a passive approach (eliminating the term, specifying the number of main controls) for the completeness and accuracy of the main control extraction, through which the subject was analyzed from various angles. As a result, users were found to be mostly discussing depression, relationships, mood and feelings, depression symptoms, suicide, medical references, and family.

People with depression have several characteristics related to communication. Libet, &Lewinsohn, (1973) explained the characteristic communication behaviors of depressed people through the concept of social skills. According to this study, social skills, defined as the ability to receive positive responses from the other person consist of five aspects. The first is the amount of communication communicated to other people within time; the second is the efficiency judged by the actions obtained from them compared to the actions delivered to the other person; the third is the range of interpersonal relationships with which they interact; the fourth is the positive response out of the overall communication behavior. The fifth is the amount of time lag in mutual communication behavior.

In addition to examining the overall communication behavioral characteristics of depressed people, more specifically, studies on the influence of depression on interpersonal communication include studies by Hokanson et al. (1989) and Siegel & Alloy, (1990). They conducted a research on college students who are roommates, looking at the effects of depression on communication in close contact and face-to-face situations. According to Hokanson, roommates of depressed students did not enjoy their relationship with depressed students and showed high levels of aggressive behavior toward depressed students. Siegel and Alloy's study also showed that roommates who are not depressed evaluated students with depression negatively, and as a result of the interaction with depressed roommates, they experienced negative emotions and consequently reacted negatively (Siegel & Alloy, 1990).

2.3   DEPRESSION AND ONLINE COMMUNICATION

Unlike general online communities and bulletin boards, it is possible to form a one-one relationship in social media and communicate individually, while simultaneously delivering a message to a large number of unspecified people. Social relations formed in social media are focused on the individual user and hence the contents of the message that are written often indicate a personal state. For example, it was found that the number of users who use Twitter primarily to compose messages expressing their current status and thoughts is far greater than those who use Twitter for information sharing as the main purpose (Naaman et al. 2010). The message about the personal state reflects the individuals' emotional state. In this context, studies have been conducted to reveal the relationship between the emotional aspect of the individual and the behavior of the individual on social media.

The work of Choudhury et al. (2013) which analyzed Twitter data in connection with depression, studied the relationship between depression and the use of social media. They collected and analyzed Twitter messages of 376 women who had just given birth, and created a statistical model that could predict women who are at risk of postpartum depression after giving birth through messages on Twitter before childbirth (Choudhury et al. 2013a). They also analyzed about 70,000 messages written on Twitter by 489 people to identify messages that indicate general depression, and based on them, presented a social media depression index that represents the level of depression in the local population (Choudhury et al. 2013b). In the two studies conducted by Choudhury et al. a common result was that

the Twitter activities of users reflecting high depression were significantly less in the amount of tweets, the amount of responses using '@' symbol, and the amount of retweets '#'. In other words, when depression is high, the amount of social connection and communication through Twitter tends to decrease. (Choudhury et al. 2013a, 2013b).

Most of the studies examining the relationship between the use of social media and depression were focused on English-speaking users. Nevertheless, a study was also conducted to analyze non-English culture users based on English-speaking studies. For example, Tsugawa et al. (2015) reported Japanese tweet data based on the postpartum depression prediction model through Twitter by Choudhury et al. (2013a). The study was conducted to extract users with depression. While using the methods employed by the existing model, such as tweet frequency, number of followers, and positivenegative vocabulary, elements were adjusted to fit the usage trend of Japanese users. The study revealed that Japanese Twitter users with high feelings of depression had a higher frequency of tweets and retweets, and there was no difference in the frequency of replies using '@' symbol, unlike the study by Choudhury et. Al

The theoretical discussions and prior studies reviewed so far can be summarized into the following contents. First, the negative emotion of depression is reflected in behavior of the individual during interpersonal communication. People with high depression are passive in interpersonal communication, and the other person also tends to not enjoy communication with people having high depression. Second, depression is reflected not only in face-to-face situations but also in online communication behavior. In particular, it became possible to analyze the patterns of online communication associated with depression through social media in more specific units of action. Third, it is necessary to consider the personality factor in the process of linking communication with emotional states such as depression. Among the personality factors, neuroticism is a state in which the association has not been sufficiently explored, although it can have a certain effect when a feeling of depression is reflected as a communication behavior by controlling negative emotions. On the other hand, this research focused on neuroticism, which is closely related to depression, unlike many existing studies that consider personality factors together and examine how the use of Facebook functions varies according to each personality factor. Through this study it is intended to look at how depression and personality are reflected in communication behavior on Facebook.

2.4 FEATURE RANKING METHOD

GiotaStratou& Louis-Philippe Morency (2017) plays out the multisense conduct examination which helps to recognize the downturn and Post-Traumatic Stress Disorder (PTSD). The new structure of multi sense investigation helps to distinguish and focus on use instances of the psychological well-being bolster which keeps up by the choice tree support. The additional bit of leeway of multi model space is intended to lead the organized meetings with human members. The test results investigate the significance of the multi space relevant verbal examination and misery pointers of human connection. The location of sadness, uneasiness and stress scales is structured with the assistance of passionate discovery dependent on the penmanship and drawing acknowledgment which is displayed by Laurence Likforman-Sulem et al. (2017). The strategy utilizes the element positioning techniques and AI classifier which process the objective exactness of the passionate information. Results quantify the exactness, affectability and explicitness of the cross approval techniques, constantly the measures are observed to perceive the Depression Anxiety Stress Scales (DASS).

AI approach is pursued to distinguish the psychological worry of the person which structures the PC helped indicative device to recognize the feeling of anxiety. An AI system including electroencephalogram signal examination on members is proposed. Stress was incited by receiving a notable exploratory worldview dependent on the Montreal Imaging Stress Task. The acceptance of stress was approved by the undertaking execution and emotional input. The proposed ML structure included EEG highlight extraction, highlight choice, grouping and 10-crease cross-approval by Ahmad Rauf Subhani et al. (2017). The outcomes demonstrated that the proposed structure created 94.6% precision for two-level recognizable proof of pressure and 83.4% exactness for different level distinguishing proof.

3.METHODOLOGY

3.1 INTRODUCTION

An important step to understand how today society work is to understand how people communicate and share information. Especially communication via social networking platforms is of profound interest to the scientific community. In this research contribute to the recent interest in analyzing social media and micro-blogging websites. Especially a microblogging platform Twitter is considered. Twitter has become a valuable source for quantitative socio-researchers in the last few years. Researchers are also beginning to pay attention to people's emotions and opinions in social media situations. Many scholars extract and predict many practical problems, such as product opinions, stock earnings, political election results, etc. by analyzing people's statements on social platforms. At the heart of these studies is the analysis of the emotions (opinions) expressed by users on social platforms, i.e. emotional analysis. Emotion analysis is an active research field, and its motivation is to improve the automatic recognition results of emotional expression which reveals the depression level of the users.

Through literature collection and combing, finds that the current social media situation of emotional analysis research mainly explores what emotional analysis does, how to do and what role to do. Therefore, this research focuses on the social media situation of emotional/sentimental analysis tasks, methods and applications of three aspects.

(1) What kind of valuable emotional/sentimental information can be obtained through social media, that is, the task of emotion/sentiment analysis, so as to understand the research direction of emotion/sentiment analysis using comments or reviews for the prediction of mental depression level of the web user.

(2) How to use social media data for emotional analysis, especially for social platforms commonly used methods of emotional analysis, in order to make technical improvements and innovations.

(3) What are the application areas of emotion analysis technology, and how social media emotional research can help solve mental or social problems.

3.2 SCOPE OF THE RESEARCH

In recent years, there is an increasing tendency for users to search for health information on social media which has triggered research on health care and mental health issues. With the aid of social media platforms that are enriched sources of information, emotional analysis can help medical personnel

investigate the psychological changes in individuals and the prevalence of patients with a variety of diseases, that in turn help build bridges of communication and understanding between doctors and patients. For example, many studies use existing social media information to identify diabetes, mental depression and certain rare diseases. Patients are also provided with advice on diagnosis and treatment. Thelwall et al. (2011) used emotional classification data from social media to confirm the relationship between negative emotions such as stress, anger and fear and the heart disease mortality. Many researchers suggest that observing and extracting text from social networks can help determine the extent of depression. Based on the ability to mine the patients' point of view, emotional analysis research can also be used to improve medical services and prevent mental depression disease.

3.3 PROPOSED METHODOLOGY

The methodology proposed in the present work is more effective in the prediction of social media emotional mental depression. It uses several algorithms to reduce the prediction error and computational complexity. The proposed methodology for depression prediction consists of three phases. The overall architecture of the proposed model is shown in Figure 3.1, in which the flow of depression classification and prediction of depression level is illustrated.
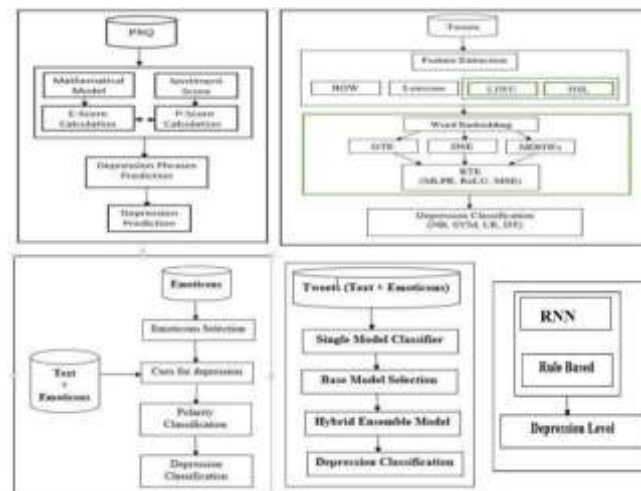

Figure 3.1 Overall System architecture for prediction ofdepression

The proposed methodology to predict depression has led to the following contributions.

3.3.1 Contribution 1

A supervised machine learning based model is designed to estimate the P-Score and E-Score, indicating the level of depression using questionnaire data framed with the help of domain experts.

3.3.2 Contribution 2

Enhanced Depressive Text Classifier (EDTC) is designed using tweet text to analyse the words polarity to identify the attitude of the users.

3.3.3 Contribution3

Improved Emoticons Classifier (IEC) is modelled to classify the behaviour of the user and to predict the depressive level of the user using tweets.

3.3.4 Contribution4

An Intelligent Hybrid Feature Ensemble Model (IHFEM) is deigned to combine EDTC and IIEC features to give better behaviour prediction of the user with maximum accuracy.

3.3.5 Contribution5

Neural Network is introduced with machine learning classification called Mixed Recurrent Neural Network (M-RNN) to predict the level and symptoms of depression.

3.4 DATA COLLECTION FROM TWITTER TWINT

is an advanced Twitter scraping tool written in Python that allows for scraping Tweets from Twitter profiles without using Twitter's API.

TWINT utilizes Twitter's search operators to let scrape Tweets from specific users, scrape Tweets relating to certain topics, hashtags & trends, or sort out sensitive information from Tweets like e-mail and phone numbers.

TWINT also makes special queries to Twitter allowing to scrape a Twitter user's followers, Tweets a user has liked, and who they follow without any authentication, API, Selenium, or browser emulation.

Some of the benefits of using TWINT vs Twitter API are,

- Can fetch almost all Tweets (Twitter API limits to last 3200 Tweets only);

- Fast initial setup;

- Can be used anonymously and without Twitter sign up;

- No rate limitations.

4.CONCLUSIONANDFUTUREWORK
4.1 Conclusion

The PSQ is analysed by calculating E-Score, P-Score which then calculate the E-Ranking to estimate the depression of the user. The survey questions also helped to find some phrases related with the depression. Hence the prediction of depression is evaluated by the estimates and P-value which prove that proposed PSQ is best when comparing to the existing questionnaires'. The depression cannot be determined only by questionnaire, hence in further work the social media is used to bring automation in

depression analysis and prediction of level of depression by various machine learning, deep learning models.

Enhanced depression analysis using text is modelled by extracting the text from twitter using TWINT. The text which is extracted is processed with feature extraction using BOW and Lexicons. Here for Lexicons, to identify the depression related words LIWC and Enhanced HSL are used to find the score and magnitude of the tweets.

After feature extraction, word embedding model is designed by regulating the general twitter word embedding (GTE) using RTE. For regulating the words related with depression MDHW is used, in which mental depression weight is calculated by frequency of words. Hence, the classification model is introduced RTE and other exiting feature extraction model, which shows that RTE gives the best accuracy on classifying the depression users. The experimental results shows the F1 score as follows, LR+ RTE = 0.80 , DT +RTE= 0.67, LSVM+RTE=0.83,RSVM+RTE=0.43 NB+RTE=0.81.

The improved Emoticon classifier is designed by selecting the best emoticons by using the different frequency of emoticon selection. After selection of emoticons the polarity score is calculated by evaluating the emoticon score and text score. The emoticons are given with the signals of the depression by the different place of the emoticons in the text.

Based on the position of the emoticons in the text the different levels of polarity score is generated and then evaluation is made by different combination of the polarity initialization. Hence the accuracy of the emoticon classification is done for the depression and found that emoticons is need for depression classification. The evaluation model is formed by precision, recall and F1 score, in which different polarity is compared in different level of documents.

The proposed intelligent hybrid ensemble model is designed by using the base classifier. The base classifier is selected by the probability and ranking generated by the probability between the single classifier and the test data. The meta classifier is designed to relabel the training data by using the base classifier and the training data probability value. By sorting the probability value in the ascending order, the rank is generated to relabel the training data. RMSD is used to find the loss function bywhich the exact hybrid ensemble model is designed. The comparison with the existing model shows the best accuracy in the proposed hybrid model when comparing with stacker classifier, averaging ensemble model.

The proposed blended Recurrent Neural network is designed to evaluate the level of depression and symptoms of depression. The proposed model gives best accuracy when comparing to the existing model. The rule which is written correlate with the RNN and classify the level of depression. The RNN + Rule based model gives 87% accuracy when compared to the existing model CoreNLP and RNN.

The rule generated by the various parts of speech (POS) tagging given with four rules is managed by calculating the scores in the combination of adjectives and adverbs. Hence the combined model of Recurrent Neural network and rule based model gives the accurate level of depression and symptoms when comparing to PSQ model and intelligent hybrid ensemble model.

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