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An overview of the application of sentiment analysis in mental well-being

Jiayi Zhang

Warren College, University of California San Diego, La Jolla, United States, 92093

zhangnd16@gmail.com

Abstract. Sentiment analysis is a field of study in natural language processing, usually implemented by machine learning and deep learning methods. Its purpose is to identify the information from pieces of text and categorize them based on their subjective opinion, such as positive, negative, and/or neutral. It has been used in a variety of fields, usually fields related to business, such as customer service and marketing, to analyze the opinions of customers to help businesses adjust their products to accommodate the customer's needs. This work analyzes the use of sentiment analysis in mental health. Starting in 2020, the emergence of COVID-19 has disrupted the lives of billions around the world. The isolation brought by the pandemic has forced the public to spend a much greater amount of time on social media and very little time socializing. This has caused a significant increase in the numbers of mental diseases such as anxiety, depression, obsessive-compulsive disorder (OCD), schizophrenia, and bipolar disorder. This paper provides an overview of the recent research of machine learning and deep learning methods on sentiment analysis in the field of mental health since 2020, when the COVID-19 was confirmed and obligatory and non-obligatory quarantines were enforced within different countries. Then, this paper examines the potential applications of sentiment analysis in addressing the mental illness of the public, in aspects of diagnosing feedback from patients, social media monitoring, and mental health apps. Lastly, several challenges that sentiment analysis still faces today will be presented and briefly analyzed. More research on sentiment analysis needs to be done in order to achieve a higher level of accuracy when applying sentiment analysis models to psychiatric uses, but the benefits of a developed sentiment analysis model is highly substantial in mental health.

Keywords: sentiment analysis, machine learning, deep learning, mental health, chatbot, social media, text monitoring.

1. Introduction

Mental health has become a critical issue affecting people globally. Statistics show that approximately one in four adults is affected by psychological problems at some point in their lives, with some of them experiencing more than one mental illness at the same time [1]. Despite the widespread nature of mental health issues, they are often under-diagnosed and under-treated in many regions. A study shows that among all patients with mood disorders, those who receive proper treatment within the year only comprise 37.4% to 41.6% of that population [2]. The COVID-19 pandemic beginning in 2020 has only added to this problem. People under social isolation caused by the quarantine policies were more likely to struggle with mental disorders including depression, acute stress, generalized anxiety disorder,

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and intrusive thoughts [3]. The consequences of mental health problems are far-reaching. The increased risk of suicide, the reduced productivity, and the potential for other physical health problems are all found to be caused by mental disorders.

The importance of maintaining mental well-being in society cannot be overstated, given all the negative consequences of mental disorders mentioned above. However, the traditional methods of diagnosing mental disorders, such as clinical interviews and psychological surveys, can be both time-consuming and expensive. Additionally, patients may be unwilling to accept treatment, either due to financial constraints or a lack of knowledge of mental disorders. As the number of people struggling with mental disorders increases, the demand for psychiatric services is becoming increasingly high. Therefore, there is a growing need for alternative methods of mental health screening and treatment to alleviate the pressure on these resources.

Sentiment analysis, or opinion mining, is a field of study in natural language processing. Its purpose is to identify the information from pieces of text and categorize them based on their subjective opinion. It has been used in fields related to business, such as customer service and marketing, to analyze the opinions of customers help businesses adjust their products to accommodate the customer's needs. In this paper, the potential application of sentiment analysis in detecting mental illness on both a collective and an individual scale will be discussed. Some recent research on sentiment analysis has focused on its application on detecting mental diseases from a wide range of datasets, including social media posts, online mental disorder communities, and chatbot conversations. Sentiment analysis has been proven to be conducive in detecting mental illness due to its function of detecting the sentiment of a piece of text, which reflects some of the author's emotions as a result of the current mental state.

2. Recent researches on sentiment analysis

2.1. Methodologies

Sentiment analysis can be implemented using two main categories of methodologies: traditional machine learning approaches and deep learning approaches. Traditional machine learning methods are mainly consisted of statistical methods and algorithms, including Naive Bayes, Adaptive Boosting, Support Vector Machine, and Decision Trees. These algorithms tend to exhibit time efficiency when dealing with large amounts of labeled training data. On the other hand, deep learning uses neural networks, which are developed to imitate the functions of human brains. Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) are widely used deep learning models to handle an even larger labeled or unlabeled dataset.

Research has shown that deep learning methods tend to perform better on sentiment analysis than the statistical method based approaches. In a study that uses Guardian newspaper, an online media website, as the dataset for the classification of sentiments, Single Layer Convolutional Neural Network has the highest accuracy of 0.939 [4]. While Support Vector Machine and Adaptive Boosting methods that are also used in the study exhibit a lower running time and memory, Support Vector Machine cannot handle a dataset with constant adjustments, and Adaptive Boosting is subject to the problem of overfitting [4].

While deep learning methods have a more favorable accuracy on the classification. The process between inputs and outputs is not interpretable to the users. This might cause the sentiment analysis based on deep learning models less conducive to the diagnosis of mental disorders, as the reasoning behind the evaluations made by these models is important to psychiatrists in order to make proper treatments [5].

2.2. Detection of sentiment of the public in social media posts

Social media platforms offer a great deal of information on their users' mental well-being. By analyzing the emotion from the daily texts shared by users on these platforms, it is possible to gain insight into their long-term mental state. The COVID-19 pandemic has led to an increase in the

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reliance of social media, which results in a greater availability of data for study. Social media posts can be utilized to gain both a collective understanding of the change in the public's morale, as well as to track an individual user's mental state based on their activities.

In a study about sentiment monitoring in daily posts of Twitter, a general social media platform, it is discovered that when Twitter users post discouraging tweets, they tend to write a series of despondent words that represent a negative sentiment based on the preclassification of the watchwords of the model [6]. Moreover, in the negative sentiment posts, there is a high occurrence of some subsequent supplementary negative watchwords that are used to add more details to the content, which is a phenomenon utilized by the model to enhance the model's performance of the sentiment analysis of the tweets [6].

Another research focuses on a change in the public's sentiment with respect to time during the COVID-19 period, also by analyzing Twitter posts. As the self quarantine policies are enforced, the quantity of social media surges to a considerable amount, which provides a sufficient source for data mining. The major theme of social media posts correspondingly shifts to US daily domestic lifestyles, while some others are about the pandemic events [7]. COVID-19 related posts from approximately the beginning of the spread of the pandemic in the United States. Posts with a similar topic word are collapsed to general themes related to the pandemic, such as "social distancing", "deaths". The frequency of a theme appearing in the posts is determined by dividing the number of words related to that theme by the total number of words. Then, Valence Aware Dictionary for Sentiment Reasoning (VADER) is used to recognize the opaque expressions in the texts, such as abbreviations, negations, idioms, jargons, etc., and evaluate the sentiment score of the posts.

In this study, it is discovered that for tweets about topics related to daily life, the sentiment score demonstrates a considerable decrease when the pandemic is declared, which represents a decrease in the public's morale due to the quarantine policies, which impact people's daily lives [7]. However, surprisingly, an increase in the sentiment of COVID-19 related tweets is found. The research suggests a possible explanation to this anomaly, that languages are naturally biased towards the positive side [7]. Along with the fact that the intended tones of most pandemic related posts are objective since a majority of these posts are released by formal news media, the VADER detects a fake optimism in these pandemic related posts.

Even more interestingly, it is observed that there is a significant decrease in the sentiment of the tweets related to daily topics around the end of January 2020, the time period when the famous basketball star Kobe Bryant dies because of the crash of the helicopter, before the spread of the pandemic in the United States [7]. The model in the research is able to detect that the effect of this negative event lasts around a day before returning to the original level, whereas the effect of a pandemic on sentiment is long lasting [7].

These studies provide solid evidence that it is effective to detect the mood shift of a community by analyzing their social media posts. The public social media posts are a great mining field for datasets to evaluate the general mood of a large number of people for the government and related institutions, and devise corresponding actions to prevent further deterioration to maintain the mental well-being of the public on a large scale.

2.3. Mental disorder monitoring with lexicon data

Similar research is also being done on monitoring direct mental problems from online texts. Given that the author or the community of the texts is subject to mental issues, lexicon-based sentiment analysis can be employed to detect the potential development or facilitation of mental disorders. By comparing the frequency and intensity of the words with pre-defined sentiment scores, the mental state of the author can be inferred to some extent.

Mental disorder communities on Reddit, an online social network, in which Reddit users post their mental issues related thoughts and experiences, are used as datasets. After the preprocessing of the text to remove trivial words, VADER is used to compute the sentiment scores of each comment in the posts and their corresponding comments. By analyzing the datasets, it is attempted to predict the

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emotional tone of the last comment made by the author of the post based on the comments by other users in that post [8]. Recurrent Neural Network, a deep learning approach with feedback loops that allow the network to maintain the memory of previous inputs while processing the current data, is used to accomplish this goal [8].

With the intention of improving the author of the initial post, other users tend to write more positive comments, which indeed generally enhance the sentiment score of the following comments by the majority of the initial authors [8]. However, it is uncertain whether the positivity presented in the comments indeed represents a better emotional state of the author. Moreover, the prediction model fails to accurately predict the sentiment scores of some posts. Irony, negation, and other literacy elements that are hard to detect by the neural network present in these posts, which might not reflect the actual mental state of the author [8].

The deep learning method for detecting the sentiment in individuals' texts might not work for every user, due to the use of some vague expressions. Moreover, the analysis of these lexicon data only represents the emotional tone of the author at that specific period of time when the text is written. Texts alone cannot be the lone factor in determining the mental disorder of individuals.

2.4. Chatbot for developing mental well-being

Sentiment analysis has also gained increasing interest in applications that aim to promote the mental well-being of users. A chatbot, "Muni", is invented, which the users can interact with, ask for simple forms of guides, and answer mental screening tests [9]. However, this conversation system is only at the entry level, with a limited number of words and sentiments recognized [9].

Another chatbot intended for providing diagnosis and support to potential psychiatric patients is developed using a logistic regression model. In this system, sentiment analysis is performed to identify the tone of the text input by the user, which is accomplished with a training dataset of tweets, labeled into eight different emotions [10]. Unique responses are generated as output by the chatbot based on the emotional tone.

The current application of sentiment analysis in chatbots specific for the mental well-being is still limited. One significant reason for this is that it can be much more difficult to accurately detect the sentiment when the setting becomes informal and less relevant context is given. Another factor is again the literacy techniques that make the expressions vague to recognize the true meaning of the communicator.

However, the benefits a chatbot for mental well-being can bring are numerous once it reaches a certain level of accuracy and can be put into daily use. The subsequent costs of an chatbot in practical use is considerably low. With its time efficiency, it can drastically reduce the pressure of psychiatrists, who have relatively low availability currently. In addition, some potential psychiatric patients choose not to go to meet with a psychiatrist because the process of communicating or recalling might trigger their internal stigma [10], while others simply underestimate or totally ignore the possibility and the impact of the mental disorder. A well-developed chatbot can address both situations, facilitating the process of potential patients seeking help by providing another favorable option other than a real-person psychiatrist.

3. Discussion

The use of sentiment analysis has the potential to help both facilitate the need for mental clinicians and improve the general mental well-being of the public. The growing use of social media and other media websites has become a suitable mining site to either be used as a training dataset for an emotional state model, or be monitored to detect the general well-being rating of a community and make corresponding adjustments. For example, a sentiment analysis model can be used on the recent activities on the social media and websites of a community that has recently experienced trauma to monitor their mental status and perform any mental aids as needed.

On an individualistic perspective, sentiment analysis can be applied, but more research and development need to be done in the current methods of sentiment detection. A much higher degree of

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accuracy on the sentiment is required in order to diagnosing the mental state of a single person. One of the challenges that sentiment analysis faces today is the use of vague expressions that can be interpreted in multiple ways, with the use of sarcasm, puns, proverbs, etc. In order to ensure the accuracy of the diagnosis, the potential patients should be required to express formally, or under the supervision of clinicians.

Another problem of applying sentiment analysis to maintaining mental well-being is the privacy of the author of the texts analyzed. Although there are a great deal of public social media posts to use as training datasets, when it comes to diagnosing a potential patient with a mental disorder, it might be a concern to the patient that his or her online activities are being analyzed. The thought of a patient's online posted texts, which he or she might previously consider "private" from people around him or her, being analyzed by others might cause a disturbance to the person's life, which could bring more harm than benefit. Chatbots, on the other hand, might be more favorable to patients who are unwilling to share their experiences to a real person. However, in order for the chatbots to provide the maximum mental support possible to the patients, chatbots should be developed to a certain extent that they can perform a great imitation to the communication between real people, and be a practical substitute for a real psychiatrist.

In addition, more data than the texts alone are needed to perform a comprehensive diagnosis and treatment for the patients. Neither machines nor chatbots alone can maintain people's mental well-being. Sentiment analysis currently can only be treated as an assistance to the traditional method of treating mental disorders.

However, the application of sentiment analysis in mental health has the potential to provide benefits in identifying individuals who may be at risk of developing mental health problems so that early support can be offered. With further research and development, sentiment analysis can play an important role in improving the mental health well-being for people worldwide.

4. Conclusion

Sentiment analysis has the potential to significantly improve mental health and well-being by providing a powerful tool to monitor the emotional state of individuals and communities. The growing use of online text websites and social media has made it possible to collect an unprecedentedly large amount of data, which is an optimal mining site to train sentiment analysis models. However, there are still challenges to overcome in order to achieve an accuracy high enough to be applied into practical uses to assist psychiatrists.

References

[1] "Mental Health Disorder Statistics." (2023). Mental Health Disorder Statistics | Johns Hopkins Medicine, February 1. Online: https://www.hopkinsmedicine.org/health/wellness-and-prevention/mental-health-disorder-statistics.

[2] Philip S. Wang, MD. (2005). "Failure and Delay in Initial Treatment Contact after First Onset of Mental Disorders in the National Comorbidity Survey Replication." Archives of General Psychiatry. JAMA Network, June 1. Online: https://jamanetwork.com/journals/jamapsychiatry/fullarticle/208684.

[3] Marroquín, Brett, Vera Vine, and Reed Morgan. (2020). "Mental Health during the COVID-19 Pandemic: Effects of Stay-at-Home Policies, Social Distancing Behavior, and Social Resources." Psychiatry Research, 293: 113419. DOI: https://doi.org/10.1016/j.psychres.2020.113419.

[4] Zhang, Tianlin, Annika M. Schoene, Shaoxiong Ji, and Sophia Ananiadou. (2022). "Natural Language Processing Applied to Mental Illness Detection: A Narrative Review." npj Digital Medicine, 5(1). DOI: https://doi.org/10.1038/s41746-022-00589-7.

[5] Alanazi, Saad Awadh, Ayesha Khaliq, et.al. (2022). "Public's Mental Health Monitoring via Sentimental Analysis of Financial Text Using Machine Learning Techniques." International Journal of Environmental Research and Public Health, 19(15): 9695. DOI: h

DOI: 10.54254/2755-2721/8/20230186

ttps://doi.org/10.3390/ijerph19159695.

[6] Dixit, Rohan, Geetika Chawla, and Ishaan Bajaj. (2022). "Mental Health Monitoring Usi ng Sentiment Analysis." International Journal of Scientific Research in Computer Scie nce, Engineering and Information Technology, 324–30. DOI: https://doi.org/10.32628/cs eit228443.

[7] Valdez, Danny, Marijn ten Thij, Krishna Bathina, Lauren A Rutter, and Johan Bollen. (2 020). "Social Media Insights into US Mental Health during the COVID-19 Pandemic: Longitudinal Analysis of Twitter Data." Journal of Medical Internet Research, 22(12). DOI: https://doi.org/10.2196/21418.

[8] Silveira, Bárbara, Henrique S. Silva, Fabricio Murai, and Ana Paula da Silva. (2021). "P redicting User Emotional Tone in Mental Disorder Online Communities." Future Gene ration Computer Systems 125: 641–51. DOI: https://doi.org/10.1016/j.future.2021.07.01 4.

[9] Aujero, John Kcero, Nico Manuel Cruz, et.al. (2022). "Muni-Muni: Mood Analyzer and Screening Tests for the National Center of Mental Health Using Sentiment Analysis." International Journal of Computing Sciences Research, 6: 1019–31. DOI: https://doi.o rg/10.25147/ijcsr.2017.001.1.88.

[10] Moulya, S, and T R Pragathi. (2022). "Mental Health Assist and Diagnosis Conversation al Interface Using Logistic Regression Model for Emotion and Sentiment Analysis." J ournal of Physics: Conference Series 2161, (1): 012039. DOI: https://doi.org/10.1088/1 742-6596/2161/1/012039.