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Analyzing Linguistic Patterns for Depression Identification in Social Media

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ABSTRACT: Examining the viability of loss indicator identification by language analysis of social media user-generated content is the primary objective of this research. An innovative and adaptable risk assessment tool is urgently required because of the alarming increase in the prevalence of mental health issues, especially depression. The widespread use of social media for the purpose of story sharing has greatly increased the likelihood of early intervention. Researchers searched through social media postings for linguistic indications connected to depression using natural language processing (NLP) methods. The diverse dataset includes people from a wide range of languages and racial backgrounds. Several different social media networks provided the data. Topics covered in the entries range from word choice and emotional content to linguistic complexity and chronological patterns. Prediction models for depression detection incorporate a plethora of machine learning approaches. This class contains a great many algorithms, including SVMs, neural networks, and ensemble methods. Tagged datasets are used for training models, where labels indicate ground truth obtained from clinical tests, self-reports, or a combination of the two. Common metrics for evaluating a model's performance include precision, recall, and F1-score.

KEYWORDS: social media, mental health issues, dataset, linguistic indications, recall, and F1-score.

I. INTRODUCTION

In studies that investigated suicide and mental health status, such as depression, according to a recent systematic literature review of 96 relevant studies concerning suicide and depression detection on social media only several studies detected both the depression level and suicide or self-harm from social media content. A study also investigated suicide risk and its risk factors, such as depression and anxiety, on Weibo. To the best of our knowledge, few prior studies have forecasted the SI of depressed patients on social media. As failing to identify a person with high suicide risk could lead to loss of life, a more targeted strategy to precisely identify people with a high suicide risk is advantageous for suicide prevention. Social media platforms, such as Twitter, Facebook, and Weibo, are popular places where individuals express and record their personalities, feelings, moods, thoughts, and behaviors. Text mining on social media is useful in detecting cases of depression. For example, based on Weibo posts from 180 users, found that the quantity of emoticons and first-person pronouns significantly predicted depression. This study employed three types of classifiers and achieved around 80% accuracy. In this research, achievement-related words and work-related words were significantly associated with depression, but the classifiers did not achieve a satisfying performance. Sentiment analysis is a rapidly developing technique that can automatically capture users' feelings. Using information available on social media, sentiment analysis can identify early signs of suicidal ideation and prevent attempts at suicide. As a direct consequence of this, machine learning (ML) and natural language processing (NLP) are increasingly used to infer suicidal intent from social media content.

II. LITERATURE REVIEW

Xianbin Wang (2023) Depression is one of the most common mental illnesses but remains underdiagnosed. Suicide, as a core symptom of depression, urgently needs to be monitored at an early stage, i.e., the suicidal ideation (SI) stage. Depression and subsequent suicidal ideation should be supervised on social media. In this research, we investigated depression and concomitant suicidal ideation by identifying individuals' linguistic characteristics through machine

learning approaches. On Weibo, we sampled 487,251 posts from 3196 users from the depression super topic community (DSTC) as the depression group and 357,939 posts from 5167 active users on Weibo as the control group. The topic modeling results were in accordance with the machine learning results. This study systematically investigated depression and subsequent SI-related linguistic characteristics based on a large-scale Weibo dataset. The findings suggest that analyzing the linguistic characteristics on online depression communities serves as an efficient approach to identify depression and subsequent suicidal ideation, assisting further prevention and intervention.

Ali Saleh Alshebami (2022) Individuals who suffer from suicidal ideation frequently express their views and ideas on social media. Thus, several studies found that people who are contemplating suicide can be identified by analyzing social media posts. However, finding and comprehending patterns of suicidal ideation represent a challenging task. Therefore, it is essential to develop a machine learning system for automated early detection of suicidal ideation or any abrupt changes in a user's behavior by analyzing his or her posts on social media. In this paper, we propose a methodology based on experimental research for building a suicidal ideation detection system using publicly available Reddit datasets, word-embedding approaches, such as TF-IDF and Word2Vec, for text representation, and hybrid deep learning and machine learning algorithms for classification. A convolutional neural network and Bidirectional long short-term memory (CNN–BiLSTM) model and the machine learning XGBoost model were used to classify social posts as suicidal or non-suicidal using textual and LIWC-22-based features by conducting two experiments.

Gerardo Sierra (2021) Suicide represents a public health issue that requires new preventive strategies. Therefore, this study analyzes differences in language use between a themed posts group (suicide and depression) and a random posts group (non-specific topics) from different social media platforms. In addition, the similarity of the texts of themed posts group with the set of phrases linked to suicide risk factors is analyzed. Texts were processed using the Linguistic Inquiry and Word Count (LIWC) software. A 95% bootstrap confidence interval (CI) was built for the difference in means for the resulting values per word category across groups. Significant differences in the use of language were observed between the themed post group and the random post group, whereas no differences were found between the themed post group and the set of phrases linked to suicide risk factors.

Jose Luís Oliveira (2020) The World Health Organization reports that half of all mental illnesses begin by the age of 14. Most of these cases go undetected and untreated. The expanding use of social media has the potential to leverage the early identification of mental health diseases. As data gathered via social media are already digital, they have the ability to power up faster automatic analysis. In this article we evaluate the impact that psycholinguistic patterns can have on a standard machine learning approach for classifying depressed users based on their writings in an online public forum. We combine psycholinguistic features in a rule-based estimator and we evaluate their impact on this classification problem, along with three other standard classifiers. Our results on the Reddit Self-reported Depression Diagnosis dataset outperform some previously reported works on the same dataset.

Ryan Leary (2018) The pervasiveness of social media—and the near-ubiquity of mobile devices used to access social media networks—offers new types of data for understanding the behavior of those who (attempt to) take their own lives and suggests new possibilities for preventive intervention. We demonstrate the feasibility of using social media data to detect those at risk for suicide. Specifically, we use natural language processing and machine learning (specifically deep learning) techniques to detect quantifiable signals around suicide attempts, and describe designs for an automated system for estimating suicide risk, usable by those without specialized mental health training (eg, a primary care doctor). We also discuss the ethical use of such technology and examine privacy implications. Currently, this technology is only used for intervention for individuals who have "opted in" for the analysis and intervention, but the technology enables scalable screening for suicide risk, potentially identifying many people who are at risk preventively and prior to any engagement with a health care system.

Introduction to Online Social Media

On a platform called "online social media" (OSM), users may post and debate user-generated content, which can be anything from an opinion to an idea to plain old facts. Because of the lowered publication barriers compared to traditional media, an enormous number of individuals may engage and contribute to OSM platforms. The fourth most

popular thing people do while they're online is browse social networking sites. According to data collected in January 2017, about 75% of all internet users participate in any OSM website. The rules of the website regarding allowed content determine the structure of an OSM platform. Users may do things like create and manage online journals, blogs, and forums; play social games; trade material like videos and photographs; and engage in question and answer sessions. While Face book integrates micro blogging with social networking, Tumblr and Sina Weibo focus only on micro blogging.

Image Spam Creating Techniques

In the Spammer's Compendium, a dedicated group of volunteers has organized and collected spammer tactics. John Graham-Cumming maintains the site, and both scholars and students depend on it. We used broad terms to classify the spam messages so they could pass through the screening process. It seems like just another text-based email at first glance. On closer examination, though, its true nature as an image becomes apparent. Another form of image spam called "sliced images" is a collection of related photos displayed in a jigsaw puzzle style. To hide their edits, spammers often manipulate image pixels. Because the pixels are generated at random, many photo spam filters treat each iteration as if it were a new image. Photo spammers change the picture's properties to add new pixel locations and IDs, changing the colour. This is because there is an infinite number of possible fonts and colours.

Emotion Recognition on Social Media

A lot of individuals express their feelings on social media for various reasons. Reasons such as the chance to express oneself, build one's community, and help one another out are among them. Scientific investigations on the identification, prediction, and detection of direct emotional disclosures on social media are increasingly reliant on computer tools. A literature review has just voiced its disapproval of studies that treat people as anonymous "users" or "subjects" to probe their psychological well-being. In opinion (i.e., non-empirical) articles, the usage of Emotion AI by social media networks to assist users going through emotional distress has been met with both acclaim and condemnation. Recent advances in face recognition and artificial intelligence have made it possible to diagnose emotional and mental disorders and moods, and Instagram posts that indicate a depressive episode are only one less obvious indicator of this. A new threat to people's privacy is developing AI systems and approaches, which have the ability to infer personal information from data that individuals choose not to divulge.

Mental Health and Social Media

There has been an explosion of recent work examining mental health signals through social media. Most of the work has focused on pervasive mental health concerns and psychological states, for example detecting depression examining personality factors, or assessing psychological well-being. Alternate methods for obtaining data related to mental health conditions were introduced by Coppersmith et al., which widened the aperture of possible conditions to investigate. These techniques enabled analysis of rarer conditions like schizophrenia which affects an estimated 1% of the population of the United States. Those rates are roughly equivalent to the suicide rate, and many times smaller than the estimated rate of suicidal ideation. Suicide and suicidal ideation has been less well studied via social media.

III. RESEARCH METHODOLOGY

In order to get an understanding on the impact of the previously described patterns of depressed users we experimented standard feature extraction methods, which we have complemented with the design of a rule-based estimator that solely relies on these psycholinguistic features. We have experimented several classifiers that have been identified in the literature as appropriate for this classification task. All experiments were managed using the scikit-learn machine learning framework. The texts in the dataset were curated for any direct link to mental health. We considered this curation relevant as it relates to the possibility of identifying people that are unaware of their mental health status through heterogeneous texts. The dataset consists of all Reddit users who made a post, matching high-precision patterns of self-reported diagnosis. The depressed users were matched by control users, who have never posted in a subreddit related to mental health and never used a term related to it. In order to avoid a straight-forward separation of the two groups, all posts of diagnosed users related to depression or mental health were removed. The preprocessing of the Reddit posts follows standard approaches in text classification. The posts are lowercased and tokenized, after removing

all non-alphabetic characters. Stop words are filtered, by using an altered version of the stop words list of the Natural Language Toolkit. The alteration consists of removing from the original stop words list self-related words and words that belong to the list of absolutist words, as described next.

IV. RESULTS AND DISCUSSIONS

The data used in this study was collected in collaboration with our research team and Advanced Symbolic, an Ottawa-based consultancy. The Bell Let's Talk campaign was established by Bell Canada with the purpose of removing the stigma associated with mental health illnesses and creating better understanding and acceptance of individuals who suffer them.
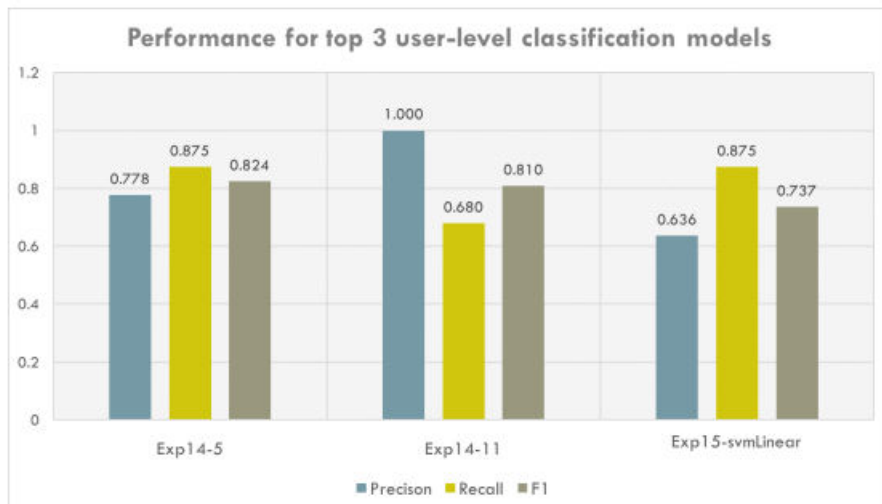
Graph 1: Performance for top 3 user-level classification models

On Bell Let's Talk Day, Canadians raised over $6.1 million for mental health services by beginning a debate about mental health via over 122 million tweets, mails, calls, and social media postings. When compiling 2015 statistics, only users in Canada were taken into account. It took 25,362 people for us to retrieve 156,612 tweets. For this study, we just used user-generated data that was publicly accessible.
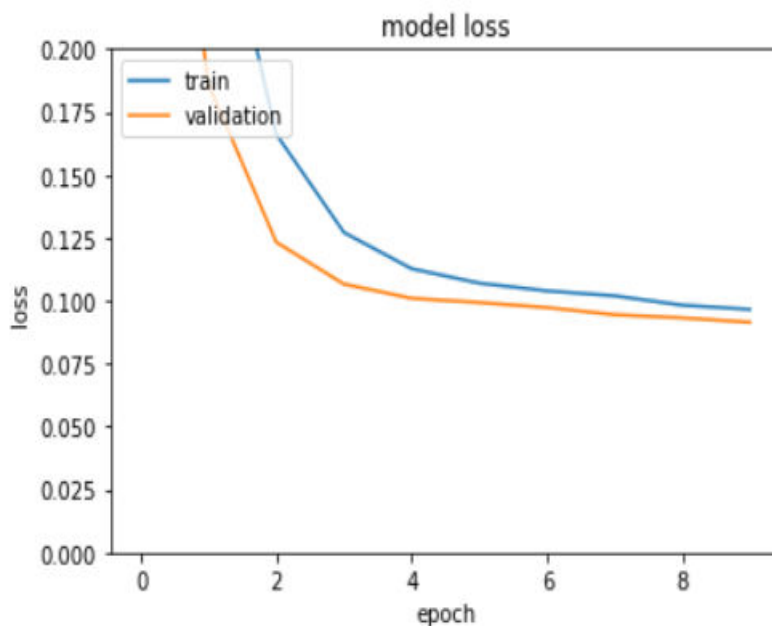
Graph 2: Model Loss

Table 1: classifying individuals as "depressed" based on what they "self-reported" (scenario a)

Model Name	Accuracy	Precision	Recall	F1
baseline	0.9469	1.0000	0.122	0.0212
exp1-svm-Original	0.9224	NA	0.0001	NA
exp1-svm-SMOTE	0.7944	0.1826	0.6984	0.2642
exp1-svm-Down	0.74146	0.1224	0.8124	0.2442
exp2-svm-Original	0.94421	0.2212	0.0122	0.2441
exp2-svm-SMOTE	0.8442	0.2114	0.6242	0.2144
Exp3-svm-SMOTE	0.2264	0.9644	0.2244	0.4698

The results demonstrate that the training process is enhanced by excluding individuals whose tweets do not correspond to their reported despair. For the classifier to function, it must be able to detect patterns in the training sample using its attributes. The accurate classification of many "self-reported" users has also contributed to improved performance.

Table 2: User-level classification improved results

Model Name	Accuracy	Precision	Recall	F1
baseline	0.9669	1.0000	0.111	0.0111
exp1-svm-Original	0.9116	NA	0.0001	NA
exp1-svm-SMOTE	0.7966	0.1816	0.6986	0.1661
exp1-svm-Down	0.76166	0.1116	0.8116	0.1661
exp1-svm-Original	0.96611	0.1111	0.0111	0.1661
exp1-svm-SMOTE	0.8661	0.1116	0.6161	0.1166
Exp3-svm-SMOTE	0.1166	0.9666	0.1166	0.6698

The current system wills auto-label individuals as "depressed" when they do not meet the classifier's prediction parameters according to pattern matching criteria. A pseudo-code example of using is Self Reported function to verify whether the user has a depression diagnosis is shown here:
When this criterion is met, the number of tweets expressing concern drops below 10%. As anticipated, the "depressed" group would most certainly take the lead. When the classifier is not actively processing data, this code will be executed.

V. CONCLUSION

Analysis of social media texts has the potential to provide methods for understanding a user's mental health status and for the early detection of possible related diseases. We have presented in this paper preliminary results on the use of hand-crafted psycholinguistic features as possible improvements to standard classification approaches of depressed online personas. In this study, we utilized publicly available Twitter data to support the Bell Let's Talk campaign. Members of the control group and those who chose to remain anonymous had 100–300 tweets apiece, so we selected 30 of them. The 60 people's tweets were subsequently meticulously rated from 0 to 3 by two human annotators. "Depressed" and "not-depressed" were also used to label users next to their tweets. Afterwards, we developed two

classifiers through trial and error: one for tweets that can identify when a tweet indicates distress, and another for users that can identify when a person is depressed. The experiments included a wide range of features and methods in an effort to find the optimal combination for our requirements. The most effective classifier discovered at the tweet level has a recall of 0.80 and an accuracy of 0.12. The support vector machine (SVM) method, trained on balanced under sampled data, was utilized to train this classifier. There are seven characteristics that are used, including word counts for polarity, depression, and pronouns. It considers ten factors, including the frequency of pronoun use, the frequency of words describing depression, the frequency of tweets indicating depression, the total frequency of tweets, and the frequency of tweets specifying depression as a proportion. It relies on a criterion to remove depressed users with less than 10% distress tweets in order to improve performance even further.

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