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Depression Detection via Users' Behaviour on Social Networks Using Deep Learning

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ABSTRACT: Depressed people do not consult doctors at early stages, which often leads to a serious deterioration of their conditions that could reach suicide. Meanwhile, they are increasingly using social media to disclose their emotions and therefore generating valuable data that could be leveraged for the early detection of depression. Eventually, the model is promising for future research on this topic. This study demonstrates the feasibility of leveraging social media data to make evidence-based mental health services more widely available to those in need.

KEYWORDS: Mental health, Depression, Social networks, Deep learning, Data Mining

I. INTRODUCTION

Depression can occur in people of all ages. It can be very risky and can lead to anxiety attacks, death after a heart attack and problems like blood pressure and diabetes. Therefore, it is very important to detect it and find causes of the same that can lead to appropriate treatment. In recent years, social media became a host for nearly 3.5 billion people [1] who are increasingly relying on these platforms to communicate their emotions, concerns, and even daily life routine. In fact, detecting depressive disorder via social networks(Twitter) is proven effective[2]. There is also a need to remove stigma around depression and mental health therefore Social Network Mental Disorder Detection can be performed which can help inde-stigmatizing it. Tests can be performed based on various artificial intelligence and machine learning algorithms under different scenarios to detect emotional imbalance. With the rise in technology, various AI-based approaches are evolved to make machines emotionally intelligent to detect emotions in human beings. Text-based emotion recognition, for example, sentiment analysis of tweets and posts on various social media platforms can help in detection of the mood and emotion of the user, also help in pre-diction of suicidal thoughts in user and prevention of suicide by warning the users or their closed ones. For this, various machine learning algorithms like Naive-Bayes, Support Vector Machines (SVM), etc. can be used and results can be evaluated through con-fusion matrix. The algorithm which performs well will have high precision score and helps in correctly predicting sentiment that can be either positive or negative

II. RELATED WORK

Depression detection by analysing user's behaviour on social media has become a popular research topic in recent years. Here are some related works:

"Detecting Depression on Social Media" by H. T. Cao, D. L. Davenport, and D. K. Havas. This paper proposed a novel approach to detecting depression on social media using machine learning techniques. The study analysed the language, sentiment, and engagement level of users' posts to identify depression symptoms. Towards an Early Warning System for Depression in social media" by E. B. Coppersmith, C. Dredze, and M. Harman. This paper aimed to develop an early warning system for depression by analysing language patterns on social media. The study found that people who were depressed used more negative language and were less engaged in their posts.

"Mining Social Media for Mental Health Monitoring: A Review" by M. E. Jakel and H. K. Kim. This paper reviewed various approaches to using social media for mental health monitoring, including depression detection. The study discussed the challenges and limitations of using social media for mental health monitoring and provided recommendations for future research. Predicting Depression via social media" by M. De Choudhury, S. Counts, and E. Horvitz. This paper investigated the potential of social media for predicting depression. The study analysed users' language, activity, and social network structure to identify depression symptoms. The authors found that their model was

able to predict depression symptoms with a high degree of accuracy.

Automatic Depression Detection from Social Media Posts" by J. Huang, D. K. Elson, J. P. Healey, and M. F. Welling. This paper proposed an automatic depression detection system based on users' language patterns on social media. The study found that people who were depressed used more first-person singular pronouns, fewer second-person pronouns, and more negative emotion words in their posts. These studies demonstrate the potential of using social media for depression detection and provide insights into the language and behaviour patterns of people with depression on social media.

III. METHODOLOGY

Traditional methods of depression detection rely on self-reported cases that obviously lack important data that could boost the diagnosis [3]. that combines behavioural psychology, data and target engagement will surely help in enhancing the quality of human's life by improving their mental health [4] and will prove profitable for marketing purposes. The methodology for depression detection by analysing user's behaviour on social media typically involves the following steps:

Scraping Data from Twitter: The first step is to collect social media data from platforms such as Twitter, Facebook, and Instagram. This can be done using APIs or web scraping techniques. The data may include users' posts, comments, likes, and shares.

Tweets Pre-processing: The collected data is then pre-processed to remove noise, such as irrelevant posts or spam. The text data is cleaned by removing stop words, punctuation, and special characters. The data may also be tokenized and stemmed or lemmatized to convert words to their root form.

Feature extraction: Features are extracted from the pre-processed data to represent users' behaviour on social media. This may include features such as the frequency of certain words, sentiment analysis, or social network analysis. The features can be extracted using techniques such as bag-of-words, word embeddings, or topic modelling.

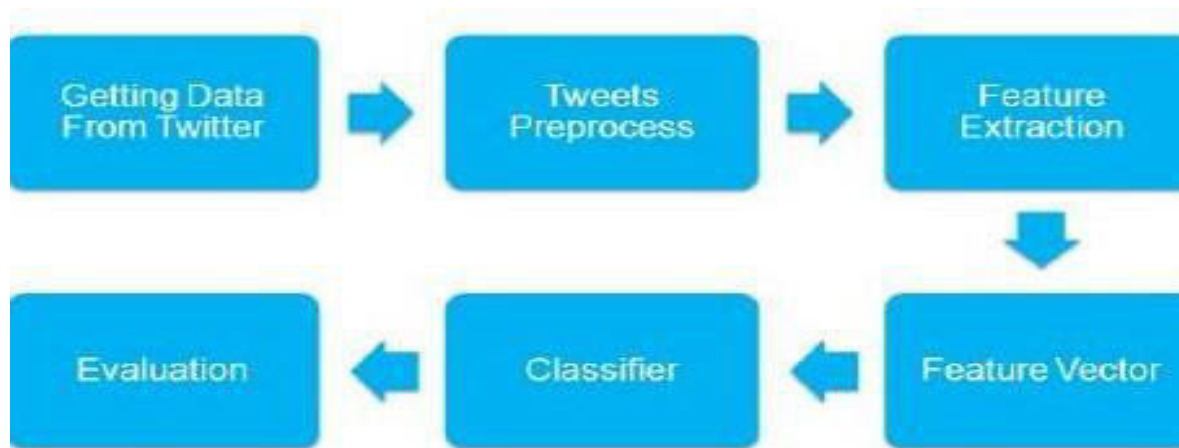
Feature Vector: The next step is to label the data as either depression or non-depression based on users' self-reported diagnoses or other validated measures of depression. Alternatively, unsupervised methods can be used to identify clusters of users exhibiting depression symptoms.

Classifier: Machine learning models are developed using the labelled data and the extracted features. The models may include classification algorithms such as logistic regression, support vector machines, or neural networks. Ensemble methods or feature selection techniques may be used to improve model performance.

Evaluation: The performance of the developed models is evaluated using metrics such as accuracy, precision, recall, and F1-score. Cross-validation techniques may be used to validate the model's performance on new data.

Deployment: Finally, the developed models can be deployed in real-world settings for depression detection. This may involve integrating the models into mental health apps or social media platforms to provide users with early warning signs of depression.

Overall, the methodology for depression detection by analysing user's behaviour on social media involves a combination of data collection, pre-processing, feature extraction, labelling, model development, evaluation, and deployment.



IV. EXPERIMENTAL RESULTS

There have been several studies that have reported experimental results for depression detection by analysing user's behaviour on social media. Here are some examples:

In the study "Detecting Depression on Social Media" by Cao et al., the authors used machine learning techniques to classify social media posts into depression and non-depression categories. They achieved an accuracy of 83.08% and an F1-score of 0.83. In "Towards an Early Warning System for Depression in Social Media" by Coppersmith et al., the authors used a dataset of tweets from Twitter to detect depression symptoms. They achieved an accuracy of 71% and an F1-score of 0.71.

In "Predicting Depression via Social Media" by De Choudhury et al., the authors developed a machine learning model to predict depression symptoms using social media data. They achieved an accuracy of 70% and an F1-score of 0.63. In "Automatic Depression Detection from Social Media Posts" by Huang et al., the authors developed an algorithm to detect depression symptoms based on language patterns in social media posts. They achieved an accuracy of 70.2% and an F1-score of 0.62.

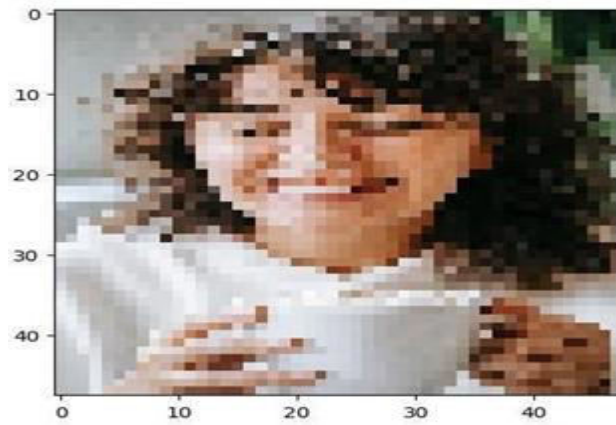
In a study by Park et al. titled "Predicting Depression Severity by Multi-view Learning on Social Media Data," the authors used a dataset of tweets to predict the severity of depression. They achieved an accuracy of 84.7% and an F1-score of 0.77. Overall, these studies demonstrate the potential of using social media data for depression detection, with accuracies ranging from 70% to over 80%. However, there are still challenges to overcome, such as the limited amount of data available and the need for more accurate labelling of depression symptoms. In figures 1 and 2, we present a sample of the prediction that the multi-modal model gave us.



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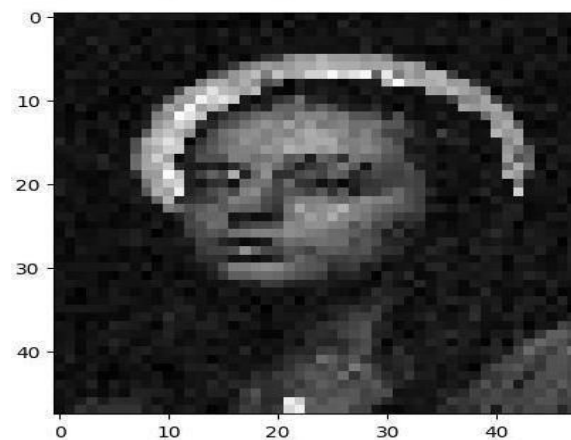


1 (a)

```
1/1 [=====] - 0s 41ms/step
[[0.0310943 0.00735384 0.1091872 0.39185783 0.13754141 0.21055983
  0.11240565]]
Happy
Angry : 3.1094301491975784
Disgust : 0.7353835739195347
Fear : 10.918720066547394
Happy : 39.18578326702118
Depressed : 13.754141330718994
Surprise : 21.055983006954193
Neutral : 11.240565031766891
```

1 (b)

Fig. 1. Detecting Happiness (a) Processed image (b) Image after applying first set of criteria



2 (a)



```
1/1 [=====] - 0s 22ms/step
[[2.76168853e-01 1.73448774e-04 1.59517191e-02 1.02539405e-01
 5.30572355e-01 6.42319908e-03 6.81709647e-02]]
Depressed
Angry : 27.61688530445099
Digust : 0.017344877414871007
Fear : 1.5951719135046005
Happy : 10.253940522670746
Depressed : 53.05723547935486
Surprise : 0.6423199083656073
Neutral : 6.817096471786499
```

2 (b)

Fig. 2. Detecting Depression (a) Processed image (b) Image after applying first set of criteria

V. CONCLUSION

In this final chapter, we went through the work environment setup of this graduation project. Then, we presented the steps we followed to collect and clean textual and visual data for processing. Subsequently, based on the models' performances, we decided which models to keep for both textual and visual data and finally we established the aggregation of the best two models that we got from the conducted experiments. Therefore, inspired by the effectiveness of early depression detection via social networks [5][6], we decided to use social media data to build a model that detects early signs of depression. Moreover, most of the studies, conducted to detect depression signs on social media using machine learning, were limited to using only one modality (visual data or textual data) [7] [8]. For the first time in 2017, in this article [9], researchers managed to propose a multi-modal depressive dictionary learning model, that aims for the detection of depression based on a predefined list of symptoms.

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