

Depression Detection on Social Media Network (Twitter) using Sentiment Analysis

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Abstract - Depression as a disorder has been an excellent concern in our society and has been continuously a hot topic for researchers in the world. Despite the massive quantity of analysis on understanding individual moods together with depression, anxiety, and stress supported activity logs collected by pervasive computing devices like smartphones, foretelling depressed moods continues to be an open question. In this paper, we have proposed a depression analysis and suicidal ideation detection system, for predicting the suicidal acts supported the extent of depression. The present study aims to exploit machine learning techniques for detecting a probable depressed Twitter user his/her tweets. For this purpose, we trained and tested classifiers to differentiate whether a user is depressed or not using features extracted from his/her activities within the tweets. Classification machine algorithms are used to train and classify it in different stages of depression on scale of 0-100%. Also, data was collected in the form of tweets and were classified into whether the one that tweeted is in depression or not using classification algorithms of Machine Learning. In this way, Predictive approach for early detection of depression or other mental illnesses. This study's main contribution is that the exploration a neighborhood of the features and its impact on detecting Depression level.

Key Words: Twitter, Sentiment analysis, Natural language processing, Machine Learning (ML), Depression Detection, Support Vector Machine (SVM), Decision Tree

1. INTRODUCTION

Depression is additionally a typical mental issue. In today's world, the stresses of existence events in one's life could increase potentialities of depression. Throughout Gregorian calendar month 24–30, 2020, U.S. adults reported considerably elevated adverse status conditions associated with COVID-19. Younger adults, racial/ethnic minorities, essential staff, and unpaid adult caregivers reported having intimate disproportionately worse status outcomes, raised substance use, and elevated unsafe cerebration. Youth is printed as age fifteen to twenty four years, and it includes middle and late adolescence. It's characterized by current changes in physical, psychological, and social dimensions. For healthy growth and development, youth should have the simplest way of happiness, love, action, and independence and to have a purpose in life. Throughout this organic process stage, many sorts of behavior square measure developed which can cause either normalcy or status malady.

Depression can cause the affected person to suffer greatly and performance poorly at work, at college and in social events. A despite what you nearly actually did recently on your phone or laptop computer, it's apparently that social media was concerned. Did you catch up with friends on Facebook, post photos of your cat or video of your totter walking for 1st time on Instagram? perhaps a Twitter link brought you here. These days folks tend to specific their emotions, opinions associate degree disclose their daily lives through an enlargement of social media platforms like Twitter, Facebook and Instagram. These expressions square measure generally through photos, videos and primarily through text.

Twitter is additionally a social media application that permits users to broadcast news, info, and private updates to completely different users in tweets or statements of one hundred forty characters or less. On one hand, is that this is usually} this will be often nice for users of social networking information processing system to overtly and freely contribute and answers any topic online; on the choice hand, it creates opportunities for folks operative among the health sector to induce insight of what could be happening at standing of somebody United Nations agency reacted to a difficulty throughout a specific manner.

Sentiment analysis is that the maneuver of determinative the emotional tone behind a series of words; would like to appreciate Associate in nursing understanding of the attitudes, opinions, and emotions expressed throughout a text. It's the thanks to gauge written or language to work out if the expression is positive, or negative, or neutral? The flexibility to extract sentiment and emotions insights from social knowledge is additionally determined that's being wide adopted by organizations across the globe. This paper focuses on the varied ways used for classifying a given piece of language text in line with the opinions expressed in it. So, on manufacture such perception, machine learning techniques may presumably offer some outstanding selections which are able to assist in examining the distinctive patterns hidden in on-line communication. We have a tendency to tend to aim to utilize machine learning techniques and algorithms for depression detection on social media sites like Twitter.

2. LITERATURE SURVEY

A data-analytic based model to detect depression of any human being is proposed in the paper [1]. The data is collected from the users' posts of two popular social media websites: Twitter and Facebook. In this research, machine learning is used to process the scrapped data collected from SNS (Social Networking Sites) users. Natural Language Processing (NLP), classified using Support Vector Machine (SVM) and Naïve Bayes algorithm to detect depression potentially in a more convenient and efficient way.

The research [2], employs Natural Language Processing (NLP) techniques to develop a depression detection algorithm for the Thai language on Facebook where people use it as a tool for sharing opinions, feelings, and life events.

The health tweets are analyzed for Depression, Anxiety from the mixed tweets by using Multinomial Naive Bayes and Support Vector Regression (SVR) Algorithm as a classifier in paper[3].

In the paper [4], researchers present how to find the depression level of a person by observing and extracting emotions from the text, using emotion theories, machine learning techniques, and natural language processing techniques on different social media platforms.

The paper [5], aims to apply natural language processing on Twitter feeds for conducting emotion analysis focusing on depression. Individual tweets are classified as neutral or negative, based on a curated word-list to detect depression tendencies. In the process of class prediction, support vector machine and Naive-Bayes classifier have been used. The results have been presented using the primary classification metrics including F1-score, accuracy and confusion matrix.

The paper [6], proposes depression analysis and suicidal ideation detection system, for predicting the suicidal acts based on the level of depression. Real time data was collected in the form of Tweets and Questionnaires. Then, classification machine algorithms are used to train and classify it in five stages of depression depending on severity.

The given paper [8], gives the overview of three major models prepared to predict depression among people:

a) Using Machine learning classifiers and WEKA, b) Using Imaging and Machine learning methods, c) Using the Risk factors.

3. METHODOLOGY

Nowadays, Social media networking sites are the new knowledge gateway for all age groups. It has become a manifesto to express sentiments in the form of opinions, judgments, feelings, expressions and reviews on almost everything-such as movies, brands, product, and clothing industry, social - activities and so on. The reviews or

expressions can be positive, negative or neutral. Automated process of analyzing these opinions or text of data is known as 'Sentiment Analysis'.

"Sentiment Analysis can be delineated as a standardize analysis of online expressions."

There are a numerous and growing range of methodologies and techniques for detection of the depression level from the posts on Social Media Network. In our study, we consolidate a technical description of techniques applied for depression identification using the Natural Language Processing method (NLP) and text classifying techniques. The framework is comprised of Data pre-processing step, Feature extraction step following the Machine Learning classifiers, Feature analysis of the data and Experimental results.

3.1 Dataset

The dataset consists of tweets collected using the Twitter Application Programming Interface (API). We have collected total of 15,000 Tweets for the generation of the training module and testing module for our model. We will exercise ratio of approximately 70:30 for splitting the data collected from Twitter API into training module and testing module. Two word-records will be compiled for the training and testing datasets for the classification. The training record comprised of systematized list of words demonstrating mental illness such as depression proclivity like 'depressed', 'sad', 'suicide', 'gloomy', 'unhappy', 'low', 'down', 'heartsick', and many more. For the testing dataset, we will include tweets that are collected at random which will include neutral as well as negative components.

3.2 System Architecture

A quantitative study is conducted to train and test various machine learning classifiers to determine whether a twitter account user is depressed, from tweets initiated by the user or his/her activities on Twitter.

Data preparation, feature extraction, and classification tasks are performed using various R packages. The classifiers are trained using 10-fold cross validation to avoid overfitting, and then tested on a held-out test set.

Following figure (1) illustrates the depression detection using activity and content features classification model.

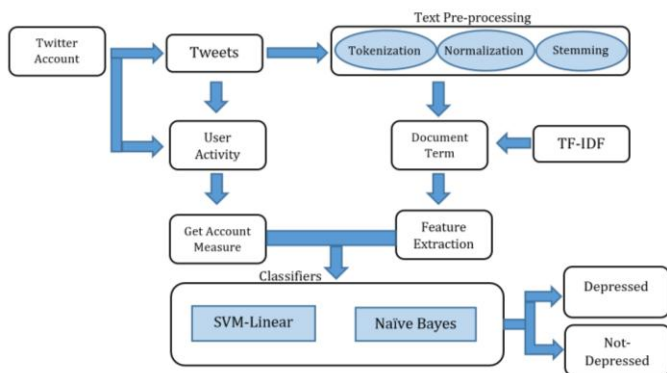


Fig 1: Architecture of the system

First, all tweets for depressed and non-depressed accounts, as well as information of user account and activities such as number of followers, number of following, time of posts, number of mentions, and number of retweets, are retrieved. Next, all tweets of an account are assembled in one document.

Text pre-processing is applied to all documents. First, a corpus is created and tweets in each document are tokenized. Next, normalization is applied, where all characters are turned to lower case and punctuations, retweets, mentions, links, unrecognized emoji's, and symbols are removed. Usually, normalization includes removing stop words, such as first-person pronouns like "I," "me," and "you," but when removing stop words, we keep the first-person pronouns. Later, stemming is applied and a document term matrix (DTM) is created for each account. The matrix indicates the frequency of words in each tweet, where each row indicates a document of tweets and each column indicates all words used in all accounts.

TF-IDF is used to measure the words' weight.

Features applied on the DTM are then merged with account measures extracted from the social network and user activities. Results of the merge are then treated as independent variables in a classification algorithm to predict the dependent variable of an outcome of interest. Ultimately, we decide upon the DT, a linear kernel support vector classifier, and an NB algorithm as a study suggests SVM and NB classifiers have highest accuracy among the others [6]. The following figure shows the graph of Depression Detection Accuracy of various classifiers.

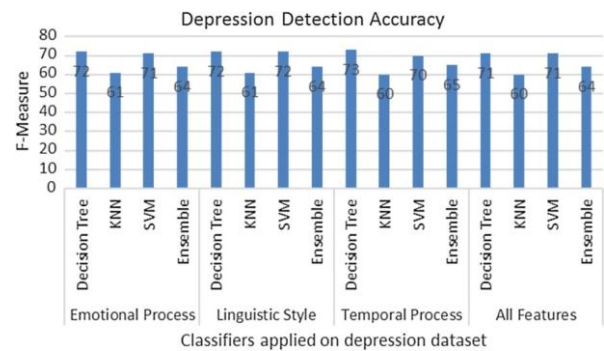


Fig 2: Depression Detection Accuracy

3.3 Data Pre-Processing

Data pre-processing is a necessary step in building a Machine Learning model and counting on how well the information or text data has been pre-processed; the results square measures are seen. And if it involves unstructured information like text, this method is even a lot of necessary.

We use the Natural Language Processing (NLP) tools to pre-process the dataset before it is preceded to the feature selection and training stage. In the first step for pre-processing data, we use Tokenization method to divide the posts from Twitter into individual tokens. After that, we remove all the URLs, punctuations and stop words which could lead into unpredictable results if stay ignored. For Sentiment Analysis of the text for depression detection, we need not remove the emojis or emoticons as it can convey some important information about the sentiment. Then we tend to apply stemming so as to scale back the words to their root type and cluster similar words along.

3.4 Feature Extraction

Machine Learning algorithms learn from a pre-defined set of options from the training information to supply output for the check information. However, the most downside in operating with language process is that machine learning algorithms cannot work on the raw text directly. So, we want some feature extraction techniques to convert text into a matrix (or vector) of options.

Some of the foremost in style ways of feature extraction included are:

- Bag-of-Words
- TF-IDF

A] Bag-of-Words:

The bag-of-words model may be a simplifying illustration employed in tongue process and data retrieval (IR). During this model, a text (such as a sentence or a document) is delineated because the bag (multi-set) of its words, disregard less synchronic linguistics and even order however keeping multiplicity.

In a process of depression detection sentiment analysis, the appearance of the words like 'joyful', 'happy', 'amazing' indicates a positive response towards life, while words like 'sad', 'depressed', 'dejected', 'sorrowful', 'miserable' point to a negative response. There are 3 steps included creating a Bag of Words model:

A) The first step in text-preprocessing which involves:

1. Converting the entire text into lower case characters.
2. Removing all punctuations and unnecessary symbols.

B) The second step involves creation of a vocabulary of all unique words from the collection.

C) In the third step, we create a matrix of features by assigning a separate column for each word, while each row corresponds to the sentiment. This process is known as Text Vectorization. Each entry in the matrix signifies the presence (or absence) of the word in the Sentiment.

B] Inverse Document Frequency (IDF) :

TF-IDF or (Term Frequency(TF) — Inverse Dense Frequency(IDF))is a method that is employed to seek out that means of sentences consisting of words and cancels out the in capabilities of Bag of Words technique that is sweet for text classification or for serving to a machine scan words in numbers.

C] Parts of Speech (POS) Tagging :

Part of speech tagger is a piece of software that reads text in some language and assigns parts of speech to each word such as nouns, verb adjective etc.

4. ALGORITHMS

Machine Learning Classification Techniques used for the model :

4.1 Naïve Bayes :

Naïve Bayes Classifier Sentiment analysis could be a field dedicated to extracting subjective emotions and feelings from text. One common use of Sentiment Analysis is to work out if a text expresses negative or positive feelings. Written reviews area unit nice datasets for doing Sentiment Analysis as a result of they usually go with a score which will be wont to train a rule.

Naive mathematician classifiers are heavily used for text classification and text analysis Machine Learning classification. Although it's moderately straightforward, it usually performs still the maximum amount a lot of difficult solutions. It needs less coaching time and fewer coaching

knowledge. Given an information matrix X and a target vector y, we are able to state our drawback for Naive mathematician as:

$$P(y | X) = \frac{P(X | y)P(y)}{P(X)}$$

Where, y is category variable and X could be a dependent feature vector with dimension d i.e., X = (x1, x2, x2, xd), wherever d is that the range of variables/features of the sample.

4.2 Support Vector Machine :

Support Vector Machines is an algorithm that determines the most effective call boundary between vectors that belong to a given cluster (or category) and vectors that don't belong thereto. It will be applied to any reasonably vectors that inscribe any reasonably knowledge.

In the SVM rule, we have a tendency to tend to plot each data item as some extent in n-dimensional space (where n is varying of choices you have) with the price of each feature being the price of a particular coordinate. Then, we tend to perform classification by finding the hyper-plane that differentiates the 2 categories fine (look at the below diagram).

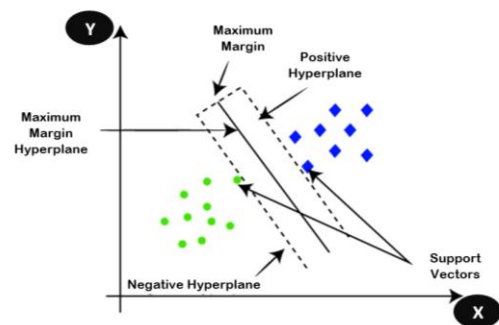


Fig 3: SVM Model

Support Vectors square measure merely the co-ordinates of individual observation. The SVM Classifier could be a frontier that best segregates the 2 categories (hyper-plane/line).

5. MATHEMATICAL MODEL

Let the proposed system be described by the set theory as follows:

$$S = \{DC, REC, S, F, O, I, Q, q0, qf, NDD, D\}$$

Where,

$$I = \text{input: \{tweets of user\}}$$

O = output: {depression detection and recommendation}

q0 = initial state: {system starts and asks for user input tweets}

qf = final state: {system displays the resultant depression percentage and recommendations}

S = success: {If the system works accurately without any halt or error.}

F = failure: {System halts due to some error or doesn't predict accurately.}

Q = set of states: {q0, q1, q2, ..., qf}

D = deterministic data: {Null}

NDD = non deterministic data: {All states resulting output is non deterministic}

DC = data collection: {q : already trained dataset.}

REC = recommendation: {q : results in expected output.}

6. FUTURE SCOPE

In future work, the performance of the model might be improved by including additional features of online user's behavior. e.g., time of tweets or interaction with others.

7. CONCLUSION

In conclusion, we provide evidence as to whether users share their depressive feelings or admit their depression on widely used platforms such as Twitter. We built a predictive model to predict whether a user's tweet is depressed or not based on detecting depressed users using a supervised learning approach to sentiment analysis. We examined the performance of the four classifiers using a dataset collected from Twitter in the Gulf region based on manually constructed corpus with truth labels (depressed, non-depressed). We have observed that people suffering from depression are more socially isolated as evidenced by determining how they interacted with trending hashtags, popular emojis used in their tweets. We found the optimal accuracy with the linear classifier at 87.5%.

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9. REFERENCES

- [1] N. A. Asad, M. A. Mahmud Pranto, S. Afreen and M. M. Islam, "Depression Detection by Analyzing Social Media Posts of User," 2019 IEEE International Conference on Signal Processing, Information, Communication & Systems (SPICSCON), Dhaka, Bangladesh, 2019, pp. 13-17, doi: 10.1109/SPICSCON48833.2019.9065101.
- [2] K. Katchapakirin, K. Wongpatikaseree, P. Yomaboot and Y. Kaewpitakkun, "Facebook Social Media for Depression Detection in the Thai Community," 2018 15th International Joint Conference on Computer Science and Software Engineering (JCSSE), Nakhonpathom, 2018, pp. 1-6, doi: 10.1109/JCSSE.2018.8457362.
- [3] P. Arora and P. Arora, "Mining Twitter Data for Depression Detection," 2019 International Conference on Signal Processing and Communication (ICSC), NOIDA, India, 2019, pp. 186-189, doi: 10.1109/ICSC45622.2019.8938353.
- [4] A. U. Hassan, J. Hussain, M. Hussain, M. Sadiq and S. Lee, "Sentiment analysis of social networking sites (SNS) data using machine learning approach for the measurement of depression," 2017 International Conference on Information and Communication Technology Convergence (ICTC), Jeju, 2017, pp. 138-140, doi: 10.1109/ICTC.2017.8190959.
- [5] M. Deshpande and V. Rao, "Depression detection using emotion artificial intelligence," 2017 International Conference on Intelligent Sustainable Systems (ICISS), Palladam, 2017, pp. 858-862, doi: 10.1109/ISS1.2017.8389299.
- [6] S. Jain, S. P. Narayan, R. K. Dewang, U. Bhartiya, N. Meena and V. Kumar, "A Machine Learning based Depression Analysis and Suicidal Ideation Detection System using Questionnaires and Twitter," 2019 IEEE Students Conference on Engineering and Systems (SCES), Allahabad, India, 2019, pp. 1-6, doi: 10.1109/SCES46477.2019.8977211.
- [7] B. Yalamanchili, N. S. Kota, M. S. Abbaraju, V. S. S. Nadella and S. V. Alluri, "Real-time Acoustic based Depression Detection using Machine Learning Techniques," 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), Vellore, India, 2020, pp. 1-6, doi: 10.1109/ic-ETITE47903.2020.394.
- [8] M. Hooda, A. R. Saxena, D. Madhulika and B. Yadav, "A Study and Comparison of Prediction Algorithms for Depression Detection among Millennials: A Machine Learning Approach," 2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC), Mysore, 2017, pp. 779-783, doi: 10.1109/CTCEEC.2017.8455078.

- [9] A. Noureen, U. Qamar and M. Ali, "Semantic analysis of social media and associated psychotic behavior," 2017 13th International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD), Guilin, 2017, pp. 1621-1630, doi: 10.1109/FSKD.2017.8393009.
- [10] P. Gupta and B. Kaushik, "Suicidal Tendency on Social Media: A Case Study," 2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon), Faridabad, India, 2019, pp. 273-276, doi: 10.1109/COMITCon.2019.8862236.

10. BIOGRAPHIES



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