Neural Network Based System to Detect Depression in Twitter Users via Sentiment Analysis

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Abstract – *According to WHO over 300 million people around the world suffer from depression making it one of the most widespread illnesses on the planet. Various studies have shown that people who suffer from depression use language differently. This paper attempts to address the detection of depression using neural network models based on data gathered from Twitter. A CNN (Convolution Neural Network) is used to help abate the ambiguity that often comes with Sentiment Analysis. The CNN is appraised and compared to metadata that has been pre classified. Analysis of these patterns is used to decide whether the user suffers from depression or not. This can act as a useful diagnostic tool or monitoring system.*

Key Words: Sentiment Analysis, Depression, Neural Networks, Convolution Neural Network, Twitter, Natural Language Processing

1. INTRODUCTION

Depression affects over four percent of the world's population. Long lasting depression is a serious health condition that greatly affects person's ability to function in their day to day life. It is also a leading cause of suicide which leads to over eight hundred thousand deaths a year. Surveys have shown that less than half of the people affected by depression receive treatment.

Twitter is a massive social media platform that enables person to person communication. The detached nature of social media makes people more likely to openly express themselves than they would in person. This makes social media platforms like twitter which has over 500 million users and over 400 million messages per day ideal for gathering data for sentiment analysis.

Neural Networks are computing systems based on the structure of neurons found within animal brains. These systems can learn to execute certain tasks without directly being programmed to do so. Connections or "edges" are formed between the various artificial neurons and a weight is assigned to each edge. This weight adjusts as the learning process occurs. Typically, these neurons are segregated into different layers which consists of an input and output layer as well as one or more hidden layers. Each layer is designed with the purpose of performing a certain type of transformation on the input. Signals travel from the input layer (first layer) to the output layer (last layer) after passing through the various hidden layers one or more times. The individual neurons change their activation state based on the input and produce an output based on the input as well as the activation. Sometimes a bias is added in order to shift the minimum threshold required to shift the activation state. The concept has been used in sequence and pattern recognition, finance, medical diagnosis and numerous other fields.

Sentiment Analysis is the use of text analysis, Natural Language Processing and computational linguistics to determine and appraise emotional states and subjective data. It involves circumstantial mining of text in order to parse useful information out of subjective material. It is widely used to determine costumer expectations, preferences and distastes. This is done by applying it to reviews, surveys, social media etc. It has become an essential part of market research and customer service approach as it allows you to gauge public opinion of not only your own product or service but also those of rivals.

2. Related Work

Earlier studies have shown that depression has an effect on the language used by depressed individuals. For e.g., affected individuals have been found to use singular, first person pronouns more often than those who are not affected. A study of essays authored by depressed or formerly-depressed students found that depressed students use first person singular pronouns more often than the control group of people who were not affected by the illness. The study also shows that depressed people use more words that depict negative emotions. Another study shows an increase in the use of verbs and pronouns in the past tense.

The subject of the paper implements Natural Language Processing (NLP). Natural Language Processing is a field of Artificial Intelligence and Computer Science which deals with interaction between natural language and computers. This involves Natural Language Interpretation, Generation of Natural Languages and recognition of speech.

Systems have been created to analyze text and determine the emotion conveyed through it. However, grammatical mistakes, spelling errors and the use of slang have proven to be a major challenge in Natural Language Processing and Sentiment analysis. Detection of depression from text has become an increasingly important area of research in NLP, with compelling techniques and outcomes have been observed for platforms such as Twitter, Reddit, Facebook and various Forum Posts.
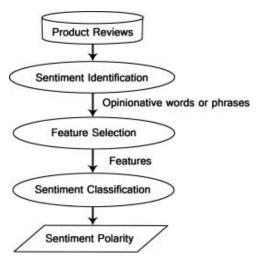
Fig -1: Sentiment Analysis Flowchart

The bag of words model also known as the vector space model is a means used to simplify the representation of text for Natural Language Processing. In this model, a sentence or document is represented as a multiset of its constituent words. This set is compiled with no regard to grammar or the order of the words. The frequency of word usage is taken into account.

3. Proposed System

3.1 Principle

In order to surmount the difficulty caused by slang and grammatical errors, the proposed system bypasses the need for accurate grammar by implementing the bog of words model. The proposed system only takes into consideration instances where the user is talking about themselves or a topic which directly involves them. Instead of a fixed allotment of weight each token is to be assigned to an emotion. Biases are applied to each of the connections in order to provide a cutoff point. This is done in order to avoid mixing up a normal expression of sadness or frustration with actual depression.

3.2 Dataset

Twitter scraper tools such as Octoparse were used to gather data which consisted of over 4000 tweets. These tweets are not initially labeled with any emotion. To find instances which are likely to be positive we used mental health related pages. After shortlisting a handful of positive pages, selected negative pages from a variety of sources such as sports and movie related pages were chosen. Effort was made to gather multiple tweets from the same user in order to form a conclusive opinion regarding the person's mental state.

3.3 Implementation

Once the data has been collected, Python based Natural Language Toolkits are used to implement the bag of words model. Once the text has been converted into this model it is ready to be characterized by the Neural Network Model. The model uses a binary sigmoidal function which restricts the output for each node between zero and one. This is used

because the system deals with absolutes i.e. depressed or not depressed. This is an integration of the perceptron model hence the weight of the biases is set to 1. Similar to the binary sigmoidal function this is used as the system is only required to return one of two values.
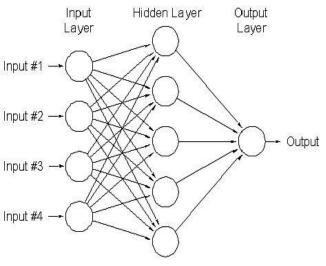

Fig -1: The Proposed Model

The Input layer categorizes the emotion displayed into positive or negative. This is the first level of screening which provides with the most basic breakdown of the input. The first hidden layer determines the severity of the emotion in question. This is to distinguish between a feeling of sadness and actual depression. The second hidden layer determines how relevant the emotion expressed is to the individual conveying it. The output of this process returns a value between zero and one where zero is a healthy mind and one indicates full blown depression.

4. CONCLUSION AND FUTURE SCOPE

4.1 Conclusion

The proposed algorithm can effectively differentiate between general posts and those which indicate depression. The available data on Social Media is always growing which makes it the perfect source to gather data. The system has a wide range of practical applications in prescreening of patients as well as trauma centers.

4.2 Future Scope

The current model is full of potential to be expanded upon. The integration of different languages as well as the local dialects and slang would go a long way towards improving results. Integration of other mental illnesses such as anxiety and bipolar disorder can lead to a more dynamic and flexible tool.

As with any field of study our understanding of the impact of depression on language is growing. The accuracy of such

tools will similarly evolve with this increase in understanding.

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