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Machine Learning in Depression Detection: Exploring the Possibilities

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ABSTRACT

This paper aims to explore the future possibilities of using machine learning to aid in diagnosing and discovering underlying mental illnesses such as depression, anxiety, etc. This is done by testing the current limitations of machine learning when it comes to emotion detection and testing the effectiveness of machine learning in this area using a Python program.

Background

According to the World Health Organization, depression is a mental illness affecting over 280 million people worldwide, however, over ⅔ of these cases go undiagnosed (1&4) . This issue has been proliferating since 2005, with some of the most affected being teenagers and young adults (3). Through looking further into the issue, it can be concluded that the reason this demographic is most susceptible to mental illnesses such as depression is due to the immense societal pressure placed on them by peers, parents, and everyday citizens. However, the biggest culprit can easily be linked to the rise of social media platforms which encourage users to share their lives with others using the incentive of likes, followers, and fans.

Though social media can be a great outlet to express oneself and meet new, like-minded individuals, users tend only to post the very best moments of their lives, leading to unrealistic standards of life. Logging on to such a platform and scrolling through a feed populated with stunning models and amazing productive routines can make one feel sad, worthless, and miserable, all of which are factors that may lead someone to develop depression (2). Due to this correlation between an increase in depression rates in teenagers and young adults and the skyrocketing popularity of social media platforms, understanding how to analyze more honest and fluid platforms such as Twitter or Reddit where people feel more open to express themselves than on platforms like Instagram, we can also predict the probability that a user may have depression. This would, hypothetically, help to decrease the ⅔ of depression cases that go undiagnosed.

Machine learning has been rising since the early 20th century and has aided in multiple fields such as manufacturing, trend prediction, and operational patterns. AI, a broader concept that encompasses machine learning, has been used in an even wider range of fields including the medical realm. A recent study by Dartmouth College shows the use of AI to detect a broader range of mental health disorders on a platform known as Reddit. This project and many others show the potential of AI and machine learning in the medical field (5).

Data Collection

To create this project, we used a demonstrative program off the Git Hub repo in which they created a program used to detect emotions in a tweet. We used this program as a model and a guideline to map out the project we were trying to create. The program was created using the basis of Baye's Theorem, which is a theorem describing how the conditional probability of each of a set of possible causes for a given observed outcome can be computed from knowledge

of the probability of each cause and the conditional probability of the outcome of each cause, as defined by oxford languages.

After importing the tweet data, we needed to spit the data into training and testing sets, so we decided on the number 80% to train and 20% to test since generally, you should use more data to train than to test (See image 2).

After training and testing the data, we decided a visual analysis would be beneficial in showing the results of the data and how the machine differentiated between different emotions. To do this we used a world cloud which visualized the keywords that the machine detected as corresponding with a certain emotion. For example, the word cloud in image 3 is for words corresponding with the emotion “joy”.

Program and Preprocessing

The program began by importing and installing libraries and necessary components such as NLTK and other elements used in the pre-processing section of the program. These include tokenization, stemming, and the removal of stop words, all necessary functions to ensure the accuracy of the program. Tokenization is when a larger body of the text is spilt into smaller entities known as “tokens”. This is what breaks a sentence into words (“tokens”) and allows the program to recognize specific words in a sentence as corresponding to a specific emotion. This function also works in relation to stemming whose purpose is to reduce words to make it easier to correspond words with emotion. This function cuts down the stems of words until only their root word is sent to be processed. For example, the words “do” and “doing” have the same root of “do”, but a machine would be unable to recognize them as the same due to the stem of “-ing” in the word “doing”. Stemming helps to get rid of the stem to allow the machine to register both as the same word since they have the same general meaning. Lastly, the removal of stop words prevents general words such as “a” or “the” from being registered as words that correspond to an emotion rather than filler words. To combine these concepts, let’s take the sentence “I am a very fearful person” and see the effects of all the functions on the word. To begin, tokenization would separate the sentence into 6 tokens, each consisting of 1 word. Then the removal of stop words would delete stop words like “a”. Lastly, the words with stems, in this case, the word “fearful”, would be cut down to its root, which would just be “fear”. In image 1 you can see the code implementing these functions into preprocessing.

The described program, although incredibly useful, is not enough to accurately detect depression. We can use the base of this program to understand how machines can detect emotions in social media, and use this along with more professional, medical standards to create an effective depression detection software.

```
[ ]  !pip install wordcloud
     !pip install nltk
     import nltk
     nltk.download('punkt')
     from nltk.tokenize import word_tokenize #I am doing -> [I, am, doing]
     from nltk.corpus import stopwords #Stop words like a, the, ..
     from nltk.stem import PorterStemmer #running -> run, doing ->do
     import matplotlib.pyplot as plt #Plot functions
     from wordcloud import WordCloud #WordCloud
     from math import log, sqrt
     import pandas as pd #Use to maniplulate dataframe (data), excel in python
     import numpy as np #Matrix, fancy of list
     import re #use to remove special characteres from strings.
     %matplotlib inline
```

Figure 1. Pre-Processing.

```
[ ]  totalTweets = 8000 + 2314
     trainIndex, testIndex = list(), list() #Create 2 empty lists
     for i in range(tweets.shape[0]): #for loop
         if np.random.uniform(0, 1) < 0.98:
             trainIndex += [i]
         else:
             testIndex += [i]
     trainData = tweets.iloc[trainIndex] #Create new training df based on the Train indexes
     testData = tweets.iloc[testIndex]
```

Figure 2. Filtering Data.

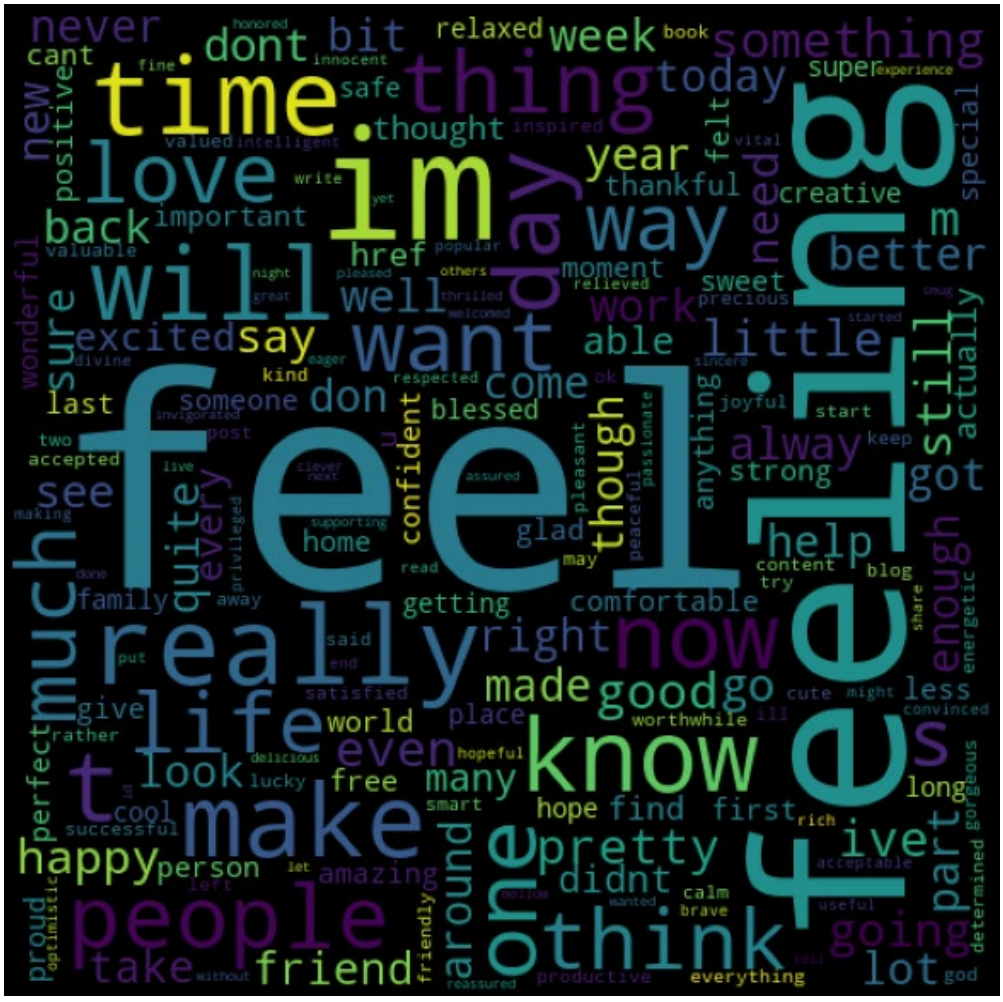

Figure 3: Word Cloud.

Conclusion/Deployment and Future Plans

We plan to deploy this program through a simple app interface using Tkinter, where you can enter a tweet and/or sentence. Through this user input, the program will calculate the probability that the person who wrote that tweet has depression, which is the output. This interface would be a prototype for a more advanced interface that can search all of the public social media data of an individual given their consent, such as comments and posts. The desired input would be one's email address used to make their online accounts. The output would be a detailed report about the results of whether or not that user may have depression. Due to privacy concerns relating to this advanced version of the application, this version would only be available to medical professionals who may use it for clinical purposes with the user's consent. This would make it very useful to psychiatrists in the process of diagnosing a patient with depression or related illnesses as they can now search through their patients' online data with a click of a button.

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