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Research Article

Detecting Signs of Depression from Social Media Platforms

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Abstract

Depression is a common mental illness that involves sadness and lack of interest in all day-to-day activities. Detecting depression is important since it must be observed and treated at an early stage to avoid severe consequences. Our Project aims to detect the signs of depression of a person from their social media postings wherein people share their feelings and emotions. Given social media postings in English, our system should classify the signs of depression into three labels namely "not depressed", "moderately depressed", and "severely depressed". To build a sophisticated classification system we use different Neural Network models like Long Short Term Memory (LSTM), Bi-Directional LSTM, Convolutional neural network (CNN), Gated recurrent units(GRU). On developing all the models we obtained the highest train accuracy of 98.8 percent and test accuracy of 48 percent.

Keywords: Online Social Media; Depression; Machine Learning; Deep Learning

Introduction

Human beings are social creatures that require the companionship of others to make progress in life. Thus, being socially connected with other people can relieve stress, anxiety, and sadness, but lack of social connection can pose serious risks to mental health. Social media has recently become part of people's daily activities; many of them spend hours each day on Messenger, Instagram, Facebook, and other popular social media. Thus, many researchers and scholars study the impact of social media and applications on various aspects of people's lives. Moreover, the number of social media users worldwide in 2019 is 3.484 billion, up 9 percent year-on year (data reportal, 2019). A statistic on the gender distribution of social media audiences worldwide as of January 2020 founded that only 38 percent of Twitter users were male but 61 percent were using Snapchat (statista.com, 2020). In contrast, females were more likely to use LinkedIn and Facebook. There is no denying that social media has now become an important part of many people's lives. Social media has many positive and enjoyable benefits, but it can also lead to mental health problems. Previous research found that age did not have an effect, but gender did females were much more likely to experience mental health than males.

Literature Review

Many Artificial intelligence approaches such as Machine learning and Deep Learning models [1-7,9-50] have been used in several studies on the early classification of depression but in different formats. Wonkoblap. A in [8] used convolutional neural networks to compare and contrast a variety of models for analysis and for the prediction of emotions, they depended on linguistic metadata. They had success with the proposed strategy when completing state-of-the-art jobs. Most research investigations on the identification of depression are based on textual data or person-descriptive methods using social media posts to select features. The linguistic elements of the social media content, such as words, Part-of-Speech (POS), Ngrams, and other linguistic properties, are the subject of textual-based featuring in the paper [1]. Kim Jin in [4] discussed

the impact of using a supervised machine learning algorithm to measure predictive factors for detecting post-traumatic stress disorder. They built a model in every language style, using Twitter users as part of their research. Mathur and Puneet in [6] proposed a solution using Bidirectional LSTM (BLSTM) + Attention model for the early detection of depression from the historic tweets of Twitter users. One thing that came out after the literature review/analysis that most of the researchers used a single machine-learning method whereas in our research we explored all the suitable and possible approaches for the classification of depression and further streamlined our model on the basis of accuracy.

Methodology

For this Task, our main goal is to develop a system which segregates text/words from a selected social media platform and further filters it into tokens which will then determine whether it contributes to a depressed person's thoughts/ideas. Our initial approach to this problem is by using long-short term memory (LSTM) from the deep learning concepts. LSTM works in the following manner: A sequence or a set of information (in our case long sentences/paragraphs) words get transformed into machine readable vectors. The LSTM processes data passing on information as it propagates forward. These operations allow LSTM to predict the output (in our scenario depressed or not). Adding to the context, our model will learn/predict the output based on the selected target variable. Our dataset provides us with approximately 9000 instances (social media responses) depicting a person's state of depression. We start by importing the following instances from a CSV file to our variables. We then proceed with our data-pre-processing where we saturate all our responses to have equal segments of every subdivision within the labels. We then tokenized the sentences based on words using fit on texts and then the sentences using the "texts to sequences". After that to have the equal number of words in one sentence we used padding in which the values are added after the sentences. After that to have the equal number of words in one sentence we used padding in which the values are added after the sentences. We Then load the embedded file or the corpus as referred to as in 'NLP' with glove. After that we created the LSTM layer with bidirectional LSTM and embedding layer to predict the depression status/level of sentences (not depressed, moderate and severe) which is further explained in dataset. The next step in our process is to perform the test-train split with the ratio being 80:20 for ideal optimality (general splitting criterion). Then comes our implementation of our LSTM model with different sets of hyperparameters which will further be fine-tuned in a trial-and-error fashion to get the optimal test scores. And thus compare the obtained scores with our normal Machine Learning models [1-3,9-12,15] to depict the advantage of using Neural Networks [16,18-26] over the traditional methods. Furthermore,

Class: Count

Moderate: 6019

Not Depression: 1971

Severe: 901

We use other models that are within the Neural Networks to diversify our knowledge on the subject.

Dataset

The dataset which we have taken has three labels namely moderate, severe, and not depressed. Each of them has 6019, 901 and 1971 respectively the data is imbalanced therefore we take 901 instances for all the labels to make it balanced. Then this file provides us a way to create tokens which is very useful in prediction. After tokenizing the values, we came to know that there is no ample number of words to cover all types of sentences due to which it takes a dip in accuracy to overcome this problem we introduce an embedding file, named glove, which has minimum number of words in dictionary words which made the model more optimal. In order to normalize the data as the labels are not equal we proceed with Data down-sampling and bring all the labels to a count of 901 which is the number of records in severely depressed category and as the task mainly focused on extremely depressed text classification we down-sample all the other labels to match with the before mentioned class.

Further, readers are suggested to refer to use Tyagi., *et al*. work [9-50] to know about importance of Machine learning and other essential technologies in this smart era. You will find in these works "how to solve real world problems" with effective and simplest mechanism.

Observations

To understand our model better we have hyper tuned our parameters to get the best out of our models thus aiming for increasing our accuracy score and reduce the loss function the observations after 3 sets of hyper-tuning.

Results and Discussions

Our project's final stage is to predict a person's mental condition (severity of depression) through online texts posted on various social media platforms. The last step of the model building process is to understand how well our model performs in a real time scenario. To do the same, we executed our demo model with some sentences which mimics real life social media behavior of the public and figuring out whether that sentence/paragraph contributes to a person being depressed or not.

Test case-1

Input Sentence: "I want to die" Output Sentence: Severe.

Test case-2

Input Sentence: "'Feeling stressful", "I am going to commit suicide! Output Sentence: Severe

Test case-3

Input Sentence: "I am so cheerful today!!" Output Sentence: Severe.

```
new_complaint =['Life is so uneasy for me and its complicated!']
seq = tokenizer.texts_to_sequences(new_complaint)
```

Figure 1: Adding sentence - 1.

```
Prediction:  [[0.17379075 0.700565   0.12564428]]
     Label:  not depression
```

Figure 2: Prediction of sentence - 1.

```
new_complaint =['Life makes me uneasy all the time!']
seq = tokenizer.texts_to_sequences(new_complaint)
```

Figure 3: Adding sentence - 2.

```
Prediction:  [[0.27219826 0.69021183 0.03758992]]
     Label:  not depression
```

Figure 4: Prediction of sentence – 2.

Layers	Loss	No of Neurons	Accuracy
1	0.1216	64	0.9656
2	0.1361	128	0.9575
3	0.1574	256	0.9501

Table 1: Convolution Layer Hyper-Tuning.

Dropout	Bi-Direction	Loss	Accuracy
0.1	0.05	0.0484	0.9889
0.2	0.1	0.0735	0.9815
0.35	0.15	0.1216	0.9656
0.5	0.3	0.0735	0.9327

Table 2: Dropout Hyper-Tuning.

Model	Loss	Train-Accuracy
CNN	0.055	0.993
Bi-dir. LSTM	0.0484	0.9889
LSTM	0.0557	0.9859
GRU	0.2459	0.9179

Table 3: Model Layer Hyper-Tuning.

Here as humans we can see the person is clearly not happy with his life and should be classified un-der depressed or atleast moderately depressed. This is due to oversimplification in training of our neural network (generalization), hence this is something which can be improved upon in the future for better results.

Metrics: Score

Accuracy: 0.472111

Macro F1-score: 0.37782

Error analysis

After obtaining the test accuracy of approximately 50 percent we further move on to investigate and understand why our model couldn't perform better. Taking our bestfit model we see that Bi-directional LSTM classifies with the best accuracy score and least loss function value. With a training accuracy of 98 percent it is inferred that the given model has learnt very well but it doesn't really guarantee that it will perform similarly in a test environment. Error Identification and diagnosis - The reason for this approach is due to our dataset being completely text-based, we use this method to know how errors are distributed across key hypotheses or

key features of the dataset. We train our model using 901*3=2703 text sentences and its label in different settings and test using the dataset provided by the organizers which means half of the classification were right and the other half wrong. By manually reviewing the examples we come across certain words which trigger our model to provide the wrong response.

One such example is the word uneasy is a word which can have several meaning depending on the context but the classification always sticks to not depressed even though we give a statement that clearly indicates a person's depressed state.

Conclusion

After the model building process followed by the hyper tuning all the models, we have thus reached to a conclusion that the Bi-directional-LSTM model with a spatial dropout value of 0.1 and a bi-directional dropout value 0f 0.05 embedded within the bi-directional layer with a batch size of 32 gives us the best training accuracy score of 0.9878 and the validation accuracy of 0.472111 along with the least loss function value of 0.0471 and Macro F1-score of 0.37782 making it the most appropriate and efficient deep learning model for our project. Along with that the activation function used for the final output dense layer is of "softmax" and the loss function utilized for finding out the goodness of fit is "categorical cross entropy" along with the generic adam optimizer.

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