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Real-time twitter data analytics of mental illness in COVID-19: sentiment analysis using deep neural network

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ABSTRACT

The World Health Organization (WHO) states that the COVID-19 epidemic is being treated as a pandemic, with thousands of individuals infected and dead worldwide. School and college students are suffering from their online classes without any physical activities. Working men and women are also suffering from their working situations, as lots of people have lost their jobs and unemployment rates have become high due to the pandemic, and people are also losing physical contact with other family members, friends, and colleagues. The main objective of the proposed model is to monitor and analyse the real-time Twitter data-related tweets, such as coronavirus mental illness that are commonly used while referencing the pandemic. We have compared three deep learning approaches to sentiment analysis and found them to be useful. The first deep learning technique is to use a basic recurrent neural network (RNN), and the second is to use a deep learning RRN with long short-term memory (LSTM), followed by a gated recurrent unit (GRU). The experiment results indicate that the recurrent neural network built using GRU has the maximum accuracy of 99.47% for positive, negative, and neutral words and statements in Twitter data.

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1. INTRODUCTION

The entire world is battling an exclusive COVID-19 epidemic. The number of those infected is increasing, with statistics indicating that thousands of new cases occur daily. On the other hand, the government is taking steps to address the current and potential COVID-19 pandemic challenges. As a result of the pandemic, a great number of people are feeling emotional breakdowns, uneasiness, tension, stress, anxiety, sadness, and loneliness, as well as sleep difficulties. Fear of losing employment and going out, instability for oneself and loved ones, and job risks are just a few of the factors affecting people's mental health. Individuals with a history of mental illness are more prone to these effects. Psychologists are expected to make more efforts to assist marginalised and lonely people. Social media networks and blogs have evolved into useful resources for real-time analytics. Additionally, this vast volume of data has piqued researchers' interest in eliciting public opinion. The real-time Twitter data enables us to ascertain the opinions and viewpoints of those impacted by the COVID-19.

Sentiment analysis is a computer-assisted procedure for categorising text data as positive, negative, or neutral. In recent years, deep learning with Twitter categorisation has shown a lot of potential. According to Araque *et al.* [1], the purpose of this work is to achieve a high level of performance on sentiment categorization using deep learning. This article makes use of Word2vec and auto-encoders, as well as the

recurrent neural network (RNN). This research utilised RNNs, which outperform binary and fine-grained sentiment analysis. They achieved good performance in sentiment analysis by combining the geometric mean of three models: weighted BOW, language model approach, and continuous representation of phrases. The experiment generated six sentiment classification datasets using a base classifier and an ensemble of classifiers and features. Future work suggests that this work can be expanded to include emotional analysis. In their May 2018 paper, Jianqiang *et al.* [2] used convolutional neural network (CNN) for sentiment analysis in their May 2018 paper. The purpose of this project is to acquire knowledge about Twitter terms and to create an implicit extract of their semantic relationships. This project makes use of CNN to analyse Twitter tweets, as well as radial basis function (RBF) kernel support vector machine (SVM) and logistic regression. As a result, the model captures the repeated data and converts it to a text representation using CNN. The model outperforms state-of-the-art and baseline models in terms of performance. In the paper, Barathi and Poonkuzhali [3] subsequently examined the sentiments of breast cancer messages on Twitter in the form of big data.

2. REVIEW OF LITERATURE

COVID-19's related work is outlined in this section. Social media platforms have the potential to aid in the diagnosis and treatment of mental illnesses. Sentimental analysis employing machine learning and deep learning technologies, as well as Twitter analysis, play an important role in gaining a better understanding of people's mental health and possible remedies.

2.1. COVID-19

In the paper, Gupta *et al.* [4] compiled a massive amount of publicly annotated data on the COVID-19 outbreak. They experiment with the basic statistics of topical and emotional attributes and their temporal distributions, and they discuss their potential use as well as their algorithms, such as natural language or the CrystalFeel algorithm, in communication, psychology, public health, economic and epidemiological research. The experiment's purpose was to find a new dataset for larger studies and research communities. The investigation says that cheap and efficient planed ordered charging (POC) kits can be developed. In the paper, Pokhl *et al.* [5] chest computed tomography (CT) imaging, nuclear acids, and diagnostic procedures are the resources and algorithms employed for the experiment and immunoassays. Immunoassays have achieved remarkable results. The data has been obtained to isolate and treat patients during the early outbreak of the viruses in the panic zone. In the paper, Afroz *et al.* [6] which focuses on public opinion during India's COVID-19 nationwide lockdown, according to their results, lockdown 1.0 received the most positive sentiments, followed by input common-mode range (ICMR) and medical facility. In the paper, Hung *et al.* [7] identified five common themes in the COVID-19 conversation, with sentiments ranging from positive to negative. They have also mentiones that the themes and sentiments can help officials navigate the pandemic as well as clarify the public's response to COVID-19. In the paper, Kaur *et al.* [8] proposed a a sentiment analysis of Twitter data based on hashtag terms, such as COVID-19, coronavirus, deaths, and new cases, and categorised them as positive, negative, or neutral sentiment scores.

2.2. Mental health and sentiment analysis

In the paper, Sridivya *et al.* [9] emphasise that mental illnesses such as stress and social anxiety, depression, obsessive-compulsive disorder, addiction to substances, and personality disorders lead to mental health difficulties. The experiments were performed using several machine-learning techniques, including support vector machines, decision-making boards, nave Bayes classification, K-nearest neighbour classification, and logistic regression on a target group to detect a state of mental health. The relevance of social networks and their postings is a new resource for people's mental health monitoring to communicate their sentiments, atmosphere, and everyday activities, as Almouzini *et al.* [10] note. They have utilised Arabic data to investigate depressing feelings using non-depressed tweets, and then constructed a predictive model based on monitored learning algorithms, predicting if a user twitch has been depressed or not. They have used Arabic data. Using sensor data and machine learning methodologies, Garcia-Ceja *et al.* [11], have suggested their study into systems for monitoring mental health. They concentrated their research on mental problems, including depression, anxiety, and stress. In the paper, Mathur *et al.* [12] have examined the Twitter data to determine people's mental health using sentimental analysis and classified it into essential emotions during the COVID-19 epidemic.

2.3. Machine learning and deep learning with twitter analysis

On the Twitter dataset, Wazery *et al.* [13] suggested RNN-long short term memory to categorise the positives and negative opinions of people with different airline datasets and compare the accuracy results with other machine learning techniques.

In the paper, Go *et al.* [14] have presented a novel way of detecting Twitter message feelings automatically, and they have trained a model using emotional tweets. They have reached an accuracy of more than 80%. Twitter postings on electronic products, such as naive bayes, the SVM, maximum entropy and the ensemble classification, were analysed by Neethu and Rajasree [15], to analyse Twitter data sets of electronic devices, including power conditioning system (PCS), mobiles, and laptops. The study provided a novel vector which classifies tweets as favourable, negative and provides product opinions.

In the paper, Gautam and Yadav [16] have suggested a system for analysing and categorising customer feedback into favourable, negative, or somewhere between them. They measured precision, accuracy, and recall using various machine study methods like nave bayes, entropy, support vector and semantic analysis (WordNet), and SVM, which achieved a precision index of 89.9%. in the paper, Tang *et al.* [17] have developed coooolll, a deep learning system that is both a supervised learning framework and a feeling-specific word embedding system. Tweets containing positive and negative emotions have also been collected without manual annotation.

In the paper, Gokulakrishnan *et al.* [18] used a tweet stream that is pre-processed and categorised by positive or negative content on the basis of their emotional content. It also developed a Bayesian logistic regression classification model, utilised to achieve high precision. The classification of sentiment, or the tweets as positive, negative or neutral, was investigated by Jiang *et al.* [19] They contributed several phases, including data from Twitter, which was pre-processed and then built into an adjective vector, which was extracted from Twitter's data after different machine learning algorithms were applied, such as the vector machines supported by nave bayes, maximum entropy with WordNet, and semantic orientation to select synonyms and similarity. They also employed several methods: recall, precision and precision in order to measure the model.

In the paper, Kaur *et al.* [20] pre-processed the tweets, and then the tweets were analysed with textblob, which showed the intriguing results through several visualisations of positive, negative, and neutral attitudes. In Guntuku, *et al.* [21], a Twitter dashbox is being established, with special mention of mental illnesses and symptoms in the U.S. during the COVID-19 epidemic.

In the paper, Monika *et al.* [22] used word embedding models in tweets, utilising profound learning methods to predict sentiment polarity. They studied sentimental analysis for prediction and visualisationutilising the model RNN with the long-short term memory network. In the paper, Zhang *et al.* [23] created transformer models with the largest depression dataset, with a lot of training. They may easily be employed to monitor stress and depression trends of selected groups across geographical entities like states with their deep learning patterns. The live application for Kabir and Madria [24] was designed to monitor tweets on US-generated COVID-19. Different data analytical systems were generated for some time to analyse changes in subjects, subjectivity and human emotions. In the paper, Alharbi *et al.* [25] examined a number of developed and analysed deep learning algorithms, including standard RNN and four versions, long short-term memory networks and group long short-term memory networks.

3. RESEARCH METHOD

The proposed system includes the following processes: real-time data collection from Twitter by using the application programming interface (API). After authentication, the Twitter data is collected through the consumer key, consumer secret, access token, and access token secret in the course of the code script. Then the data set is preprocessed, then feature extraction, sentiment classification, and evaluation, as illustrated in Figure 1.

3.1. Collecting data set from Twitter

Since February 2020, we have gathered a real-time dataset from Twitter. By obtaining authentication keys such as consumer key, consumer secret, access token, and access token secret. Furthermore, we divided the dataset into a 67 percent training dataset and a 33 percent testing dataset for training and evaluating the model.

3.2. Pre-processing

We cannot directly input raw data into deep learning algorithms. The raw data must be preprocessed, which prepares and cleans the data and lowers noise, allowing the classification process to run more efficiently and quickly. After preprocessing the real-time Twitter data, we classified it using deep learning techniques.

The Keras deep learning package includes some fundamental tools for pre-processing the text data.

This step consists of the following phases:

- By deleting hyperlinks and special characters through the use of basic regular expressions.

- Use text to word sequences to split words.
- Separate words with a space (split="").
- Removes punctuation (filters='!"#$%&()*+,-./:;<=>?@[\\]^_`{|}~\t\n').
- Converts lowercase text (lower=True).
- API for tokenizers
- Keras includes a class called Tokenizer, which may be used to prepare text documents for deep learning. The Tokenizer must first be constructed and then applied to raw text or integer-encoded text documents.
- Stop word removal - Stopwords are commonly occurring words in a language like ''the'', ''a'', "of", "I", "it", "you", and"and so on.
- Stemming process, stemming is a procedure that reduces words to their source by eliminating inflection via the deletion of superfluous characters, typically a suffix.

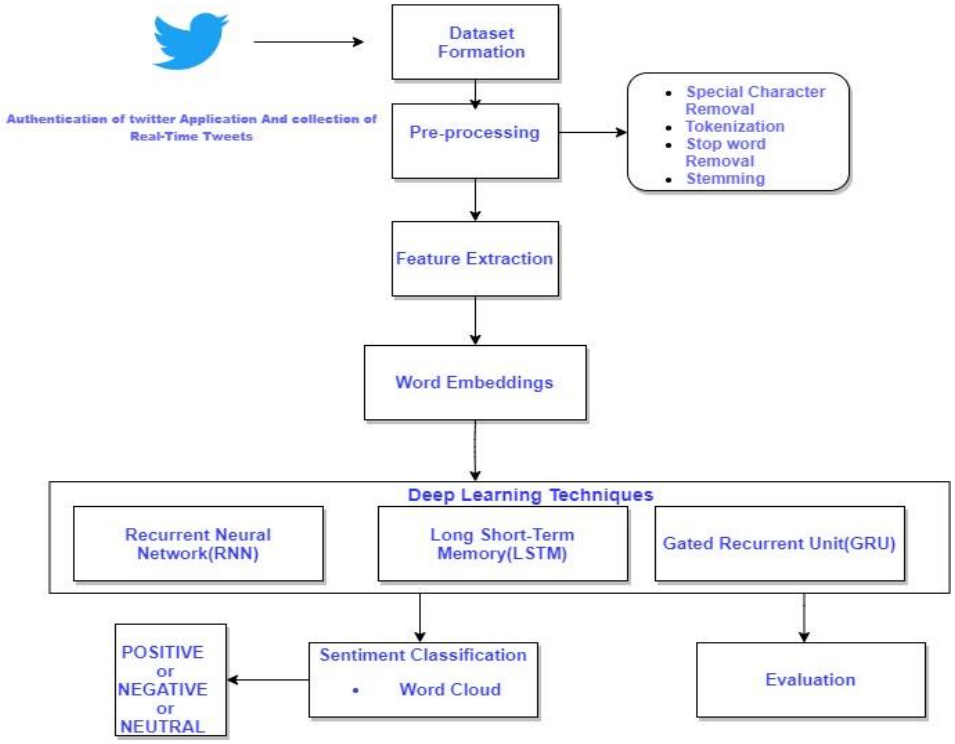

Figure 1. Proposed method for real-time sentiment classification

3.3. Feature extraction

Words are converted to a matrix of vectors using feature extraction. This level is implemented differently than supervised algorithms or a deep neural network.

- Constructing the bag of words: a collection of words that will be used as input for machine learning. Additionally, countvectorizer built a bag of words, which is a frequent vectorizer usage, and it is library building in the python language.
- A word embedding: the deep neural network is implemented with a word embedding. It is used to create dense vector representations of words and documents.

3.4. Classification

3.4.1. Deep neural network approach

- A recurrent neural network

A recurrent neural network is a special case of a feed-forward neural network with internal memory. RNNs are recurrent in nature since they perform the same function for each data input while the output of the current input is dependent on the previous computation. After the output is generated, it is replicated and returned to the recurrent network. It examines the current input and the output it has learned from the prior input while making a decision.

– Long short term memory (LSTM)

These networks are a variant of recurrent neural networks that make it easier to recall previously stored data. Here, the RNN's vanishing gradient problem is resolved. LSTM is well-suited for classifying processes and forecasting time series with uncertain time delays. Back-propagation is used to train the model.

– The gated recurrent unit (GRU)

RNN is not able to memorise a communication context that is not appropriate for real-time use. So the solution to this GRU was represented. It has a memory cell unit that can recall the meaning of the previous sequences. The key advantage of GRU is the decreased number of parameters relative to LSTMs without any conflict, which has resulted in better accuracy and a more generalised model.

3.4.2. Sentiment classification

Sentiment Analysis is a broad term used in the context of text classification. It refers to the process of interpreting and classifying emotions in text content using natural language processing and machine learning. Using deep neural network techniques, we classify the COVID mental health-related tweets as positive, negative, or neutral. textblob is a Python module for text file processing. It provides a straightforward API for doing natural language processing (NLP) activities such as part-of-speech tagging, noun phrase extraction, sentiment analysis, classification, and translation.

3.5. Evaluation

There are numerous approaches to evaluating a deep learning model; the model's accuracy has been defined as the ratio of correctly identified tweets to the total number of available tweets. Following the introduction of actual and predicted values, all other performance evaluation metrics such as Accuracy, F1 score, precision, and recall are introduced. These metrics are also used to assess the performance of various deep learning (DL) classifiers such as RNN, LSTM, and GRU.

4. RESULTS AND DISCUSSION

4.1. Dataset formation

We developed a model for corona mental health using a real-time Twitter dataset. The Twitter dataset is made up of random tweets from public Twitter accounts related to the search term "covid mental health." The dataset was compiled over the course of a year, beginning in December 2019, using Twitter's stream API. Additionally, the dataset was divided into a 67% training dataset for training the model and a 33% testing dataset for evaluating the model.

4.2. Sentiment analysis

Sentiment analysis is a computer-assisted procedure for categorising text data as positive, negative, or neutral. By analysing people's ideas about corona mental health in Twitter data, businesses can gain a better understanding of how their brand is being discussed. The percentages of positive, negative, and neutral tweets are listed below, and Figure 2 illustrates the count of positive, negative, and neutral sentiments.

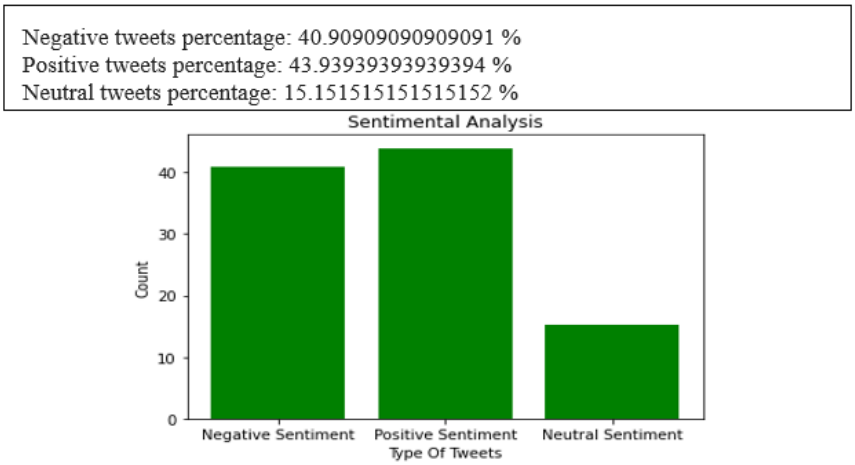

Figure 2. Count of positive, negative and neutral sentiments

4.3. Classification: RNN_LSTM

Table 1 describes the network configuration with the parameter value such as batch size, activation function,optimizer of simple RNN, RNN-LSTM, and RNN-GRU. Has been performed using tensorflow and Keras. Among the three classifiers, GRU gives the highest accuracy is also shown in Figure 3 and the performance evaluation of different classifiers is shown in Table 2.

Table 1. Parameters with values

Parameter	Value
Batch size	32
Activation function for hidden layer	softmax
Activation function for output layer	softmax
Optimizer	Adam
Learning rate	0.001
Drop out	0.2
Loss Function	Categorical crossentropy
Total parameters & Trainable parameters	511,588
Training size	67%
Testing size	33%

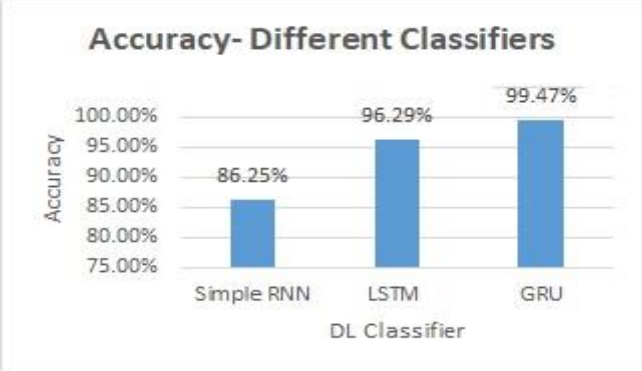

Figure 3. Accuracy–simple RNN, LSTM and GRU

Table 2. Performance metrics of different DL classifiers

DL Classifier	Accuracy	Precision	Recall	F-Measure
Simple RNN	86.25%	0.9271	0.8095	0.8636
LSTM	96.29%	0.9629	0.9524	0.9575
GRU	99.47%	0.9947	0.9947	0.9947

4.4. Word cloud

Figure 4 represents several useful points that could be inferred from the Tweets available in the word cloud. The following inferences were made from the dataset.

- There is lack of oxytocin among people due to the COVID-19 pandemic. Oxytocin is a neuropeptide that promotes pleasant, feel-good sentiments of confidence, relational bonding, and social bonding, while lowering apprehension and anxiety responses in the brain.
- The tweeters have discussed the consequences of Touch starvation due to the necessity for people to maintain a certain physical distance, as a precautionary measure to avoid the transmission of Coronavirus. The absence of human touch and close interaction might lead to mental and physical health issues.
- There is frequent mention of the words "stress," "depression, "loneliness due to lockdown, financial burden, daily wage workers, job insecurity, homeschooling of children, and the unpredictable end of the virus," and lack of societal well-being.
- Government actions to help people through helplines, TV, radio, awareness workshops, and webinarsconducted for the physical and mental wellbeing of the huge population.
- The narration of experiences of people who have either avoided corona by observing the precautions and also of those who have undergone treatment and successfully recovered after the affliction of the virus.

- Announcement of the nationwide lockdown, its duration, and the imposed restrictions for people to follow strictly and relaxations they can count on.
- WHO's initiative on the development of vaccines is the result of innovative research on the nature of the virus and its spread.
- Information on the Covidshield and Covaxine vaccines, as well as vaccination programs, including age group and comorbidity.

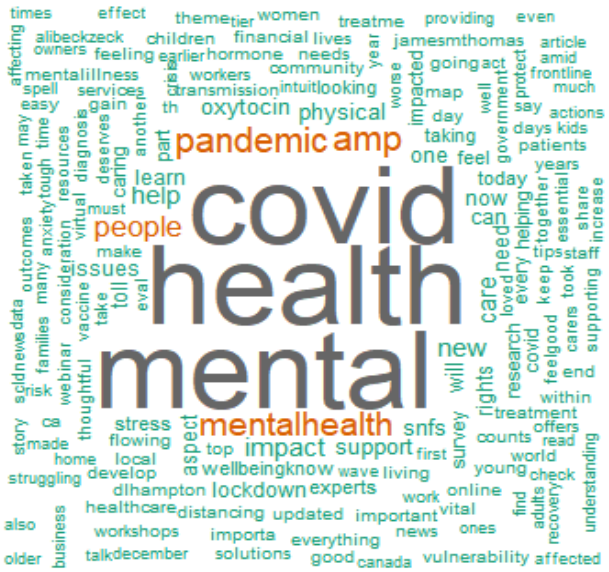

Figure 4. Word cloud

5. CONCLUSION

The purpose of this work is to apply fundamental RNN, LSTM, and GRU techniques to the Twitter dataset in order to classify people's perspectives on the coronavirus as positive, negative, or neutral, as well as to compare the accuracy impacts. The GRU model is more precise than other models, with a precision of 99.47 percent. The word cloud is used to illustrate common phrases and phrases based on their frequency and importance in this research. The numerous important details about COVID mental health treatment that may be extracted from the Tweets in the word cloud are also included to demonstrate the technology's use.

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