

Sentimental Analysis Applications and Approaches during COVID-19: A Survey

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ABSTRACT

The social media and electronic media has a vast amount of user-generated data such as people's comment and reviews about different product, diseases, government policies etc. Sentimental analysis is the emerging field in text mining where people's feeling and emotions are extracted using different techniques. COVID-19 has declared as pandemic and effected people's lives all over the globe. It caused the feelings of fear, anxiety, anger, depression and many other psychological issues. In this survey paper, the sentimental analysis applications and methods which are used for COVID-19 research are briefly presented. The comparison of thirty primary studies shows that Naive Bayes and SVM are the widely used algorithms of sentimental analysis for COVID-19 research. The applications of sentimental analysis during COVID includes the analysis of people's sentiments specially students, reopening sentiments, analysis of restaurants reviews and analysis of vaccine sentiments.

CCS CONCEPTS

• **Computing methodologies** → **Classification and regression trees**; • **Applied computing** → **Multi-criterion optimization and decision-making**; • **Information systems** → **Sentiment analysis**; • **Human-centered computing** → **Heat maps**; • **Social and professional topics** → *Employment issues*.

KEYWORDS

Big Data, Sentimental Analysis, Social Media, Machine Learning, COVID-19, Coronavirus, People's reviews

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1 INTRODUCTION

Today, people usually make review on internet to express their opinion about the service, things they use or about any trending topic, [34]. With the advancement of technologies and industrialization era, a number of industries have been setting up and appealing the customers to buy their products online and also make review to highlight their positive and negative experience about their products. The overwhelming of review data on internet has increased the chances of extracting valuable information from it in the form of sentiments [15] [16]. Sometimes, people express multiple sentiments polarities in a single text. It is good for a business or organization to understand the sentiments of the customers. Sentimental analysis is natural language processing (NLP) task which usually understands the meaning of the text [14] and classify in positive, negative or neutral sentiments of different aspects in a text. The aspect level sentimental analysis is the fine-grain task in sentimental analysis and provides a complete sentimental expression [34]. For instance, "The chair is comfortable but its price is high". In this example, "comfortable" and "high" represent positive and negative sentiments respectively. The advancement in artificial intelligence techniques has eliminates the traditional methods of sentimental analysis.

After World War II, COVID-19 has considered as the biggest problem faced by whole world. The coronavirus was first spotted in China in December 2019 and has spread in the whole world. According to John Hopkins University, more than 130 million people have been affected and 2, 861, 677 number of deaths have been occurred due to COVID-19 till the first week of April 2021. The destabilization caused by COVID has created the multiple emotions in people such as fear, anger, anxiety, depression even hostility [31].

The two ways to solve sentimental classification tasks are traditional machine learning methods and deep learning methods. The traditional methods usually use classifiers i.e. SVM (Support Vector Machine) and Naive Bayes for this purpose while in deep learning methods Recurrent Neural Network (RNN) and Convolutional Neural Network (CNN) have widely used in NLP tasks. Deep learning is becoming famous in this regard as it perform feature engineering and extract meaning features automatically [34]. The

literature shows that CNN does not perform well in capturing the sequential dependencies and RNN suffers from gradient vanishing and parallel-unfriendly problems due to its recurrent nature. This indicates that the existing approaches for sentimental classifications have shortcomings such as low performance in terms of accuracy and recall and high training timings etc. When there are multiple aspects with inconsistent sentiment polarity in a sentence, the dependencies between the words will be weakened due to increase in distance. In such case, the attention mechanism can put its focus on the most important information.

In this study, we have performed the survey of thirty primary studies related to sentimental analysis during COVID-19 pandemic and figure out the techniques that have been applied in order to classify the sentiments of the people as well as the application areas of sentimental analysis during COVID research. The objectives of this survey are to identify the data sources and data volume of sentimental analysis during COVID-19, to identify the mostly used approaches and the applications of sentimental analysis during COVID. This study also presents the future implications of research with respect to COVID.

2 METHODOLOGY:

The review of thirty primary studies has been conducted in this study as shown in Table 1. In Table 1, benchmark data sets and well known data sources are mentioned in column 2 to help the researchers or readers in getting similar kind of data. The volume of data used in individual study has been mentioned in column 3. The Column 4 specifies the types of approaches or techniques which have been widely used during COVID for sentimental analysis and classification. During COVID, sentimental analysis was performed over different application areas which have been illustrated in column 5 of Table 1. This is the most important aspect of this surveys as it can open new research directions or topics for future researchers. The future trends and implications have been presented in column 6.

2.1 Data Sources during COVID-19 research:

Sentimental analysis is considered as a sentimental classification task. During COVID-19 pandemic, people experience different emotions and express their emotions using different social media platform. The social media platforms are the rich source of information as well as data in order to figure out the people's reactions and feelings during the destruction of COVID. Table 1 shows that the biggest data source for the research during pandemic was **twitter**. The statistics shows that 24 out of 30 studies uses twitter as a data source while other sources of data are online media and forums, Weibo account, WeChat account, Reddit, Yelp, RateMDs, HealthGrades, and Vitals and Qingbo Big Data Agency. The information which can be found on these popular social media is given in table ??.

Twitter: Twitter is considered as most popular social media platform having almost 81.47 million registered users [1]. People share message, that are called "tweets", related to public and global situations ultimately turning the twitter into data hotspot for web-based media conversation. In a single day, people post about 500 million tweets which results in 200 billion tweets posted per year

[4]. The tweets are grouped based on their topics such as political matters, personal opinion, national economic issues, COVID-19 pandemic [9].

WeChat: WeChat is the Chinese multi-purpose social media and messaging platform. It has one billion monthly active users which regarded the WeChat as most popular social media platform.

2.2 Approaches for COVID Sentimental Classification

With the rise of big data, there is a need to develop efficient analytics tools [10]. Sentimental Classification Approaches, during COVID-19 research, can be divided into three types. Machine learning based approaches, lexicon based approaches and hybrid approaches.

2.2.1 Machine Learning Approaches: The machine learning based approaches use the famous ML algorithms for the SC during COVID. They further consists of two categories i.e. supervised and unsupervised learning methods.

Supervised Learning Methods: In the supervised learning methods, the instances of the data are labelled already [30]. Various supervised learning methods have been used in literature for the sentimental classification in COVID-19 related research as seen in Table 1.

Naive Bayes: Naive Bayes is one of the supervised learning algorithm and have been used in [1] and [27]. It works on the principle of Bayesian theorem given in equation 1.

$$P(H|X) = P(X|H)P(H)/P(X) \quad (1)$$

Support Vector Machine: SVM is the statistical learning based machine learning algorithm that works by converting feature space into high dimensional features in order to find the hyperplane. It is used by [1], [20], [25] and [32].

Decision Tree and Random Forest: Decision tree is the machine learning algorithms that trains its model to predict the class values based on simple decision rules found in entire train dataset. Random Forest belongs to the family of decision tree and works by choosing random features as well as random instances. It has been used by [1], [12], [25] and [32].

Other supervised learning approaches used in SC for COVID research are KNN [1], Linear Regression [1], Logistic Regression [27], [32], LSTM [11], [25], RNN [19] and BERT model [4], [18] etc.

Unsupervised Learning Methods: In unsupervised learning methods, the data is not labelled. The unsupervised methods have been used in SC related to COVID. K-means clustering has been used by [6] while Latent Dirichlet Allocation (LDA) method has been used in many studies i.e. [5], [9], [22], [29], [32], [33], [35].

2.2.2 Lexicon Based Approaches: Two types of opinion words are used to express the feelings i.e. positive opinion words and negative opinion words which are used to express likes and dislikes respectively. Different approaches are used to collect the opinion words list.

Dictionary-based approach and Corpus-based approach Dictionary based and corpus based approaches have been used in [3] in order to perform the sentimental analysis during COVID-19

Natural Language Processing Natural language processing (NLP) is used along with lexicon based methods in order to find the semantic relationship in a sentence. It has been used in [2] for the mental health analysis of students during COVID. In [19] and [23], NLP has been used to Analyze sentiments and characteristics of Covid-19 respectively. [33] has also used NLP to examine COVID-19-related discussions, concerns, and sentiments using tweets.

2.3 Sentimental Analysis Applications during COVID-19

COVID-19 has attracted the researchers in the area of sentimental classification as COVID has effected people's behaviours and attitudes in many ways. There are various topics that work under sentimental classification during COVID-19.

2.3.1 Sentimental analysis on palliatives distribution during COVID-19. It is responsibility of any government to maintain the sustainability of any country. During COVID-19, people needed help in order to lessen the economic as well as psychological stress. For this purpose, different governments releases the relief packages and certain other bonuses. In developing countries, monitoring the public funds transparency is a challenge. Therefore, it is necessary for the government to analyse the people' reaction and sentiments on the palliative distribution as it will indicate the reach of funds and its impact on people's circumstances during COVID-19. In [1], Adamu et al. performed sentimental classification on on Nigerian Government COVID-19 Palliatives Distribution

2.3.2 Public sentiments and mental health analysis of students during the lockdown. COVID-19 has stopped the lives of people as it spreads with the human-to-human interaction. To stop the spread of coronavirus, it is necessary to impose such steps which tend to stop the movement and results in lesser human-to-human interaction. The one measure which was adopted by almost all the states of the world is "lockdown", resulting in closing airspace, closing educational institutions and workplaces, closing public transport etc. Hence, these implications have caused sadness, loneliness, anxiety, fear and many other psychological issues in peoples specially in students. Some of the students have stuck in their hostels, far away from their hometowns, few students are worried because of their exams and educational activities. Thus, the lockdown has effected people's lives and emerged many physiological issues like depressions. During these days, people are using social media in order to express their feelings and emotions. These social media posts such as tweets can be analyzed and helps the researchers to understand the state-of-mind of the citizens [5], [22], [3] and students [2]. In [6], [19], [24], [25], [27], [23], [13], [29], [33], [9], [28] sentimental analysis of people's behaviour and attitudes during COVID-19 has been performed using twitter data. In [32], the sentimental analysis of tweets is carried out with respect to the age of the social media users and they found out the extent of tweets is higher in youth during COVID.

2.3.3 COVID-19 reopening sentiments: With the paradigm shift due to COVID-19, billions of people's life has been effected directly or indirectly. COVID-19 has induced the feelings of fear, anxiety as well as economical crisis, which altogether are the challenges towards the reopening after COVID [26]. Long-term lock-down

is not a solution, instead a threat for the economy of any country. COVID-19 has effected the life of the students as well as the working people. Considering this situation, everyone is craving for going back to normal life and physical activities [17]. Hence, in [17] and [26], the researchers tried to analyse the sentiments of the people towards reopening after COVID-19 disasters.

2.3.4 Analyzing online restaurant reviews. This era of e-commerce has enabled the customers to led a satisfy and quality life. The on-line reviews has helped the customers in decision-making. Online reviews are important for the restaurants as well because they are aligned with the star rating and one-star increase can earn a good revenue for the restaurant. During COVID-19, many restaurants got negative reviews for being the cause of COVID-spread, for not proper heating the outdoor area or for slow service. Therefore, it is important to analyse the customers' sentiments in order to improve their quality. The researchers analyzed the customers' sentiments which in-turn helped the customers as well as restaurants management to get good quality food and environment and maintain high quality respectively [12].

2.3.5 Vaccine sentiments and racial sentiments. In [18], researchers used concept drift in order to classify the sentiments of people associated with COVID vaccine. During COVID, a rise in prejudice and discrimination behaviour against Asian citizens have been seen. The researchers tries to describe variations in people attitudes towards racism before and after COVID-19 [20].

2.4 Future implications of research about COVID

Various future implications have been given below:

- Consider huge amount of data and explore multiple data sources and platforms.
- Analyze sentiments expressed in multiple languages.
- Real-time monitoring and visualizations should be performed.
- Consider socioeconomic factors and household information while analysing the sentiments of the people.
- Use deep learning approaches in future.
- Sentiments on different age-groups should be performed.
- Explore public trust and confidence in existing measures and policies, which are essential for their well-being.
- More precise location information can improve spatial analysis.
- More specific topics can be analyzed to help policy maker, government and local Communities during any emergency conditions.

3 COMPARISON OF STUDIES

In this study, the comparison of thirty primary studies have been performed and represented in the tabular form in Table 1.

4 CONCLUSION

This survey paper reviewed the thirty primary studies related to COVID-19 sentimental analysis and presented comparison with respect to sentimental analysis data sources, techniques and applications. This article contributes to the sentimental analysis field by considering its applications in real-world scenarios. The article

Table 1: Sentimental Analysis Approaches and Applications During COVID-19 Pandemic

Ref	Data Source/set	Volume of Data	Techniques	Application	Limitation/ Future Direction
[1]	Twitter	9803 Tweets	KNN, RF, NB, SVM, DT, LR	Sentimental analysis on COVID-19 Palliatives Distribution	Large data, consider multiple language
[2]	Twitter	330,841 tweets	NLP, bar graph,	Mental Health Analysis of Students	N/A
[4]	Twitter	3090 tweets	BERT Model	Classifying the fake tweets	N/A
[5]	Twitter	410,643 tweets	Scatter plot, line chart, LDA	Public sentiments during the lockdown	Focus on English language, analyze negative sentiment
[3]	Twitter	6,468,526 tweets.	Dictionary-based and corpus-based	Sentiment Analysis During COVID-19	N/A
[6]	Online survey	N/A	clustering algorithm (k-means)	Understand adults' thoughts and behaviors	N/A
[8]	Weibo account, WeChat account	N/A	Correlation analysis	Construct a framework of COVID-19 from five Dimensions i.e. epidemic, medical, governmental, public, and media responses	N/A
[9]	Twitter	N=1,001,380	Latent Dirichlet Allocation	Sentimental Analysis, Identify dominant topics during COVID	Population is not represented, real-time posting
[11]	Reddit	563,079 Comments	LSTM	Uncover issues related to COVID-19 from public opinions	Use hybrid fuzzy deep-learning techniques
[12]	Yelp	112,412 reviews	GBDT, RF, LSTM, SWEM	Analyzing online restaurant reviews	Different review platforms and restaurant locations.
[13]	Twitter	20,325,929 tweets	CrystalFeel	Examine worldwide trends of fear, anger, sadness, and joy	Expanding the scope to include other media.
[7]	Twitter	500,000 tweets	TextBlob	Determining polarity and subjectivity in COVID tweets.	Explore other social media
[18]	Twitter	57.5M English	BERT	Concept drift on vaccine sentiments	Concept drift in real-time social media project
[19]	Twitter	N/A	NLP, RNN	Analyze sentiments and manifestations	Visualization, clustering and classification
[20]	Twitter	3,377,295	SVM	Changes in racial sentiment	Examine changes in racial attitudes
[21]	Twitter	840,000 tweets	TextBlob, LDA,	Attitude of Indian citizens while discussing the anxiety, stress, and trauma	Analyzing how perception changes for different biographies
[23]	Twitter	57 454 tweets	NLP and text analysis	Analyse the characteristics of Covid	N/A
[24]	Twitter	370 tweets	subjectivity vs. polarity, WordCloud	Sentimental analysis for COVID	N/A

concludes that the sentimental analysis during COVID-19 is still an open field and contains many interesting topics using advanced methods of machine learning and deep learning. This article reported that Naive Bayes and SVM are the widely used algorithm for sentimental analysis during COVID.

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