

The Text Sentiment Analysis Method Based on BiGCN and Sentiment Dictionary

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Abstract

Text sentiment analysis is an important branch in the field of natural language processing, which is widely used in opinion analysis and content recommendation, and is a hot research topic in recent years. The concepts and features related to sentiment analysis methods based on sentiment dictionary, machine learning, deep learning and multi-strategy hybrid are outlined, their recent research results are analyzed, and the advantages and disadvantages of using different methods are analyzed, their advantages and disadvantages are summarized, and the future development directions and trends of text sentiment analysis are proposed by sorting out the current situation of domestic and international research and conducting an in-depth analysis of sentiment analysis methods.

Keywords

Text sentiment analysis; machine learning; deep learning; sentiment dictionary.

1. Introduction

With the development of the digital era, the continuous updating and iteration of mobile terminal device technology and the popularity of smart mobile terminals have led to the continuous growth of the number of global Internet users. As of January 2021, the number of global cell phone users was 5.22 billion, equivalent to 66.6% of the world's total population, and the global Internet penetration rate was 59.5%, which shows that the Internet occupies an important position in people's lives. Along with the rapid increase of Internet users, the data information on the Internet shows growth. According to the report "Data Age 2025" released by IDC, the annual data generated worldwide in 2025 will grow from 33ZB in 2018 to 175ZB. In the context of such an era of data volume, it has created opportunities for the rapid development of Natural Language Processing (NLP).

Natural language processing [1] is the study of human-computer language interaction and various theories and methods that allow to achieve effective communication between humans and computers in natural language. With the rapid growth of data, massive amounts of text containing users' opinions have emerged. How to extract the desired sentiment from the large amount of sentiment text for summarization has triggered the exploration of research on sentiment analysis. Currently, sentiment analysis is widely used in applications such as stock price prediction, opinion monitoring, product reviews, event monitoring, etc [2].

2. Sentiment Analysis

Sentiment Analysis, also known as Opinion Mining and Propensity Analysis [3], is usually the process of extracting and analyzing, summarizing and reasoning about subjective texts with Sentiment overtones using, for example, NLP, Statistics, Machine Learning, Deep Learning [4]. For example, for a certain topic, the data of all users' opinions or text evaluations on the topic are extracted, and the data are processed using NLP, statistical knowledge, Machine Learning, Deep Learning techniques to derive whether the opinions or evaluations on the topic are positive or negative sentiment [5]. In terms of granularity, sentiment analysis can be divided into coarse-grained and fine-grained, where coarse-grained is divided into chapter-level sentiment analysis and sentence-level sentiment analysis [6]. The fine granularity is based on the evaluation of the target product on its attribute analysis. From different based on data types, it can be divided into text sentiment analysis [7], image sentiment analysis [8], speech sentiment analysis [9], and video sentiment analysis [10]. Based on the difference in the number of modalities used, it is divided into single-modal sentiment analysis and multimodal sentiment analysis [11]. The classification of sentiment analysis is shown in Figure 1.

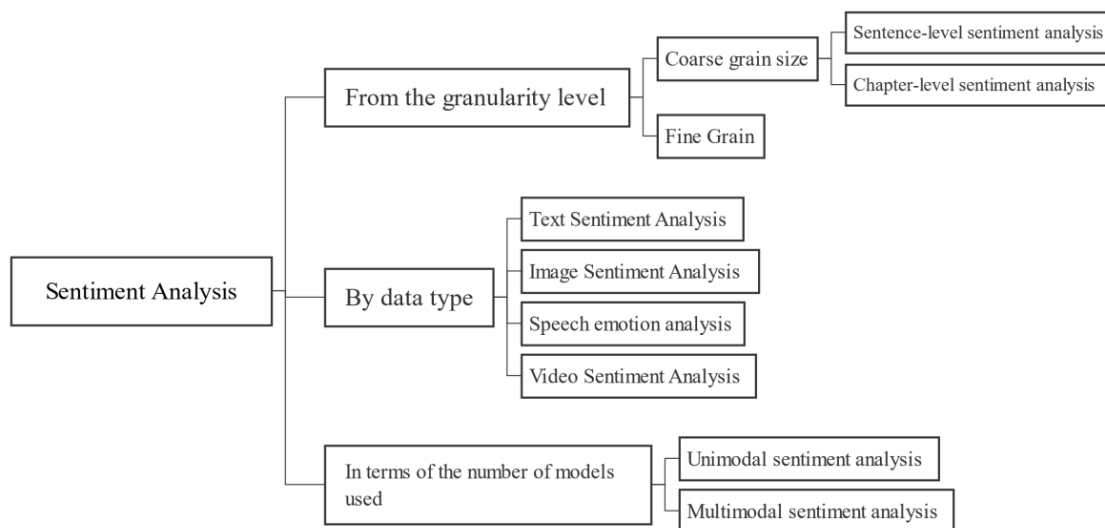


Figure 1 Classification of sentiment analysis

Table 1 Applications in Sentiment Analysis

Applications	English Literature	Chinese Literature
Social Media	Twitter, microblogging, Facebook, public opinion, forecasting, crisis, politics, health, disease, satire detection	Microblogging, Twitter, opinion analysis, forecasting, opinion analysis
Online Comments	Product reviews, consumer reviews, user reviews, movie reviews, hotel reviews, travel reviews	Product reviews, user reviews, movie reviews, pop-ups
Business Investment	Stock market, stock prices, investor sentiment	Stock forecasting, stock market, investor sentiment, behavioral finance
Other	News articles, Arabic, transfer learning, cross-domain, cross-	Journalism, Uyghur, new word discovery, transfer learning, cross-

language

domain, multimodal, cross-language

With the explosion of data in the era of big data, sentiment analysis has become an important research hotspot in the field of natural language processing. The application areas of sentiment analysis are shown in Table 1. Based on the existing results of sentiment analysis, this paper aims to study the technical methods of text sentiment analysis, summarize the models of their methods, compare and analyze the advantages and disadvantages of each method, and finally propose potential research directions in this field.

3. Text Sentiment Analysis

Text sentiment analysis, as an important research branch of sentiment analysis, is a hot research topic in NLP, and has great research significance in opinion analysis, user profiling and recommendation systems. Text sentiment analysis, extracts and analyzes the words with sentiment features in the target document, extracts and analyzes, inductive processing and summarized reasoning to dig out the sentiment tendency embedded in it and classify the sentiment attitude. The process of text sentiment analysis is shown in Figure 2, including the acquisition of raw data, pre-processing of data, feature extraction, classifier, and output of sentiment categories.

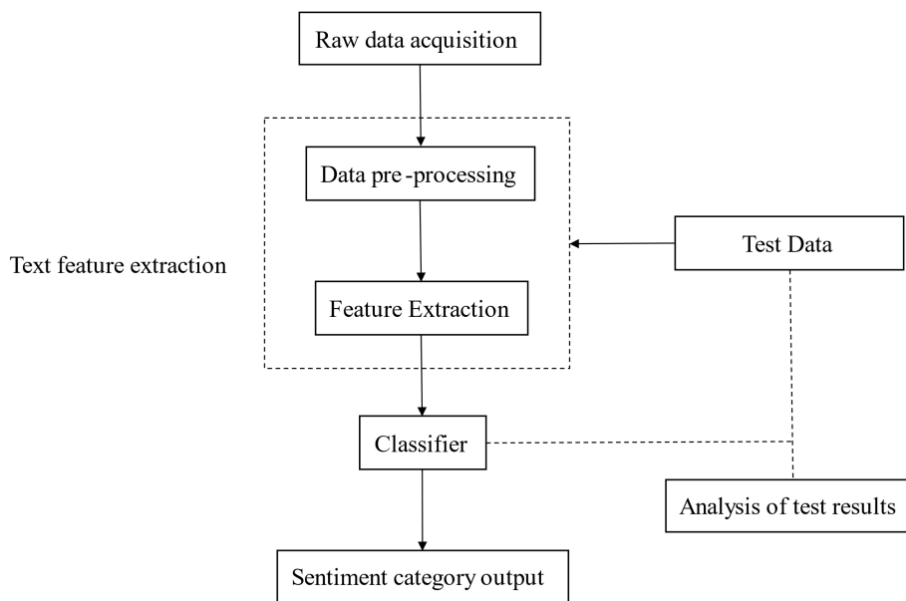


Figure 2 text sentiment analysis process

4. Text Sentiment Analysis Methods

As shown in Figure 3, the sentiment analysis methods are classified according to the different methods used: sentiment analysis methods based on sentiment dictionaries, sentiment analysis methods based on shallow machine learning, and sentiment analysis methods based on deep learning.

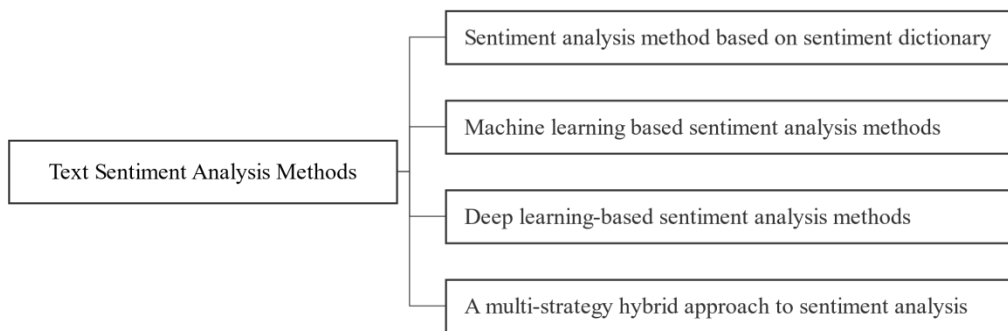


Figure 3 method of text sentiment analysis

4.1. Sentiment lexicon based approach

The method based on sentiment lexicon [12] analyzes the sentiment tendency of a text by counting the number of sentiment words or phrases in the text dataset according to the constructed sentiment lexicon, and the final classification effect depends on the perfection of the sentiment lexicon. The sentiment lexicon reflects the unstructured features of the text, and it is an important resource for the sentiment analysis of the text. The general process of this method is shown in Figure 4. Firstly, the input text is pre-processed, followed by word separation operation, then the sentiment dictionary is trained, and finally the sentiment type is output according to the sentiment judgment rules. The earliest English sentiment lexicon appeared abroad is SentiWordNet [13], besides the commonly used ones are General Inquirer, Opinion Lexicon and MPQA (Question And Answer From Multiple Perspectives). Different from English sentiment lexicon, Chinese sentiment lexicon mainly consists of NTUSD [14], HowNet, and Sentiment Word Ontology Library. These three types of sentiment dictionaries contain different numbers of positive and negative words, and many sentiment analysis researchers have studied and used these three types of sentiment dictionaries extensively.

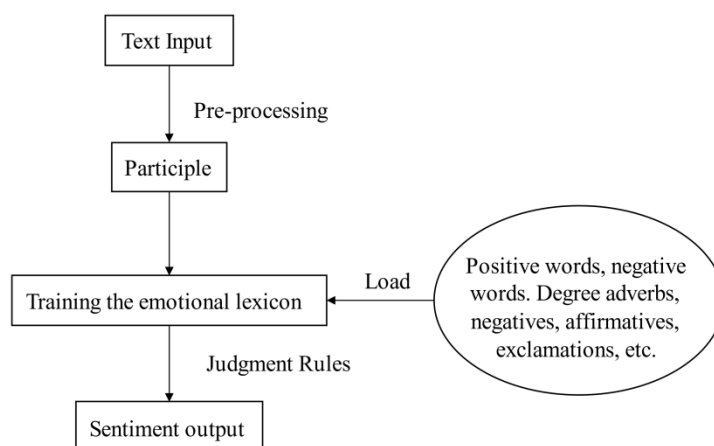


Figure 4 flow chart of sentiment analysis method based on emotion dictionary

Rao Y et al [15] proposed an effective algorithm and three pruning strategies to automatically construct word-level sentiment dictionaries for social sentiment detection, which have a wide range of applications in predicting the sentiment distribution of news articles and identifying the social sentiment of specific entities and news events. Based on the tree structure in which there is little similarity between sibling nodes under different parents, Dong X et al [16] used the features of the tree structure to store the item

classification in the tree structure and added the item features and sentiment words extracted by syntactic analysis and association rules to the tree structure to form a tree-based sentiment dictionary. The dictionary solves the problem of various contexts that may have various Sentiment tendencies and the problem of finding no sentiment words under the item classification in the dictionary. Based on the existing sentiment dictionary, the sentiment intensity calculation method of sentiment words of different sentiment categories in the sentiment dictionary is improved. Jia K et al [17] proposed a sentiment dictionary and semantic rules based on a sentiment classification method. For the existence of some polysemantic sentiment words, which cannot accurately express the polarity of words and reduce the accuracy of text sentiment analysis, Xu G et al [18] proposed a text sentiment analysis method based on an extended sentiment dictionary. Alharthi K A et al [19] proposed a new method based on sentiment analysis, which can be effective on large-scale system log constructing reusable sentiment dictionaries on which errors are detected and error components are identified. Some of the classification advantages and disadvantages of sentiment lexicon based approaches are collated in Table 2.

Table 2 advantages and disadvantages of classification based on affective dictionary method

Author	Advantages	Disadvantages
Rao Y et al. [15]	The algorithms for building sentiment dictionaries are automatic, language-independent, capacity-independent, and fine-grained in their limitations.	Due to the limited vocabulary of short texts, the Sentiment notes in the news headlines are not effective.
Dong X et al.[16]	The combination of similar items and feature-categorized emotion words using the features of the tree structure improves the effectiveness of sentiment computation.	Vulnerability to corpus and word segmentation algorithms is greatly influenced.
Jia K et al. [17]	Calculating the sentiment intensity of different categories of sentiment words is more accurate and reasonable than the manual setting method, and tuning up the performance of sentiment classification.	Using Word2Vec to mine Sentiment word vectors requires a large amount of data as a training set to be used as a test corpus.
Xu G et al. [18]	Adding field sense words and multi-sense emotion words expands the emotion dictionary and improves the classification effect.	The weights of sentiment words for active and passive verbs are not reasonable and need further refinement in setting. The sentiment classifier is limited and only used for a few specific fields.
Alharthi K A et al. [19]	Detection of error logs, accurate identification of non-error logs	Problems encountered with similar components may lead to the same emotions, resulting in similar Sentiment scores.

In the absence of training data sets, the dictionary-based approach can achieve relatively good classification results, but the approach is dependent on the construction of sentiment dictionaries, which have limitations that limit the sentiment analysis of texts, e.g., new online vocabulary, and the sentiment dictionaries need to be constantly updated to improve the classification accuracy. The dictionary-based sentiment classification method depends on the quality of the sentiment dictionary, which is constructed by considering the following aspects:

- (1) How to consider the definition boundaries and selection of sentiment words based on a priori knowledge.
- (2) How to keep the existing sentiment dictionaries up to date with the emergence of online vocabulary.
- (3) How to build new sentiment dictionaries for different domains based on existing sentiment dictionaries to improve the classification effect of sentiment analysis.

4.2. Machine learning based approach

The shallow machine learning based approach refers to the selection of sentiment words as features for performing annotation and matrixing the text to form a text feature set. Text feature extraction is generally based on Term Frequency-Inverse Document Frequency (TF-IDF) [20]. Then, classification models constructed by logistic regression, Naive Bayes, and support vector machine (SVM) are used to predict the sentiment tendency of the data in the test set. The classification effect depends on the selection of training text and the correct sentiment labeling. The data processing process based on machine learning is shown in Figure 5.

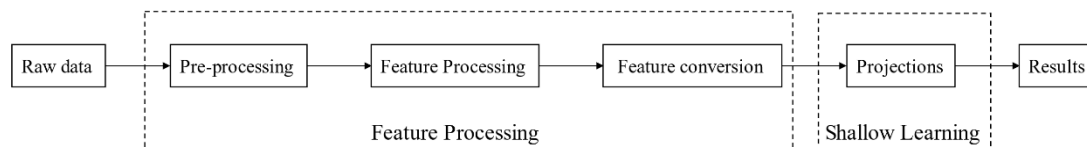


Figure 5 data processing flow of machine learning

Based on the Gradual Machine Learning (GML) paradigm, Wang Y et al [21] proposed a new aspect-level sentiment analysis method which can achieve accurate machine tagging without manual tagging. Text sentiment analysis relies excessively on the statistics of sentiment words, and to address the fact that SVM sentiment analysis does not adequately consider the lexical and underlying semantic information involved in the text. Han K X et al [22] proposed an improved support vector machine (FK-SVM) based on Fisher kernel function. Kurniawan C et al [23] used support vector machine method for sentiment analysis can classify students' responses based on positive and negative polarity.

Compared with lexicon-based methods, machine learning has obvious advantages. On the one hand, machine learning methods are simple, expandable, and more accurate for sentiment analysis, and do not require human to build. On the other hand, it can update the lexicon in time for a huge database. However, the machine learning-based approach also has the following shortcomings:

- (1) Machine learning is very dependent on feature representation, and it is difficult to obtain satisfactory classification results due to the complexity of feature engineering.
- (2) In the face of massive data resources, features require a lot of manpower to label, which is time-consuming and costly.
- (3) The methods used in machine learning are classified as shallow learning, which cannot compute complex functions and have weak generalization ability.
- (4) In language, context is very important, yet machine learning cannot make full use of contextual information of text for modeling, resulting in poor sentiment analysis.

4.3. Deep learning based approach

Deep learning [24] is a computer-based modeling approach that consists of many processing layers for understanding data representations with multiple levels of abstraction by learning a deep nonlinear network structure that enables approximation of complex functions. As shown in Figure 6, with the widespread use of deep learning and significant results in speech and image processing, there has been a gradual transition

from shallow machine learning to deep learning in sentiment analysis. The use of deep learning-based approaches mainly uses artificial neural networks to avoid the manual construction of a large number of text features, saving human and material resources and thus effectively overcoming the constraints of shallow machine learning. Current deep learning models include Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), LSTM, BiLSTM (Bi-directional Long Short-Term Memory), Gated Recurrent Unit (GRU), and attention mechanisms [25].

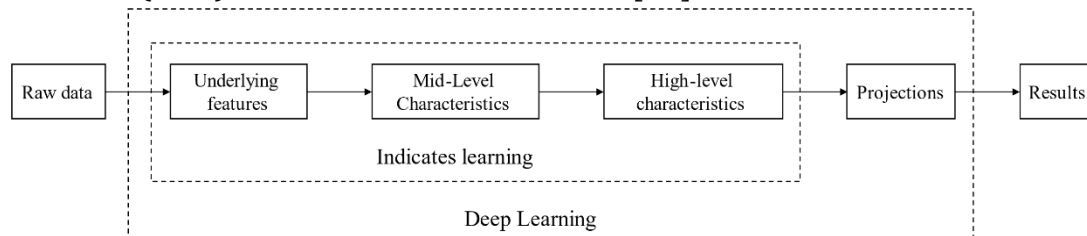


Figure 6 deep learning data processing flow

Since traditional machine learning methods cannot extract salient features, resulting in low classification accuracy, Pan Z et al [26] proposed a deep learning-based BERT-RCNN model for analyzing the sentiment of Internet users in public health emergencies. In studying the negation component that determines the polarity shift of sentences, Singh P K et al [27] proposed a deep neural network inverse problem processing model based on LSTM, which can automatically learn to label the inverse problem features in the input training dataset. Based on the long and short-term memory approach and the selected-pass recursive unit approach, Zarzour H et al [28] proposed a deep learning-based sentiment analysis architecture for automatically predicting the sentiment of comments. Alzyout M [29] proposed an attention mechanism and Bi-LSTM-based sentiment classification model.

Compared with methods based on sentiment dictionaries and machine learning, deep learning has stronger expressive power and model generalization ability, but sentiment analysis methods based on deep learning cannot cover all texts for sentiment classification and have the following shortcomings:

If the text length is too short, it is easy to lead to sparse data features.

(1) The cross-domain portability of deep learning models is poor, which leads to more practical tasks.

(2) Only the contextual information of the text is considered, and no specific lexical issues are taken into account.

(3) Not applicable to the lack of large-scale training data.

(4) There are problems of gradient disappearance and explosion, how to set the model parameters and reduce the complexity of the model.

4.4. A multi-strategy approach to blending

The sentiment dictionary approach has better analysis for fine-grained text, but relies too much on the quality of the sentiment dictionary. Machine learning and deep learning approaches have better feature extraction performance, but the former relies on the selection of text features and the latter on neural network model construction. Therefore, a mixture of several strategies can be used to improve sentiment classification capabilities.

In order to carry out refining and analyzing the hidden sentiment information in movie review text data, thus helping web personnel such as media platforms, to analyze the audience's preference for this movie. Lu K et al [30] proposed a movie review text sentiment analysis method based on SVM sentiment lexicon classification technique and machine learning. Radha S et al [31] proposed a method using support vector machine

classifier combined with lexicon and machine learning for sentiment analysis of customer behavior feedback, achieving efficient data collection, data loading and sentiment analysis of deep and hidden web. To build a framework and process for social media sentiment analysis, Chen L C et al [32] proposed a self-developed military sentiment lexicon for improving sentiment classification and analyzing the performance of different deep learning models under different parameter calibration combinations.

Compared with a single strategy for sentiment analysis of this paper, the use of sentiment lexicon with machine learning and deep learning want to combine the strategy can effectively improve the effect of sentiment classification. The method of mixing multiple strategies has a little advantage of being able to analyze the sentiment of the text more deeply and comprehensively. However, there are some shortcomings that limit its performance:

(1) The model constructed by the multi-strategy hybrid approach is highly complex and difficult to train.

(2) How to efficiently cooperate among strategy methods needs to find a suitable balance.

4.5. Comparison of text sentiment analysis methods

By comparing and analyzing sentiment analysis methods based on sentiment dictionaries, sentiment analysis methods based on traditional machine learning, sentiment analysis methods based on deep learning, and sentiment analysis methods based on multi-strategy hybrid, their different advantages and disadvantages are summarized as shown in Table 3.

Table 3 advantages and disadvantages of text emotion analysis method

Method	Advantages	Disadvantages
Sentiment lexicon based approach	It can effectively reflect the structural features of the text and is easy to understand. The effect of sentiment classification is obvious when the number of sentiment words is sufficient or when there is a lack of training data.	Over-reliance on the quality of sentiment dictionaries. Sentiment dictionaries need to be updated and expanded in real time, and apply to relatively few taxonomic domains.
Machine learning based approach	The method is simple and expansive, with added accuracy for sentiment analysis and the ability to classify the sentiment of a text based on the selection of sentiment features.	Over-reliance on feature representation, which does not make full use of contextual information of the contextual text. Inefficient and low quality when the amount of classification data is large.
Deep learning based approach	Make full use of contextual information, actively learn text features, and have strong expressive and model generalization skills.	Deep learning-based methods are not suitable for small-scale data and require large amounts of data support. Poor cross-domain portability and long model building time.
A multi-strategy approach to blending	To a certain extent, the advantages of the three basic methods are retained, and the influence of their respective disadvantages on the accuracy is weakened, thus	The models constructed by multi-strategy hybrid methods are highly complex and difficult to train. It is relatively difficult to find a suitable balance when

improving the classification
results.

combining

5. Conclusion

With the rapid development of social media, people are expressing their opinions and views more and more in the network, and their position attitude can be judged by sentiment analysis of their speeches, especially in the sentiment analysis of comments on political positions, online shopping and other issues is very necessary.

This paper introduces the results achieved by various methods by classifying and summarizing different methods through the research on the problems of text sentiment analysis at the present stage at home and abroad. By comparing sentiment analysis methods based on sentiment dictionaries, traditional machine learning-based sentiment analysis methods, deep learning-based sentiment analysis methods and multi-strategy hybrid sentiment analysis, it can be found that a multi-strategy hybrid sentiment analysis method works well for a single model that cannot be classified comprehensively and effectively. It can be predicted that in the future natural language processing field, as the scale of text data continues to expand, the use of multi-strategy hybrid for sentiment analysis is the future research trend.

From the development trend of different methods, future research on text sentiment analysis needs to focus on the following aspects:

- (1) Through comparison, it is found that sentiment analysis methods are usually based on a single domain, and how to achieve cross-domain and improve the universality of the model is the direction of future research work.
- (2) The rapid development of the Internet era, how to more effectively dig out new words and update the existing lexicon in real time is the focus of current research.
- (3) At present, sentiment analysis is applied to a single language environment, mainly in English and Chinese, how to improve the generalization of sentiment analysis in different language environments is very important.
- (4) Existing research on irony and implicit text is relatively small, and further research is needed.
- (5) Multimodal research is a hot research in recent years, and how to extract and fuse the sentiment information in multiple modules is an important goal at present.
- (6) Pre-training model is also a current research hotspot, and how to achieve the best classification effect under the premise of effectively shortening the training time is a direction worthy of research.

In the era of big data, it is both an opportunity and a challenge for the field of text sentiment analysis in terms of technical method enhancement and expansion of applications. With the development of the era, there will be more effective methods and results in the future. We also hope that this paper will be of some help to scholars in the field of text sentiment analysis research.

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