Jurnal Sistem Informasi Bisnis 02(2025)

On-line: http://ejournal.undip.ac.id/index.php/jsinbis/article/view/71826

Review of Systematic Literature about Sentiment Analysis Techniques

Cornelius Damar Sasongko[a*], R. Rizal Isnanto[a], Aris Puji Widodo[b]

[a]Doctoral Program of Information System, School of Post Graduate Studies, Diponegoro University, Jl. Imam Bardjo S.H., No. 5, Pleburan, Semarang, Indonesia 50241
[b]Department of Informatics, Faculty of Science and Mathematics, Diponegoro University, Jl. Prof. Soedarto, S.H., Tembalang, Semarang, Indonesia 50275

Submitted: February 25th, 2025; Revised: March 24th, 2025; Accepted: April 17th, 2025; Available Online: May 31st, 2025
DOI : 10.14710/vol15iss2pp227-236

Abstract

Sentiment analysis, also known as opinion mining, is an important task in natural language processing and data mining. It involves extracting and analyzing subjective information from textual data to determine the sentiment or opinion expressed by the author. With the advancement of technology and the widespread use of social media and online review platforms, it is increasingly important to understand users' opinions and sentiments regarding a particular product, service or issue. The purpose of this research is to present a comprehensive literature review on sentiment analysis techniques. This research utilizes the systematic literature review method. This method involves systematic steps in searching, evaluating, and analyzing relevant literature in the field of sentiment analysis. The literature search was conducted through scientific databases and other reliable sources. Relevant articles were then selected based on pre-determined inclusion and exclusion criteria. The data from the selected articles were then comprehensively analyzed to identify the sentiment analysis techniques used and the key findings in the research. The results show that there are various techniques and approaches that have been developed and tested in sentiment analysis, some of the commonly used techniques include rule-based methods, classification-based methods, and machine learning-based methods.

Keywords : opinion mining; sentiment analysis; rule based; classification based; machine learning based

1. Introduction

Sentiment analysis also known as opinion generation is an important task in natural language processing and data mining. The main purpose of sentiment analysis is to identify, collect, and understand the opinions, attitudes, and emotions contained in the text or data being analyzed. This aims to extract subjective information from texts that are used to understand individual or group views or responses to a topic, product, service, brand, or event (Nugraha, 2022).

The sentiment analysis process involves collecting text or data related to a particular topic or entity, such as product reviews, social media posts, or news articles (Alwasi'a, 2020). Then, the text is analyzed computationally using various techniques and algorithms to identify and classify the sentiments contained in the text. Sentiments are generally divided into three main categories: positive, negative, and neutral (Ardiani et al., 2020).

Sentiment analysis involves the extraction and analysis of subjective information from textual data to determine the sentiment or opinion expressed by the author. This involves natural language processing and the use of computational methods to understand and classify the sentiments contained in the text (Adi et all, 2018). With the advances in technology and the widespread use of social media and online review platforms, it has become increasingly important to understand user opinions and sentiments regarding a particular product, service or issue. This is caused by several factors:

1. Breadth of user participation
   In today's digital era, many people use social media and online review platforms to share their experiences, opinions and evaluations of various products or services. The amount of content these users generate is enormous, and understanding the sentiments embodied in that content can provide a company or organization with valuable insights.
2. Direct impact on reputation
   User reviews and opinions can have a direct impact on the reputation of a product, service or organization. Positive reviews can enhance brand image and influence purchasing decisions, while

*) Corresponding author : corneliusdamarsasong@students.undip.ac.id

negative reviews can damage reputation and lead to decreased sales. Therefore, accurately understanding user sentiment and responding promptly to it is very important.

3. Product and service improvement opportunities
   Sentiment analysis can provide valuable insight into the strengths and weaknesses of a product or service from a user perspective. By understanding user sentiment in depth, companies can identify areas of improvement and take steps to improve the quality of their products or services, as well as increase customer satisfaction.
4. Monitoring issues and trends
   Social media and online review platforms are also valuable sources of information to monitor current issues and trends in society. By monitoring user sentiment regarding social, political, or environmental issues, organizations can better understand public views and responses, and direct their strategies and policies according to public needs and expectations.

Sentiment analysis plays an important role in understanding and interpreting user opinions and sentiments. Using natural language processing techniques and computational methods, sentiment analysis helps decompose vast textual data into useful information that can be used for better decision-making in various aspects of business, marketing, and product and service development (Lawelai et al., 2022) . The importance of understanding sentiment analysis techniques makes researchers interested in conducting research with the title "Systematic Literature Review on Sentiment Analysis Techniques".

2. Related Works

This section discusses prior research closely aligned with the scope of this study. The total number of relevant articles for literature review is 24. Although only a few, the articles used focus on sentiment analysis techniques. The following is the journal data used as research material with the general description at Table 1. :

Table 1. Research Literature

No	Author (Year)	Title & Journal
1.	Zucco, C., Calabrese, B., Agapito, G., Guzzi, PH, & Cannataro, M. (2020).	Sentiment analysis for mining texts and social data networks: Methods and tools. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery* , *10* (1), e1333.
2	Abdi, A., Shamsuddin, SM, Hasan, S., & Piran, J. (2019).	Deep learning-based sentiment classification of evaluative text based on Multi-feature fusion. *Information Processing & Management* , *56* (4), 1245-1259.
3	P Indrani1, P Janaki2, P Gayathri3, P Chandrahasini4, P Charitha Reddy5, G Apparao6, Rajeshwari7	Product Review Sentiment Analysis. International Journal For Multidisciplinary Research, 6(3), 1–8
4	Amalia, R., Wise, MA, & Darmantoro, D. (2018, March).	Negation handling in sentiment classification using rule-based adapted from Indonesian language syntactic for Indonesian text on Twitter. In *Journal of Physics: Conference Series* (Vol. 971, No. 1, p. 012039). IOP Publishing.
5	Yadav, RK, Lei, J., Granmo, OC, & Goodwin, M. (2022).	Robust interpretable text classification against spurious correlations using AND-rules with negation. In *IJCAI International Joint Conference on Artificial Intelligence* . International Joint Conferences on Artificial Intelligence.
6	Krishnamoorthy , S. (2018).	Sentiment analysis of financial news articles using performance indicators. *Knowledge and Information Systems* , *56* (2), 373-394.
7	Nguyen, H., Veluchamy, A., Diop, M., & Iqbal, R. (2018).	Comparative study of sentiment analysis with product reviews using machine learning and lexicon-based approaches. *SMU Data Science Review* , *1* (4), 7.
8	Mittal, N., Sharma, D., & Joshi, ML (2018, December).	Image sentiment analysis using deep learning. In *2018 IEEE/WIC/ACM international conference on web intelligence (WI)* (pp. 684-687). IEEE.

9 Verma, B., & Thakur, RS (2018). Sentiment analysis using lexicon and machine learning-based approaches: A survey. In *Proceedings of International Conference on Recent Advancement on Computer and Communication: ICRAC 2017* (pp. 441-447). Springer Singapore.

10 Birjali, M., Kasri, M., & Beni-Hssane, A. (2021). A comprehensive survey on sentiment analysis: approaches, challenges and trends. *Knowledge-Based Systems* , *226* , 107134.

11 Gandhi, A., Adhvaryu, K., Poria, S., Cambria, E., & Hussain, A. (2022). Multimodal sentiment analysis: A systematic review of history, datasets, multimodal fusion methods, applications, challenges and future directions. *Information Fusion* .

12 Ray, P., & Chakrabarti, A. (2022). A mixed approach of deep learning method and rule-based method to improve aspect level sentiment analysis. *Applied Computing and Informatics* , *18* (1/2), 163-178.

13 Malviya, S., Tiwari, AK, Srivastava, R., & Tiwari, V. (2020). Machine learning techniques for sentiment analysis: A review. *SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology* , *12* (02), 72-78.

14 Charbuty, B., & Abdulazeez, A. (2021). Classification based on decision tree algorithm for machine learning. *Journal of Applied Science and Technology Trends* , *2* (01), 20-28.

15 Vali, A., Comai, S., & Matteucci, M. (2020). Deep learning for land use and land cover classification based on hyperspectral and multispectral earth observation data: A review. *Remote Sensing* , *12* (15), 2495.

16 Pratiwi, AI, & Adiwijaya. (2018). On the feature selection and classification based on information gain for document sentiment analysis. *Applied Computational Intelligence and Soft Computing* , *2018* , 1-5.

17 Xu, D., Tian, Z., Lai, R., Kong, X., Tan, Z., & Shi, W. (2020). Deep learning based emotion analysis of microblog texts. *Information Fusion* , *64* , 1-11.

18 Shahi, TB, Sitaula, C., & Paudel, N. (2022). A hybrid feature extraction method for Nepali COVID-19-related tweets classification. *Computational Intelligence and Neuroscience* , *2022* .

19 Jindal, K., & Aron, R. (2021). A systematic study of sentiment analysis for social media data. *Materials today: proceedings* .

20 Steenwinckel, B., De Paepe, D., Hautte, SV, Heyvaert, P., Bentefrit, M., Moens, P., ... & Ongenae, F. (2021). FLAGS: A methodology for adaptive anomaly detection and root cause analysis on sensor data streams by fusing expert knowledge with machine learning. *Future Generation Computer Systems* , *116* , 30-48.

21 Zhang, S., Wei, Z., Wang, Y., & Liao, T. (2018). Sentiment analysis of Chinese micro-blog text based on extended sentiment dictionary. *Future Generation Computer Systems* , *81* , 395-403.

22 Ahuja, R., Chug, A., Kohli, S., Gupta, S., & Ahuja, P. (2019). The impact of features extraction on the sentiment analysis. *Procedia Computer Science* , *152* , 341-348.

23 Alharbi, NM, Alghamdi, NS, Alkhammash, EH, & Al Amri, JF (2021). Evaluation of sentiment analysis via word embedding and RNN variants for Amazon online reviews. *Mathematical Problems in Engineering* , *2021* , 1-10.

24 Pahwa, B., Taruna, S., & Sentiment analysis-strategy for text pre-

On-line: http://ejournal.undip.ac.id/index.php/jsinbis/article/view/71826

Kasliwal, N. (2018). processing. *int. J.Comput. appl* , *180* (34), 15-18.

The data obtained from the selected articles were analyzed systematically. The analytical method includes identifying the sentiment analysis techniques used, analyzing the strengths and weaknesses of each method, and compiling the main findings from existing studies. This analysis aims to provide a comprehensive understanding of sentiment analysis techniques that have been developed and tested in the literature.

3. Methods

This study uses a systematic literature review method. This method involves systematic steps in searching, evaluating, and analyzing relevant literature in the field of sentiment analysis which is depicted in Figure 1.

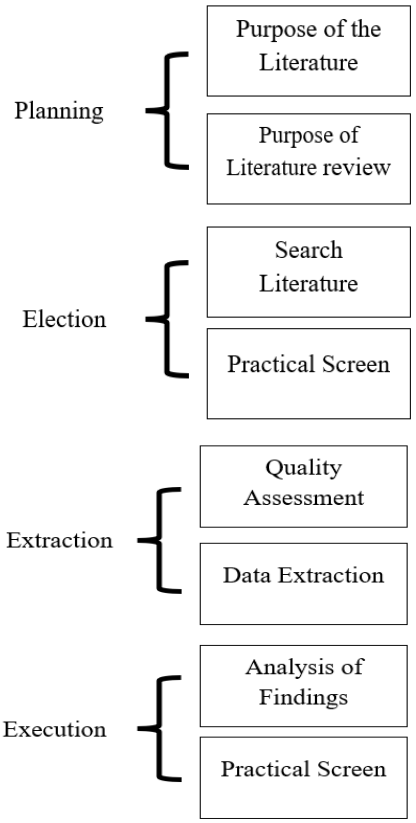

Figure 1. A systematic guide to developing a literature review.

Literature search was carried out through scientific databases and other reliable sources. Relevant articles were then selected based on pre-determined inclusion and exclusion criteria. The data from the selected articles were then comprehensively analyzed to identify the sentiment analysis techniques used and the main findings in the research.

Data for this study were collected through a scientific literature search using databases such as IEEE Xplore, ACM Digital Library, and Google Scholar. Searches are carried out with relevant keywords such as “sentiment analysis”, “opinion mining”, “sentiment analysis techniques”, and the like.

Article searches using the database on the keywords "sentiment analysis" were 36,500, "opinion mining" were 17,400, "sentiment analysis techniques" were 23,900, and the like. Relevant articles were selected based on inclusion criteria such as relevance to the topic, novelty and accuracy of the data. Following are the study inclusion and exclusion criteria at Table 2.:

Table 2. Research Inclusion and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
Journal published in 2018-2023	Journal published before 2018
Journals are written in Indonesian or English	Journals are written in other than Indonesian and English
Specific journals discuss sentiment analysis techniques	The journal does not specifically discuss sentiment analysis techniques

Based on predetermined inclusion criteria, search articles using the database on the keywords "sentiment analysis" of 16,000, "opinion mining" of 6,900, "sentiment analysis techniques" of 15,700, and the like.

4. Discussion

Sentiment analysis is the process of extracting and analyzing subjective information or opinions contained in textual data, with the aim of determining the sentiments or opinions expressed by the author. Sentiments can include positive, negative, or neutral emotions, attitudes, evaluations, or opinions towards an entity, such as a particular product, service, brand, event, or issue (Zucco et al., 2020). Sentiment analysis is a natural language processing method used to analyze and identify sentiments or emotional attitudes contained in texts. The goal of sentiment analysis is to understand people's feelings, opinions, and responses to a topic, entity, product, or service based on the text they generate, such as reviews, comments, tweets, and so on. The sentiment analysis method involves the process of collecting, processing, and analyzing text using computational and artificial intelligence techniques (Jindal & Aron, 2021). There are three different levels of sentiment analysis that have been proposed. Document Level, in sentiment analysis Document Level, analyzes whether documents express positive or negative sentiments. Sentence Level, in Sentence Level sentiment analysis, the document is broken down into several sentences and

On-line: http://ejournal.undip.ac.id/index.php/jsinbis/article/view/71826

each sentence is treated as one unit and analyzed at one time. Aspect Level, in Aspect Level, the main task is to extract aspect terms from the product and then customer feedback is analyzed based on the extracted aspects (Ray & Chakrabarti, 2022). Basic concepts related to sentiment analysis include (Abdi et al., 2019):

1. Sentiment
   Refers to the feelings or emotions expressed by the author in the text. Sentiments can be positive, negative, or neutral.
2. Opinion
   Opinion or subjective judgment expressed by the author regarding an entity. Opinions can be evaluations, preferences, or beliefs.
3. Extraction of subjective information
   The process of identifying and collecting information that is subjective or related to feelings, opinions, or attitudes from the text being analyzed.
4. Sentiment scale
   Systems or scales used to measure or classify the level of sentiment in a text, such as a scale of 1-5 or positive-negative.
5. sentiment feature
   Features or keywords used to identify sentiments in the text. For example, positive words like "good" or negative words like "bad" can feature sentiment.
6. Sentiment classification
   The process of classifying text into appropriate sentiment categories, such as positive, negative, or neutral. Classification methods can involve machine learning or rule-based linguistics.

The purpose of sentiment analysis is to understand and explore subjective information contained in textual data, so as to identify and analyze the sentiments or opinions expressed by the author.c include (- et al., 2024)

1. Understanding customer perceptions
   Sentiment analysis helps in understanding how customers or users describe and respond to a particular product, service, brand or experience. It provides insight into customer perceptions, preferences, satisfaction and dissatisfaction.
2. Evaluate brand reputation
   With sentiment analysis, companies can track and monitor customer opinions and sentiments towards their brands. This helps in evaluating brand reputation and understanding how the brand is seen in the eyes of consumers.
3. Business decision making
   The information obtained through sentiment analysis can be used as a basis for making better business decisions. This allows companies to adapt their marketing strategy, product development, or service improvement according to customer feedback and needs.
4. Monitoring social media and public opinion
   Sentiment analysis enables monitoring and understanding of the opinions and sentiments currently circulating on social media and online review platforms. This is important for understanding trends, issues that receive attention, and people's responses to a particular topic or event.
5. Detect market trends and changes
   With sentiment analysis, companies can identify market trends and changes in consumer preferences. This information can be used to anticipate changes in demand, develop more effective marketing strategies, or capture new market opportunities.

The first step in sentiment analysis is to preprocess the data. Preprocessing data is the initial processing performed on the text or data to be analyzed. Some steps that are commonly carried out in data preprocessing in sentiment analysis are as follows (Pahwa et al., 2018)

1. Clear Data
   Data often contains special characters such as punctuation, emoticons or URLs that are irrelevant for sentiment analysis. This step involves removing those characters to simplify the text.
2. Lowercasing
   Converts all text to lowercase. This is done so that the text does not depend on irrelevant capitalization differences in sentiment analysis. For example, the words "Good" and "good" would be considered synonymous.
3. Remove Stopwords
   Stopwords are general words that usually carry no special meaning and do not make a significant contribution to sentiment analysis. Examples of stopwords are "and", "or", "the", "of". Removing stopwords helps simplify text and focus on important words.
4. Stemming or Lemmatization
   Stemming and lemmatization are techniques for reducing words to their basic form. Stemming removes prefixes or suffixes to get the basic form, while lemmatization changes words to basic forms based on a dictionary of existing words. The purpose of stemming or lemmatization is to reduce the variety of words that have the same meaning, thus facilitating sentiment analysis.

After data preprocessing, the next step in sentiment analysis is feature extraction. At this stage, the important features in the text are extracted to be used as a numerical representation. Methods such as TF-IDF or Word2Vec can be used to generate representations of these features. These features can

On-line: http://ejournal.undip.ac.id/index.php/jsinbis/article/view/71826

be key words, phrases or n-grams that have important information in sentiment analysis. After feature extraction, the sentiment analysis model is built using machine learning algorithms or deep learning algorithms. Algorithms such as SVM, Naive Bayes, Random Forest, RNN, or CNN can be used to build this model. This model is trained using training data that has been labeled sentiment to study patterns and relationships between features and related sentiments (Ahuja et al., 2019).

Then, after the model is obtained, the evaluation and validation stages are carried out to measure the model's performance in classifying sentiments correctly. Evaluation metrics such as accuracy, precision, recall, and F1-score are used to evaluate model performance. This evaluation helps understand the extent to which the model can classify sentiments accurately. If the model does not provide satisfactory results, improvement and adjustment efforts are made. This could include trying different feature extraction algorithms or methods, adding to training data, or adjusting model parameters. The aim of this step is to improve the performance of sentiment analysis and get better results in classifying sentiments with higher accuracy (Alharbi et al., 2021).

Sentiment analysis involves various techniques and methods that can be used to identify and analyze sentiment from textual data. Following are some of the techniques and methods commonly used in sentiment analysis:

Rule based method

The rule-based method is an approach to sentiment analysis that uses predefined rules or heuristic rules. These rules are used to classify texts based on the sentiments contained therein (Amalia et al., 2018). The rule-based method is a type of method in data analysis that uses predetermined rules or principles to classify or make decisions on new data. This method is based on a logical approach, where predetermined rules are used to interpret patterns in data. In a rule-based method, these rules can be simple logical rules or a series of conditions and actions to be followed. These rules can be derived through domain knowledge, practical experience, or by using rule learning techniques from existing data. The application of rule-based methods can involve data mining to find relevant and significant rules from the data. These rules can then be used to classify or make decisions about new data based on existing conditions (Steenwinckel et al., 2021) . The Process of Rule Base Method is shown in Figure 2.

Rule-based methods tend to be more transparent and interpretable, but require more effort in creating rules. Rule-based methods of sentiment analysis tend to be more transparent and interpretable. This method involves making rules or heuristic rules that are used to classify text based on the sentiments contained therein. These rules are made based on human knowledge and understanding of language and sentiment (Yadav et al., 2022).

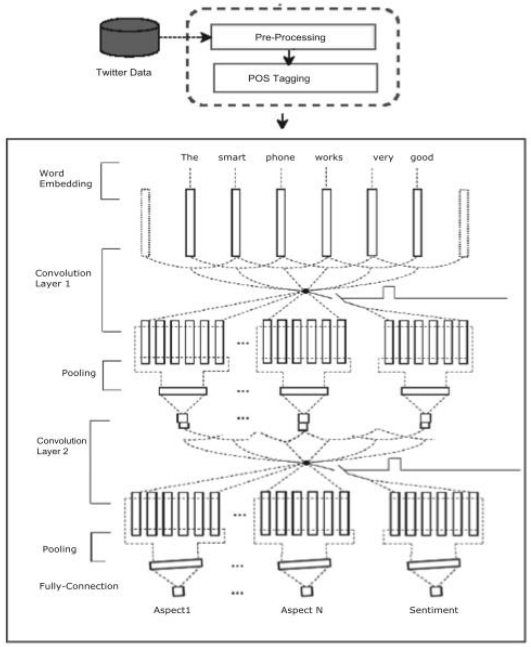

Figure 2. Rule-Based Method.

The main advantage of the rule-based method is its transparency. Because the rules used in sentiment analysis are explicitly defined, the results of the analysis can be explained and understood by humans. This allows interpretation and validation by the relevant user or domain expert. However, the rule-based method also has some limitations. One is a greater effort at rulemaking. Creating rules that are accurate and cover a wide range of cases can take time and deep knowledge of the domain being analyzed. Creating complete and detailed rules can be a complex and time-consuming task. In addition, rule-based methods may lack flexibility in dealing with variation and complexity in human language and sentiment. Any change in language or context may require recreating or adapting existing rules. This method also may not be able to overcome ambiguity or understand more complex contexts in human language (Krishnamoorthy, 2018).

Classification based method

The classification-based method is an approach to sentiment analysis that uses machine learning algorithms to automatically classify text based on the sentiments contained therein. A classification-based method is a type of method in machine learning that is used to classify data into predetermined categories or classes. The main objective of this method is to identify patterns in the data that enable proper classification (Charbuty & Abdulazeez, 2021)

Classification-based methods involve building models or classifiers that can study the relationship

On-line: http://ejournal.undip.ac.id/index.php/jsinbis/article/view/71826

between features in the data and predetermined class labels. These features can be numeric, categorical, or even text attributes. The model will use patterns that have been learned from the training data to classify new data that has not been labeled into the appropriate class. Some examples of commonly used classification-based methods are Naive Bayes, Decision Tree, Random Forest, Support Vector Machines (SVM), and k-Nearest Neighbors (k-NN). Each method has its own advantages and disadvantages depending on the characteristics of the data and the purpose of the analysis (Vali et al., 2020).

The application of classification-based methods in sentiment analysis can be carried out using text data, where text is converted into features that can be used to classify sentiment (positive, negative, or neutral) of the text (Zhang et al., 2018). Models that have been trained using training data with known sentiments can be used to classify sentiments in new text data. Classification-based methods are very useful in various applications such as sentiment analysis, document classification, spam detection, pattern recognition and many more. With their ability to classify data automatically, this method enables more efficient and accurate decision making in various domains (Pratiwi & Adiwijaya, 2018).

This method utilizes machine learning techniques to study the patterns contained in the training dataset, and then apply these patterns to classify unfamiliar texts (Veluchamy et al., 2018). The classification-based method has the following advantages:

1. Automatic classification
   This method can perform sentiment classification automatically without human intervention. Machine learning algorithms can learn complex sentiment patterns and make predictions quickly and efficiently.
2. High accuracy
   Using advanced machine learning techniques, classification-based methods can achieve a high degree of accuracy in classifying sentiments. Machine learning algorithms can learn important features that support accurate classifiers.
3. Scalability
   Classification-based methods can be applied to large datasets with good efficiency. Machine learning algorithms can be learned using large training datasets, thereby being able to handle large amounts of data.

However, classification-based methods also have some drawbacks, such as:

1. Reliance on training dataset: This method requires a high quality, representative training dataset to obtain accurate classification results. The process of collecting and annotating training datasets can be time-consuming and labor-intensive.
2. Lack of interpretability: While classification-based methods may provide accurate classification results, interpretation and understanding of the sentiments extracted may be difficult. Machine learning algorithms tend to be complex and difficult for humans to interpret directly.

Machine learning based method

A machine learning-based method is an approach to sentiment analysis that uses techniques from the field of machine learning to process and analyze textual data (Mittal et al., 2019). Machine learning-based methods (Machine Learning) are used to process and analyze text data in order to identify and understand the sentiments or opinions in the text. This method involves training a model using training data that contains texts that have been labeled sentiments (positive, negative, or neutral). This model will learn patterns and correlations between features in text and related sentiments (Xu et al., 2020)

Machine learning-based methods can use classification algorithms such as Support Vector Machine (SVM), Naive Bayes, or Random Forest to classify text into the appropriate sentiment categories. This process involves extracting features from text, such as key words, phrases, or n-grams, and using a classification algorithm to recognize patterns related to sentiment (Shahi et al., 2022).

1. Convolutional Neural Networks (CNNs) are a type of nervous system that are especially effective at processing spatial information, especially in the context of image processing. The convolutional layers in CNN use special associations from the previous layer, in which nearby neurons are connected to neurons in the next layer. This allows the layer to understand a general perspective on the information sources it encounters. Following is the process of CNN at Figure 3.

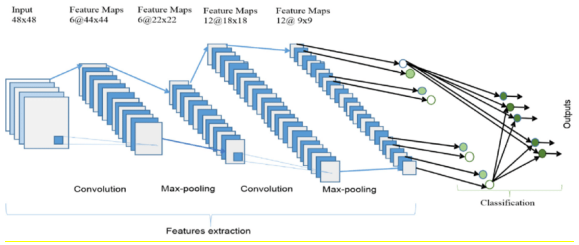

Figure 3. CNNs.

2. Recurrent Neural Networks (RNN) is a method used in opinion analysis, taking into account past calculations and using sequential data. RNNs assist in Natural Language Processing tasks, such as word prediction in sentences. RNN can effectively model contextual relationships between words in sentences. Following is the process of RNN at Figure 4.

On-line: http://ejournal.undip.ac.id/index.php/jsinbis/article/view/71826

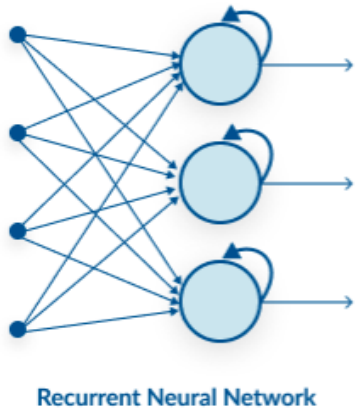

Figure 4. RNNs.

3. Long Short-Term Memory (LSTM) is a variant of RNN specifically designed to solve the problem of losing historical data in long sequences. LSTMs use memory gates to retain relevant historical information, thereby avoiding data loss caused by poor training of the RNN. Thus, LSTM enables better analysis of long sequence data. Following is the process of LSTM at Figure 5

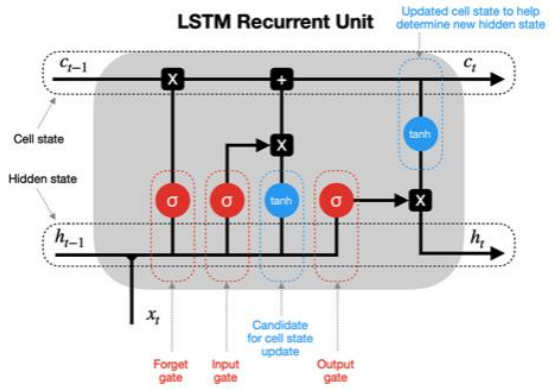

Figure 5. LSTM.

4. Bidirectional Long Short-Term Memory (BiLSTM) is an extension of the LSTM that brings advantages in more complex contexts, such as psychosocial transfer. BiLSTM combines forward hidden and backward hidden states, thus allowing information flow in both directions. This helps in modeling contextual relationships better and improves performance in situations that require information from both directions. Following is the process of BiLSTM at Figure 6.

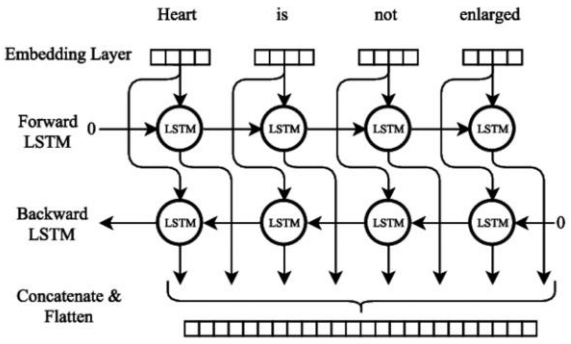

Figure 6. BiLSTM.

Basically, machine learning-based methods work by providing a computer model with a large amount of training data consisting of desired inputs and outputs. This model will study the patterns in the data and build relationships between input and output. After the training process is complete, the model can be used to make predictions or classifications on new data that has not been labeled (Malviya et al., 2020). This method has several advantages in dealing with data complexity in sentiment analysis, including (Verma & Thakur, 2018):

1. flexibility
   Machine learning-based methods provide flexibility in dealing with data complexity. Machine learning algorithms are able to learn complex, non-linear patterns embedded in textual data, so they can recognize subtler sentiments and complex nuances.
2. Generalization
   This method is capable of generalizing from training data to new data that has never been seen before. By learning common patterns from the training data, machine learning algorithms can recognize shared sentiments in new data with a high degree of accuracy.
3. Scalability
   Machine learning-based methods can be applied to large and complex datasets. Machine learning algorithms can deal with high dimensions and large volumes of data, thereby efficiently processing and analyzing complex data.

However, the use of machine learning-based methods also has some challenges:

1. Deep understanding
   Implementation of machine learning-based methods requires a deep understanding of modeling and data processing. Selection of the right algorithm, efficient data processing, and optimal parameter settings requires sufficient knowledge and experience.
2. Complex data processing
   This method can overcome data complexity, but at the same time requires more complicated data processing. This includes data pre-processing,

such as text cleaning, removing stopwords, vectorizing text, and selecting relevant features.

3. Dependence on the amount of data
   The machine learning method requires a sufficient amount of data to obtain a good and accurate model. Limited training data can affect the performance and generalizability of the model.

Recent developments in sentiment analysis have involved the integration of sentiment analysis techniques with other technologies such as natural language processing, social networks and social media analysis (Birjali et al., 2021). This integration enables more sophisticated processing and a deeper understanding of user opinion and sentiment. Advanced natural language processing using transformer-based NLP techniques has increased the accuracy of sentiment analysis with understanding more complex contexts. In addition, integration with social networks allows the use of social interaction and relationship information in sentiment analysis (Gandhi et al., 2023). Social media analytics is also a focus, where data from social media platforms is used to understand the distribution of opinion and influence of users. In addition, sentiment analysis also increasingly involves multimodal data such as text, images and videos, with the development of multimodal sentiment analysis techniques that combine information from various data sources. Improvements in classification and prediction techniques such as the use of deep learning are delivering good results in sentiment classification. The integration of other technologies with sentiment analysis opens up new opportunities in understanding user opinions and sentiments, providing a more holistic and accurate analysis across various communication channels and media.

5.Authors's opinion

The paper effectively maps the sentiment analysis landscape but leans toward theoretical synthesis. Future work should: Bridge empirical gaps (e.g., benchmark studies comparing techniques). Address real-world constraints (e.g., latency, bias, multilingual support). Leverage cutting-edge tools (e.g., transformers, federated learning). Final Note: This SLR serves as a solid foundation but calls for more applied research to tackle emerging challenges in dynamic, multilingual, and multimodal sentiment analysis.

6. Conclusion

Based on the research results, there are various techniques and approaches that have been developed and tested in sentiment analysis. Some of the commonly used techniques include rule-based methods, classification-based methods, and machine learning-based methods. Each sentiment analysis technique has its own advantages and disadvantages. Rule-based methods tend to be more transparent and interpretable, but require more effort in creating rules. Classification-based methods are capable of performing automatic classification with high accuracy, but require large training datasets. Machine learning-based methods provide flexibility in dealing with data complexity, but require deep understanding of data modeling and processing. Recent developments in sentiment analysis involve the integration of sentiment analysis techniques with other technologies such as natural language processing, social networks and social media analytics. This opens up new opportunities to understand user sentiment in a more comprehensive and real-time manner.

References

-, P. C. R., -, P. I., -, P. J., -, P. G., -, P. C., -, G. A., & -, R. (2024). Product Review Sentiment Analysis. *International Journal For Multidisciplinary Research*, *6*(3), 1–8. https://doi.org/10.36948/ijfmr.2024.v06i03.20551

Abdi, A., Shamsuddin, S. M., Hasan, S., & Piran, J. (2019). Deep learning-based sentiment classification of evaluative text based on Multi-feature fusion. *Information Processing and Management*, *56*(4), 1245–1259. https://doi.org/10.1016/j.ipm.2019.02.018

Ahuja, R., Chug, A., Kohli, S., Gupta, S., & Ahuja, P. (2019). The impact of features extraction on the sentiment analysis. *Procedia Computer Science*, *152*, 341–348. https://doi.org/10.1016/j.procs.2019.05.008

Alharbi, N. M., Alghamdi, N. S., Alkhammash, E. H., & Al Amri, J. F. (2021). Evaluation of Sentiment Analysis via Word Embedding and RNN Variants for Amazon Online Reviews. *Mathematical Problems in Engineering*, *2021*. https://doi.org/10.1155/2021/5536560

Amalia, R., Bijaksana, M. A., & Darmantoro, D. (2018). Negation handling in sentiment classification using rule-based adapted from Indonesian language syntactic for Indonesian text in Twitter. *Journal of Physics: Conference Series*, *971*(1). https://doi.org/10.1088/1742-6596/971/1/012039

Ardiani, L., Sujaini, H., & Tursina, T. (2020). Implementasi Sentiment Analysis Tanggapan Masyarakat Terhadap Pembangunan di Kota Pontianak. *Jurnal Sistem dan Teknologi Informasi (Justin)*, *8*(2), 183. https://doi.org/10.26418/justin.v8i2.36776

Birjali, M., Kasri, M., & Beni-Hssane, A. (2021). A comprehensive survey on sentiment analysis: Approaches, challenges and trends. *Knowledge-Based Systems*, *226*, 107134. https://doi.org/10.1016/j.knosys.2021.107134

Charbuty, B., & Abdulazeez, A. (2021). Classification

Based on Decision Tree Algorithm for Machine Learning. *Journal of Applied Science and Technology Trends*, *2*(01), 20–28. https://doi.org/10.38094/jastt20165

Gandhi, A., Adhvaryu, K., Poria, S., Cambria, E., & Hussain, A. (2023). Multimodal sentiment analysis: A systematic review of history, datasets, multimodal fusion methods, applications, challenges and future directions. *Information Fusion*, *91*(June 2022), 424–444. https://doi.org/10.1016/j.inffus.2022.09.025

Jindal, K., & Aron, R. (2021). WITHDRAWN: A systematic study of sentiment analysis for social media data. *Materials Today: Proceedings*, 11. https://doi.org/10.1016/j.matpr.2021.01.048

Krishnamoorthy, S. (2018). Sentiment analysis of financial news articles using performance indicators. *Knowledge and Information Systems*, *56*(2), 373–394. https://doi.org/10.1007/s10115-017-1134-1

Lawelai, H., Sadat, A., & Suherman, A. (2022). Democracy and Freedom of Opinion in Social Media: Sentiment Analysis on Twitter. *PRAJA: Jurnal Ilmiah Pemerintahan*, *10*(1), 40–48. https://doi.org/10.55678/prj.v10i1.585

Malviya, S., Tiwari, A. K., Srivastava, R., & Tiwari, V. K. (2020). Machine Learning Techniques for Sentiment Analysis: A Review. *SAMRIDDHI : A Journal of Physical Sciences, Engineering and Technology*, *12*(2), 72–78. https://doi.org/10.18090/samriddhi.v12i02.3

Mittal, N., Sharma, D., & Joshi, M. L. (2019). Image Sentiment Analysis Using Deep Learning. *Proceedings - 2018 IEEE/WIC/ACM International Conference on Web Intelligence, WI 2018*, 684–687. https://doi.org/10.1109/WI.2018.00-11

Pahwa, B., Taruna, S., & Kasliwal, N. (2018). Sentiment Analysis- Strategy for Text Pre-Processing. *International Journal of Computer Applications*, *180*(34), 15–18. https://doi.org/10.5120/ijca2018916865

Pratiwi, A. I., & Adiwijaya. (2018). On the Feature Selection and Classification Based on Information Gain for Document Sentiment Analysis. *Applied Computational Intelligence and Soft Computing*, *2018*. https://doi.org/10.1155/2018/1407817

Ray, P., & Chakrabarti, A. (2022). A Mixed approach of Deep Learning method and Rule-Based method to improve Aspect Level Sentiment Analysis. *Applied Computing and Informatics*, *18*(1–2), 163–178. https://doi.org/10.1016/j.aci.2019.02.002

Shahi, T. B., Sitaula, C., & Paudel, N. (2022). A Hybrid Feature Extraction Method for Nepali COVID-19-Related Tweets Classification. *Computational Intelligence and Neuroscience*, *2022*. https://doi.org/10.1155/2022/5681574

Steenwinckel, B., De Paepe, D., Vanden Hautte, S., Heyvaert, P., Bentefrit, M., Moens, P., Dimou, A., Van Den Bossche, B., De Turck, F., Van Hoecke, S., & Ongenae, F. (2021). FLAGS: A methodology for adaptive anomaly detection and root cause analysis on sensor data streams by fusing expert knowledge with machine learning. *Future Generation Computer Systems*, *116*, 30–48. https://doi.org/10.1016/j.future.2020.10.015

Vali, A., Comai, S., & Matteucci, M. (2020). Deep learning for land use and land cover classification based on hyperspectral and multispectral earth observation data: A review. *Remote Sensing*, *12*(15). https://doi.org/10.3390/RS12152495

Veluchamy, A., Nguyen, H., Diop, M. L., & Iqbal, R. (2018). Comparative Study of Sentiment Analysis with Product Reviews Using Machine Learning and Lexicon-Based Approaches. *SMU Data Science Review*, *1*(4), 1–22. https://scholar.smu.edu/cgi/viewcontent.cgi?article=1051&context=datasciencereview

Verma, B., & Thakur, R. S. (2018). Sentiment Analysis Using Lexicon and Machine Learning-Based Approaches: A Survey. In *Lecture Notes in Networks and Systems* (Vol. 34, Nomor January 2018). Springer Singapore. https://doi.org/10.1007/978-981-10-8198-9_46

Xu, D., Tian, Z., Lai, R., Kong, X., Tan, Z., & Shi, W. (2020). Deep learning based emotion analysis of microblog texts. *Information Fusion*, *64*, 1–11. https://doi.org/10.1016/j.inffus.2020.06.002

Yadav, R. K., Jiao, L., Granmo, O. C., & Goodwin, M. (2022). Robust Interpretable Text Classification against Spurious Correlations Using AND-rules with Negation. *IJCAI International Joint Conference on Artificial Intelligence*, 4439–4446. https://doi.org/10.24963/ijcai.2022/616

Zhang, S., Wei, Z., Wang, Y., & Liao, T. (2018). Sentiment analysis of Chinese micro-blog text based on extended sentiment dictionary. *Future Generation Computer Systems*, *81*, 395–403. https://doi.org/10.1016/j.future.2017.09.048

Zucco, C., Calabrese, B., Agapito, G., Guzzi, P. H., & Cannataro, M. (2020). Sentiment analysis for mining texts and social networks data: Methods and tools. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, *10*(1). https://doi.org/10.1002/widm.1333