ISSN 2278-3091
Volume 10, No.2, March - April 2021
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse421022021.pdf
https://doi.org/10.30534/ijatcse/2021/421022021

Sentiment Analysis by using deep learning and Machine learning Techniques: A Review

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ABSTRACT

More and more individuals are now using online social networks and resources throughout this day and age to not only interact and to communicate but also for sharing their views, experiences, ideas, impression about anything. The analysis of sentiments is the identification and categorization of these views to evaluate public opinions on a specific subject, question, product, etc. Day by day, the relevance of sentiment analysis is growing up. Machine learning is an area or field of computer science where, without being specifically programmed, computers can learn. Deep learning is the part of machine learning and deals with the algorithm, which is most widely used as Neural network, neural belief, etc., in which neuronal implementations are considered. For sentiment analysis, it compares their performance and accuracy so then it can be inferred that deep learning techniques in most of the cases provide better results. The gap in the precision of these two approaches, however, is not as important enough in certain situations, and so it is best to apply and use the machine learning approaches and methods because these are simpler in terms of Implementation.

Key words : Deep Learning, Machine Learning ,Sentiment Analysis, Neural Network.

1. INTRODUCTION

A. Sentiment Analysis:

SA deals with the management of opinion, sentiment and the subjective type text [1].Sentiments analysis is the analysis of customer or user emotions or ratings to decide if positive, neutral, or negative reactions are elicited by a product, service, post, document, etc. It takes into account not only the polarity but in fact also the depth of emotion towards a particular service or product. Sentiment classification aims to decide if there is a positive or negative touch in a specific text. In several market fields, sentiment classification is commonly used to enhance goods or services by recognizing the perceptions of consumers regarding that product.

Alternatively, the study of opinion also enables customers to get a clearer understanding of the product or service's benefits and disadvantages. Nowadays, opinion-rich tools such as evaluation sites, blogs, etc. are increasingly accessible and popular[25]. The feedback can even be part of a service or products sold in online stores like Amazon. It can be misleading to many jargons and mixed comments, and this is the platform where sentiment analysis comes into place. This helps businesses to better grasp the general reactions towards their goods and they can come to know about their level in the market. Nowadays, sentiment analysis is largely beneficial to most companies[18].Moreover, along with expanding their company and organizational growth, they can better satisfy customer needs and wants. Sentiment analysis is the most commonly used instrument for text classification that analyses an incoming message and decides whether positive or negative is the underlying sentiment.[19].

Sentiments can be conveyed in a variety of ways. It can be conveyed by a variety of feelings, judgments, vision or insight, or people's points of view.[28][29In several ways, sentiment analysis is carried out. The level of sentiment analysis is chosen based on the time that can be dedicated to the sentiment analysis and its value to an ongoing assignment. Second, the review is at the level of the sentence. There is always a subject & an object to a sentence. The subjectivity of the sentence provides the object's subjective opinions. The subjective aspect of the sentences is then graded as a negative, positive or neutral one. The function level is another level, it takes words and phrases into account, this is the best standard. With an emotion, it takes a word and decides the word's purpose. The word is then divided into categories of negative, positive, or neutral. Therefore, the maximum misleading comments can be eliminated. Document-level opinion analysis is considered the third level. The document level approach takes the whole document collectively and categorizes it as a complete document with negatives or positives. It does not account for the finer points of reality and emotion. The functional level is then selected over the others in most instances[20]

B. Features Of SA:

Sentiments includes the variety of the featured values such as bi- gram & trigrams through polarities & combinations. sentiment are being evaluated from both negative & positive aspect, through various SVM 'support vector machine', by the use of training algorithm, in sentiment analysis, neural network are applied to calculate belongingness of labels. The conditional dependency between the several nodes & edges of acyclic graph run by Bayesian network are used to assist data extraction at the context level. Data accuracy and learning could be achieved on platform of social media by optimizing sentences and words. Data tokenization is used at word root levels to produce positive and negative aspect of data. Techniques and methods are used for reducing flaws of sentiment analysis for achieving a greater stage of accuracy in the data of social media [2].

C: Multidisciplinary field:

Sentiment analysis is a broad discipline, as its multidisciplinary field, so it evolves various fields like information retrievals, computational linguistic, semantics, artificial intelligence and natural processing of language , and M.L[3].so the classification of sentiment analysis is approached can be performed on 3 extraction levels: a) aspects or features level; b) sentence and c) documents level [2].

D : Sentiments Analysis technique:

SA is based upon the two types of the technique, that are Machine-learning based techniques & lexicon-base techniques. [35]

a) Techniques based upon Machine learning:

Such kind of the techniques is applied by the extracting aspect and sentence levels. So the characteristics consist of bi-grams, (POS), n-gram, and bag-of-words. At aspect and sentence level, Machine learning contains three flavors i.e. (SVM), Maximum the Entropy and Nave Bayes.[30]

b) Techniques base on the Lexicon or corpus:

Above approaches are based on the decision trees like Sequential Minimal Optimization (SMO), k-Nearest Neighbors (k-NN), Hidden Markov Model (HMM), Conditional Random Field (CRF), single Dimensional Classification (SDC), related to sentiment classification methodologies.

There are three categories of machine learning approaches: (a)Supervised, (b) Semi Supervised and (c) Un-Supervised. These approaches are capable for automation also it can handles large quantities of the data, so it is very appropriate for sentiments analysis.[3].

II. SENTIMENTS ANALYSIS PROCEDURES

A. Data collections

The very first job in the process of sentiment analysis is data collection. Data can be collected from various sources like any website, from the several online opinion sets & ratings.[31].

B. Preprocessing

It is the cleaning process of data. Unrequired words & symbols are omitted. This is required for further processing to be streamlined. Part of this move is eliminating hyperlinks, repeated sentences, emoticons, and special characters. It also performs lemmatization and stemming. Finally, it takes a reduced collection of features and passes them to the classifiers.

C. Classifications

The most critical aspect of a system for sentiment analysis is a classifier. Classification is achieved in negatives, positive, or neutrals categories. A third of the database is usually used as training sets to generate the classifiers. To a large degree, the precision of the classifier relies on the training collection. By Using machine learning classifiers like SVM, Bayesian classifiers, maximum entropy classifiers, and so on, the classification can be performed. However, before training and testing the classifier, machine learning classifiers do feature extraction, which can also use deep neural networks for classifying the data. These classifications can also be performed simply by using a method of deep learning. In the context of neural networks, there are distinct forms of depth strategies, such as B. It is possible to use the Convolutional Neural Networks (CNN) or Probabilistic Neural Networks (PNN), Recurrent Neural Networks(RNN), etc.

D. Show results

After the data has gone through the classifier, the output is shown. It shows the polarity of feelings of the whole data, and the degree of detail depends upon the type of classifiers which is used.

III. MACHINE LEARNING

ML is being used without specific programming to give computers, the ability to learn. It involves statistical and predictive analysis for allowing the machine to recognize several patterns and to use this knowledge to uncover secret insights into information supplied.

Both algorithms for machine learning are split into the supervised machine learning & un-supervised machine learnings algorithms. This is accomplished by observing the latest trend and studying how to apply it in a new pattern. On the other hand, unsupervised machine learning algorithms are mainly used to group various specific data types and are applied

in various areas where data separation is necessary.[32]
In sentiment analysis, classification plays a crucial role. A pre-classified sample of database which is named a training dataset is used for training and creating a classifier in the classifications stage of sentiments analysis by using machine learning techniques.[33].Upon learning the pattern, this classifier then can label the previous unlabeled data. The precision of a classifier, however, often depends heavily on the data used for training. Therefore, we see that for sentiment analysis, supervised machine learning methods are better suited. The key machine learning classifier used for sentiments analysis are the following:

A.Naive Bayesian Classifiers

It is believed that the Naive Bayesian Classifier is very simple and easy in terms of implementation. This is not any single algorithm but consists of the set based on Bayes' theorem of various classification algorithms. A term used to define an event's probability. This probabilistic classifier utilizes and analyses all the characteristics present in the vector of the function differently, i.e., it considers them independently of each other. By analyzing a pre-categorized collection of documents, you will learn the pattern. This model states that the conditional probabilities of the event p1 occurring could be determined in presence of the two events, p1 & p2 if p2 has already occurred. The Naive Bayes classifier's input for training consists of preprocessed data along with its extracted features. The classifications process is conducted on the data set of test data after completing the training and then, depending on the outcomes, the new data. A polarity of the feelings of the data is given by this classification method. For instance, the "It was good" review statement would have resulted in positive polarity [11].

B.SVM classifier

SVM is a popular machine learning technique that employs a statistical approach. It is extremely effective at text classification.[26]There is an n-dimensional space in the SVM, in which n represents number or quantity of features presented in a vector of the function. In the n-dimensional space, each of the data elements presents in the training dataset is registered, the value of each character is the coordinate value. In this particular n-dimensional space, the key concept of this approach is to find linear separators that best differentiate the various groups.[34].
SVM uses a differentiation function with the following parameters [10]: "X" is the vector of the function; the weight vector is "w", and the bias vector is "b".
On the training set, the weights & preload vector are automatically learned. Between these two classes, a margin that is far from a document is described. The classifier margins are defined by this distance and indecisive choices are reduced by maximizing this margin. [11] While some features are important to this system, due to the sparse nature of the text [12], they are correlated and therefore well suited for SVM text classifications.

C.Decision trees

For classification issues, the decision trees are mainly used. Depending on the important trait or attributes, also known as the independent variable, the tree is split. Based on these attributes, the space of training data is described in hierarchical form. There is a condition for each attribute value, which is the existence or the absence of one or more than one words. The inner nodes are labeled with characteristics, however, the edges that exit the nodes are called a trace of the weight of the dataset. The name of every leaf in the tree was a group or class [14]. In this way, in inferring what value is required of the element, a decision tree classifier associates data from an element.

D.Maximum entropy

The maximum entropy principle states that all known constraints should be met when estimating the probability distribution of a random occurrence without making a subjective judgment of the unobjective[12]. The classifier, therefore, makes no assumptions about the
The relationship between the different features [11]. The objective of Maximum Entropy is to maximize the system entropy described by the distribution of the conditional probability. For the data supplied, a mood polarity is given, similar to Naive Bayes.

IV. DEEP LEARNING

It's a part of machine learning that is more nuanced and informative. Deep learning models have been widely used in the field of NLP in recent years and have shown incredible potential.[22].It is consists of various forms of neural networks and neural beliefs that function in a brain loss based on the theory of neurons. For these approaches, the data sets usually used are incredibly broad. Deep learning is being used to construct DNN, a deep neutrals network which, with high precision, solves complex binary questions, makes decisions, or returns numerical responses.[24].

A.Neural Networks in Convolution (CNN)

CNN is One of the most basic types of neural networks. This is an improved type of conventional neural network which have a neuron corresponding to a neuron in the next layer in each

layer, and so on. A variety of convolution layers along with the pooling layer and an output layer are used in a CNN(convolutional neural networks).[21] CNN measures the input layer neurons and the local connections between them made to the output. CNN then applies filters and depending on the job at hand, learns the scale of the filters on its own, in this case, the classification of terms using the filters. The findings are then pooled using the pooling layer and a multi-layered neural network is generated that operates on concepts similar to those in the brain's neurons. To boost the efficiency of standard CNNs, dynamic CNNs are also now being used.

B.Neural probabilistic networks (PNN)

PNN is a kind of feed-forward neural network [12] which deals with the quantization of learning vectors. It uses a training dataset and a test set, so the training set contains a picture that is not in the training set.PNN is being selected over the other neural networks because of this purpose. The PNN consists of three primary layers: input, pattern, and output Layer. Between the output and the pattern layer, there is also a summation layer. In the form of a neural implementation, the pattern layer which is also called the rule layers is the real classifier. By Using the Parzen eliminator, the probability density function is determined, and the PDF is such that the likelihood of wrongly classifying the training dataset is minimized. The difference between the initial mood and that of the training dataset is computed in the basic first step. The next layer summarizes and produces a probability vector for the contribution of the input clauses. After that, the layers continuously take the maximum probabilities from previous ones and then finally generate the outcome.

C.Neural Network Recurrent (RNN)

By applying the same or familiar set of weights within an environment, a recurring neural network is generated so that the nodes form a directed graph along a chain. The RNN follows the bottom-top method for sentiment analysis, so that, after the use of composition function and a classifier, the superordinate vectors, the characteristics of knot vectors are determined each time knot vectors are used. The opinions include the nodes[27].The benefit of this neural implementation is that it can process the sequence of nodes using its internal state memory.

D.LSTM (long-term short-term memory)

This is a recurring neural network of sorts[11]. It can process sequences using its ‘internal states memory’ is superior. For several modeling duties, it can be used. Over a long period, it can save a state. This approach overcomes the drawbacks of recurring neural networks, like the absence or decrease of the gradient vector after a long period.[23] In LSTM, the middle tier is a forgotten portal. The forgotten gate is used to determine the data that is needed to be saved and the data which is needed to be forgotten for productive long-term learning. The middle layer takes data from the input layer and the effect is displayed by the output layer.

V. LITERATURE REVIEW

For sentiment analysis, Chen and Zhang[4] have proposed a model which combines SVM and a CNN(Convolutional Neural Networks). The outcomes of their experience indicate that for analyzing text sentiment alone, their approach offers greater accuracy than CNN or SVM. They used the NLPCC2014 emotion assessment data package. This data set has been processed in such a way that it is filtered first and then Word2vec trains the filtered set. While the SVM does the classification, the CNN learns the properties.

The authors propose in [5] a model for the classification of sentences using a popular CNN and RNN structure. The words from the sentences are changed into feature vectors in the first stage. A small CNN alternative is then used to decreases the number of parameters. Then the outcome is passed on to a multi-layered recurring ‘LSTM’ neural network. To monitor the neural network, a "black propagation through time" algorithm is used. Finally, there is a classification layer that is a classifier for logistic regression to achieve the final results with the accuracy having a range from 89.2% to 93.3%.

In [6], for Google Play customer feedback in Chinese, the authors perform sentiment analysis. Via a web crawler, 196,651 ratings were gathered for the experiment. Then the knowledge was preprocessed, and dictionaries were incorporated. Classifiers for LSTM, Naive Bayes, and the support vector machine were used, and the outcomes were compared. Then the findings indicate that the model LSTM gave an accuracy of 94% And the accuracy of 76.46 percent and 74.12 percent for SVM, and Naive Bayes respectively the results are much better than SVM and Naïve Bayes.

In [7] Zharmagambetov and Pak present a deep learning approach to sentiment analysis by Using Google's Word2Vec. For extracting features, the first step is preprocessing. Word2-Vec is used in a way that the present word is predicted by a model ‘Continuous Bag of Words’ (CBOW), while a skip-gram predicts the surrounding words. To train the data, and Elman's [7] style RNN is used, and clustering is done later. The findings showed that deep learning gave better results than the conventional method of CBOW, but there was not any great difference inaccuracy.

In[8], the researcher suggests a hybrid approach using a model 'Restricted Boltzman Machine' (RBM) and Probabilistic Neural Networks (PNN) for mood classification, which performed better in 5 data sets than traditional depth architectures. The RBM was initially used for dimensionality reduction. First, the process of learning is implemented, and a divergence algorithm of contrast is used. Finally, with the PNN, the mood classification takes place.

In [9], for sentiment analysis at the document level, unattended hierarchical deep neural networks are implemented, and the results are contrasted with those of an SVM, and it is assumed that the neural network is involved. Dataset Electric products, movie reviews, Hotel reviews was used. Outcomes of study shows that The neural network gives more accurate results as the size of the dataset grows

In a recommendation framework in the cloud, one of the many applications of sentiments analysis is Depending upon the positive polarity of the scores, the researchers of[11] used a model recurring neural network to suggest places nearby. Amazon dataset, Food item reviews, and Movie Reviews is used as Dataset in this study and the results show that RNN outperformed as compared to Naïve Bayes.

For an efficiently trained classifier for various issues, different feature vectors should be developed Different controlled classifiers with a similar feature vector are trained in[13] and variance of the correctness is registered Results showed that Naive Bayes gave better results as compared to SVM & Maximum Entropy

The sentiments analysis was performed on a pre-labeled Twitter data set in[14] and the precision of each approach was compared. Naive Bayes has been shown to have better performance, i.e., a higher rate of accuracy compared to Maximum Entropy & SVM.

Based on theoretical accuracy and the theoretical training speed, Dans [15] compared SVM, Naive Bayes, Maximum Entropy. Outcomes declare that ANN gives a higher performance in theoretical accuracy, but SVM outperformed in theoretical training speed.

In [16] researchers did a comparison of the different approaches to machine learning that are tracked, taking into account the precision, accuracy, recall & F-Score metrics. Dataset Amazon, Canon camera reviews is used. The results show that Experiments show that the proposed hybrid approach is stronger than the machine-learning approach and the lexicon-based approach.

VI. COMPARATIVE ANALYSIS:

This chapter offers performs a comparison and analyzes. different methods and algorithms that different researchers have proposed and implemented.

Table I: Comparative Analysis of Machine learning and deep learning approaches:

Research Year & Author	Aim/Purpose	Model(used)	Dataset	Outcomes/Results
2018,[4]	Text Sentiment Analysis	Combined SVM &CNN	NLPCC2014 Emotional Evaluation	Better accuracy in Combined use of SVM &CNN as compared to using them alone
2018,[5]	Sentence Classification	A Joint framework of RNN&CNN	Words from random sentences	Accuracy between 89.2% and 93.3%
2017,[6]	Sentiment Review Analysis	LSTM, Naïve Bayes& SVM	Google Play consumer reviews,196651 reviews in the Chinese language	LSTM gave 94% accuracy, SVM gave 76.46% accuracy and Naïve Bayes gave 74.12% correctness
2015,[7]	Sentiment analysis of movie reviews	RNN & Decision trees	labeled data set consisting of 50,000 IMDB movies review.	DL is much better as compared to the traditional CBOW approach. However, the accuracy was not as much higher.
2016,[8]	Sentiment classification	RBM(Restricted Boltzmann Machine), PNN (Probabilistic Neural	5 different Data Set	Better results than traditional deep architecture

		Network)		
2015, [9]	High dimension data mining problems	HDNN(Hierarchical Deep neural network)	Electric products, movie reviews, Hotel reviews.	The neural network gives more accurate results as the size of the dataset grows
2017, [11]	Recommender system	RNN (Recurrent neural network), RDSA	Amazon dataset, Food item reviews, and Movie Reviews	RNN outperformed as compared to Naïve Bayes
2014, [13]	Methods' performance Comparison	Naïve Bayes	Pre-labeled twitter dataset	Naive Bayes gave better results as compared to SVM & Maximum Entropy
2017, [14]	Performance evaluation of different techniques	SVM,Naïve Bayes,ANN,Maximum Entropy	Different Datasets	ANN gives a higher performance in theoretical accuracy, but SVM outperformed in theoretical training speed
2016, [15]	Text Analysis framework	Decision trees & Naïve Bayes algorithms	200,2000, and 4000 tweets, Twitter data from Apple, ICICI & BSNL using apache spark	For datasets of varied sizes and domains, the decision tree performed best over Multinomial Naïve Bayes.
2017, [16]	Classifying reviews for future decisions	Hybrid SA Technique	Amazon, Canon camera reviews	Experiments show that the proposed hybrid approach is stronger than the machine-learning approach and the lexicon-based approach.

Table ii: Comparison of the key classifiers for tuning and their performance

LSTM network (for analysis of Chinese texts [6]	94%
Combination of CNN_SVM_K [4]	88.8%
Common 'CNN' & 'RNN' frameworks [5]	93.3%
PNN network (having single and smooth parameter for the entire networks) [14]	92%
PNN network (having various smooth parameter for the different types of classes.) [14]	95%
PNN & RBM [8]	93.1 to 94.9 %
Word2-Vec and decision trees [7]	89.9%
RNN network (recommendations systems) [11]	90.48%

Table iii: Deep Classifiers and combined classifiers

Sentiment Classifier Techniques	**Correctness (%)**
Naive Bayesian classifiers [13] [15]	83 to 88%
SVM(Support Vector Machine) Classifiers[4]	82.5 to 85%
Decision trees classifiers [15]	85 to 90%
Maximum Entropy classifier (ME) [14]	79 to 83.25%
Support vector machine (Chinese texts) [9]	76.47%
Naive Bayes (Chinese texts) [6]	74.13%
LSTM network (for analysis of Chinese texts [6]	94%

VII. CONCLUSION

With many applications, sentiment analysis is a rapidly growing field. Not only can consumer expectations be fulfilled based on the outcome of the sentiment analysis, but suppliers, distributors, etc. can also get an idea of the user or client's reaction and therefore ensure that they can make and meet the required adjustments. We have studied different methods and approaches of DL and ML. The techniques of machine learning are much simple and easy to incorporate. These approaches achieve critical outcomes. Methods for deep learning and the combination of methods of DL and ML are complex and superior. They offer better results in most cases than

conventional algorithms for machine learning. In certain extreme cases, however, the gap in precision between the two methods is not very significant and the deep learning approach just increases the difficulty of the solution in such cases.

REFERENCES

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[1] V Yeole, P. P. Y 'chavan, and M. C. Nikose, "IEEE Sponsored 2nd International Conference on Innovations in Information Embedded and Communication Systems Opinion Mining for Emotions Determination," 2015

2] J. Singh, G. Singh, and R. Singh, "A review of sentiment analysis techniques for opinionated web text," *CSI Transactions on ICT*, vno. 2–4, pp. 241–247, 2016, doi: 10.1007/s40012-016-0107-y

[3] E. Aydogan and M. Ali Akcayol, "A comprehensive survey for sentiment analysis tasks using machine learning techniques," *Proceedings of the 2016 International Symposium on INnovations in Intelligent SysTems and Applications, INISTA 2016*, 2016, doi: 10.1109/INISTA.2016.7571856

[4] I. Kaur and G. Lal, "Sentiment Analysis of Amazon Canon Camera Review using Hybrid Method," *Int. J. Comput. Appl.*, vol. 182, no. 5, pp. 25–28, 2018, doi: 10.5120/ijca2018917545.

[5] M. Y. Day and Y. Da Lin, "Deep learning for sentiment analysis on google play consumer review," *Proc. - 2017 IEEE Int. Conf. Inf. Reuse Integr. IRI 2017*, vol. 2017-January, pp. 382–388, 2017, doi: 10.1109/IRI.2017.79.

[6] G. Gautam and D. Yadav, "Sentiment analysis of twitter data using machine learning approaches and semantic analysis," *2014 7th Int. Conf. Contemp. Comput. IC3 2014*, pp. 437–442, 2014, doi: 10.1109/IC3.2014.6897213.

[7] R. Ghosh, K. Ravi, and V. Ravi, "A novel deep learning architecture for sentiment classification," *2016 3rd Int. Conf. Recent Adv. Inf. Technol. RAIT 2016*, pp. 511–516, 2016, doi: 10.1109/RAIT.2016.7507953.

[8] A. Hassan and A. Mahmood, "Convolutional Recurrent Deep Learning Model for Sentence Classification," *IEEE Access*, vol. 6, no. c, pp. 13949–13957, 2018, doi: 10.1109/ACCESS.2018.2814818.

[9] Z. Hu, J. Hu, W. Ding, and X. Zheng, "Review Sentiment Analysis Based on Deep Learning," *Proc. - 12th IEEE Int. Conf. E-bus. Eng. ICEBE 2015*, pp. 87–94, 2015, doi: 10.1109/ICEBE.2015.24.

[10] A. P. Jain and P. Dandannavar, "Application of Machine Learning Techniques to Mineral Recognition," *Computer (Long. Beach. Calif).*, no. October, pp. 628–632, 2016, [Online]. Available: http://innovexpo.itee.uq.edu.au/2001/projects/s369357/thesis.pdf.

[11] A. Kumar and R. Rani, "Sentiment analysis using neural network," *Proc. 2016 2nd Int. Conf. Next Gener. Comput. Technol. NGCT 2016*, no. October, pp. 262–267, 2017, doi: 10.1109/NGCT.2016.7877425.

[12] M. S. Neethu and R. Rajasree, "Sentiment analysis in twitter using machine learning techniques," *2013 4th Int. Conf. Comput. Commun. Netw. Technol. ICCCNT 2013*, 2013, doi: 10.1109/ICCCNT.2013.6726818.

[13] G. Preethi, P. V. Krishna, M. S. Obaidat, V. Saritha, and S. Yenduri, "Application of Deep Learning to Sentiment Analysis for recommender system on cloud," *IEEE CITS 2017 - 2017 Int. Conf. Comput. Inf. Telecommun. Syst.*, pp. 93–97, 2017, doi: 10.1109/CITS.2017.8035341.

[14] A. K. Uysal and Y. L. Murphey, "Sentiment Classification: Feature Selection Based Approaches Versus Deep Learning," *IEEE CIT 2017 - 17th IEEE Int. Conf. Comput. Inf. Technol.*, pp. 23–30, 2017, doi: 10.1109/CIT.2017.53.

[15] P. Yang and Y. Chen, "A survey on sentiment analysis by using machine learning methods," *Proc. 2017 IEEE 2nd Inf. Technol. Networking, Electron. Autom. Control Conf. ITNEC 2017*, vol. 2018-January, pp. 117–121, 2018, doi: 10.1109/ITNEC.2017.8284920.

[16] A. S. Zharmagambetov and A. A. Pak, "Sentiment analysis of a document using deep learning approach and decision trees," *Proc. 2015 12th Int. Conf. Electron. Comput. Comput. ICECCO 2015*, 2016, doi: 10.1109/ICECCO.2015.7416902.

[17]. B. K. Bhavitha, A. P. Rodrigues, and N. N. Chiplunkar, "Comparative study of machine learning techniques in sentimental analysis," *Proceedings of the International Conference on Inventive Communication and Computational Technologies, ICICCT 2017*, no. October, pp. 216–221, 2017, doi: 10.1109/ICICCT.2017.7975191.

[18] A. Kalia, "A Brief Survey Paper on Sentiment Analysis," vol. 3, no. 2, pp. 740–744, 2018.

[19] A. M. Ramadhani and H. S. Goo, "Twitter sentiment analysis using deep learning methods," *Proceedings - 2017 7th International Annual Engineering Seminar, InAES 2017*, 2017, doi: 10.1109/INAES.2017.8068556.

[20] A. Yadav and D. K. Vishwakarma, "Sentiment analysis using deep learning architectures: a review," *Artificial Intelligence Review*, vol. 53, no. 6, pp. 4335–4385, 2020, doi: 10.1007/s10462-019-09794-5.

[21] O. Habimana, Y. Li, R. Li, X. Gu, and G. Yu, "Sentiment analysis using deep learning approaches: an overview," *Science China Information Sciences*, vol. 63, no. 1, pp. 1–36, 2020, doi: 10.1007/s11432-018-9941-6.

[22] L. Zhang, S. Wang, and B. Liu, "Deep learning for sentiment analysis: A survey," *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, vol. 8, no. 4, pp. 1–25, 2018, doi: 10.1002/widm.1253.

[23] L. Zhang, S. Wang, and B. Liu, "Deep learning for sentiment analysis: A survey," *arXiv*, 2018.

[24] H. H. Do, P. W. C. Prasad, A. Maag, and A. Alsadoon, "Deep Learning for Aspect-Based Sentiment Analysis: A Comparative Review," *Expert Systems with Applications*, vol. 118, pp. 272–299, 2019, doi: 10.1016/j.eswa.2018.10.003.

[25] M. Thomas and C. A. Latha, "Sentimental analysis using recurrent neural network," *International Journal of Engineering and Technology(UAE)*, vol. 7, no. 2.27 Special Issue 27, pp. 88–92, 2018, doi: 10.14419/ijet.v7i2.27.12635.

[26] K. Raviya and S. Mary Vennila, "A hybrid deep learning approach for sentiment analysis using cnn and improved svm with multi objective swarm optimization for domain independent datasets," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 9, no. 3, pp. 3200–3206, 2020, doi: 10.30534/ijatcse/2020/111932020.

[27] A. Severyn and A. Moschitti, "Twitter Sentiment Analysis with deep convolutional neural networks," *SIGIR 2015 - Proceedings of the 38th International ACM SIGIR Conference on Research and Development in Information Retrieval*, pp. 959–962, 2015, doi: 10.1145/2766462.2767830.

[28] P. Mehta and S. Pandya, "A review on sentiment analysis methodologies, practices and applications," *International Journal of Scientific and Technology Research*, vol. 9, no. 2, pp. 601–609, 2020.

[29] A. Sinha, Y. Agrawal, V. Kumar, and C. Kumar, "Survey of Stock Price Prediction Using Sentiment Analysis," no. May, pp. 1140–1143, 2020.

[30] A. Yousif, Z. Niu, J. K. Tarus, and A. Ahmad, "A survey on sentiment analysis of scientific citations," *Artificial Intelligence Review*, vol. 52, no. 3, pp. 1805–1838, 2019, doi: 10.1007/s10462-017-9597-8.

[31] M. V. Mäntylä, D. Graziotin, and M. Kuutila, "The evolution of sentiment analysis—A review of research topics, venues, and top cited papers," *Computer Science Review*, vol. 27, no. February, pp. 16–32, 2018, doi: 10.1016/j.cosrev.2017.10.002

[32] A. Alsaeedi and M. Z. Khan, "A study on sentiment analysis techniques of Twitter data," *International Journal of Advanced Computer Science and Applications*, vol. 10, no. 2, pp. 361–374, 2019, doi: 10.14569/ijacsa.2019.0100248.

[33] C. Musto, G. Semeraro, and M. Polignano, "A comparison of lexicon-based approaches for sentiment analysis of microblog," *CEUR Workshop Proceedings*, vol. 1314, pp. 59–68, 2014.

[34] V. A. and S. S. Sonawane, "Sentiment Analysis of Twitter Data: A Survey of Techniques," *International Journal of Computer Applications*, vol. 139, no. 11, pp. 5–15, 2016, doi: 10.5120/ijca2016908625.

[35] A. M. Abirami and V. Gayathri, "A survey on sentiment analysis methods and approach," *2016 8th International Conference on Advanced Computing, ICoAC 2016*, pp. 72–76, 2017, doi: 10.1109/ICoAC.2017.7951748.