A COMPARATIVE ANALYSIS OF LEXICON-BASED AND MACHINE LEARNING APPROACHES IN SENTIMENT ANALYSIS: INSIGHTS FROM RECENT RESEARCH

P. Revathi Assistant Professor, Department of Computer Science (UG&PG), Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India. revathi.ethi@gmail.com

Abstract:
Sentiment analysis has been used to determine people's behavior and level of sensitivity to environmental issues. The widespread adoption of social media has made it possible for companies to conduct previously unheard-of, labor-intensive, and error-prone analyses and evaluations of a wide range of factors. Sentiment analysis is closely similar to this kind of analysis technique. Within the field of natural language processing (NLP), sentiment analysis deals with the recognition and classification of subjective information extracted from text. The primary approaches to sentiment analysis that are compared in this study include lexicon-based approaches, machine learning approaches, and deep learning approaches. Using performance criteria from the literature, this study looks at several approaches in terms of accuracy, precision, recall, and computational efficiency. Through a comparative analysis, this paper identifies opportunities for future research and provides a thorough summary of how each approach performs in various circumstances. It also emphasizes crucial insights and emerging trends. Based on their unique requirements and limitations, the findings are intended to assist academics and practitioners in choosing the best sentiment analysis methods. The main contributions of this study are the detailed classifications of many recent papers and the portrayal of the present research trend in the disciplines of sentiment analysis and related ones.

Keywords:
Natural language processing (NLP), Social media data, Sentiment analysis, Lexicon-Based Approach, Machine Learning Techniques, Deep Learning Methods.

1. Introduction

In the modern digital environment, the growth of digital social media is causing digital information to become ever more dynamic. Due to recent advancements in internet technology, sentiment analysis is becoming more and more popular on blogs, review sites, forums, and social media. Finding and classifying the opinions or emotions expressed in a text is the main objective of sentiment analysis.Words used in sentiment analysis are categorized based on their semantic orientation, which typically indicates the text's weight, polarity, and strength. Much work has been done on sentiment classification at the document level using machine learning approaches for reviews and comments from interactive websites. Similarly, lexicon-based techniques have been used to classify sentiment on the same themes. This study examined several research papers on the subject of sentiment analysis that used deep learning, machine learning, and lexicon-based approaches. The goal of this paper is to present a thorough analysis of deep learning, machine learning and lexicon-based approaches, emphasizing the methods, uses cases, and performance measures of each. We want to provide insights into each approach's applicability for different NLP tasks and to suggest possible directions for future study and development by analyzing the advantages and disadvantages of each method. Sentiment analysis is the result of individuals' written or spoken sharing of their feelings, attitudes, ideas, sentiments, etc. This idea primarily relies on polarity identification, which distinguishes between positive and negative viewpoints within the text.

This study examines a number of sentiment analysis techniques, including deep learning methods, machine learning techniques, and lexicon-based techniques. Section 2 of this paper provides an overview of sentiment analysis and its methods. Section 3 examines the diverse methodologies employed by distinct researchers. Section 4 provides suggestions for future sentiment analysis study.

2. Sentiment analysis: an Overview

Sentiment analysis is a crucial area of natural language processing (NLP) that deals with locating and obtaining subjective information from textual sources. Its main goal is to identify the

emotional undertone of a passage of text so that it may be categorized as good, negative, or neutral. This feature is widely used in a variety of fields, including political attitude monitoring, customer feedback analysis, social media monitoring, and market research. Two main approaches have been used to approach sentiment analysis: lexicon-based approaches and machine learning-based approaches. Every approach has unique benefits and drawbacks that affect how it is applied and how successful it is in different situations. Three levels of sentiment analysis are performed: at the word or phrase level, in sentences, and at the document level. To solve sentiment categorization issues, lexicon-based, learning-based, and hybrid-based techniques are typically utilized.

Figure 1 illustrates two different techniques to sentiment analysis: the Lexicon Based approach and the Machine Learning approach.Deep learning approaches have been the basis of recent sentiment analysis research, which likewise yields improved results.
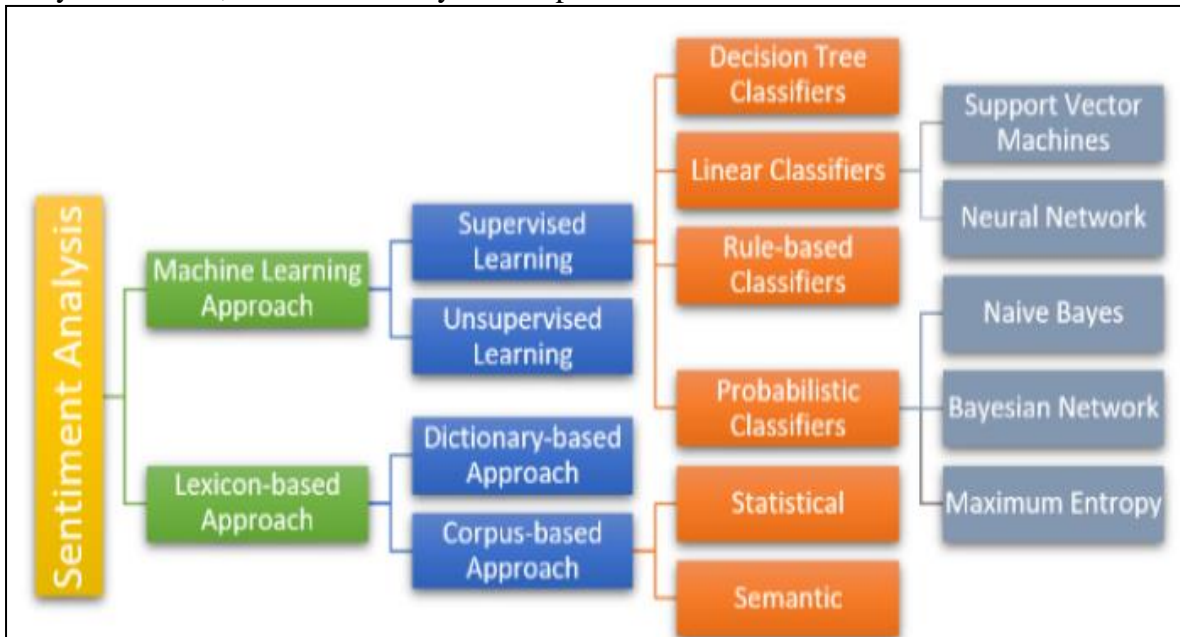
Figure 1: Sentiment analysis approaches

2.1 Lexicons based approaches

Lexicon-based sentiment analysis uses lists of words that have already been created and annotated with feelings or emotional scores. These lists are referred to as sentiment lexicons. Using rules or heuristics to take context and modifiers into account, these lexicons provide a basis for assessing the sentiment of a given text by combining the sentiment ratings of individual words. The lexicons AFINN, SentiWordNet, and VADER (Valence Aware Dictionary and Sentiment Reasoner) are often used examples. Lexicon-based techniques offer clear mechanisms for sentiment assessment and are easy to understand. They are accessible and simple to use because they don't require a lot of computing power. These techniques have trouble understanding idiomatic language, sarcasm, and meanings that change according on the context, which could result in errors.*:* As language changes, lexicons may become out of date and frequently aren't flexible enough to handle jargon unique to a certain domain.

2.2 Machine Learning-Based Approaches

Sentiment analysis based on machine leaning uses statistical models and algorithms to learn from labeled data and predict sentiment in previously unread texts. These methods cover a wide range of methodologies, from deep learning models like Long Short-Term Memory (LSTM) networks and Transformers (e.g., BERT and GPT) to more conventional methods like Support Vector Machines (SVMs) and Naive Bayes. Deep learning-based machine learning models, in particular, are good at recognizing context and subtle meanings, which helps them, classify sentiment more accurately. These models can be optimized for certain languages or domains, which increases their performance and usefulness in a range of applications. It is evident from a comparison between lexicon-based and machine learning-based approaches that each has a role depending on the requirements of the work and the available resources. Lexicon-based approaches are resource-efficient and provide insightful information, but they may not be able to handle context and complexity. Although very effective and

adaptable, machine learning techniques necessitate a substantial investment in computer equipment and data.

Figure 2 illustrates various machine learning approaches used in sentiment analysis, including Support Vector Machine, Logistic Regression, Decision Trees, Random Forests, LSTM, and Naive Bayes.
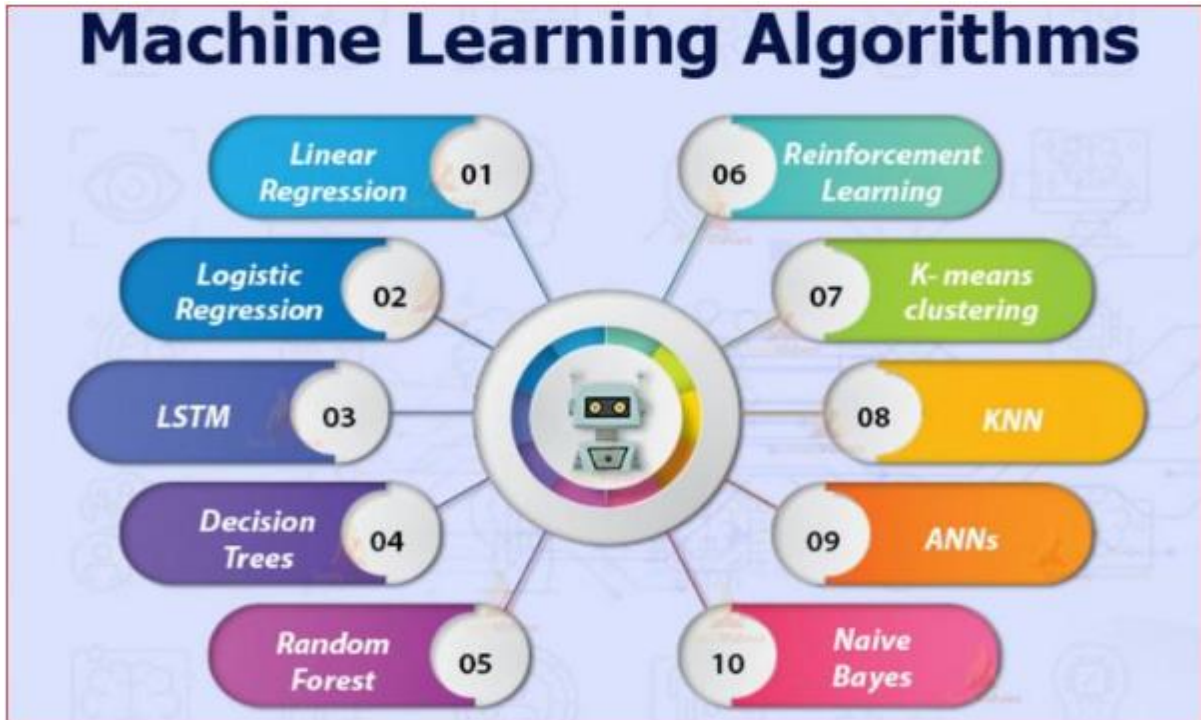
Figure 2: Machine learning approaches

2.3 Deep Learning Approaches

Deep learning can identify intricate patterns in data; it has emerged as a potent tool for sentiment analysis. The following are some popular deep learning techniques for sentiment analysis: Word2Vec model uses a corpus's context to create dense vector representations of words. Comparable vectors between words with comparable meanings aid in capturing semantic links. Glove (Global Vectors for Word Representation) tool builds word embedding by utilizing global statistical data about word occurrences, much to Word2Vec.

Basic RNNs are good for sequence data since they maintain a concealed state to track data from previous time steps. They may have trouble with long-term dependence. Long Short-Term Memory (LSTM) employ gates to better capture long-term dependencies and avoid problems like as vanishing gradients, making them an upgrade simpleRNNs.GRUs, or gated recurrent units is a less complex LSTM version that has fewer gates, which can sometimes make them faster and more effective for specific tasks. Despite being primarily utilized for image processing; CNNs have shown promise in text categorization applications. They function by capturing local patterns in word embedding through the use of convolution filters, which might be helpful for sentiment analysis. Bidirectional Encoder Representations from Transformers, or BERT, is a text processing tool that may capture context in both directions during its bidirectional processing. It has been optimized for particular tasks like sentiment analysis and pre-trained on sizable texcorpora.GPT (Generative Pre-Trained Transformer): Although the primary purpose of GPT models is text generation, its underlying architecture is also useful for sentiment analysis and classification. To be properly tailored for sentiment analysis, GPT needs to be trained on labelled sentiment data. DistilBERT is a speedier, more compact variant of BERT with lower processing overhead while maintaining a large portion of its functionality.

Figure 3: Deep learning algorithms

3. Literature Survey

A literature survey, sometimes referred to as a literature review, is a thorough summary of the body of knowledge already available on a given subject or area of study. To present readers a clear picture of what is known, where there are gaps in the knowledge, and how various works relate to one another, it entails methodically looking for assessing and summarizing pertinent publications, studies, and theories.

3.1 Existing approaches using machine learning Techniques

"Sentiment Analysis was using Support Vector Machine and Random Forest" by Talha Ahmed Khan, Rehan Sadiq, Zeeshan Shahid stated that the findings of this research contribute to a deeper analysis and offer thoughts on how well machine learning techniques work in this field. Based on the outcomes, the accuracy of two machine learning algorithms—Random Forest and SVM—in a classification job was assessed.

"Sentimental Analysis of Product Based Reviews Using Machine Learning Approaches" - Manvee Chauhan, DivakarYadav summarizes that product reviews by assigning a good, negative, or neutral rating to these reviews. Internet information is extremely unstructured which are classified using machine learning. Combining support vector machines and naïve Bayes methods with inputs like unstructured product reviews, executes preprocessing, determines the reviews' polarity, and extracts features from which receives feedback and creates a graph showing the outcome. Measured are the algorithm accuracy, precision, and recall. Social media data obtained by employing an Application Programming Interface (API) search to live stream public tweets is thought to be a feasible and trustworthy resource for researching public opinion around Covid-19 vaccination reluctance. Consequently, to look into vaccine hesitancy for COVID-19. This paper looks at three sentiment computation techniques: TextBlob, VADER, and Azure Machine Learning. Using varying combinations of the three vectorization techniques (Doc2Vec, CountVectorizer, and TF-IDF), five learning algorithms (Random Forest, Logistics Regression, Decision Tree, LinearSVC, and Naïve Bayes) were implemented in Covid-19 vaccine hesitancy: "Text mining, sentiment analysis and machine learning on COVID19 vaccination Twitter dataset"Miftahul Qori ,Timothy Oladunni ,Max Denis,Esther Ososanya ,Paul Cotae.

"Climate Change Sentiment Analysis Using Lexicon, MachineLearning and Hybrid Approaches" -Nabila Mohamad Sham and Azlinah Mohamed has discussed that by comparing and contrasting different sentiment analysis techniques, this study seeks to determine which approach is most useful for tweets about climate change and related topics. Considering this, seven lexicon-based methods—TextBlob, SentiWordNet, Hu and Liu, MPQA, SentiStrength, VADER, and WKWSCI—were applied. Three machine learning classifiers were employed in the interim, including Support

Vector, Logistic Regression, Naïve Bayes, and Machine use two feature extraction methods, namely TF-IDF and Bag-of-Words. The hybridization of lexicon-based and machine learning-based methodologies was then carried out. The outcomes show that the hybrid approach performed betterthan the other two methods, with an F1-score of 75.3% obtained by hybrid Text Blob and Logistic Regression; Therefore, this has been determined to be the most successful strategy .

"Text Mining Attitudes toward Climate Change: Emotion and Sentiment Analysis of the Twitter Corpus"- Zhewei mi and Hongwei zhanstated thatusing R software for automatic sentiment analysis, one can find the most common negative viewpoints. Emotion analysis can identify the main emotions and their relationship to various opinion groups, which can then be tested using logistic regression models. These findings support climate policy and more accurately reflect public concerns.

"Decoding violence against women: analysing harassment in middle eastern literature with machine learning and sentiment analysis", Hui Ki low,Pantea Kaikhosrokiani research presents a comparative examination of both supervised machine learning and lexicon-based approaches for text sentiment classification models employing word frequency inverse document frequcy vectorization. Numerous intriguing lexicon-based and machine learning approaches have been developed, but it is unclear how effective each strategy is in comparison for different kinds of issues. A total of six algorithms to provide academics with thorough insights. Gradient Boosting, Support Vector Machine (SVM), and Logistic Regression (LR) are the three machine learning algorithms. The three lexicon-based algorithms are SentiWordNet, Pattern, and Valence Aware Dictionary and Sentiment Reasoner(VADER)[7].

"Research on the Application of Deep Learning-based BERT Model in Sentiment Analysis"- Yichaowu, Zhengyu jin,Chenxishi,Penghao Liang,Tongzhan stated that sentiment analysis utilizing deep learning methods, with an emphasis on BERT models in particular. This work uses the third lockdown period in England as a case study to investigate the sentiments expressed in tweets using a variety of techniques, such as lexical and machine learning approaches in Cantonese sentiment analysis and contrasted their results with those of other popular techniques, such as lexicon-based techniques and machine learning approaches.

"Efficacy of ChatGPT in Cantonese Sentiment Analysis: A comparative study "examined how users' tweets are categorized as "positive" or "negative" using polarity-based sentiment analysis and deep learning models. It is evident from a comparison between lexicon-based and machine learning-based approaches that each has a role depending on the requirements of the work and the available resources. Various machine learning classifier algorithms can be used to analyze these tweets. Classification is also done by dense neural network deep learning."Sentiment Analysis on Covid-19 Using Deep Learning"-Soni Mehta, Shruti Pednekar paper's primary goal is to use Twitter data to understand people's emotional expressions. After gathering the corona-specific tweets from Twitter, pre-processing is carried out to clean up the data. Next, a pre-trained model for word embedding is employed, and finally CNN, LSTM, and CNN- BiLSTM hybrid deep learning techniques are applied. The model is evaluated using memory, accuracy, and precision techniques.

The following table specifies various deep learning and machine learning techniques used in different research papers and their accuracy levels are discussed below:

Table 1: A Comparative Analysis

Ref No	Year	Title with Author	Techniques	Inference
[6]	2024	Harassment analysing in middle eastern literature with machine learning and	LR and LSTM	Accuracy:LR: 75.8%,LSTM:84.5%
[18]	2023	Sentiment analysis using Twitter data: a comparative application	Text Blob & VADER,MNB,SVC,RF	Sentiment analysis with SVC outperformed the total model accuracy
[19]	2023	Using Deep Learning in Iraqi Sentiment and Emotion Analysis.	GRU and CNN.	CNN and GRU A hybrid deep learning model is displayed, with one layer

[20]	2023	Sentiment Analysis for Sarcasm Detection using Deep Learning.	GRU,LSTM,Bi-LSTM.	Outperforming the other models is the BiLSTM.
[23]	2020	Sentiment Analysis of Shared Tweets on Global Warming on Twitter with	KNN,NB,SVM.	The K-NN classification algorithm produced the best performance rate.
[5]	2017	Sentiment Analysis of Tweets using SVM.	SVM in Weka.	Accuracy:70.2%,71.2%and 69.9%
[2]	2023	Text mining, sentiment analysis and machine learning on COVID-19	TextBlob,VADER RF,lR,NB,TF-IDF	Text Blob + TF-IDF + LinearSVC performs the best.
[17]	2018	HYBRID ARCHITECTURE FOR SENTIMENT ANALYSIS	CNN and RNN.	To attain the best accuracy, hybrid architecture consisting of CNNs and
[21]	2021	Sentiment Analysis on Twitter Data: A Comparative Approach	Machine learning-SVM.	Higher accuracy score given by Machine Learning models.
[22]	2024	Comparative Study for Sentiment Analysis of Financial Tweets with	CNN,LSTM,GRU, GRU-CNN.	CNN Model performs better than other models.

3.2 Existing approach using lexicon based approach

"Aspect-based sentiment analysis using smart government review data"by Omar Alqaryouti and Nur Siyam,Azza Abdel Monem,Khaled Shaalan proposes an aspect-based sentiment analysis hybrid approach that integrates domain lexicons and rules to analyse the entities smart apps reviews. This paper combines a rule-based model with an integrated lexicon to report excellent performance outcomes. An integrated lexicon and rule-based model is used as a technique to implement lexicon based approach. The datasets utilized in this study were lexical resources for government smart apps, relevant to a given domain .Among the most widely used social networking sites is Twitter. "Tweets" are communications that users post online that can include text, images, videos, and links. Because Twitter is so popular and there is so much activity on the platform, it is becoming more important to analyze Twitter data.

"Marathi text sentiment analysis using lexicon based approach", Saroj stated that scholars working on natural language processing (NLP) are actively developing lexical resources for a variety of languages, including Marathi. Some of these resources are the Marathi version of LIWC (MR-LIWC2015), Marathi NRCVAD, and Marathi Senti-wordnet.In the framework of web-based counseling."Efficacy of ChatGPT in Cantonese Sentiment Analysis: Comparative Study" examined the effectiveness of GPT-3.5 and GPT-SpaCy to assess people's emotions. The Lexicon method is the basis of these APIs. This study divides sentiment into three categories: neutral, negative, and positive. Lexicon-based approaches are not domain dependent, but supervised machine learning techniques yield excellent accuracy but require training data. Even though creating a lexicon is expensive, once it is, it can be used in many different fields.

"Rich semantic sentiment analysis using lexicon based approach" by Hedayatullah, Lodi and Prem Balani discussed that the semantic orientation of words, phrases, or the material under review is used by the lexicon-based technique to ascertain sentiment polarity. For quick and precise sentiment analysis, a large, high-quality lexicon is crucial. Opinions were derived from Vader sharp, a common vocabulary comprising information with a common semantic meaning or sense across disciplines. After analysis, the viewpoints are categorized as neutral, negative, or favorable. "Comparative analysis of sentiment analysis using lexicon based approach" Monali V.Waghmare, et.al examines tweets from 2002 to 2019 about Triple that were posted on Twitter. The primary goal of the work is to use two popular APIs, such as Text Blob and VADER.

"Automated customer opinion mining using lexicon based approach sentiment analysis"Letticia,TendaiTagwira,WellingtonMakondo,ChiedzaHwata,TrevorMakausi,Wellington Manjoro, Walter Mambodza-In this paper the sentiment analysis and recommendation phases make

up the two stages of the suggested methodology. The Arabic dataset's unique lexicon is used in the sentiment analysis step to derive sentiment scores. The second stage makes use of item-based and singular value decomposition-based collaborative filtering. In order to improve the precision of collaborative filtering for Arabic, sentiment analysis of user reviews is being utilized.

Table 2: Comparative analysis of lexicon based approach

Ref No	YEAR	TITLE/AUTHOR	Techniques	Inference
[25]	2023	A comparative application of lexicon- and machine-learning-based approach: Sentiment analysis using	Text Blob and VADER and Multinomial NB,	SVC using TF-IDF or BoW outperformed
[24]	2024	Smart government review data in aspect-based sentiment analysis.	Rule-based model with integrated	Rule-based model with an integrated lexicon to report
[10]	2024	Marathi text sentiment analysis using lexicon based approach.	Modified Marathi NRC-VAD.	When the modified Marathi NRC-VAD
[12]	2019	Sentiment Analysis using Lexicon based Approach.	Textblob and SpaCy.	Practically any NLP project can benefit from using
[13]	2017	Rich semantic sentiment analysis using lexicon based approach.	SentiWordNet, SenticNet, SentiStrength.	The accuracy achieved by a 72.8% for the
[15]	2021	Automated customer opinion mining using lexicon based approach sentiment analysis.	Lexicon based approach.	This study emphasized the need to employ a
[26]	2022	Improving collaborative filtering using lexicon-based sentiment analysis.	Lexicon based approach.	The assessment was deemed favorable if there

4. Conclusion

This research work states that when compared to other approaches, deep learning techniques yield superior results through analysis and comparison of diverse research studies.A number of significant differences and revelations arise from the comparison of lexicon-based, machine learning techniques and deep learning techniques to sentiment analysis. The lexicon-based method uses dictionaries or thesauri to extract sentiment from a given text by using re-defined lists of terms linked to sentiment values. On the other hand, machine learning methods especially those that use deep learning and natural language processing provide a more sophisticated and flexible answer. Subsequent investigations and advancements may concentrate on the smoother integration of these methods, the automation of lexical resources, and the improvement of machine learning models to better manage subtle sentiment. This paper lays the groundwork for a more thorough investigation of the ways in which various methodologies have been used and developed in sentiment analysis, offering a basis for comprehending their individual effects and prospects going forward.

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