

A Survey On Sentiment Analysis Tasks, Approaches And Applications

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Abstract

The World Wide Web that involves social networks forums, review websites and blogs produce vast quantity of knowledge in the kind of thoughts, feelings, viewpoints and arguments about one of a kind social events, products, brands and politics. Sentiment analysis is the automatic recognition technique that analysis the attitude of people towards social events, product, brands, person and political issues. The role of sentiment analysis involves textual data mining by means of natural language processing (NLP). Text communication method such as tweets, reviews blogs are important for examining a person's emotion by analyzing the input text. Sentiment analysis of social networking websites is a manner to pick out the user's opinion. The growing need of modern times is to resolve the consumer opinion and depth of the sentiment in the direction of the entity. The paper concludes a survey on sentiment analysis. The key objective of this survey is to provide almost complete picture with brief descriptions of the techniques of sentiment analysis and the interrelated fields.

Keywords: *Sentiment analysis, SA, Machine Learning, CNN, SVM, Deep Learning*

1. INTRODUCTION

Social media has become yet another medium of communication between organizations and client. In social networking websites such as Twitter, Flipkart, Amazon users are provided with a forum to share their feelings, views, and preferences about different subjects. In terms of the development of technology and the internet, users use social media to deliver their input and views in free text, voice or video form. Opinion conveyed in social media can be categorized as sentiments (negative, positive, neutral) in order to resolve the orientation of the received text and it is used determined the user's view and emotion on a specific product or service.

Sentiment analysis is one of the interesting application of data mining to analyze the text reviews. Nowadays, we are aiming for the automation as it is hard for the service providers to study and evaluate all reviews manually and on that basis, to come to a conclusion and take the vital steps to improve the product/service quality. It has grabbed the attention of the researchers with the rapid increase of possible applications. Different models have been implemented by researchers with efficient performance, which have recently been expanded. These models include lexicon based, machine learning, deep learning and hybrid approaches. The paper presents a detail survey of various sentiment analysis techniques in detail along with their comparison.

2. RELATED WORK

Vijendra Singh, Gurdeep Singh [1] proposed in a dictionary-based approach a human sentiment analysis model (HSAM), here the sentiwordnet as a lexicon dictionary for obtaining the sentiments related with each word. Antonio, Fernández [3] outlined the corpus-based domain-specific sentiment analysis framework initially designed for general language text.

Rishija Singh and Vikas Goel [4] proposed a novel machine learning algorithm for analyzing sentiments on tweets and compared with their evaluation parameters. Deep learning in both unsupervised and supervised learning could be very successful, many researchers concentrate on the concept of deep sentiment analysis model for the current scenario. QuratTul, Ain Mubashir Ali [14] addresses the deep sentiment analysis methods and algorithms, the hybrid approach is also another important promising technique in sentiment analysis. Devi, Mounika, and Sowjanya [8] defined a hybrid approach using the lexicon-based HARN algorithm to achieve sentence level emotional polarity. In this paper we took the survey of various sentiment analysis techniques for instance lexicon based, machine learning, deep learning and hybrid approaches and referred papers with accuracy and key points of each techniques and it is represented in tables.

3. DATA SOURCES

This section discusses approximately the data sources used for sentiment analysis.

It may be in the form of speech, text, gestures, etc.

- **Blogs:** Now-a-days people explicit their opinions or views about a specific product, service, event or issue on a specific place called blogs.
- **Review Sites:** Companies evaluate the customer reviews in order to provide right products and services. These reviews are stated on sites along with www.amazon.com, www.flipkart.com, www.reviewcenter.com etc.
- **Data Sets:** Movie reviews and product reviews extracted from well-known web sites are widely used datasets for sentiment analysis
- **Microblogging:** The practice of creating and publishing personal blog post on a microblogging website. For e.g.: A “tweet” on twitter
- **News Articles:** News Articles Websites such as www.bbc.com, www.cnn.com, www.thehindu.com etc. allows the person who reads to comment on a current event or topics.

4. SENTIMENT CLASSIFICATION FRAMEWORK

This section focuses on the meaning of the basic terminologies and a brief description of sentiment analysis framework, which involve pre-processing, extraction of features, classification of sentiments and so on.

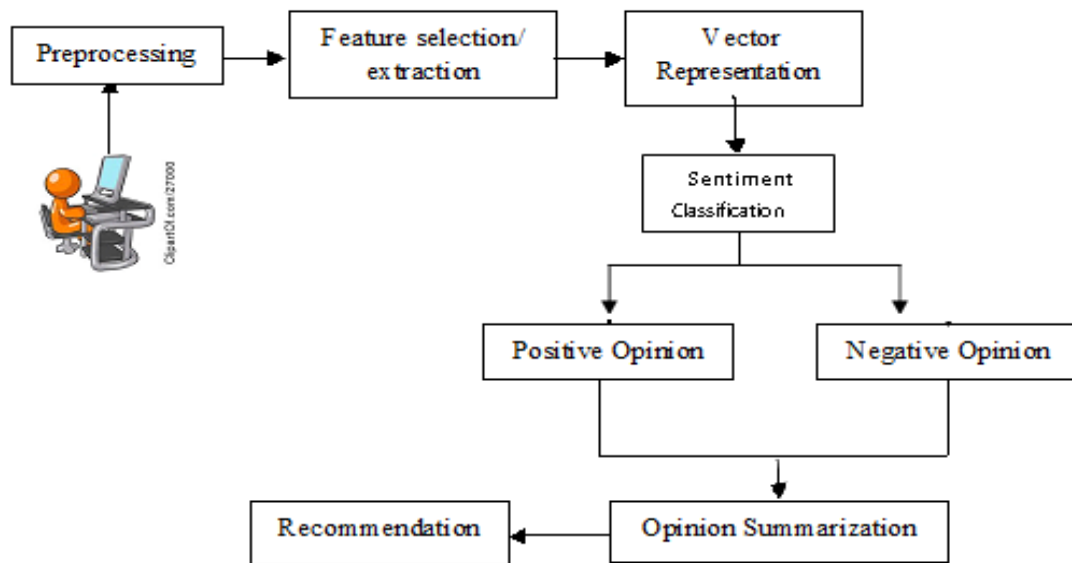


Figure-1 Sentiment Analysis Framework

A. Basic Terms

- **Opinion:** This is a belief, judgement, or perception of any entity that is founded on facts or practice.
- **Opinion Holder:** The man or woman who express their views approximately any item is named as opinion holder.
- **Object:** Things like topics, items, facilities, events etc. that relate to the object.
- **Feature:** The object's attribute, based on which judgements are made.
- **Sentiment Polarity:** The polarity of the sentiment shows whether the opinion expressed is positive, negative or neutral.

B. Preprocessing:

For extraction of sentiment feature, the fresh data is taken and pre-processed in the following stage.

- **Tokenization:** It splits the sentences in to tokens by eliminating white spaces and symbols or special characters.
- **Stop Word Removal:** Eliminates terms from the document as “a, an, the”.
- **Stemming:** Condenses the phrases or tokens to their original form.
- **Case Normalization:** Transforms the full text in lower case letters or in upper case letters.

C. Feature Extraction:

- **Feature Type:** It's about defining the type of features used for opinion viz. term frequency, co-occurrence, opinion word, negation, syntactic dependency.
- **Feature Selection:** This is to pick out exact features for classification in subsequent ways such as information gain, odd ratio, shared knowledge, document frequency.
- **Feature Weighting Mechanism:** It estimate weight for rating the features by using Term frequency and Inverse document frequency (TF-IDF).
- **Feature Reduction:** To maximize a classifier efficiency, the vector size must be reduced.

D. Sentiment Analysis

Sentiment analysis is mainly conducted at three different stages depending on the input text.

- **Document Level:** The document contains opinion of a single person. In this level the entire document is taken as single entity and is labeled as positive or negative.
- **Sentence Level:** Here the documents acquired are separated in to sentences and then the sentence polarity is categorized as positive, negative or neutral.
- **Word or Phrase Level:** Analysis of product features (product attributes or components) for sentiment classification is referred to as phrase or feature based sentiment analysis. It is fine grained analysis among all other models.

5. APPROACHES FOR SENTIMENT ANALYSIS

There are several applications and improvements that have been proposed on SA algorithms in recent years. This survey aims to provide a more detailed understanding of these improvements and to summarize and categorize some articles provided with various SA techniques in this field. More specifics detailing related papers and originating referrals also highlight different approaches to sentiment classification techniques, as shown in Fig.2.

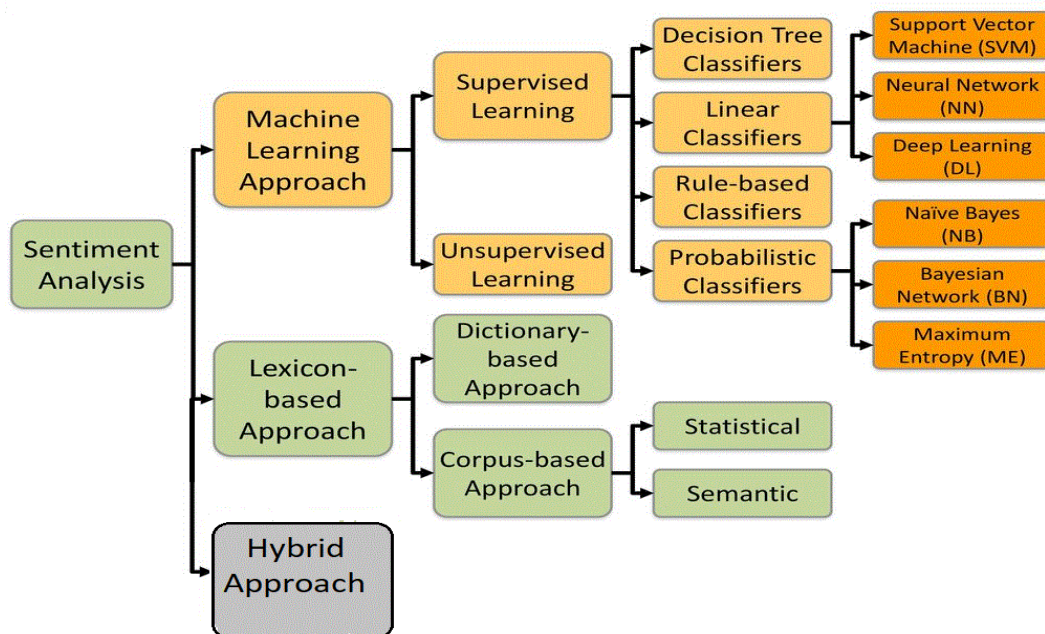


Figure-2 Sentiment Analysis Approaches

A. Lexicon Based Method:

Lexicon based approach use dictionary of feelings with opinion phrases and combines them with the knowledge to assess polarity. They assign emotion scores to the opinion phrases explaining how the words in the dictionary are positive, negative, objective. Lexicon-based approaches rely in particular on a sentiment lexicon, i.e., a collection of established and pre-compiled words, phrases and even idioms developed for conventional genres consisting of the opinion finder lexicon. In this method, three sub classifications are:

1. Manual approach:

This takes time to consume and is not used alone all the time. In order to prevent the errors caused by automated processes, it is also combined with the other two automated approaches. These two automated methods are illustrated in the subsections below.

2. Dictionary-based:

This is based on the use of words (seeds) usually gathered and manually annotated. This collection expands when looking for a dictionary's synonyms and antonyms. WordNet is an instance of the dictionary, used to extend a thesaurus known as SentiWordNet. It can't deal with different orientations for the domain and the context.

3. Corpus-based:

The corpus aims at offering dictionaries specific to a given domain. Such dictionaries are created from a collection of terms of seed opinion that develop through the hunting of related words through the use of both statistical or semantic techniques.

we described some of the Lexicon-based methods utilized on sentiment analysis in Table-1.

Table 1. Survey Summary of Lexicon Based Approaches

Name of the technique	Approaches	Data Set	Source	Accuracy	Key Points
Lexicon-based technique	Manual approaches	The four data set contain 1332,4432, 2005,540 words as input to the system	[1]	68.71	The manual method needs maximum time and is not necessarily used alone.
	Dictionary based	four data set from various domains: agriculture, movie, kitchen, and book	[2]	62	Wide verity of words covered. Better usage of a sentiment dictionary improvises the efficiency and accuracy of the system
	Corpus based	Labeled data from economic news section	[3]	84.21	Many words in lexicon then it assigns sentiment scores to each and every word

B. Machine Learning Based Approach

Machine learning may further divide into supervised, unsupervised and semi- supervised methods. The approaches to supervised learning using labeled training materials and it is based upon automated text classification that use pre-defined training set. Many of the supervised classifiers are

1. Naïve Bayes, Bayesian Network Maximum Entropy etc. are the probabilistic classifiers.
2. Linear classifiers define appropriate separators that can better divide the space into different classes. logistic regression and support vector machine are best known linear classifiers.
3. Rule-based classifiers divide the data into rules in the form of “IF condition THEN conclusion” and generate it during the training process. The classification system for the decision rules classifies the data in to the marked categories.
4. Decision tree classifiers construct a tree-like hierarchical structure based primarily on training material categorization with true/false queries.

Unsupervised approaches to learning are not based on the training data context and subject matter. It overcome the challenge of gathering and generating labelled data for teaching. Neural Network, Sematic Orientation are some the unregulated approaches to learning discussed in Table-2. A variety of machine learning techniques were framed to classify the reviews or tweets into classes. Supervised machine-learning algorithms such as Naive Bayes (NB), maximum entropy (ME), and support vector machines (SVM) are proved to be very efficient in sentiment analysis. In Table-2 The survey is based on various recent studies in the area of sentiment analysis using machine learning algorithms.

Table 2. Survey Summary of Machine Learning Based Approaches

Machine learning Approaches	Algorithms	Data Set	Source	Accuracy	Key Points
Supervised technique	Naive Bayes	Large movie review data set	[5]	87.5	Model is easy to interpret and not affected by irrelevant features Assumes independent attributes
	SVM	Movie review data	[10]	84.7	Data set dimensionality has low dependency. Difficult interpretation of resulting model
	Maximum entropy	Product reviews harvested from website	[11]	81.65	Should not consider random variables as statistically independent. It requires more of the human efforts in the form of additional resource or annotations.
	Bayesian network	Amazon online product reviews	[21]	78.9	Capable of learning almost any relationship between input and output variable. Requires more time for execution.
Unsupervised technique	Neural network	BBC News Data set	[23]	88.2	Neural network algorithms produce excellent outcomes and substantial evolution in sentiment analysis. It takes much amount of time for training
	Semantic orientation	online product review of digital camera	[13]	83.39	It requires broad dataset to identify the polarity of the terms and Limited because of inadequate coverage of the multi-word features.

C. Deep learning Approach

G.E. Hinton initially suggested deep learning in 2006 and is the machine learning part of the deep neural network [14]. Neural network is constructed by multiple neurons that gives an outstanding network and it is activated like a human brain. Deep learning can provide both supervised and unsupervised training [6]. It includes numerous networks such as Convolutional Neural Networks, Recursive Neural Networks, Long Short-Term Memory, Gated Recurrent Unit, Deep Belief Networks and several more. Neural networks are very helpful in text era, vector representation of words, sentence form, sentence modeling and presentation of features. Recent days Through deep learning techniques, this sentiment analysis is being applied. The high precision in both the fields of sentiment analysis and deep learning solved many problems. Many researchers in their analysis used a variety of models, which is described under the section on the hybrid neural network. This survey addressed unique studies to include a comprehensive expertise on the effective growth of deep learning algorithms in the domain of sentiment analysis.

Deep learning models promise one item - provided sufficient data and sufficient training time then it can perform the task of classifying sentiments on any text genre with minimal constraints. In this survey, we described some of the extra-ordinary deep learning approaches utilized in sentiment analysis.

Table 3. Survey Summary of Deep Learning Based Approaches

Deep learning Approaches	Data Set	Source	Accuracy	Key Points
CNN	Movie Review	[25]	81	It is capable of capturing related features from any part of the word. but fails to maintain long-term dependency.
RNN	IMDB Movie Review	[7]	87.42	It gives more emphasis on the sequence of words in the data. But fail to process very long sequences
LSTM	IMDB Large Movie Review Dataset contain 50,000 review	[24]	85.9	Could selectively overlook and recall details that improve the sentiment classification. The network is considerably slow and computationally expensive
GRU	Amazon product reviews	[26]	95.67	It can catch interdependencies which occurs between the review sentences. It is not having memory unit, as a result unregulated disclosure of hidden content.
DBN	Text Reviews	[22]	71.3	It is able to learn useful information from a corpus using several hidden layers. But unable to recall the previously trained task due to shortage of memory.

D. Hybrid Approach

Hybrid methodology is a combination of approaches to lexicon and machine learning.

Researchers have shown that the combination of both methods provides enhanced classification performance [15]. The benefit of hybrid approach is that the novel combination of algorithm allows the detection and measurement of sentiment at the concept level with high accuracy [20].

Many researchers have used more than one model in their analysis to improve output by using either machine learning with deep learning algorithms or two deep learning algorithms. These are listed below the section hybrid neural network. This study is focused on various current sentiment analysis studies using hybrid algorithms in Table- 4.

Table 4. Survey Summary of Hybrid Approaches

Hybrid Approach	Dataset	Source	Accuracy	Key Points
CNN+SVM	Book Reviews	[27]	83.23	CNN is for feature extraction and SVM as classifier.
CNN+K Means	Movie Reviews	[19]	83.4	applicable for larger datasets, which improves the efficiency and accuracy.
CNN+Logistic Regression	Tweets from REST API	[18]	80.66	In CNN non-linearity effectively find and reduce the latent features and Logistic Regression as sentiment classifier.
CNN+SVM	Text Reviews	[17]	98	This model is independent of the domain knowledge and hand designed features
CNN+SVM	Mix of text data set	[16]	87	CNN for feature extraction and SVM for sentiment classification.
RNN with LSTM and NB-SVM	NLPCC 2014	[12]	85.10	The hybrid approach incorporates generative and discriminatory frame work for the classification of multi-language textual content.
NB_SVM + HARNs Algorithms	Amazon product Reviews	[8]	80-85%	They used both supervised and lexicon-based approaches to get the result with great precision with this hybrid method.
Hybrid frame work using Genetic algorithm	Geopolitical information for U.S. Presidential election-2016	[9]	95.7	Novel feature reduction algorithm using a GA based approach with a custom fitness function. The fitness function uses SentiWordNet to evaluate feasible solutions, which lead to improved scalability of the system.
Genetic Algorithm (GA) is used for extraction of feature and SVM, Artificial Neural Networks and Centroid based algorithms for the classification	Tweets	[20]	96.8	The method of feature selection is paired with the classification to examine the effect on the success rate of analysis.

6. CHALLENGES IN SENTIMENTAL ANALYSIS

The key challenges facing SA are as follows

- A) Spam and fake review detection:** Both authentic and spam contents are available on the website. This spam content should be eradicated before processing for an efficient sentiment classification. This can be achieved by finding duplicates or fake reviews.
- B) Domain- independence:** SA's greatest problem is the domain dependent nature of sentiment words. some feature set can produce good performance in one domain; at the same time, in another domain, it performs very poor.
- C) Temporal Relations:** The analysis period could be important for SA. The reviewer might think that Samsung galaxy-note5 was fine in 2015, but now due to new Samsung-note10, he may have negative opinion in 2020. Therefore analyzing these types of views that change over time will enhance the efficiency of the SA system. This allows us to see if a particular product is changed over time or people change their minds.
- D) Sarcastic sentences:** Text may contain Sarcastic and ironic phrases. For example, "Movie was so awesome that I had to sleep through it to forget it" In such case, successful words can have destructive sense of meaning. Sarcastic or ironic sentences are difficult to recognize and it leads to imprecise opinion mining.
- E) Knowledge Base:** Knowledge about f the facts, events, people are also required to interpret the text correctly. For Example, "Casablanca and a lunch comprising of rice and fish: a delicious Sunday "The frame work without world knowledge classifies above phrase as positive because of the word "delicious", but Casablanca is the name of the famous movie and it is an impartial phrase.

7. APPLICATIONS OF SENTIMENTAL ANALYSIS

It can be used for various purposes in different fields. Several specific fields are discussed in this section as follows.

A. Online Product Analysis In the e-industry, the most general use of SA is. Websites encourage users to apply their shopping experience and revisit their views, perceptions and product quality assumptions. By awarding ratings or scores, they provide a description of the product with various features.

B. Voice of Customers (VOC) and Voice of Market (VOM) VOC is a market research methodology to explain the in-depth method of capturing the preferences, interest, antipathies of a customer, while VOM indicates that not only your own customers but also those of key competitors will be surveyed. Detection of these details as early as possible allow for key marketing campaigns in direct and tailored form.

C. Brand Monitoring Brand Reputation Management (**BRM**) helps determine whether a particular brand's consumer image changes positively or negatively, during an incident the difference can be analyzed with SA.

D. Recommender Systems By classifying the people's opinion, the system will tell which one should be recommended and which one should not be recommended.

E. Policy Making Using SA, politician may transfer public opinion about a policy and use it to create policies that are in demand by the public at large.

8. ONLINE TOOLS AND API FOR SENTIMENT ANALYSIS

Monkey Learn: It is an easy-to-use machine learning tool for text analysis. It offers a pre-trained model for sentiment analysis.

IBM Watson is a multi-cloud platform which provides many APIs primarily based on NLP for sentiment analysis.

Lexalytics is a tool for recognizing consumer feelings. NLP is often used to process the text and then analyzes the thoughts and emotions behind the words of customers.

MeaningCloud is an API that analyzes multilingual sentiments. This online tool conducts aspect-based sentiment analysis to assess if the text is positive, negative, or neutral.

Aylien is another online resource that exposes the hidden value of texts via acting sentiment evaluation.

Clarabridge has a customer experience management solution platform to review emails, chats, and surveys. which gives you a statistic about the consumer state of mind. This also incorporates lexical and grammatical methods in order to evaluate each word in a text. It concentrates on audio data-based sentiment analysis This online program analyzes not only the caller's voice, but also its tone and diffusion of feelings.

9. CONCLUSION

The value of sentiment analysis correlates with social media growth, such as forum, micro-blogs, Facebook, Twitter. Marketing activities tend to dominate the applications in the field of financial, healthcare and hospitality and tourism industries, A description of the various approach and algorithms for sentiment analysis was presented in the survey report. There are advantages and disadvantages to each kind of techniques. Machine learning approaches such as supervised method of learning is higher than unsupervised learning methods. In this survey, numerous studies were explored to provide an in-depth knowledge of the effective growth in the field of sentiment analysis. Among various approaches all has its benefits and drawback we are considering hybrid method to be the most useful method as we can customize the operations based on data and incorporate benefits of more than one approach.

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