

# A Survey on Sentiment Analysis and Mining of Opinions using Natural Language Processing Techniques

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**Abstract**— In the past few years, sentiment analysis received a great attention as the mining of opinions or reviews from the customer about the product or object. Mining of opinions is defined as a computational task for reviewing the emotions, attitudes and opinions of an individual about a particular product. It evaluates the results as positive, negative or neutral. Before buying a product, the customers want to know the reviews of other users about that product. To make the product more profitable and other future determinations, customer feedback about the product are analyzed by the companies. So the sentiment analysis is decisive for both individuals and companies for making certain decisions. Now a day’s opinion mining is most prominent branch of research in the area of text mining. This survey deals with a detail study of sentiment analysis, opinion mining and natural language processing techniques used for sentiment analysis. Some existing work that has been done in past few years has also been discussed in this survey.

**Keywords**—Data mining, Web mining, Opinion mining, Sentiment analysis, NLP.

## I. INTRODUCTION

Sentiment analysis also known as mining of opinions or opinion mining is an application of natural language processing which is used to identify and extract subjective information from different resources in the form of text documents. It also evaluates the results as positive, negative or neutral. *Opinion mining is a type of data mining that measures the tendency of people’s opinions through natural language processing and text analysis, used to extract and analyze useful information from the web i.e. review sites and social media etc.*(Source: Wikipedia). This paper presents a survey on sentiment analysis with natural language processing (NLP) techniques and gives a brief overview on the data mining and web mining techniques. Rest of the paper is organized as follows, Section I contains the introduction of the terms related to opinion mining. Section II contains the data sources from which the data is collected. Section III explains the levels or sentiment classification. Section IV explains the NLP and NLP toolkit available for OM. Section V contains the related work carried out so far. Section VI concludes the work with future direction for research work.

### A. Data Mining

Data Mining refers to a process or technique which is useful for extracting the useful information from the large amount of data, stored in the databases, the web and various data streams i.e. data warehouses. The various data mining tools

and techniques are used to convert the vast amount of data into some useful information for decision making and to make market analysis etc.

Data mining is the crucial step in the Knowledge discovery from data (KDD) process. The following diagram represents a hierarchal model of data mining:

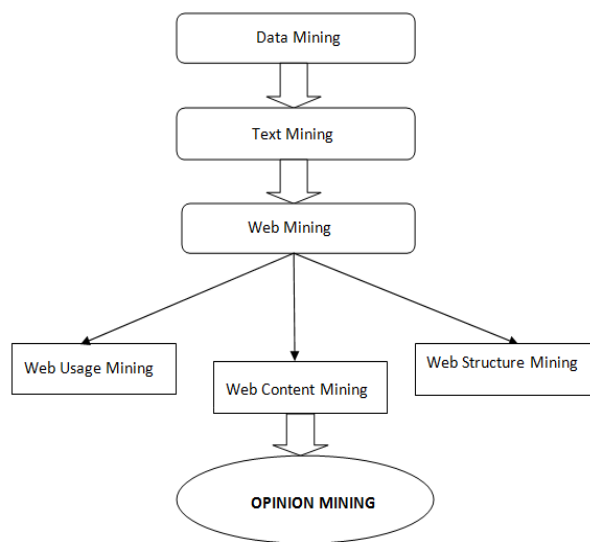


Figure 1: Hierarchical model of Data Mining

The hierarchical model represents the various sub disciplines of data mining process. Text mining is used in various domains like Machine learning, Computational statistics, Information retrieval and Data mining to extract mining algorithms and some other hidden patterns.

Web mining is a subpart of text mining, used to mine the web data in the form of structured, unstructured or semi-structured data.

### B. Web Mining

As the vast amount of data as well as information is available online, the internet became an interesting area for mining the data. Web mining is basically a task or process to find the hidden patterns from the web (WWW) such as internet by using the tools and techniques of data mining. Sentiment analysis (SA) is typically related to the web mining. The actual goal of web mining is to examine the usage of data mining on the web (WWW).

Web mining is categorized under three types: Web usage mining, Web content mining and web structure mining. Following figure shows the different categories of web mining [2]:

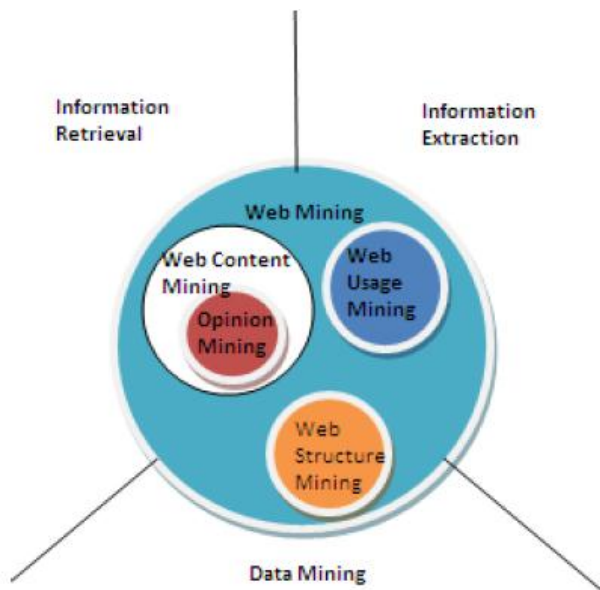


Figure 2: Categories of Web mining

#### a. Web Usage Mining

Web usage mining is a sub discipline of web mining that performs mining process on the web usage data. It is a process of discovering useful information from web usage data and the web logs or user logs. The hidden patterns are discovered by using web usage mining from the weblogs or user logs.

#### b. Web Content Mining

In the web content mining, we extract the information from various contents of the web such as text, image, audio, video documents and hyperlinks etc. This process integrates the useful data as well as knowledge from the various contents of the website.

#### c. Web Structure Mining

The process of web structure mining reveals the schema of weblogs for easily access the information from the web pages and generate the information. By using web structure mining, we can also find the structure of web document itself. It provides the design summary about the web logs and web pages. It also identifies the relationship between different websites such as how a web page is related and linked to the other web page. The structure of web provides a comprehensive overview about the construction of the websites and web pages. The Page Rank algorithm is a technique of web structure mining that is used to ranking the search results on the Google.

#### C. Opinion Mining

Now a day's opinion mining is most prominent branch of research in the area of text mining. Sentiment analysis or opinion mining is a type of natural language processing (NLP) which is used to identify and extract subjective information from different resources in the form of text documents. It also evaluates the results as positive, negative or neutral. It basically deals with the contextual polarity of a document. In simple words, sentiment analysis or OM is the people's feeling, emotions towards an entity and also a judgment about particular product, area etc. Opinions influence the thinking level of humans. Opinion mining is a computational task for reviewing the emotions, attitudes and opinions of an individual about a particular product. It also deals with the summarization of these reviews and subjectivity of text. Most of the data available on the Internet is semi-structured and un-structured forms and the sentiment analysis is used to find the admiration and criticism type opinions from these unstructured data. We can classify the sentiment analysis into three different levels: Document level, Sentence level and Feature level.

Sentiment analysis can be used in different ways: Suppose we want to check the customer's reviews about a particular product. Opinion mining used to tracks the success rate of that product, determines the product popularity among the customers by extracting the opinions and reviews of product from the users. In past few years, many researchers have trying to collect and analyze the sentiments automatically within the computers. The objective diagram of opinion mining is described as below:

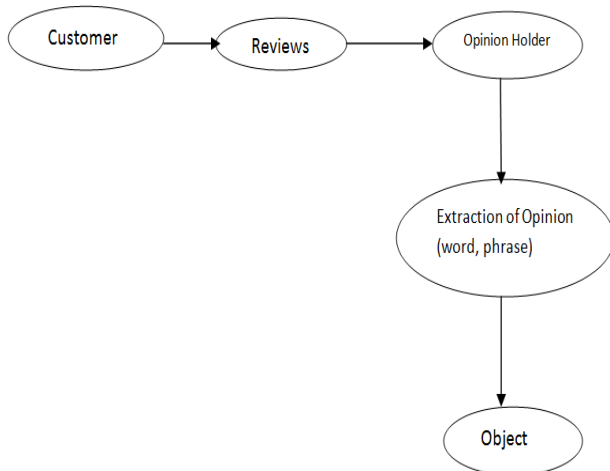


Figure 3: Object model of Opinion Mining

The above diagram shows the five components: a customer that is giving the different views or some judgments on a product using various resources; the judgment is either experience based or a hypothesis. The reviews given by the user should be positive, negative or neutral. The opinion holder may be a person or organization that expresses the opinions or interestingness of a product/object. The last component is an object, that is refers to as an organization or entity about which we defines and expresses our sentiments. We can allocate the different opinions from various resources such as television, newspapers to communicate with the individuals. Some examples of opinion statements are listed below:

*Virat Kohli is a good player.*  
*He is a good player.*  
*Hostel 1 is better than hostel 2.*  
*Green tea is expensive, but coffee is cheap.*

The sentiment analysis and opinion mining are used interchangeably for each other because they both have same meaning. An opinion has many synonyms. Following diagram [2] represents some terms as the synonym for sentiment analysis:

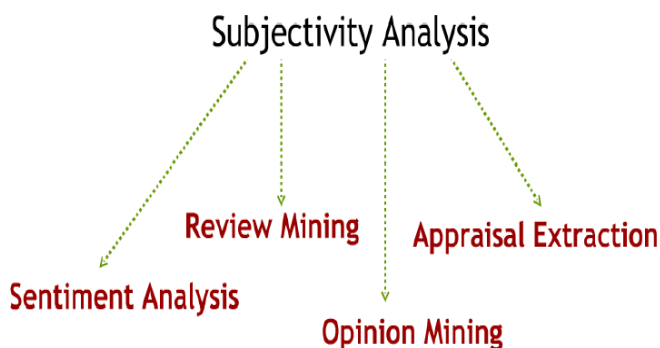


Figure 4: Synonyms of Sentiment Analysis

## II. DATA SOURCE

Text analytics are used to extract/mine different data sources for collecting the opinions, in the process of sentiment analysis. Generally, the sentiment analysis is done on the data, collected using social networking sites and Internet. Blogs, review sites, datasets, online posts and micro-blogs generates a better understanding about many services or products.

### A. Blogs

To express the opinion of an individual, blog posts and the blog pages are widely used today. In the past few years, the usage of blogs and blog posts are increasing expeditiously with the internet. Different blogs contains different reviews about so many products i.e. objects. Blogs are useful as source of opinions which leads to the sentiment analysis.

### B. Online Posts

The online posts on the social sites/websites are another source of opinion mining. There are so many posts daily posted on the different sites of online shopping such as Amazon, Flip cart etc. We can see the various good and bad reviews about same product. Now a day's people used social networking sites such as Face book and Twitter for express the opinions about the current affairs, fashion styles and politics etc.

### C. Micro-blogging

One of the popular tool micro-blogging is provided by the Twitter where the user gives your own opinion in the form of 'Tweets'. These tweets are used as data source for analyze the sentiments. Tweets are very short messages posted by the users. Micro-blogging is used as a communication tool, used within the internet on the different websites/web pages.

### D. Review Sites

For making a purchase by any user, the opinion of another person is an important thing. The product reviews generated by the user are widely available on the internet. The sentiment classification uses the data of reviewer's which is collected from the various websites like [www.amazon.com](http://www.amazon.com) (product reviews), [www.gsmarena.com](http://www.gsmarena.com) (mobile reviews), hosts millions reviews by the customers about the products. [1]

## III. SENTIMENT ANALYSIS AND OPINION MINING: LEVELS OR CLASSIFICATIONS

We can classify the sentiment analysis into three different levels: Document level, Sentence level and Feature level.

### A. Document Level:

We can classify the documents according to the opinions instead of text or concept. When we want to summarize any document on the basis of positive, negative or neutral

polarity about any product or object (i.e. mobile, laptop, camera, car, politics and movie), the document level classification is very useful. At this level, sentiment belongs to an individual and expresses on a single topic. For example: the reviews about restaurant, movie, current affair and product, are made up of a document that is scrawl by the reviewer for explaining all the positive or negative things about the product/object. At this level, sentiment analysis is performed on the whole document rather than performed on the aspect level or sentence level. There are two classification methods are used under the sentence level sentiment analysis: supervised method and unsupervised method. The support vector machine (SVM) and Naïve Bayes classifiers (NB) are two different types of algorithms in the machine learning, used for classifying a document.

#### *B. Sentence Level:*

The subjectivity classification is the first step to classify the sentence level sentiment analysis. The subjectivity classification refines a sentence as subjective or objective. If the sentence is subjective then it is further classified into positive, negative or neutral inclination. If the maximum number of words are positive then the product/object represents the positive opinion and if the maximum number of words are negative then the opinion of an object is negative otherwise object's opinion will be neutral. Generally, the meaning of neutral opinion is no opinion. This level is called sentence level sentiment classification. It is important to collect information about the target of a sentence for the polarity detection of sentences. The sentiment classification is another step performed on the sentence level after completing the first step. It is important to collect information about the target of a sentence for the polarity detection of sentences. The polarity of sentences also recognize the opinion holder. At this level, a segment or a piece of text is analyzed rather than a whole document. This classification level has no concern to the features of document i.e. text. It is a special task used for classification of text.

#### *C. Fine-grained Level:*

At the fine-grained level of opinion mining, the detailed information is required for performing many applications. To find out the specific target and the corresponding polarities of sentiment is the main objective of aspect level opinion mining. The fine-grained sentiment analysis has many synonyms i.e. aspect, attribute or feature and also known as concept level sentiment classification. This classification level is used to find great details or knowledge about opinioned texts which is used to identify the different opinions from users. The feature level sentiment classification is more suitable to find out some parameters such as what people like or not and also discover the specific targets. The fine-grained classification level provides summarization application from different reviews that is based on the feature based opinion mining.

Shiliang presented the three components: entity, aspect and sentiments, discovered by the aspect level sentiment analysis. After that the task is split into two sub-tasks: target extraction and sentiment classification. The lack of annotated corpora at this level is a major challenge in aspect level sentiment analysis [3].

## **IV. Natural Language Processing (NLP)**

### *A. Introduction to NLP*

Natural language processing or NLP is an inter-disciplinary field of computer science that examine the interactions between computer system and the different languages used by the human. The computer system requires the programming languages to understand that what user wants to do. The natural language processing is the technique or ability to understand the human languages (i.e. in which the person is spoken), by a system or computer program. The important elements of the human language sentence are interpreted using the machine or computer system and it returns a specific answer.

Sentiment analysis is an interesting application in the area of natural language processing. Opinion mining or Sentiment analysis strongly depends on the techniques of natural language processing. To extract and analyze the information, knowledge base is required by the various tasks of NLP. For building a knowledge base there are many techniques required whereas other techniques analyze the documents by using the existing knowledge base. For many tasks such as text pre processing and information retrieval, natural language processing plays an essential role. The plain texts and the texts at different levels of languages i.e. morphological and lexical level are analyzed by using the natural language processing. For processing the text element, natural language processing is used to transform the text into the machine format. The speech recognition and natural language generation are some challenging tasks faced by the natural language processing.

### *B. NLP: Text Preprocessing Techniques*

To organize the text and mining the features, various preprocessing steps are required for the sentiment analysis. The preprocessing steps includes: tokenization, word segmentation, Part of Speech (POS) tagging, parsing. We briefly discuss these techniques as below:

Tokenization is a basic technique for the various tasks that are performed by NLP. It divides a document or character stream into tokens. Generally, the tokens are phrases or words and numbers that is used for understanding the text and further preprocessing. Open NLP Tokenizer is a good example of open source tokenizers of NLP.

Word Segmentation is used for quickly accessing the data. It is the process of dividing a text or string into its meaningful

component words. It has the drawback of sequential labeling.

Part of Speech (POS) tagging and parsing are text preprocessing techniques, required to examine the lexical based information. The POS tagging distinguish the phrases as noun or verbs clauses and form the POS tag according to the each word. The POS tags are in the adjective form are quite useful because the opinion words are mostly in the form of adjectives whereas the aspects are nouns. Parsing shows tree structure which is the grammatical form of given sentence. The parsing method provides deep information about structure rather than POS tagging.

### C. NLP Toolkits

We present the commonly used available toolkits for natural language processing with the help of following Table 1 [3].

Table 1: Available Toolkit for NLP

Toolkit	Language	Description
NLTK [9]	Python	Natural Language Toolkit (NLTK) is an open source platform for performing various NLP and text preprocessing techniques such as tokenization, web segmentation, POS tagging and parsing.
OpenNLP	JAVA	The Apache OpenNLP is a JAVA library for processing the natural language texts and examine some common tasks i.e., tokenization, coreference resolution, parsing and sentence segmentation.
CoreNLP [10]	JAVA	Stanford CoreNLP is a framework which supports advanced sentiment analysis but also basic NLP tasks such as POS tagging, parsing and named entity recognition.
Gensim [13]	Python	Gensim is an open source platform for modeling of topics such as Latent Semantic Analysis (LSA), Latent Dirichlet Allocation (LDA) and Random Projection etc. It is necessary to have large scale corpora for implementing all algorithms.

Toolkit	Language	Description
FundanNLP [14]	JAVA	FundanNLP is an open source toolkit for Chinese NLP that performs word segmentation, named entity recognition and POS entity.
LTP [15]	C++/Python	The Language Technology Platform (LTP) is an open source NLP system. It supports SVM and maximum entropy based techniques for NLP tasks such as POS tagging and named entity recognition.
NiuParser [17]	C++	NiuParser is a Chinese Syntactic and Semantic Analysis Toolkit that supports various tasks such as POS tagging, named entity recognition, word segmentation and the dependency parsing etc.

## V. RELATED WORK

**Nidhi R.Sharma, Prof. Vidya D. Chitre** discussed about source of data, its classification, evaluation process, grouping techniques, tool used and future challenges in sentiment analysis. How we can develop a software system for opinion mining, the overall scenario is presented in this survey with analysis techniques. There are three levels of sentiment classification: Document level, Sentence level and Feature based level. At document level, sentiment analysis is performed on the whole document rather than performed on the aspect level or sentence level. Feature based level also known as aspect or fine-grained classification. For feature selection or grouping features, regular expressions and clustering techniques are used. For an opinion mining application, clustering technique find out various feature expressions from text. The Entropy and Polarity are two different evaluation measures for evaluating clustering. To identify the subjective or objective information for describing the product feature, to tackle each language according to its organization, dealing with different writing styles, to find out the fake reviews and to deal with the free format language i.e. abbreviation of words, short words and

roman language are some challenging tasks for mining of opinions [1].

**G.Vinodhini and RM.Chandrasekaran** talked about the web resources i.e. review sites, blogs, discussion forum and news corpora that is accessible online in digital form, for mining opinions. The basic idea behind the sentiment analysis is to track the mood of public about a particular product. To extract the accurate opinions from the web resources available on internet and predict the preference of various customer improves the economic and marketing skills.

The sentiment classification: machine learning, handling negation and feature based classification are reviewed in this paper. Review Seer, Web Fountain and Red Opal are various kind of tools used by sentiment analysis to find out the product's features. Review Seer tool uses the NB classifier for identify and extract the feature terms. Web Fountain uses beginning definite Base Noun Phrase (bBNP) heuristic to mine the features of product. Red Opal tool used to scores the product on the basis of product features and customer reviews. The challenge of sentiment analysis includes the dealing with negation expressions, complexity of document summarization of opinions based on features etc [4].

**Bin Lin, Fiorella Zampetti, Gabriele Bavota, Massimiliano Di Penta, Michele Lanza, Rocco Oliveto** developed a software library recommender exploiting developer's opinions mined from stack overflow. They talked about how the datasets influence the tool performance and the strong limitations of opinion mining tools. There are various sentiment analysis tools for performing software engineering tasks such as evaluating app reviews. The SentiStrength, NLTK, Stanford CoreNLP and Emotxt are the different sentiment analysis tool that has been applied to evaluate sentiment analysis for software engineering applications. The goal of evaluating SA to examine the accuracy of sentiment analysis tools with the datasets of software engineering. Some of these tools are commercial while other tools are sentiment analysis libraries. The software engineering community has adopted these tools for the different application area. They want to develop a

technique to automatically advance the API's and libraries given the functional or non-functional requirements. We should not expect 100% accuracy from sentiment analysis tools. Customization to the specific usage context is an important application of SA tools to the software engineering datasets [6].

**Arti Buche, Dr. M.B. Chandak, Akshay Zadgaonkar** focusing on the area of opinion mining. They have surveyed and analyzed various techniques for the development of key tasks for sentiment analysis. To develop the software system for opinion mining, the overall scenario is presented in this paper. Various methods such as sentiment classification, text classification and evaluation measures are performed within the machine learning. Machine learning is area of computer science that is useful for developing the computer programs to improve learning from data without human interference. For classification of text documents, the statistical text learning algorithms can be trained. For example: the Naive Bayes classifier called probabilistic classifier, used to integrate the unlabelled data [7].

**S.Bird, E. Loper**, describes related fields of the sentiment analysis i.e. text mining, web mining and information retrieval. To make certain decisions, opinion mining is very useful technique. Reviews are in the form of unstructured text, mined from web structure or Internet. For summarization of the reviews, various computational techniques are needed. Various computational methods, tasks and algorithms are used for mining sentiments. Source of opinion, target of the opinion and the expressions given by opinion holder is the three main components of opinion mining problem. The approach for each sub problem of opinion mining includes the subjectivity and polarity classification, opinion target identification and opinion source identification. The subjectivity and polarity classification is a key task for automatic identification of opinions from text documents. The opinion target should be a person, topic, feature and an object, on which we expresses our opinions. Opinion holder presents the opinions or sentiments [9].

Table 2: Details of existing related work

AUTHOR NAME	TITLE OF PAPER	JOURNAL/ CONFERENCE	YEAR	TOOLS/ TECHNIQUES USED	MERITS	DEMERITS
Bakhtawar Seerat, Farouque Azam	Opinion Mining : Issues and Challenges (A Survey)	IJCA	2012	KDD process	Leads to overcome the necessity of marketing and product analysis in the production industry. [2]	Spam or biased opinions affect the mining system. Simultaneously addressing of opinion mining challenges are

						not exist.
G. Vinodhini, RM. Chandrasekaran	Sentiment Analysis and Opinion Mining: A Survey	IJARCSSE	2012	Review Seer, Web Fountain and Red Opal	Presents an accurate method for predicting the opinions by using Internet.	Need to improve the performance measures because sentiment classifiers are acutely depends upon various province.
Wala Medhat, Ahmed Hassan, Hoda Korashy	Sentiment analysis algorithms and applications: A survey	Elsevier	2014	Machine learning approach, Lexicon-based approach	Various proposed algorithm enhancement and Opinion mining applications are investigated.	For considering the context of the text and the user preference, there's more research needed on context-based SA.
Nidhi R.Sharma, Prof. Vidya D. Chitre	Opinion Mining, Analysis and it's Challenges	IJIACS	2014	Red Opal, Review seer tool and NB classifier	Presents overall scenario to develop a Software system for sentiment analysis.	There are sustained need of user-friendliness and better usability in mining systems.
Khairullah Khan, Baharum Baharudin, Aurnagzeb Khan, Ashraf Ullah	Mining opinion components from unstructured reviews: A review	Elsevier	2014	Subjectivity and polarity classification, Opinion target identification, opinion source identification	Provides a literature review on models, algorithms and techniques used to mine sentiments from unstructured reviews.	Manually, from the unstructured text; summarization of information is impossible.
Maria Giatsoglou, Manolis G. Vozalis, Athena Vakali, Konstantinos Diamantaras	Sentiment analysis leveraging emotions and word embeddings	Elsevier	2017	Lexicon-based features, Word embedding-based features, Hybrid features	Presented a fast, flexible and hybrid methodology for SA to express the public opinions in different languages.	Some approaches i.e. state-of-the-art are computationally costly and their performance testing is done by using only one language.
Bin Lin, Fiorella Zampetti, Gabriele Bavota, Massimiliano Di Penta, Michele Lanza, Rocco Oliveto	Sentiment Analysis for Software Engineering: How Far Can We Go ?	ICSE	2018	SentiStrength, NLTK, Stanford CoreNLP, SentiStrength-SE, Stanford CoreNLP SO	Developed a Software library recommender exploiting developer's opinions mined from stack overflow.	We should not expect 100% accuracy from sentiment analysis tools.
S.S. Ansari, T. Diwan	Survey on Tweet Segmentation and Sentiment analysis	ICSE	2018	NB classifier, Lexicon	Provides an economical and effective way for decision making in various domains.	High level security is required so that implementation of real time tweet environments are needed in future.

## VI. CONCLUSION AND FUTURE DIRECTIONS

This paper gives a small glimpse on the classification/levels, tools, data sources and related disciplines of sentiment analysis. It also provides a brief overview on work which has been done so far.

Sentiment analysis is an emerging field of data mining that is used for extracting the useful subjective information from web resources such as review, feedback and user comments on any product/object. Opinion mining is a sub-discipline of web content mining that is

further a part of web mining. I have presented review on the various techniques of NLP named as NLTK, OpenNLP, CoreNLP, Gensim, LTP, FudanNLP and NiuParser for the sentiment analysis or OM. Basic introduction to the text processing techniques for NLP is also given.

From this study, we propose the use of hybrid approach for predicting and mining the opinions and analyze it.

The more future research is committed in the various aspects/ domains such as opinion summarization on the basis of product features, Complexity of sentence/text, dealing with negation expressions and handling implicit product's feature etc.

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