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# State-of-the-Art Review on Opinion Mining from Online Customers' Feedback

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## Abstract

*Dealing with the ever-growing information overload in the Internet, Recommender Systems are widely used online to suggest potential customers item they may like or find useful. Collaborative Filtering is the most popular techniques for Recommender Systems which collects opinions from customers in the form of ratings on items, services or service providers. In addition to the customer rating about a service provider, there is also a good number of online customer feedback information available over the Internet as customer reviews, comments, newsgroups post, discussion forums or blogs which is collectively called user generated contents. This information can be used to generate the public reputation of the service providers'. To do this, data mining techniques, specially recently emerged opinion mining could be a useful tool. In this paper we present a state of the art review of Opinion Mining from online customer feedback. We critically evaluate the existing work and expose cutting edge area of interest in opinion mining. We also classify the approaches taken by different researchers into several categories and sub-categories. Each of those steps is analyzed with their strength and limitations in this paper.*

**Key words:** Data mining, Text mining, Opinion, Sentiment analysis, customer feedback

## 1. Introduction

Opinion Mining is the area of research that attempts to make automatic systems to determine human opinion from text written in natural language. It is a recent discipline at the crossroads of information retrieval and computational linguistics. The task of Opinion Mining is technically challenging because of the requirement of natural language processing; which itself is a tedious job. But it has potentiality and usefulness in real life applications. For example, to improve the quality of their product and services; businesses always interested to find their customers' opinions or feedback. Opinion Mining is concerned with the opinion it expresses instead of the topic of a document. The discipline is also known as Sentiment Analysis. According to Bing Liu (Bing et al, 2005) "Given a set of evaluative text documents  $D$  that contain opinions (or sentiments) about an object,

opinion mining aims to extract attributes and components of the object that have been commented on in each document  $d \in D$  and to determine whether the comments are positive, negative or neutral."

Before emerge of the Internet, there was a very little written text opinion available in the market. In that time, if an individual needed to make a decision, he/she typically asked for opinions from friends and families. When an organization needed to find opinions of the general public about its products and services, it conducted surveys and focused groups. With the rapid expansion of e-Commerce, more users are becoming comfortable with the Web and an increasing number of people are writing reviews (Wang and Zhou, 2009). As a result, the number of reviews that a product receives grows rapidly. With the explosive growth of the user generated content on the Web, the world has changed. One can post reviews of products at merchant sites and express views on almost anything in Internet forums, discussion groups, and blogs, which are collectively called the user generated content (Pang and Lee, 2008). Now if one wants to buy a product, it is no longer necessary to ask friends and families because there are plentiful of product reviews on the Web which give the opinions of the existing users of the product. For a company, it may no longer need to conduct surveys, to organize focused groups or to employ external consultants in order to find consumer opinions or sentiments about its products and those of its competitors. The existing online customer feedback can be used effectively to fulfill that objective. There are three major advantages of automated Opinion Mining systems over the traditional polling or focus groups. First, they are consistent over time; companies using manual scoring will find that results change when their personnel turn over. Second, these systems can operate in near real time, assimilating vast amounts of information from the Web; this also makes them relatively inexpensive. Third, some opinion mining systems are multilingual and can process documents that might prove difficult for a given group of human scorers (Subrahmanian, 2009).

In section 2, the background and the motivation of the current study is described. Section 3 presents the classification framework of the existing work on Opinion Mining. Section 4 contains the discussion of the findings of this study and the paper concludes in section 5.

## 2. Background

As a human being, people like to express their own opinion. They are also interested to know about others opinion on anything they are interested; especially whenever they need to make a decision. The technology of opinion mining thus has a tremendous scope for practical applications. In order to enhance customer satisfaction and shopping experience, it has become a common practice for online merchants to enable their customers to review or to express opinions on the products that they have purchased. If an individual wants to purchase that product, it is useful to see a summary of opinions of existing users so that he/she can make an informed decision. This is better than reading a large number of reviews to form a mental picture of the strengths and weaknesses of the product. For this reason, mining and organizing opinions from different sources are important for individuals and organizations. The basic idea behind is that, from the customer review text, an overall opinion; either positive, negative or neutral will be calculated. The summation of that value will give the public reputation of that particular service or service provider. The opinion regarding different element or feature of the service could be considered. Most existing techniques utilize a list of opinion bearing words, generally called opinion lexicon; for this purpose (Ding et al. 2008). Opinion words are words that express desirable (e.g. awesome, fantastic, great, amazing, exceptional, excellent, best, etc.) or undesirable (e.g. bad, poor, frustrating, disappointing, horrible, terrible, worst, sucks etc.) states (Lu and Zhai, 2008).

Information available as text format can be broadly classified into two main categories, facts and opinions. Facts are generally objective statements about entities and events. But opinions are subjective statements that reflect people's sentiments or perceptions about the entities and events which is the area of interest for this work. Most of the existing research like information retrieval, Web search, and other text mining and natural language processing tasks on text information processing has been focused on mining and retrieval of factual information. Only a little work has been done on the processing of opinions until recently. Though the number of research interest in this area is growing fast.

Now-a-days it is very common to have customer feedback in the form of written customer review through the respective web site. Some popular products can get hundreds of reviews at some large merchant sites. Furthermore, many reviews are very long and have only a few sentences containing opinions on the product. This makes it harder for a potential customer to read them all to make an informed decision on whether to purchase the product or service. If he/she only reads a few reviews, he/she may get a biased view. It is very difficult for a human reader to find relevant sources, extract pertinent sentences, read them,

summarize them and organize them into usable forms. An automated opinion mining and summarization system is thus become important.

## 3. Classification of Related Works

Opinion mining has been studied by a good number of researchers in very recent years. To make the unambiguous research opportunities in this field, we classify the current literature in the following ways which is shown in Fig.1. After an extensive study on this area of work, we have identified two main research directions namely :

- (i) Sentiment Classification and
- (ii) Feature-based Opinion Mining.

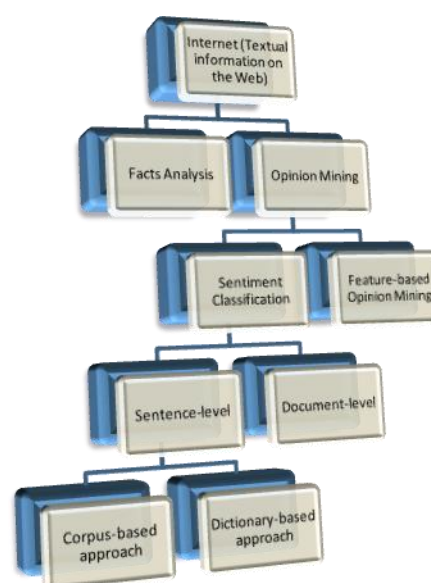


Fig.1 Classification of Opinion Mining Research

### 3.1 Sentiment Classification

Research on opinion mining basically started with identifying opinion or sentiment bearing words, e.g., great, amazing, wonderful, bad, poor etc. Many researchers have worked on mining such words and identifying their semantic orientations or polarity such as positive, negative or neutral (Goldberg and Zhu, 2006, Lin et al. 2006). In (Hatzivassiloglou and McKeown, 1997), the authors identified several linguistic rules that can be exploited to identify opinion words and their orientations from a large corpus. This method has been applied, extended and improved in (Ding et al. 2008, Kanayama and Nasukawa, 2006, Popescu and Etzioni, 2005). Sentiment Classification investigates ways to classify each review document as positive, negative or neutral. The next major development is sentiment classification of product reviews at the document level (Dave et al, 2003, Pang et al, 2002, Turney 2002). In (Dave et al, 2003) sentiment classifiers are built from some training corpus. The objective of this task is to classify each

review document as expressing a positive or a negative sentiment about an object (e.g., a movie, a camera, a book, a laptop computer or even a car).

Some researchers do it at document level, where some others at the sentence level by classifying each sentence as a subjective or objective sentence and/or as expressing a positive or negative opinion (Kim and Hovy, 2004, Wiebe and Riloff, 2005, Wilson et al, 2004). Sentence level subjectivity classification is studied in (Hatzivassiloglou and Wiebe, 2000), which determines whether a sentence is a subjective sentence but may not express a positive or negative opinion or a factual one. Wiebe and Riloff (2005) distinguish subjective sentences from objective ones. Kim and Hovy (2004) propose a sentiment classifier for English words and sentences, which utilizes thesauri. However, template-based approach needs a professionally annotated corpus for learning; words in thesauri are not always consistent. Like the document-level classification, the sentence-level sentiment classification does not consider object features that have been commented on in a sentence.

Abbasi et al. (2008) proposed the use of sentiment analysis methodologies for classification of the Web forum opinions in multiple languages (Fig.2). The design has two major steps: extracting an initial set of features and then, performing feature selection. These steps are used to carry out sentiment classification of forum messages. Their experiment produces a fantastic result on the benchmark movie review dataset. Their method focuses on document level classification of sentiment only.

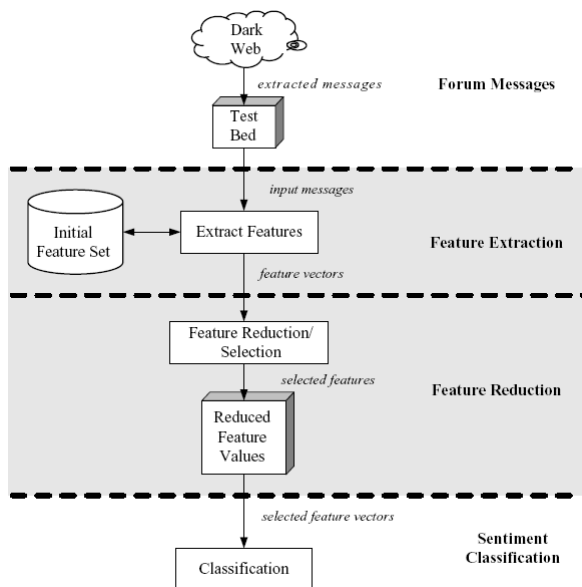


Fig.2 Sentiment classification system design

Gamon et al. (2005) presented a prototype system named Pulse, for mining topics and sentiment orientation jointly from customer feedback. However, this technique is limited to domain of products and highly dependent on the training dataset, so is not

generally applicable to summarize opinions about an arbitrary topic.

Most sentence level and even document level classification methods are based on identification of opinion words or phrases. There are basically two types of approaches:

- (i) Corpus-based approaches and
- (ii) Dictionary-based approaches.

Corpus-based approaches find co-occurrence patterns of words to determine the sentiments of words or phrases (Hatzivassiloglou and Wiebe, 2000, Turney, 2002).

Dictionary-based approaches use synonyms and antonyms in WordNet to determine word sentiments based on a set of seed opinion words (Fellbaum, 1998). In (Hu and Liu, 2004, Kim and Hovy, 2004), a bootstrapping approach is proposed, which uses a small set of given seed opinion words to find their synonyms and antonyms in WordNet ([wordnet.princeton.edu](http://wordnet.princeton.edu)) to predict the semantic orientation of adjectives. In WordNet, adjectives are organized into bipolar clusters and share the same orientation of their synonyms and opposite orientation of their antonyms. To assign orientation of an adjective, the synset of the given adjective and the antonym set are searched. If a synonym/antonym has known orientation, then the orientation of the given adjective could be set correspondingly. As the synset of an adjective always contains a sense that links it to the head synset, the search range is rather large. Given enough seed adjectives with known orientations, the orientations of all the adjective words can be predicted (Lee et al. 2008).

Yu et al. (2008) proposed a method for combining How-Net and sentiment classifier. They divide the sentiment text features into characteristic words and phrases extracted from the training data. Then they compute semantic similarity of characteristic words, phrases with tagged words in How-Net, and adopt the positive or negative terms as features of sentiment classifier. Negative rules for negation sentences are also added to sentiment classifier. If a word is matched, the whole meaning of the sentence is changed contrarily. However, the performance of their proposed method is not that satisfactory according to their experiment result. Day and Haque (2008) proposed a hybrid approach while focusing on opinion extraction from noisy text data. They have argued that most of the existing Natural Language Processing (NLP) techniques assume that the data is clean and correct. But generally opinions expressed in the online environment as a blog comments or review writing are full of spelling mistakes and grammatical errors due to informally written which they called 'noisy text'. Their proposed system uses a plugged in domain ontology to extract opinions from pre-defined websites which allows opinions to view at multiple levels of granularity based on the requirements. They proposed a

text pre-processing mechanism which exploits domain knowledge to clean the text. Those clean texts are then processed by NLP tools. But the process is iterative and difficult to implement.

### 3.2. Feature-based Opinion Mining

Classifying evaluative texts at the document level or the sentence level does not tell what the opinion holder likes and dislikes. A positive document on an object does not mean that the opinion holder has positive opinions on all aspects or features of the object. Likewise, a negative document does not mean that the opinion holder dislikes everything about the object. In an evaluative document such as a Customer review of a product, the opinion holder typically writes both positive and negative aspects of the object, although the general sentiment on the object may be positive or negative. To obtain such detailed aspects, Feature-based opinion mining has been proposed (Hu and Liu, 2004, Popescu and Etzioni, 2005) to summarize the overall opinion.

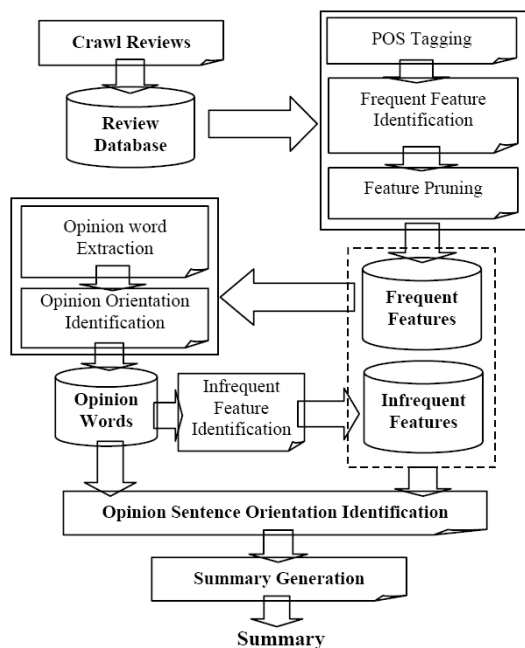


Fig.3 Feature-based Opinion Summarization

The model of Feature-based opinion mining and summarization is proposed by many researchers (Hu and Liu, 2004, Liu et al. 2005, Popescu and Etzioni, 2005) while Balahur and Montoyo (2008) proposed feature driven opinion summarization method. They emphasize on the term 'driven' to describe the concept-to-detail approach. In Feature-based opinion mining, features broadly mean product features or attributes and functions. The main tasks in this technique are:

- (i) Identifying product features that have been commented on,
- (ii) Decide whether the comments are positive or negative and
- (iii) Summarizing the discovered information.

In the feature driven opinion summarization method, for each product class, at first it automatically extracts general features, then specific features and attributes and then assigns polarity to each of the feature attributes using a corpus and Support Vector Machines Sequential Minimal Optimization machine learning with the Normalized Google distance (Cilibrasi and Vitanyi, 2006, Patt, 1998).

Hu and Liu (2004) proposed an opinion summarization of products, categorized by opinion polarity. Their works are the most representative ones in this area of study. Initially, they proposed the association rule mining to extract feature words. Then extract the opinion words in those sentences that contain at least one feature word. Finally, the feature-opinion pairs are generated and summarized according to the extracted features (Fig.3). They identified the sentiment orientation by the adjective synonym set in WordNet (Fellbaum, 1998, Morinaga, 2002). Liu et al (2005) then illustrated an opinion summarization of bar graph style, categorized by product features. This model gives a more complete formulation of the opinion mining problem. It identifies the key pieces of information that should be mined and describes how a structured opinion summary can be produced from unstructured texts. Though, both of them are domain-specific. Popescu and Etzioni (2005) proposed a domain-independent information extraction system. They identified four tasks in the review analysis:

- (i) Product feature identification
- (ii) Identification of opinions regarding product features
- (iii) Determination of the opinion polarity and
- (iv) Opinion ranking based on their strength.

It extracts explicit product features using the PMI. It uses explicit features to identify potential opinion phrases based on the intuition that an opinion phrase associated with a product feature will occur in its vicinity on syntactic parse tree. After the extraction of the opinion expression, relaxation labeling (Hummel and Zucker, 1983), which is an unsupervised classification technique, is used to disambiguate the semantic orientation of opinion words. As a result, set of (feature, ranked opinion list) tuples are extracted (Lee et al. 2008).

## 4. Application Area

Opinion Mining is now becoming available from commercial applications. Companies like BuzzMetrics, Umbria, SentiMetrix ([www.sentimetris.com](http://www.sentimetris.com)) offer opinion mining services on a continuous scale. The University of Maryland's opinion analysis system OASYS (<http://oasys.umiaccs.umd.edu/oasys>) achieved high accuracy on sentiment queries while tested with humans opinion data (Subrahmanian, 2009). As more accurate opinion information is available commercially, the demand for such system is increasing by the corporations, governments, non-profits and also individuals. Opinion Mining can be

used in various fields to meet varied purposes. Binali et al. (2009) presented some application domain where Opinion Mining can be used to be benefitted. They have listed in the area of shopping, entertainment, government, research and development, marketing and education for e-Learning with some example of current applications. There are many other fields which could be also benefitted to opinion mining information in individual or organisational level.

## 5. Discussion and Future Direction

In their recent work, Wang et al. (2009) analyzed three major aspects of opinion mining on the web; which they called evaluative texts, opinion search and opinion spam. As the paper is in Chinese language, it fails to contribute to the broader community of opinion mining researchers. Binali et al. (2009) presented the potential application domains of Opinion Mining including science and technology, entertainment, education, politics, marketing, accounting, law, research and development. They have explored different application areas which could be benefitted from the effective use of Opinion Mining.

Ku et al. (2006, 2009) employ the results of opinion mining in relationship discovery, and compare the results with those of the traditional collocation model, which discovers relationships among terms based on their co-occurrences in physical contexts such as documents, sentences, and adjacent words. The basic idea is that if entities involved in the same sequence of events yield similar opinion trends, they may be correlated. To minimize chance co-occurrences, two entities should be observed over a sufficient amount of time. However, the target of their work is limited only on the relationship between companies. The company to company, company to person, person to person are not explored. It may be noted that most of the existing work focused on sentiment classification and opinion extraction for positive or negative comments on an entity or event. Comparisons are also a related but different from sentiments and opinions, which are subjective. Comparisons can be subjective or objective. It is important in a situation where a product manufacturer wants to know customer opinions of its products in comparison with those of its competitors. Jindal and Liu (2006) studied this problem of identifying comparative sentences in evaluative texts, and extracting comparative relations from them. Two techniques were proposed to perform the tasks, based on class sequential rules and label sequential rules, which give some syntactic clues of comparative relations. But the accuracy of their experiment analysis is not that promising.

Systems that support Opinion Mining have the potential to provide subjective information for the end user. Though there are many works available in this area, the industry standards and efficient algorithms for the Opinion Mining are still desirable. Future work

may include but not limited to the development of a method to extend the list of product-dependent features and feature-attributes, new methodologies for polarity assignment, a system that could verify the quality of the extracted feature and assigned polarity, improve the performance of text sentiment orientation analysis etc.

## 6. Conclusion

Opinion Mining has the potentiality to use from the individual level to organizational level such as companies and government. People and organizations from several domains could be benefitted in various ways by using the Opinion Mining techniques from online customers' feedback. In this paper we have reviewed the current research work in the area of Opinion Mining. We have analyzed several approaches taken by the researchers to extract overall opinion from the unstructured text expressed as opinion. We have classified and critically evaluated the existing work. We strongly believe that this study will help to new researchers to expose cutting edge area of interest in Opinion Mining.

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