

Sentiment Analysis: A Literature Review

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Abstract - Sentiment analysis has aroused the interest of many researchers in recent years, since subjective texts are useful for many applications. In particular, sentiment analysis on online reviews has become a hot research field. Studies on sentiment analysis mainly focus on framework and lexicon construction, feature extraction, and polarity determination. This paper presents a survey on the latest development in sentiment analysis, and makes an in-depth introduction of its research and application in business and Blogosphere. The methods used in current research are especially emphasized and the existing problems of those studies are discussed. Finally, some possible future directions of research are pointed out.

Keywords - Sentiment analysis, Information extraction

I. INTRODUCTION

Sentiment analysis, or opinion mining, aims at user's attitude and opinions by investigating, analyzing and extracting subjective texts involving users' opinions, preferences and sentiment. Since Bo Pang [1] put forth this concept in 2002, the academics have undertaken a diverse range of related research, due to its practicality in opinion monitoring and business competitive intelligence. Sentiment analysis on online reviews has become increasingly popular. A multidisciplinary research field in nature, sentiment analysis includes multiple fields such as natural language processing (NLP), computational linguistics, information retrieval, machine learning and artificial intelligence etc.

As an astronomical quantity of sentimental subjective texts appear on Internet, researchers put more emphasis on complex sentimental sentences and texts instead of on words only. In light of text granularity, sentiment analysis is conducted on distinct research levels—word, phrase, sentence, text and multi-text.

This paper presents an overview and the prospects of the several major research fields in sentiment analysis.

II. FRAMEWORK AND LEXICON CONSTRUCTION

Natural human language carries two types of information: objective information about facts and critical information with human subjective sentiment. The rapid development of forum, BBS, Blog, and review websites contributes to the exploding amount of such critical information, which reflects users' attitudes, viewpoints and

opinions on products, policies, people and events, etc. Sentiment analysis has grown into a hot research field in natural language processing.

Sentiment analysis first created a sensation at Text Retrieval Conference (TREC), and since 2006 related evaluation tasks have appeared every year. The annual multi-lingual opinion analysis task (MOAT) also started in 2006, including standard libraries in three languages, Chinese, English and Japanese. However, the research in China, particularly the sentiment analysis on Chinese has barely taken off. Initiated in 2008, Chinese opinion analysis evaluation (COAE) is the first sentiment analysis of the kind.

A. Research on Framework

Sentiment analysis research in China has seen a steady growth since 2008. YAO Tian-fang et al. [2], and HOU Feng et al. [3] approached from the perspective of opinion mining, WANG Hui et al. [4], Ren Hongjuan and Zhang Zhiqiang [5] took the method of viewpoint mining, ZHOU Li-zhu et al. [6], Li Gang et al. [7], ZHAO Yan-Yan et al. [8], and WEI Wei et al. [9], however, adopted the sentiment analysis method. Li Xiaojun et al. [10] followed the route of the sentiment polarity. All the above-mentioned research makes distinctive summary and exploration of the language and technology support in this field.

Kaiser et al. [11] proposed a warning system for online market research which allows the identification of critical situations in online opinion formation. Hasan and Adjero [12] proposed three proximity-based features, namely, proximity distribution, mutual information between proximity types, and proximity patterns. The experiment results showed that proximity-based sentiment analysis is able to extract sentiments from a specific domain.

B. Lexicon Construction

As tagged Chinese opinion subject text facilitates technologies, e.g. machine learning, to realize classification, topic extraction, sentiment analysis and subject-sentiment relation recognition, so lexicon/corpus construction is generally viewed as a prerequisite for sentiment analysis.

Bai [13] proposed a heuristic search-enhanced Markov blanket model that is able to capture the dependencies among words and provide a vocabulary that is adequate

for the purpose of extracting sentiments. Kanayama and Nasukawa [14] introduced clause-level evaluation detection, which is a fine-grained type of opinion mining, and describes an unsupervised lexicon building method for capturing domain-specific knowledge by leveraging the similar polarities of sentiments between adjacent clauses. Tan and Wu [15] conceived a random walk algorithm to construct domain-oriented sentiment lexicon by simultaneously utilizing sentiment words and documents from both old domain and target domain (or "new domain"). For a specific domain, the sentiment resource can be regarded as a lexicon, which contains a list of product feature words and opinion expressions pair with polarity tag. To construct such a sentiment resource, Li et al. [16] designed an automatic algorithm to extract opinion expressions and determine its polarity to existing feature words.

III. FEATURE EXTRACTION

A. Topic Extraction

FAN Na et al. [17] noted a method of extracting Chinese sentiment topic sentences. Then, FAN Na et al. [18] proposed a method based on mixture model for analyzing subject and sentiment in texts. Firstly texts in corpus were labeled as positive or negative and their subjects were labeled too. The method is general and can be applied to any text collections.

B. Object Extraction

One of the fundamental tasks of sentiment analysis is to extract the object from review sentences, in order to identify all the features of the events in a certain text.

Zhang and Liu [19] employed a learning-based method called Bayesian Sets to extract opinions expressed on entities and their attributes. To improve the performance of opinion targets extraction, XU Bing et al. [20] proposed to integrate shallow parsing features and heuristic position information for modeling of the training process without introducing domain lexicon. HUANG Yi-hua et al. [21] constructed a phrase tree structure to present the appraisal expression pattern, as well as a method based on approximate convolution tree kernels to calculate the similarity between these structures.

C. Relation Extraction

ZHANG Jian-feng et al. [22] presented a novel method to extract the pairs of opinion-bearing terms and opinion targets as the candidate set, and then employed the maximum entropy model to combine lexical, part of speech, semantic and positional features derived from text. The method incorporated relation extraction into opinion mining and solves the problem of coreference and omitting of opinion targets to some extent.

Qiao et al. [23] noted that keywords are parallel to each other. "Tensor Field Model" (TFM) was proposed,

and its perspectives are field theory in physics and multilinear algebra in mathematics. The tensor representations of documents and queries in TFM were constructed, presenting some key concepts such as term field, tensor product of term array and term field constant.

IV. SENTIMENT POLARITY ANALYSIS

Sentiment polarity analysis prefers to the analysis and judgment of the sentiment expressed in a subjective text, which is capable of distinguishing positive, negative, or even more subtle sentiment, such as happiness, anger, grief or joy. It largely involves two tasks: the dichotomy of subjective/objective information, and the sentiment classification of subjective information, including the commonplace positive/negative dichotomy as well as more exquisite n-multiple taxonomy [24].

There are some focuses of research on Chinese:

(1) in the granularity of words, Du Weifu et al. [25] proposed a novel scalable word semantic orientation computing framework, in which the word semantic orientation computing is transformed into the function optimization. As an instance of the proposed framework, the authors built an undirected graph in the use of word similarity computing technology first, and then partition the word-to-word graph by the idea of ' minimum-cut ' , thereby function optimization was adopted in this word semantic orientation computing framework and resolved by using simulated annealing algorithm. A method of collocation orientation identification based on hybrid language information was proposed by WANG Suge and YANG Anna [26]. Firstly, according to the characteristics of six kinds of collocation patterns, the probability latent semantic models were determined for them. Then the obtained semantic models were used to identify the sentiment orientations of collocations. Lastly, for some collocations containing a sentiment word, their previous tags were modified by using some constructed rules. The experiment result in the corpus of car reviews indicated that the proposed method is superior to the method based only on probability latent semantic model or rule for collocation orientation identification. The technology of the Chinese word sentiment polarity judgment was discussed and analyzed by ZHANG Jing and JIN Hao [27]. The polarity was described by using the sentiment characteristics set. The model of the sentiment polarity mutual information characteristics was created based on the bi-gram dependency of POS tagging. The classifier was available by machine learning to automatically judge, compare and optimize the word sentiment polarity. All of these helped to improve the properties, the highest accuracy of SVM reaches 95.47%, and the F value is up to 93.90%.

(2) In the granularity of sentences, WANG Gen, and ZHAO Jun [28] proposed a new method called Multi-redundant-labeled CRFs and applies it on sentence sentiment analysis. This method can not only solve ordinal regression problems effectively, but also obtain global optimal result over multiple cascaded subtasks by merg-

ing subjective/objective classification, polarity classification and sentimental strength rating into an integrated model, with each subtask maintaining its own feature types. YAO Tian-fang and LOU De-cheng [29] presented how to identify the topics as well as the relations between the topics and the sentimental descriptive terms in a Chinese sentence, and how to compute the sentiment polarity of the topics. They extracted the topics and their attributes from a sentence with the help of a domain ontology, then identify the relations between the topics and sentimental descriptive terms based on parsing results, and finally determine the polarity of each topic in the sentence.

V. BUSINESS APPLICATION

With the development of Internet application in the last decades, more clients have started to browse the huge quantity of online reviews to know about the common opinions of products and services so as to improve decision-making. Meanwhile, online client reviews serve as a feedback mechanism to help producers and marketers to promote their products and services, and increase competitiveness. As a newly emerging research area, online review sentiment analysis has attracted great attention from a wide range of related disciplines such as computer science, economics, and management. Zhang Ziqiong [30] conducted a summary and analysis of the present situation and development of online reviews.

Kang et al. [31] proposed a new senti-lexicon for the sentiment analysis of restaurant reviews. In order to mitigate such problem, an improved Naive Bayes algorithm is applied and a unigrams + bigrams was used as the feature.

Benton et al. [32] presented an approach that is able to collect a corpus of medical message board posts, de-identify the corpus, and extract information on potential adverse drug effects discussed by users. Using a corpus of posts to breast cancer message boards, they identified drug event pairs using co-occurrence statistics. Sun et al. [33] investigated the distinctive characteristics of customer opinions found on internet forums. A comparison of the similarities and differences between customer reviews and forum feedbacks was given. Finally, data mining techniques based on concept-based representations were used to analyze feedback from forums. Chen et al. [34] treated the evaluation of review quality as a classification problem and employed an effective information quality framework to extract representative review features. Park and Lee [35] presented a framework for extracting customer opinions from websites and transforming them into product specification data.

LI Shi [36] focused on product features mining from reviews of Chinese network customers and proposes a method based on Apriori algorithm which is an unsupervised mining method. It extracted the candidate features collection by Apriori algorithm, and took redundancy pruning and compactness pruning algorithms. To solve the implicit product feature extraction task in product opinion mining, QIU Guang et al. [37] constructed a nov-

el regularized topic modeling framework based on the classical topic modeling through the analysis of the distribution of opinion words for different product features in reviews and also the assumption of topic dependency of opinion words. In the new framework, they took into consideration the opinionated information by defining a regularizer based on the similarity in opinion word usage of different reviews. SHI Wei and WANG Hongwei [38] adopted a method that information quality framework is used to evaluate the quality of the reviews. The study treated the evaluation of review quality as a classification problem, advanced the review features based on quality, classified the reviews quality by using classification model, and got the reviews ranking by calculating reviews quality and query-relevance scores, then the result was returned to users. To enlarge the size of document, WANG Bo [39] introduced reviews from other domains and evaluated system performance with them based on PMI and SI techniques. Mining product features and polarity of customers' opinion from Chinese online customer reviews helps manufactures and service providers improve their products and services, and gain competitive leverages. LI Shi et al. [40] proposed an approach based on Apriori algorithm which uses unsupervised feature extraction algorithm and supervised sentiment analysis technology to realize the summery information of customer reviews. And then ranked the work features and opinions based on customer attention strength.

VI. BLOG-BASED SENTIMENT ANALYSIS

The robust growth of Web2.0 technology advances the prevailing idea of "User Generate Content" in internet era. Most of the website users are attracted by the blogs and microblogs. However, this form of commentaries is characterized as bulky, unformatted and full of spams. To facilitate a quick and effective analysis of the texts, the blog-based sentiment analysis has caught on rapidly [41].

In the scope of blog-specific sentiment analysis, feature extraction is an essential aspect of research. Previous research on feature-based opinion mining has not had good results due to drawbacks, such as selecting a feature considering only syntactical grammar information or treating features with similar meanings as different. To solve these problems, Jeong et al. [42] posed an enhanced feature extraction and refinement method called FEROM that effectively extracts correct features from review data by exploiting both grammatical properties and semantic characteristics of feature words and refines the features by recognizing and merging similar ones. Fan and Chang [43] addressed the concept of Blogger-Centric Contextual Advertising, which refers to the assignment of personal ads to any blog page, chosen in accord with bloggers' interests. Traditional keyword extraction methods are usually designed for formal documents such as news articles or scientific papers. Messages posted by microblog users, however, are usually noisy and full of new words, which is a challenge for keyword extraction. Liu et al.

[44] combine a translation-based method with a frequency-based method for keyword extraction to mine user interests via keyword extraction from microblogs. Xu et al. [45] proposed a novel graphical model to extract and visualize comparative relations between products from customer reviews, with the interdependencies among relations taken into consideration, to help enterprises discover potential risks and further design new products and marketing strategies.

VII. CONCLUSION

This paper conducts an overall survey of the three major research fields in sentiment analysis: framework, feature extraction and sentiment analysis, making a summary and analysis of the present development, and giving a detailed introduction of its application in business and Blogs. Despite the current immaturity of related research, sentiment analysis of online review has taken its position as an emerging research frontline, which takes advantage of the achievements in many areas, such as text mining, natural language processing, web mining, and machine learning. But the related research did not take place until recently, and semantic parsing and understanding exhibit high complexity, the overall research in this field being in its infancy. Still a lot of problems need further exploration and solution as follows:

(1) Insufficient empirical language data and platform. So far no experimental platform has been released for public use and cast widespread influence; experimental public corpora, especially marked corpora are relatively sparse. The available corpora for English sentiment analysis are MPQA news corpus and the movie critic corpus by Pang. They are confined with limited arrange of tasks and under-satisfied corpus quality. For lack of an open experiment platform and standardized benchmark, it is difficult to assess the effectiveness of all the methods.

(2) No breakthrough in textual sentiment analysis. Deep sentiment analysis inevitably involves semantic parsing, and sentiment transfers in texts moreover, so there is not much progress in deep-structure semantic sentiment analysis, and in textual sentiment analysis.

(3) No research on the commercial value of online product reviews. Online reviews cast a profound influence on the purchase behavior of consumers, but related research in China is still at the onset stage, only tentative attempts by some domestic researchers using simple statistical economy model such as linear regression model. However the lack of control over other sales influential factors besides online reviews leads to failure of drawing consistent conclusions and regular patterns. Different algorithm for customers' commentaries and discrepant used data also give rise to differences in conclusion. As a result, further research into the mechanism in which online reviews affect product sales is urgent. Other problems concern the supporting system of new product development (NPD), and how producers more efficiently gather, process and exploit online reviews. Finally, it is not clear if

information contained in blogs relates back to financial measures, such as stock price is not established, but should be investigated.

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