



## Warning system for online market research – Identifying critical situations in online opinion formation

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### ARTICLE INFO

#### Article history:

Received 6 August 2010

Received in revised form 19 March 2011

Accepted 20 March 2011

Available online 2 April 2011

#### Keywords:

Warning system  
Online market research  
Web  
Opinion mining  
Social network analysis  
Neuro-fuzzy system

### ABSTRACT

More and more consumers are relying on online opinions when making purchasing decisions. For this reason, companies must have knowledge of the actual standing of their products on the Web. A warning system for online market research is being proposed which allows the identification of critical situations in online opinion formation. When critical situations are detected, warnings are subsequently sent to marketing managers and thus allowing marketers the ability to initiate preventive measures. The warning system operates on a knowledge base which contains product-related success values, online opinions and patterns of social interactions. This knowledge is acquired using methods coming from information extraction, text mining and social network analysis. Based on this knowledge the warning system judges situations accordingly. For this purpose, a neuro-fuzzy approach is chosen which learns linguistic rules from data. These rules are employed to estimate future situations. The warning system is applied to two scenarios and yields good results. An evaluation shows that all components of the warning system outperform alternative methods.

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### 1. Introduction

The Internet is an important platform for information exchange. Numerous consumers meet online where they debate over their experiences with various products. By interacting with each other they influence one another's opinions and purchasing decisions. A survey conducted by the Opinion Research Corporation showed that 66% of consumers rely on online opinions when making purchasing decisions [60]. Several other studies also proved that online opinions have a great influence on consumers' decision making [61,45,23]. Moreover, some researchers found coherence between online reviews and sales volumes [32,34]. Therefore, it is of vital importance that companies know what opinions are exchanged on the Internet. Since negative word of mouth has a higher informative value [53,24] and a greater effect on purchasing intensions [44,5] than positive word of mouth, it is crucial for companies to identify critical situations at an early stage.

Situations become critical for a company when negative opinions are on the verge of spreading. The diffusion of negative opinions poses a reputational and financial threat [12]. It can harm the company's image and future sales volume. Therefore, it is of great

importance to alert marketing managers when such a critical situation arises so that they are in a position to initiate counteractive marketing measures. Case studies have shown that late reactions to negative word of mouth can cause considerable damage to a company's reputation [12].

However, judging the situation correctly is a very difficult task since many influencing factors must be weighed in order to decide if a situation is critical. Polarities of exchanged opinions must be considered, interaction patterns determining the spread of opinions should be observed and opinion leaders as well as the structure of the network also play a major role in opinion diffusion. Success factors concerning the product in question such as the current sales volume should be regarded as well. A comparison with competing products improves the judgment even further. Due to the complex interdependencies of these factors, considerable experience in the field of online market research is required to estimate situations correctly and automating this task poses a great challenge to researchers. The warning system should not only classify situations correctly but should also be able to learn from data and to produce comprehensible results in order to enable an easy usage and a high acceptance.

On the basis of these requirements, a neuro-fuzzy approach was implemented for warning marketing managers. The warning system operates on a knowledge base which comprises all influencing factors needed for the classification of the situations. The influencing factors are automatically extracted from the company's database and the Internet by applying methods coming from

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information extraction, text mining and social network analysis. The warning system learns linguistic rules from the estimation of past situations and applies these rules for judging future situations. Due to their linguistic form, the rules can be easily interpreted by marketing managers. For evaluation purposes, the approach was applied to two scenarios: a reviewing platform where opinions about soccer shoes were exchanged and a social network where experiences with computer games were discussed. The results of these applications are presented in this paper and comparisons to other methods are made to improve validation.

The paper is structured as follows: Section 2 introduces related work and describes our contribution. Section 3 gives an overview of the overall approach. The two main components of the approach are presented in Sections 4 and 5. Applications of this approach are illustrated in Section 6. Comparisons to other methods are drawn in Section 7. Finally, Section 8 concludes with a summary and an outlook on future work.

## 2. Related work

Opinion mining aims at discovering attitudes in texts and is applied increasingly to the Internet to reveal consumer opinions. Numerous text mining approaches have been introduced for identifying opinions towards products and their features [26,15,43,46,20,31,33]. However, these approaches only survey opinions at a certain point in time.

There are also many papers which monitor the dynamic evolution of online contents. For example, Viermetz et al. [56] propose a method for tracking short-term and long-term trends over time. Tong and Yager [54] outline a system which automatically summarizes online discussions. The summaries contain a linguistic description of the temporal development of contents exchanged in online forums. Bun and Ishizuka [6] introduce a system for tracking emerging topics with information agents employed to detect changes in topics and generate summaries. Zeng et al. [66] describe a system for analyzing user activities on interactive websites. In their experiments they find coherence between user activities and user interests. Huang et al. [25] present an approach for detecting and tracking evolutionary clusters in online communities. New clusters may emerge and old clusters may disappear due to the changing interests of the community's members. Choudhury et al. [10] analyze the development of online communities with the aid of key groups by identifying groups which are representative for the whole community and infer the dynamic behavior of the community from the behavior of the groups. These papers deal with past developments, but neglect future developments.

Some researchers observe online activities in order to predict future sales volumes. For example, Gruhl et al. [21] find correlations between the mentioning of books in blogs and Amazon's sales ranking for these books. They have developed an algorithm which allows the prognosis of peaks in sales on the basis of how often the books were mentioned in the blogs. Dhar and Chang [16] forecast music sales based on the mentioning of songs and links to musicians. Onishi and Manchanda [41] show that user generated contents are a good indicator for predicting the sale of green tea, movies and cellular phones. All of these approaches again focus on the consequences of online activities but do not predict future behavior.

There is also some research on predicting behavior in online communities. For example, Choudhury [9] analyzes past activities of online groups in order to predict future activities. Dastani et al. [13] predict user preferences based on their e-commerce activities. Choudhury et al. [8] propose a method for forecasting the flow of communication in online communities. Kaiser and

Bodendorf [27] identify opinion leaders and trends with the aid of communication relationships. As a result, future opinion formation can be estimated. However, only single patterns of user behavior are considered.

The existing approaches from the fields of online market research are only appropriate for warning purposes to a limited degree. The monitoring approaches, which keep track of the recent opinion, only detect critical situations when negative consequences have already occurred. The outlined predictive approaches only focus on single aspects of opinion formation but do not judge the overall situation. This approach, however, aims at detecting critical situations at an early stage by taking all relevant factors of opinion formation into account.

When studying other disciplines such as medicine or meteorology, approaches were found in which the detection of critical situations at an early stage is possible. These approaches rely on methods coming from soft computing to ensure a timely warning. Murtha [35] for example, uses fuzzy-logic to predict dense fog. The author states that the method could also be used for other scenarios such as the prediction of a snowstorm. Becker et al. [2] also adopt fuzzy-logic. They present a warning system for cardiovascular anesthesia. Other authors employ artificial neural networks for creating a warning system. Boese [7] for example, presents an early warning system for earthquakes. Hamilton and Hufnagel [22] describe a warning system for epileptic fits. Moreover, Fawcett and Provost [18] demonstrate a warning system for detecting telephone fraud. Yang et al. [62] propose a warning system for loan risk assessment. There are also warning systems which are based on neuro-fuzzy systems. Xu and He [63] for example, illustrate a fire alarm system for high-rise buildings. Paetz and Arlt [42] also apply a neuro-fuzzy approach and outline an alarm system for septic shock patients.

The presented approach adopts methods from soft computing to the given problem. With the aid of a neuro-fuzzy system, situations are judged as a whole by taking all relevant factors of opinion formation into account. If critical situations are expected to arise, warnings are sent to marketing managers. Thus they are in a position to initiate counteracting measures.

## 3. Approach

The objective of the warning system is to alert marketing managers in critical situations. Situations are considered as critical if negative opinions towards a product are about to spread and to harm the company's image and sales volume. The warning system operates on a knowledge base which must be fed with knowledge (see Fig. 1). The component for knowledge acquisition collects data from internal and external sources and transforms it into valuable knowledge. Key values characterizing the success of the product in question are extracted from the company's database. In addition, consumers' opinions on the product are gathered from the Web and classified as positive, negative or neutral by means of text mining. Furthermore, relationships in online social networks are examined in order to identify influential persons and to determine the network structure. The acquired knowledge is put into a structured form and saved in the knowledge base. The warning system takes this knowledge as input. Situations are judged on the basis of success factors, Web opinions and network characteristics concerning the product. A fuzzy perceptron is employed to learn the rules which allow the differentiation between critical and non-critical situations. Rules learned from past situations are applied for evaluating future situations. If critical situations are detected, warnings are sent to marketing managers. Consequently, marketing actions can be taken in time in order to prevent the spread of negative opinions.

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