

The Users Trust Mining Based On Sentiment Similarity Analysis Using Various E-Commerce Reviews

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Abstract- Electronic commerce is the phenomenon of buying and selling of goods and services on the Internet system. Apart from buying and selling, so many people are using Internet as a source of information look at the latest products on offer or to compare prices before to buy. The E-commerce systems are usually estimated as the prominent resources that give user's experience, feelings, and interest to purchase items by using Consumers' views. This type of data involves consumers' views on products that can show interest, sentiments, and expressions. The different research ideas have shown that people are more likely to trust each other with the same attitude toward similar things.

In this paper, we consider both seeking and accepting sentiments and suggestions in E-commerce systems represents a form of trust between consumers during shopping. Based on this point, an E-commerce system reviews mining oriented sentiment similarity analysis approach is put forward to explore users' similarity and their trust. Basically we can divide the trust into two categories, namely direct trust, and propagation of trust, which gives a trust relationship between two individuals. The direct trust degree is obtained from sentiment similarity, and we present an entity-sentiment word pair mining method for similarity feature extraction. The propagation of trust is calculated according to the transitivity feature. The shortest path to describe the tightness of trust and put forward an improved shortest path algorithm to figure out the propagation trust relationship between users using the proposed trust model. A large-scale E-commerce reviews dataset is collected to examine the accuracy of the algorithms and feasibility of the models. The experimental results indicate that the sentiment similarity analysis can be an efficient method to find trust between users in E-commerce systems.

I. INTRODUCTION

E-Business is sometimes used as another term for the same process. More often, though, it is used to define a broader process of how the Internet is changing the way companies do business, of the way they relate to their customers and suppliers, and of the way they think about such functions as marketing and logistics. For the purpose of this study e-commerce is taken to mean doing business electronically. By the increasing diffusion of ICTs, more specifically the Internet, the global business community is rapidly moving towards Business-to Business (B2B) e-Commerce.

The buyers gain a clear advantage when the Internet gives them access to the global market, by which they can compare

prices across regions, find out whether prices vary by order fragmentation and get awareness about substitute products. Due to transparency of the market, customer can compare the services of various e-commerce sites easily. For instant, in case of e-commerce the competitors are one click away from customer. If clients are not happy with the products, prices or services offered by a particular ecommerce site, they are able to change much more easily than in the physical. From the Sellers' point of view, they don't need to have physical existence of shop.

BENEFITS OF E-COMMERCE

The main benefit from the customers' point of view is significant increase and saves of time and eases access from anywhere in the globe. Customer can place a purchase order at any time. The main benefits of ecommerce for customers are as follows:

- Reduced transaction costs for participating exchange in a market.
- Increased comfort - transactions can be made 24 hours a day, without requiring the physical interaction with the business organization. Time saving- Customer can buy or sell any product at any time with the help of internet.
- Quick and continuous access to information. Customer will have easier to access information check on different websites at the click of a button.
- Convenience-All the purchases and sales can be performed from the comfort sitting home or working place or from the place a customer wants to.
- Switch to others companies-Customer can easily change the company at any time if the service of a company is not satisfactory.
 - Customer can buy a product which is not available in the local or national market, which gives customer a wider range of access to product than before.
 - A customer can put review comments about a product and can see what others are buying or see the review comments of other customers before making a final buy.
 - Reduces purchase and procurement costs.
 - Raises customer loyalty and retention.
 - Reduces transportation costs.
 - Develops customer and supplier relationships.
 - Improves speed of the process of selling.
 - Improves internal and external communication. And
 - Develops the company image and brand.

Reviews from consumers are very important information in E-commerce systems. Many online shops have developed reviews system for users to post their reviews. With the rapid development of social networking media, more and more people are willing to share their feelings, opinions and suggestions on their bought items with their friends or even strangers in social network applications or E-commerce systems.

SENTIMENT ANALYSIS

Sentiment analysis is meant to determine the polarity of a certain text, which can be positive, negative or neutral. Related academia and industries have been extensively investigating sentiment analysis methods over the last decade. While most of the early work in sentiment analysis is aimed at analysing the polarity of customer reviews.

The object of sentiment analysis has typically been a product or a service whose review has been made public on the Internet. This might explain why sentiment analysis and opinion mining are often used as synonyms, although, we think it is more accurate to view sentiments as emotionally loaded opinions. The interest on other's opinion is probably almost as old as verbal communication itself. Historically, leaders have been intrigued with the opinions of their subordinates to either prepare for opposition or to increase their popularity.

II. LITERATURE REVIEW

2.1 TRUST COMPUTATION

The concept of trust has been studied by scholars all over the world in diverse contexts and from various disciplines, including Economics, Management, Computer Science and Sociology. In the field of economic research, trust is explained from the theory of rational choice, and defined as a rational action to make a choice of whether to give a trust after careful thought and cost calculation. That is, individuals are inclined to make rational and maximizing benefit choices, which is usually called computational trust in existing research work [1]. In trust computation, there are two core kinds of trust as direct trust and indirect trust. Trust can be established according observations on whether the previous interactions among the subjects, and can be called direct trust. Direct trust is used for reflecting the trustworthiness between direct connected users. Typically, many direct historical interactions data, such as behaviours, reviews, or other various evidences, are used to compute the direct trust degree among users.

Dimah explore the potential of social information derived from micro-bloggings as a source of user relevant recommendations. They proposed an approach ISTS that can exploit two factors from online social network: the sentiment orientation in friends posts about certain items and the trust relations between friends [2]. Li and Dai proposed a promising methodology to handle the trust mechanism for P2P network. They let parties rate each other after the completion of transaction, and use the aggregated ratings of a given party to derive a trust score. While indirect trust is used widely in long path connected users through intermediate users. This kind of trust is treated as transferability that may arise from one familiar context to another new context, or from one trusted entity to another unknown entity.

Bo, Yang. and Qiang present an information propagation mechanism in semantic web to semantic trust score computation. Entire trust is measured by a combined trust score from both subjective and objective sides of information. The objective side of trust is semantic trust of information, and the subjective side is trust relationship between peers. And trust relationship is based on the historical interactions between peers,[3]. Faruk and Arnab proposed a trust management model which will take factors like direct, indirect and global trust of the service to find out the final trust value of the service. They take the trust path distance into consideration while calculating the indirect trust [4]. Li *et al.* [5] propose two trust models to content delivery network: a local trust model and a cross-domain trust model. Hong *et al.* [6] presents a new method called Max-aggregation, which calculates peer's reputation through the view of multidimensional and multi-attribute, and gets the indirect reputation using trust propagation and aggregation in the web of trust.

A. SENTIMENT SIMILARITY ANALYSIS

The methods take the similarity analysis as an important and basic content, which consider the sentiment and emotion as the evaluation factors for trust. Additionally, sentiment and affective similarity analysis have been studied extensively in natural language understanding, data mining and statistical analysis. The existing methods of sentiment analysis-based similarity exploration can be divided into three levels, which are document level, sentence level, and entity and feature level. All three levels are based on opinion lexicon, which is a collection of specific keywords or sentiment lexicons (extracted from gathered reviews) with parts-of-speech tags and treaded as the basis for analysing the reliability of reviews. At document level, the task is to classify a whole opinion document according to whether it expresses a positive or negative sentiment.

At sentence level, the task considers the sentences and determines whether each sentence expresses a positive, negative, or neutral opinion. Neutral usually means that no opinion is given. The analysis, both at the document level and at the sentence level, cannot exactly discover those specific objects whether people like or dislike. At entity and feature level, the approach concerns directly about the opinion itself instead of looking at language construct (documents, paragraphs, sentences, clauses, or phrases). It is based on the idea that an opinion consists of a sentiment (positive or negative). Hsu [7] adopted a sentiment word database to extract sentiment related data from microblog posts and used these data to investigate the effect of different types of sentiment-related words on product recommendations. The main goal of the existing sentiment analysis methods is to cluster the sentiments of users, commonly dividing people's sentiments to things into several types. Even at the entity and feature levels, its main purpose is to divide the user's sentiments into likes or dislikes. However, the above methods concern directly in overall trend which is insufficient when we calculate the trust based on sentiment similarity. It is necessary to analyse the specific attitudes on specific objects in reviews.

B. ON CORRELATIONS BETWEEN TRUST AND SIMILARITY

Over the past few years, many works have focused on the relationship analysis between trust and similarity. The similarity

analysis based on sentiment has become an important research approach to establish trust relationship. Many studies have shown that there is highly correlation between trust and similarity. They demonstrated that individuals with similarities also have a high degree of trust in certain areas. These similarities include interest, content, behaviour, etc. Cai-Nicolas Ziegler and J. Golbeck investigated correlations between trust and interest similarity. They established a formal framework for investigating interactions between trust and similarity. They used a mathematical model to compute similarity and presented computation algorithms for profile and profile similarity. They used two experiments to analyse possible positive correlations between similarity and interpersonal trust. At meanwhile, through the analysis of the data from the Film Trust Web site, the results show that when the similarity of users changes within a certain range, the trust between users changes accordingly. This change indicates that there is very strong relationship between trust and similarity [8]. Li proposed a node interest similarity-based trust model, which took both node interest bias and reputations in each interest domain into consideration, and used interest domain reputation vector to maintain the behaviours of node in specific interest domain. They used interest similarity between nodes to weight domain local trust recommendation. These innovative studies proved that there is a correlation between trust and similarity, and they had presented the corresponding calculation method.

III. PROBLEM STATEMENT

However, most of these above methods focus on exploring the overall trend of some sentiment or emotional tendencies to classify users by text sentiments. They do not take into account the similarity of sentiment between individuals and trust relationship between users. And at meanwhile, sentiments can spread in social networks, and this propagation feature also has an important impact on user relationships. So, if we want to get accurate text similarity and user trusts, we should start from real sentiment vocabulary. Bloom believe that in the reviews text, the sentiments words are always targeted at specific evaluation objects.

- In our existing work focused on trust construction and maintenance between customers and companies over time and after repeated experiences.
- While limited effort is spent on trust between consumers and potential consumers in E-commerce systems. In the field of E-commerce reviews, people are more concerned about the credibility of reviews and the trust of user who post the reviews.
- These reviews are important to the business holders as they can take business decisions according to the analysis results of users' opinions about their products.
- Some of the major problems with processing unstructured text are dealing with spelling mistakes, incorrect punctuation, and irrelevant words, use of non-dictionary words or slang terms, and undefined abbreviations.

IV. OBJECTIVES

The main objectives are

- To show customer reviews based on sentiment similarity analysis in E-commerce systems can be an efficient method to find trust between users.
- To enhance business strategies for the better outcomes in E-commerce.

SENTIMENT SIMILARITY BASED USER TRUST RELATIONSHIP CALCULATION FRAMEWORK

The users are usually the consumers who have involved in E-commerce activities. They may have purchased some items or services and posted reviews on these objects, as shown in fig1. Typically, a user can post multiple reviews on multiple items. Therefore, these reviews for specific items can be expressed in several texts. These reviews can usually be obtained by collecting network information. To find the trust, including direct and propagation, based on sentiment similarity of reviews by users in E-commerce systems, we propose a generally four-step computing framework. Firstly, the entity-sentiment word pairs are extracted from reviews. The step is a key process to further deal with the sentiment similarity analysis and direct trust computing.

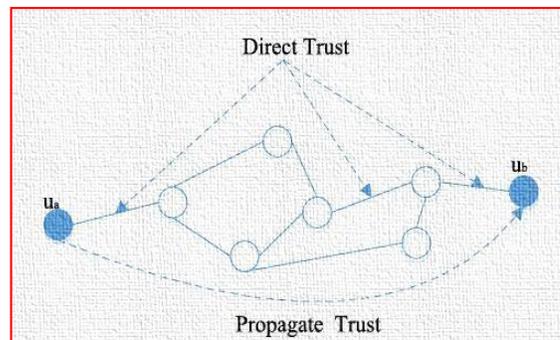


FIG (1). Propagation trust link based on direct trust.

The extraction of entity-sentiment word pairs in part 1 is mainly to analyse the vocabulary of the text, extract the entity words and sentiment words which describing the object. We use NL Processor linguistic parser for entity word and high frequency word combined with public lexicon for sentiment word. A mutual information formula is used to calculate the relationship between each entity word and the sentiment word. And then we can find those words pairs with close relationship.

Secondly, we perform sentiment similarity calculations for two user-related reviews based on entity-sentiment word pairs. Calculation of sentiment similarity in part 2 is to compute the similarity degree of different reviews texts. This step is to use the obtained entity-sentiment word pairs for comparative analysis. Thirdly, we use a new formula to calculate direct trust between two users with a common review object. Calculation of direct trust in part 3 is to compute direct trust that have reviews on same item or object. The calculation method mainly includes two aspects, one is sentiment similarity, and the other is the user's rating of the object. Finally, calculation of propagation trust in part 4, assume users as nodes, and the links, which are based on their direct trust, as edges to create a trust network.

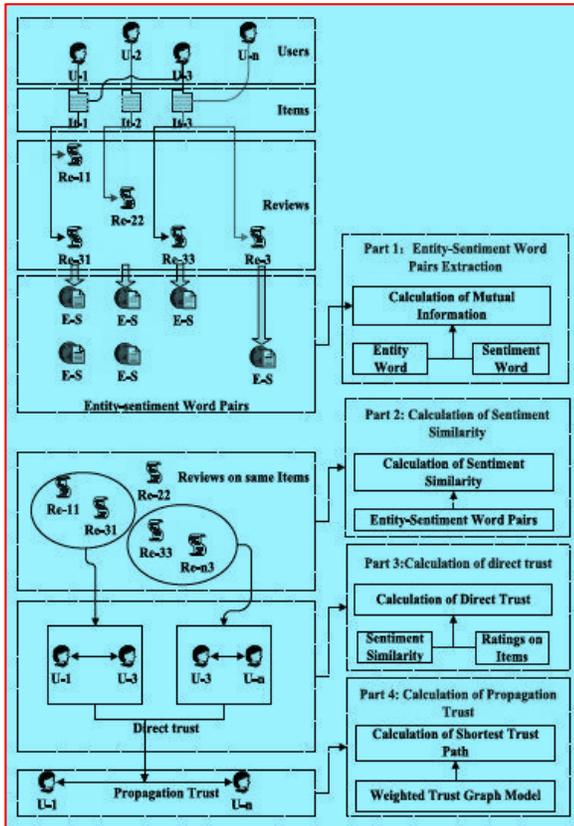


FIG (2). Trust calculation framework

Then we use an improved shortest path algorithm to calculate the propagation trust links between each pair of user nodes.

B. SENTIMENT SIMILARITY AND DIRECT TRUST COMPUTING

The sentiment similarity is to compute the similar degree of two reviews texts. For two users ui and uj , the reviews texts they post on an object o are t_{ui} and t_{uj} respectively. The similarity degree between these two texts can be calculated by formula (6) based on Pearson Correlation

$$Sim(t_{ui}, t_{uj}) = \frac{\sum_{k=0}^{\min|V|} (r_{ik} - \bar{r}_i)(r_{jk} - \bar{r}_j)}{\sqrt{\sum_{k=0}^{\min|V|} (r_{ik} - \bar{r}_i)^2 \cdot \sum_{k=0}^{\min|V|} (r_{jk} - \bar{r}_j)^2}}$$

where $\min |V|$ is the minimum number of entity-sentiment pairs in reviews text of user ui and uj . For any two users who have reviewed on same object, their sentiments may be positive, negative, or neutral. Whenever the emotion or sentiments of their reviews on the same object are consistent or approximate, the opinions or sentiments of the two users are treated as generally similar in E-commerce environment. Thus, sentiment similarity between users ui and uj can be acquired based on the context of their all reviews on same object, and can be calculated according to the following formula (7).

$$D_{ui,uj} = \frac{1}{|O_{ui} \cap O_{uj}|} \times \left(\sum_{i \in O_{ui} \cap O_{uj}} \rho(i) \frac{\sum_{k=0}^{|T|} \sigma(S_{ui}, S_{uj}) \cdot Sim(t_{ui}, t_{uj})}{\sum_{i \in O_{ui} \cap O_{uj}} Sim(t_{ui}, t_{uj})} + (1 - \rho(i)) \cdot D_0 \right)$$

where $O_{ui} \setminus O_{uj}$ is a set of objects that the two users have commented simultaneously.

In E-commerce, user ratings are ubiquitous information. We consider using user rating factors and combining sentiment similarity to calculate users trust. $(s_{ui}; s_{uj})$ is an influence function and it can be calculated using a covariance function as following formula 8.

$$\sigma(s_{ui}, s_{uj}) = \frac{\sum_{i=1}^n (s_{ui} - \bar{s}_{ui,uj})(s_{uj} - \bar{s}_{ui,uj})}{n - 1}, \quad n \neq 1$$

where s is the rating for an object. s_{ui} and s_{uj} indicate that the rating on an object of users ui and uj respectively, and $\bar{s}_{ui,uj}$ is the mean of the ratings of the two users on same object. $\rho(i)$ is a control function of the number of reviews by the two users. It reflects the user's activity level and stability to the objects. The higher the control function, the greater the degree of intersection between the two users, the higher the activity level, and then the greater the influence of similarity on trust. Conversely, the smaller the control function, the smaller the degree of intersection between the two users, the lower the activity, and the less the effect of similarity on trust. The control function has the following properties:

- (1). $0 \leq \rho(i) \leq 1$
- (2). $\rho(i)$ is monotonically increasing function, that is when $i_1 < i_2$, there is $\rho(i_1) \leq \rho(i_2)$;
- (3). When $i \rightarrow \infty$, there is $\rho(i) \rightarrow 1$

The calculation formula of $\rho(i)$ can be expressed as following formula 9.

$$\rho(i) = \frac{\arctan(i + \alpha)}{\pi} + 0.5$$

where i is the number of objects with common reviews of two users. Parameter $\alpha \geq 1$ is an adjustment factors of i .

A. PROPAGATION TRUST COMPUTING

According to definition (3), propagation trust of two users can be acquired from direct trust between intermediate users. We proposes a weighted trust graph model $G = (U; L; D)$ for all users who review items in E-commerce systems. In the trust graph model, U is the collection of users, denoted as nodes in the graph;

L is the set of links that connect nodes; D is the weight of direct trust between the user nodes that are directly connected by L . Let lij be the path distance between two user nodes (i and j), Dij is the direct trust degree between the two user nodes and set $lij D \ln Dij$. According to the definition (3), there are $0 < Dij \leq 1, \ln Dij \leq 0$, and the path distances between all nodes is a set of nonnegative numbers. When the shortest path of two users i and j is calculated, the propagation trust between the users can be obtained by $Dij D \ln lij$.

Take part of a weighted trust graph model (as shown in Figure 3) as an example, if $D_{i;k} = 0.6, D_{k;j} = 0.8$, then path distances $lij = 0.6 \times 0.8 = 0.48$, and

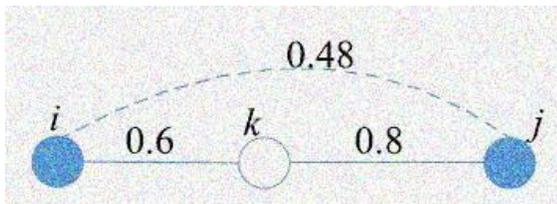


FIG (3). Part of a weighted trust graph model.

Experiment Evaluation for Sentiment Similarity Based User Trust Relationship

V. DATASET COLLECTION

The experimental dataset is collected from Amazon.com. It contains 143.7 million reviews on 24 categories of products with 9.4 million items from May 1996 to July 2014. The dataset includes basic information about reviewers, such as user name, user ID, and object information of the review, e.g. the product name or the product ID, the specific text of the review and the user's rating status, etc. Specifically, the dataset contains two files:

- (1) Review data file, which consists of ratings, text and helpfulness votes.
- (2) Product metadata file that contains item description, product category information, price, brand, and image features and also-viewed / also-bought. The whole dataset is more than 350GB, and we just collect reviews on five categories (books, electronic, sports and outdoors, video games and baby) of products as test data for our experiments.

S.No	Category	Reviews	Items
1	Books	21.5M	2.17M
2	Electronics	8.21M	564K
3	Sports and Outdoors	1.5M	856K
4	Video Games	4.5M	87K
5	Baby	968K	85.3K

Table 1. Selected dataset of reviews from amazon

VI. MEASURES

According to the data description in Tab. 1 and 2, we use three elds: related, overall and helpfulness, which is in the original experiment dataset, to judge whether the trust exists between users. If two users have the same related products (also bought, also viewed, bought together, buy after viewing), the same overall value (rating of the product) and the same helpful value (helpfulness rating of the review), we assume there is trust relationship between them. To our best knowledge, there are no published papers adopt the same or similar approach to explore users' trust from E-commerce system reviews based on sentiment similarity analysis. Therefore, we just follow the existing research and introduce four evaluation indicators, *Precision*, *Recall*, *F value* and *Accuracy* to evaluate the effectiveness of our approach.

If the trust of any two nodes obtained by the sentiment mining algorithm is greater than a pre-set non-zero threshold value and trust relationship exists actually at the same time, then we deem the result of calculation is correct, and otherwise it is incorrect. If the results acquired by the proposed algorithm do not show trust links (including direct and propagation) relationship between two users, but the trust between them is true actually, this situation is called trust relationship missing. *Precision* and *recall* are defined as following formula 10:

$$precision = \frac{CorrectLinksNumber}{CorrectLinksNumber + IncorrectLinksNumber}$$

$$recall = \frac{CorrectLinksNumber}{CorrectLinksNumber + MissedLinksNumber}$$

According to the relationship between *precision* and *recall*, *F value* is used to represent the common impact of the two indicators on the results and it is defined as formula :

$$F - value = \frac{2precision \times recall}{precision + recall}$$

VII. EXPERIMENTAL RESULTS AND ANALYSIS

We divide the review dataset into two parts, which is randomly divided into two non-overlapping parts, namely, training dataset and test dataset. We use 80% of the dataset for training and extracting entity-sentiment word pairs, computing sentiment similarity and trust. We use the left 20% of the dataset for experiment of accuracy and effectiveness of direct and propagation trust.

Product Id	Product Name	Price	Rating	Friend Name
2	speaker	4000	0	padmasri
2	speaker	4000	2	padmasri
5	java	600	0	padmasri

FIG (4). Recommended products

Both direct trust relationship and the propagation trust are analysed experimentally to get trust between users.

VIII. CONCLUSION AND FUTURE WORK

The main idea of this paper is to address the problem of mining users trust in E-commerce system. By defining two kinds of trust relationship, namely, direct trust and propagation trust, we transfer the point of exploring trust between users into calculation of sentiment similarity of their reviews with the help of entity-sentiment word pairs mining, sentiment similarity of reviews can be calculated and direct trust relationships can be obtained through sentiment similarity analysis, which contains of sentiments and ratings aspect. These two aspects can be used jointly to analyse the sentiment direct trust relationship. We establish a weighed trust graph model for propagation trust computing. Propagation trust is the use of the propagation characteristics of trust. It is an indirect trust between two users without direct trust and is obtained through intermediate users who have direct trust between these two users.

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