Trust Computation using Feedback Sentiment Analysis

Pandurang M. Agjal[1] Ankita Gupta[2] Prof. Subhash Tatale[3]
[1,2]Student [3]Professor
[1,2,3]Department of Computer Engineering
[1,2,3]Vishwakarma Institute of Information Technology, Pune, Maharashtra, India

Abstract— Trust is an important factor in any business relationship, but even more crucial for e-commerce vendors. Reputation-based trust models are widely used in e-commerce applications. In the current e-commerce, reputation score of each product is universally high and it is not easily possible for customers to select trustworthy product. All major online-shopping websites encourage buyers to provide feedback, often in the form of ratings along with some textual comments, to facilitate potential transactions. The "all good reputation" problem is a big challenge for customer while shopping on online websites like Flipkart, Amazon, eBay, etc. User text feedback is always multi-dimensional. Its expresses different aspects about the product. In this paper we are proposing a model which computes trust of a product by identifying its different dimensions from customer feedback.

Keywords: Dependency relation analysis, Trust, E-commerce, Sentiment analysis

I. INTRODUCTION

In this paper, based on the observation that customers often express opinions openly in free text feedback comments, we have proposed a model, a multi-dimensional trust computation model, for computing comprehensive trust profiles to products in e-commerce websites. Different from existing multi-dimensional trust models, we calculate dimension trust scores and dimension weights via extracting dimension ratings from user's free minded text feedback. The product rating indicates the ability of the vendor or seller to provide satisfactory service in the upcoming future, which is beneficial to new customers. The well reported issue in the current reputation system is the "all good reputation" problem. Where 90% user ratings are positive on an average [1].

From user's perspective, average ratings may not be fully reliable measure, it is only the easily accessible measure. Browsing through number of feedbacks is also time consuming and it is not easy to digest all the information from feedbacks is also daunting task as well. In this algorithm by analysing the wealth of information from feedbacks we are uncovering customer's opinion towards different aspects of the product. E.g. Book can have aspects like price, level, content, relativity etc. We are proposing an approach which uses typed dependency relation analysis.

By analysing the wealth of information in user text feedback comments we can uncover users embedded opinions towards different aspects of product, and compute comprehensive trust profiles for products in e-commerce. Specifically using the positive and negative subjectivity of opinions towards aspects of transactions as dimension ratings, we are proposing an algorithm Multi-dimensional trust evaluation model for e-commerce websites like Amazon, Flipkart, and eBay.

II. LITERATURE REVIEW

The "all good reputation" problem in the current reputation system is well documented in the literature [1]. Rating aggregation algorithms for computing individual reputation scores include simple positive feedback percentage or average of star ratings as in the eBay and Amazon reputation systems. The multi-dimensional approach to fine-grained trust computation has been studied in agent technologies. In individual, social and ontological reputations are computed and their ratings are combined to form an overall score. It is demonstrated that feedback comments are noisy and therefore analysing them is a challenging problem. In missing aspect comments are deemed negative and models built from aspect ratings are used to classify comments into positive or negative. Our work is related to opinion mining, or sentiment analysis on free text documents. A comprehensive overview of the field is presented in WordNet is used to identify opinion orientation for all the adjectives in the opinion word list [5].

Opinion lexicons like SentiWordNet have been developed in linguistic studies, and have been widely used for various sentiment analysis tasks. SentiWordNet is an opinion lexicon derived from the WordNet database where each term is associated with numerical scores indicating positive and negative sentiment information [6].

Collaborative filtering (CF) is a popular approach for recommender systems, and matrix factorization is a well-recognized approach to CF. Singular value decomposition (SVD) is applied to decompose a term by document matrix into a set of orthogonal factors from which the original matrix can be approximated by linear combination [9].

In proposed model we focus on mining dimension opinions from free text feedbacks, and furthermore our trust computation model computes dimension trust scores and dimension weights, both from the dimension rating matrix obtained by mining feedback comments. With this rather than simply classifying comments into positive or negative as in, we mine the text comments to extract dimensions and their associated feedback orientations hidden in the free text, which is free from the positive bias in the overall transaction ratings.

In proposed model we develop an approach which makes use of typed dependency relationship. For dependency relationship representation we are using Stanford parser [2] [3]. SentiWordNet is applied to determine sentiment orientation [6].

III. RELATED WORK

The core of this proposed paper is divided into following sub parts-

- Proposed Model Overview
- Trust Computation Algorithm
- Experiments and results

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– Proposed Model Challenges

A. Proposed Model Overview:

In our proposed recommendation system model we are considering each user feedback as multi-dimensional feedback. User expresses different aspects of product in his/her feedback. Aspect opinion expressions and their associated ratings (positive or negative) are first extracted from feedback comments. Dimension trust scores together with their weights are further computed by aggregating dimension ratings.

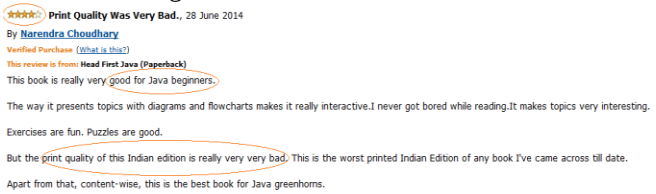

Fig. 1: One Sample User Feedback Taken from Amazon

In the above figure we have taken one sample feedback on Head first Java book expressed by a user on amazon. Above example is enough to show how a user text feedback can be multi-dimensional. User says that Head first java is good for beginners. So user trying to express his opinion on the content of book. Again user is expressing negativity towards the print quality of the book.

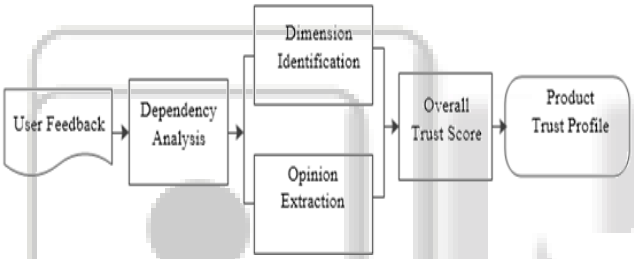

Fig. 2: Algorithmic Steps

Definition 3.1. The overall trust score *T* for a product is the is given by,

$$T = \sum_{d=1}^{n} (t_d)/n \qquad (1)$$

Proposed system computes the overall trust score *T* for a product using above formula. Where t_d is the trust score for dimension d and n is the number of dimensions.

B. Trust Computation Algorithm:

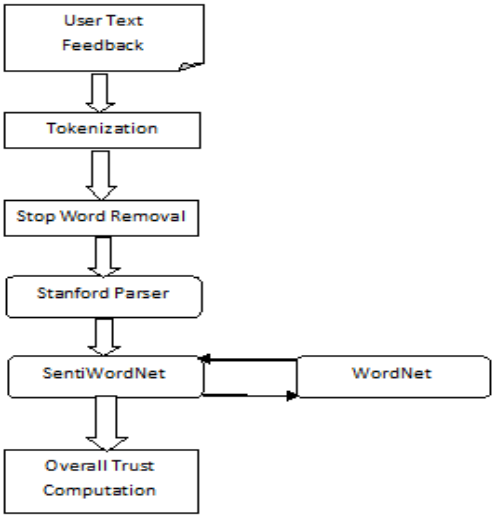

Fig. 3: Algorithmic Steps

1) Pre-Processing:

In the proposed model tokenization and stop words removal are pre-processing tasks. Tokenization extracts tokens from user text feedback. Stop words are the words which are filtered out in pre-processing. There is no single list universal list of stop words. In our proposed model stop words removal process removes words from user text feedback which are not useful in our algorithm.

2) Extracting Different Aspects from Feedback:

User text feedback contains different aspects of product and their opinion given by user as explained above. Our analysis reveal that these short sentences and phrases in feedback can be accurately described using dependency relations [3] in natural language parsing. The typed dependency relation representation [2] is a recent Natural Language Processing tool to help understand the grammatical relationships in sentences.

With typed dependency relation parsing, a sentence is represented as a set of dependency relations between pairs of words in the form of (Head, Modifier). In the head we are going to extract dimension of the product and modifier term will be opinion given by user to that dimension of the product. We are using Stanford parser [2] for typed dependency analysis. The negation function from the Stanford parser is used to detect any negation part of sentences in dimension expressions of the user text feedback.

Proposed model uses WordNet to find out synonyms of head term. User can put different words for given dimension. WordNet is used to find out synonym set of any word [5].

3) Extracting Polarity of the Modifier Term:

We apply a general opinion word lexicon SentiWordNet which is a widely used public domain NLP resource to identify opinion polarities [6]. When (Head, Modifier) pairs are grouped into dimensions, the associated modifier terms express the opinion priority of dimensions. In applying SentiWordNet, words with a sum of positive and negative scores greater than or equal to 0.5 is considered as express subjectivity, and if the positive score equals negative score for a subjective word, the word carries prior positive polarity.

4) Assigning Weightage to the Dimension:

SentiWordNet assigns to each synset of WordNet three sentiment scores: positivity, negativity, objectivity. According to the output of SentiWordNet we are going to assign weightage to that dimension term.

5) Rating evaluation of the feedback:

After processing feedback given by user our proposed system will evaluate overall rating given by user. This overall feedback rating will be according to product dimensions opinions given by user in his/her free minded text feedback.

6) Computing Trust Score T:

The overall trust score of the product is computed from the formula given in the def. 3.1. Where t_d and n represent the trust score for dimension and number of dimension d respectively.

7) Recommendation according to dimensions:

Once overall trust score T for products is computed, proposed system will give recommendations to user according to dimension opinions given by users. So that user

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can identify products to choose according to their specific need. User do not need to be confused by 5 star rating, user can view details of each and every dimensions. User do not need to explore through number of user feedbacks. User can get recommendations from proposed model according to their need.

IV. EXPERIMENTS AND RESULTS

A. Implemented System:

For experiment purpose, we have proposed a recommendation system which processes user text feedback. We are taking academic books as a product. User will give review (text feedback) to the books according to his/her experience. System will process this review on daily or hourly basis and will give recommendations to user. We have developed our own dataset on academic books for Book Recommendation System as mentioned. Extensive experiments on given dataset were conducted to evaluate various aspects of proposed algorithm, including the trust model.

B. Datasets:

Around 200+ books were crawled for mentioned Book Recommendation System, where almost each book have at least 10+ user text feedbacks. Around 1900+ reviews were in the original dataset and the following pre-processing was applied. Reviews with any missing aspect rating were removed so that all reviews have coverage of all aspects. Reviews that Stanford parser cannot parse were also removed. After pre-processing we got noiseless reviews.

C. Results:

Sample results produced by implemented system are shown below. Here we have taken five books. Number of feedbacks is nothing but the open minded opinions expressed by the users in text format. Proposed system will process these text feedbacks and will extract particular dimensions opinion. Here dimensions are Language, Usefulness, and Price etc

Sr. No.	Book Title	Number of Feedbacks	Dimension1 (Language) Positive Feedback	Dimension2 (Usefulness) Positive Feedback	Dimension3 (Price) Positive Feedback	Overall Positive Trust Score
1	Head First Java	15	70%	79%	30%	59.67%
2	Hadoop In Action	35	64%	70%	-	67.00%
3	Let Us C++	0	-	-	-	-
4	Data Structures and algorithms	5	40%	65%	10%	38.34%
5	Let Us C	51	95%	91%	30%	72.00%
6	Head First Ajax	10	30%	50%	20%	33.34%
7	The 8051 Microcontroller	17	65	84%	67%	72.00%

Table 1: Positive Trust Score

Sr. No.	Book Title	Number of Feedbacks	Dimension1 (Language) Negative Feedback	Dimension2 (Usefulness) Negative Feedback	Dimension3 (Price) Negative Feedback	Overall Negative Trust Score
1	Head First Java	15	67%	10%	75%	50.67%
2	Hadoop In Action	35	20%	9%	-	14.50%
3	Let Us C++	0	-	-	-	-
4	Data Structures and algorithms	5	4%	8%	70%	27.33%
5	Let Us C	51	5%	-	10%	5.00%
6	Head First Ajax	10	15%	30%	35%	26.67%
7	The 8051 Microcontroller	17	17%	7%	56%	26.66%

Table 2: Negative Trust Score

Positive opinions will construct positive trust score of the book (as shown in first table) and Positive opinions will construct positive trust score of the book (as shown in second table). Overall trust score is the average of dimension trust score.

The main drawback proposed system is that what if a book don't have any user feedback review. This problem in current recommendation system is known as cold start problem. In above sample results from our proposed system book number third don't have any single user feedback. So the trust score of this book will not be calculated by our system. If user feedbacks does not contain any opinion on a particular dimension then system will neglect that dimension while calculating overall trust score. We can calculate trust score of books which are not having user feedbacks using item-based or user based collaborative filtering.

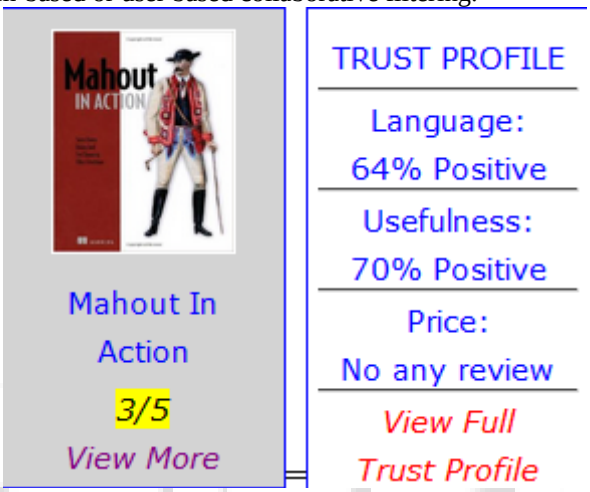

Fig. 4: Product Trust Profile

D. Performance Evaluation:

Proposed system is a recommendation system; recommendation engine's task is time consuming tasks. In our proposed system, we are using Stanford parser for dependency relation analysis. This is the time consuming task. So, to avoid this we only going to process reviews when user will add a new review is added and this can be run as an hourly or daily batch. Usually the number of products sold on a site is far more than the number of users. So if we need to calculate the similarity for a product with every other product, then it is very time-consuming task. However the benefit of this is, we only need to calculate product similarity when a new product is added and this can be run as an hourly or daily batch.

V. PROPOSED MODEL CHALLENGES

A. Language Limitations:

Proposed system deals with user free minded text feedback but unable to process overly free minded feedback. In this paper, based on the observation that customers often express opinions openly in free text feedback comments. Proposed model limited to English language. Also proposed model laid down restrictions to user to his/her "free minded", "open" feedbacks. In short, proposed model can't process overly free minded text feedback. E.g. "ek number book" (native language), "I will give A+++ *" (jargon language), "buk was gud" (spelling mistakes).

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B. Dimension Limitations:

Proposed model is a multi-dimensional trust evaluation model. Its expresses different aspects about the product. In this paper we are proposing a model which computes trust of a product by identifying its different dimension from customer feedback. But proposed deals with limited set of dimensions. User can have their own experience with product. User have different kinds of needs expecting from products. Proposed system cannot consider each and every aspects of user. But we have implemented this system on such dimension set which we daily found.

C. General Challenges:

Current recommendation system frequently faces some known problems that are – Cold start, Noisy data and Privacy of user.

1) Cold Start: The success of the algorithm as stated earlier, depends on the data. So if we don't have any users available in our system, then we can't get started. This is what is termed the cold-start problem. There are solutions available for this.
2) Noisy Data: The other aspect which influences the success of this algorithm is the quality of data. If the ratings are coming from people, how genuine is it or they are doing it for an incentive.
3) Privacy: Privacy is being compromised in these applications. So some people would not like to share their private information and generally clear the browser cache after the session. Some of the Governments are taking up Privacy as a bigger issue and enforcing rules around it.

VI. CONCLUSION AND FUTURE SCOPE

We have proposed a model to compute product trust scores via extracting aspect opinion expressions from user feedbacks and clustering them into dimensions. Our approach demonstrates the effective application of combining natural language processing with sentiment analysis and summarisation techniques in trust computation for e-commerce applications.

The proposed model has good future scope in the current e-commerce system as well as great scope in academic system. In the current e-commerce, reputation score of each product is universally high and it is not easily possible for customers to select trustworthy product. The "all good reputation" problem is a big challenge for customer while shopping on online websites like Flipkart, Amazon, eBay, etc. E-commerce system deals with big data. The proposed algorithm can be used with Apache Hadoop, Apache Mahout to provide best product recommendation to the users. Stanford typed dependency parser takes too much of time for dependency relation analysis. So, performance evaluation will be future research issue. But there are many general options to increase performance of the recommendation system as explained above.

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