# Evaluation of Recommendation Systems using Trust Aware Metrics

**Gopichand G, Koduri Sai Sankeerth, AnirudhParlapalli**

***Abstract*— A recommendation system is that type of system which uses the entities such as "likes", "preferences" and "ratings" in order to predict the items that a user would want. It is kind of a filtering system which suggests the users what products they would like to see. This technique can be used to counter the information overloading. In the current online world, information overloading is a major issue as we have a plethora of choices and this can be done using personalized systems. The recommendation systems can mainly classified into three types. The first is based on the content where the system uses the information regarding the other user to suggest and recommend the items which are most likely to satisfy the customer needs. Next is the collaborative filtering, where the own information of the individual is only taken into consideration. Finally, comes the trust-aware system, where the information related to the social media and its trust information is used to predict the user's likings and his preferences.K- nearest neighbour(k-NN) is one of the best algorithms when it comes to the collaborative filtering(CF) and is used to fine tune the recommendation systems. It also deals with the information overloading problem which is mentioned above by generating predicted ratings for all those users who have not expressed their opinions. Here, in this paper we will try to discuss how one can use the trust as an alternative in order to overcome the limitations of collaborative filtering. A k-nearest recommenders (k-NR) algorithm is proposed in the paper where the user learns who all he or she should trust and up to what extent he can trust, by studying and assessing the ratings that the individuals have received.***

***Key Words: Trust, Recommendation system, K- Nearest Neighbour, K- Nearest recommenders algorithm, Collaborative filtering***

## 1. INTRODUCTION

Recently, In the past decades, recommendation frameworks have been developed in the domain of personalised services. It has been one of the most important development in this domain. With the boom of Big Data, the recommendation system applications have grown in a large scale in the personalisation needs of the user. A wide range of businesses have adopted the recommendation systems in the form of intelligent virtual aides. Most of the e-commerce websites have already adapted these recommendation systems. By using the concepts of machine learning, such as information and content filtering, user profiling, etc. recommendation systems are able to these concepts and establish an efficient way to provide a user-friendly and a hands-on intelligent recommendation system which is able to predict the preferences and requirements.This recommendation system applies to various fields such as movies, music, e-commerce websites, etc. In all these domains, the end game of the system is to retrieve the information and the content. These systems predict and present customers with data and products based on their preference history and past behaviour, which is done instead of trying to answer to a specific query. The leading and the best algorithm that has been developed for the recommendation system is the Collaborative Filtering (CF). As the name suggests, the Collaborative filtering(CF) uses the collaborative effort of the community of the end user as the whole to help each individual by examining the huge volume of the data present online. The basic concept of collaborative filtering is that like-minded people will have similar likings in the upcoming future. The main aim and the most vital role of the the recommendation system is to determine the extent of similarity as only k maximum similar customers who are at the top are accepted in the contribution of their ratings and every contribution has its own weightage based on how similar it is with respect to his neighbour based on what they share with the current user .The main advantage of using the collaborative filtering algorithm is that the similarity computation reduces a lot of loop holes, which maybe caused due to the missing data on the user profiles. In the case where the user does not have any profile, there is no way to predict the similarity based on any other individual and therefore, the cold start problem arises where nothing can be predicted for a user. In another case, the user profile of an individual may be present but may not be similar to anyone of his neighbour's recommendation .This may happen when the user expects the recommendation system to provide both useful and unpredictable outcomes for him. These problems arise because the user profile data is extremely thin or sparse. Due to the total number of items and the set in which they belong and the size and different data types the similarity varies and it is difficult to propose a perfect recommendation system. The Collaborative filtering contains incomplete information of the contributing users and there is a need to deal with the large amount of uncertainty that the other approaches based on similarity fall short. Another method based on trust is proposed. This approach has the capability to tackle the difficulties which are mention above. Trust can be used in numerous situations which include accessing problems by which one can tell who one should trust to get information and punishing network nodes which do not obey the specified information, it can be also used to help the users decide whether they have to choose a source or not. As discussed earlier, the most

**Revised Manuscript Received on April 05, 2019**.

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important problem is overloading of data as the amount of content is very high and the recommendation system tackles the issue by helping the user select the content they want. To this, if trust is added on, the scope of the recommendation system is widened with more number of characteristics. Recommenders can be described as trustworthy if they are sources of content which are reliable and valuable which the system can be used to predict the rate of liking for the current user accurately.

## 2. TRUST FACTOR IN RECOMMENDATION SYSTEM

The basic quality of survival is trust. With trust, comes the sharing of information with the society. Living in the society with peace, we share our information. The systems which use trust for the recommendation systems are based on the relation of the trust between the users. The trust between users means that both of the users believe that a recommendation from a trusted user is of a level which is satisfactory. By using this algorithm, the users can use the level of trustworthiness of friends because there is a huge chance that the friends are likely to consider the recommendation made by trusted friends. It is also scientifically proven that the users are more likely to rely on the recommendations which are suggested by their close or best friends when compared to the suggestions which are given by someone who are foreign. Therefore, using trust and recommendation system together will improve the accuracy of the predicted recommendation. The accuracy is highly improved when both are used together. Using this, the classical problems such as the cold start problem and its responding attacks can be countered.

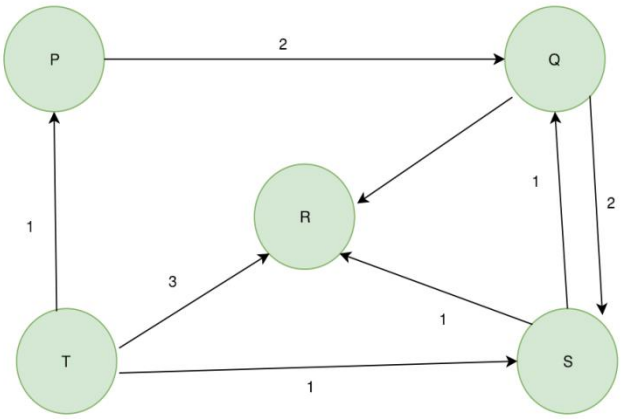


**Figure 1. A pictorial representation of the Trust Network Model**

$$T = \begin{vmatrix} 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 3 \\ 0 & 2 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 \end{vmatrix}$$

**Figure 2. Trust Network Matrix**

In the above mentioned model, directed graphs are used. The model consists of trust networks which include actors with their corresponding weights. In the directed graphs, the edges are the trust between the users and the nodes are the users themselves. The social relationship for the nodes is the trust and the strength of the edges between the users depicts the level of trust between them. The building blocks of the trust aware system includes the trust metrics and the recommendation systems. Trust is used by the recommendation system to create recommendations which are more personalised and these are all based on user and what they trust, this trust can be seen from the graphs of the social network. This data is used to create a similarity matrix based on the user to user trust. When this is added to the classical recommendation system accuracy, quality and coverage is improved significantly and it addresses the problem faced by the existing systems. Hence, we can use these concepts to handle the problems which are related to information overloading and trust can be evaluated based on these factors:

- **Neighbors are selected Based on Trust:** The neighbours are chosen in such a way that they are well established on profile similarity which are switched with practical assessed value for each user provided by others and the trust is alloted accordingly.
- **Trust is relative when compared to the degree of information:** This method is used to give a variable degree of trust to each and every user who could be a potential recommender for the items a user looks into. On top of this, it also reduces the trust values for the user who do not provide sufficient information. Trust and information play a vital role in making of EF based systems.
- **Content of Recommenders is used instead of Neighbors:** The area of the coverage used for the prediction can be reduced by picking the k neighbours who are at the top and hence, we can take the top k recommenders into consideration.
- **Divergent Users are considered.** Even if any two users might completely disagree or their similarity rating maybe completely different yet that are not completely useless, if they are interpreted correctly we can use it in the future.

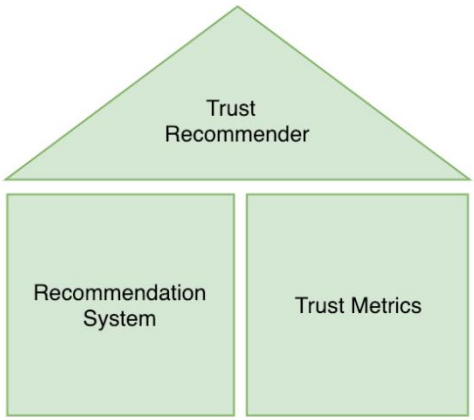


**Figure 3. The two pillars of trust aware Recommendation System**


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## 3. SYSTEM ARCHITECTURE

The block diagram of the proposed architecture is given in this figure, In this model, we are going to follow the steps with different modules (black box) with the input/output of each matrix (white box). The input matrix consists of the rating matrix (contains the entire ratings provided by the users to the items) and the trust matrix (contains the trust value for the entire community) which produces the output matrix with the predicted values for the rating and preferences that the users give to the items. The matrix is then used by the recommendation system to indicate the most items which are rated. The recommendation system chooses the maximum value from the row of predicted values for the rating relative to the respective user, but the final output matrix may have some missing values in its cells. Various modules present in the system are now discussed.

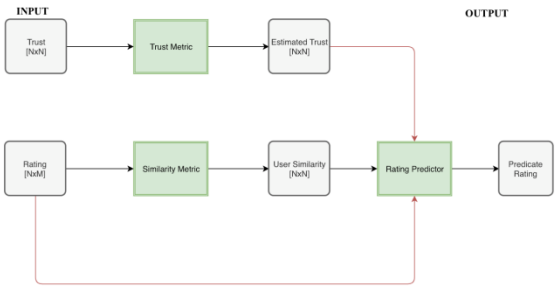


**Figure 4. Architecture of the Trust Based Recommendation System**

**Module based on trust Metric-** The network model is the input of the matrix and the matrix uses trust propagation to predict the amount of trust between the users. The value given in a cell r, c is how much metric predict how much peer r can trust peer c. This can also be used as a weight to know how it represents a generation of a recommendation.

**Similarity metric-** The similarity metric is used to calculate the similarity of the current user when compared to other users by using the steps present in collaborative filtering. It is useful to calculate the correlation between the users giving a matrix as an output. The user similarity matrix is used where values represent the similarity of a user r with user c. The weight of each rating that has been predicted by using correlation.

**Rating Predictor –** The main step of CF is performed in this module. The predicted rating for an item r for the given user u become the weighted sum of the ratings for item r with respect to neighbors of u.

## 4. METHODOLOGY

Unnecessary stress on similarity is the main problem of the traditional CF. When the sparse data user-item rating matrix is used, the traditional similarity computation techniques don't use the scoring matrix. This in turn provides less accuracy. But now, in recent time the social networks are used and the users can go through the pages using the data of the other users, in which the users are interested and which help to make a new trust relation. Hence, we can now use the trust friends of friend function where a reduced trust value is used. This model helps to implement the factor of users interest which is derived from the behavior and history of a user and then used to calculate the trust among the friends. The trust metrics that potray the likeliness of the choice being selected is calculated and established. The cases of direct user is calculated and if there no real trust, we return the output as 0.A good recommendation can be given by lookinat at the number of neighbours that it is connected. Implement of the normal collaborative system is done along with trust metric. It is then created using the wright of the rating along with similarity matrix. Trust filtering method is used where the user can rate the item depending on their preferences and can give results. This rating is then used as threshold and used in the computation of the predicting matrix.

**Algorithm 1. Trust matrix algorithm**

**Input:** Target user u, other user v, relationship of u and v

**Output:** Trust of u and v

a. If v € friend(u) then
b. Tuv = 1
c. Else
d. Tuv = Similarity(u,v)
e. End if
f. Tuv' = reciprocal(T'uv)
g. Tr'(u,v) = raring(T'uv)
h. Tr(u,v) = predict (Tr'(u,v))
i. Return Tr(u,v)

## 5. THEORETICAL RESULT

A much better collaborative algorithm based on the social network and trust metrics is used. An analysis of the relationship of users is made and the trust metrics are tactically and carefully bound based on which the trusts are computed. Greater efficiency is provided for the recommendation when the standard evaluation matrix of the dataset is used. The method which is proposed provides more restrictions and is much more applicable as it uses the social networks. In the upcoming future an attempt will be made to implement this using a larger dataset and also applying it on the real time applications such as Facebook, amazon etc.

## 6. CONCLUSION

In this paper, a methodology to evaluate recommendation system based on Trust aware metrics is proposed. This proposed method is mainly designed to improvise the user experience and interface in the recommendation system using trust metrics such as rating patterns and user behavior. In future, we will try to propose a method that would be able to be tested and built on a real-time recommendation system depending on the applications for the comparative analysis and performance evaluation with respect to the already existing methods.

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