Confidence on Collaborative Filtering and Trust-Based Recommendations

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Abstract. Memory-based collaborative filtering systems predict items ratings for a particular user based on an aggregation of the ratings previously given by other users. Most systems focus on prediction accuracy, through MAE or RMSE metrics. However end users have seldom feedback on this accuracy. In this paper, we propose confidence on predictions in order to depict the belief from the system on the pertinence of those predictions. This confidence can be returned to the end user in order to ease his/her final choice or used by the system in order to make new predictions. It takes into account some characteristics on the aggregated ratings, such as number, homogeneity and freshness of ratings as well as users weight. We present an evaluation of such a confidence by applying it on different collaborative filtering systems of the literature using two datasets with different characteristics.

Keywords: recommendation, confidence, evaluation, dataset.

1 Introduction

Recommender systems are one solution classically proposed to help users select items among a lot of possibilities [13]. In this paper, we focus on memory-based collaborative filtering recommender systems that rely on relations between users to predict items that best fit their interests.

More and more e-commerce and collaborative websites include a recommendation system that proposes items or actions adapted to the user. Collaborative filtering is notably used on the Amazon website. The evaluation of such systems in the literature is mainly based on accuracy and coverage. These criteria are valuable for the comparison of systems and for the selection of the most efficient one. But when the system is deployed, end-users require other indications on the value of recommendations. Recommendations explanations can be provided using traces of the computation, but they are qualitative and difficult to interpret by naive end-users.
A quantitative confidence value, provided by the system as an indicator of the reliability of the recommendations, is easier to interpret. A study of the literature has shown that few systems propose a notion of confidence associated to their predictions. The few systems we have found just compute very simple confidence, for example with a standard deviation of the gathered ratings. In order to enrich the confidence notion, and to make it more valuable to the end-user, we propose a confidence formula dedicated to collaborative filtering recommender systems that takes into account five different confidence axes. Confidence should be provided with each prediction proposed to the end-user.

We also provide an evaluation of the proposed confidence so as to verify whether it is correlated with predictions accuracy. This evaluation is done using two different datasets extracted from two real websites with different characteristics. These datasets include data required for this evaluation as well as additional information gathered for wider purpose.

This paper is structured as follows. After a rapid tour of the literature, we define the five axes of confidence, as well as a synthetic confidence formula. We then describe our datasets and our evaluation protocol that measures the correlation between the confidence and accuracy of recommender systems predictions. Finally, we show the results of this evaluation on five different systems of the literature before concluding.

2 Related Work

Collaborative filtering systems predict item ratings for a particular user based on the items previously rated by other users [1]. To do so, they usually aggregate other users’ ratings with the following function:

\[
 r_{a,i} = \frac{\sum_{a' \in A_i} \omega_{a,a'} \times r_{a',i}}{\sum_{a' \in A_i} \omega_{a,a'}}
\]

where \( r_{a,i} \) is the rating given by user \( a \) to item \( i \), \( A_i \) is the set of users having rated item \( i \) (aka. “advisors”) and \( \omega_{a,a'} \) is a weight between \( a \) and \( a' \), typically a similarity coefficient. In this paper, we call UserBasedCF (respectively ItemBasedCF) the collaborative filtering algorithm defined in eq.1 where the \( \omega \) coefficient is calculated using the Pearson’s correlation coefficient between two users’ ratings (resp. two items’ ratings) [2].

Trust-based recommender systems build a subclass of collaborative filtering based on different links between users: users state that they trust the ratings expressed by other users [11,8,6]. For such systems, equation 1 is modified so that \( \omega \) represents trust instead of similarity. Trust is implemented as a value in \([0, 1]\) that weights the links between users. Trust is the belief of one user in the usefulness of information provided by another user [5].

In the literature, very few collaborative filtering and trust-based systems use the notion of confidence. We present here the two best known trust-based systems as well as our previous work. We briefly explain the prediction principle and the associated confidence if any.