A Study of Recent Recommender System Techniques

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ABSTRACT

The influx of data in most domains is huge and dynamic, leading to big data and hence the need to build a recommender system grows stronger. This work is a comprehensive survey of the current status of different recommendation approaches, their limitations and extension which when applied may eradicate the incessant information overload problem of web entirely. Further, an investigation is conducted on the Google Scholar database, delineating the temporal distribution of different recommendation techniques. Several popular and most-used evaluation metrics, domain-specific applications, and data sets used in the recommendation are reviewed. By summarizing the current state-of-the-art, this work may help researchers in the field of recommendation system techniques and provides future directions highlighting issues that need to be focused on.

KEYWORDS

Cold-Start, Collaborative Filtering, Evaluation Metrics, Fuzzy, Genetic Algorithm, Group Recommender System, Hybrid Approach

INTRODUCTION

Recommender system (RS) has emanated as the most popular application of big data (Mayer-Schönberger & Cukier, 2014; Livinus et al., 2016) that helps the user to find relevant information in the era of data deluge. As a result of the expansion in the e-commerce business, the customers (buyers) have to process a large amount of information before they decide to buy an item. RS provides the solution to this information overload problem as it is used to suggest products to the customers. It further enhances the e-commerce business since it helps to find the interesting things for the users which they may wish to purchase, however, did not come across things, due to information overload. RS is often used to improve customer’s trust and loyalty as it provides unique personalized service to each customer. User interest may be determined in the following ways:

- By monitoring past buying behavior
- By directly asking user preferences

A formal definition of RS is as follows: Let U be the set of users and I be the set of items. We define a function F that quantifies the utility of item \( I \in I \) to a user \( u \in U \) by the mapping \( F : U \times I \rightarrow R \) where R is defined as the set of ratings (Sarwar et al. 2000). The goal is to learn and use F to determine the rating of a previously unseen item i by user u in order to generate a possible set of recommended items.

DOI: 10.4018/IJKSS.2019040102

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Several traditional recommendation techniques include collaborative filtering (CF) (Ekstrand et al., 2011), Content-Based Recommender System (CBS) (Lops et al., 2011) and Hybrid Recommender System (Varshavsky et al., 2014). Each technique has its advantages and limitations; for example, domain free nature of CF has averted most research work from CBS (Ekstrand et al., 2011). However, CF suffers from cold start and sparsity problem (Hedge et al., 2015) while CBS suffers from overspecialization (Lops et al., 2011). Consider a case where a user is new to the system and the system does not have any information about the user. In such a case, drawing inference about user’s preferences becomes difficult and a quality recommendation cannot be produced. Such a scenario occurs both in the case of novel users and new items and is a perfect example of a cold start problem which indirectly leads to sparsity problem. Many advanced techniques have been suggested for mitigating these limitations such as, social, interactive, deep learning, context-aware, and fuzzy logic-based RS which also increase coverage and accuracy. For recommending items to a group of users, group recommender system (GRS) came into picture which exploits individual contextual information, tastes and demographic information for developing suggestions (Boratto, 2016). Various nature-inspired algorithms such as Cuckoo search (Tosun, 2014), swarm optimization (Chen et al., 2012) and genetic algorithm (Whitley, 1994) have been investigated by the researchers for accuracy and optimization of the system.

Several evaluation methods used for RS are Recall, Precision, F-measure, Mean absolute error (MAE), Coverage, Root Mean Square (RMSE), Sensitivity, Specificity and Receiver Operating Characteristics (ROC) (Franzen, 2011). In order to analyze the system developed, an appropriate metric should be chosen taking into consideration the user perspective and purpose that needs to be fulfilled by the system. Therefore, to help the researchers understand the RS development from various aspects including evaluation metrics and datasets and to assist them, this paper reviews the RS from all aspects that need to be considered for its development.

In recent years, several survey papers have been published but none of the paper to best of our knowledge have considered every aspect of RS including approaches, application domain, evaluation metrics, and datasets at one place. For example, Jie Lu et al. (2015) in their work reviewed application development of RS categorizing into eight major domains. Herlocker et al. (2004) reviewed various evaluation metrics and focussed majorly on the user-centric evaluation of the system as a whole. Bobadilla et al. (2013) discussed evolution and overview of RS including the CF algorithm. It further provides the classification for these systems. Sharma et al. (2013) in their work classified RS into three major categories i.e., CF, CBS, and hybrid recommender system and discussed several challenges associated with them. Yera et al. (2017) investigated the use of fuzzy logic in the recommendation delineating various research gaps. They also collected several papers from Web of Science and studied the temporal distribution of papers, distinguishing them by journal and conference. Although several works have been published in the field of RS, none of the work has conducted a comprehensive review of the RS approaches and evaluation metrics.

The main contributions of this paper are:

1. This paper surveyed the different approaches of RS, evaluation metrics used by the researchers and datasets that have majorly been worked upon.
2. This paper statistically, perceptively and comprehensively summarizes and categorizes the RS into 8 major approaches including the advanced RS techniques such as social, genetic, fuzzy, context-aware and group RS.
3. Framework for each approach has been further carefully analyzed, delineating its contribution, shortcomings and motivating the researchers to further carry out the research work suggesting research directions in the area of RS.
4. Different evaluation metrics have been investigated with a view of studying metrics according to the purpose of the system, enlightening the user-centric direction for evaluating the system.


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