

Recommender Systems Review of Types, Techniques, and Applications

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INTRODUCTION

Recommender or Recommendation Systems (RS) are software tools in applications or websites that suggest information (e.g. items, people, news articles) that might be of interest to the end user, taking into account various types of knowledge and data, such as the user's preferences, actions, tasks and contextual information. In most cases these systems use computational methods to analyze users' past actions and decisions, along with other user-related or task-related information, to offer useful, usually personalized recommendations. The motivation behind this is to alleviate the information overload problem, by bringing to surface what is most relevant, interesting to the user. Examples can be seen in many well-known e-commerce websites such as Amazon.com, which promotes products that were last examined or purchased by a user, or products that have been rated or reviewed by other users. In addition to that, there are cases where the recommendations are the result of a combination of factors that are difficult to accurately determine. In such cases, a variety of alternative methods are employed to generate recommendations.

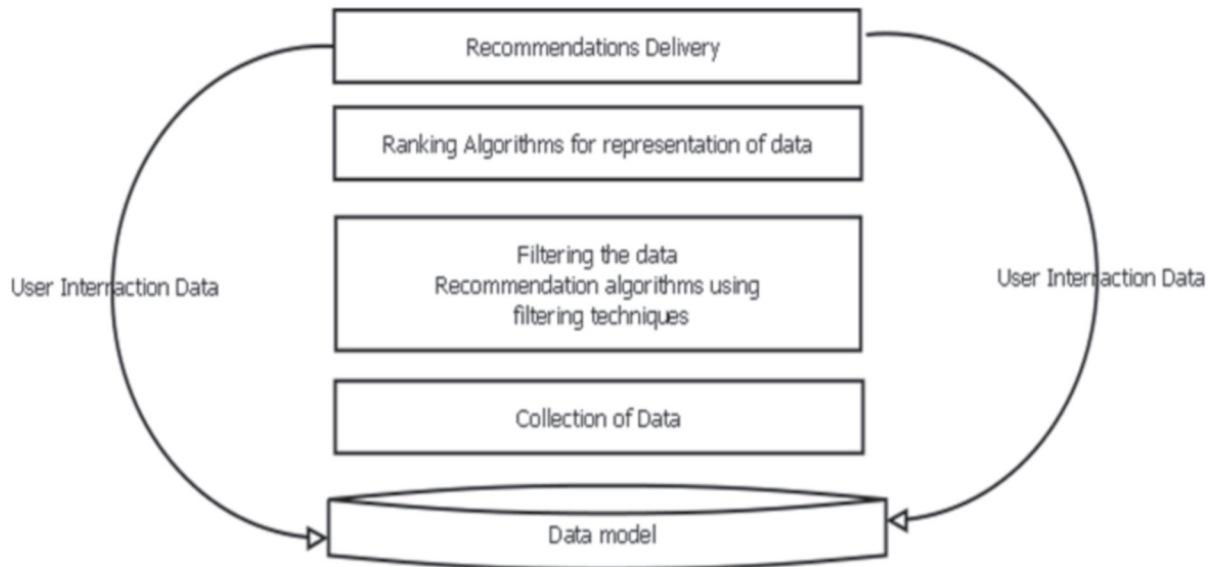
RS belong to the information filtering systems family and therefore seek to predict the rating or the preference that a user would give to an item. Thus the common methodology that RS follow is to find the correlation between three types of models, user, rating and item, in order to produce recommenda-

tions. All recommendation algorithms and their variations follow this model for the computation of recommendations. The present article includes a review of the different types of RS, their typical architecture and the algorithms used for generating recommendations. Finally the challenging topic of evaluation of RS is discussed, outlining the possible approaches to assess the accuracy, usefulness and user satisfaction from recommendations.

BACKGROUND

The Internet is a source of information where we can find almost everything. Nevertheless, this information is not structured and well organized and following the web's expansion information filtering has become more complex. This complexity is due to more information-related factors being introduced, e.g. social, psychological, and behavioral and other factors related to the users who receive or created the information. RS are mechanisms that are used for filtering and removing the irrelevant information based on how each user perceives the information. In other words, RS take into account the preferences of a particular user, compare it to what other users with similar preferences liked or disliked and try to predict the information that would satisfy the user the most. Based on this logic several recommendation algorithms have been implemented and used in commercial, as well as research recommendation tools.

Figure 1. Functional RS architecture



RECOMMENDATION FILTERING TECHNIQUES/ALGORITHMS

In general RS refer to the production of recommendations to be presented to a user, where these recommendations are useful to the user for the accomplishment of a task. This task might be related to navigation to web pages that interest the user, finding items to buy, explore learning resources or find people to socialize with or collaborate with. The types of recommendations are usually domain and task dependent and consequently context dependent. Specifically, recommendations systems can be identified as content-based, collaborative, or hybrid, depending on the basis of the filtering technique they use. In this section we describe the high level RS architecture and describe the several recommendation techniques that can be used for the development of a RS.

Functional Architecture of Recommender Systems

A recommender system consists of cyclic functioning procedures that are divided in the following four steps: *Data collection*, *data filtering*, *Rank the recommended items* and *Presentation of data*.

By the execution of the above-mentioned procedural steps a recommender system aims at two tasks.

Firstly, the production of recommendations and secondly to use the users feedback after the delivery of the recommendations to them, so the process can be repeated and produce new recommendations as it is depicted in Figure 1.

- Collection of Data:** The collection of data is directly correlated to the data model that is used within a software application. The data is usually defined based on the overall design of a software application and based on the contextual information that a software application collects and processed into further computations. The data model usually depends on the domain that a recommender system is built for and the methods of storage and representation of the data (e.g. relational databases or semantic web representation methods).
- Recommendation Filtering Techniques:** As mentioned above the recommendation filtering techniques depend on the type of data that a RS is processing and the type of recommendations it plans to produce. The recommendation filtering techniques are divided in three categories according to the type of data they use for the computation of recommendations as well as the computational algorithm methods they

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