Recommendation Systems

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INTRODUCTION

As e-commerce expands and Big Data becomes more widespread, a massive quantity of data becomes available, and the number of Internet users increases. On the other hand, users are finding it difficult to acquire the products they desire. In a great knowledge area, the challenge is to help users in discovering and selecting resources. Recommendation systems have recently been a popular topic for researchers. Several big companies, such as Amazon and Netflix (Paul et al., 2017) have adopted these systems. Recommender Systems explore users' preferences in order to supply them with items that best meet their needs.

According to Klašnja-Milićević et al. (2015), Recommender systems are software tools and algorithms that provide suggestions for items that a user could find useful. These systems leverage the dependence principle between user-based and item-based tasks to select the most relevant item (Aggarwal, 2016).

Recommender systems remain to be a significant business tool for both Internet users and service providers; on the one hand, they improve company's sales, profits, and revenues, while also reducing the price of discovery and adoption in an online shopping.

However, Recommender systems are not limited to marketing products but emerged to support the healthcare community for decision-making and predict healthiness. In order to make user recommendations, the Recommender systems collect efficiently simple and standard data from different data sources, such as user evaluations and suggestions. Data belongs to different types and are mainly related to the elements proposed and the users receive the appropriate recommendations. Moreover, Data can be more informational, for example, users or items descriptions or constraints, social relationships, and user's activities (Portugal et al., 2018).

In addition, with the explosion of the Web Services on the internet, such as YouTube, Amazon, eBay, and many others, Recommender systems are becoming increasingly important in our life. Recommender systems are now inevitable in our daily online trips, from e-commerce (suggest articles to buyers that may be of interest) to online advertising (suggest the proper contents to consumers based on their preferences).

Overall, recommender systems are becoming increasingly important in a variety of fields, most particularly healthcare. Here some examples:

- Movies: Netflix and Movielens
- E-commerce: Amazon.com
- Music: lastFM
- Tourism: Tripadvisor.com
- Youtube.com: video

DOI: 10.4018/978-1-7998-9220-5.ch169

Recently, in order to provide users with better recommendations, these systems have introduced Machine-Learning algorithms. However, given the large number of methods presented in the literature and the effectiveness of each approach, selecting an appropriate Machine-Learning algorithm for a Recommender system is challenging (Portugal et al., 2018).

Recommender systems are usually used to manage massive amounts of data and knowledge. Ontologies play a crucial role in knowledge representation, exchange, and reuse in these systems. Ontology-based recommenders are knowledge-based systems that employ ontologies to describe information about items and users in the recommendation process. Indeed, including ontological information in the recommendation process enriches the data with semantics and can overcome the limitations of conventional recommender systems.

According to recent studies (Chicaiza and Valdiviezo-Diaz, 2021), combining ontology domain information about users and items increases the accuracy and quality of suggestions while reducing the downsides of traditional recommender approaches like cold start and score dispersion. The ontology is useful for constructing user profiles with several dimensions, such as user comments, reviews, and ratings. Furthermore, the ontological model makes it easier to comprehend user preferences by representing them from several viewpoints.

Thus, the main contributions of this work are:

- First, we discuss the paradigms of the most popular recommender systems. We detail how they work, their conceptual model, and their strengths and shortcomings.
- Secondly, we present a state-of-art of the main proposals based on Machine-Learning algorithms and ontologies. In addition, we highlight the need to combine Machine-Learning algorithms and ontologies to provide accurate and efficient recommendations.
- Finally, we discuss and give an insight into the future research trends in this area of recommender systems and present a general solution including Machine-Learning algorithms and ontologies.

The remainder of this chapter is organized as follows. Section 2 gives a background about Recommender systems and their techniques. In Section 3, we discuss the challenges faced. In section 4 and 5, we review the basic concepts related to Ontologies and Machine-Learning. The literature review is described in Section 6. In section 7, we discuss how to evaluate a Recommender system. Finally, Section 8 gives a conclusion and points out future directions.

BACKGROUND

Before going into the details of this survey, let us examine some basic terms and ideas related to recommendation systems, machine learning and ontologies. We also discuss the reasons and motivations for introducing Ontologies and Machine-Learning algorithms to Recommender systems.

Overall, recommendation lists are generated based on various collected data, such as user preferences, item features, previous user-item interactions, and some other information. User profiles, item databases, a recommendation engine, and a ranking mechanism are all high-level components of every recommender system. Figure 1 depicts these components and their interrelationship.

Usually, a Recommender system includes two databases: “a database of user profiles and a database of items”. The two databases are interlinked in order to express the relationship between a user and an item. This relationship can be one of interest expressed (e.g., a “like”) or one of engagement (Chounta,