Knowledge-Based Recommendation Systems: A Survey

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ABSTRACT

Knowledge-Base Recommendation (or Recommender) Systems (KBRS) provide the user with advice about a decision to make or an action to take. KBRS rely on knowledge provided by human experts, encoded in the system and applied to input data, in order to generate recommendations. This survey overviews the main ideas characterizing a KBRS. Using a classification framework, the survey overviews KBRS components, user problems for which recommendations are given, knowledge content of the system, and the degree of automation in producing recommendations.

Keywords: Advice, Automation, Classification Framework, Decision-Making, Knowledge-Base System, Recommendation Problem, Recommendation System, User Profile

1. INTRODUCTION

In the past decade, recommendation technology has been a steadily growing domain of research, and a hot topic in the information technology industry. Various applications and domains—such as fraud detection, logistics, e-commerce, transport, environment, energy, health, leisure, etc.—have been benefitting from the use of Recommendation Systems (RS). Such systems help respond to the information overload, being able to provide the user with advice about a decision to make or an action to take, when there may be a great many options to consider. The recommendation, or the advice, is made on the basis of the user’s behavior and context, which renders the suggestion customized to the user’s requirements.

Several types of recommendation techniques exist today and many are already used in commercial applications. The most commonly used techniques can be classified in three categories: collaborative filtering techniques, content-based filtering techniques, and...
and hybrid systems (Adomavicius & Tuzhilin, 2005). These RS identify trends among a large number of users. The trends, identified on the basis of the users’ behaviors, are then used to classify new users. The resulting classification allows the generation of a recommendation under the hypothesis that users belonging to the same class will have and prefer a similar behavior. Companies like Amazon, Google and Facebook apply these types of recommendation algorithms in order to provide their users with books and movies, information sources and ads, and potential friends suggestions, respectively.

However, while the collaborative filtering technique, the content-based technique and the hybrid technique are popular means for the generation of recommendation, it does not mean they are the perfect. Indeed, they have a number of limitations: the new user problem, the new item problem, the grey sheep problem, limited content analysis, over-specialization, and data sparsity (Adomavicius & Tuzhilin, 2005; Martinez et al., 2008; Ramezani et al., 2008).

A Knowledge-Based Recommendation System (KBRS) distinguishes itself among the various types of RS by applying another technique to produce a recommendation. A KBRS generates recommendations on the basis of the domain knowledge. A user will get a recommendation based on his particular profile and the behavior of other users will not be taken into account at all, or when it is, it will not play a central role in determining the recommendation.

The KBRS can thus be used to address limitations of the common recommendation approaches. When using the knowledge-based approach, no large data set is necessary and the cold-start, new item and the grey sheep problem are thus avoided. Also, because the domain knowledge, on which are based the recommendations, is noise-free the recommendations are more reliable. The only limitation faced by the KBRS is the construction of the knowledge base, which usually is a complicated task that demands considerable domain knowledge, and expertise in knowledge representation.

In spite of the interest in knowledge-based recommendation systems, some questions about them remain unanswered. What are the components of a KBRS? Which features can such a system have? Which features must it have? Which steps are necessary for the design of a KBRS? How to analyze a KBRS? How to compare two KBRSs? How to systematically design a KBRS? The lack of answers to these questions motivated our work here.

The objective of this paper is to propose a classification framework for knowledge-based recommendations systems that distinguishes such systems on the basis of their features. The contributions of this research are twofold. Firstly, the framework aims at facilitating the analysis of existing KBRS. Secondly, the proposal of this paper is intended to facilitate the systematic design of new KBRS.

The rest of the paper is structured as follows. In Section 2, we discuss the most commonly used recommendation techniques and we introduce the elements composing the knowledge-based recommendation methodology. We examine several existing KBRS. Based on the related work, we look at the main steps necessary for the development of a knowledge-based recommendation system in Section 3. Next, we introduce the classification dimensions of our classification framework, followed by the application of our framework to the existing literature, in Section 4 and Section 5 respectively. We discuss the results of the framework application in Section 6. Finally, Section 7 concludes our paper.

2. BACKGROUND

In this Section, we will examine the most commonly used recommendation techniques in more detail; this is followed by a review of the literature on knowledge-based recommendation systems.

2.1. Common Recommendation Techniques

Collaborative Filtering is the most common technique for the recommendation of products to users. The first paper to appear on collaborative filtering dates back to the mid-1990s (Park
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