Multi-Criteria Recommender Systems: A Survey and a Method to Learn New User’s Profile

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ABSTRACT
A Recommender System (RS) works much better for users when it has more information. In Collaborative Filtering, where users’ preferences are expressed as ratings, the more ratings elicited, the more accurate the recommendations. New users present a big challenge for a RS, which has to providing content fitting their preferences. Generally speaking, such problems are tackled by applying Active Learning (AL) strategies that consist on a brief interview with the new user, during which she is asked to give feedback about a set selected items. This article presents a comprehensive study of the most important techniques used to handle this issue focusing on AL techniques. The authors then propose a novel item selection approach, based on Multi-Criteria ratings and a method of computing weights of criteria inspired by a multi-criteria decision making approach. This selection method is deployed to learn new users’ profiles, to identify the reasons behind which items are deemed to be relevant compared to the rest items in the dataset.

KEYWORDS
Active Learning, Bootstrap, Cold-Start Problem, Learning User’s Profile, Multi-Criteria Ratings, New User Problem, Preferences Elicitation

INTRODUCTION
Daily, people are forced to make quick decisions and answer questions like: “what movie can I see?”, “Which place should I visit?”, “What is the most appropriate product to me?” etc. With the immense amount of data which flows on the web, it becomes difficult and tiring more and more to find the right answer at the right moment. Lately, Recommender systems (RSs) (Hdioud et al., 2012) capture interest and became an important area of research, as they support users to discover potentially interesting items easily and quickly. They allow users to accede to a limited amount of well-filtered items -in a personalized way- that match with their preferences, instead of crawling thousands or hundreds of items until finding the adequate ones (Adomavicius et al., 2005). Therefore, RSs are usually classified into four main categories (Adomavicius & Tuzhilin, 2005): Content-based approaches, Collaborative Filtering (CF) approaches, Hybrid approaches and Knowledge-based recommenders. All of these approaches require the presence of a large amount of data about users’ preferences and items characteristics (Kalloori & Ricci, 2017). Hence, RSs need to acquire this necessary information to operate correctly and generate accurate recommendations. However, collecting this information isn’t obvious as it seems, since the performance of a RS depends mainly on the usefulness of the

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collected data. In this article we address this problem by focusing on an extension of CF RSs-Multi Criteria ones- and on techniques that are aimed at identifying what information about the user tastes, i.e. ratings, should be elicited by the system to generate more effective recommendations.

**New User Cold-Start Issue**

The CF approach suffers from a serious issue, namely cold-start which occurs when the RS fails to acquire enough ratings (Eckhardt, 2009; Sarwar et al., 2001). The lack of sufficient data about either users or items impacts negatively the quality of the generated recommendations and prevents the system to perform accurately. A study was conducted in (Golbandi et al., 2010; 2011) quantifying this point by ensuring that the quality of recommendation relies mainly on the quantity of information harvested from users about their preferred items. Generally, the cold-start problem has three typical situations: when a new RS is newly launched (new system), when the RS is unable to recommend new items to existing users (new item) or when new users’ preferences are unknown and the RS is unable to recommend them existing items (new user). Specifically, in this article, we address the new user cold-start problem which is among the most challenging and serious issues.

Generally, users come into RSs seeking for novel products and hoping to discover more interesting and serendipitous items. Furthermore, RSs are mainly conceived to please users and maximize their satisfaction in order to increase the number of sales leading to revenue growth. However, new users present a big deal for RSs that must be handled. The new user issue (Bobadilla et al., 2012; Hdioud et al., 2014; Lam et al., 2008) is raised at the arrival of a new user, whose profile is completely empty or contains just a few ratings; hence personalized recommendations can’t be delivered.

In order to solve this problem various approaches were proposed in the literature, a detailed survey of them is approached in section 2 dedicated to related works. More specifically, among of these approaches, we focus in our article on the Active Learning (AL), which has shown promising results in dealing with the cold start problem. The AL technique tackles the new-user issue from its roots, by implementing a ratings elicitation strategy (Christakopoulou et al., 2016) whose aim is identifying best items to be presented to a user at the sign-up stage in order to get back his ratings about them.

**Ratings Elicitation At Sign-Up Process**

Generally, RSs work much better for warm users -i.e. Active users who rate items and express their preferences very often- on which they have more information about. Since a RS is unable to recommend something for a user without any prior knowledge about him, generating satisfactory recommendations for new users is conditioned by a crucial step, which is learning profile (Rashid et al., 2002; 2008). During this step, it is very important to acquire useful and informative ratings that represent the real preferences of the user to improve the performance of the system.

Therefore, prior works aimed to tackle the lack of sufficient data on the new user’s profile by conducting a brief interview (sign-up process), during which the user is asked explicitly to give his feedback about a set of items. However, RSs deal often with large items catalogs, as well as their task isn’t limited only to providing recommendations for new users, but mainly on satisfying them with valuable and accurate recommendations. Hence, the necessity of selecting items to be presented during the new user sign-up (Haught et al., 2016; Clarke et al., 2016), with a great care. Nevertheless, the choice of these items is not formalized enough and almost of times still detached of the concerned new user. This leads to asking two main questions (Hdioud et al., 2014; Rashid et al., 2008): 1) How can a RS satisfy its new users in term of low-initial effort and high quality? 2) How will we profile rapidly the new users? A related problem of RS is the systemic bootstrapping problem. First of all, the RS has to ask feedback for well-known items that the new user has prior knowledge about; this
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