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Personalized Business to Business E-services using Tree-based Recommender System

Rishi Kumar N, Nanda Kumaru, Pandikumar K

Department of CSE, Dhanalakshmi College of Engineering, Chennai, Tamilnadu, India

ABSTRACT

Although recommender systems have been well studied, there are still two challenges in the development of a recommender system, particularly in real-world B2B e-services: 1) items or user profiles often present complicated tree structures in business applications, which cannot be handled by normal item similarity measures and 2) online users' preferences are often vague and fuzzy, and cannot be dealt with by existing recommendation methods. To handle both these challenges, this study first proposes a method for modelling fuzzy tree-structured user preferences, in which fuzzy set techniques are used to express user preferences. A recommendation approach to recommending tree-structured items is then developed. We make the user to give the selection about the recommendations actually the user will give set of items which he likes.so the recommender system will recommend the items user like. The key technique in this study is a comprehensive tree matching method, which can match two tree-structured data and identify their corresponding parts by considering all the information on tree structures, node attributes, and weights. Importantly, the proposed fuzzy preference tree-based recommendation approach is tested and validated using an Australian business dataset and the Movie Lens dataset. This study also applies the proposed recommendation approach to the development of a web-based business partner recommender system.

Keywords: e-services, Tree-Based Recommender System, B2B, Fuzzy Set, Smart Biz Seeker, RDBMS

I. INTRODUCTION

WITH the use of recommendation methods, recommender systems [1], [2], which are web-based support systems, actively suggest a set of limited and ranked items from all available items without the direct input of users. These systems are widely used to overcome the problems created by the so-called Manuscript received August 27, 2013; revised January 6, 2014; accepted March 11, 2014. Date of publication April 4, 2014; date of current version January 30, 2015. This work was supported in part by the Australian Research Council under discovery Grant DP110103733.The authors are with Decision Systems and e-Service Intelligence Laboratory, Centre for Quantum omputation & Intelligent Systems, Faculty of Engineering and Information Technology, University of Technology Sydney, Ultimo, NSW 2007, Australia (e-mail: Color versions of one or more of the figures in this paper are available onlineat Digital Object Identifier 10.1109/TFUZZ.2014.2315655"information explosion" in a variety of web-based applications in e-commerce [3], e-learning [4], and e-tourism, as well as in such areas as the recommendation of news, movies, books, videos, resource es [5], and real estate [6]. Prior to making a recommendation, recommender systems use background data, such as historical data consisting of ratings from users, and input data, such as features of items or user ratings, to initiate a recommendation; models and algorithms combine the two and generate a recommendation [7], [8].In real situations, the features of items and user behavior are often subjective, vague, and imprecise [8], and users' item preferences are frequently subjective and uncertain. It is difficult for a user to express his/her interest in an item with exact numbers. Fuzzy set theory and techniques lend themselves well to handling the fuzziness and uncertain issues in recommendation problems. User preferences

and item features have been represented as fuzzy sets in previous research [8]-[11], and recommendations to customers for the selection of the most suitable items are made with incomplete and uncertain information[12], [13]. Current research and recommender system applications focus mainly on making recommendations to personal users. Fuzzy user preference and item representations focus on vector representations accordingly. The abundance of information created and delivered via the Web provides excellent opportunities for the development of business-to-business (B2B) e-services, such as finding a business partner online [14]. Excessive amounts of information on the Web creates a severe information overload problem. An effective solution for this problem is the development of personalized recommender systems; however, recommendation techniques have been rarely used in the B2B environment. The main reason is that items or user profiles in a B2B environment are so complex that they can only be presented as complicated structures, such as tree structures. For example, a business in a B2B application environment may supply several product categories, each of which may contain a number of subcategories, under which there may be multiple specific products, which together form a tree structure. Therefore, tree-structured data modeling and tree matching methods are needed. However, an item is normally.

Described as a single value or a vector in current research, and tree-structured items or user profiles have not been considered to date. The fuzzy preferences models mentioned previously, which are represented as vectors, are not suitable to dealing with the tree-structured data in a Web-based B2B environment. To solve these challenges namely, tree-structured items (products/services), tree-structured user preferences, vague values of user preferences, and personalization of recommendations in B2B e-service recommendation problems, this study proposes a method for modeling fuzzy tree-structured user preferences, presents a tree matching method, and, based on the previous methods, develops an innovative fuzzy preference tree-based recommendation approach. The developed new approach has been implemented and applied in a business partner recommender system. This paper has three main contributions. From the theoretical aspect, a tree matching method, which comprehensively considers tree structures, node attributes, and weights, is developed. From the technical aspect, a fuzzy tree-structured user preference modeling method is developed, as well as a fuzzy preference tree-based recommendation approach for tree-structured items. From the practical aspect, the proposed methods/approaches are used to develop Web-based B2B recommender system software known as Smart Bessemer, with effective results. The remainder of the paper is organized as follows. In Section II, the related works in recommender systems, tree matching methods, and fuzzy set techniques are expatiated. Section III presents the fuzzy tree-structured preference model. Section IV proposes a comprehensive tree matching algorithm to identify the corresponding parts between two trees. The fuzzy preference tree construction algorithm is proposed in Section V.A fuzzy preference tree-based recommendation approach for tree-structured items is presented in Section VI. The approach has been tested using the Australian business dataset and Movie-Lens dataset. The experimental evaluations and results are given in Section VII. In Section VIII, the proposed recommendation approach is implemented in a recommender system software- Smart Bessemer-to help businesses find partners (suppliers or buyers). Finally, the conclusions and future study are given in Section IX.

II. METHODS AND MATERIAL

A. Network Architecture

The arrows in the figure represent the function call relations. As a Web-based online system, Smart Biz Seeker has a standard multitier architecture, which includes web browser, web server, and database server. The main components of the system are as follows. A database which stores all the business data in the system is designed and implemented in the Postgre SQL database server. The application in the web server contains three layers: the presentation layer, business logic layer, and data access layer. The presentation layer is responsible to generate the requested web pages and handling the user interface logic and events. The business logic layer realizes the business services and the core recommendation algorithm. The proposed recommendation approach is applied here for both the buyer and supplier recommendations. The data access layer deals with the data operations of the database.

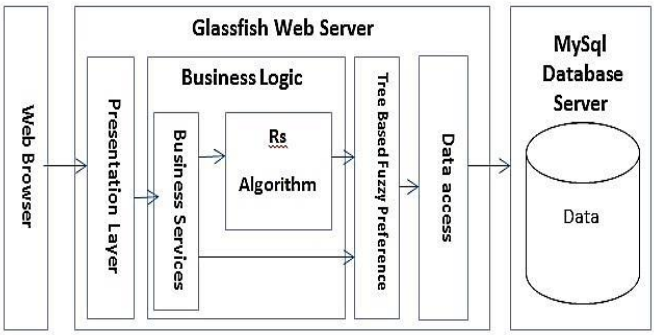

Figure 1. Architecture of A Fuzzy Preference Tree-Based Recommender System for Personalized Business-to-Business E-Services

1. Web browser: A web browser (commonly referred to as a browser) is a software application for retrieving, presenting, and traversing information resources on the World Wide Web. An information resource is identified by a Uniform Resource Identifier (URI/URL) and may be a web page, image, video or other piece of content.
2. The presentation layer is layer 6 of the 7-layer Open Systems Interconnection (OSI) model. It is used to present data to the application layer (layer 7) in an accurate, well-defined and standardized format. The presentation layer is sometimes called the syntax layer
3. In computer software, business logic or domain logic is the part of the program that encodes the real-world business rules that determine how data can be created, displayed, stored, and changed.
4. MySQL is an open source RDBMS that relies on SQL for processing the data in the database. MySQL provides APIs for the languages C, C++, Eiffel, Java, Perl, PHP and Python.
5. Glass Fish is an open-source application server project started by Sun Microsystems for the Java EE platform and now sponsored by Oracle Corporation. The supported version is called Oracle Glass Fish Server

B. Iii. Basicdefinitions

Definitions

Let *T*be a tree which represents an access structure. Every non leaf hub of the tree speaks tolimit entryway. On the off chance that numx is the quantity of youngsters hubof a node x and $k_x$is its threshold value,then, it will be $0 \leq k_x \leq num_x$. Each leaf node of the tree*T*is described by an attribute and a threshold value $k_x=1$. λ_x, denotes the key attribute associated with the leaf node in thetree.$\rho(x)$ represents the parent node of the node in the tree *T.*

The children of every node are numbered from 1 to num. The capacity index(x) returns such a number associated with the node. The index values are not commonly assigned to nodes in the access structure for a given key in an uninformed manner.

Let T_x be the subtree of tree *T* rooted at the node x . If a set of attributes γ satisfies the access tree T_x , we denote it as $T_x(\gamma)=1$. $T_x(\gamma)$has been recursively computed as shown below. If$x$is a nonleaf node of a tree, evaluate $T_x'(\gamma)$ for all children x' of node $x$then $T_x(\gamma)$ returns 1 if and only if at least k_x children return 1, if $x$is a leaf node, then $T_x(\gamma)$ returns 1 if and only if $\lambda_x \in \gamma$.

C. Proposed Scheme

This study proposes a method for modeling fuzzy tree-structured user preferences, presents a tree matching method, and, based on the previous methods, develops an innovative fuzzy preference tree-based recommendation approach. The developed new approach has been implemented and applied in a business partner recommender system.

This paper has three main contributions. From the theoretical aspect, a tree matching method, which comprehensively considers tree structures, node attributes, and weights, is developed. From the technical aspect, a fuzzy tree-structured user preference modeling method is developed, as well as a fuzzy preference tree-based recommendation approach for tree-structured items. From the practical aspect, the proposed methods/approaches are used to develop a Web-based B2B recommender system software known as Smart BizSeeker, with effective results.

User's Fuzzy Preferences

To make a recommendation to a user, the information about the user's preferences must be known. The modeling method for user's preferences is presented in this section. Information about user preferences can essentially be obtained in two different ways:

extensionally and intentionally. The extensionally expressed preference information refers to information that is based on the actions or past experiences of the user with respect to specific items. The intentionally expressed preference information refers to specifications by the user of what they desire in the items under consideration. In this paper, the user preference model covers both kinds of information. In the practice of recommender systems, a business user's preferences are usually complex and vague. It might be difficult to require a business user to express a crisp preference for an item or a feature of an item, and it is therefore difficult to represent the user's preferences with crisp numbers. In this study, fuzzy set techniques are used to describe users' complex and vague preferences.

User Profile Module

In this module, we collect user profile information such as Name, age, gender etc. To evaluate and propose our model we develop online movie recommender services. In this online movie recommender services consists of admin and User modules. Where the admin can upload the movies, with their details. Can view user details. Can delete the movies etc. User has to register first to access the recommendation model. After registering user gets access to the system, where all the movies information are updates.

User Ratings Module

Users' preferences or items' reputations are drifting, thus we have to deal with the dynamic nature of data to enhance the precision of recommendation algorithms, and recent ratings and remote ratings should have different weights in the prediction.

So we propose a set of dynamic features to describe users' multi-phase preferences in consideration of computation, flexibility and accuracy. It is impossible to learn weights of all ratings for each user, but it is possible to learn the general weights of ratings in the user's different phases of interest if the phases include ranges of time that are long enough. In this module, user can rate to the movies by clicking the movie which they interested.

Similarity Computation Module

Users' preferences or items' reputations are drifting, thus we have to deal with the dynamic nature of data to enhance the precision of recommendation algorithms, and recent ratings and remote ratings should have different weights in the prediction.

For the sparsity of recommendation data, the main difficulty of capturing users' dynamic preferences is the lack of useful information, which may come from three sources - user profiles, item profiles and historical rating records. Traditional algorithms heavily rely on the co-rate relation (to the same item by different users or to different items by the same user), which is rare when the data is sparse. Useful ratings are discovered using the co-rate relation, which is simple, intuitional and physically significant when we go one or two steps along, but it strongly limits the amount of data used in each prediction.

Fuzzy Preference Recommendation Module

More information can be used for recommender systems by investigating the similar relation among related user profile and item content. We proposed a novel dynamic personalized recommendation algorithm for sparse data, in which more rating data is utilized in one prediction by involving more neighboring ratings through each attribute in user and item profiles. A set of dynamic features are designed to describe the preference information based on fuzzy preference recommendation technique, and finally a recommendation is made by adaptively weighting the features using information in multiple phases of interest.

III. CONCLUSION

This paper proposes a fuzzy tree structured user preference modeling method by separating the uncertainty and develops a new recommendation approach using users extensionally and intentionally expressed preferences. we are separate users based on the login credentials for example we got the age from the Login details and then we are recommending age based solutions. The data collection is collected from the real time scenario in order to achieve a better matching method for identifying the corresponding parts in the database. It takes the user similarities from the

feedbacks and sharing of recommendation on the social rating as a main source. By using this valid detail an efficient user preference is modelled and computed in a Fuzzy to achieve an overall structured tree. The experimental result according to the real-time data proves the improvisation of the proposed system is far better than the existing system. The future worked is carried in the motto of achieving an efficient method in identifying business groups and make group recommendations with similar features and characteristics.

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