The Recommendation Systems: Types, Domains and the Ability Usage in Learning Management System

JAMIL AHMAD ITMAZI* and MIGUEL GEA MEGÍAS**

*Faculty of IT, Palestine Polytechnic University, Hebron, Palestine
Jamil.de.palestina@gmail.com

**Faculty of Info. ETSI, University of Granada, Granada 18071, Spain
mgea@ugr.es

ABSTRACT

Recommendation Systems (RS) have been widely used in many Internet activities and their importance is increasing due to the "Information Overload" problem arising from Internet. This paper describes the current usage domains of RS, giving a background, and some examples of systems used in every domain. In addition, it presents the different approaches for RS, giving a background and some examples of systems that use one of these approaches. Furthermore the paper discuss the ability of using RS in Learning Management Systems (LMS) to support students' needs and preferences, explore the LMS fields which may use RS, discuss the suitability of every RS approach to recommend Learning objects and finally state the suitable approach/es as well as designing a proposal structure of RS in LMS. This paper aims to highlight the importance of RS in the scope of eLearning and the ability to use it in LMS.

Keywords: *Recommendation systems, learning management systems, course management system, eLearning platform*

1. INTRODUCTION

Last decade, RSs have been widely implemented and accepted in many sectors of Internet. We are familiar with recommendations of products (e.g. books, music, movies) and of services (e.g. restaurants, hotels, Web sites), likewise "recommendation is not a new phenomenon arising from the digital era, but an existing social behaviour in real life" [27]. In everyday life, we rely on recommendations from others.

More and more information is available electronically; moreover, the World Wide Web is still growing faster; as a result, the users suffer from the "Information Overload" problem, when searching on Internet. For example, when we search AMAZON.COM, to find an object, sometimes we found thousands of results.

The aim of RSs in Web applications, is presenting interest information that fits the users tastes and preferences with little effort. In contrast, some times RSs are used to hide special information!

From the view of eLearning, RSs are listing "the closest available learning objects to what the instructor describes as the module's content" [4]. Historically, the first RS was the Tapestry which coming out in 1992 from Xerox PARC [11], then a variety of techniques and technologies of RS have been produced and introduced.

We agree that some of RS activities are part of IRS (Information Retrieval System) techniques with special characters. In addition, "Personalization" is an RS related concept, aims at optimizing the presented information to the user's needs.

2. CURRENT USAGE OF RS

RSs have been widely used in many Internet activities and it is worth mentioning some examples of the current actual uses of RS. However, we will mention some main sectors that use one or more techniques of RS.

2.1 E-COMMERCE

The e-commerce becomes an important media to exchange products and services. Within e-commerce sites, buying and selling things between client and trader is easy, suitable and comfortable, especially in our e-societies age. But the growth of e-commerce sites caused the product information overload; however, RSs are used to solve this problem and are used "to suggest products to their customers and provide consumers with information to help them decide which products to purchase. There are more and more e-commerce businesses that use one or more variations of RSs technologies in their Web sites" [5]:8.

Examples of e-commerce sites which used RS: Amazon.com, barnesnoble.com and CdNow.com.

2.2 WEB PAGES

Researchers used RS effectively with this sector to solve the "overload problem" in the Internet, which becomes very clear while using search engines (e.g. Google, Yahoo) which produce thousands of pages to one researched item, most of them have worthless relation to the researched item or of no interest to the user.

Example of search engines which used RS:

- Mi Yahoo! <http://my.yahoo.com>,
- Google <www.google.com/preferences>

2.3 NEWS (AND E-MAIL MESSAGES)

"Almost all portals provide access to news and also many companies provide specialized news services, usually related to their commercial fields or to the interests of their customers. The primary goal of these

services is to attract Web surfers and to gain their loyalty" [1].

Here are some examples of news recommenders:

- Net perceptions <www.netperceptions.com>,
- GroupLens <www.cs.umn.edu/Research/>,
- Le Monde newspaper <www.lemonde.fr>.

2.4 DIGITAL LIBRARY

The DL (Digital Library) "is a library without walls and without paper" [6]. In general, while the traditional library is a collection of books, documents, and materials; the DL is a collection of these materials on an electronic form.

In fact, using RS is a new issue to library; however, here some DL using RS:

- eLibraryHub <www.elibraryhub.com>,
- Fab, part of the Stanford DL project [2],
- The DL Project of the University of California <http://elib.cs.berkeley.edu>.

2.5 CENSORSHIP SYSTEMS

RSs are used in the sector of the protection, mainly, at the following domains:

- Kids and children protection from accessing undesirable material on the internet. Example of such system: Cyberpatrol.com.
- Prevent the citizens from exploring some Web sites; which some governments already did due to many reasons!, [21].

3. RECOMMENDERS TYPES

RSs are consisting of many approaches (techniques, modes or methods), every type of those methods has its advantages/disadvantages, where some of them are suitable to some domain while others are suitable to other domains. Several main approaches will be discussed at the following.

3.1 CONTENT-BASED SYSTEM (CBS)

In this type, the objects are selected by having correlation between the content of the objects and the user's preferences. Objects or their attributes must be of some machine parsable form [25], also "by detecting similarities between content of items that the user rated positively, these systems suggest other items that are unknown to this user, but share the same content" [9].

Examples: Infofilter [8] and InfoFinder <http://infofinder.cgiar.org>.

Shortcomings:

- It could be used only with textual items [2].
- Users can see only content essence they have seen before [23]:2.
- It is difficult to be applied on the items that cannot be decomposed.

3.2 Collaborative Filtering Systems (CFS)

It recommends items or objects to a target user, based on similar users' preferences, and on the opinions of other users with similar tastes. It computes the similarity between the target user preference and the one of other users. It "employs statistical techniques to find a set of users known as neighbors, who are on similar behaviors in purchasing to the target user. Once a neighborhood of users is formed, these systems generate recommendation" [23]:2.

Examples: Amazon.com and ebay.com.

Shortcomings:

- No way to recommend new items [23]:2.
- It needs a large number of people to express their preferences about a large number of options [14]:36-41.
- A user with few ratings is difficult to categorize.

3.3 Economic Filtering System (EFS)

The information is filtered upon cost factors. Such factors can be the relation between cost and benefit of use, or the available network bandwidth and size of the objects [25]. It moves the focus of filtering from the receivers to the senders.

In general, this approach considers information, somehow, as goods, because it selects data objects (news, articles, documents…) based on some computation of cost-benefit to the user through some explicit or implicit pricing mechanisms.

Examples: EFS is scarcely used in existing systems; it has seen little practical application until now [25]; [18]:10, however we find few examples that used some kind of this approach:

- An approach found in [10], a bout applying the idea of authors to Usenet news,
- Its usage in context of DL in thesis of [7]:45.

Shortcomings:

- It needs a limited resource related to user interest [7].
- It focuses on the limitations of the user [7]:29.
- The problem of how to estimate the value of the information.

3.4 DEMOGRAPHIC-BASED SYSTEM (DBS)

It uses "prior knowledge on demographic information about the users and their opinions for the recommended items as basis for recommendations" [18]:10. It aims to categorize the user based on personal explicit attributes and make recommendations based on demographic group that a user belongs to, such as (income group, age group, occupation kinds, learning level, or geographical region), or a combination of these clusters/groups.

Examples:

- Grundy, a book RS, where people's descriptions of themselves were used to build a user model and then predict characteristics of books [19],
- Free e-mail suppliers put advertisements based on the user demographic information, such as RS used in Hotmail and Yahoo.

Shortcomings:

- It is difficult to collect personal information.
- It is a non-anonymous, thus brings up privacy issues [13]:30.

3.5 RULE-BASED FILTERING (RBF)

It is filtering information according to set of rules expressing the information filtering policy [26]. These rules may be part of the user or the system profile contents and it may refer to various attributes of the data items. In general, this system could be used widely with:

- Censorship: RBF is useful in the protection domain e.g. the protection of kids from accessing some materials.
- Spam Filtering: RBF is useful to be a method undertaken on each e-mail to judge the likelihood that it is Spam [24].

Examples of Spam filtering systems used RBF: Spam Assassin < spamassassin.apache.org/>, MailEssentials <www.gfi.com> and Information lens, (e-mail message filtering system which relies primarily on the Content-Based approach and uses Rule-Based approach) [16].

Examples of Censorship Systems used RBF: Cyberpatrol.com and.cybersitter.com,

Examples of other systems used RBF: Systems that used customizes and personalizes Web sites, e.g. Yahoo! and Msn.

Shortcomings:

- It requires a large set of rules [26].
- It needs items capable to extraction methods.

3.6 HYBRID RECOMMENDER SYSTEM (HRS)

"HRS combines two or more recommendation techniques to gain better performance with fewer of the drawbacks of any individual one" [20]. In fact most of the exiting HRSs are consist of CBS and CFS.

Examples of systems mixed CBS and CFS: Tapestry [11], Fab, it suggests relevant URLs to users by combining users' ratings and Web pages' similarities [2] and Quickstep, it supports Web page recommendation [17].

Examples of systems mixed other approaches: A hybrid algorithm system presented by the authors of [28], which it combines the CFS with demographic information and Information lens, which combines CBS with RBF [16].

4. RS AND ELEARNING

eLearning somehow is a new field to apply RS, which may be used to recommend the most appropriate content to students and may be used in students registration.

In this paper, the focus will be at the use of RS in LMS or CMS (Course Management System).

4.1 LEARNING MANAGEMENT SYSTEM

The LMS/CMS is an eLearning platform which is considered as an important part of eLearning solutions from the university's viewpoint [12]. Moreover, there are some concepts similar to LMS (some of them with a small difference), e.g. CMS, LCMS (Learning Content Management System), Portal Learning and platform of eLearning.

Any way, LMS is software that automates the administration of training events. "All LMSs manage the log-in of registered users, manage course catalogs, track learner activities and results, and provide reports to management. An LMS may or may not include additional functions such as: Authoring of content, Management of classroom training, instructors and resources…collaboration tools (chat, discussion groups, etc.)" [3].

The market of LMS is increasing very fast, and there are more than 70 vendors; some of LMSs are commercial Software, while others are free Open-Source LMSs. The following list shows some LMSs:

Commercial Software:

- WebCT <www.WebCT.com>
- eCollege <www.ecollege.com>
- Blackboard <www.blackboard.com>

Open-Source Software:

- MOODLE <http://moodle.org>
- ILIAS <www.ilias.de/ios/index-e.html>
- Claroline <www.claroline.net>

4.2 THE ABILITY TO USE RS

RS could be use in LMS because the reasons and motivations of using RS on other sectors are present in LMS. The reasons and motivations are the following:

- LMS is an adaptive system, which could give personal ambient fits and facilitates the students' needs.
- LMS is an interactive and interaction system, which tries to give its users their references and needs by using user modeling.
- Typical LMS, which contains thousands of courses, needs RS to overcome the information overload problem.
- Feedbacks to leverage enhance and improving those sites upon the users needs, preferences, and opinions.

Some researchers mentioned the abilities and necessities of using RS in eLearning systems in general and LMS in particular. Here some examples of those researchers (authors of the following):

- [22], they proposed the recommending of learning content based on the expert learning object knowledge base and personal learning progress.
- [4], he presented the RS as an important feature within the Intelligent LMS.
- [14], they proposed a framework for individualized learning object selection. This framework selects a short list of suitable learning objects appropriate for the learner and the learning context.
- [15], he presented a framework of personalized eLearning material recommender system and discusses related technology.
- [12], they encouraged using RS at open source LMS.

4.3 FIELDS WHICH COULD USE RS

The typical place of LMS is the university environment that means any education center that give a normal or open learning, have registered students and give planed classes/courses, e.g. normal and open universities, institutes, colleges, high schools…etc. The fields of LMS which could use RS are:

- **Learning objects (content) recommendations:**

Within this field, RS is recommending the closest learning objects (e.g. material, content, homework) to students. It helps the student to find useful resources near or similar to their class. "This feature (RS) would allow iLMS to recommend the most appropriate content to students…the RS may list the closest available learning objects to what the instructor describes as the module's content" [4]. Also [22]; [15] discussed some kind of Learning objects recommendations.

- **Learning subjects (or courses) recommendations**

This kind of RS is recommending subjects or courses to help student in the registration. To do that, the education center needs to have a database of the following:

- The academic students' information, their progress and personal information,
- The subjects' information, their considerations, requests and availabilities.

- **Teacher/Tutor recommendations**

In large universities, RS could be used to assign teacher, tutor or supervisor to a student in case of many teachers' gives similar subjects. To implement that, the education center needs to have a database of the following:

- All the information of registration,
- All the subjects' information,
- All the necessary information about the teachers and tutors,
- The laboratories information.

- **On-line library resources recommendations**

Most of the universities have an online Library system to manage their books, magazines and other resources, so their students can search, review and some times download its electronic material learning objects. To implement RS in library systems within LMS, it needs that the university:

- Has online library,
- Develops method to integrate the LMS with the library system,
- Gives the LMS the ability to access the library database to find books and resources fit the students' needs and necessities.

4.4 THE CHOSEN FIELD TO STUDY

This paper tends to discuss the ability to use one field from the four previous ones of LMS which could use RS because the limited space of this paper. Three fields of them need to be integrated with other systems in order to work, specifically field of:

- Learning subjects/courses recommendations needs automate registration system.
- Teacher/tutor recommendations needs an automate registration system as well as automate employee system.
- On-line Library resources recommendations need an online library system.

Thus, to implement any one of them, the university needs to have more than LMS, while the implementation of the field (learning objects recommendations) do not need more than LMS itself, so if the university already using LMS, we could implement this field based on the database of the LMS.

We chose this field to study, as RS in LMS, because it only needs an algorithm to work with the LMS.

4.5 BENEFITS OF INTRODUCING RS IN LMS:

- Overcoming the information overload problem when searching on a LMS which contains thousands of courses.
- Presenting useful information to a student.
- Giving personal ambient fits and facilitates the students' needs and references.
- Giving feedbacks to leverage enhance and improving LMSs.
- Allowing the user to filter the incoming information.

5. THE SUITABILITY OF RS APPROACHES

After reviewing the characters of LMS and the approaches of RS, we are going to study the suitability of every RS approach to recommend learning objects:

5.1 CONTENT-BASED SYSTEM (CBS)

The CBS can be used within LMS to recommend objects learning, alone or as a primer approach with other, due to the flowing:

- The ability to make correlation between the content of the objects and the user's preferences.
- The Learning objects content (or its assigned data) is machine parsable form.
- Every user (student) has a profile which contains his data.

There are some CBS implementation methods; the suitable one here is finding relationships between user/ group preferences and objects attributes; or detecting similarities between the current learning objects and other learning objects. These attributes include name, keywords, abstract …etc.

Discussing the main shortcomings

Previously, we mentioned the general shortcomings of a pure CBS. Here we discuss those shortcomings when implementing them to recommend learning object in LMS:

- Problem of {the textual items}, does not exist here because the learning object is already a machine parsable form.
- Problem of which {the users can see only content essence that they have seen before}, does not exist with the last implementation method.

– Problem of {the decomposition}, does not exist here because the learning object could be decomposed into content elements.

5.2 COLLABORATIVE FILTERING SYSTEMS (CFS)

CFS can be used to recommend learning objects in LMS, due to the flowing:

– Large registered students could be found in one university.
– The students have the ability to rate the LMS resources.
– The ability to form groups as “nearest neighbours”; whose preferences are similar to the preferences of the student who seeks advice.
– The ability to calculate the average of the group preferences.

CFS has some methods to calculate the likeliness from the rating matrix, the suitable one here named as Memory-Based Algorithm (also known as k-Nearest Neighbour Method), which is suitable to environments where the user preferences have to update rapidly or frequently, however it is convenient in LMS environments.

Discussing the main shortcomings

The following shortcomings could be appearing when the CFS used lonely. Here, the discussion will be from the LMS view:

– Problem of {new items} exists and it is the most critical restriction of CFS when it could not possible to recommend learning object without information (votes or preferences).
– Problem of {sparsity} exists because the system only becomes useful after a collection of "critical mass" of opinions.
– Problem of {new User}. This problem could be overcome because the student can get the other courses which are similar to his current course.

5.3 ECONOMIC FILTERING SYSTEM (EFS)

Truly, EFS is not a preferable system to be used in LMS due to the following reasons:

– It treats the information as goods and this is against the universities policies.
– Normally, the filtering process is requested from the receivers (the students) while the EFS let the senders put the filtration.
– The current available Internet bandwidth is sufficient to access successfully a typical LMS.
– It does not focus on the need of the student but on the limitations of the student.

5.4 DEMOGRAPHIC-BASED SYSTEM (DBS)

DBS can be used to recommend learning objects in LMS, but not alone, because it is insufficient to implement comprehensive RS.

Discussing the main shortcomings

– Problem of {personal information collection}, does not exist here because the students already registered in the LMS.
– Problem of {privacy issues}, does not exist here because the students is already registered in the university as well as in its LMS.

5.5 RULE-BASED FILTERING (RBF)

This system could be used beside another RS method to recommend learning objects by filtering the incoming “recommendations” from the others RS. It compares them to set of common rules (rules from system profile) and then to set of rules of the users (rules from user profile).

Discussing the main shortcomings

– Problem of {the large set of rules}, dose not exist here because RBF is not used here alone.
– Problem of {the extraction methods}, dose not exist here because the learning object is capable of extraction.

5.6 HYBRID RECOMMENDER SYSTEM (HRS)

Now, it is clear that the suitable RS approach to recommend learning objects in LMS will not be a pure one, but it will be a system which mixed some of the previous approaches; it is the an HRS, which consists mainly from CBS and partly from CFS, EFS and RBS.

6. A GENERAL RS PROPOSAL

As we stated above, the suitable RS approach to recommend learning objects in LMS will not be a pure one, but it will be a HRS which mixed some of the previous approaches.

6.1 THE PROPOSAL STRUCTURE

Figure 1 shows a general RS structure to be used in LMS to recommend learning objects.

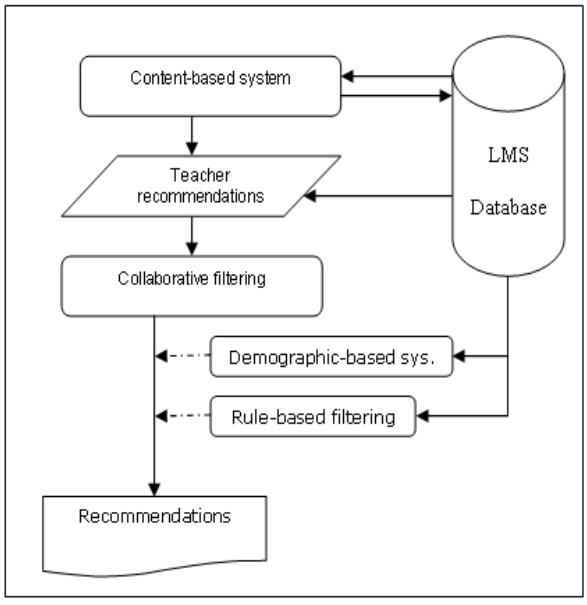

Figure 1: a general proposal structure of RS-LMS

6.2 Approaches consideration

- CBS was used as a primer approach because it can give comprehensive, related and sufficient recommendations by using the objects attributes in the recommendation process.
- CFS was not used as a primer approach because this approach is still suffering from “new object” problem and becomes useful only after a "critical mass" of opinions, which means less numbers of recommendations or null recommendations.
- DBS and RBF were used as complementary approaches, because the demographic information

6.3 Proposal Explanations

- At the first stage, the CBS which was used as the primer approach checks the objects attributes and retrieves the related learning objects from the LMS database.
- Then, the teacher recommendations stage retrieves the recommendations which have been saved by the course supervisor at the LMS database .
- In the stage of the CFS, which was used as a complementary approach, it filters or organizes the priorities of the recommendations upon the students rating.
- In the filtration stage (DBS and RBS), the system filters the previous recommendations upon the following criteria:
  * The system rules which could be founded in the system profile.
  * The student rules which could be founded in the student profile.
- The demographic information of the students which could be founded in the student profile.
- Finally, the recommendations are prepared to be displayed in a suitable way at suitable place of the course screen.

7. CONCLUSION

RSs have been widely used in many Internet activities, mainly to overcome the information overload problem and to achieve many other goals. Some of those activities are related to e-commerce sites, searching Web pages, news portal, digital library and censorship systems. In addition, there are some researches about using RS in some eLearning solutions like LMS.

In fact, RSs are consisting of some approaches; Content-Based System, Collaborative Filtering, Economic Filtering, Rule-Based Filtering, Demographic-Based System and Hybrid Recommender System.

After studied the suitability of RS approaches to be used to recommend learning objects and materials in LMS, the suitable approach is the Hybrid Recommender System which mainly consist of Content-Based System and partially of Collaborative Filtering, Rule-Based Filtering and Demographic-Based System.

ACKNOWLEDGEMENT

This research was implemented at Granada University under the supervision of Dr. M. Gea.

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