Using Recommendation Systems in Course Management Systems to Recommend Learning Objects

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Abstract: *Recommendation systems have been widely used in many internet activities and their importance is increasing due to the information overload problem arising from internet. This paper gives background and some example of the RS current usage domains, the different recommendation systems approaches. In addition, the paper discusses the recommendation systems ability using in the learning management systems / course management system to support students' needs, as well as it discusses the suitability of every recommendation systems approach to recommend learning objects, finally it presents a design of a proposal structure of recommendation systems in learning management systems which could be recommend a suitable learning objects (e.g., courses) to students from a big list of those learning objects.*

Keywords: *Recommendation systems, learning management systems, course management system, e-learning platform.*

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1. Introduction

Last decade, Recommendation Systems (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" [17]. In everyday life, we rely on recommendations from others.

More and more information is available electronically; moreover, the World Wide Web (WWW) is still growing faster; as a result, the users suffer from the "Information Overload" problem, when searching on internet.

Generally, 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, and specifically, the aim of RSs in e-learning applications (e.g., Learning Management Systems (LMS)) is listing "the closest available learning objects to what the instructor describes as the module's content" [3].

2. Current Usage of Recommendation Systems

RSs have been widely used in many internet activities and it is worth mentioning some examples of the current actual uses of RS.

2.1. e-Commerce

e-Commerce becomes an important media to exchange products and services and they use RSs "to suggest products to their customers and provide consumers with information to help them decide which products to purchase" [4], for example Amazon.com and barnesnoble.com.

2.2. WebP ages

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. For example: My Yahoo! http://my.yahoo.com and Alexa.com, is a search engine which uses RS.

2.3. Censorship Systems

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

- Children protection from accessing undesirable material on the internet. e.g., cyberpatrol.com.
- Prevent the citizens from exploring some web sites, which some governments already did.

2.4. Other Sectors

Examples:

- News: e.g. <www.lemonde.fr>
- Encyclopedia: e.g. <http://en.wikipedia.org>
- Software: e.g. <www.download.com>
- Stores: e.g. <www.drugstore.com>
- Tourist information: e.g. <www.viamichelin.com>
- Digital library: e.g. <www.elibraryhub.com>.

3. RS and e-Learning

e-learning somehow is a new field to apply RS, which may be used to recommend the most appropriate content to students. In this paper, the focus will be at the use of RS in LMS or CMS.

3.1. Learning Management System

The LMS/CMS is an e-learning platform which is considered as an important part of e-learning solutions from the university's viewpoint [7]. Moreover, there are some concepts similar to LMS (with a small difference), e.g., Learning Content Management System (LCMS) and portal learning.

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" [2].

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 LMS: e.g., WebCT <www.WebCT.com> and eCollege <www.ecollege.com>.
- Open-Source LMS: e.g., MOODLE<http://moodle.org> and ILIAS <www.ilias.de>.

3.2. The Ability to Use RS in LMS

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

- LMS is an adaptive system, which could give personal ambient fits the students' needs.
- LMS is an interactive and interaction system.
- Typical LMS, which contains thousands of courses, suffers from the information overload problem.
- Some researchers mentioned the abilities and necessities of using RS in e-learning systems in general and LMS in particular. For example:
  - [3] presented the RS as an important feature within the Intelligent LMS.
  - [1] presented a project of three Italian universities, which aims to integrate a multi-agent RS that suggests educational resources to students into a mobile learning platform in a university context.
  - [9] 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.
  - [10] presented a framework of personalized e-learning material recommender system and discuss related technology.
  - [7] Encouraged using RS at open source LMS.

4. The Suitability of RS Approaches

Actually, RSs are consisting of approaches (techniques); every approach has its advantages/disadvantages. However, there are many systems used Hybrid Recommender System (HRS), which combines two or more recommendation techniques to gain better performance. Here, we are going to study the suitability of the main RS approaches to recommend learning objects:

4.1. 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. Examples: Infofilter [5] and InfoFinder <http://infofinder.cgiar.org>.

In the case of LMS, CBS can be used within LMS to recommend objects learning, as a primer approach by detecting similarities between the current course attributes (name, keywords, abstract …etc.) and the other courses.

4.2. 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 employs statistical techniques to find a set of users known as neighbours to the target user [15], examples: Amazon.com and ebay.com.

CFS has some methods to calculate the likeliness from the rating matrix, the suitable one to our RS of LMS 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.

4.3. 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" [12]. 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, age, 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 that they would enjoy [13] and the free e-mail suppliers put advertisements based on the user demographic information, such as RS used in Hotmail and Yahoo.

The DBS could be used in the process of recommending learning objects as a complementary approach.

4.4. Rule Based Filtering (RBF)

It is filtering information according to set of rules expressing the information filtering policy [16]. 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 used widely with:

- Censorship: RBF is useful in the protection domain e.g. the protection of kids from accessing some materials, e.g. Cyberpatrol.com and Cybersitter.com.
- Spam Filtering: RBF is useful to be used against the Spam e-mails, e.g. Spam Assassin <spamassassin.apache.org/> and MailEssentials <www.gfi.com>.

In RS of LMS, RBF could be used to filter the recommendations list of learning objects upon some system rules and users' rules.

4.5. Hybrid Recommender System (HRS)

"HRS combines two or more recommendation techniques to gain better performance with fewer of the drawbacks of any individual one" [14]. Examples of systems: Tapestry [6], which mixed CBS and CFS, hybrid algorithm system [18] which mixed CFS and DBS, and information lens, which combines the CBS with the RBF [11].

5. A General RS Proposal

The suitable RS approach to recommend learning objects in LMS will not be a pure one [8], but it will be a HRS which mixed some of the previous approaches. We suggest the following general RS structure to be used in LMS to recommend learning objects (see Figure 1).

We list some consideration of this proposal structure:

- 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 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 of DBS and the rules of RBF are not useful to be a primer approach.
- The recommendations will be displayed at the course screen when the student enters his course.

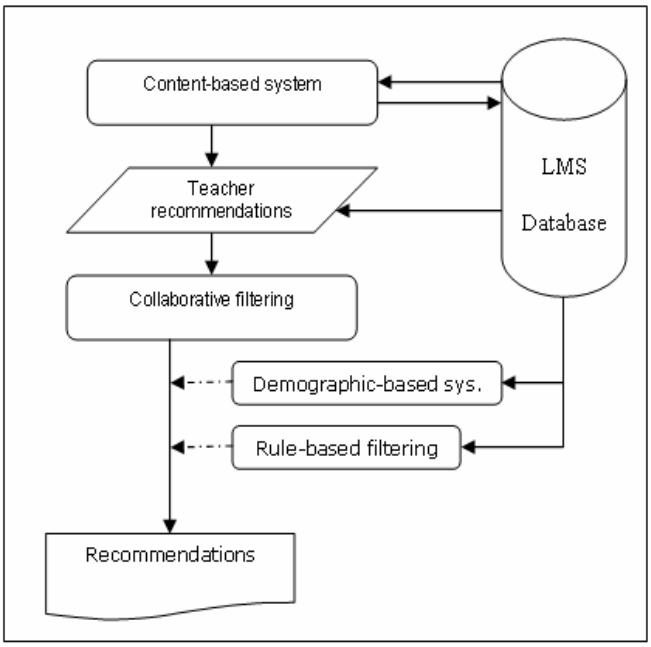

Figure 1. A general proposal structure of RS in LMS.

5.1. The Content-Based System

In this stage, the courses are selected by detecting similarities between the items of current course (the active course which the student already enters) and the items of other courses. These course items include: name, keywords, abstract, etc. So, at the first stage, the CBS retrieves the related course from the LMS database.

The general steps of the CBS (see Figure 2) are:

- Getting the current course attributes (ID, Name, Keywords and Abstract).
- Reading other course attributes from the LMS Database, (ID, Name, Keywords and Abstract).
- Making the attributes comparison between the current course and the other.
- Putting the name of a course at the recommendation list if it is related to the current course.
- Finally, the "recommended courses" are passed to the next stage.

5.2. The Teacher Recommendations

The "teacher recommendations" are the resources which the teacher put them in his course as recommended resources. They could be internal resources (courses from the same LMS) or external resources. However, the algorithm filtered the resources to allow only to the internal courses to be added to the recommendation list.

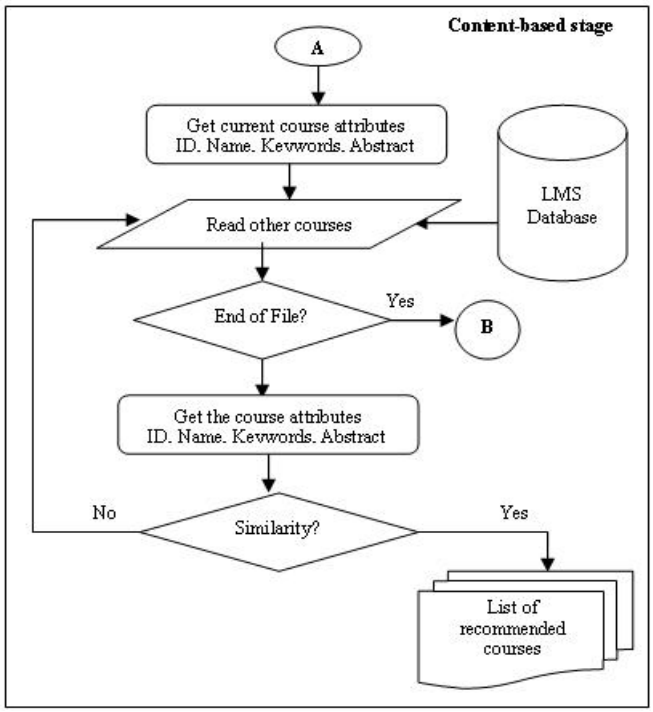

Figure 2. The general steps of the CBS stage.

The general steps of the "teacher recommendations" stage (see Figure 3) are:

- Receiving the list of the recommended courses from the previous stage.
- Reading the (teacher recommendations) resources from the LMS database.
- Choosing the "Internal Courses" from these resources and give them high priorities.
- Deleting the duplicate recommendations of low priorities.
- Finally, adding the chosen resources to the "recommended courses" from the previous stage and passing all of them to the next stage.

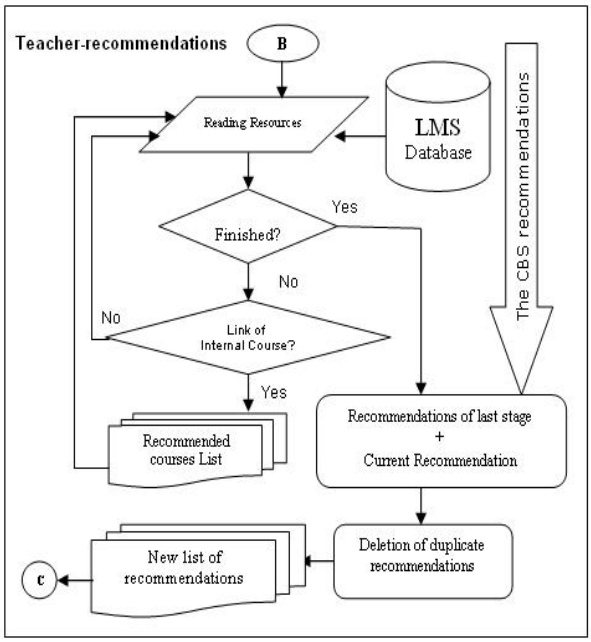

Figure 3.The general steps of the teacher recommendations stage.

5.3. The Collaborative Filtering

We use CFS as a complementary approach to organize the priorities of the recommendations. The general mechanism of CFS based on defining subgroups (every subgroup known as the nearest neighbours) whose preferences are similar to the active user, so the nearest neighbours of the active student are those students who share the same institute (department, school). Then this stage calculates the average of the subgroups rating to order the recommendations upon the high rates.

The target LMS, must have a way to capture the rating by explicit, implicit methods or mixed of both. These students' rates of the courses save in the LMS database as a table of two dimension matrix; where the row represents all the rates of one student on all courses while the column represents all the rates of all students on one course (see Table 1).

Table 1. Rating matrix.

Course / Student	C1	C2	…	Cm
S1				2
S2	5	3	3	
…			3	5
Sn	3		5	

The general steps of this stage are as the following (see Figure 4):

- Receiving the list of the recommended course from the previous stage.
- Finding the neighbours of the active student.
- Finding the average rates of the neighbours for every one of the recommend courses.
- Organizing the recommendations upon the highest average; firstly, organizing the set of the "teacher recommendations" which already have the higher priorities then organizing the other recommendations set which came from CBS stage.
- Finally, the "recommended courses" are passed to the next stage.

5.4. The Demographic-Based Filtering

Theoretically, the role of DBF in a LMS is to filter the incoming recommendations from the previous stage upon the students' demographic (and personal) data that related to education issues. For example, the following demographic-personal data could be related to the education issues: preferred language, student specialization, study level year and faculty and department. For example, the language filtration mean that the active student needs all the recommendations courses in his preferred language, so any language course defer from his preferred language will be filtered.

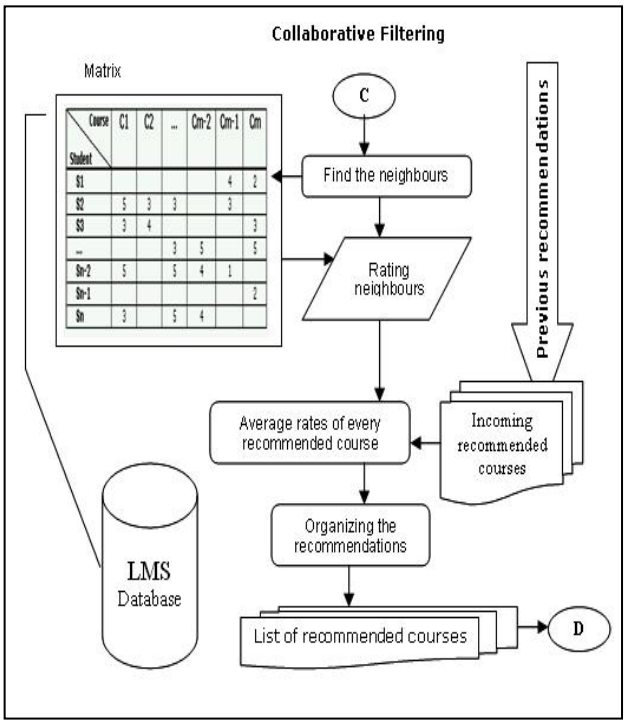

Figure 4. The general steps of the CFS stage.

DBF could be work as follow, (see Figure 5):

- Receiving the list of the recommended courses from the previous stage.
- Reading the related demographic and personal data of the active student profile.
- Matching the related fields of every incoming course with the fields of the active student profile, so if the matching process is not positive; matched course will be deleted from the list.
- Finally, the "recommended courses" are passed to the next stage.

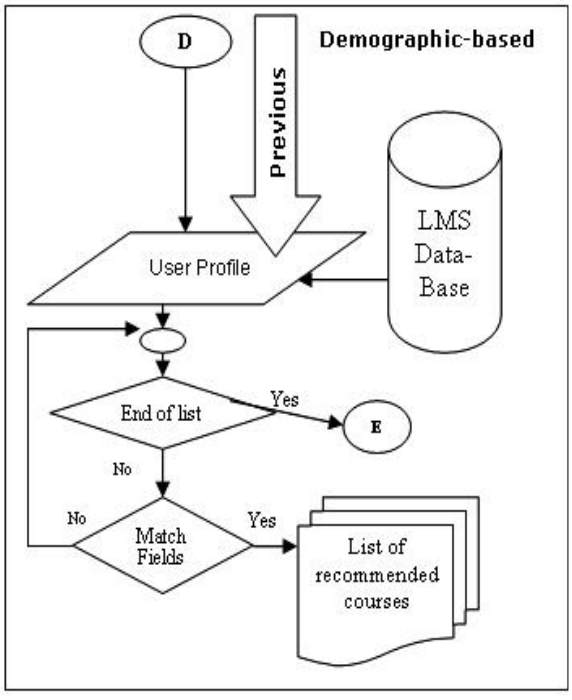

Figure 5. The general steps of the DBF stage.

5.5. The Stage of Rule-Based Filtering

Theoretically, the RBF will filter the incoming recommended courses upon a set of rules which could be found in the student profile and in the system profile. We suggest that the following types of rules could be used in the student profile and the system profile to filter the incoming courses (see Figure 6):

- Link: the system will filter out any course whose link founded in the rules.
- Phrase or word: the system will filter out any course which any of his name, keywords or abstract match any "phrase" or "word" founded within the rules.
- Date: the system will not show any course dose not fit the date criteria.

The system administrator put some rules in the system profile, while the student can put his own rules in his profile. We can make some clarification on the using of these three types:

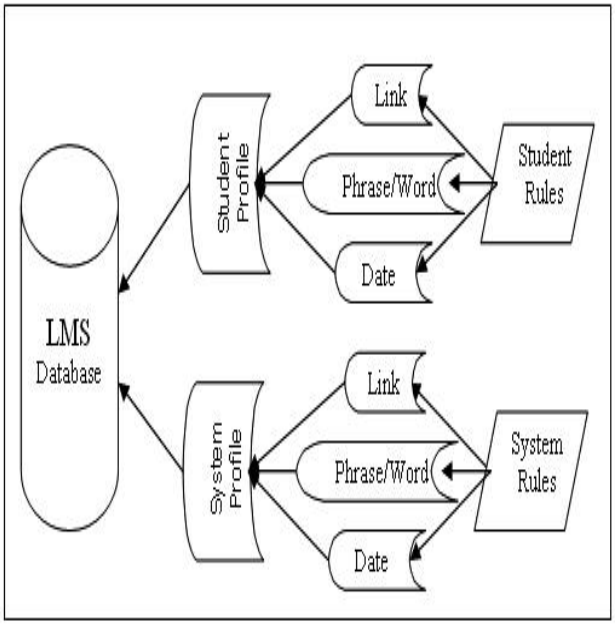

Figure 6. Student and system rules.

RBF could be work as follow, (see Figure 7):

- Receiving the list of the recommended courses from the previous stage.
- Reading the following fields of the system rules:
  - Field which contains courses numbers.
  - Field which contains keywords of courses.
  - Fields of maximum and minimum dates.
- The system deletes from the recommendations list every course that matches any number or key words as well as deletes any course whose dates out of the minimum-maximum dates.
- Reading the same fields of rules from the student profile and repeat the filtration process.

- Finally, the "recommended courses" are prepared to be presented in a suitable way on the active student course.

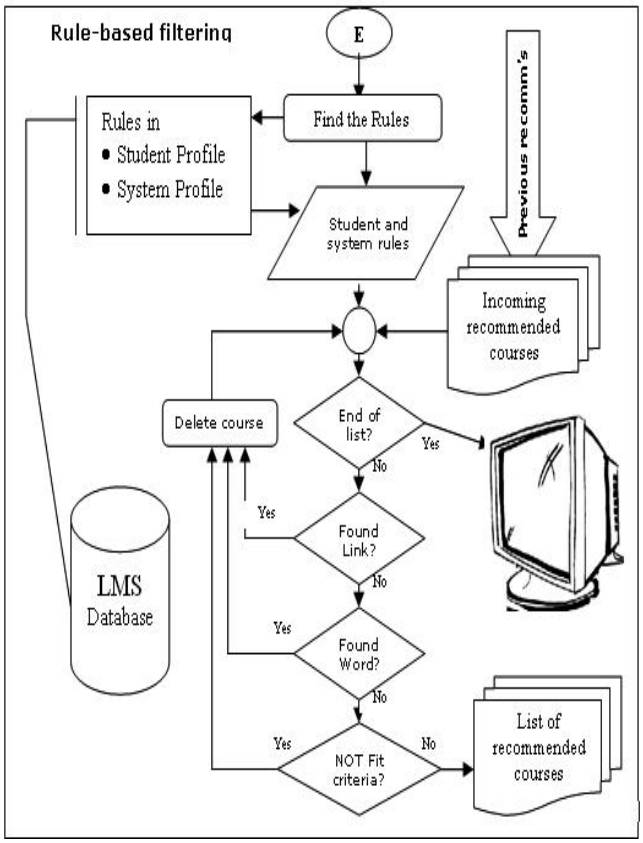

Figure 7. The general steps ofthe RBF stage.

6. Conclusion

RSs have been widely used in many internet activities, mainly to overcome the information overload problem. 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 writes about using RS in some e-learning solutions like LMS.

This paper is studying and searching the ability to use RS in LMS as well as designing a new RS algorithm to recommend list of suitable courses to students while entering their course. These proposed algorithm is considered as a HRS which consists of some RS approaches; content-based system, collaborative filtering, rule-based filtering, demographic-based system.

As a related future work, it is recommended to study the ability to use RS in e-learning portal at the following fields:

- Recommendations of courses registration that help students select courses.
- Recommendations of teachers that help students select their teacher, in case of many teachers' that gives similar courses (in large universities).
- Recommendations of online library resources that help students find good resources from their university online library suitable to their current course.

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