



Recommendation System based on user interaction data applied to intelligent electronic books

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ABSTRACT

Nowadays, new technologies and the fast growth of the Internet have made access to information easier for all kind of people, raising new challenges to education when using Internet as a medium. One of the best examples is how to guide students in their learning processes.

The need to look for guidance from their teachers or other companions that many Internet users experience when endeavoring to choose their readings, exercises or practices is a very common reality. In order to cater for this need many different information and recommendation strategies have been developed. Recommendation Systems is one of these.

Recommendation Systems try to help the user, presenting him those objects he could be more interested in, based on his known preferences or on those of other users with similar characteristics.

This document tries to present the current situation with regards to Recommendation Systems and their application on distance education over the Internet.

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1. Introduction

The new technologies, and particularly the fast growth of the Internet, enable users find a great variety of books, newspaper articles, pages or movies, without the need of a prior precise knowledge of the contents of every one of them. Users find themselves overwhelmed by the overload of information and seek help to identify the objects which may be more interesting for them. Most of the time, users solve this problem following other people's recommendations, or selecting the objects that look similar to what they are looking for.

As the new e-book devices have more computing power and start being more capable to present custom contents, user claims for more features especially focused on interaction and usability to improve the user experience. This is one of the main aims of eInkPlusPlus¹ project, which is the base of this paper. Now is possi-

ble to face the creation of a self-customizing device and self-customizing content.

A Recommendation System is an application capable of presenting a user a suggestion for an object, obtained on the basis of his previous preferences and the preferences of a community which has likings and opinions similar to his. For Batul (2001), Recommendation Systems help us reduce the overload of information we suffer nowadays, providing, at the same time, customized access to information for a specific domain.

Recommendation Systems are used in areas such as e-commerce, leisure or digital libraries in order to solve the information overload they produce. However, there are many other fields that present a similar problem, such as those domains related to education and learning object.

This paper presents a recommendation-based solution, for the case of intelligent electronic books using data gathered from the user interaction.

2. What is an intelligent electronic book?

Today is very common talk about e-books, electronic books and related topics, but as they are getting popular, user claims to get more from the new devices. This is the main idea of creating an intelligent electronic book. These devices should be capable of much more than just display text. It should be able to show audio, video and multimedia content; it also should have computation

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and I/O capabilities. It should support standards and be able to gather the interaction data from the user (Kuroiwa & Bhalla, 2007; Lytras, Damiani, & Ordóñez de Pablos, 2008; Lytras & Ordóñez de Pablos, 2009).

3. The problem of the content overflow

Lets suppose that, in a teaching environment, a student has a great number of electronic content, such as papers, lectures, practices and exercises. The student can access many more objects than he is able to use, and has no idea of where he should begin, so bearing in mind the electronic contents are classified by levels, he decides to begin with the basic level. The student browses through all these contents for their topics and remembers a friend told him how much he enjoy those exercises related with an specific topic. The student decides to start with those contents, and once he has finished with them he calls his friend so he can recommend him more since the ones he has already gone through did match what he was looking for.

If we move this process to the field of distance learning, how can a student find the contents he will like the most? In order to resolve the information overload problem different techniques can be used, and one of them is based on Recommendation Systems.

Our investigation tries to prove the feasibility of using Recommendation Systems applications in electronic book environments. These electronic books can be used in a learning environment or in a more general way. This article introduces the work that is being done to provide the educational environment with a Recommendation System.

The rest of this work is organized as follows: next sections will comment on the current state of distance learning and the problems it presents, then we will justifies the use of a Recommendation System as a solution to the problems we are facing, after we presents the general aims of the investigation, then there is a description and a presentation of the results obtained in the first stage of the investigation and the last section closes this paper, presenting the conclusions.

4. Intelligent electronic books in the Internet and the learning environments

A Recommendation System is an application capable of presenting a user a suggestion for an object, obtained on the basis of his previous preferences and the preferences of a community, which has likings and opinions similar to him. For Batul (2001), Recommendation Systems help us reduce the overload of information we suffer nowadays, providing, at the same time, customized access to information for a specific domain.

Looking through specialized literature we find many different definitions for education through the Internet:

- (1) "An Internet formation is an environment created in the Web, in which students and teachers can perform teaching and learning tasks. It is not only a mechanism to distribute information through to students; it also supports tasks related with communication, students evaluations and class management" (McCormack & Jones, 1998).
- (2) "Formation through the Internet is a hypermedia program that uses attributes and resources from the Internet to create significative learning environments, where training is improved and leveraged" (Khan, 1997).

Formation through the Internet poses several problems, such as the rising cost of design and creation of curricular material, the

impossibility of reutilization and the interoperability of the curricular material just mentioned (Roig, Lledó, & Grau, 2004). Learning objects (LO) are proposed as a possible solution to these problems.

According to Wiley a learning object is "any digital resource that can be reutilized to make learning easier" (Wiley, 2001). In this author's opinion, digital resource is defined as anything that can be distributed through the net, no matter how small or large it might be. Examples for small reusable digital resource are images, small portions of text, or small Web applications. Bigger size reusable digital resource examples are Web pages that combine text, images and other means of communication. So we can consider that an e-book has all the necessary characteristics to be used as a learning object and e-book reading device can be used as a client for learning objects.

The principal advantage of distance learning and the use of learning objects are:

- (1) *Access easiness*: a great amount of people can access the formation, making temporal and geographic barriers disappear. Time problems disappear as the Internet is available at any time. The movement problems disappear as well as a person can be formed without the need of travelling several kilometers or to another city.
- (2) *Costs saving*: many more people can be formed with fewer resources.
- (3) *Customized formation*: most of the courses are interactive allowing the user to choose the way of his formation according to his needs or personal interests.
- (4) *Possibility of being in contact with other students*: allowing a greater collaboration and information interchange.

The principal problem posed in the distance learning through the Internet with great learning object collections is that students can find themselves overwhelmed with the overload of information. As it has already been expounded, a possible solution is the Recommendation Systems.

5. Recommendation Systems

The Recommendation Systems help the users to choose objects they can find useful or of their interest. A Recommendation System is "the system that has, as principal task, to choose certain objects that meet the users requirements (Wang, 1998)". These objects can be any kind of information or articles, such as books, movies, songs, Web pages, blogs, etc.

The main operation of these systems is to ask the user to evaluate a series of objects. These evaluations will be used by the Recommendation System to predict the user's evaluation of the object or the evaluations the user has done in the past. The more evaluations the users make, the better the results will be.

The Recommendation System must provide a mechanism to compile the biggest amount possible of information from the users in order to make better recommendations. This process is called "feedback". This is one of the weak points, as we could see in our research users do not like to measure the contents, so in many cases there is no feedback.

In order to realize the recommendations there are two types of algorithms that give way to two big Recommendation Systems groups. (Adomavicius & Tuzhilin, 2005; Balabanovic & Shoham, 1997).

- (1) *Based in the content*: the system recommends similar objects to those the user has liked in the past.
- (2) *Collaborative*: the system recommends the user objects that have been liked by users with similar likings.

A Recommendation System based in the content is defined as: “system in which the recommendations are done based only in the profile made taking into consideration the object content analysis the user has evaluated in the past” (Balabanovic & Shoham, 1997). The key of the systems based in the content is that the objects, which can interest the user, must be similar to the objects he has liked in the past.

The Recommendation Systems based in the content are mainly used to recommend documents, Web pages, publications, jokes or news. Some examples are: SYSKILL & WEBERT, which recommend Web pages (Pazzani, Muramatsu, & Billsus, 1996) or PTV (McCormack & Jones, 1998) that recommends TV programs to the user.

A collaborative recommendation system is defined as “the system in which recommendations are made based only in the similarity degree between users” (Balabanovic & Shoham, 1997). The collaborative Recommendation Systems are based in the fact the objects a user likes can be liked by other users with similar likings.

In this case, we are interested not only in the way of doing the recommendation but where we get the data to recommend. How can we get the necessary data to recommend in a very automatic way with no explicit intervention from the user?

6. Project objectives

This investigation's main objective is to solve the information overload problem produced in big digital contents collections taking advantage of intelligent electronic books.

The information overload problem has been solved in other systems, as for example commercial systems such as Amazon, or entertainment systems, such as Movilens, using Recommendation Systems. This is why the idea of integrating Recommendation Systems to the intelligent electronic book by means of Internet services assistance was taken into consideration. Because these systems adapt themselves consistently to the properties an object recommendation processing must fulfill.

6.1. Stages of the project

The Project has the following stages:

- (1) Define the possible interaction characteristics that can be measured in order to detect the user interest with no need of specific task or test.
- (2) Develop a prototype in which the users are provided with large collections of digital contents and state the problem of information overload. Developing a prototype of intelligent e-book reading device including a Recommendation System is also a need.
- (3) Make a comparison between the algorithm used in the prototype and other types of prototypes used in other environments, looking for the algorithm that better adjusts to an educational environment.
- (4) Make a study of the advantages of having a Recommendation System inside the intelligent e-book reading device.

7. Stage 1. Define the possible interaction characteristics that can be measured in order to detect the user interest with no need of specific task or test

When you are trying to measure the user experience and interest, there are many ways; most of them based on questionnaires and reviews made by the users (Sharp, Rogers, & Preece, 2007). We want to measure the user experience in order to improve the recommendations but we have realized that test and questionnaires bother the users (Fig. 1). One possible option to measure

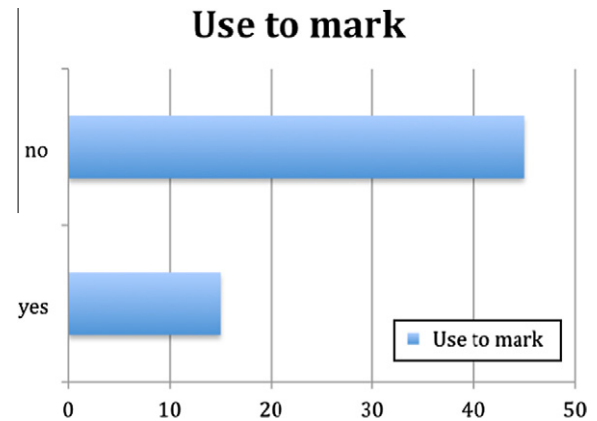


Fig. 1. Number of students that use to mark the e-books when finish.

the user experience without asking is the eye tracking mechanism (Bojko & Schumacher, 2008) but eye tracking is not a lightweight mechanism suitable for an e-book reading device. In order to achieve this goal, we are going to take advantage of the parameters that we can acquire directly from the interaction between the user and the reading device. So we are going to measure:

- Total interaction time (total number in minutes).
- Favorite topic (ordered list of topics).
- Favorite content (ordered list of contents).
- Session duration (ordered list of pairs content/duration)
- Reviews (number).
- Direct feedback (number of “starts”).
- Repetitive readings (number of iterations).
- Session duration/Content size.
- Time to completion.

8. Stage 2. Development of a prototype in which the problem of information overload is confirmed

The main objectives in stage 1 of the project are:

- (1) To state the problem of the large content collections.
- (2) Collect the data directly from the user interaction.
- (3) Verify the feasibility for the Recommendation Systems application to the large learning collections in order to solve the problem of information overload.
- (4) Collect data to bring into service a Recommendation System.

8.1. Methodology

The study has been made with student from “Universidad Pontificia de Salamanca”, at the campus in Madrid. 60 students registered in a certain course have been used as reference.

A portal has been developed in which the students have 40 e-books with practices and exercises of the course at their disposal. To access the digital contents the students had used a web portal that shows the different e-books that can be downloaded to the reading device.

The access to the portal is made by user id and password. Once in, the system provides the contents by a random method. When a student finishes an e-book he can evaluate it so the system can obtain the information we will use to make recommendations. The device has been gathering all the information about the interaction in order to get the user preferences even in the case that the user refused to do the evaluation. This data is transferred to the main system when the student downloads the next e-book.

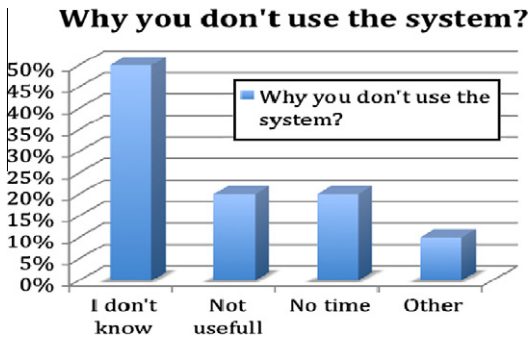


Fig. 2. Why did not you use the system?

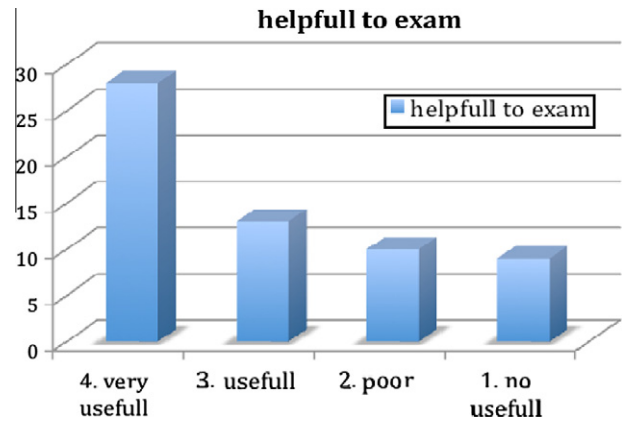


Fig. 4. Did you find useful the portal for preparing you for the exam?

9. Obtained results

The study has been divided in two stages:

- (1) System test with no recommendations.
- (2) System test with recommendations.

9.1. Stage 1

- * Sixty users, who have done and evaluated 1.050 e-book, have used the practice portal for two weeks. Most of then did not mark any of the read e-books, as you can see in the figure below.
- * Fifty-eighty of the sixty registered students answered a system use survey. Forty of them had used the system.

Fig. 2 shows a chart with the reasons why the students that did not use the portal did so.

We have asked the students to mark from 0 to 4 the utility of the system in order to do practises of the course and prepare for the exam. Most of the students, which used the system, thought it had been useful for their practises and for preparing them for the exam (see Figs. 3–5).

Regarding the number of practises they would be willing to do, most of the students indicated between 20 and 30.

9.2. Stage 2

In se second stage we included the recommendation system and we improve even more the satisfaction of the students. In this case all of the students surveyed expressed their wish of having a similar system for other courses including theoretical courses where all that can be offered is bibliography and documentation.

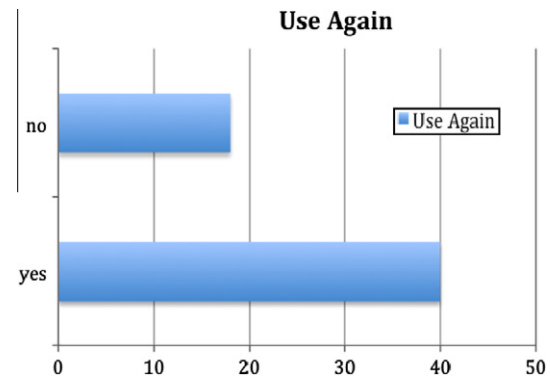


Fig. 5. Would you use a similar platform if you had it available for other courses? (a) Yes and (b) No.

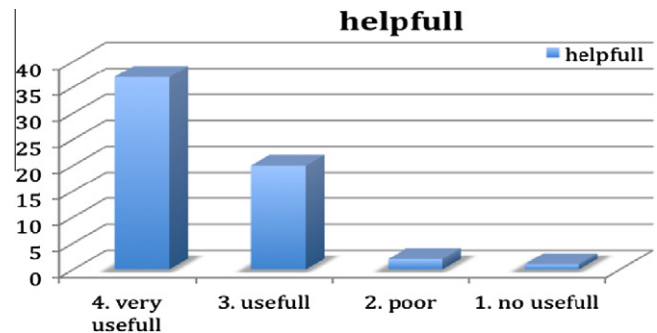


Fig. 6. Did you find useful the portal?

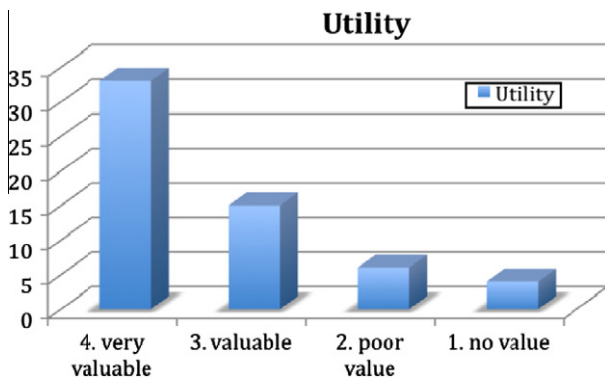


Fig. 3. Did you find useful the portal to do the practises of the course?

The inclusion of the recommendation also has improved the way of thinking about the utility of the system as we can see on Fig. 6.

Regarding the number of practises they would be willing to do, most of the students indicated between 30 and 40.

10. Conclusion

During this research we have achieve the next conclusions:

The great amount of information that exists in the Internet makes the use of techniques that help the user find what he is looking for necessary.

Recommendation Systems are used efficiently to solve the problem of information overload in areas such as electronic commerce and leisure time.

Recommendation Systems improves the user experience specially when they gather the user information in a very automatic way.

Our investigation shows the problem of the information overload is also present in distance educational environments.

The obtained results show most of the users are not willing or can not do all of the practices the system puts at their disposal, that is why they would find help useful in order to decide which practices they should do.

Recommendation Systems are specially useful as a part of an e-book environment.

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