A Recommender System for Learning Resources Suggestion Based on Learner Characteristics

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Abstract— Advances in Information Technology (IT) have solved information deficiency, but another problem has been brought about: information overload. One of the most appropriate methods to deal with this issue is the use of recommender systems. A recommender system can be used as a tool to support and even for decision-making. Although it can recommend the appropriate educational resources in e-learning system for the learners, so that they would be able to choose the best educational content, but according to the recent studies, such a recommender system has rarely been used in e-learning. A recommender system based on collaborative filtering methodology is introduced in this study to recommend the suitable resources to the learners and therefore save their precious time and facilitate the learning process. In this study, two groups of learners are selected from the same educational level. The first group will be given no recommendations at all and they themselves have to choose their educational resources. However, the second group will be supported by the proposed recommender system in order to select their appropriate resources. The obtained results show that the learners in the second group, who had been supported by the recommender system, outperform the first group and have a superior learning experience.

Index Terms— Recommender System, E-learning, Collaborative Filtering, Similar Learners, Learning Resources.

I. INTRODUCTION

The great volume, yet growing amount of information on the internet makes it hard for users to get the proper information, data and products. This issue has motivated the researcher to find a way to overcome this problem known as ‘information overload’. One of these solutions is the use of recommender systems [1].

There are various definitions for recommender systems. Liang considers RS (recommender system) as one of the subcategories of DSSs [2]. He defines them as information systems that are able to analyse the past behaviour to give recommendations for the current issues.

In another word, in recommender systems it is tried to predict the user’s way of thinking (with the help of collected information from his/her behaviour or similar users’ behaviour) to identify and suggest the most suitable and closest product to his/her taste. In fact, these systems simulate the same procedures in our daily lives and automatically implement them [3]. The people with tastes similar to ours are found and asked for their opinions about our selections. Suggestions that are recommended by the system can have two primary results: The first result is helping users for decision making (for example, which one of the options you have is good for you to pick). The second is increasing the awareness of the user about the items he/she is in search of (for example, the recommendations introduce new products to the user which he/she was not aware of before) [4].

1. Motivation: According to the past researches, recommender systems are rarely used in e-learning. By the growing development of e-learning, the use of recommender systems is becoming inevitable. Using the recommender systems in e-learning has great potential. Giving consultations to the learners, recommendations to lecturers and scoring every activity of learners are some regions that recommender systems can be used in.

In the learning process, selecting the right resources has direct impact on the learning. So one of the main issues is offering the right resources according to the learner characteristics in the shortest time possible.

2. Contribution: As previously mentioned, one of the main problems of the learners in e-learning systems is selecting the right resources without wasting time and energy. To solve this problem and to save time, a website is designed.

This website suggests appropriate educational resources to the users by using a collaborative filtering recommendation method and thus saves time and reduces confusion of the users. In this research, two groups of users log in to the system within specific time intervals.

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1 Decision Support Systems

The International Conference on E-Learning in the Workplace 2012, www.icelw.org
The first group will take the test after selecting three resources and commenting about them and will log out of the system in the end. The results from comments of the first group will be used for the second group that will log in to the system a week later without having access to the system resources. But the system will suggest the resources to the target users by finding 3 similar users from the first group. The system will give tests to both groups.

The results of this project will show whether the learners studying with self-paced learning method (first group) can have a better understanding or the learners receiving recommendations from the system (second group).

II. BASIC THEORY

It is necessary to study the concepts below in order to understand the recommender system.

Target User (Main User): In recommender system, the user for whom the current suggestion is being processed and prepared in the system is known as the active user or the target user [5, 6].

Self-paced learning method: Self-paced or individualized learning is defined as the learning directed by the individuals in order to meet personal learning objectives. In self-paced learning, the content, learning sequence, the pace of learning and possibly even the media are determined by the individual [7].

Recommender system: The growth of the internet and the fast distribution of information on the web will give rise to the information overload. In this case, the user is not able to manage, get and update the available information on the web [8]. One of the solutions to this problem is the recommender system. These systems are trying to present user’s favorite information or help them personalize their experiences of the net. Recommender systems are generally divided into three categories: content-based method, knowledge-based method and collaborative filtering method. There can be a fourth method under the name of “hybrid recommender system” [9].

Collaborative Filtering Method: An approach in recommender systems is using CF or collaborative filtering. In this approach, instead of using the content of items, the opinions and rankings suggested by other users will be used for recommendations. In other words, suggestions will be produced by calculating the similarity between interests and selections of the target user and other users [10].

User-based method: User-based method is one of the most famous methods of recommending.

Item-based method: In Item-based method instead of using the correlation between users and opinions of similar users, item-item correlation will be calculated in a similar way [11]. Then, items similar to what the user was interested in earlier will be recommended. An important point about this method is that unlike the content based methods, items similar to the earlier items that the user was interested in will be provided without using the content of items and only by using users’ interactive data [12, 13].

III. RELATED WORKS

Recommender systems are effective systems in guiding and leading the user through the great volume of available options toward the most desirable option such that the procedure is personalized only for a particular user. CF algorithms are one of the important strategies to create recommendation, because they do not fit in the domain of items. The users’ tendencies are expressed by items rate and recommendations are calculated based on subscriptions of similar users. The technical problems of this method are: cold start problem and scarcity problem [14]. When the system doesn’t have any information about the user interests, it cannot give any recommendations. The reason is that maybe the number of people that rate an item in a particular base is very small relative to the total number of items. This means that there is no specific similarity among users and the quality of recommendation is low [15].

The websites like digg.com, reddit.com and Balatarin.com have recommender systems that collect and process comments of users, then filter them and give them to the potentially interested users. This is called “collaborative filtering” [16]. Also many methods have been developed to create a versatile web (adaptable web). These methods try to adjust and organize the web pages dynamically according to users’ interests. Using the “recommender systems” in web is another approach which is the basis of this research. Recommender systems are known as a tool that facilitates citizens in using the web. By using recommender systems, one is able to search for the concepts that are not reachable by normal searching processes in electronic education [17].

IV. SYSTEM DESIGN

Facing a wide range of options makes users search for suggestions. Recommender systems with collaborative filtering find all of the options that are in accordance with users interests. In this section the recommender system architecture for electronic education will be explained.

As you can see in Fig 4.1, the architecture of the recommender system consists of three major parts: learners, collaborative filtering unit and learning resources. This system has two sub-systems. The first sub-system is about the first group and the second sub-system is about the second group. The following steps show the general architecture of the system.
1. Analysis of the learners from first and second groups:
Each group has 30 participants in this study. These 60 individuals, who are logging into the system during a week, are the normal learners and don’t have any special characteristics. The resources in the website are not specialized and they can be used by general learners. These ten resources are about the “hardware ergonomic” and they are suggested by an expert.

The learners of the two groups log into the system separately. The learners of the first group got into the system in the first week of April. The first group didn’t receive any recommendations from the system and used the “self-paced learning” technique. The second group just studied the resources that were recommended by the system.

The method of recommending depends on the statistical characteristics and behavioral analysis of the earlier learners. This means that the system will help the learners by finding similar learners and recommend the resources to them. In the first week of April 2011, 30 learners of the first group got into the system. In the second week of April 2011, 30 learners of the second group got into system.

2. Analysis of the resources in the system: In this system, 10 resources are available to the learners. These resources are visible only to the first group. Learners should choose the right resources that are related to the main concept. The main concept is about suitable use of hardware such as mouse, monitor, keyboard, etc. An abstract is written about it in the section of "resources", so learners can read it. After reading the abstract and learning the concept, learners should choose the right resources according to the name of the resource.

Content and spelling of these resources are different from each other. There are just 5 resources related to the abstract and just 3 of them are good. So first of all, learners should read the name of the resource. If it is close to the content of the abstract, they should select and read it. After selecting the resource, learners should comment about them.

In the "comments" section, learners should comment about the resources. This section has two parts. The first part has 3 questions about spelling, relation to the abstract and completeness. But the second part is optional. Learners can comment about the resource from an official reference. These comments can be added to the available resources after being reviewed by an expert.

V. SYSTEM ARCHITECTURE

1. Subsystem 1 Architecture: In this research two groups of learners are logging into the system within specific time intervals. The first group has the first week of April to log into the system and take the test. The first learners have to select three resources out of 10 resources and put their comments about them. Then they have to participate in the test and in the end log out the system. The results of their comments are being used for the second group. Architecture for the first group is designed as below:

Data Entry: The first learners should enter their name and surname in the registration section. It will be known as the username for them. Then they will enter their e-mail address and a password. There are 5 questions in this part and the learner should answer them. These questions are to evaluate learners and to find similar learners.
Recommended Resources: After the learners of the first group log out of the system, it is the second group’s time to log into the system. Learners of the second group will study the instruction manual in the “home” section after they log into the system. By going to their profiles they are suggested 3 resources by the system. Learners should read 3 recommended resources.

Test: The learners of the second group will be navigated to the “test” and after doing that they will log out of the system.

VI. PROPOSED METHOD FOR LEARNER CLASSIFICATION

One of the main problems of collaborative filtering is collecting the interests of the learners. The ideal condition to make the system trustworthy is that a large number of learners rate the resources. This will be achieved only by spending too much energy and time. As the system will only be capable of giving suggestions with good quality when it has essential information, the learners from the first group are not highly motivated at the beginning. But 30 learners were chosen for the first group to overcome this problem.

User-based method is one of the most famous and initiatory methods of the collaborative filtering recommendation methods. There are many methods developed according to this model. The main idea behind this method is that when a person asks for a recommendation for a product (for example a book), he/she will be more respectful about the suggestions of the people who have much similar interests for books as him/her. Although algorithmic suggestions are more efficient, in many cases learners would prefer their friends’ suggestions to the algorithmic suggestions.

After the learners of the first group log out of system, it is the second group’s time to log into the system. The 5 questions that learners of the first group answered in the registration section are being used as criteria for finding “similar learners” for the target user. Relation (1) is defined for finding similar users from the first group (learner$_{i0}$) to the target user from the second group.

The system will compare each answer from learner “$i$” (a user from the first group) with the answers of the target user.

$Learner_{i0}$ Score $= 2Q_i + 2Q_2 + 4Q_3 + 6Q_4 + 6Q_5$ $Q_i \in \{0,1\}$

(1)

For example the target user chooses “c” for the first question in the registration section. The system will study the answer of the first question of the learner “$i$”. If he/she chooses “c” then the system will assign “1” to “Q1” in (1). But if he/she chooses another option then the system will assign “0” to “Q1”. For question 2 if the learner “$i$” chooses an answer similar to the target user’s answer, then the system will assign “1” to “Q2” and this procedure continues like that.
The more learner “i” answers similar to the target user the more scores he/she will have. It means that it will be more probable that learner “i” is similar to the target user.

Numbers written in the relation (3-1) are scores that are given to each question according to their importance. In the end 3 learners from the first group with the highest scores (highest similarity) will be calculated for the target user.

VII. RESULTS

1. System Pre-Evaluation: After the members of both groups finished their tests, now it’s time to compare the results. The comparison of the results will show whether the learners with “self-paced learning” technique are having better understanding of their studies or the second group that were receiving recommendation.

If the first group yields better results, some changes should be made in the algorithm and formulation of the system. If the second group yields better results, the research goal is achieved and efficient resources are presented to the learners in the least possible time. Decreasing the time is the most important point that should be achieved according to the phenomenon of “information overload”. Learners will show less behavioural disturbance against the information overload when they are receiving recommendations from the system.

Recommending the educational resources to the learners is one of those points that are not taken into consideration until now. Therefore, a system was developed to study this problem and to present strategies to solve it. By using collaborative filtering recommendation, the system recommends efficient educational resources and prevents learners from wasting their time and getting confused in finding efficient resources.

2. Analysis of resource selection of the learners of first and second groups: In this section the main issue is that how many learners are successful in selecting the resources that are close to the mentioned issue of the abstract. It will be checked whether the resources suggested by the system to the second group are the suitable resources or not!

Three optional resources were added by three members of the first group and an expert accepted just two of them for the resources of the system. So the resources increased from 10 to 12. These two resources were commented by 6 learners. The resource that was rejected by the supervisor didn’t have proper similarity to the abstract.

Resources number 1, 7 and 10 have the full scores (average 5). This shows that the learners who chose these 3 resources can answer all of the questions in the test section. Resource number 3 has score 4, resource number 6 has an average score of 3, resources number 2,5,11,12 have an average score of 2 and resources number 4,8,9 have score 1. Selecting resources number 3 and 6 helps the learners to answer more than half of the questions. Resources number 2,5,4,8 and 9 can barely help learners to answer the questions. Because these resources have little information related to the abstract.

Now the main question is that if the resources with
higher scores will be given to the second group or not. Learners of the second group, without wasting time, can study the resources that are less prone to not having “good writing” or “little relation to the abstract”.

According to the results recorded in the system, the resources that each group studied are observable. In diagram 7.1 the resource selecting percentage of learners in the first and second groups are shown:

As it can be seen in diagram 7.1, the horizontal axis shows the resources of the system and the vertical axis shows the resource selecting percentage by the learners from the first group and the resource receiving percentage of the learners from the second group.

The yellow columns show the resource selecting percentage from learners of the first group. The brown columns represent the resource receiving percentage of the learners of the second group. The learners of the first group studied different resources. The resources number 4, 11 and 12 were selected by 3 learners from the first group. These 3 resources achieved the low average scores of 1, 2 and 2 respectively. Resource number 4 was automatically deleted and was presented by number 0 in the graph. This means that resource number 4 is not presented in the second step to any learners of the second group. Resources number 11 and 12 were only suggested to 2 learners of the second group. Resource number 9 that was selected and studied by 5 learners was suggested to only 1 learner because it had a low score.

As it is presented in diagram 7.1, resources number 7 and 10 are recommended to 75.33% of the learners in the second group, while 51.33% of the learners in the first group selected them. In fact, the learners of the second group experience an efficient resource selection. They were benefited from the experiences of the members of the first group. Here, without evaluating the test, it’s obvious that the main goal is achieved.

3. Result Analysis: Fig. 7.1 compares the resource selecting percentage of the first group (left side) with the resource receiving percentage of the second group (right side). As it is obvious, the resource reading percentage of the target resources (1, 4, and 7) in the second group is much higher. It can be concluded that if the resources or items are not selected by the learners, those items and resources are not going to be suggested to the new learners.

In the test section 10 questions were presented and the learners of both groups answered them. In this part the questions of the test and the resources are discussed. The test results of both groups are shown in diagram 7.2 which compares the correct answer percentages of learners of both groups in the “test” section. The horizontal axis shows the questions of the test.

The vertical axis shows the correct answer percentages of the learners of the first and the second groups.

It is obvious that in all questions (except question number 1) there is a big difference between learners of the second and first groups. For answering the first question, the learners didn’t need to study any resources and they were able to answer that question by their own knowledge. The learners of the second group had better results than the learners of the first group. The recorded results in the system show that 53.33% of the learners of the first group were able to answer more than half of the questions correctly while 77.77% of the learners of the second group answered more than half of the questions correctly. This result is very useful because the learners are going to spend less energy and time.

VIII. DISCUSSIONS

The internet has provided a great volume of data as an opportunity for its users. But if there is no efficient management for such a mass of data, this opportunity will turn into a barrier to the users. Nowadays a recommender system is essential to guide users toward their desired products and services in such an ever increasing volume of information and data.

According to the recent studies, such a recommender system has rarely been used in e-learning. The results of this project showed that the learner can have a better understanding while receiving recommendations from the system.

So a system was designed which was able to recommend educational resources to the learners and thus saved time and cost. The main goal for conducting this project was that a learner in an e-learning environment could receive suggestions and recommendations according to his/her characteristics in the least possible time and select the best option for using the resources.
Limitations of this Study: According to the CF algorithm, the system is not able to recommend good-quality suggestions and recommendations if it has few learners. Therefore, by increasing the number of learners and comments the quality of the recommendations will increase. Some volunteers of the system didn’t show any interest for studying the resources. If this system is used in an educational environment and the teacher forces students to use the system, then the impatience of the learners will turn into high motivation and learners can benefit from the website more and more.

IX. CONCLUSION

The internet learners are always facing “information overload” and time waste. One way to overcome these problems is to use the recommender systems. In this study a recommender system was designed as a new and efficient strategy to open a new path in e-learning. It prevents the learners from wasting too much time in order to have better access to the content with higher speed and better quality. It is advised to create the culture of using the recommender systems before implementing these systems in the educational systems. It is quite beneficial to put these systems in the highly visited websites like banks’ websites so everyone will get used to these kinds of systems. It is obvious that in this case we are not going to face the problem of cold start. So interaction between these systems and learners will be much higher.

If students get scored for each activity, they will show more interest. If new resources are added to the system, the interaction in the system will be increased. Therefore, the learners of the first group will be able to receive recommendations just like the learners from the second group.

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Diagram 7.2 Percentage of correct answers to questions by the users group 1&2


