

ADDITIONAL PARAMETERS THAT AFFECT THE TAG-BASED COLLABORATIVE FILTERING

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Abstract: Selecting the most useful learning resources is very important aspect in the modern e-learning systems as well as distributing learning content in adequate format. That is e-learning systems need to have ability to determine student needs and their most adequate learning style. Our previous research was focused on tag-based collaborative filtering and learning style determination in order to suggest useful learning material in adequate format and we have proposed an algorithm for tag-based collaborative filtering. Also, we focused on some parameters that are important for tag-based collaborative filtering too. In this paper we are focused on additional parameters that affect the process of tag-based collaborative filtering. In that context, we consider students previous knowledge level, tag's ratings and author's ratings of materials as factors that have impact on the tag-based collaborative filtering.

Keywords: *factors, collaborative filtering, tags, recommendation.*

1. INTRODUCTION

The set of available resources in e-learning systems is rapidly increasing and it leads to mandatory using different kind of tools for filtering the most suitable materials. That tools can assist to students to find out resources that match their individual goals, interests and current knowledge [1]. Based on fact that each student has different characteristics, a personalized searching becomes very crucial and challenging from one hand, but also and very valuable in practice on the other hand.

Except the volume of resources, there are few more factors that impact to effective learning process: learning materials' format, authors rating, students experience and previous knowledge. Accordingly, e-learning system need to consider that factors in the process of selecting and suggesting learning resources to the users.

Recommendation modules in e-learning systems aim to improve the users' search experience and suggesting the most adequate learning materials in e-learning systems.

It's known that learning resources are available in different formats and styles, suitable for learners with different learning styles. Based on recent researches, traditional implementations of classical recommended approach, such as collaborative filtering, are not working well in this new context [2].

Collaborative tagging systems allow users to annotate resources with their custom tags, which provide a simple but powerful way for organizing, retrieving and sharing different types of social resources [3]. There are several algorithms for collaborative filtering and several available

metrics used in the process of calculating similarity between the two resources.

Additionally, it is necessary to be consider the fact that all learners have different ratings, some tags are used more often than other tags, some learning materials are more popular than other learning materials and so on. Therefore, we need to think about factors that impact the process of tag-based collaborative filtering.

2. RELATED WORKS

Number of researchers are focused on using tag-based collaborative filtering in e-learning systems, wherein they are using different measures and algorithms. Some of them are focused to factors and parameters that impact the collaborative filtering process. In [4], the authors were focused on the importance and usefulness of tags and time information when predicting users' preference and examine how to exploit such information to build an effective resource-recommendation model. Based on the results, the authors concluded that tags and time information are adequate parameters for presenting users' need and requirements. Additionally, they concluded that better performances can be achieved if that information are integrated within collaborative filtering. The authors in [2] have evaluated two enhancements of user-based collaborative filtering algorithms to provide recommendations of articles on Cite ULike. Based on the same research, incorporating the number of rates into the algorithms for collaborative filtering leads to precision improvement, while tag-based BM25 similarity measure, an alternative to Pearson correlation for calculating the similarity between users and their neighbours, increases the coverage of the recommendation process. Authors in paper [3] covered limitations of previous tag-based personalized search, proposing a new method to model

users and resources profiles in a collaborative tagging environment. Also, they implemented a prototype system named as FMRS. Based on the results, they concluded that the proposed method outperforms baseline methods. In [5], authors studied different tag-based collaborative filtering recommendation. In that manner, they implemented 16 different tag-based collaborative filtering recommendation algorithms, memory based as well as model based, and compared them in terms of accuracy and user satisfaction. The results of the conducted offline and user evaluations reveal that the quality of users' experience does not correlate with high-recommendation accuracy. The authors in [6] extended the SPARFA framework significantly in order to enable the exploitation of tags/labels for questions that partially describe the question. According to results, the authors concluded that updated system greatly enhances the interpretability of the estimated concepts. They were using a real educational data that Ordinal SPARFA-Tag out-performs both SPARFA and existing collaborative filtering techniques in predicting missing learner responses. In [8], authors proposed a new approach to compute users' similarities and they are focus on tag ratings. Based on the results from their survey, they summarized that rating tags has influence for more effective collaborative filtering. Authors in [7] proposed more recommendable tags, which have numerical interactions with users, to refine users' tag preference first, and then deliver quality item recommendations based on the global relationship between tags and items. Authors in [10] were focused on giving tag recommendations for students. Based on the results, they conclude that selecting tag from the suggested list instead of adding tags by using free text field impact in simplifying the tagging process and in improving its quality. In order to improve their previews system, authors in [9] coupled 5-star ratings with commenting to increase the cost and complexity of evaluating and gave students individual presence with nicknames to increase social presence and enable reputation formation. The result shows that high enough cost of evaluating together with high enough social presence can lead to complete honesty in evaluations and enhance both user experience and students involvement. The authors in [11] present a tag-based collaborative filtering recommendation method to use with recently popular online social tagging systems. Based upon testing, their system provides a higher level of relevant recommendations over other commonly used search and recommendation methods. In paper [13], the authors analyze a database of records found on Bibsonomy, CiteULike and Connotea and explored the tripartite connection of users, documents and tags by three measurement methods. The authors in [12] pinpoint three tasks that would benefit from personalization: collaborative tagging, collaborative browsing and collaborative search. They propose a ranking model for each task that integrates the individual user's tagging history in the recommendation of the tags and content, to align its suggestions to the individual user preferences. They demonstrated on two real data sets that for all three tasks, the personalized ranking should take into account both the user's own preference and the opinion of others.

3. SYSTEM OVERVIEW

Modern e-learning systems need to be more effective, practical and easy for using. In that manner, they need to be able to make difference between students and to select and recommend the most suitable resources to students. Using tools for learners' needs determination and selecting the most adequate learning materials in e-learning systems has several advantages – it recommends the most useful resources to the learners and it produces more effective learning process [14].

On the other hand, learning materials are available in different formats (text, audio, practical examples, video, external link, presentations and etc.) and learners have different learning styles too. That is why, in [15] we have implemented an intelligent system for e-learning that suggests the most useful learning materials and delivers the learning material based on the most adequate learning style to the students. The system uses VARK questionnaire for learning style determination and was implemented in the educational process in Faculty of Law in Bitola. Tag-based collaborative filtering is using to filter the most adequate learning materials for the logged student. Based on the results in [15], using tags in the process of learning materials recommendation is useful and valuable technique. Additionally, in [16] we focused on some parameters that are important for tag-based collaborative filtering.

This paper covers additional parameters that can affect the process of tag-based collaborative filtering: students knowledge level, tag ratings and material author's ratings.

Student knowledge level determination

Based on the fact that different students have different knowledge level and skills, the system need to makes distinction between the students and to group them in specific virtual groups based on their knowledge level and prior knowledge, due to delivering the most adequate learning materials to students based on their learning knowledge. The system supports several types of questions: checking one answer, checking more answers and writing words. Questions are added by teachers with correct answers. The student needs to fill a test with 20 questions from the selected learning area during to the registration process. The result determines the student's knowledge level.

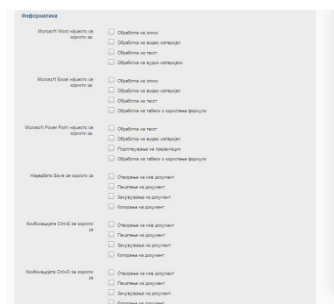


Image 1: Test for knowledge level determination

Author ratings

Authors rating is in correlation with the average ratings of his learning material and can be calculated as an average value of two coefficients: average rating posted from the students (R_{av}) and students' average rating that added rating to learning material (R_{sav}):

$$LM_r = \frac{R_{av} + R_{sav}}{2}$$

In order to determinate student rating, we have introduced two coefficients: knowledge level coefficient (C_{kl}) and student activity coefficient (C_{sa}). Total student rating can be calculated as an average value of the two coefficients.

$C_{kl} = \sum(\frac{P_n}{N_t} * K_{ln})$ where P_n is a score from the test of knowledge level K_{ln} and N_t is the maximum number of test points.

$C_{sa} = \frac{T_{su}}{T_t}$ where T_{su} is number of total tags posted from the student s , while T_t is total number of tags posted from the other students for learning materials tagged by student S . Student rating S_{rat} can be calculating as:

$$S_{rat} = \frac{C_{kl} + C_{sa}}{2}$$

Tag rating

Tag rating T_r can be calculated as:

$$T_r = \sum(\frac{T_{slm}}{N_{tlim}} * S_{rat})$$

Where T_{slm} is a number of tags added from the student S to the learning material l_m , N_{tlim} is a total number of tags added for the learning material l_m and S_{rat} is rating of the student S .

4. RESULTS

In order to review the factors that impacts the tag-based collaborative filtering, our system was implemented at Faculty of Law in Bitola. The survey covered subjects from undergraduate studies. The implemented system contains total 98 learning units, each of them composed from video, audio, text and examples and demonstrations. The system was used from 91 students. In the scope of this paper we are focused of factors that affect the process of tag-based collaborative filtering like: student rating, tag rating and materials rating.

Authors rating

In the implemented system, the authors can add and manage learning materials and resources. Additionally, they can add tags for their resources. From the other site, students can also add tags via free text field or select tags from suggested list of tags. In order to check if authors' rating has an impact on tag-based collaborative filtering, we have implemented modules that generate and propose to students two lists, selected based on tags. The first list contains learning material added by N authors with

highest rating. The second list contains learning material added by N authors with lowest rating. While using the system, students selected total 441 learning materials from the first list and 108 learning materials from the second list. It means that the rating of authors has an impact to the process of suggesting learning materials. In other words, if an author A has highest rating that an author B , than learning materials added from the author A are more useful and reliable than learning materials added from the author B .

Tag rating

The main goal of the implemented system is to filter and recommend the most adequate learning content to the students based on their needs. To archive that, the system uses tag-based collaborative filtering. Based on common used tags, the system can calculate similar learning materials and suggest the most suitable to the students. In order to check how tags' rating has an impact on collaborative filtering, the system recommends to students two lists with learning materials. The first list contains learning materials selected with collaborative filtering based on the tags with the highest rating. The second list contains learning materials selected with collaborative filtering based on the tags with the lowest rating. Based on the results, tag rating has an influence in the process of tag-based collaborative filtering, because students selected 379 learning materials from the first list and 104 learning materials from the second list.

Student knowledge level

Our system considers students knowledge level in the process of selecting and suggesting adequate learning resources. Based on results from the quiz, the system knows students' knowledge level and selects resources adequate to that level.

In order to calculate how that parameter impact to process of recommendation, we have suggested learning materials for different knowledge level. We have asked students to answer (with yes or no) to following question on the end of using learning resources: "Selected resource was adequate for me?".

Results are present in table 1.

Table 1: Results from the questionnaire

Action	Selected resource was adequate for me?	
	Yes	No
Selected learning resource was for lower knowledge level than current student knowledge level	46%	54%
Selected learning resource was adequate to current student knowledge level	84%	16%
Selected learning resource was for higher knowledge level than current student knowledge level	38%	62%

Based on results in table 1, we can conclude that selecting learning resources based on knowledge level is important aspect in e-learning systems.

Results from questionnaire

In the scope of this research, students were giving answers for several questions. According to the given answers, we can conclude that students accept the fact that learning materials added by authors with high rating are more useful. It's the same for tags rating. In addition, they agree that the recommendation process need to consider students' knowledge level in order to be selected the most suitable resources.

Table 2: Results from the questionnaire

Question	(1 – dissatisfied, 5 – satisfied)				
	1	2	3	4	5
Suggested learning materials added by authors with low rating were useful	55	14	9	10	3
Suggested learning materials added by authors with high rating were useful	10	6	7	24	44
You used some of suggested tags with low rating	51	8	11	12	9
You used some of suggested tags with high rating	8	7	9	22	45
Learning materials should be selected based on your knowledge level	2	3	5	11	70

5. CONCLUSION

Tag-based collaborative systems can provide an effective mechanism to deal with the information overload problem in e-learning systems. The success of e-learning systems depends on several aspects, but the most critical are selecting and providing adequate learning materials to the learners, according to their requirements, need and goals. Additional, searching for adequate learning materials in large database without some techniques for filtering and recommendations is almost impossible and leads to inefficient process. In our previous researches we have implemented an intelligent e-learning system that classifies students based on their learning style so that the learning materials are delivered in the most adequate format. This paper covers factors that affect the process of tag-based collaborative filtering: students previous knowledge level, tag's ratings and author's ratings of materials. After a period of using the system, we have compared the results obtained from the student's activities and we can conclude that students experience and previous knowledge, tag's ratings and author's ratings of materials impact in the tag-based collaborative filtering. Suggested learning materials with added by authors with higher rating were more used versus suggested learning materials from author with lower rating. Also, suggesting learning materials based on students' knowledge level is very useful and valuable.

Finally, tags rating need to be consider if we want to produce more effective tag-based collaborative filtering system.

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