UNIVERSITY OF NOVI SAD
TECHNICAL FACULTY "MIHAJLO PUPIN"
ZRENJANIN
REPUBLIC OF SERBIA

INTERNATIONAL CONFERENCE ON

INFORMATION TECHNOLOGY AND DEVELOPMENT OF EDUCATION ITRO 2014

PROCEEDINGS

MEĐUNARODNA KONFERENCIJA

INFORMACIONE TEHNOLOGIJE I RAZVOJ OBRAZOVANJA ITRO 2014

ZBORNIK RADOVA

ZRENJANIN, JUNE 2014

Organiser of the Conference:
University of Novi Sad, Technical faculty „Mihajlo Pupin", Zrenjanin, Republic of Serbia

Publisher:
University of Novi Sad, Technical faculty „Mihajlo Pupin", Djure Djakovica bb, Zrenjanin, Republic of Serbia

For publisher:
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Printed by:
Printing office DIGINET ProStudio, Djure Jaksica street, no. 14, Zrenjanin

Circulation: **60**

ISBN: 978-86-7672-225-9

By the resolution no. 114-451-970/2014-03, Autonomous Province of Vojvodina Provincial Secretariat For Science and Technological Development donated financial means for printing this Conference Proceedings.

The Conference is supported by the Autonomous Province of Vojvodina, the City Administration of Zrenjanin, The National House of Mihajlo Pupin, Idvor and Organizing Committee for the Anniversary of the "Mihajlo Pupin year".

CIP – Каталогизација у публикацији
Библиотека Матице српске, Нови Сад

37.01:004(082)
37.02(082)

INTERNATIONAL Conference on Information Technology and Development of Education (2014 ; Zrenjanin)
Proceedings = Zbornik radova / International Conference on Information Technology and Development of Education, ITRO 2014, Zrenjanin, June 2014 = Međunarodna konferencija Informacione tehnologije i razvoj obrazovanja, ITRO 2014 ; [organiser] University of Novi Sad, Technical Faculty "Mihajlo Pupin", Zrenjanin. - Zrenjanin: Technical Faculty "Mihajlo Pupin", 2014 (Zrenjanin: Diginet ProStudio). –
VII, 441 str. : ilustr. ; 30 cm

Tiraž 60. – Bibliografija uz svaki rad .

ISBN 978-86-7672-225-9
1. Technical Faculty „Mihajlo Pupin" (Zrenjanin)
a) Информациона технологија – Образовање – Зборници b)

Образовна технологија - Зборници
COBISS.SR-ID 287020807

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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2014 is also published.

We are very grateful to:

Autonomous Province of Vojvodina
The National House of Mihajlo Pupin, Idvor
Organizing Committee for the Anniversary of the
"Mihajlo Pupin year"

for donated financial means which supported printing of the Conference Proceedings and organizing of the Conference.

INTRODUCTION

This Proceedings comprises papers from the **International conference on Information technology and development of education** that is held in the National House of Mihajlo Pupin, Idvor on June 27th 2014.

The International conference on Information technology and development of education has had a goal to contribute to the development of education in Serbia and in the region, as well as, to gather experts in natural and technical sciences' teaching fields.

The expected scientific-skilled analysis of the accomplishment in the field of the contemporary information and communication technologies, as well as analysis of state, needs and tendencies in education all around the world and in our country have been realized.

The authors and the participants of the Conference have dealt with the following thematic areas:

- Theoretical and methodological questions of contemporary pedagogy
- Personalization and learning styles
- Social networks and their influence on education
- Children security and safety on the Internet
- Curriculum of contemporary teaching
- Methodical questions of natural and technical sciences subject teaching
- Lifelong learning and teachers' professional training
- E-learning
- Education management
- Development and influence of IT on teaching
- Information communication infrastructure in teaching process

All submitted papers have been reviewed by at least two independent members of the Science Committee.

The papers presented on the Conference and published in this Proceedings can be useful for teacher while learning and teaching in the fields of informatics, techniques and other teaching subjects and activities. Contribution to science and teaching development in this region and wider has been achieved in this way.

The Organizing Committee of the Conference

CONTENTS

IMPROVED ALGORITHM FOR TAG-BASED COLLABORATIVE FILTERING

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Abstract - Critical aspect in the modern e-learning systems is selecting the most adequate learning materials based on learners' requirements, needs and knowledge goals. It is especially important because of information overload. In addition, e-learning systems should deliver learning materials to learners in the format adequate to their learning style. On the other hand, it is common practice to use tags in order to filter the most useful learning materials because they allow learners to mark or highlight some learning materials with their own tags. In that way learners contribute to organizing and retrieving useful learning materials. Our previous research was focused on tag-based collaborative filtering and learning style determination in order to suggest useful learning material in adequate format.

In this paper, we propose a new tag-based collaborative algorithm that takes in consideration the factors that affect the tag-based collaborative filtering in order to develop more efficient and accurate algorithm, and suggest the learning materials based on posted tags rating and students rating.

The developed system was implemented at the Faculty of Law – Bitola, and the evaluation results are shown in this paper.

I. INTRODUCTION

Recommending systems in e-learning environments utilize information about learners and learning activities and recommend items such as papers, web pages, courses, lessons and other learning objects that meet the pedagogical characteristics and interests of learners [1]. The effective recommending system in e-learning environments must take in consideration some learners' characteristics like learning goals, knowledge level, learning characteristics, strategies and etc. The main goal of the recommending systems is making predictions using as much as possible user ratings and tags available for a given item.

Collaborative filtering is a wildly used approach to recommend adequate items to users based on the assumption that similar minded people will have similar taste, requirements, needs or behaviors. It can help users organize, share and retrieve information in an easy and quick way [2].

With the increased use of the collaborative tagging systems, tags could be useful information to enhance algorithms for recommending systems. These systems can support learners by recommending learning resources and tags. Collaborative tagging is a mechanism for describing items in large on-line collections. In other words, collaborative filtering approaches predict the rating of items for a specific user based on the ratings and tags from other users, which have similar interests. The same is for tag suggestions. Tagging has recently become very popular and useful. At the same time, it is an effective way of classifying items and categorizes them in groups that contain items with similar characteristics. Tags are assigned by users to describe and find back items [3]. The use of tags, keywords freely chosen by users for annotating resources, offers a new way for organizing and retrieving web resources that closely reflects the users' mental model and allows the use of evolving vocabularies [4].

Because different learners may add different tags on the same learning material while the same tag may contain different items for different users, the user should be profiled not only by the tags and items, but also by the relationship between the tags and items of the user [5].

In our previous researches [6,7,8], we have implemented an intelligent e-learning system that was used in the educational process at the Faculty of Law in Bitola. It includes the use of an adaptation rules and ontology for knowledge representation and supports the learners by recommending learning materials, online learning activities based on their learning style, knowledge level and the browsing history of other students with similar characteristics, based on the tags entered by the students. In other words, the system uses collaborative filtering based on tags posted from the students. The students can add tags for the learning materials by using an interface and simply by entering one or more tags separated by

commas in the free-text input text field. In our another research [9], we have identified the factors and parameters that influence a tag based collaborative filtering used for recommending the most adequate learning materials. In that content, we have identified the following factors: students rating, tags rating and learning materials rating.

In the scope of this paper, we review several tag-based collaborative filtering algorithms and propose a new tag-based collaborative algorithm that takes in consideration the factors that affect the tag-based collaborative filtering in order to develop more efficient and accurate algorithm. Our approach determinates the similar profile with logged student, selects the adequate learning materials and forces the more important learning materials – materials that have tags with high rating set by students with high rating.

II. RELATED WORKS

The authors in [2] proposed a tag-based collaborative filtering approach for recommending personalized items to the users. Based on the distinctive three-dimensional relationships among the users, tags and items, they proposed a new similarity measuring method, which generates the neighborhood of users with similar tagging behavior instead of similar implicit ratings. Based on experimental result, the authors show that by using the tagging information, the proposed approach outperforms the standard user and item based collaborative filtering approaches. In [10], the authors proposed a framework for improving recommending systems through exploiting the users tagging activity. They stress social annotation as a new and powerful kind of feedback and as a way to infer knowledge about users. In addition, they investigated the role of tags in the definition of the user model and the impact of the tags on the accuracy of the recommendations. The authors in [11] proposed a novel algorithm for tab-based collaborative filtering, which exploits user-contributed tags that are common to multiple domains in order to establish the cross-domain links necessary for successful cross-domain collaborative filtering. The authors introduced a constraint involving tag-based similarities between pairs of users and pairs of items across domains. By using two publicly available collaborative filtering data sets as different domains, the authors experimentally demonstrated that the new algorithm substantially outperforms other state-of-the-art single domain collaborative filtering and cross-domain collaborative filtering approaches. The authors in [12] proposed a collaborative approach for expanding tag neighbors and investigate the spectral clustering algorithm to filter out noisy tag neighbors in order to get appropriate recommendation for the users. Based on the preliminary experiments that have been conducted on MovieLens dataset to compare the proposed approach with the traditional collaborative filtering recommendation approach and native tag neighbors expansion approach in terms of precision, the result demonstrates that the proposed approach could considerably improve the performance of the recommendations. The authors in [3] focused on generating tab-based profiles for the users and then recommended new learning materials based on the generated profile. In addition, they introduced topic aware recommendation algorithm - first detect different interests in the user's profile and then generate recommendations for each of these interests. The authors in [13] present a tag recommending system, which extends the collaborative filtering with a content-based approach able to extract tags directly from the textual content of HTML pages. Results of their experiments carried out on a large dataset gathered from Bibsonomy, where's shown that the use of content-based techniques improves the predictive accuracy of the tag recommender.

III. PROPOSED APPROACH

All of the users can describe learning materials with a set of tags. In that manner, the system creates a complex network of users, learning materials and tags. In this paper, we use three-dimensional relation: learner – learning material – tag in order to determinate learners that set tags for specific learning material. In that manner, we can define the following sets:

$S = \{ S_1, S_2, ... S_n\}$: set of learners (in our case students)

$L = \{L_1, L_2, ... L_n\}$: set of learning materials (video or audio)

$T = \{T_1, T_2, ... T_n\}$: set of tags posted from students S for learning materials L

Additional, learners and tags have their own rating. The learning material becomes important if it is tagged with important tags by important learners. For instance, one learning material could be tagged with important tags by important learner. Then, the tagged learning material can be considered as an important learning material and suggest it to the logged learner. The same holds for the learners and tags.

The main idea of our paper is using tag-based collaborative filtering in order to suggest the most relevant learning materials to the learners, but also to take in consideration the learners' and learning materials' rating. With other words, the suggested algorithm will force the more important learning materials – materials that have tags with high rating set by learners with high rating.

To generate the suggested list of learning materials using collaborative filtering, the system needs to complete two steps.

The first one is finding the neighborhood of the logged learner - a set of the most similar profiles, order them by their rating and select the top N profiles.

Once the most similar profiles are identified, the second step is to select the learning materials that could be recommended. These materials will be taken from the set of materials which the selected similar top rating profile set tags, and which the logged learner has not posted yet. In this step, the system will force the learning materials with higher rating.

Within the first step, we use BM25, also known as Okapi BM25. It is a non-binary probabilistic model used in information retrieval [14]. It calculates the relevance that the learning materials of one group have given to a query. We take in consideration a set of tags of each learner and make two analogies, comparing the tags of the logged learner with a query, and the set of tags of each similar profile as a document. It means that we performed calculation of profile similarity based on the BM25 model and thus we generate a set with all the similar profiles to the logged learner. The BM25-based similarity model is taken from the calculation of the Retrieval Status Value of a document (RSV_d) of a collection of a given query [14]:

$$RSV_d = \sum_{tεq} IDF * \frac{(k_1+1)tf_{td}}{k_1\left((1-b)+b*\left(\frac{L_d}{L_{ave}}\right)\right)+tf_{td}} * \frac{(k_3+1}{k_3}$$

In our model RSV_d represents the similarity score between the logged learner (the terms of the query q) and one neighbor (the terms of the document d). This similarity is calculated as a sum over every tag t posted by the logged student. The neighbor n is represented as her set of tags with their frequencies. L_d is the sum of the frequencies of each tag of the neighbor n. L_{ave} is the average of the L_d of every neighbor. The term tf_{tn} is the frequency of the tag t into the set of tags of the neighbor n, tf_{tq} represents the frequency of the tag t into the query - the set of tags of the logged user.

After calculating the similarity between the logged learner and each neighbor, we choose the top N similar neighbors (learner profiles) with the highest rating.

Within in the second step, the system uses Cosine-based Similarity to calculate the similarity between two learning materials – learning materials for which the logged learner has set tags and learning materials for which the similar learners has set tags. Then, the system will select top N materials with highest rating. To get the more reliable results for calculating the similarity between learning material *a* and learning material *b*, we need to isolate the students who have set tags to both of these items and then to apply a similarity computation technique to determine the similarity between learning material *a* and learning material *b*.

We use Cosine-based Similarity to calculate the similarity between two learning materials. In this case, the learning materials are thought of as two vectors in the m dimensional user space [15]. The similarity between the materials is measured by computing the cosine of the angle between these two vectors, based on following calculations:

$$Similarity\ (a,b) = cos\ (\ ,\ ) =$$

Because the learners rating and the learnin materials rating have an impact on the process of determining the relevant learning materials, we need to calculate them.

A. *Student rating*

In order to calculate the learners rating, we are using two coefficients: knowledge level coefficient (C_{kl}) and student activity coefficient (C_{sa}).

Total student rating C_{kl} can be calculated as an average value of the two coefficients:

$$C_{kl} = \sum(\quad * K_{ln})$$

P_n is a score from the test of knowledge level K_{ln} and N_t is the maximum number of test points.

The student activity coefficient (C_{sa}) can be calculated as:

$$C_{sa} =$$

T_{su} is number of total tags posted from the student *S*, while T_t is total number of tags posted from the other learners for learning materials tagged by learner S.

Finally, learner rating S_{rat} can be calculating as:

$$S_{rat} =$$

B. *Learning material rating*

Average material rating (LM_r) can be calculated as an average value of two coefficients: average rating posted from the learners (R_{av}) and learners' average rating that post rating to learning material (R_{sav}):

$$LM_r =$$

The Figure 1 shows the diagram of proposed approached.

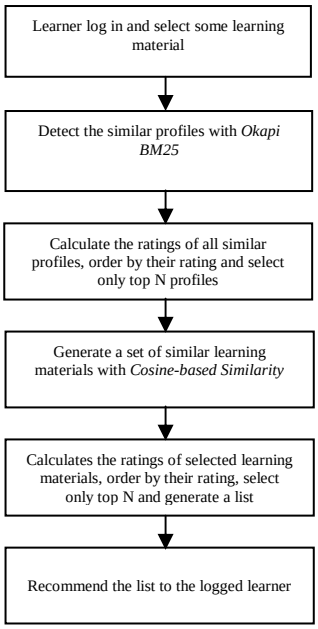

Figure 1. Proposed approach diagram

IV. RESULTS

The system was implemented at the Faculty of Law in Bitola. We compared the results from our preview research and the current research. In our preview research, we were using simple collaborative filtering for learning material recommendation, but we did not take in consideration any additional factors that affect the collaborative filtering process. In the current research, we use BM25 probabilistic model for determination of similar students with the logged student and Cosine-based Similarity for selecting the most adequate learning materials.

TABLE I. COMPARATION OF THE RESULTS

Activity	***The old research***	***The current research***
Number of learning units	91	148
Number of students	110	110
Number of tags	739	1345
Average students ratings (1-5)	/	3.89
Average learning materials ratings (1-5)	/	4.12
Used learning materials from the suggested list (%)	74.6	83.8

V. CONCLUSION

The system's ability to select the most adequate learning content and deliver it in the adequate format to the users. The main goal of our system is to recommend the most appropriate materials to the students based on the tags they set for the learning materials. Additional, we have taken in consideration students rating and learning material rating in the process of collaborative filtering.

In the scope of this paper, we proposed a tag-based collaborative filtering algorithm that takes in consideration the factors that affect the tag-based collaborative filtering in order to develop more efficient and accurate algorithm. Our approach determinates the similar profile with logged student, selects the adequate learning materials and forces the more important learning materials – materials that have tags with high rating set by students with high rating. The system calculates the rating of the learning materials and students first. Then, the system determinate the similar profiles to the logged learner based on the BM25 probabilistic model. Second, by using Cosine-based Similarity the system calculates the similarity between two learning materials – learning materials for which the logged learner has set tags and learning materials for which the similar learner has set tags. Then, the system will select top N materials with the highest rating.

After a period of using the system, we have compared the results obtained from the student's activities and we can conclude that the proposed algorithm for tag-based collaborative filtering that takes in consideration ratings of students and learning is more efficient that a standard collaborative filtering. It can be concludes based on the highest percentage of accepted items from the suggested list in the current research versus the percentage in the preview research.

The future researches could be focused on including lists with synonyms for the tags and cold star problem in tag-based collaborative filtering process in order to be recommend more adequate learning materials.

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