

Personalisation of Programming Tutoring System Using Tag-based Recommender Systems

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Abstract - Collaborative tagging systems have grown in popularity over the Web in the last years based on their simplicity to categorize and retrieve content using open-ended tags. Besides helping user to organize his/her personal collections, a tag also can be regarded as a user's or expert's personal opinion expression. Thus, the tagging information can be used to make recommendations. In this paper, an innovative architecture for a tag-based recommender system dedicated to the e-learning environments is introduced. This system could support learners by recommending tags and learning resources, online learning activities or optimal browsing pathways, based on their preferences, learning style, knowledge level and the browsing history of other learners with similar characteristics.

Keywords - *personalized recommendation; tutoring system; learning profile; collaborative tagging*

I. INTRODUCTION

With the development of sophisticated eLearning environments which characterize the huge information, the strong interactivity, the great coverage and no space-time restrictions [4], personalisation is becoming an important feature in eLearning systems due to the differences in background, goals, capabilities and personalities of the large numbers of learners, the main users of such systems. Personalized learning occurs when eLearning systems are designed according to educational experiences that fit the needs, goals, and interests of their learners. Personalisation can be achieved using different recommendation techniques [6]. Ideally, Recommender System (RS) in eLearning environments should assist learners in finding relevant learning actions that perfectly match their profile, at the right time, in the right context, and in the right way, keep them motivated and enable them to complete their learning activities in an effective and efficient way [7].

To improve recommendation quality, metadata such as content information of items has typically been used as additional knowledge [2]. With the increasing popularity of the collaborative tagging systems, tags could be interesting and useful information to enhance algorithms for RSs. These systems could support learners by recommending tags and learning resources, online learning activities or optimal browsing pathways, based on their preferences, goals, talents, learning style, knowledge level and the browsing history of other learners with similar characteristics. In this paper, we propose an innovative architecture for a tag-based recommender system adjusted to the adaptive and intelligent web-based programming tutoring system – Protus

(PROgramming TUtoring System) that takes into account pedagogical aspects of the learner. We first analyze applicability of tag-based recommender systems to eLearning environments, then we propose how can personalize a programming tutoring system using tag-based RS. Finally, we provide the concluding remarks.

II. APPLYING TAG-BASED RECOMMENDER SYSTEMS TO E-LEARNING ENVIRONMENTS

RSs in eLearning environments utilize information about learners and learning activities (LA) and recommend items such as papers, web pages, courses, lessons and other learning objects which meet the pedagogical characteristics and interests of learners [1]. Such a RS could provide recommendations which are based on previous learners' activities or on the learning styles of the learners that are discovered from their navigation patterns. To design an effective RS in eLearning environments, it is important to understand specific learners' characteristics [1]: learning goal, prior knowledge, learner characteristics, learner grouping, rated LAs, learning paths, and learning strategies.

According to these learners' characteristics, which serve as guidelines for framework design and platform implementation of good RS in eLearning environment, we considered some collaborative tagging systems for extending capabilities of traditional recommendation method. The innovation with respect to the eLearning environments lies in their ability to find appropriate content on the web, and capability to personalize and adjust this content based on the system's examination of its learners and the collected tags given by the learners and domain experts [5]. These systems also have ability to promote the learning performance of individual learners.

III. PERSONALISATION OF PROGRAMMING TUTORING SYSTEM USING TAG-BASED RS

Protus is a tutoring system designed to help learners in learning essentials of programming languages. In spite of the fact that this system is designed and implemented as a general tutoring system for different programming languages, the first completely implemented and tested version was for an introductory Java programming course. Java was chosen because it is a clear example of an object-oriented language and therefore suitable for teaching the concepts of object-orientation. The main purpose of the Protus system is to recommend useful and interesting materials to e-learners based on their different backgrounds,

preferences, learning purposes and other meaningful attributes [3]. Protus system consists of five functional modules: domain module, learner model, application module, adaptation module and session monitor.

The adaptation module provides personalization based on RSs. The proposed framework for building automatic recommendations is composed of three modules (Fig. 1):

A. A learner-system interaction module

A learner-system interaction module pre-processes data to build learner models. The data about learners' activities (like sequential patterns, visited pages, test results and grades earned) are collected within this module. The pages for learners' registration, theory sessions, tutorials, examples and tests are extended with background processing of the input data.

B. An off-line module

An off-line module uses learner models on-the-fly to recognize learners' goals and content profiles. After appropriate learning style is determined for each learner, based on the initial survey, learning content is filtered, depending on the current status of the course and learner's affiliation.

C. A recommendation engine

A recommendation engine produces a recommendation list. From the filtered list of learning content, the list of recommended actions and recourses is sent to alter learner-system interaction within a new session. Recommendations cannot be made for the whole pool of learners, because even for learners with similar learning interests, their ability to solve a task can vary due to variations in their knowledge level. In our approach, we perform a data clustering technique as a first step to cluster learners based on their learning styles. These clusters are used to identify coherent choices of learning activities. Then, a recommendation list can be created according to the learners' and experts' tags for each generated cluster based on the user-centric tag model which produces more accurate recommendations than existing state-of-the-art algorithms [8]. To create a tag in Protus the learner simply starts by clicking on active learning resource in the content and enter arbitrary keywords in the

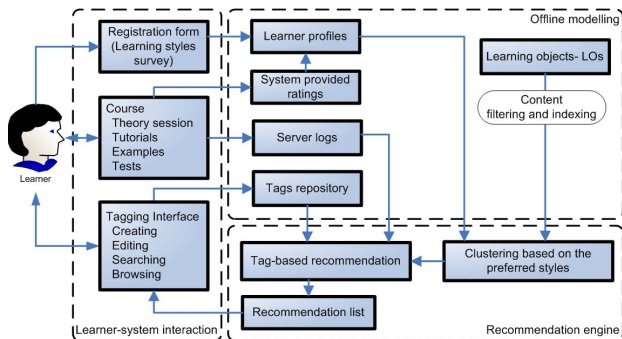


Figure 1. The recommendation component of Protus system

appropriate text field. The system allows participants to enter as many tags as they wished, separated by commas. This makes it possible to use spaces in tags, rather than restricting the participant to a single word. This is in contrast to many popular tagging systems. We will allow the use of multi-word tags to eliminate the problem of establishing a convention for word combination.

To evaluate our system, we plan to carry out some experiments on an educational dataset on 1st year undergraduate learners. Involved learners will be programming beginners that successfully passed the basic computer literacy course at previous semester. The research will be focused on appropriate selection of collaborative tagging techniques which could lead to applying the best results in terms of increasing motivation in learning process and understanding of the learning content. As a result, personalized and the most likely preferred recommendations can be estimated to an active learner that will be in accordance with the learner's interests, his/her learning style and previously acquired knowledge.

IV. CONCLUSION

This work contributes to research on personalisation of programming tutoring system. It proposes an approach that can be used to improve the functionality of RSs that aim at adapting to individual learner. We have conducted preliminary evaluations obtaining favourable results. Although this paper shows an application in programming tutoring system, considered approach can be applied in a variety of other learning domains.

REFERENCES

- [1] H. Drachsler, H. Hummel and R. Koper, "Personal recommender systems for learners in lifelong learning networks: the requirements, techniques and model", *International Journal of Learning Technology* 3 (4), pp. 404-423, 2008.
- [2] H. Karen, L. Tso-Sutter, L. Marinho, and L. Schmidt-Thieme, "Tag-aware recommender systems by fusion of collaborative filtering algorithms", *SAC '08 Proceedings of the 2008 ACM symposium on Applied computing*, pp. 1995-1999, 2008.
- [3] A. Klačnja-Milićević, B. Vesin, M. Ivanović, and Z. Budimac, "Integration of recommendations and adaptive hypermedia into java tutoring system", *Computer Science and Information Systems*, 8(1), pp. 211-224, 2011.
- [4] B. Mallinson, and D. Sewry, "Elearning at Rhodes University – a case study", *Proceedings of the IEEE International Conference on Advanced Learning Technologies (ICALT'04)*, pp. 708-711, 2004.
- [5] N. Manouselis and C. Costopoulou, "Experimental analysis of design choices in a multi-attribute utility collaborative filtering system", *International Journal of Pattern Recognition and Artificial Intelligence* 21, pp. 311-331, 2007.
- [6] P. Resnick, and H. Varian, "Recommender systems", *Communications of the ACM* 40, 1997.
- [7] T. Tang, and G. McCalla, "Smart recommendation for an evolving e-learning system: architecture and experiment", *International Journal on e-Learning*, 4(1), pp. 105 – 129, 2005.
- [8] R. Wetzker, C. Zimmermann, and C. Bauckhage "I tag, you tag: Personomy translation for advanced user models" In *WSDM '10: Proc. Int. Conf. on Web search and data mining*, pp. 71-80, 2010