Mojisola Anjorin, Doreen Böhnstedt, Christoph Rensing: Towards Graph-Based Recommendations for Resource-Based Learning using Semantic Tag Types. In: Steffen Friedrich, Andrea Kienle, Holger Rohland: DeLFI 2011: Die 9. e-Learning Fachtagung Informatik - Poster Workshops Kurzbeiträge, TUD press, September 2011. ISBN 9783942710367

Towards Graph-Based Recommendations for Resource-Based Learning using Semantic Tag Types

Mojisola Anjorin, Doreen Böhnstedt, Christoph Rensing

{Firstname.Lastname}@kom.tu-darmstadt.de

Abstract: Nearly everyone learns about new topics by searching on the Internet to be able to solve a specific task at work. Semantic tagging technologies and recommender systems can be used to support this form of resource-based learning on the Internet by suggesting similar or related resources and tags. In this paper, an approach is proposed explaining how the semantic tagging structure can be used to enhance the potential of graph-based recommendations by introducing a weighting concept based on semantic tag types.

1 Introduction

The amount of available resources on the Internet is increasing very rapidly, especially due to socially constructed resources such as wikis and blogs. It becomes increasingly difficult to determine which resources are relevant to the task at hand. Recommender Systems can be used to support the learner by suggesting interesting or similar resources to those already found [MDV+11]. An even more important support for the learner is the ranking of recommended resources considering the current task the learner is working on. The CROKODIL project [ARB+11] aims to provide a platform supporting collaborative knowledge acquisition in professional education. Along with a pedagogical concept, it offers semantic tagging, recommendations and social network functionality to support the learning community. The central pedagogical elements in CROKODIL are *activities* [ARB+11]. Activities are used to structure tasks and the resources needed to accomplish these tasks.

Section 2 explains Resource-Based Learning (RBL) and shows how CROKODIL supports learners in all process steps of the RBL model highlighting the concept of semantic tagging. Section 3 gives a brief overview of recommender systems and relevance ranking in folksonomies. In Section 4, the concept of using semantic tag types to enhance graph-based recommendations is proposed and explained with a concrete example. Finally, this paper concludes in Section 5 with an outlook on future work regarding the evaluation of this proposed approach.

2 Semantic Tagging in Resource-Based Learning

Resource-based learning can be described as using resources found for example on blogs, in forums, in Wikipedia or on YouTube for learning purposes [Rak96], [HH01]. Even at work, it is increasingly common to learn about job-related topics by referring to information found on the Internet. A resource-based learning model has been proposed by Böhnstedt [Böh11] (see Figure 1). In the *Planning and Reflecting* process step, the information need is determined and goals are defined. In the *Searching* process step, relevant resources are looked for, mainly on the Internet. These resources are tagged and stored in the *Annotating and Organizing* process step. The resources are then used in the *Utilization* process step to solve the aforementioned task and the results are shared with others in the *Sharing and Distributing* process step. These process steps can be executed independently of one another, they can be executed in any order and not all process steps have to be executed.

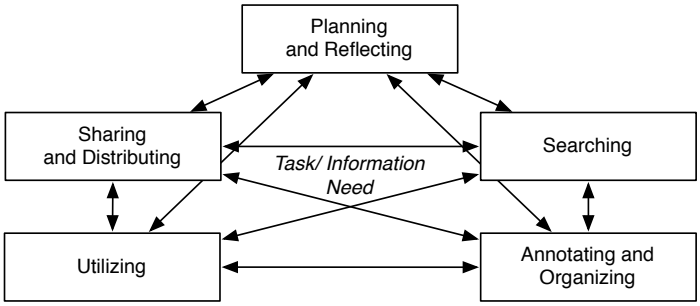

Figure 1: Resource-Based Model [Böh11]

Semantic tagging gives added meaning to tags by assigning or classifying them with a tag type [BSRS09]. CROKODIL offers five tag types: a location tag, a genre tag, a topic tag, an event tag and a person tag. In addition, CROKODIL offers activities which support the user in organizing their tasks and resources. Defining activities is seen as the starting point of each learning process. Activities are usually worked on in groups of learners. A tutor or group leader often sets the high-level activities for the group. The group then creates sub-activities which help them to organize their learning process. Users can collect resources and easily attach them to the defined activities using a Firefox add-on in CROKODIL [ARB+11]. CROKODIL offers support for all the process steps in the RBL model as described in the following example. Jonas is a public health officer in Germany and he has been asked to prepare a report for his project on the current EHEC epidemic. In the Planning and Reflecting process step of the RBL model, Jonas plans the outline of his presentation and defines what he has to learn about EHEC to write the report. As shown in Figure 2, Jonas the Activity A1 "*Prepare EHEC Report*" having some sub-activities. He creates a group for his project and invites his colleagues to join this group in CROKODIL. In the Searching process step, he searches on the Web for information about EHEC and finds the WHO website where a lot of interesting facts are given. He attaches this website

as a resource to the sub-activity A1.2.1 "*How EHEC is transmitted*". In the Annotating and Organizing process step, Jonas semantically tags this resource with the topic tag "*EHEC*" and the location tag "*Germany*". These tags will help him to find this resource later on. Jonas can browse his resources and those of others on the platform. Recommendations are made to Jonas suggesting similar or related resources about EHEC from other colleagues. After Jonas has read through the resources he has collected, he then prepares the report in the Utilization process step and attaches this report to the activity with his comments. Finally, during the Sharing and Distribution process step, he chats or sends personal text messages to his colleagues on the project requesting them to review the report.

3 Related Work

3.1 Recommender Systems

Recommender systems help to identify what is important - as well as what could be new and interesting. There are different kinds of recommender systems [JZFF11], most implementations combine different approaches to form hybrid recommender systems. Collaborative-filtering uses the ratings of users on the platform to determine which resources are important or most used or known. Graph-based recommender systems use the links between nodes to traverse the graph to find related nodes. Content based methods compare the content of items to determine the similarity or semantic relatedness between them. Knowledge based methods use external data sources such as Wikipedia to determine relationships between items. Recommender Systems have been applied to E-learning scenarios as shown in [MDV+11].

3.2 Relevance Ranking in Folksonomies

When users collaboratively attach keywords called tags to resources such as websites or blogs, a graphical structure is formed called a folksonomy. The users, resources and tags form the nodes of the graph. The relationships between these resources, users and tags such as "is tagged by" or "has a resource" form the links between the nodes in the graph. With this folksonomy structure, information about related resources or users can be inferred by traversing the links between nodes. This forms the basis for so called graph-based recommender systems [Ram11]. For example, when several users tag different resources with the same tag, this common tag could be used to connect these resources and users. One challenge here is however identifying what is important especially when the network grows to become a larger network over time, relevance ranking is proposed as a possible solution [Pet10].

Ranking can be described as a way to classify search results or in the case of recommender systems, recommendations, according to importance or relevance. There exist various graph-based approaches and algorithms for ranking in folksonomies such as FolkRank,

SocialSimRank or SocialPageRank [HJSS06]. However, according to Peters [Pet10], there still is work to be done regarding relevance ranking in folksonomies. In this paper, a ranking approach in folksonomies is introduced considering semantic tag types.

4 Graph-Based Recommendations using Semantic Tag Types

Graph-based recommendations are made by traversing the links between tags, users and resources. An approach is proposed here considering the tag types in CROKODIL to determine the weights of links in the graph for relevance ranking. In collaborative filtering, the number of users tagging a resource indicates the popularity or importance of this resource. This concept could be applied to determine the weights of tag types. For example, the number of users who used the tag type "*Topic*" shows how popular or important this tag type is to the users. This could be used as a good indication for the weight of these tag types. This could then be used to determine which resources are more relevant to be recommended. The resources will therefore be weighted according to the tag types of the tags attached to the resource. For example, in the example above, Jonas could invite his colleague Katja to join the EHEC project group to help with the Activity A1 "*Prepare EHEC Report*". Considering Katja's new Activity A1, relevant resources will be recommended to her according to the weights of these resources following the approach described above.

4.1 Determining Tag Weights based on Semantic Tag Types

The CROKODIL tag types (genre, topic, person, location, event) can therefore be used to give weights to the resources in order to rank them. For example the tag type "*Topic*" could be given more weight than the tag type "*Event*"or "*Location*". This ranking could be explained as some tag types like "*Topic*" or "*Goal*" might have a common meaning for a group of users rather than other tag types like "*Event*" which might have a more individual meaning. In a user study [Böh11], the frequency of usage of these tag types were evaluated resulting in an ordering of these tag types as shown in Table 1 (tags with no tag type (14%) are not considered here). Corresponding weights can thus be given to each of these tag types in CROKODIL according to their frequencies of usage in Table 1 (activities will be considered as goal tags when attached to resources).

Tag Type	Topic	Person	Goal	Event	Genre	Location
Frequency of usage	30%	22%	20%	16%	5%	3%

Table 1: Tag Types and their Frequency of Usage cf. [Böh11]

4.2 Determining Resource Weights based on Activity Hierarchies

CROKODIL has the concept of an activity which can be compared to the tag type "*Goal*" in Table 1, therefore activities will have the weight 0.20. Activites when attached to resources are considered as a tag type. However, activities can also be ordered in a hierarchy i.e. actvities can have sub-activities. Graph-based recommendations in CROKODIL follow the links between activities to find relevant resources. An advantage of this approach [HCZ04] is to lessen the impact of the well-known cold-start problem [JZFF11], especially at the beginning, when the platform does not yet have a lot of resources. The more links that exist between the activity under consideration and the resources in the hierarchy, the less relevant these resources get. Therefore, weights on the links between activities will reduce the overall weight of a resource (i.e. by -0.20 for every link between activities).

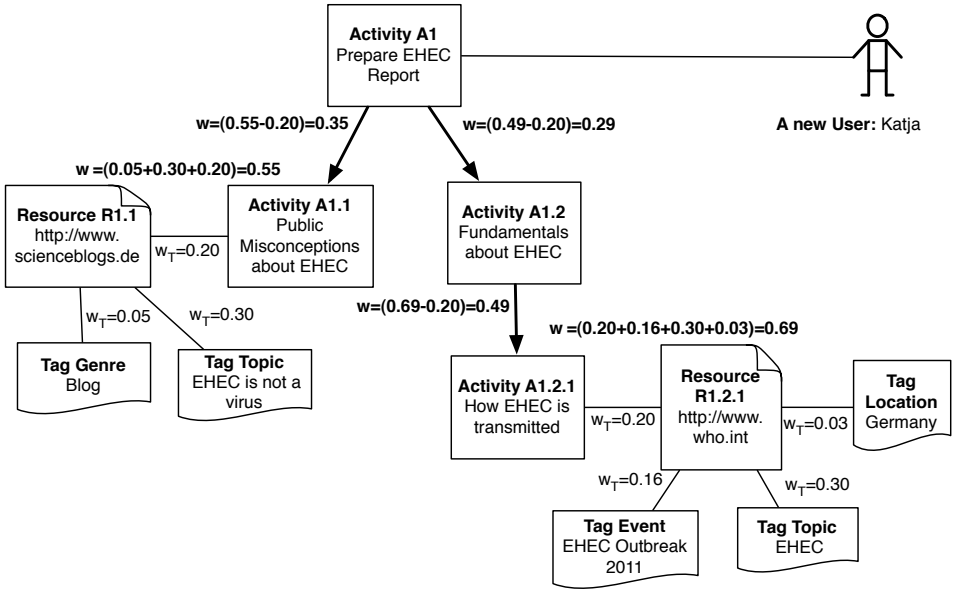

Figure 2: An Approach to Relevance Ranking based on Semantic Tag Types

In Figure 2, Katja as a new user has no resources yet. She will be working on Activity A1, therefore Resources 1.1 and 1.2.1 are potential recommendations. To determine which resource to rank higher, the weights w_T of the tag types and activity links from Table 1 are considered. Resource R1.1 therefore has a total weight w of 0.35 (0.05 from Tag Genre "*Blog*" + 0.30 from Tag Topic "*EHEC is not a virus*" + 0.20 from the Activity A1.1 (in this case, seen as a Goal tag) and - 0.20 for the link between A1.1 and A1). While Resource R1.2.1 has a total weight w of 0.29 (0.16 from Tag Event:"*EHEC Outbreak in Germany*"+ 0.30 from Tag Topic "*EHEC*" + 0.03 from Tag Location "*Germany*" + 0.20 for the activity A1.2.1 (seen as a Goal tag) - 0.20 for the link between A1.2.1 and A1.2 and - 0.20 for the link between A1.2 and A1. Therefore, Resource 1.1 is ranked higher than R1.2.1.

5 Future Work

An evaluation of the ranking approach for graph-based recommendations using the weights from the tag types in CROKODIL as introduced in this paper is planned. This will involve learners from the target scenarios [ARB+11]: IBB (Institut für Berufliche Bildung) and Siemens Professional Education. The impact of this approach will be compared to other ranking algorithms. In CROKODIL, not only resources can be recommended, but also tags, friends, learning groups and learning activities, therefore it will be interesting to consider additional ranking factors available such as social network features e.g. friendships.

Acknowledgements
This work is supported by funds from the German Federal Ministry of Education and Research und the mark 01 PF 08015 A and from the European Social Fund of the European Union (ESF). The responsibility for the contents of this publication lies with the authors.

References

[ARB+11] Mojisola Anjorin, Christoph Rensing, Kerstin Bischoff, Christian Bogner, Lasse Lehmann, Anna Lenka Reger, Nils Faltin, Achim Steinacker, Andy Lüdemann, and Renato Dominguez Garcia. CROKODIL - a Platform for Collaborative Resource-Based Learning. *To be published: EC-TEL*, 2011.

[Böh11] Doreen Böhnstedt. Dissertation. *Technische Universitä Darmstadt*, 2011.

[BSRS09] Doreen Böhnstedt, Philipp Scholl, Christoph Rensing, and Ralf Steinmetz. Collaborative Semantic Tagging of Web Resources on the Basis of Individual Knowledge Networks. In *UMAP*, LNCS, 2009.

[HCZ04] Zan Huang, Hsinchun Chen, and Daniel Zeng. Applying Associative Retrieval Techniques to Alleviate the Sparsity Problem in Collaborative Filtering. *ACM Trans.Inf.Syst.*, 2004.

[HH01] Janette Hill and Michael Hannafin. Teaching and Learning in Digital Environments: The Resurgence of Resource-Based Learning. *Educ. Tech. Research and Dev.*, 2001.

[HJSS06] Andreas Hotho, Robert Jäschke, Christoph Schmitz, and Gerd Stumme. Information Retrieval in Folksonomies: Search and Ranking. In *ESWC*, LNCS, 2006.

[JZFF11] Dietmar Jannach, Markus Zanker, Alexander Felfernig, and Gerhard Friedrich. *Recommender Systems An Introduction*. CUP, 2011.

[MDV+11] Nikos Manouselis, Hendrik Drachsler, Riina Vuorikari, Hans G. K. Hummel, and Rob Koper. Rec. Systems in TEL. In *Rec. Systems Handbook*. 2011.

[Pet10] Isabella Peters. *Folksonomies. Indexing and Retrieval in Web 2.0*. De Gruyter - Saur, Berlin, 2010.

[Rak96] Glenda Rakes. Using the Internet as a Tool in a Resource-Based Learning Environment. *Educational Technology*, pages 52–56, 1996.

[Ram11] Maryam Ramezani. Improving Graph-based Approaches for Personalized Tag Recommendation. *Journal of Emerging Tech. in Web Intelligence*, 2011.