

Non-invasive User Modelling for Recommending Knowledgeable Persons in Work-integrated Learning Systems

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1 Introduction

It is widely acknowledged that knowledgeable colleagues are one of the most important sources of knowledge for workers. Finding knowledgeable persons, however, can often be difficult for several reasons. Firstly, the number of workers within an organization may be too large to know the fields of expertise of everyone. Secondly, even if workers work together in one and the same office, they are often not aware of what their colleagues are working on. Thirdly, competency databases, if available, might be outdated. In addition, such competency databases often comprise rather coarse-grained competencies (e.g. „programming skills“). This often results in the situation that most of the questions that occur are posed to a relatively small group of „experts“, even though other persons also might have been able to provide support. In our view, within an organisation all employees are potential sources of knowledge who can help in a very specific situation. This situation is determined by the user context. In line with [Fischer 2000], we argue that a user’s context typically is defined (a) by a goal of the user which can, for instance, be a task a user wants to perform or a topic he or she is working on, and (b) by the skills the user has available.

The work underlying this contribution has been carried out in the course of the integrated EU-project APOSDLE (Advanced Process-Oriented Self-Directed Learning Environment, www.aposdle.org). In APOSDLE, to achieve (a), a task and topic detection is implemented in a specialised agent. This agent observes the user interactions (e.g. keystrokes, mouse movements, applications specific actions) with typical MS Office and Internet applications and compares them to previously learned task or topic specific interaction patterns of the organisation. Whenever a new task execution or topic is detected, a logging service is invoked. For (b), a user model [e.g.

Brusilovsky and Millán 2007] is needed which is continuously updated according to each user's knowledge state.

With this contribution we present the APOSDLE People Recommender Service, a service which is based on the APOSDLE user model and which takes into account the user context for identifying knowledgeable persons within an organization.

2 Modelling Users in a WIL Environment

For recommending knowledgeable persons, a user model is needed which represents the knowledge and skills of each individual user, and which is continuously updated. A variety of methods have been proposed for designing user models [e.g., Brusilovsky and Millán 2007]. While in traditional learning systems user models are typically updated by means of tests, work integrated learning (WIL) systems are facing unique challenges for maintaining user models: on the one hand each user's knowledge level needs to be determined based on his or her work activities because testing is not a viable option. On the other hand users do interact with a multitude of different applications - there is no central learning system.

Within APOSDLE we are suggesting hybrid user modelling approaches and utilise heuristics (scruffy approaches) in order to determine knowledge levels, identify subject matter experts, et cetera. The APOSDLE user model is automatically maintained applying the approach of knowledge indicating events (KIE). In a nutshell, different types of naturally occurring actions of users are observed and inferences are made on the user's underlying knowledge level in a certain topic. To give an example the repeated execution of a task „preparing a creativity workshop“ can be seen as a KIE for topics such as „*creativity technique*“ and „*workshop moderation*“. Another KIE for the topic „*creativity technique*“ could be that a person has been contacted repeatedly about this topic. The idea of KIE is similar to the approach of *evidence bearing events* proposed by [e.g., Brusilovsky 2004].

In APOSDLE's third prototype three different levels of expertise are distinguished: Learner, Worker and Supporter. For instance, "carrying out a task" is a KIE for the "Worker" level, whereas "being contacted by another person" would indicate a "Supporter" level. Thus, whenever a KIE occurs within the APOSDLE environment, the levels for all topics related to the KIE are updated. This means, at any point in time, an algorithm in the APOSDLE user model decides in which level of expertise a user is with respect to every topic in a domain. An overview of the APOSDLE user model and its services has been given in [Lindstaedt et al. 2009]. The classification into three levels of knowledge constitutes a qualitative approach to diagnosing user skills as it has been suggested for example by [Dreyfus and Dreyfus 1986] who identified five stages of skill development. The APOSDLE user model is implemented in a Java component, offering a set of service interfaces to store and access user data.

3 Recommending Knowledgeable Persons

In WIL, recommending knowledgeable persons means finding people within the organization who have expertise related to the current (learning) goal of a user. This

kind of functionality is inspired by expert finding systems which have already been implemented and described for example in [Yimam-Seid and Kobsa 2003]. In APOSDLE, the People Recommender Service provides this functionality. Based on the knowledge levels stored in the user model the People Recommender Service suggests knowledgeable persons. Users specialized in certain topics are represented in the user model with higher knowledge levels for these topics. Other users can now individually be provided with colleagues having equal or higher experience. Similar recommendations are made by systems like the MetaDoc system [Boyle 1994]. However, APOSDLE's People Recommender Service uses a more dynamic way of identifying experts. Knowledgeable persons are found by comparing the current knowledge levels of all users with the knowledge level of the user who will receive the recommendation.

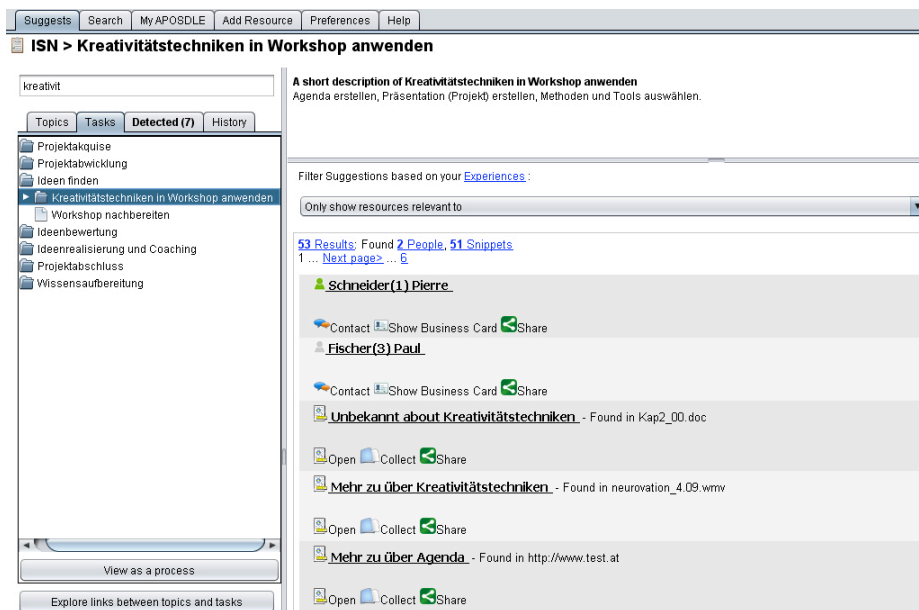


Figure 1: APOSDLE Suggests application recommending people and resources

Together with other knowledge resources (documents, videos, etc.) knowledgeable persons are suggested in an application called *APOSDLE Suggests* (Figure 1). For instance, in the left pane of Figure 1, the task “Kreativitätstechniken in Workshop anwenden” (Applying creativity techniques in a workshop) is selected. Based on this selection APOSDLE recommends different types of resources. In this example the first two entries listed in the right pane (Schneider Pierre and Fischer Paul) are knowledgeable users provided by the People Recommender Service.

The People Recommender Service is implemented as a Java component providing its functionality as a web service to clients as shown in Figure 1. The component is integrated into the client-server architecture of APOSDLE applying the SOA paradigm to structure the server functionality into services.

4 Conclusions and Outlook

Two challenges have been addressed within this contribution namely the non-invasive diagnosis of user skills and the recommendation of knowledgeable persons.

Clearly, the KIE approach is promising. However, our work suggests several avenues for follow-up. On one side, research must focus on the suitability of different KIE for diagnosing knowledge levels, which may also depend on the organizational setting.

Moreover, we are currently working on including a variety of additional KIE such as collaboration events and document creation. We also plan to incorporate negative KIE, such as unsuccessful task executions. Further, a simulation study will shed light on the usefulness of different algorithms for the maintenance of individual user models. With our simulation, two aspects shall be taken into account, that is the question of how well an inference mechanism is able to detect the knowledge state of a user, and the question of how well an inference mechanism is able to detect modifications in the knowledge level of a user.

The usage of KIE also brings up concerns with respect to user privacy. KIE can be seen as a specific form of eavesdropping and within WIL environments could potentially be abused for hidden productivity measurements [Hartman 2001]. Within APOSDLE, a dedicated Privacy Enhancement Service handles a variety of privacy measures such as filtering of service outputs or controlling access to certain usage data. Nonetheless, more in-depth research will be required to address remaining privacy issues.

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