Automating Knowledge Transfer and Creation in Knowledge Intensive Business Processes

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Abstract. It is a well known fact that a wealth of knowledge relies in the employees which makes them one of the most or even the most valuable asset of organisations. But often this knowledge is not documented and organised in knowledge systems as required by the organisation, but informally shared. Of course this is against the organisation's aim for keeping knowledge reusable as well as easily and permanently available independent of individual knowledge workers.

In this contribution we suggest a solution which captures the collective knowledge to the benefit of the organisation and the knowledge worker. By automatically identifying activity patterns and aggregating them to tasks as well as by assigning resources to these tasks, our proposed solution fulfils the organisation's need for documentation and structuring of knowledge work. On the other hand it fulfils the the knowledge worker's need for relevant, currently needed knowledge, by automatically mining the entire corporate knowledge base and providing relevant, context dependent information based on his/her current task.

1 Introduction

In knowledge intensive organisations it has become a common practice to utilise Knowledge or Content Management Systems to document the knowledge and structure it. In order to support the execution of business processes Workflow Management Systems are used. However, all these systems usually are very rigid and often do not contain the information relevant to the user, namely information exactly matching her current demands. This is especially true for non-routine knowledge intensive and weakly-structured business processes such as consulting, paper work, research etc. (see for example [12]). Moreover, information provided by these systems usually is not exhaustive, sometimes difficult to retrieve, and not being interlinked only allows one perspective on the contained information. Extensive and sophisticated knowledge about how to execute a task and the resources which are needed to do so are usually held by the knowledge workers themselves. On demand, and most often informally, they exchange their knowledge. This meets their need for flexibility and self-organised working, and helps them evade the before mentioned problems.

Of course, this practice is limited. With an increasing number of employees, tasks and business processes as well as potentially useful resources, sharing becomes difficult. Employees cannot overlook the amounts of resources any longer, and multiple sharing takes time. Moreover, this kind of unorganised knowledge sharing might not be in the interest of the organisation. Especially larger organisations aim for standardisation and control in order to achieve business compliance. Knowledge resources and activities must be structured in order to make them easily and permanently reusable, independent of individual knowledge workers. Though, despite its need for structure the organisation is interested in reverting to the wealth of knowledge their employees possess, maybe thereby detecting knowledge otherwise remaining hidden. So, both sides want to utilise the collective intelligence, but both for a different purpose.

Our proposed solution is a system which allows sharing resources like documents, web pages but also task lists or ad-hoc processes automatically - automatically because with a certain amount of employees and resources personal sharing becomes even more difficult. This requires means for capturing resources accessed by a knowledge worker, capturing the context and/or task in which a resource has been accessed and the attention a knowledge worker has paid to the resource (see for example [4]). Also, recent trends in Web 2.0 show that additional effort for users should be kept low while providing an immediate benefit for the user. Hence the effort for a knowledge worker and for sharing her knowledge should be as small as possible in order to let the employee concentrate on the work at hand rather than on sharing knowledge.

Therefore this contribution introduces and analyses automatic methods and techniques for sharing knowledge and best practices in knowledge intensive business processes. In particular we propose techniques for

– Collaborative creation of knowledge intensive ad-hoc processes
– Support for automatic task oriented information delivery
– Automatic task oriented tagging and sharing of valuable resources

Beside outlining those techniques in theory, results found in the research project DYONIPOS [1] confirm the applicability of those techniques in large, knowledge intensive organisations. Our use case evaluations show that applying such techniques can enhance knowledge exchange along informal paths, emerging from the need of the workers rather than from the structure of the organisation.

[1] DYnamic ONtology based Integrated Process OptimiSation, http://www.dyonipos.at

The rest of this publication is organised as follows: Section 2 outlines the approach taken in the research project DYONIPOS for supporting knowledge sharing in knowledge intensive business processes. Section 3 discuses techniques successfully applied in a use case and provides a conceptual viewpoint on techniques for knowledge transfer. Section 4 concludes on the presented results and provides a future outlook.

2 Approach

DYONIPOS introduces the concept of two different roles a modern knowledge intensive organisation has to intertwine closely in order to support knowledge intensive business processes: the role of the process executor/knowledge worker and the role of the process/knowledge engineer. DYONIPOS starts with recording the daily activities of the knowledge worker (see figure 1, right hand side) and transforming those activities automatically into process oriented tasks.

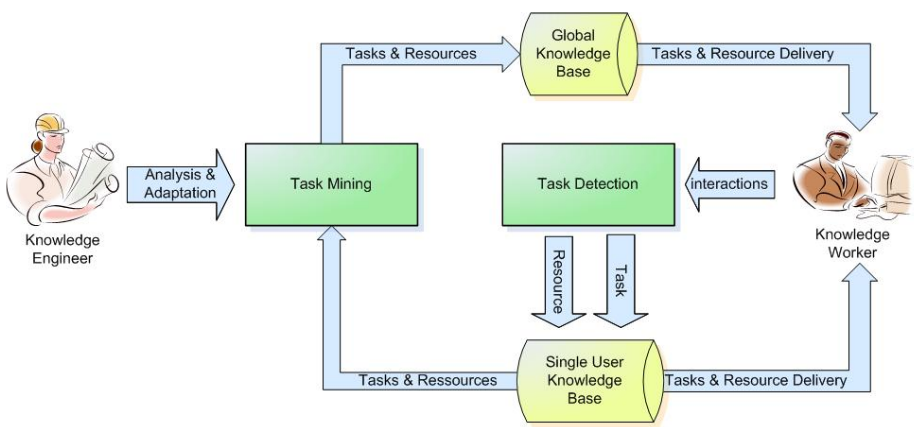

Fig. 1. Sketch of the DYONIPOS cycle for supporting knowledge workers and knowledge engineers

Recording of activities begins on a very low level where DYONIPOS records events like mouse clicks and key strokes. Events are aggregated into larger units called "Event Blocks" by using a set of static rules. One such rule e.g. is that continuous events in an application belong to the same event block. In addition, the content displayed by an application is added to an event block. By utilising supervised machine learning techniques DYONIPOS is capable of learning which sequence of event blocks belong to which user specific task. Users may train or re-train the classifier over time, achieving a highly accurate mapping between their digital interactions with tasks they are currently doing. Having those tasks allows DYONIPOS to move to the process level and aggregate tasks to processes. Therefore we utilised the process mining framework ProM [3], but evaluation showed that currently this step is too inaccurate for further use and so it will be excluded for further analysis. Figure 2 provides an overview over the extraction process.

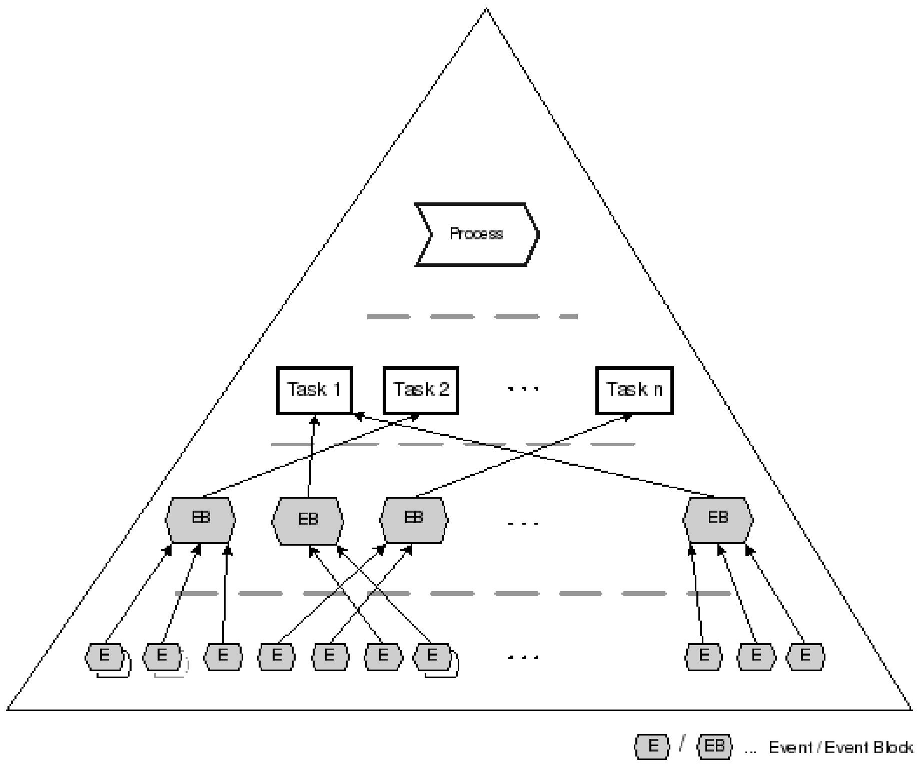

Fig. 2. Aggregation of single events to event blocks, tasks and processes.

After determining the current task of the users, DYONIPOS identifies the resources (e.g. documents, inter- and intranet web pages, e-mails etc.) the user pays attention to in this particular task. Resources the user payed attention to are assigned to the current task and stored in the database for retrieval and further evaluation. In this way, DYONIPOS is capable of automatically determining the valuable knowledge resources for the specific task. More details on the DYONIPOS System are outlined in [10].

However, the most important aspect here is that DYONIPOS is capable in automatically detecting a user's tasks and assigning relevant resources to these tasks. So, for example, if a user surfs the web for and finds interesting sites on a specific topic, DYONIPOS automatically extracts this task and assigns the found sites to this task.

All tasks and resources are stored into a user specific and a global knowledge base. For reasons of data security the user specific knowledge base is locally stored, while the global knowledge base is somewhere in the corporate intranet. The m2n Intelligence Management Framework [6] - an ontology driven application framework - is the backend of the local and global knowledge base. Based on RDF, OWL-DL and containing state-of-the-art text mining and ontology learning techniques, the m2n Intelligence Management Framework allows to semantically harmonise all different resources encountered.

In particular, local and global knowledge bases serve two general purposes:

- It provides data to be analysed by the knowledge engineer.
- It is used to automatically deliver resources to the user based on her specific context and task.

In the example above some resources on the topic of interest may already exist in the knowledge base. After the task of the user has been detected, those resources can be delivered (see [5] for details). Note, that not only resources the user has accessed in the past are returned from her local knowledge base, but also resources from other knowledge workers as well as tasks of other users similar to the current task from the global knowledge base. Initially, it was also planned to provide users with similar workflows, but the process mining component was too inaccurate for automatically extracting such workflows.

However, for supporting the knowledge engineer, DYONIPOS utilises process and data mining techniques to identify interesting activity patterns in the global knowledge base. By means of simple statistics like bar charts, box plots etc. DYONIPOS provides the knowledge engineer with information on how often resources have been accessed which allows to infer their usefulness.

Besides, DYONIPOS allows to analyse tasks stored in the global knowledge base using more complex visualisations like for example a landscape visualisation. Herein, tasks are grouped according to their similarity forming clusters of similar tasks. Those clusters, as well as the tasks themselves, are placed onto a 2D surface preserving the similarities of those tasks. Thus, tasks similar to each other are placed close to each other forming islands of similar tasks. Each island is labeled with the most frequent keyword occurring in either the title of the task or the content accessed in the task. Figure 3 shows an example of such an visualisation. The visualisation follows the InfoSky approach outlined in [2]. The knowledge engineer may interact with this visualisation by zooming in, panning or selecting tasks of interest and refining them in a separate visualisation. Overall, this kind of visualisations provides means to explore a huge amount of tasks gathered by the users and to analyse their work patterns, which in turn may be used to optimise the companies internal organisation.

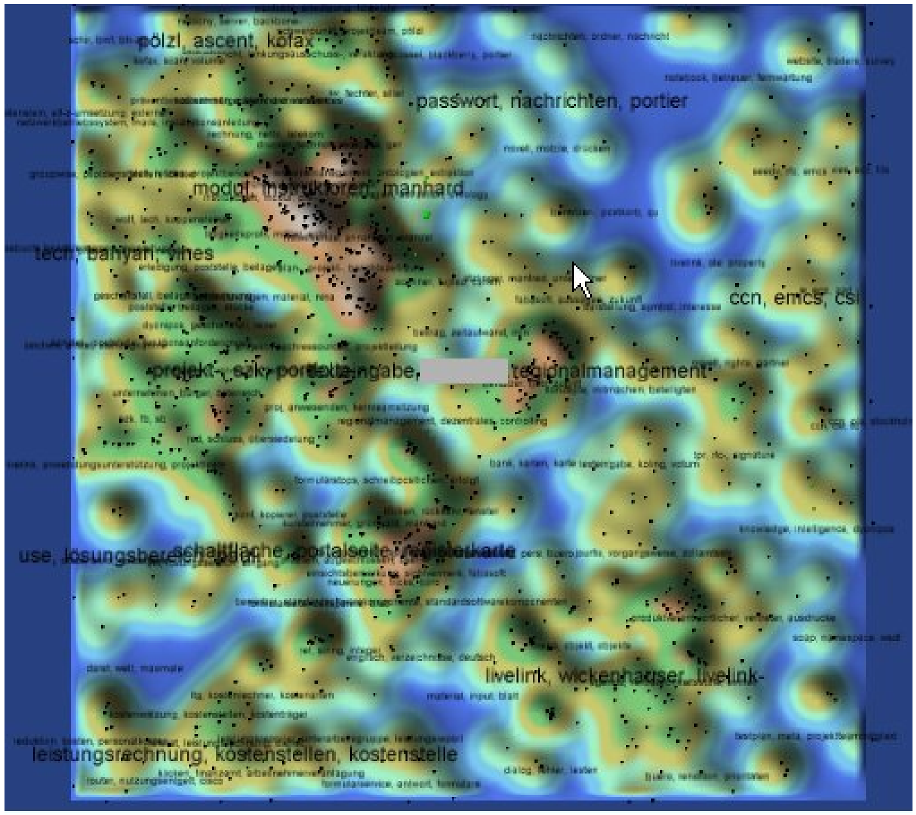

Fig. 3. Visualisation of similar tasks utilising landscape visualisation methods. Similar tasks are placed close to each other generating "islands" of similar tasks. Height indicates the amount of similar tasks. Additionally, islands are labeled with the most frequent keywords and/or persons for the tasks in this island.

To summarise, DYONIPOS allows to automatically extract tasks and important resources from the users' daily work, automatically provides relevant resources based on the current task and allows to analyse patterns in the tasks of all knowledge workers. Based on this functionality, the next section outlines use case results and derives concepts for automatic knowledge transfer based on our findings.

3 Concepts and Use Case Results

DYONIPOS has been developed over the last two years and was applied in two use case settings with 10 test users over several weeks for evaluation of different aspects (see [7]). Those test users were employees in a governmental institution and heavily involved in knowledge intensive processes. Especially the capability of DYONIPOS of automatically delivering knowledge about how to perform a task, in addition, of sharing relevant information sources without increasing the workload of the user, has been proven to be one of the most important points.

For evaluation data gathered by DYONIPOS was analysed. Furthermore, a questionnaire was answered by the key users summarising their findings. Looking at the results in more detail, several concepts and their technical solution for fostering knowledge sharing and utilising collective knowledge can be derived:

- Collaborative creation of knowledge intensive ad-hoc processes: One important aspect in DYONIPOS lies in the implicit collaborative aspect of creating the global process and task knowledge base. While knowledge on how to perform a task is valuable, sharing of such knowledge suffers two major problems. First, knowledge workers can hardly express how they are doing tasks which makes sharing difficult. Additionally, traditional systems hardly allow users to share their knowledge besides writing it down - a task adding additional workload to knowledge workers.

  As DYONIPOS and our use case evaluation showed, state-of-the art data mining techniques allow the creation of personal task repositories with satisfyingly high accuracy. Experiments indicated that tasks can be correctly identified with an accuracy of roughly 77% and user tests revealed that most of the users where satisfied with the quality of the task detection. Those results are in line with other research groups like [9], reporting similar accuracy levels for task detection.

  Having tasks digitally stored and having the ability to treat tasks similar to documents, a lot of new possibilities arise. For example, tasks can be distributed among users easily. Users have the possibility to search for specific tasks or the system may suggest specific tasks to users based on their role and current position in a standardised workflow. Additionally, process and knowledge engineers are able to analyse knowledge intensive work and to optimise specific workflows and processes.

- Support for automatic, task oriented information delivery: As outlined in [1], process specific information delivery greatly enhances knowledge transfer. However, the rigidity of traditional systems inhibits a finer grained, personalised task specific information delivery, due to the simple fact that not all knowledge intensive tasks are covered. Since DYONIPOS automatically extracts the current task of a user and since it is able to detect similar tasks of other users, information delivery can be greatly enhanced, overcoming the above restrictions of granularity and personalisation.

Furthermore, we followed the just in time (JIT) retrieval paradigm, as pointed out by [11]. JIT retrieval means, that on specific points in time information resources are searched and displayed automatically. The benefit, in contrast to classical retrieval where users are doing keyword based queries, is the fact that without user interaction relevant results are displayed on the screen. While there is room for improvement of the underlying retrieval model, the current user interface and the detection of retrieval time point, JIT retrieval increases the probability of knowledge workers getting information from their colleagues. However, use case results show that accuracy of the retrieval process must be high in order to achieve a high acceptance.

– Automatic task oriented tagging and sharing of valuable resources: Usually corporate document management systems are used for sharing valuable resources. However, due to the growing importance of the WWW web sites are of increasing relevance as corporate information resources. Since document management systems usually exclude websites, they remain incomplete. Recent studies (see [8]) show a high acceptance of bookmaking web sites in corporate settings and of sharing those sites with colleagues.

  Since DYONIPOS is capable of identifying relevant web resources and storing those resources into the personal and global knowledge base, DYONIPOS cultivates such sharing of web resources. To consider privacy issues, resources are not automatically committed to the global knowledge base but only after approval from the users. However, since DYONIPOS knows the current task the user currently performs, resources can be automatically tagged with this task. This may be used either instead of tagging or to bootstrap a corporate social bookmarking system. Overall, by providing semi-automatic support in sharing relevant web sites the wide acceptance of corporate social bookmarking systems may be increased.

4 Conclusion

Overall these concepts point towards collective creation and sharing of knowledge in business domains, supported by intelligent techniques. There is a strong evidence that user driven, bottom up growth of knowledge intensive business processes is feasible and that knowledge sharing can be leveraged by automatic support as provided in DYONIPOS. Of course, because of automatisation collective knowledge creation and sharing happen in an indirect and unconscious way.

However, open questions remain concerning user acceptance and privacy issues. While we did not encounter any negative effects of recording user interactions, users may decline the use of such systems due to privacy concerns. Another open point is the quality of automatic processing. While we achieved reasonable results of around 77% accuracy and our test users acknowledged this accuracy, one potential risk is that automatic methods aggregate non related tasks or yield to unsatisfactory results. Also, the automatic delivery of resources may not necessarily judged as a benefit by the user.

Nevertheless, results obtained in DYONIPOS did not show such effects and are a positive indicator for the acceptance of intelligent technologies mining collective knowledge. Applying DYONIPOS methods in further scenarios and practical settings will show the acceptance level of such technologies. Hopefully the techniques outlined in this contribution will serve as possible starting point for other research groups.

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