Workflow Adaptation in Process-oriented Case-based Reasoning

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Workflows are an important research domain, as they are used in many application areas, e.g., there are business workflows, scientific workflows, workflows representing information gathering processes, or cooking instructions. Workflows are "the automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules" [4]. Thus, workflows consists of a structured set of tasks and data objects shared between those tasks. In this regard, Process-oriented Case-based Reasoning (POCBR) [7] addresses the creation and adaptation of processes that are, e.g., represented as workflows. Although, POCBR is of high relevance little research exist so far.

The presented research focuses on the development of new workflow adaptation approaches and related topics, for instance the retrieval of workflows. Methods are investigated, which automatically learn adaptation knowledge from the case base. This prevents limited adaptation capabilities due to the acquisition bottleneck for adaptation knowledge.

1 Research Questions

This section presents the research questions addressed by my doctoral thesis in note form.

1. How can workflows be efficiently retrieved?
2. How can workflows be adapted regarding defined preferences or restrictions?
3. How can interactive workflow adaptation be realized?
4. How can the adaptability of workflows be reflected during retrieval?
5. How can adaptation knowledge be revised to address the retainment of adaptation knowledge?

The approaches to address the first two research questions are described in the next section and section 3 describes how the remaining open research questions are going to be investigated.

2 Current state of research

The presented research is implemented and evaluated using the CAKE (Collaborative Agent-based Knowledge Engine) framework[1] developed at the University of Trier. It deals with semantic workflows and is able to compute the similarity between two workflows according to the semantic similarity [2]. The approaches will are illustrated and investigated in the cooking domain, i.e., the workflows represent cooking recipes.

Currently, approaches addressing the first two research questions have been investigated:

1. Based on research about clustering of workflows [3], the problem of improving retrieval performance by developing a cluster-based retrieval method for workflows [8] was addressed. To achieve this, a new clustering algorithm, which constructs a binary tree of clusters was developed. The binary tree is used as index structure during a heuristic search to identify the most similar clusters containing the most similar workflows in a top-down fashion. Further, POQL [12] was developed serving as query language to guide the retrieval and the adaptation of workflows regarding defined preferences or restrictions.
2. Several adaptation approaches had been investigated to address the second research question. A compositional adaptation approach for workflows was investigated [9] where workflows are decomposed into meaningful subcomponents, called *workflow streams*. In order to support adaptation, streams of the retrieved workflow are replaced by appropriate streams of other workflows. Based on this work, operator-based adaptation [11] has been developed. The adaptation operators are learned automatically based on the workflows in the case base enabling to remove, insert or replace workflow fragments. Further, workflow generalization and specialization has been addressed [10], which increases the coverage of the workflow cases and thus being able to support adaptation as well.

3 Future Work

In future work, an additional adaptation approach will be investigated for semantic workflows, similar to the adaptation approach presented by Minor et. al. [6], which is based on adaptation cases describing how to transform a particular workflow to a target workflow. The future work addressing the remaining research questions 3.-5. is summarized below.

A drawback of applying traditional adaptation methods is that the adaptation goal must mostly be known previously. Consequently, this can lead to a non-optimal or not desired solution. Hence, interactive adaption [1] will be investigated, as it is a promising approach to overcome this drawback. It supports

[1] cakeflow.wi2.uni-trier.de

the search of a suitable query and hence the desired solutions by involving user interaction during adaptation.

Further, separating similarity-based retrieval and adaptation may provide workflows that can not be at best adapted according to the query. Hence, methods will be developed that also reflect the adaptability of the workflows during the retrieval stage [13].

Moreover, feedback of workflow adaptation will be captured in order to address the retaining of adaptation knowledge [5]. This is essential, as the quality of automatically learned adaptation knowledge can not always be ensured. Thus, the quality of workflow adaptation is improved. Further, the growth of adaptation knowledge can be controlled and hence the performance of adaptation can be maintained.

References

1. Aha, D.W., Muñoz-Avila, H.: Introduction: Interactive case-based reasoning. Applied Intelligence 14(1), 7–8 (2001)
2. Bergmann, R., Gil, Y.: Similarity assessment and efficient retrieval of semantic workflows. Inf. Syst. 40, 115–127 (Mar 2014)
3. Bergmann, R., Müller, G., Wittkowsky, D.: Workflow clustering using semantic similarity measures. In: Timm, Thimm (eds.) KI 2013: Advances in Artificial Intelligence. LNCS, vol. 8077, pp. 13–24. Springer (2013)
4. Hollingsworth, D.: Workflow management coalition glossary & terminology. `http://www.wfmc.org/docs/TC-1011_term_glossary_v3.pdf` (1999), last access on 04-04-2014
5. Jalali, V., Leake, D.: On retention of adaptation rules. In: Case-Based Reasoning Research and Development, pp. 200–214. Springer (2014)
6. Minor, M., Bergmann, R., Görg, S., Walter, K.: Towards case-based adaptation of workflows. In: Case-Based Reasoning. Research and Development, pp. 421–435. Springer (2010)
7. Minor, M., Montani, S., Recio-Garca, J.A.: Process-oriented case-based reasoning. Information Systems 40(0), 103 – 105 (2014)
8. Müller, G., Bergmann, R.: A Cluster-Based Approach to Improve Similarity-Based Retrieval for Process-Oriented Case-Based Reasoning. In: Proceedings of ECAI 2014. Prague, Czech Republic (2014)
9. Müller, G., Bergmann, R.: Workflow Streams: A Means for Compositional Adaptation in Process-Oriented CBR. In: Proceedings of ICCBR 2014. Cork, Ireland (2014)
10. Müller, G., Bergmann, R.: Generalization of Workflows in Process-Oriented Case-Based Reasoning. In: 28th International FLAIRS Conference. AAAI, Hollywood (Florida), USA (2015)
11. Müller, G., Bergmann, R.: Learning and Applying Adaptation Operators in Process-Oriented Case-Based Reasoning. In: Proceedings of ICCBR 2015. Frankfurt, Germany (2015)
12. Müller, G., Bergmann, R.: POQL: A new query language for Process-Oriented Case-Based Reasoning (2015), to be submitted to LWA 2015 Trier, Germany
13. Smyth, B., Keane, M.: Retrieving adaptable cases. In: Wess, S., Althoff, K.D., Richter, M. (eds.) Topics in Case-Based Reasoning, Lecture Notes in Computer Science, vol. 837, pp. 209–220. Springer Berlin Heidelberg (1994)