SEMANTIC DESIGN PATTERNS FOR BUSINESS PROCESSES

Lobna Makni, Nahla Zaaboub Haddar and Hanene Ben-Abdallah
Faculty of Economics and Management Sciences, Mir@cl Laboratory, Sfax University, Sfax, Tunisia

Keywords: Semantic Business Process Patterns, Business process models, Conflicts, Construction rules.

Abstract: Both the academic and industrial communities are increasingly interested in developing methods and tools for automating the design of business process models. In this context, several approaches were proposed to make modeling easier and to enhance the quality of the resulting artifacts. To achieve these objectives, these approaches are based on pattern reuse. Despite the agreed uppon advantages of patterns in accelerating the design process and improving the produced model quality, a few researchers showed how to construct business process patterns. In this paper, we describe an approach to construct Semantic Business Process Patterns (SB2P) from a set of process models. A SB2P is a pattern synthesized from a set of process models belonging to the same business domain. It is composed of process fragments that are semantically close but may have structural and/or behavioral differences.

1 INTRODUCTION

Process modeling is considered a labor intensive task, whose outcome depends on personal domain expertise. Designers with low modeling competence or domain expertise may introduce errors or inconsistencies in the designed model which may lead to bad performance and high process costs (Müller et al., 2007). Thus, modeling tools must incorporate techniques to help inexperienced designers to work in an efficient manner. In fact, there is a wide agreement that reuse can accelerate the design process and produce high quality solutions by adopting best practices (Buschmann et al., 2007), (Tran et al., 2007), (Montero et al., 2010). The various modeling approaches based on reuse can be calssified into two main classes: reference modeling and pattern reuse.

Reference modeling aims to increase productivity by using configurable process models. A configurable process model is a modeling artifact that captures a family of process models and allows analysts to understand what these process models share, what their differences are, and why and how these differences occur (Rosa et al., 2010). Configured models are created for a specific domain and are meant to be customized in different application projects. They are constructed by *merging* models after detecting similarities and differences between them (Li et al., 2009) (Dijkman, 2007). On the other hand, a variety of patterns for business processes have been proposed in the literature like workflow patterns (der Aalst et al., 2003), workflow activity patterns (Thom et al., 2009) and action patterns (Smirnov et al., 2009). Workflow patterns focus on specific aspects like control flow, data flow and resource assignments. Workflow activity patterns refer to the description of a recurrent business function as it can be frequently found in business processes (Thom et al., 2009); the authors in (Thom et al., 2009) propose seven activity patterns through an extensive literature study of business process types (*e.g.,* Approval, Question-answer, Decision Making, …). In contrast to workflow patterns, action patterns are closely related to the semantic content of a process model. In addition, unlike reference models, action patterns are abstract enough to be applicable in various domains (Smirnov et al., 2009).

In this paper, we propose a pattern concept that combines the advantages of both reference models and action patterns: focusing on structural concepts specific to business processes, accounting for the semantic aspects, and ensuring a high level of abstraction to provide for a wide reuse range. More specifically, we define the concept of *Semantic Business Process Pattern* (SB2P). A SB2P is a pattern synthesized from a set of "good-quality" process models belonging to the same business domain. It is composed of process fragments that are

Makni L., Zaaboub Haddar N. and Ben-abdallah H..
SEMANTIC DESIGN PATTERNS FOR BUSINESS PROCESSES.
DOI: 10.5220/0003653500830087
In *Proceedings of the 6th International Conference on Software and Database Technologies* (ICSOFT-2011), pages 83-87
ISBN: 978-989-8425-76-8

common to the source models but it may contain fragments with different structural and/or behavioral representations in the source models. It represents a factorization of constructs *common* to process fragments in the source models. The factorization detects and resolves the semantic, structural and behavioral conflicts between them.

In the remainder of this paper, we first present our SB2P construction approach. Secondly, we highlight conflicts susceptible to exist among process fragments when trying to factorize them and we present our factorization/synthesis rules. Finally, we place the presented work in the context of already proposed approaches.

2 SB2P CONSTRUCTION APPROACH

To construct a SB2P, we start from a repository of BPM of good quality, which are classified into different business domains. Given a business domain, our approach proceeds according to the three following steps:

1. Extraction of process fragments that are semantically close and frequently present in the analyzed process models (possibly with different structures and/or behaviors): The detection of these fragments relies on label similarities (see section 3.1) using an ontology for the analyzed business process domain.
2. Difference/conflict detection: For the extracted process fragments, this step uses a set of comparison rules to identify three types of conflicts: semantic, structural and behavioral (see section 3.2).
3. SB2P construction: Once the conflicts are resolved among the semantically-close process fragments, a set of factorization rules are applied to construct the SB2P (see section 3.2).

3 CONFLICT DETECTION AND SEMANTICALLY-CLOSE BP FRAGMENT IDENTIFICATION

Comparing business processes requires a common specification notation. For the purposes of this paper, we abstract away from any specific notation and we represent BPM as directed graphs with labeled nodes. Each node has a type that represents the commonly found types in all process modeling languages: ‘activity’, ‘event’ and ‘connector’. In addition, similar to most modeling languages, our graph uses three kinds of connectors: AND, XOR and OR.

3.1 Conflict Detection

When comparing processes, we need to distinguish between semantic, structural and behavioral conflicts to carry out the comparison. A semantic conflict appears when activities use different labels between which there is a semantic relation (subsumption, part of…). A structural conflict emerges when various representations describe similar behavior. While a behavioral conflict appears when process fragments are semantically close but have different behavioral profiles. Table 1 presents our classification of conflicts inspired from (Dijkman, 2007).

Table 1: Conflicts between business process fragments.

Semantic conflicts	*Subsumed activity*: An activity named a_1 subsumes an activity a_2, if it represents the same unit of work as the other activity, but includes another unit of work as well.
	Partly corresponding activity: An activity named a_1 partly corresponds to an activity a_2, if these activities partly represent equivalent units of work, but both also represent different units of work.
Structural conflicts	*Skipped activity:* is an activity which exists in one process, but there is neither an equivalent, nor a subsumed, nor a partly corresponding activity in the other process.
	Refined activity: exists if an activity a1 exists in one process, but an equivalent unit of work is only represented by a collection of activities in the other process. The collection of activities refines the single activity, because it represents the same unit of work at a different level of granularity.
	Additional dependencies: correspond to the case in which one set of activities includes the other. The set that includes the other has additional dependencies.
Behavioral conflict	*Iterative vs. once-off occurrence*: is the case in which an activity is part of a loop in one process while it is not in the other process. This means that in one process the activity must be performed correctly in one go, while in the other process it can be performed repeatedly until the result is satisfactory.
	Different conditions for occurrence: In case the dependencies for two equivalent activities have different conditions for their occurrence.

3.2 Extraction of Similar Business Process Fragments

To compare elements of a process model with another one, we use a mapping function f_{map} inspired from (Rosa et al., 2010). With this function, a mapping between nodes of different types, or between a split and a join, has a matching score of 0. The matching score of a mapping between two activities or between two events is measured by the similarity of their labels. Given two activities, their semantic similarity score is the degree of similarity, based on equivalence between words in their labels. Words that are identical are given a score of 1, while words that are synonymous are given a score of 0.75, a value that was determined experimentally by (Dongen et al., 2008). Thus, an exact match is preferred over a synonym match. The semantic similarity score of two activities a_1 and a_2 is defined in (1).

$$f_{map}(a_1,a_2)=\frac{1*|a_1\cap a_2|+0,75*\sum_{(s,l)\in a_1\backslash a_2\times a_2\backslash a_1} synonym(s,l)}{\max(|a_1|,|a_2|)} \quad (1)$$

In equation (1) *synonym* is a function that returns 1 if the given words are synonyms and 0 if they are not. This measure considers a synonym relationship of two instances, the number of synonyms that are proposed for one term by the ontology of the domain and weights the number of synonyms against the maximum sense cardinality of these two terms. Frequently occurring words are skipped, such as "a", "an" and "for".

To find similar business process fragments, we first transform each pair of process models into a matrix where the lines and columns correspond to activities of the compared process models. Each element in the comparison matrix represents the value of the mapping function of the corresponding activities.
To illustrate our approach, we consider the two models in fig. 1describing the process of "obtaining a loan". The corresponding comparison matrix is given in Table 2.

Given a comparison matrix, we consider a *block* as a set of adjacent cells. To extract semantic process fragments from the comparison matrix, we first permute its lines and columns to form cell blocks with non zero values. Then, we use the following rules:

1. If a block consists of only one cell $C_{i,j}$ with $C_{i,j}$ =1 then activity a_i in the first process model is equivalent to activity a_j in the second model. We take this activity as it is in the pattern.
2. If a block consists of only one cell $C_{i,j}$ with $C_{i,j} \in [0.89,1[$ then the label of a_i in the first process model is semantically very close to the label of a_j in the second one. The cut off value 0.89 is determined experimantelly by (Dongen et al., 2008). We take one of these activities in the pattern.
3. If a block has a 1*k or a k*1 (k≠0) dimension and consists of cells $C_{i,j}$ with $C_{i,j} \in [0.5,0.89[$, we consider the row (or the column) activity as a *refined* one. If k=1 then the label of a_i in the first process model has the same meaning as the label of a_k in the second one. We take one of these activities in the pattern.

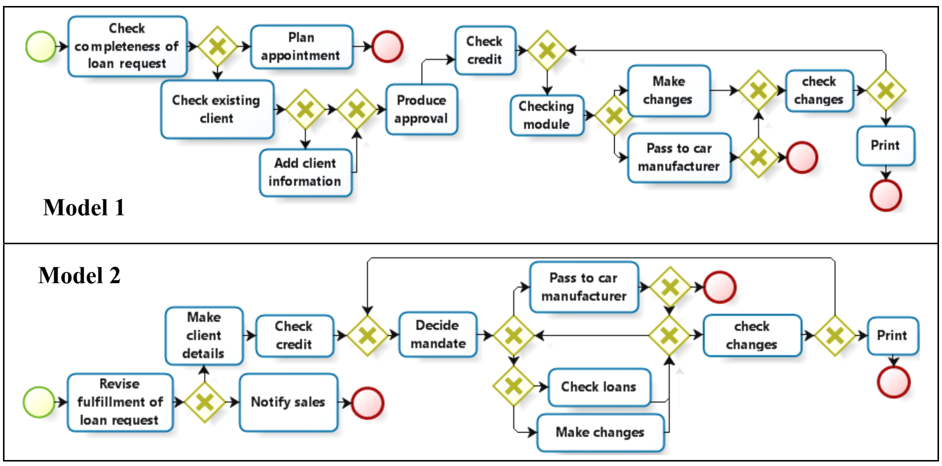

Figure 1: Examples of BPM from the repository.

Table 2: Comparison matrix for models 1 and 2.

Model 1 \ Model 2	Revise fulfillment of loan request	Make client details	Check credit	Check loans	Check changes	Pass to car manufacturer	Print	Make changes	Decide mandate	Notify sales
Check completeness of loan request	0,875	0	0	0	0	0	0	0	0	0
Check existing client	0,1875	0,583	0,33	0,33	0,33	0	0	0,25	0	0
Add client information	0	0,583	0	0	0	0	0	0,25	0	0
Produce approval	0	0	0,325	0	0	0	0	0	0	0
Check credit	0,375	0	1	0,875	0,5	0	0	0	0	0
Checking module	0,1875	0	0,5	0,5	0,5	0	0	0,325	0	0
Pass to car manufacturer	0	0	0	0	0	1	0	0	0	0
Make changes	0	0	0,325	0,325	0,875	0	0	1	0	0
Check changes	0,1625	0	0,5	0,5	1	0	0	0,325	0	0
Print	0	0	0	0	0	0	1	0	0	0
Plan appointment	0	0	0	0	0	0	0	0	0	0

Semantically close activities; Refined Activity; Additional Dependencies; Skipped Activities; Refined Activity; Identical Activities

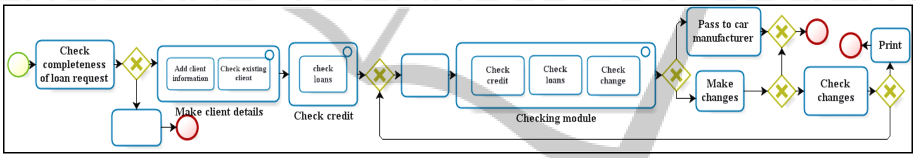

Figure 2: The resulting SB2P: Loan pattern.

4. If an activity in a model has an equivalent one in the other and has also refined activities, then we consider the refined one as additional dependencies to the activity.
5. If a block consists of only one cell $C_{i,j}$ with $C_{i,j} = 0$ then the label of a_i in the first process model haven't a corresponding activity in the second model. If a line or a column contains only 0s, we consider the corresponding activity as a *skipped* one.
   We replace a skipped activity by silent one. A silent activity in the business model is an empty activity without added value. So, it does not have label which describes his function in the model. It can be replaced by the designer during modeling.

By applying construction rules 1-5 on the example of fig. 1, we obtain the SB2P of fig. 2 which we baptize "Loan pattern".

4 CONCLUSIONS

The main contributions of this paper are to propose a new reuse concept for business processes, called Semantic Business Process Patterns (SB2P), and an approach for its construction. The proposed approach uses semantic relations to compare BPM in a given domain and to determine common fragments that are semantically close. In addition, it tolerates structural and behavioral differences among the process fragments as long as they are conflict-free. Our SB2P concept resembles more the reference modeling: they both offer process fragments. But, in contrast to the reference model construction approach which merges process fragments (Rosa et al., 2010), our SB2P construction approach factorizes fragments by taking only semantically close elements in the resulting pattern; this difference is justified by the genericity/abstraction property behind an SB2P.

On the other hand, while SB2P accounts for modeling element semantics, workflow patterns (der Aalst et al., 2003) and workflow activity patterns (Rosa et al., 2010) do not, they rather focus on specific aspects like control and data flows and resource assignments. Consequently, these patterns are more appropriate to the development of business process modeling tools than the design of business processes. We are currently automating the presented SB2P construction approach in order to evaluate its advantages and limits. In addition, we are examining the benefits of SB2P in the design of business processes.

REFERENCES

Müller, D., Reichert, M., Herbst, J.: Data-driven modeling and coordination of large process structures. LNCS, 4803:131, 2007.

Buschmann, F., Henney, K., Schmidt, D.: Past, present and future trends in software patterns, IEEE Software, 24(7/8) 31–37, (2007).

Tran, H., Coulette, B., Thuy, D.: Broadening the use of process patterns for modeling processes. In: Proc. SEKE, Knowledge Systems Institute Graduate School, 57–62, (2007).

Thom, L., Reichert, M., Iochpe, C.: On the Support of Workflow Activity Patterns in Process Modeling Tools: Purpose and Requirements, (2009).

Smirnov, S., Weidlich, M., Mendling, J., Weske, M.: Action patterns in business process models. In Baresi, L., Chi, C.H., Suzuki, J., eds.: ICSOC/ServiceWave. Volume of 5900 LNCS, 115-129, (2009).

Van der Aalst, W. M. P., Ter Hofstede, A. H. M., Kiepuszewski, B., Barros, A. P.: Workflow patterns. Distrib. Parallel Databases, 14(1), (2003).

La Rosa, M., Dumas, M., Uba, R., Dijkman, R.M.: Merging business process models. In Proc. of OTM, volume 6426 of LNCS, pages 96–113, (2010).

Li, C., Reichert, M., Wombacher, A.: Discovering reference models by mining process variants using a heuristic approach. In Proc. of BPM, volume 5701 of LNCS, pages 344-362, Springer, (2009).

Dijkman, R.: A Classification of Differences between Similar Business Processes, In Proceedings of the 11th IEEE EDOC Conference (EDOC'07), pages 37–50, (2007).

Montero, I., Pẽna, J., Ruiz-Cortés, A.: A Methodological Framework for Obtaining the Core Architecture of Business Information Systems Families. CAISE conference. (2010).

van Dongen, B. F., Dijkman, R. M., Mendling, J.: Measuring similarity between business process models. vol. 5074 of LNCS, pp. 450–464, Springer, (2008).