Configuring process variants through semantic reasoning in systems engineering

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Silvana Pereira Detro, (silvana.detro@pucpr.edu.br); Eduardo Alves Portela Santos, (eduardo.portela@pucpr.br); Hervé Panetto, (herve.panetto@univ-lorraine.fr); Eduardo de Freitas Rocha Loures, (eduardo.loures@pucpr.br) and Mario Lezoche, (mario.lezoche@univ-lorraine.fr)

Organizations faces the challenge to adapt their business process according changes that may occur in the dynamic environment in which they operate. These changes happen for different reasons, such as the introduction of new laws, changes in customers' attitudes, changes of legal regulations, among others. The result is the existence of different versions of the same process, known as process variants (Valença et al., 2013), which aim to represent all the related contexts that may differ in activities, resources, control flow and data.

Thus, it is common organizations to maintain repositories containing a collection of related process variants, known as process family (Reichert & Weber, 2012). As designing and implementing each process variant from scratch and maintaining it separately would be inefficient and costly for companies (Ayora et al., 2013), several approaches emerged aiming to support the representation of a family of business process variants via a single model. Such model is known as customizable process model, from which each variant can be derived via certain model transformations such as add, delete or move. The element of the process model that can be customized via transformations is known as variation point (La Rosa et al., 2017).

There are two approaches to variability management: by restriction and by extension. The first approach, also known as configurable process model, refers to a customizable process model that contains all behaviour of all process variants. In this approach, the customization is achieved by restricting the behaviour of the customizable process model using the delete operation. The second approach refers to a customizable process model that represents the most common behaviour, or the behaviour that is shared by most process variants. For the customization, the behaviour needs to be extended using the insert and modification operators to represent a particular situation (La Rosa et al., 2017; Asadi et al., 2014).

These approaches permit redundancies to be eliminated by representing variant commonalities only once (Ayora et al., 2012) thus providing a global view of the business process variants (Assy et al., 2015). It also fosters model reuse, i.e., parts of the model can be shared among multiple variants (Reichert & Weber, 2012) and comparison (Buijs et al., 2013).

In both approaches, selection of the most suitable variant is referred to as configuration or customization, which consists in selecting the alternatives available for each variation point. The goal of configuring a process model is to adapt the model such that it fits the model user's individual needs better than the original process model. Thus, configuring a process model means to limit the behaviour depicted by an existing process model in such a way that it only allows for the desired behaviour of the model (Gottschalk, 2009).

When configuring process variants, one challenge is to design a single basic process model from which the process variants can be configured. Another challenge is to design, model, and structure the adjustments that may be applied to configure the different process variants to this basic process model (Hallerbach et al., 2010). Besides, the process variant need be correctly configured. For example, if a model element or an entire path is removed during the customization, the remaining model elements need to be re-connected to ensure the syntactic correctness. Also, the configuration of variation points attached to parallel splits, decision points and synchronization points may lead to the introduction of problems (e.g., deadlocks) (La Rosa, 2009; van der Aalst et al., 2008).

According Ayora et al. (2012), run-time flexibility and evolution of single process variants have not been sufficiently considered so far. Run-time flexibility is concerned with the configuration decisions that only can be made at run-time when the related information is available. Thus, the challenge is related to decide by whom, when, and based on which information run-time configurations may be made. Evolution of single process variants refers to the run-time situations where the process variant needs to evolve to realign its specification to real-world business case. In this situation, proper change propagation to running process variant instances is necessary. In addition, changes in a single process variant model may require checking whether other process variants are affected as well. According the authors, another challenge is the re-configuration of a running process variant instance necessary to allow it to switch from the current process variant model to another one.

In this context, this study presents an ongoing research which aims to develop an approach for managing process variants through semantic annotations and reasoning. Semantic annotation enables to perform the semantic enrichment of "something" by using a set of well formalized and commonly agreed terms from a specific domain, such as ontologies (Liao et al., 2015). The annotation process enables the reasoning over the ontology, so to derive new knowledge.

Regarding to the configurable process model, semantic technologies have been applied for semantic validation (El-Faquih et al., 2015). Huang et al., (2013) propose to apply ontologies for process variants configuration. However, the user must to provide all the requirements before the beginning of the configuration. In our approach, the requirements must be defined during the process variant configuration.

The approach (Figure 1) proposes to select the appropriate process variant according the user's requirements by reasoning on ontologies based known expertise. The proposed approach is being developed based on the treatment of patients diagnosed with acute ischemic stroke. Thus, in our specific use case, we will use the expertise of the Brazilian guideline for acute ischemic stroke (Oliveira et al., 2012; Martins et al., 2012), both as an accepted expert knowledge for discovering different aspects about the selection of a patient's path. These aspects are essential, since they define all the conditions for the selection of any process variant in the case of acute ischemic stroke.

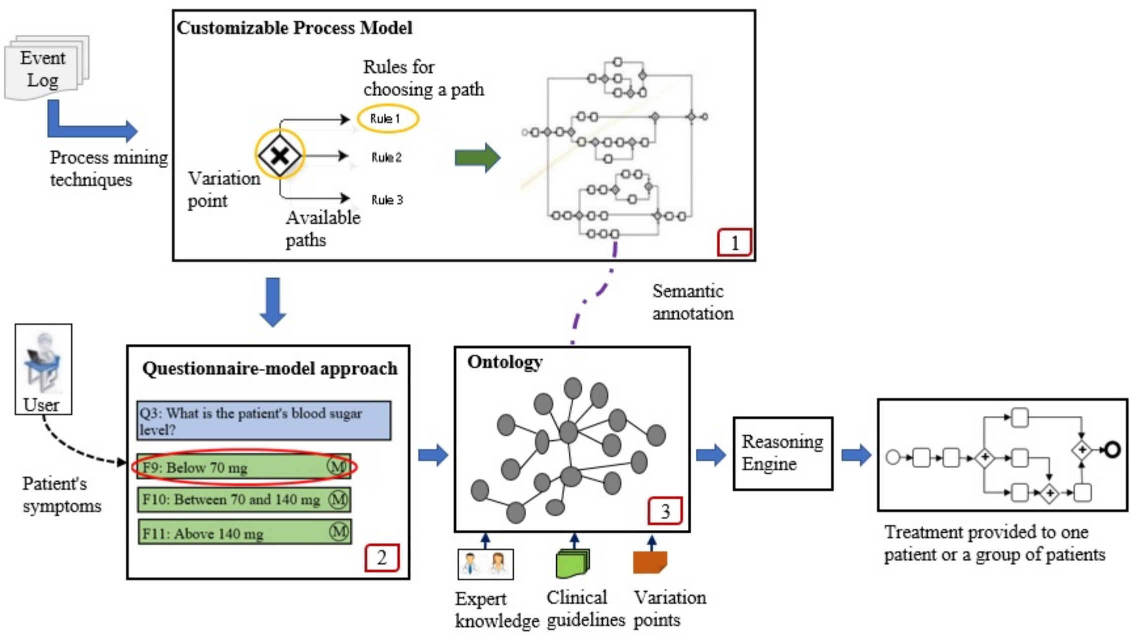

Figure 1. Framework for managing the business process variability

The framework is composed by three steps. In the first one, the event log related to the treatment of patients with ischemic stroke is analysed through process mining techniques, which enable to discover the process behaviour, to correct and to improve real processes. Thus, this technique enables to identify the three aspects to obtain a customizable process model (Ayora et al., 2012): the variation points, the alternatives available for each variation point and the rules for choosing each alternative. As result, all process variants are identified and the customizable process model is obtained.

By identifying the process variants and their characteristics from an event log, the process model can be correctly individualized by meeting the requirements of the context of application. In addition, given that process variants are identified from the event log, they reflect what happened, enabling acting more effectively in correcting or improving process variants. Besides, the implicit knowledge can be captured and made explicit, thus enabling to enrich the process variants.

The analysis of the process model enables to identify two types of variation points: mandatory and optional. According Bühne et al. (2003), a variation point is mandatory if minimum one of the related variants is selected. For example, when a patient is diagnosed with acute ischemic stroke, the neurologist must to identify the treatment appropriate to the patient according several criteria. The decision for one treatment (e.g., thrombolytic treatment) enable the selection of the related process variants. Thus, the variation point related to the selection of the patient's treatment is mandatory. Then, during the treatment, the patient may present some symptoms that will enable the execution of some activities. For example, if during the thrombolytic treatment the patient presents an elevated blood pressure, some activities must be performed to manage the patient's blood pressure (e.g. to administrate a medication such as Metoprolol or Sodium Nitroprusside). However, in this case, no process variant is selected in the variation point.

It can be noted that mandatory variation points inherit optional variation points. Thus, a selection in a mandatory variation point enables the selection of the related optional variation points. The information about the dependency between the variation points is useful for the development of the next step, which refers to configuring process variants to meet specific end-user requirements.

The analysis of the rules demonstrated that patient or treatment related information is required in selecting paths. In this way, the questionnaire-model approach was also developed (step 2) to guide users in providing the information needed for process variant selection. In this approach, each variation point refers to a question, thus the selection of an alternative refers to the selection of the paths available in relation to the respective variation point. The questionnaire-model was developed based on the information provided by the decision point analysis.

The last step is related to the ontology development. We propose to formalise in an ontology all the knowledge about the treatment and the process model. Thus, the ontology is composed by one class related to the knowledge about the variation points, the available alternatives and the rules related to the acute ischemic treatment obtained from the event log. Another class is composed by the knowledge about the Brazilian clinical guideline for the acute ischemic stroke in an ontology. This last class is also complemented with some expert knowledge. Then, we need to identify the concepts in the first class that are equivalent with the concepts in the second class.

To define an alternative related to a variation point, SWRL rules are developed based on the business rules discovered in the step 1. By reasoning on the ontology, an alternative is selected. Besides, as the ontology also contain knowledge from the guideline, the approach ensures that the selected alternative respects the regulations. Finally, the customizable process model is semantically annotating with the ontology and the Java platform can be integrated with the Jena to develop the interface with the user.

Enriching business processes with semantics improves the representation of said processes and permits automation of different tasks such as modelling, configuration, evolution, and promotes more flexible and adaptive solutions (El Faquih et al., 2014). It is also ensuring the semantically correctness of the process variant.

Besides, the customization of process model through ontologies enable to provide recommendations to the user during the selection of the process variants. According La Rosa et al., 2017 little attention has been given to this question. Thus, the configuration of process variants by means of ontologies can be an alternative to overcome the challenges related to the customization of customizable process model. The work is on-going by the operational development of the proposed framework within a prototype and its validation.

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