Tool for the Verification of BPMN Models Based on Anti-patterns

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Abstract: The verification of the behavior of business process models is an important requirement for Business Process Management. In this work, a verification tool based on behavioral anti-patterns for the verification of BPMN business process models is proposed. The purpose is to provide support to business analysts and system designers to perform verification of the control flow of business process models. The tool will be implemented as a plug-in of the *Oryx* platform and will determine whether process models are free from errors like deadlocks and lacks of synchronizations.

Keywords—business process; anti-pattern detection; behavioral anti-patterns; deadlocks

1. Introduction

Today organizations need rapid adaptation to changes to keep competitive and avoid losing market opportunities. For this reason, organizations have increased their interest in Business Process Management (BPM). BPM provides concepts, methods, and techniques to support the design, administration, configuration, execution, and analysis of business processes [1].

A *business process* model focuses on showing a process in the activity level, subprocesses, and the control flow between them [1]. The control flow allows defining the *behavior* of a business process, and refers to how an organization will carry out its activities. There are different languages proposed by consortia of organizations and companies that can be used to define business process models such as BPMN [2], EPC [3], or UML activity diagrams [4].

This work focuses on the verification of business process behavior. The incorrect definition of the behavior of business processes may increase costs and development time. Hence, in addition to methods for modeling and specification of business processes, it is required the definition of methods and tools that support the verification process behavior.

This work is organized as follows. Section 2 introduces identified problems and current solutions. Section 3 presents the goal of this work. Section 4 describes the proposed solution. Finally, Section 5 presents expected results and evaluation method.

2. Identified Problems and Current Solutions

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A business process is sound if it is free of deadlocks and lacks of synchronizations in its control flow [10,5,7]. The performance of the analysis of behavioral properties such as soundness is an important requirement to consider in verification methods.

Workflow nets [10] (WF-Nets) are a special type of Petri nets which have been used to formalize the behavior of processes and determine their soundness. However, although their analysis can be performed in linear time [6], they do not support complex constructs for advanced synchronization, cancellation, and exception management. The analysis of other types of nets, which support this type of constructs, relies on state space exploration. However, analysis of large processes may suffer the state space explosion problem, which affects negatively the performance of the verification method.

It has been proved that if a process is structured in a single-entry/single-exit (SESE) manner, it has a positive impact on verification performance [8,9,11]. However, methods using this technique do not support complex constructs.

Decomposing structured processes into smaller ones is a technique proposed to improve the performance of verification methods, since small processes can be verified more efficiently [8]. Current decomposition techniques [8,9] are essentially based on verifying independent components of a process structured as a tree in a block-based manner, where each node is a component which must be verified independently of the other nodes of the tree. However, although verification of structured processes can be performed in linear time [6], complex constructs are also not supported.

Another proposal is the use of anti-patterns to detect errors in the behavior of process models [13,14]. The concept of anti-pattern emerges from the concept of pattern. An anti-pattern captures an incorrect solution to a design problem, which should be avoided, and therefore represents inappropriate designs and practices. Although anti-patterns may improve the performance of verification methods, existing approaches may lead to erroneous conclusions about the behavior of a process such as indicating an error even though the process behavior is correct [14]. Another issue of these approaches is that they do not have enough anti-patterns to discover all possible behavioral errors of a business process.

3. Goal

The main goal of this work is to develop a tool for verifying the behavior of BPMN business process models by means of behavioral anti-patterns. The purpose is to provide a tool that offers support for business analysts and system designers to perform the verification of simple and complex control flow defined in business process models. The tool will be implemented as a plug-in of the *Oryx* platform[2] and will determine whether process models are free from errors like deadlocks and synchronization failures, indicating the exact set of model elements causing these problems.

[2] http://oryx-project.org/Oryx

4. Proposed solution

This work is focused on block-structured business process models. A business process model is block-structured if each element representing a divergence of the control flow (such as split or decision) is associated with an element representing convergence of the control flow (such as join or merge) such that with the elements of the process model it is possible to define a tree, where each node of the tree represents both the diverging and converging elements. This way, a block-structured process model is composed of blocks, where each block has a diverging and a converging behavioral semantics established by the diverging and converging elements that are part of the block respectively.

In this work, block-structured process models can be of type Single-Entry/Multiple-Exit (SEME), where there is only one entry and there could be multiple exits depending on the number of elements of type *End Event* defined in the process. In order to achieve the goal of this work, the proposed solution is described:

1. Definition of behavioral anti-patterns for SEME BPMN process models. To this aim the method proposed in [12] will be used.
2. Design and implementation as a Web Service of each behavioral anti-pattern defined in the previous task. The BPMN model input of the Web Service must be compliant to the BPMN standard so that anti-patterns can be reused by different tools.
3. Design and implementation in the *Oryx* platform of a plug-in that make use of anti-patterns defined in task 2) to determine correctness of BPMN process models.
4. Development and implementation of a module to interpret verification results returned by the proposed tool and convert them to a format understandable by any non-technical user.
5. Validation of the tool. To this aim, test cases and scenarios will be defined. Verification results and performance will be contrasted with results obtained from formal methods.

5. Expected contributions and Evaluation Method

The expected main contribution of this work is a tool that provides support to business analysts and system designers to perform the verification of the control flow defined in business process models. The tool will be implemented as a plug-in for the *Oryx* platform, and will enable the detection of errors in Single Entry/Multiple Exit BPMN process models such as deadlocks and lacks of synchronizations, showing the precise set of model elements that are the cause of the problems. Implemented anti-patterns will be able to be reused in different BPM suites. This is mainly due to the *Oryx* platform is part of the architecture of different commercial BPM suites, and also because anti-patterns can be accessed by any modeling tool, since they will be implemented as Web Services.

The evaluation and validation of the tool proposed in this work will be carried out through an empirical research of case studies. Such case studies will be developed into a process repository of the *Oryx* platform. Verification results obtained for this repository will be contrasted with other verification approaches using the same repository.

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