Semantic Business Process Analysis

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Abstract. Current Business Process Management technologies cover all
the process life-cycle but still suffer from many limitations with respect
to their complexity, maintainability and degree of automation. Recent
research initiatives aim at overcoming these limitations by introducing
Semantic technologies in the process life-cycle. One of the steps that can
benefit from this approach is the Business Process Analysis, that focuses
on the delicate phase of studying, testing and evaluating existing and
running systems and processes, with the aim of identifying the current
system (process) state, as well as pointing out problems and bottlenecks,
measuring key performance indicators and suggesting potential improve-
ments. We believe that the use of Semantic Web can be of great help in
improving and partially automating Business Process Analysis tasks. In
this position paper, we explain how we envision the future of Semantic
Business Process Analysis and we introduce the early results of our ap-
proach based on two different analysis methodologies, Reverse Business
Engineering and Process Mining.

1 Introduction

The aim of Business Process Management (BPM) is to manage, support and
analyze business operations with a high level managerial perspective. Unfortu-
nately, current technologies on the market are still accessible to IT experts only,
because of the gap between the models from the management perspective (e.g.
BPMN) and the actually deployed process models (e.g. BPEL). Therefore, busi-
ness experts still depend on the IT personnel to get feedback about the system.
Things get more and more complex when companies merge and have to inte-
grate their processes or when they want to analyze their current processes so as
to reengineer them. The major obstacle towards a truly unified view on business
processes is that *the business processes inside an organization are widely not
accessible to machine reasoning*. All the steps of the BPM life-cycle (Modeling,
Configuration, Execution and Analysis) suffer from those problems. Current re-
searches [1] envision the use of Semantic technologies to increase the level of
automation in BPM and to overcome the gap between the business experts and
the IT people. In particular, this paper explains our research on introducing
semantic technologies in the Business Process Analysis (i.e., the study and eval-
uation of the current running processes with the aim to measure performance,
find problems and solve them). The results reported here refer to the activities

within the EU-funded project SUPER[1] and adopt the technologies developed within it. The core of our approach is to link the data necessary for the analysis with defined ontological concepts. This linkage lifts the current analysis techniques from a label-based (or string-based) level to a concept-based level and, therefore, enables automatic processing and machine reasoning which, in turn, can help in decreasing the gap between the management and the IT world. Our analysis approach is illustrated by adding semantic to two prominent analysis techniques: Process Mining and Reverse Business Engineering. The idea is to improve the current status of the art that relies on huge manual efforts introducing some degree of automation thanks to the use of semantic annotations in all the steps of the business process life-cycle. This, as discussed in this paper, can result also the improvement of the quality and correctness of the outcome of the business process analysis.

The remainder of this paper is organized as follows. Section 2 introduces the current analysis techniques. Section 3 explains how to add semantic to these techniques. Section 4 contains the conclusions and future steps.

2   Business Process Analysis

Nowadays, companies use various kind of information system (e.g. ERP, CRM, Workflow Management, etc) to support the execution of their business processes. These information systems typically store data about how instances of given processes were executed (i.e. transaction, master and configuration data). These stored data are the starting point for process mining (PM) and reverse business engineering (RBE). Both techniques support the analysis of process models (and processes) and are complementary. PM mainly focuses on *discovery*-like kind of analysis (e.g., How are the processes actually being executed? What is the organizational model for a given process? Where are the bottlenecks in processes?) while RBE targets scenario-based analysis using predefined business questions (e.g., As-Is-Analysis, Continuous Improvement). The rest of this section contains more details about PM and RBE.

2.1   Process Mining

Process mining [2] aims at automatically discovering analysis information about processes. The analysis is based on event logs that contain data about the execution of these processes. The basic assumptions are that (i) an event log should uniquely identify different process instances (or executions) of a given process, and (ii) tasks (or steps) in a process instance are registered in the order in which they were performed. Typical examples are the mining of a model that portray the routes followed by a group of process instances, social networks for the handover of work in a process and the automatic inference of groups and teams for given processes, auditing tools (that need to inspect data fields linked to tasks of process instances) and performance bottleneck analysis (that highlights the specific cases that contain performance issues, the severity of these issues, and so on). Most of the process mining techniques are freely available in the open source tool ProM[2] [3].

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[1] SUPER project (FP6-026850): `http://www.ip-super.org`
[2] ProM, `www.processmining.org`.

2.2   Reverse Business Engineering

Reverse Business Engineering (RBE) is a method to analyse productive ERP systems in an automated way. The analysis results comprise transaction usage, expansions, customization, master and transaction data. The two main scenarios are to derive a model of the active and used system elements based on the analysis results (*As-Is-Analysis*) and to gain information about gaps, exceptions or potentials within an ERP system in order to redesign and improve the business processes and the underlying ERP system (*Continuous Improvement*).

The methods behind Reverse Business Engineering (RBE) were developed at the University of Wuerzburg and applied to the SAP R/3 System by IBIS Prof. Thome AG in collaboration with SAP AG[3] [4].

3   Introducing "Semantics" into the BP Analysis

Although process mining and reverse business engineering techniques provide feedback about different perspectives of process models, the degree of automation and reuse is somewhat limited because it is based on strings in event logs (for PM) or raw data in ERP (for RBE). So, this section gives an overview on how the use of semantic can improve the analysis supported by PM and RBE techniques by bringing them to the concept-level. Our approach towards a semantic analysis environment has three steps: (1) the *creation of ontologies* that capture the meanings of different elements (tasks, data fields, performers, etc.) in process models, (2) the *semantic annotation of business processes* with the defined ontologies, and (3) the definition of *semantic versions* of existing PM and RBE techniques. For what regards the *ontologization of data*, we are defining an ontology framework (in line with [5]) that comprises the relevant concepts for events description and business questions formulation. Then, we will use these ontologies to annotate the processes, by mapping (possibly in a semi-automated way) at design time the business questions onto the processes, tasks and data fields they refer to, and by assuring that the execution logs will contain the references to those ontology concepts. For what regards the *ontologization of techniques and tools*, as explained in Section 2, PM mainly focuses on discovery-like analysis and RBE on scenario-based one using predefined business questions. Thus, here we propose five possible semantic extensions for these techniques: semantic process discovery, semantic organizational model discovery, semantic auditing, semantic performance analysis and semantic RBE. *Semantic Process Discovery* builds hierarchical models based on subsumption trees for the ontologies in event logs, while current process mining techniques only capture a flat representation of process models. *Semantic Organizational Model Discovery* automatically discovers groups and teams in organizations, based on task similarity. The current version of these techniques uses string matching as the criterion to assess task similarity: the linkage of ontological concepts to task will allow for smarter inferences of tasks similarities. *Semantic Auditing* will allow the validation properties to be defined in terms of (sub-)concepts in a log. Currently, this auditing is based on strings in the log, what greatly hinders the re-use of

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[3] RBE PlusTM, `http://www.ibis-thome.com/rbe`

defined properties and make the definition of these properties too technical (recall the gap between the management and the IT world). *Semantic Performance Analysis* will use the semantic annotations to automatically identify bottlenecks in the system and violations of service level agreements. At the present time, these techniques do not have the notion of what an acceptable execution time would be for certain tasks or processes: the defined ontologies can capture these notions. The focus of *Semantic RBE* is the business question ontology which allows the generalization and reusability of RBE content and provides semantic analysis. Thus a flexible and standardized adoption of RBE to various kind of application systems, process models and respective modelling solutions can be realized.

4   Conclusions and Future Work

This paper shows how current business process analysis techniques can benefit from the use of semantic information. The main idea is to annotate the elements that are relevant for analysis with ontological concepts. The benefits are two-fold: (i) by using ontologies and, therefore, performing analysis at the concept-level, the proposed solutions reduce the gap between the management and the IT worlds in companies, and (ii) the use of ontologies greatly promote the reuse of analysis queries etc. Our future work will consist on defining the ontologies for analysis purposes and on implementing the five semantic extensions proposed in this paper. This future work is part of the SUPER European project.

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