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, mainly in the modeling and execution phases.

But other steps of the process life-cycle can benefit from this approach too, like 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 improvements. We believe that the use of Semantic Web and Semantic Web Services technologies 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 approach based on two different analysis methodologies, Reverse Business Engineering and Process Mining.

KEYWORDS: Semantic Web, Process Mining, Reverse Business Engineering, Semantic Process Analysis.

I. INTRODUCTION

The aim of Business Process Management (BPM) is to manage, support and analyze business operations with a high-level managerial perspective. Unfortunately, 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, business experts still depend on the IT personnel to get feedbacks about the system. Things get more and more complex when companies merge and have to integrate their processes or when they want to analyze their current processes so as to reengineer them. The current degree of mechanization in BPM is still very limited, creating inertia in the necessary evolution and dynamics of business processes. 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 researches [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 evaluation 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 remainder of this paper is organized as follows. Section II introduces the current analysis techniques. Section III explains how to add semantic to these techniques. Section IV contains the conclusions and future steps.

II. BUSINESS PROCESS ANALYSIS

Nowadays, companies usually have some information system (like ERP, CRM, Workflow Management, etc.) to support the execution of their business processes. These information systems typically store data about how instances (or cases) of given processes were executed. For instance, ERP systems store data about the executed transactions, the performers of such transactions, etc. 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 are complementary. PM mainly focuses on *discovery*-like kind of analysis (How are the processes actually being executed? What is the organizational model for a given processes? Where are the bottlenecks in processes?) while RBE targets *conformance*-like kind of analysis (Which parts of the processes are being used? How often?). The remainder of this section contains more details about PM and RBE.

II.I PROCESS MINING

Process mining [5] 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. The analysis performed by process mining techniques focuses on three different perspectives: *control-flow*, *organizational*, and *case*. The *control-flow* perspective focuses on mining a process model that best portrays the routes followed by a group of process instances. Control-flow analysis only requires the logs to contain process instances plus the order of execution between their tasks. The *organizational* perspective discovers organizational-related information about processes. Typical examples are social networks for the *handover of work* in a process and the automatic inference of groups and teams for given processes. This kind of analysis requires the event logs to contain also data about the *performers* (humans or systems) of tasks in process instances. The *case* perspective provides analysis of specific cases. Typical examples are auditing tools (that need to inspect data fields linked to tasks of process instances) and performance

[1] SUPER project (FP6-026850): http://www.ip-super.org

bottleneck analysis (that highlights the specific cases that contain performance issues, the severity of these issues etc). Case-related process mining techniques assume the logs to also contain data about the times in which tasks where executed and/or detailed logging for the values of the various data fields involved in the executions of process instances. Most of the process mining techniques are freely available in the open-source tool ProM ([6]), which can be downloaded at www.processmining.org.

II.II 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 and shall serve several scenarios. 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, remodel and finally improve the business processes respectively their underlying ERP system (*Continuous Improvement*). For an RBE analysis, data from productive systems is extracted, then imported into the RBE Tool and analyzed there.

The methods behind Reverse Business Engineering (RBE) were developed from 1998 to 2000 at the University of Würzburg, Germany. These methods were applied to the SAP R/3 System and converted into the tool Reverse Business Engineer by IBIS Prof Thome AG in collaboration with SAP AG [3] [4].

III. Introducing "Semantics" into the Business Process Analysis

Although process mining and reverse business engineering techniques provide feedbacks 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 explains 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 [2]) that comprises the relevant concepts for events description and business questions formulation. Then, we will use these ontologies to annotate the processes, by mapping 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 II, PM mainly focuses on discovery-like analysis and RBE on conformance-like one. 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 conformance. *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 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. *Semantic Conformance* will define a set of business question ontologies that will help in the configuration and reuse of RBE techniques. The use of semantics within the RBE environment will allow for a generalization of RBE content and thus a flexible and standardized adoption to the various kinds of application systems, process models and respective modelling and repository solutions.

IV. 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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