

A Framework for Efficiently Mining the Organisational Perspective of Business Processes (Extended Abstract)

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Abstract: Process mining aims at discovering processes by extracting knowledge from event logs. Such knowledge may refer to different business process perspectives. The organisational perspective deals, among other things, with the assignment of human resources to process activities. Information about the resources that are involved in process activities can be mined from event logs in order to discover resource assignment conditions, which is valuable for process analysis and redesign. Prior process mining approaches in this context present one of the following issues: (i) they are limited to discovering a restricted set of resource assignment conditions; (ii) they do not aim at providing efficient solutions; or (iii) the discovered process models are difficult to read due to the number of assignment conditions included. In this paper we address these problems and develop an efficient and effective process mining framework that provides extensive support for the discovery of patterns related to resource assignment. The framework is validated in terms of performance and applicability. The work summarized in this extended abstract has been published in [Sc16].

Keywords: Business process management, declarative process mining, event log analysis, organisational perspective, resource perspective

1 Introduction

Business Process Management is a well accepted method for structuring the activities carried out in an organisation, analysing them for efficiency and effectiveness, and identifying potential for improvement [Du13]. Processes are not always explicitly defined when the process models are designed. Actual process executions may constitute a valuable input for improving process design. Process mining provides methods for automatic process analysis, among others for discovering processes by extracting knowledge from event logs in form of a process model. Various algorithms are available to discover models capturing the control-flow of a process, related to the behavioural perspective of the process [vdA11, DM15]. For perspectives like the organisational perspective, which manages the involvement of human resources in processes, only partial solutions for mining have been developed despite the importance of resource information not only for performance but also for compliance analysis [Le12].

The need to better support the organisational perspective was evidenced by previous approaches that mined this perspective [SvdA08, NvdA10]. Prior work in this area focused on discovering specific aspects of the organisational perspective such as role models,

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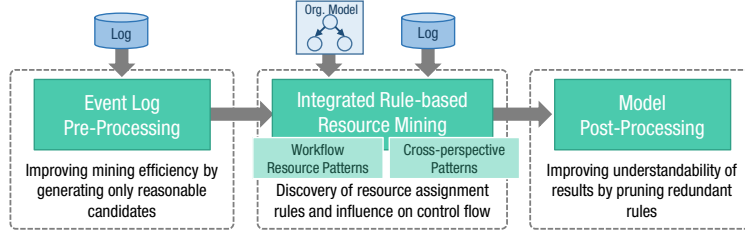


Abb. 1: Framework for discovering resource-aware, declarative process models

separation of duty or social networks. However, comprehensive and integrated support for the well-established workflow resource patterns, and specifically in this context for the so-called creation patterns [Ru05], was missing. Furthermore, the close interplay between the organisational and the behavioural perspectives was disregarded. In [Sc15] we addressed these gaps by developing a declarative process mining approach for the organisational perspective, which supports all the creation patterns as well as what we called cross-organisational patterns, which discover how the involvement of resources influences the control-flow of the process.

The research reported in this paper extends our prior work towards an efficient and effective mining framework. As illustrated in Figure 1, the framework is divided into an event log pre-processing phase, a phase for integrated resource mining including cross-perspective patterns, and a model post-processing phase. We evaluate our approach with an implementation of the three phases; with simulation experiments for measuring performance; and with the application of the approach on a real-life event log for checking its effectiveness.

This research extends our previous work [Sc15] as follows: *(i)* the developed pre-processing method increases the efficiency of the approach; *(ii)* the developed post-processing techniques increase the understandability of the results; *(iii)* a prototype of the entire framework has been implemented using Drools; and *(iv)* the approach has been extensively validated. In addition, the mining approach is explained in more detail. With our work, we complement research on process mining with an extensive support of the organisational perspective.

This is an extended abstract of the article [Sc16] published in the Decision Support Systems Journal.

2 Extracted Patterns and Target Language

The well-known workflow resource patterns [Ru05] capture the various ways in which resources are represented and utilised in business processes. Of specific interest for our approach are the creation patterns that describe the different ways in which resources can be assigned to activities. Furthermore, it has been identified that the process control-flow is intertwined with dependencies upon resource characteristics. For instance, sometimes an

activity must be executed eventually before another one for specific resources but not for others. A specific collection of such *cross-perspective patterns* capturing these situations has not been defined. They can be defined by combining the aforementioned organisational patterns with control-flow patterns. The organisational and the cross-perspective patterns constitute the set of patterns to be discovered by our framework

Next, we shortly describe the target language we use for representing the mining results. Current procedural languages like BPMN put a strong emphasis on control-flow and assume other perspectives to be specified separately. Cross-perspective patterns cannot be readily modelled. Declarative process modelling does not limit the number of perspectives involved in the constraints defined. We use DPIL [ZSJ14] for modelling the output of the mining because it supports multiple perspectives including the behavioural and the organisational perspectives, as well as the interplay between them. Nonetheless, the concepts of our approach are generic such that other declarative languages could also be used as long as they provided support for the modelling of our target patterns.

3 Mining Framework

We shortly describe our framework to discover organisational and cross-perspective patterns. Declarative process modelling languages like DPIL are based on so-called *rule templates*. A rule template captures frequently needed relations and defines a particular type of rules. Unlike concrete rules, a rule template consists of placeholders, i.e., typed variables. In declarative process mining, rule templates are used for querying the provided event log to find solutions for the placeholders. First, rule candidates need to be constructed by instantiating the given set of rule templates with all possible combinations of occurring process elements provided in the event log. The resulting candidates are subsequently checked w.r.t. the log. This provides for every candidate the number of instances, i.e., the traces in the event log where it non-vacuously holds. Based on these values rules are classified and separated into non-valid and valid ones.

Since DPIL builds upon a flexible organisational meta model, it is possible to define rule templates that describe many aspects of the organisation. By instantiating these rule templates with all possible parameter combinations of defined resources, groups and relation types, it is possible to generate rule candidates that focus on the organisational perspective of the process to be analysed. These candidates can then be checked under consideration of the event log and the organisational model. We define rule templates for our target set of patterns. Here, we distinguish between templates for organisational patterns and templates for cross-perspective patterns. The former are divided into two groups: rule templates related to a single task and rule templates related to more than one task. We provide representative examples for each group of rule templates that cover frequently needed organisational information. Note that besides the templates described next, further templates could be defined individually to cover the analyst's needs.

Real-life event logs and organisational models potentially contain a big set of distinct tasks, resources and groups. This leads to a potentially big number of rule candidates to

be checked. Although many of these parameter combinations never occur together in the same trace, the corresponding rules need to be checked. We use the well-known Apriori algorithm to *pre-process* the log and to extract *task-resource* and *task-group* combinations that frequently occur together. In this way, it is possible to reduce the number of organisational rule candidates by ignoring infrequent parameter combinations.

The mining method extracts *all* the assignment rules related to each task. However, when several rules are extracted for one single task, not all of them might be strictly necessary to understand the process. Some rules may be implied by stronger rules because they are less restrictive and do not provide any value to the current resource assignment expression of a task. Those rules complicate the understandability of discovered models. We identified two pruning approaches to eliminate unnecessary rules: (i) pruning based on organisational rule hierarchies and (ii) pruning based on transitive reduction. The requirement for all pruning operations is that they do not change the meaning of the generated model.

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