

Project Overview

Xuan Zhang

January 12, 2022

Today's business processes are supported by a variety of information systems, and every executed activity leaves a digital footprint in the form of event data. Process mining [1] is the field of data-driven process management for process analysis, transformation, and enhancement. By analyzing event data stored in the information system, process mining techniques provide objective insights through three aspects:

- *process model discovery*: refers to the automatic construction of models describing the process;
- *compliance checking*: assesses to what degree the recorded execution of the process is in accordance with a given reference model (i.e., the intended behavior);
- *process enhancement*: enriches process models with additional statistics derived on the basis of the event data.

In recent years, the focus on providing continuous process monitoring and analysis has significantly increased [2]. From a business perspective, the continuous process tracking allows the operational experts to take immediate actions and subsequently prevent undesired outcomes. From an academic perspective, architectural frameworks for action-oriented process monitoring have already been proposed [3], yet the feasibility in practice needs to be further assessed. To understand the details of the actual business process and to apply the theoretic framework in a real-life environment can reveal new potentials as well as practical limitations that are not readily apparent. Additionally, predictive process mining can be strategically integrated into the pipeline to promote immediate intervention for potentially problematic cases. To this end, we aim to study the applicability of the framework by means of a case study for the invoicing process at Bosch, where we focus on the following research questions:

- RQ 1 How to adopt the action-oriented process monitoring framework for the account payable process at Bosch?
- RQ 2 How to extend in the action-oriented process monitoring framework with predictive process monitoring?

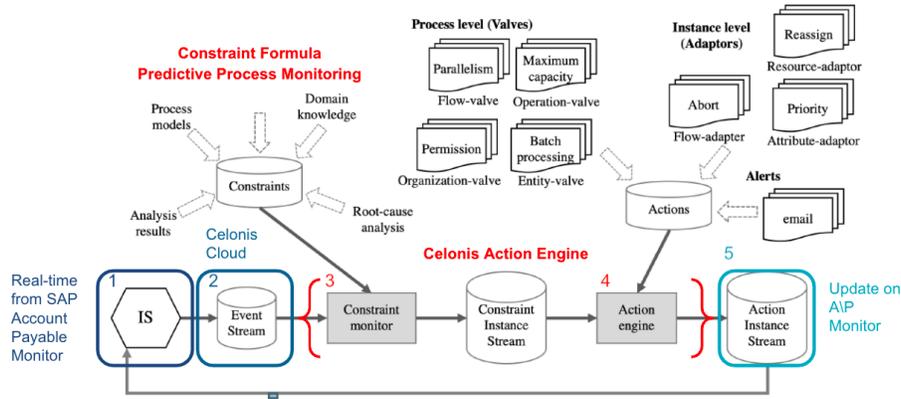


Figure 1: Case Study Design Overview: Action-oriented process monitoring instantiation on *Celonis Action Engine*, adapted from [3]

RQ 3 How to improve the accuracy of prediction results in practice?

The case study is carried out with Celonis¹, which is a market leading software solution for business process management. An overview can be found in Figure 1: As an input, the system receives incoming activity records and its corresponding attributes from the data model, and processes them in the form of streaming event data. The analysis can then be evaluated on pre-defined constraints, based on which the event stream is monitored. Next, a constraint instance stream is created and pushed to the action engine, which notifies the business users of the possible update and generates the corresponding transactions. Depending on the specific transaction, the action can be taken with simple human verification or even completely automatically. The action execution is again stored as event data as part of the instance stream for the next iteration.

The action-oriented process monitoring framework offers promising potential for the seamless integration of predictive process mining. More specifically, as is shown in Figure 1, the constraint formula can be extended based on prediction results for the running case. When embedded in action-oriented process monitoring, the prediction results makes a greater impact in the practice, for it allows follow-up corrective actions to avoid sub-optimal outcomes.

Moreover, the invoicing process is inherently dynamic and the process development needs to cope with adaptive adjustment over time. Therefore, simply using the historic event data without considering the impact of the concept drift in the process would greatly hinder the prediction performance. To make the prediction results more realistic, we also integrate concept drift detection in the training process.

We evaluate the approach both quantitatively and qualitatively: For the

¹<https://www.celonis.com/>

use case, we evaluate the user feedback qualitatively on open-ended questions regarding different features of the interface, to further gain insights of the hidden product issues and user motivations. For the out-come oriented predictive model, we evaluate its accuracy on the test data and quantitatively compare the results between models with and without detection of concept drift. Results indicate a great potential for action-oriented process monitoring in operation and a general slight improvement in prediction accuracy. Additionally, we drew experience from the implementation process and proposed best-practice guidelines, which pave the way for future application attempts.

In summary, our contributions are listed as follows:

1. We proposed an extension of the action-oriented process monitoring framework with outcome-oriented predictive process mining.
2. We proposed a new predictive model which achieves better accuracy by emphasising on concept drift detection.
3. We conducted a case study of the action-oriented process monitoring framework with a real-life use case.
4. We proposed a collection of design guidelines for such projects based on the qualitative feedback from the business users.

This work facilitates the first step towards the user-centered employment of action-oriented process monitoring in the industry. To further consolidate and further improve the business intelligence capability in financial organizations, more research efforts need to be directed towards novel and robust applications, such as constructing systematic taxonomy of constraint formulae, and utilizing unstructured data to enhance the interpretability and comprehensiveness.

References

- [1] W. M. P. van der Aalst, *Process Mining - Data Science in Action, Second Edition*. Springer, 2016.
- [2] L. Reinkemeyer, *Process Mining in Action Principles, Use Cases and Outlook: Principles, Use Cases and Outlook*. Springer, 01 2020.
- [3] G. Park and W. M. P. van der Aalst, “A general framework for action-oriented process mining,” in *Business Process Management Workshops - BPM 2020 International Workshops, Seville, Spain, September 13-18, 2020, Revised Selected Papers* (A. del-Río-Ortega, H. Leopold, and F. M. Santoro, eds.), vol. 397 of *Lecture Notes in Business Information Processing*, pp. 206–218, Springer, 2020.