

Note: All topics are available to both bachelor's and master's students.

Topic 1: Declarative Process Discovery

Process discovery is a critical component of process mining, involving the analysis of event logs from information systems to construct a comprehensive model of an organization's business processes. The typical output of a process discovery algorithm is a formal process model that explicitly describes all possible execution patterns of activities in a process.

Declarative process discovery instead focuses on analyzing business processes to identify and understand the set of rules and constraints that dictate how these processes are executed. This approach is particularly useful in environments where flexibility and adaptation to changing circumstances are critical, such as the healthcare sector. Declarative process models are collections of temporal or logic constraints that provide a framework for capturing such flexible processes.

The aim of this seminar thesis is to investigate the current state of the art of declarative process discovery methods. This includes exploring various algorithms and techniques used to extract declarative models from event logs. The participant should also identify the main application areas and assess the challenges faced in declarative process discovery.

Literature:

- [1] Maggi, F., Mooij, A., & van der Aalst, W. (2011). [User-guided discovery of declarative process models](#). IEEE Symposium on Computational Intelligence and Data Mining, 192-199.
- [2] Pesic, M., Schonenberg, H., & van der Aalst, W. (2007). [DECLARE: Full support for loosely-structured processes](#). IEEE International Enterprise Distributed Object Computing Workshop. 287.
- [3] Rovani, M., Maggi, F., de Leoni, M., & van der Aalst, W. (2015). [Declarative process mining in healthcare](#). Expert Systems with Applications, 42(23), 9236-9251.

Topic 2: Process Mining Tasks and Questions

When conducting process mining, certain tasks are fulfilled during the analysis that vary depending on the type of process mining approach or on the goal the corporation wants to achieve with process mining. However, no clear overview has been created until now of what different questions users try to answer while analyzing event data and the associated visualizations. This information could help to improve or adapt the results shown with the different process mining tools.

Therefore, this seminar thesis should provide an overview of the different tasks users want to accomplish with process mining. A differentiation should be made between different process mining approaches (discovery, conformance checking, ...). If other criteria are also applicable, these should also be highlighted and used to categorize the information further. In the end, relevant questions users ask during the analysis or tasks they want to solve should be provided and clustered. If possible, a focus should be set on the questions that are answered with the help of the different visualizations. As research is rather limited, the BPI challenges, as well as other case studies, can be used for the literature review.

Literature:

- [1] Zerbato, F., Soffer, P., & Weber, B. (2022). [Process mining practices: Evidence from interviews](#). International Conference on Business Process Management, 268-285. Springer.
- [2] BPI Challenge 2017: <https://www.win.tue.nl/bpi/2017/challenge.html>
- [3] BPI Challenge 2019: <https://icpmconference.org/2019/icpm-2019/contests-challenges/bpi-challenge-2019/>

Topic 3: Conformance Checking without a Process Model

Conformance checking is one of the main applications in process mining. It refers to the comparison of process executions recorded in an event log (so-called traces) to a process model. Whenever a trace does not follow the process model, deviations are identified. As input, most conformance checking techniques require an event log and a process model. However, the definition of such process models can be time-consuming and error prone. Therefore, in some cases, it would be desirable to conduct the conformance check without a process model solely based on event data.

The goal of this seminar thesis is to identify approaches that propose conformance checking techniques without requiring a process model as input. The applicant should identify 1) how the conformance check is conducted (e.g., deep learning, ...), 2) what process perspectives are considered in the conformance check (control-flow, data, resource, time), 3) what kind of feedback is provided, and 4) how the approaches are evaluated (e.g., with respect to traditional conformance checking with a process model). Finally, the participant should discuss whether the current state-of-art allows for conformance checking without process model and what could be potential avenues for future research.

Literature:

- [1] Park, G., Benzin, J. V., & van der Aalst, W. (2022). [Detecting context-aware deviations in process executions](#). International Conference on Business Process Management. Springer.
- [2] Peeperkorn, J., vanden Broucke, S., & De Weerd, J. (2023). [Global conformance checking measures using shallow representation and deep learning](#). Engineering Applications of Artificial Intelligence 123:106393.

Topic 4: Conformance Checking for Compliance Checking

Compliance checking involves verifying that business processes adhere to relevant laws, regulations, standards, and internal policies. It is primarily concerned with ensuring that the operations and processes within an organization meet external and internal requirements. As this is a time-consuming and error-prone process, there are multiple suggested approaches to automate compliance checking. One of these approaches is conformance checking, which is a process mining technique that compares the actual execution of business processes against predefined models or expected behaviors. It ensures that the processes are being carried out as intended and identifies deviations from the standard process models.

The goal of this seminar thesis is to curate a list of papers, where conformance checking is explicitly used for the purpose of compliance checking. Therefore, the participant should conduct a literature review, with a specific focus on process mining case studies. The identified papers should be analyzed with regard to the specific questions that compliance managers need to answer as well as the ways in which they obtain the models that serve as input for conformance checking.

Literature:

- [1] Dunzer, S., Stierle, M., Matzner, M., & Baier, S. (2019). [Conformance checking: a state-of-the-art literature review](#). International conference on subject-oriented business process management, 1-10.
- [2] Klessascheck, F., Knoche, T., & Pufahl, L. (2024). [Reviewing Conformance Checking Uses for Run-Time Regulatory Compliance](#). International Conference on Business Process Modeling, Development and Support, 100-113. Springer.
- [3] Accorsi, R., & Stocker, T. (2012). [On the exploitation of process mining for security audits: the conformance checking case](#). 27th annual ACM symposium on applied computing, 1709-1716.

Topic 5: Confirmatory Process Mining

The goal of process mining is to analyze process-related event log data in order to find improvement potentials in the underlying business process. As such, most process mining techniques are inherently exploratory: They uncover new knowledge about the phenomenon described in the data, which in this case is the process. Exploratory data analysis techniques are typically complemented by confirmatory techniques, whose objective is to validate or falsify an assumed relationship about the phenomenon in the data. The two techniques form an analytical cycle. However, in process mining, confirmatory techniques are rather rare.

The goal of this seminar thesis is to provide an overview of existing confirmatory process mining techniques. Therefore, the participant should identify papers that test hypotheses on process-related event log data and analyze them with regard to (a) the type of hypothesis that is tested and (b) the statistical procedures that are applied. In addition, the participant should also reflect on the conceptual difficulties that arise when applying statistical techniques on event log data.

Literature:

- [1] Janssenswillen, G., & Depaire, B. (2019). [Towards confirmatory process discovery: making assertions about the underlying system](#). Business & Information Systems Engineering, 61, 713-728.
- [2] Leemans, S. J., McGree, J. M., Polyvyanyy, A., & ter Hofstede, A. H. (2022). [Statistical Tests and Association Measures for Business Processes](#). IEEE Transactions on Knowledge and Data Engineering, 35(7), 7497-7511.
- [3] Tukey, J. W. (1980). [We need both exploratory and confirmatory](#). The American Statistician, 34(1), 23-25.

Topic 6: The User Perspective in Process Mining

Process mining has been increasingly implemented in organizations, leading to changes within the organization that can have a large impact. The use of process mining does not only affect the information systems, the data that can be acquired, or the efficiency of processes, but it also influences the whole organization, including the employees working with the Process Mining solution. Nevertheless, research has mainly focused on the technical aspects, such as the underlying algorithms. Little research has been done to better understand the organization's, in particular, the users' perspective.

Therefore, the goal of this seminar thesis is to provide an overview of literature that has focused on the users' perspective. First, a clear separation should be made between different users and their needs, their roles, and the requirements they need to meet. Furthermore, challenges they face during and after the introduction of Process Mining can be outlined. This can also include changes to their work. In the end, a better understanding should be achieved of the employees working with process mining and how they differentiate.

Literature:

- [1] Vom Brocke, J., Jans, M., Mendling, J., & Reijers, H. A. (2021). [A five-level framework for research on process mining](#). Business & Information Systems Engineering, 63, 483-490.
- [2] Zimmermann, L., Zerbato, F., & Weber, B. (2022, May). [Process mining challenges perceived by analysts: an interview study](#). In International Conference on Business Process Modeling, Development and Support, 3-17. Springer.
- [3] Grisold, T., Mendling, J., Otto, M., & vom Brocke, J. (2021). [Adoption, use and management of process mining in practice](#). Business Process Management Journal, 27(2), 369-387.

Topic 7: Prescriptive Business Process Monitoring for Action Recommendation

Process mining approaches have been shown to detect and predict issues in processes. The generated insights can help process managers to achieve their goals. However, the insights require the managers to define measures and address the issues themselves. Ideally, an approach would directly recommend actions that could be taken in order to resolve detected issues. This would reduce the need for domain knowledge in process improvement.

The goal of this seminar is to identify papers that address the recommendation of actions to process managers. This kind of approaches are sometimes referred to as action-oriented process mining or prescriptive business process monitoring. The applicant should identify 1) what kind of actions or improvements are recommended, 2) how these actions are triggered, and 3) how the papers evaluate the proposed approaches. Last, the applicant should discuss whether and how generative AI is already or could be of value for these kinds of techniques.

Literature:

- [1] Park, G., & van der Aalst, W. (2022). [Action-oriented process mining: bridging the gap between insights and actions](#). Progress in Artificial Intelligence.
- [2] Weinzierl, S., Dunzer, S., Zilker, S., & Matzner, M. (2020). [Prescriptive Business Process Monitoring for Recommending Next Best Actions](#). Business Process Management Forum, 193-209. Springer.

Topic 8: Anomaly Detection in Event Logs

Identifying irregular patterns in event logs is one of the main motivations for process mining because they may indicate process execution issues like errors, inefficiencies, or fraud. Statistical anomaly detection techniques are a useful tool to find these irregularities in an automated way without having to rely on handcrafted models of correct process behavior. These techniques are able to identify statistically unusual (i.e., infrequent) process behavior, hinging on the (intuitive) assumption that behavior that significantly deviates from the typical patterns observed within an event log is more likely to be erroneous.

This seminar thesis should provide a comprehensive overview of the methods and algorithms used for anomaly detection in event logs. The participant should identify and describe the different approaches employed in the literature and examine them in terms of their underlying principles (e.g., rule mining, machine learning, ...), advantages, disadvantages, and applicability to different types of processes and event logs.

Literature:

- [1] Ko, J., & Comuzzi, M. (2023). [A Systematic Review of Anomaly Detection for Business Process Event Logs](#). Business & Information Systems Engineering, 65, 441–462.
- [2] Nolle, T., Luettgen, S., Seeliger, A., & Mühlhäuser, M. (2022). [BINet: Multi-perspective business process anomaly classification](#). Information Systems 103, C.
- [3] Chandola, V., Banerjee, A., & Kumar, V. (2009). [Anomaly detection: A survey](#). ACM Computing Surveys 41(3):15.

Topic 9: Inter-case Effects in Process Mining

Most existing process mining techniques assume that each case instance is a separate process execution, whose progression is only influenced by case-specific features, such as attributes or control-flow decisions. However, this isolated view on cases does not account for potential inter-case effects, i.e., changes in the control-flow of one case that are influenced by what happens in other cases. These effects are likely to occur because different cases of the same process are inherently connected by resources, which are typically responsible for the execution of an entire process instead of a single case.

The goal of this seminar thesis is to identify techniques that consider inter-case effects in processes. The applicant should identify 1) what kind of inter-case effects are considered, 2) how they are measured (and turned into features), and 3) which application these inter-case features have (discovery, prediction, ...). Finally, the participant should discuss how inter-case features can be categorized and used in approaches.

If the number of publications in this field is too large, a specification will be done by the participant in cooperation with the supervisor before the first milestone.

Literature:

[1] Grinvald, A., Soffer, P., & Mokryn, O. (2021). [Inter-case properties and process variant considerations in time prediction: A conceptual framework](#). International Conference on Business Process Modeling, Development and Support, 96-111.

[2] Senderovich, Arik, et al. (2017). [Intra and inter-case features in predictive process monitoring: A tale of two dimensions](#). International Conference on Business Process Management, 306-323.

Topic 10: Process Model Visualization Algorithms

Visualizations are commonly used in Process Mining to make results easier to comprehend. This allows users not familiar with the processes or with the technical aspects to gain a faster overview of the acquired insights. In particular, process models are often used to visualize the whole process and its variants, for example, as directly-follows graphs or BPMN models. While all process mining tools offer some visualization options for process models, there are many differences between them, in particular with regard to the implementation of the underlying visualization algorithms. With research starting to connect the topic of visual analytics and process mining, a closer focus has been placed on the effectiveness of the currently available visualizations. Therefore, an understanding of the underlying algorithm is also necessary.

This seminar thesis should aim to identify the algorithms used across process mining tools or in research to visualize process models. The algorithms should be described in terms of how they work, their differences, advantages and disadvantages. Moreover, the literature review should highlight what visualization aspects the algorithms consider or what they focus on. If the literature is too sparse, available algorithms from other research fields that are similar to process mining can be discussed and compared with respect to their potential applicability in process mining.

Literature:

[1] Mennens, R. J., Scheepens, R., & Westenberg, M. A. (2019). [A stable graph layout algorithm for processes](#). In Computer Graphics Forum, 38(3), 725-737.

[2] Berti, A., Van Zelst, S. J., & van der Aalst, W. (2019). [Process mining for python \(PM4Py\): bridging the gap between process-and data science](#). ArXiv Preprint 1905.06169.

Topic 11: Batching in Business Processes

Batching in business processes refers to the collective execution of similar tasks or cases for specific activities. This practice is common in operational processes to save costs and time through economies of scale, such as reducing setup times. By improving efficiency, batching often enhances process performance, leading to a smoother workflow and increased productivity. To understand the effects of batch processing on various aspects of process performance, such as time, cost, and quality, it is crucial to identify potential batch-processing behaviors within business processes. However, knowledge about actual batch processing can often be hidden. Therefore, identifying different types of batch-processing behaviors from event logs is necessary.

The seminar thesis should examine the various types of batching and the techniques used to detect batching in event logs. Additionally, the thesis should provide an analysis of the advantages and limitations of these existing techniques.

Literature:

- [1] Pika, A., Ouyang, C. & Ter Hofstede, A. H. M. (2022). [Configurable Batch-Processing Discovery from Event Logs](#). ACM Trans. Manage. Inf. Syst. 13, 1–25.
- [2] Martin, N., Pufahl, L. & Mannhardt, F. (2021). [Detection of batch activities from event logs](#). Information Systems 95, 101642.
- [3] Klijn, E. L. & Fahland, D. (2019). [Performance Mining for Batch Processing Using the Performance Spectrum](#). In: Business Process Management Workshops, 172–185, Springer.
- [4] Martin, N. et al. (2017). [Retrieving batch organisation of work insights from event logs](#). Decision Support Systems 100, 119–128.

Topic 12: High-Level Event Mining

Process mining traditionally relies on low-level events that capture individual activities. However, many business problems can only be understood and addressed by analyzing higher-level process behaviors, which are not observable at the case or event level. This emerging research direction holds significant potential, although it is still in its early stages.

In the seminar thesis, the focus should be on understanding the state of the art and discussing the phenomena observable at the system level of a process. The analysis should also cover system-level problems that can be addressed using high-level event mining. Furthermore, the thesis should examine the limitations of current techniques and propose future research directions.

Literature:

- [1] Bakullari, B. & van der Aalst, W. M. P. (2024). High-Level Event Mining: [Overview and Future Work](#). ArXiv Preprint 2405.14435.
- [2] Bakullari, B., Thoor, J. van, Fahland, D. & van der Aalst, W. M. P. (2023) [The Interplay Between High-Level Problems and the Process Instances that Give Rise to Them](#). Business Process Management Forum, 145–162. Springer.
- [3] Bakullari, B. & van der Aalst, W. M. P. (2022). [High-Level Event Mining: A Framework](#). International Conference on Process Mining, 136–143.

Topic 13: Modeling Business Processes: System Dynamic vs. Discrete Event Simulation

Modeling a business process using historical event data extracted from organizational information systems provides valuable insights that can be used to improve the process. However, obtaining a reliable process simulation model from event data presents significant challenges and requires an effective approach to address these issues. Currently, two primary methods are available for modeling business processes: Discrete Event Simulation (DES) and System Dynamics (SD). Discrete Event Simulation (DES) focuses on modeling the operation of a system as a sequence of events that occur at specific points in time, while System Dynamics (SD) emphasizes the continuous flow of information and resources within a system, using feedback loops and time delays to represent complex interactions.

The aim of this thesis is to conduct a comprehensive analysis of (auto)-mined DES and SD methods for modeling a business process from event data. The focus of the thesis should be on explaining how these two methods work and what are their capabilities and limitations.

Literature:

- [1] Pourbafrani, M., & van Der Aalst, W. M. P. (2022). [Discovering System Dynamics Simulation Models Using Process Mining](#). IEEE Access 10, 78527–78547.
- [2] Meneghello, F., Di Francescomarino, C., & Ghidini, C. (2023). "[Runtime Integration of Machine Learning and Simulation for Business Processes](#)," International Conference on Process Mining, 9-16.
- [3] Camargo, M., Dumas, M., & Rojas, O. G. (2019). "[Simod: A Tool for Automated Discovery of Business Process Simulation Models](#)." BPM Demos.