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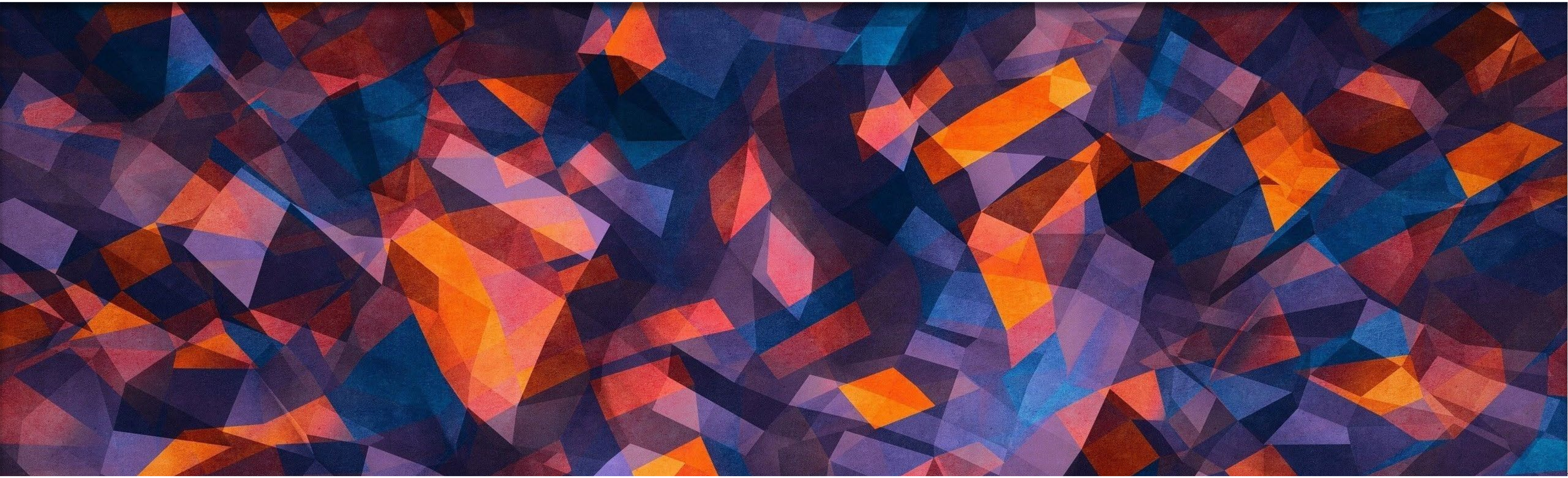
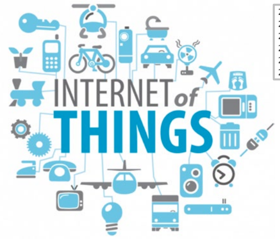


Leveraging Digital Trace Data to Investigate and Support Human-Centered Work Processes

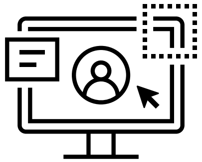
Presented by Barbara Weber

Digital Trace Data

Digital technologies create an ever-increasing volumne of **digital traces.**




```
2021-05-06T19:34:45.0744536+02:00: Adding buffer to output stream.
2021-05-06T19:34:45.0899984+02:00: Saved graph to disk in 15 millis
2021-05-06T19:34:45.9960234+02:00: (Showing log explorer view for Road_Traffic_Fine_Management_Process)
2021-05-06T19:34:50.1055319+02:00: (Showing variant Variant 1)
2021-05-06T19:37:49.2463633+02:00: (Showing map view for Road_Traffic_Fine_Management_Process)
2021-05-06T19:37:50.6212506+02:00: (Showing statistics view for Road_Traffic_Fine_Management_Process)
```



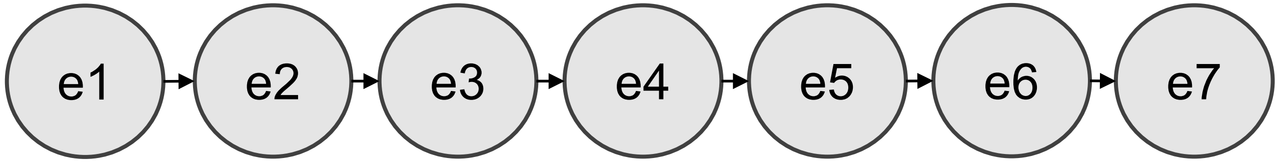
Multiple events can be related by time, causality, abstraction, or other relationships

Observation

Information Systems, Sensors

Occurence (Events)

Record about past occurence
Event Sequence



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Process Mining on the Rise

EDITORS' PICK | Jun 2, 2021, 06:00am EDT | 63.454 views

Celonis Raises $1 Billion At $11 Billion Valuation, Making It New York's —And Germany's — Most Valuable Startup

IBM acquires Italy's myInvenio to integrate process mining directly into its suite of automation tools

Ingrid Lunden @ingridlunden / 2:03 PM GMT+2 • April 15, 2021 Comment

Appian acquires process mining company Lana Labs

Kyle Wiggers @Kyle_L_Wiggers August 5, 2021 2:05 PM

INSIGHTS

SAP to acquire Business Process automation startup Signavio for a reported US$1.2 billion

Staff Writers / Thu 28 Jan 2021

Insights > SAP to acquire Business Process automation startup Signavio for a reported US$1.2 billion

Microsoft acquires process mining vendor Minit to grow its automation offerings

Kyle Wiggers @kyle_l_wiggers / 9:05 PM GMT+2 • March 31, 2022 Comment

US giant Salesforce partners with software startup Apromore after $15.3m capital raise

By Nick Nichols 6 December 2022

Magic Quadrant for Process Mining Tools

- Gartner published a market guide for process mining in 2018
- Inaugural publication of a Magic Quadrant for Process Mining tools in 2023

The Potential of Process Mining

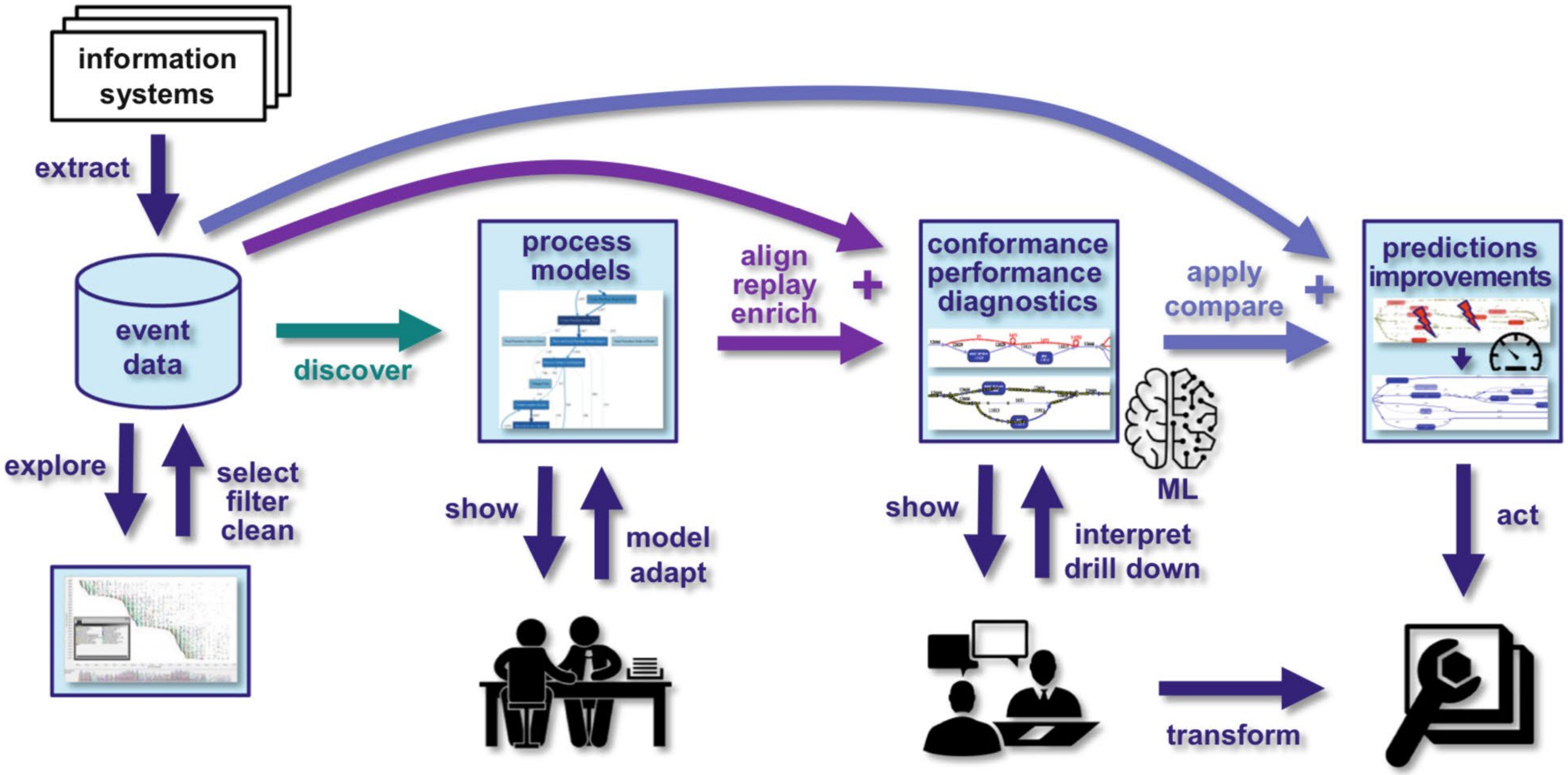
Creation of «current state» processes

Connecting BPM with Data

„Process mining software can help organizations easily capture information from enterprise transaction systems and provides detailed — and data-driven — information about how key processes are performing.“

Source: Davenport and Spanyi, What Process Mining Is, and Why Companies Should Do It

Process Mining: The Big Picture



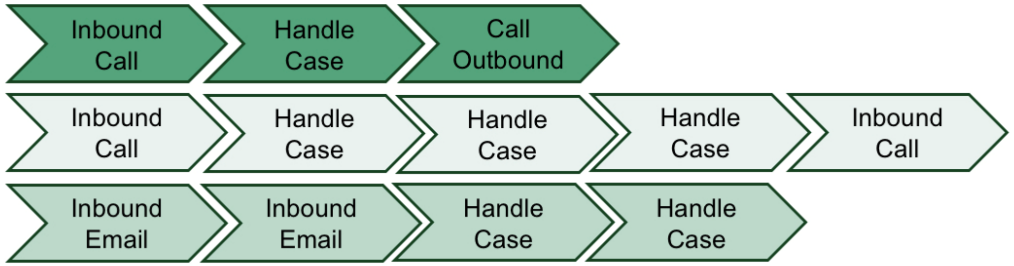
Source: van der Aalst & Carmona: Process Mining Handbook

Event Data: The Starting Point for Process Mining

Case	Activity	Start Date	End Date
Case 17	Inbound Call	04.03.2010 07:35	04.03.2010 07:46
Case 17	Handle Case	04.03.2010 07:53	04.03.2010 07:55
Case 17	Handle Case	08.03.2010 11:16	08.03.2010 11:18
Case 1	Inbound Call	09.03.2010 08:05	09.03.2010 08:10
Case 1	Handle Case	11.03.2010 10:30	11.03.2010 10:32
Case 17	Handle Case	11.03.2010 11:15	11.03.2010 11:19
Case 1	Call Outbound	11.03.2010 11:45	11.03.2010 11:52
Case 19	Inbound Email	14.03.2010 14:08	18.03.2010 08:04
Case 17	Inbound Call	14.03.2010 17:53	14.03.2010 17:56
Case 19	Inbound Email	18.03.2010 08:06	18.
Case 19	Handle Case	18.03.2010 08:07	18.
Case 19	Handle Case	18.03.2010 08:09	18.

An event log contains traces
Each trace is a sequence of events belonging to the same case

Traces of Case 1, 17 and 19



Case ID, activity and at least one timestamp per event are the minimum requirements for an event log

Universität St.Gallen

Process Science
Event Data for Studying Continuous Change

Process Science: The Interdisciplinary Study of Continuous Change

Jan vom Brocke, University of Liechtenstein, jan.vom.brocke@uni.li
Wil M.P. van der Aalst, RWTH Aachen, wvdaalst@pads.rwth-aachen.de
Thomas Grisold, University of Liechtenstein, thomas.grisold@uni.li
Waldemar Kremser, Radboud University, w.kremser@fm.ru.nl
Jan Mendling, Humboldt University, jan.mendling@hu-berlin.de
Brian Pentland, Michigan State University, Pentland@broad.msu.edu
Jan Recker, University of Hamburg, jan.christof.recker@uni-hamburg.de
Maximilian Roeglinger, University of Bayreuth, maximilian.roeglinger@fim-rc.de
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Barbara Weber, University of St.Gallen, barbara.weber@unisg.ch

Abstract

The only constant in our world is change. Why is there not a field of science that explicitly studies continuous change? We propose the establishment of process science, a field that studies processes: coherent series of changes, both man-made and naturally occurring, that unfold over time and occur at various levels. Process science is concerned with understanding and

1. Introduction

We live in an age of process. Many core phenomena of our time speak to complex dynamics involving change: Climate change, globalization, the platformization of economies, as well as societal movements including #meToo, #FridaysForFuture, #blackLivesMatter, or political decisions, have in common that we can learn a lot more about them if we

"Process science is the interdisciplinary study of continuous change. By process, we mean a coherent series of changes that unfold over time and occur at multiple levels."

Digital trace data offer new opportunities to study **how phenomena evolve** in terms of underlying **sequences of events**.

vom Brocke et al., Process Science: The Interdisciplinary Study of Continuous Change

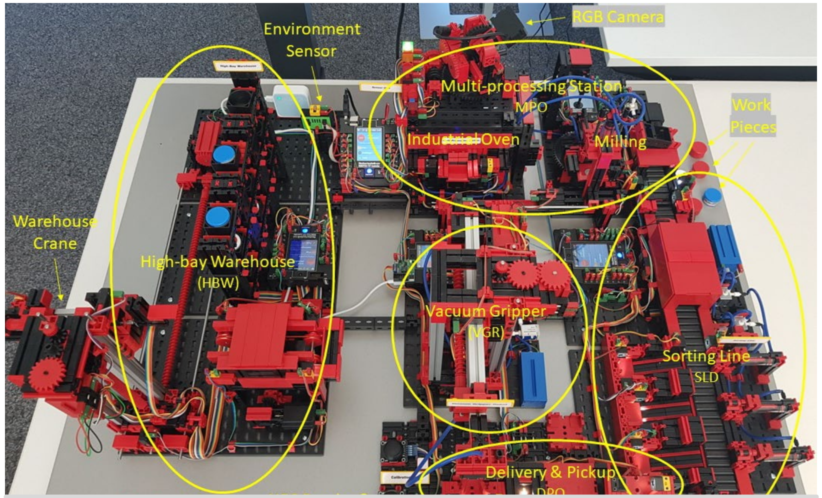
Process Science Activities

Universität St.Gallen

Methods

Discovery	Explanation	Intervention
Goal. Capture and describe processes.	**Goal.** Understand why, how and when a process unfolds.	**Goal.** Intervene and shape the process into desired directions.
Example. Methods to create process representations from digital trace data and to identify patterns in processes.	*Example.* Methods to study the context in which a pattern is situated.	*Example.* Methods to develop and evaluate interventions.

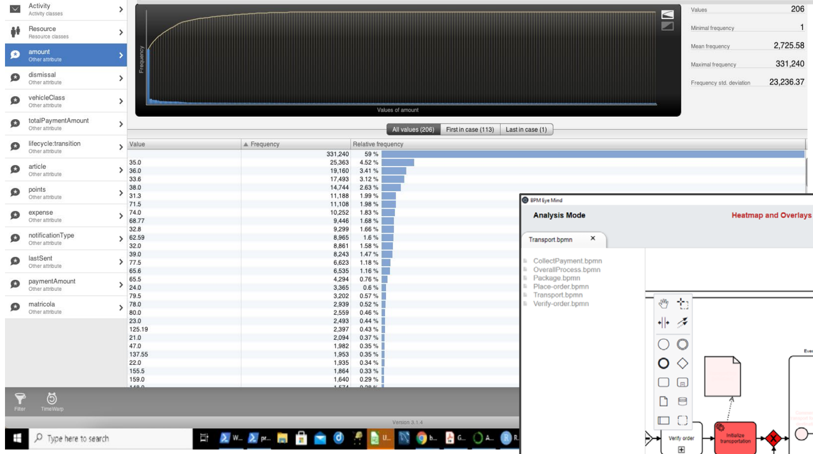
Examples of Different Processes

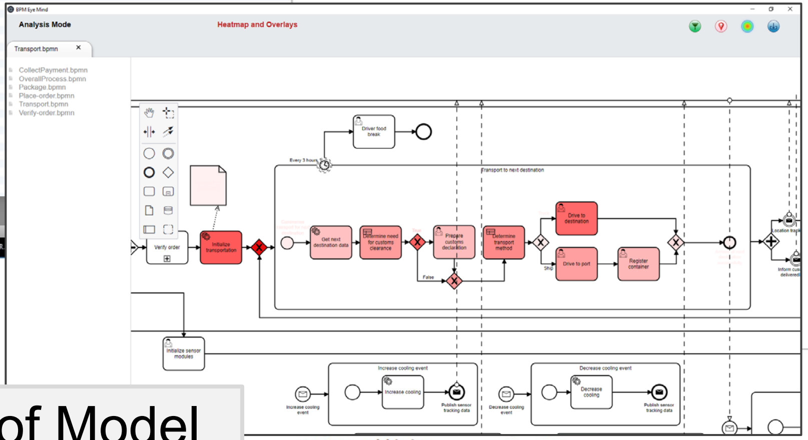


The Process of Storage and Production in a Smart Factory

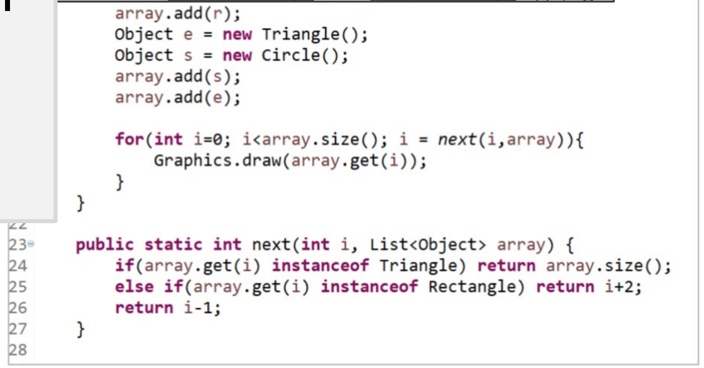
Phlebotomy: The Process of Drawing Blood

The Process of Process Mining





The Process of Model Comprehension / Program Comprehension



Universität St.Gallen

Process Science in Action

Selection of Data Sources, Data Collection, and Event Log Generation

Process Discovery and Exploration

Create „Current State“ Process Representations, Mine Behavior Pattern, Visualize Event Sequences

Conformance Checking

Process Monitoring

Linking Data Sources and Contextualizing Events and Patterns

Interpretable (Bio-)Feedback, (Neuro-)Adaptive Software Systems
Data-driven Tool Development

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Data-driven Tool Development

Process Observability Largely Differs

Example event from factory:

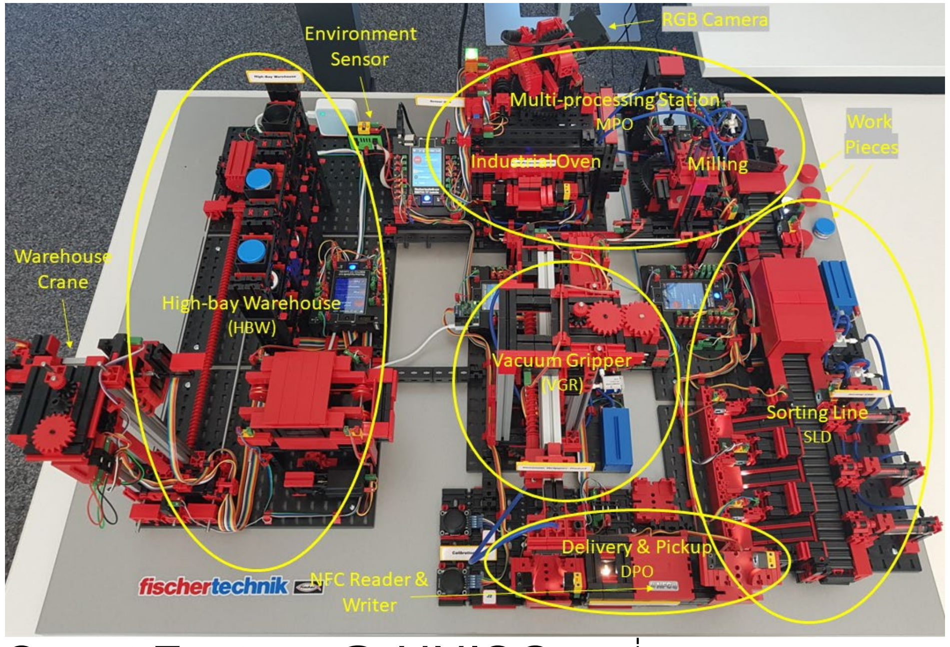
Topic: FTFactory/HBW_1

{ "id": "FTFactory/HBW_1", "timestamp": "2020-12-11 13:35:35.50", "i1_light_barrier_interrupted": false, "i2_light_barrier_interrupted": true, "i3_light_barrier_interrupted": true, "i4_light_barrier_interrupted": false, "i5_position_switch_pressed": true, "i6_position_switch_pressed": true, "i7_position_switch_pressed": false, "i8_position_switch_pressed": true, "m1_speed": 0, "m2_speed": 0, "m3_speed": 0, "m4_speed": 0, "current_state": "ready", "current_task": "", "current_task_elapsed_seconds_since_start": 0, "current_sub_task": "", "failure_label": "", "current_pos_x": 0, "current_pos_y": 0, "target_pos_x": 0, "target_pos_y": 0, "amount_of_stored_workpieces": 0}

Sensors:
- Switches
- Light barriers
- Color sensors
- Environment
- Camera
- NFC

Actuators:
- Motors
- Compressors
- Valves

Smart Factory equipped with **sensors** and **actuators** emitting **events**



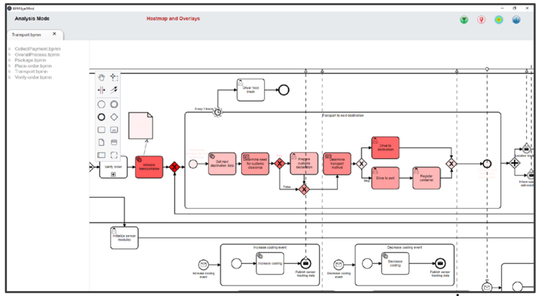
Smart Factory @ UNISG

Low

High

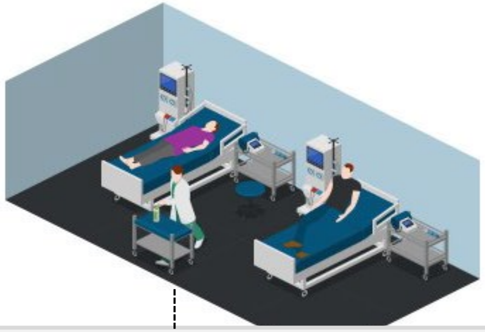
Source: R. Seiger, L. Malburg, B. Weber, R. Bergmann, Integrating process management and event processing in smart factories: A systems architecture and use cases.

Process Observability Largely Differs

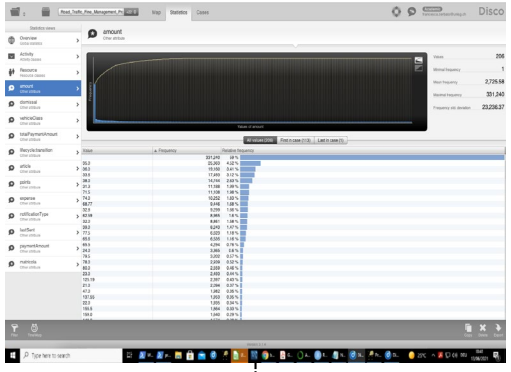


Navigation, scrolling and zooming events during model comprehension (depending on tool); large parts of the process occur in the **reader's mind**

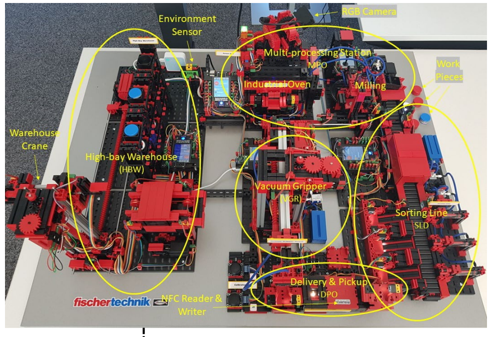
Process is largely manual; **no events** since most parts performed **outside of any IT system**



Tool interaction events during analysis (depending on the tool); large parts of the process occur in the **analyst's mind**



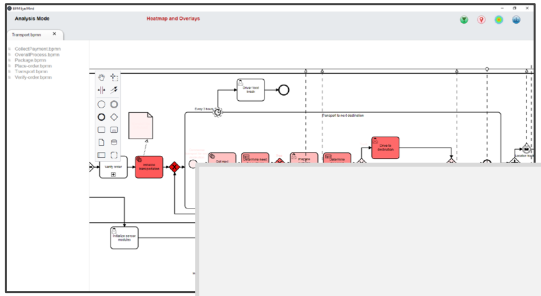
Sensors and **actuators** emitting **events**



Low

High

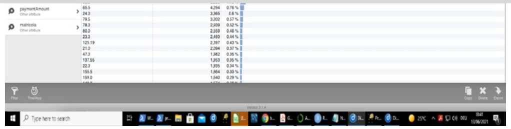
Process Observability Largely Differs



Navigation, scrolling and zooming events during model comprehension (depending on tool): large parts of the

Usage of sensors and additional forms of data collection to increase process observability.

Process is largely m
no events since mo
performed **outside o**
system



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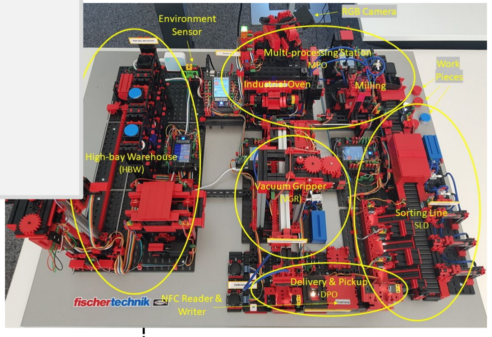
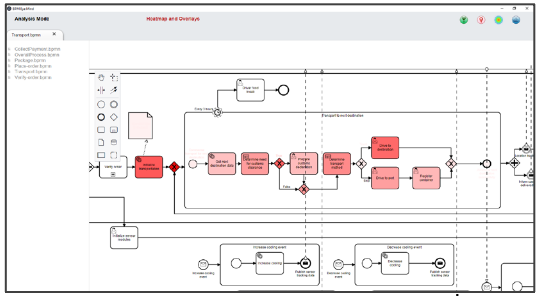


Low

High

Process Observability Largely Differs



Navigation, scrolling and zooming events during model comprehension (depending on tool); large parts of the process occur in the **reader's mind**

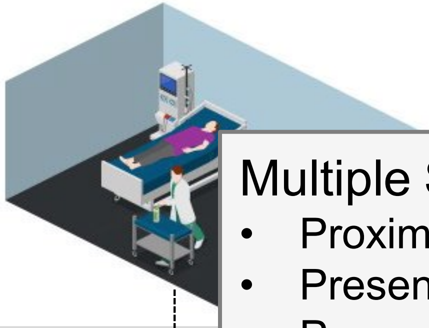
Eye-tracker

Galvanic Skin Response

Process is largely manual; **no events** since most parts performed **outside of any IT system**

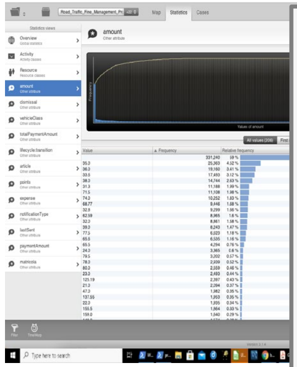
Tool interaction events during analysis (depending on the tool); large parts of the process occur in the **analyst's mind**

Sensors and actuators emitting **events**



Multiple Sensors

- Proximity sensor
- Presence sensor
- Pressure sensor
- Touch sensor
- Flow sensor

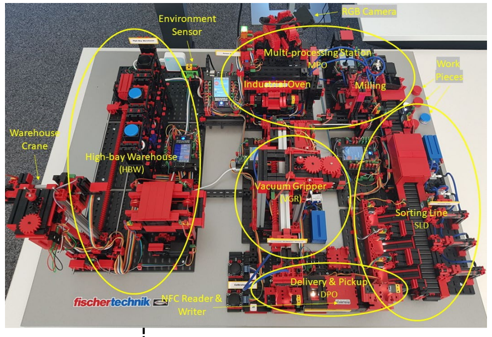


Application logs
(where available)

Screen recordings
to derive user interactions

Think-aloud data

Retrospective Interviews



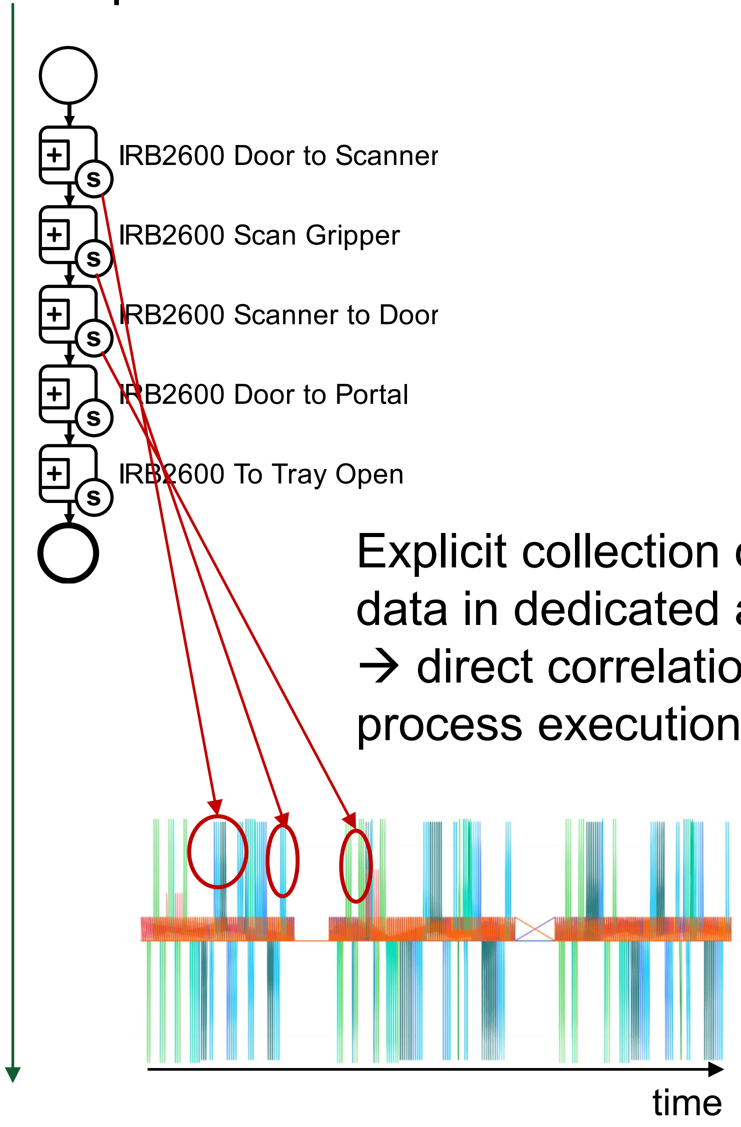
Low → High

The Importance of Data Collection

- Data collection needs to be carefully planned to enable the linking of the collected data with the different elements of the process
  - Collecting data in a process context
  - Synchronized data collection

Process-driven Execution and Collection of IoT Data in Context

Top down



Explicit collection of sensor data in dedicated activities → direct correlation with process execution

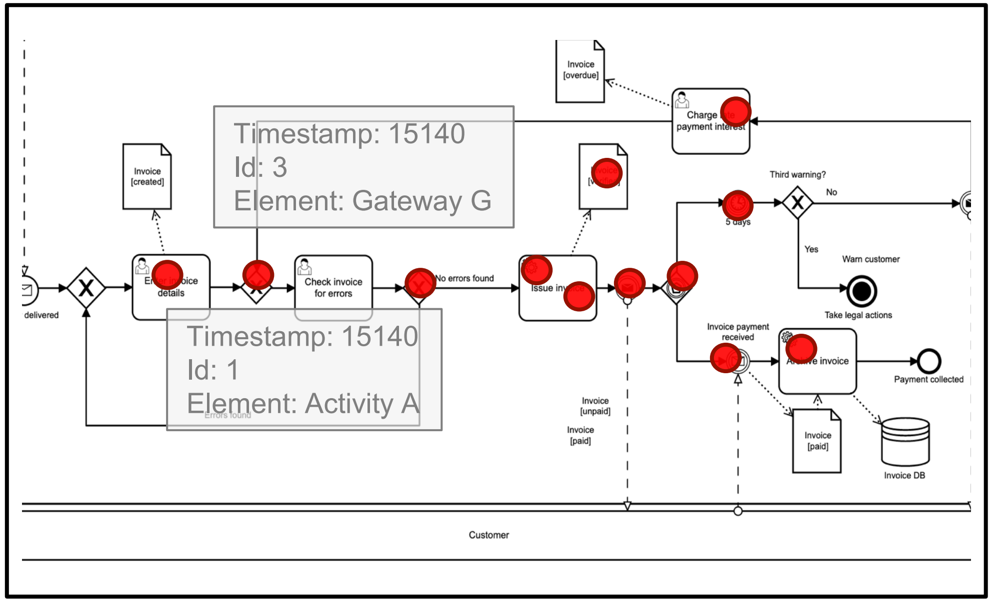
- **IoT data** is collected during process execution and gets **embedded in the broader process context**
- This results in **IoT-enriched event logs** which associate sensor data with the corresponding process execution events

Source: Mangler et al., DataStream XES Extension: Embedding IoT Sensor Data into Extensible Event Stream Logs

Automated Mapping of Attentional Processes to Software Design Artifacts

Eye-tracker

Data collection



Automated mapping of gazes to elements of the artifact

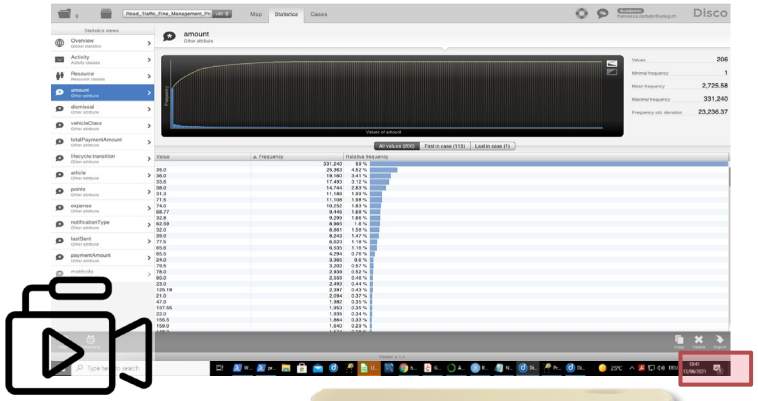
- **Gaze events** are automatically mapped during data collection to the elements of the software design artifact (here process model)
- This results in an **enriched log of gaze events** which associates gaze data with the corresponding elements of the artifact

Source: Prototype developed by Amine Abbad Andaloussi

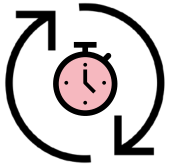
Synchronized Collection of Data

Collecting data in a process context is not always feasible.

If collected in a synchronized manner, links between different modalities can be established at later stages, e.g., using timestamps.



Screen Recording



Think-Aloud Data

P27: I would like to see, using this one. I will explore a little more the statistics. And then we have another insight here. The TotalPaymentAmount, I would like to see that one. And actually, it's TotalPaymentAmount, the cumulative amount paid by the offender, it's always initialized to zero. Well, we have an opportunity. It's always initialized to zero. Ok. The amount paid by the offender in one transaction. This one is interesting.

Application Logs

```
2021-05-06T19:34:45.0744536+02:00: Adding buffer to output stream.
2021-05-06T19:34:45.0899984+02:00: Saved graph to disk in 15 millis
2021-05-06T19:34:45.9960234+02:00: (Showing log explorer view for Road_Traffic_Fine_Management_Process
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2021-05-06T19:37:50.6212506+02:00: (Showing statistics view for Road_Traffic_Fine_Management_Process)
```
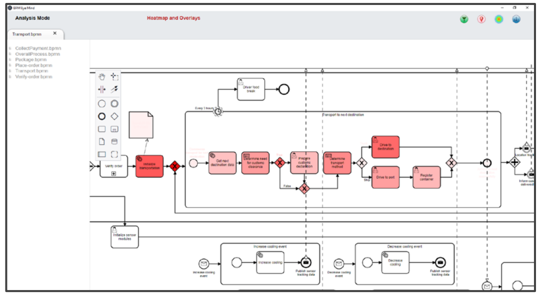
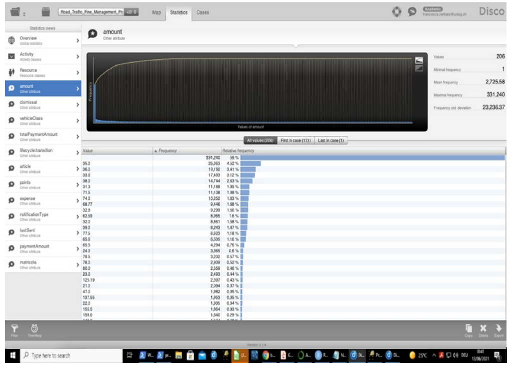
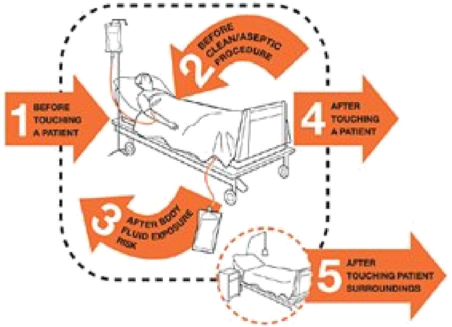

Availability of Process Knowledge

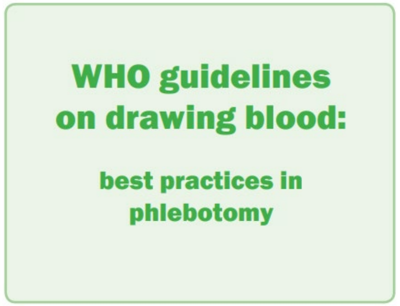
Process and **activities** largely **unknown;** high flexibility and variability



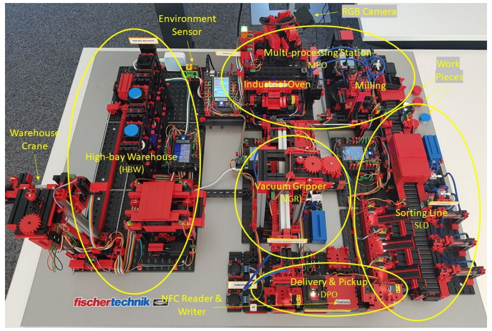


Guidelines including **process steps;** indication for hand hygiene (**business rules**); some flexibility and variability





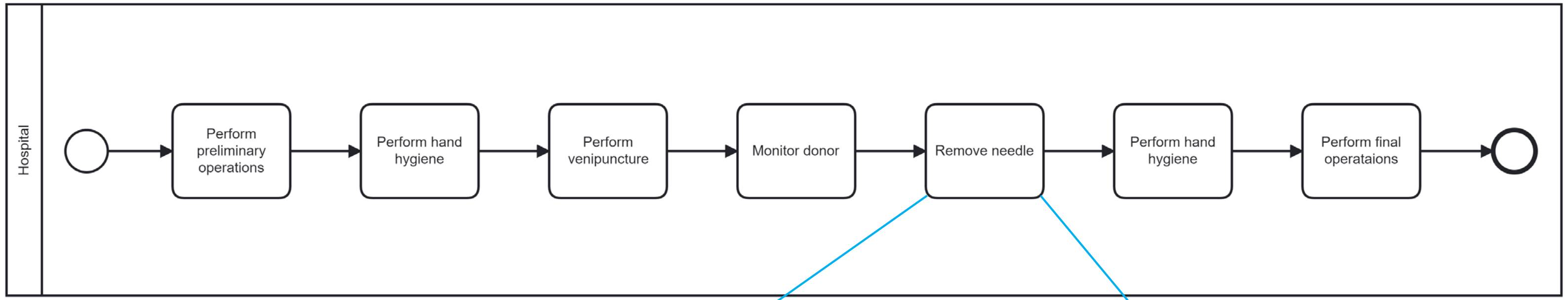
Process and **activities known**; end-to-end visibility due to process-driven execution and data collection; repetitive and well structured



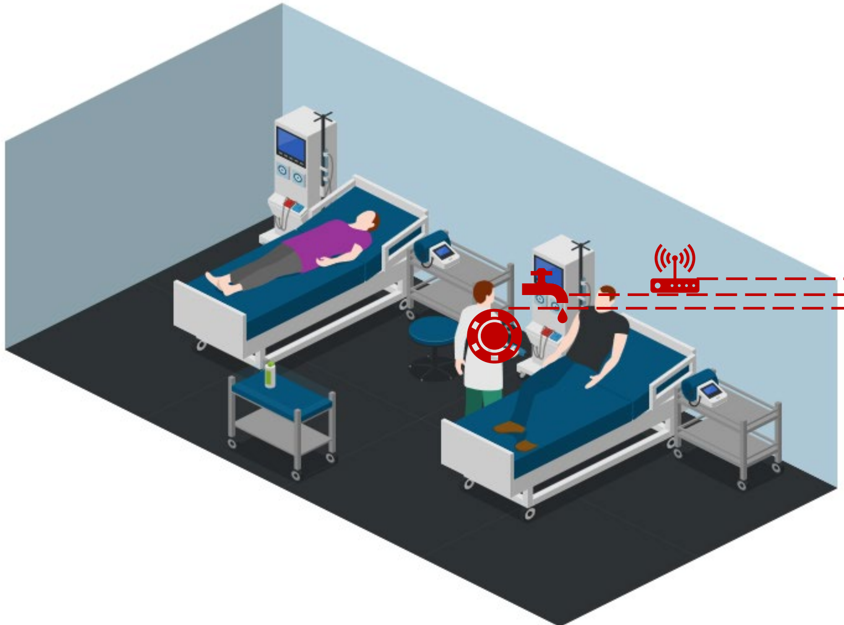
Low High

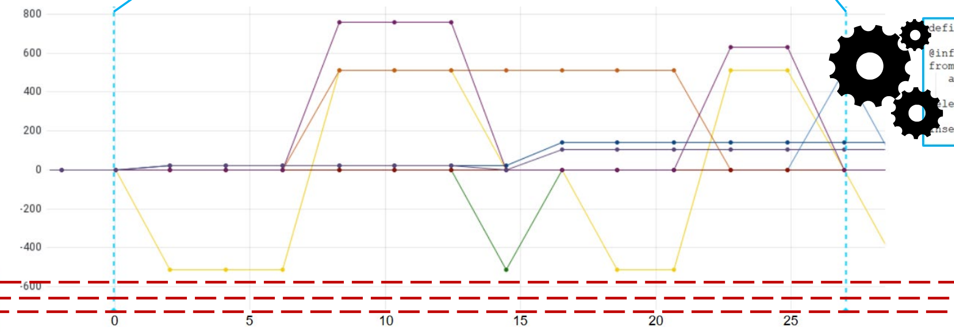
Process Activity / Event Detection from Sensors

Known process and activities



IoT to detect relevant state changes





Complex Event Processing queries

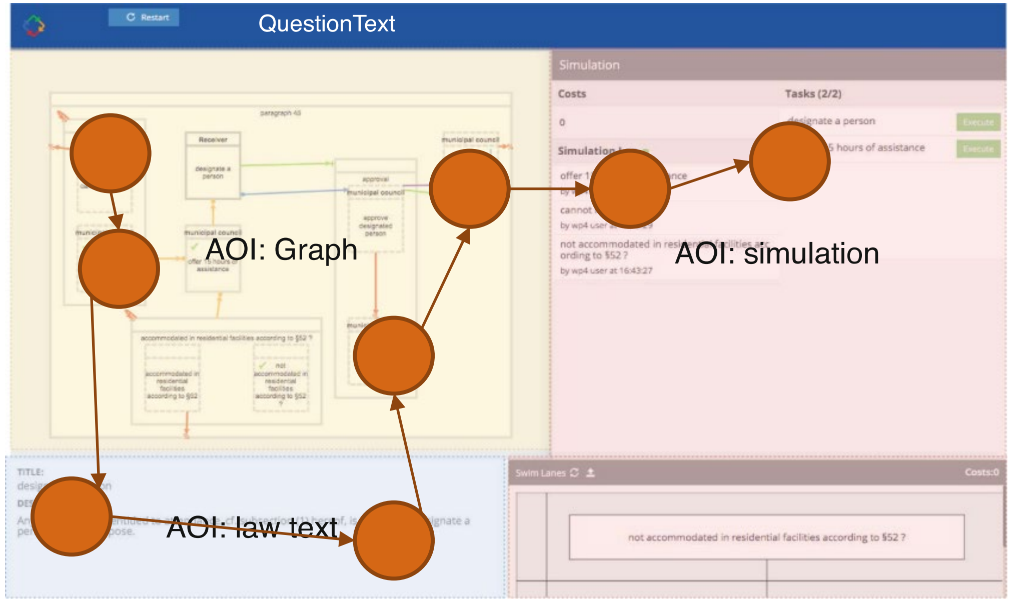
```
define stream BloodDrawingMachine(state, timestamp);

@info(name='Query')
from every e1=BloodDrawingMachine, e2=BloodDrawingMachine[(e1.active=="ON")
   and (e2.active=="OFF")]

select 'Process1_MP_BloodDrawingMachine_State_simpleSwitch_ON_OFF' as Remove_needle_ended

insert into OutputStream;
```

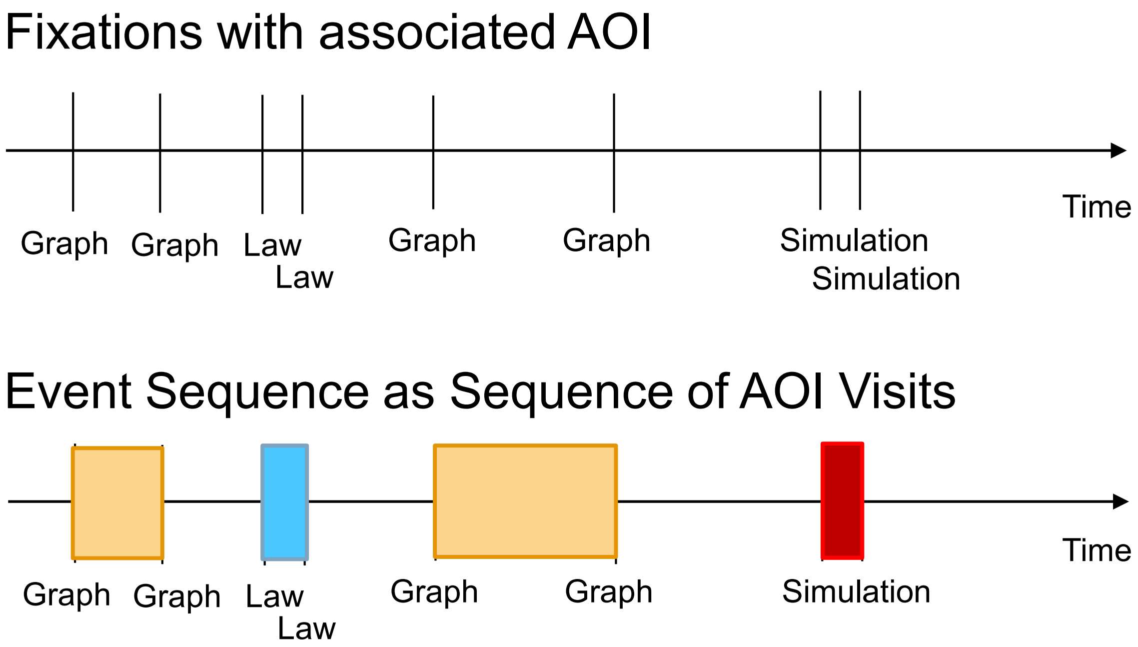
Activity signatures to record IoT devices readings corresponding to events

Source: R. Seiger, M. Franceschetti, B. Weber, An Interactive Method for Detection of Process Activity Executions from IoT Data

Areas of Interest as Activity Proxies

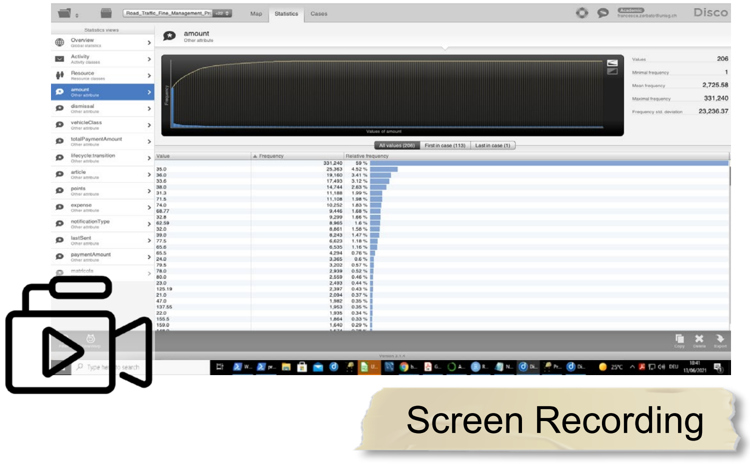
- Each comprehension task performed by a participant (i.e., trial) is considered a process instance
- Visits to Areas of Interest (corresponding to elements of the artifact) are used as proxies for activities



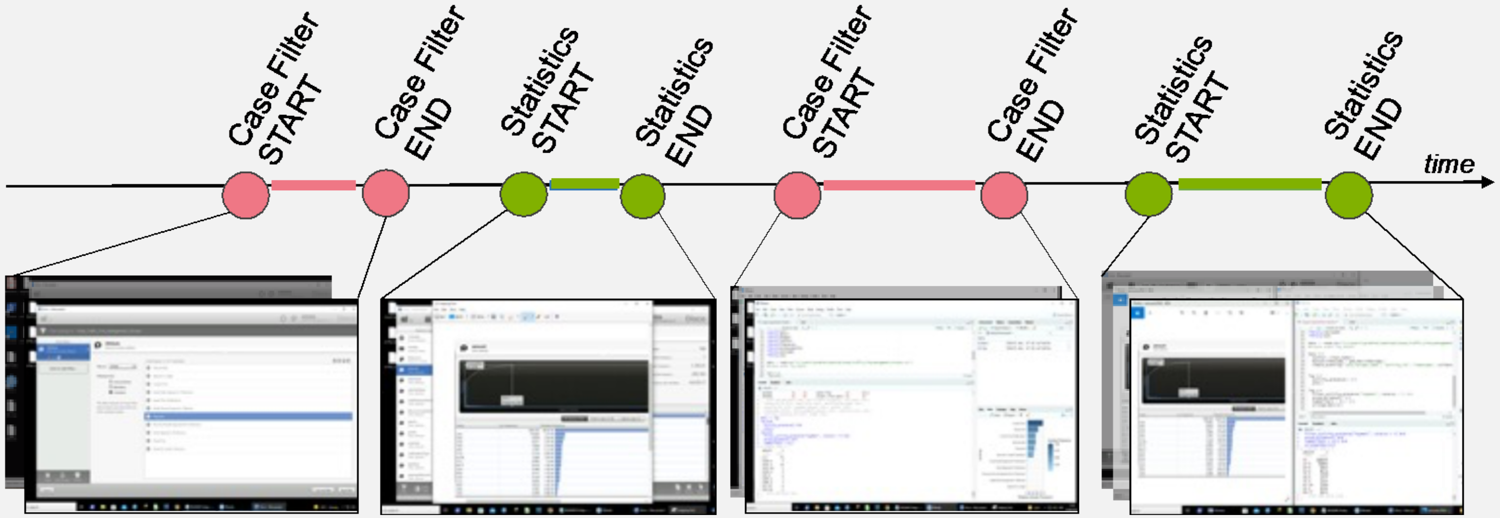


Source: Abbad Andaloussi et al., Exploring how users engage with hybrid process artifacts based on declarative process models: a behavioral analysis based on eye-tracking and think-aloud

Creating User Interaction Logs From Screen Recordings



Since processes and activities are largely unknown, decisions on **what to consider as events** is left to the researcher.



I	Tool Function	Tool	Start	End
P27	PDF Reader	Acrobat Reader	00:04:50,3	00:06:17,4
…	…		…	…
P27	Case Filter	Disco	00:09:38,3	00:11:09,9
P27	Statistics	Disco	00:11:46,1	00:12:34,3
P27	Case Filter	bupaR	00:14:00,7	00:15:09,9
P27	Statistics	bupaR	00:16:37,1	00:16:59,8
P27	Statistics	Disco	00:16:37,1	00:16:59,8
…	…	…	…	…

Process Science in Action

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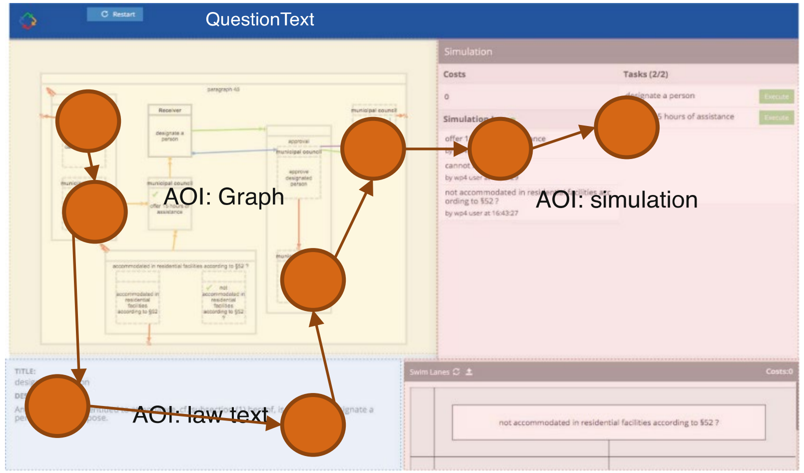
Conformance Checking

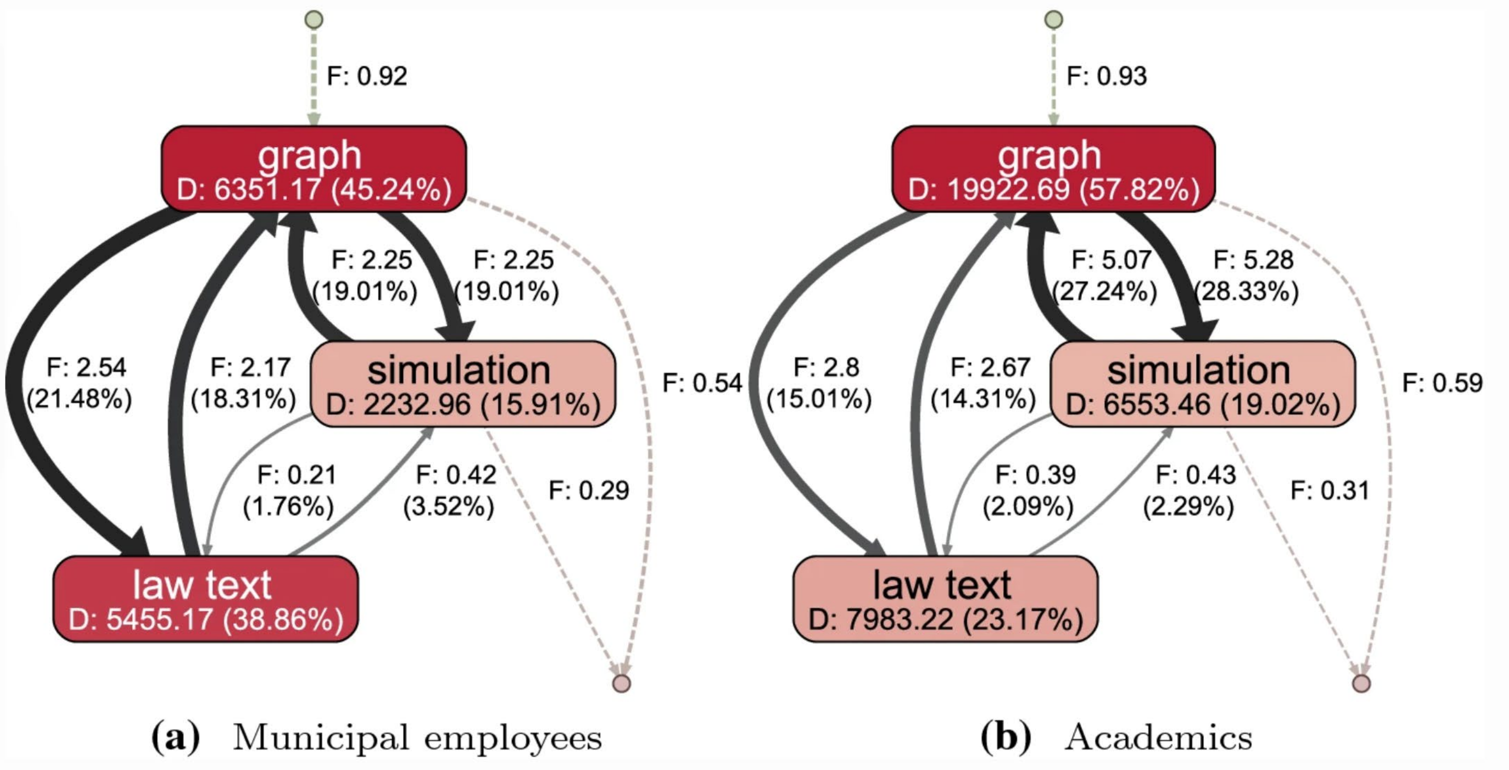
Process Monitoring

Linking Data Sources and Contextualizing Events and Patterns

Interpretable (Bio-)Feedback, (Neuro-)Adaptive Software Systems
Data-driven Tool Development

Mining User Behavior Patterns Example: Hybrid Process Artifacts

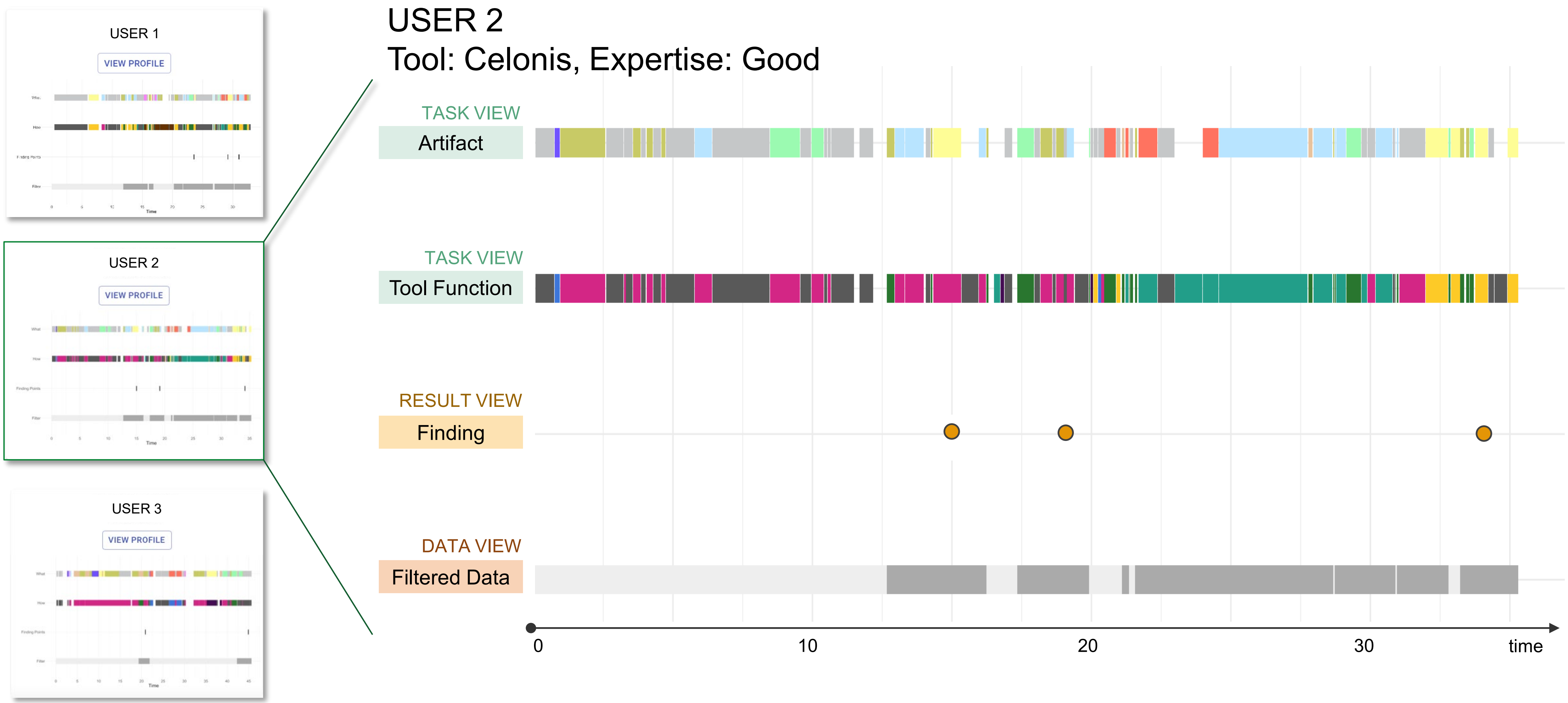




Attention maps in form of Directly-Follow-Graphs comparing the attentional processes for municipal employees and academics. *D* is the mean fixation duration, and *F* is the mean transition frequency between two AOIs.

Source: Abbad Andaloussi et al., Exploring how users engage with hybrid process artifacts based on declarative process models: a behavioral analysis based on eye-tracking and think-aloud

Visualizing Event Sequences
Creation of Multi-Perspective Profiles



Visualizing Event Sequences
Focus on Subsequences of Interest

Process Science in Action

Selection of Data Sources, Data Collection, and Event Log Generation

Process Discovery and Exploration

Create „Current State“ Process Representations, Mine Behavior Pattern, Visualize Event Sequences

Conformance Checking

Process Monitoring

Linking Data Sources and Contextualizing Events and Patterns

Interpretable (Bio-)Feedback, (Neuro-)Adaptive Software Systems
Data-driven Tool Development

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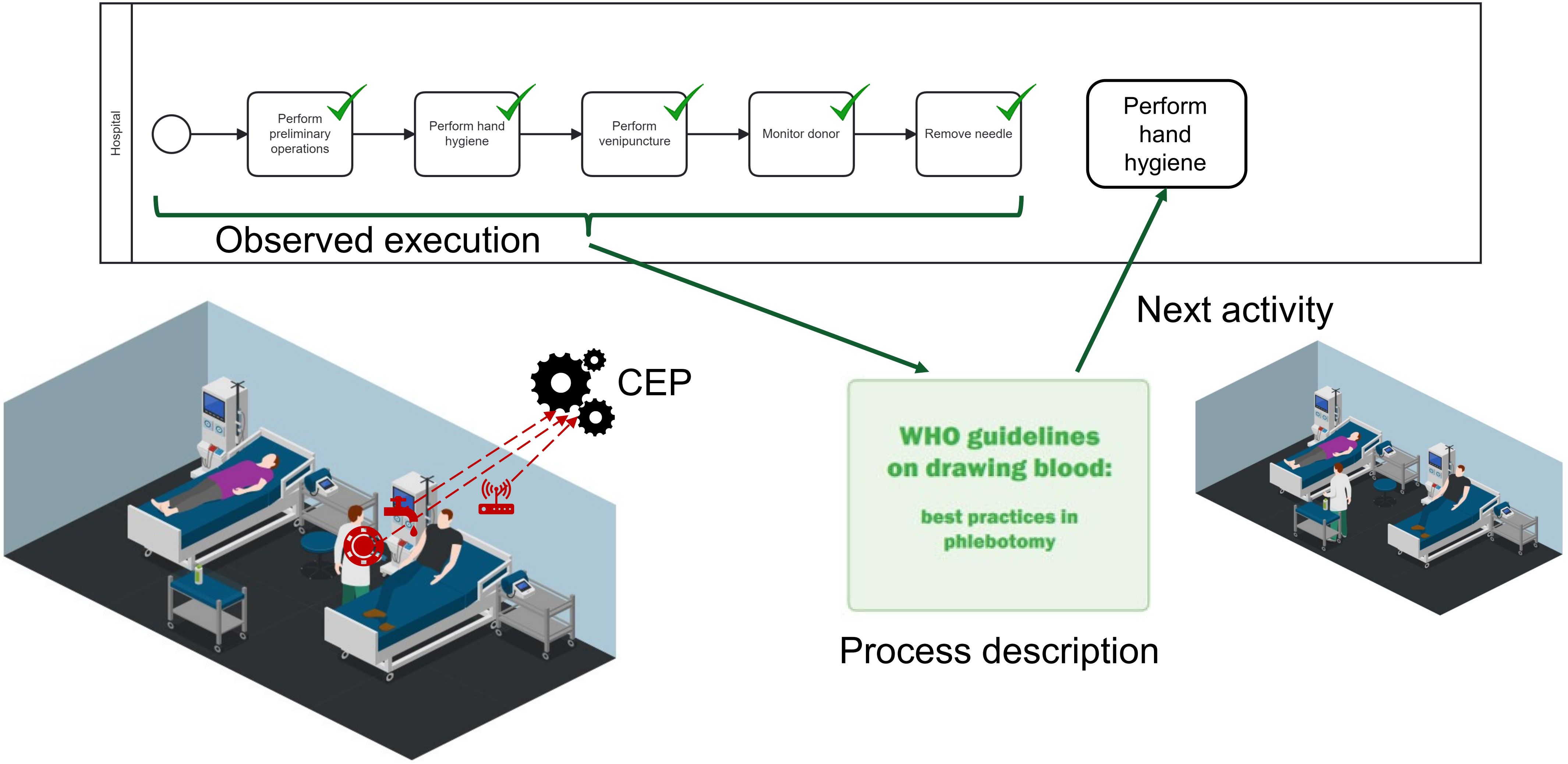
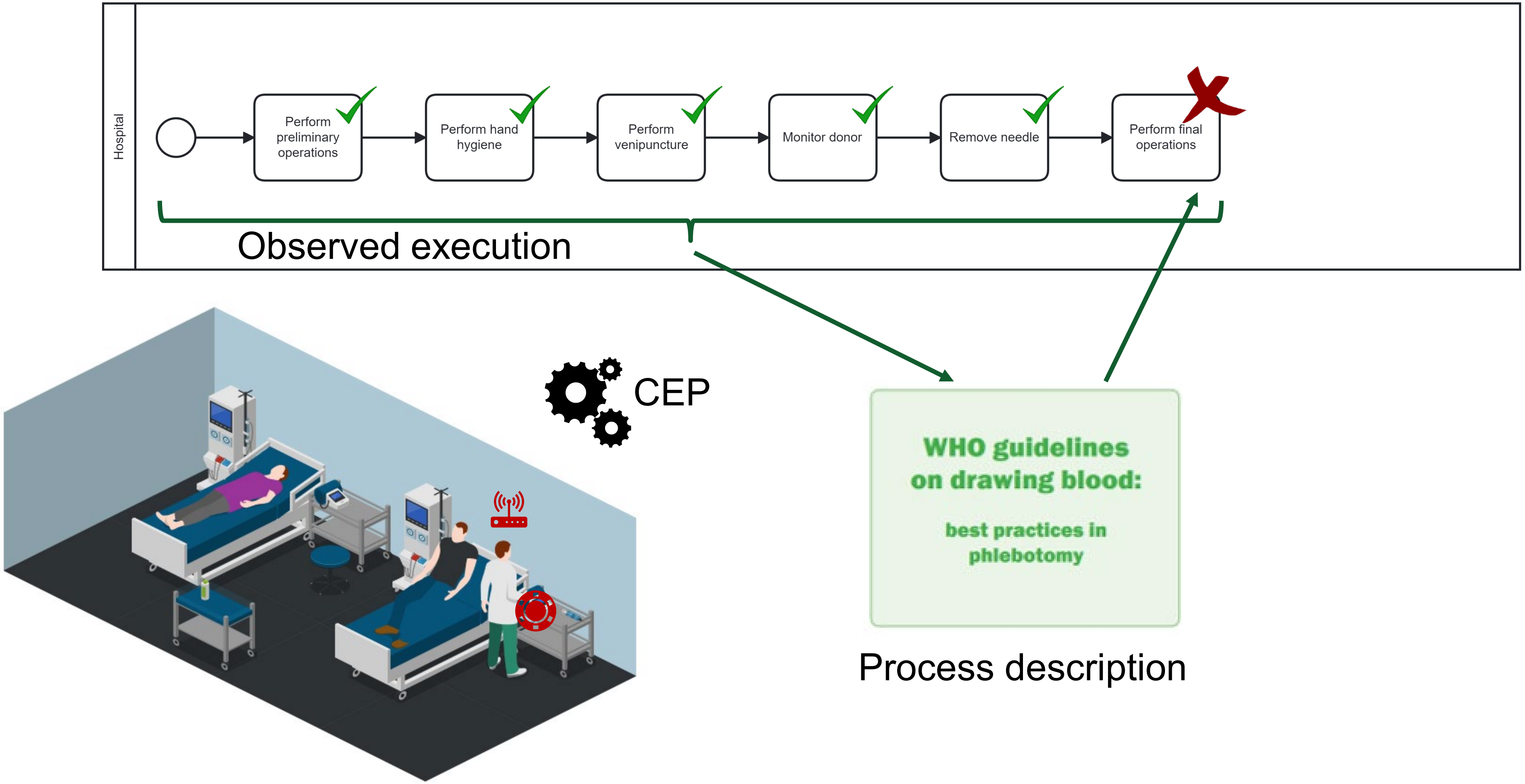
Monitoring for Hand Hygiene Indications



Process Conformance Checking



Process Science in Action

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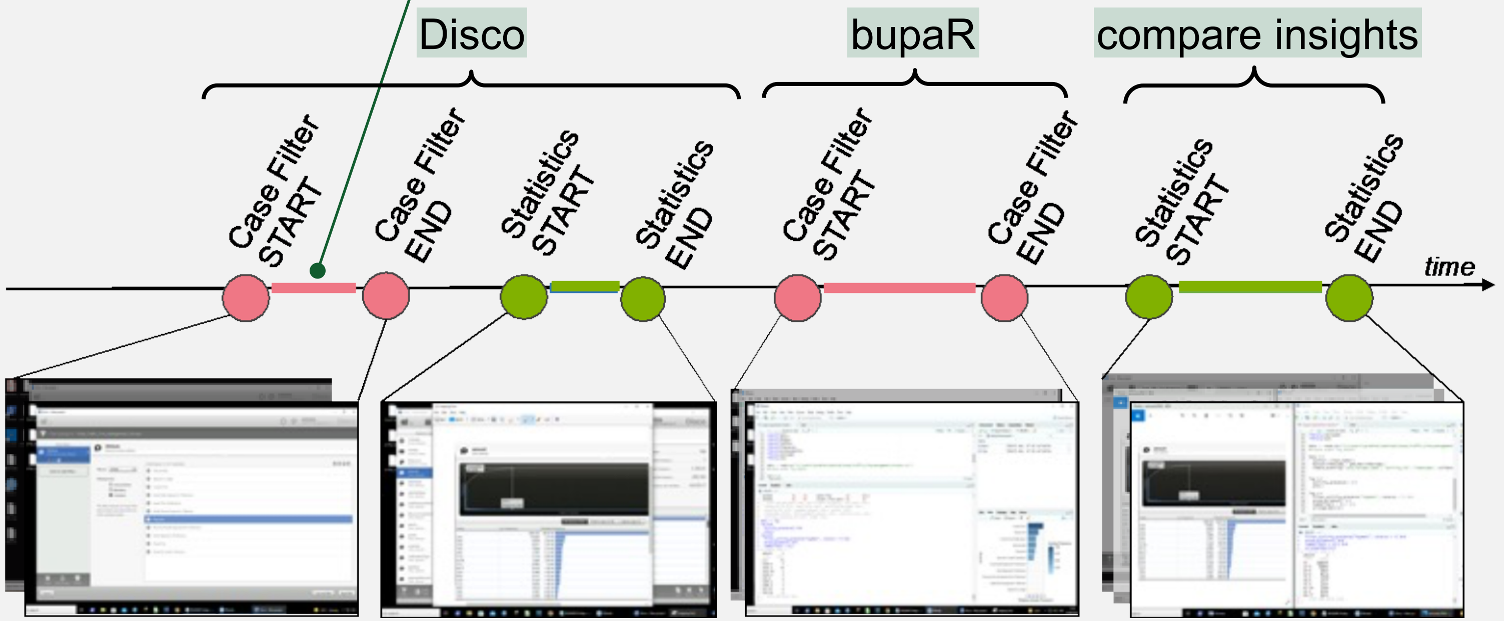
Providing Context to User Interaction Logs

Think-Aloud Data

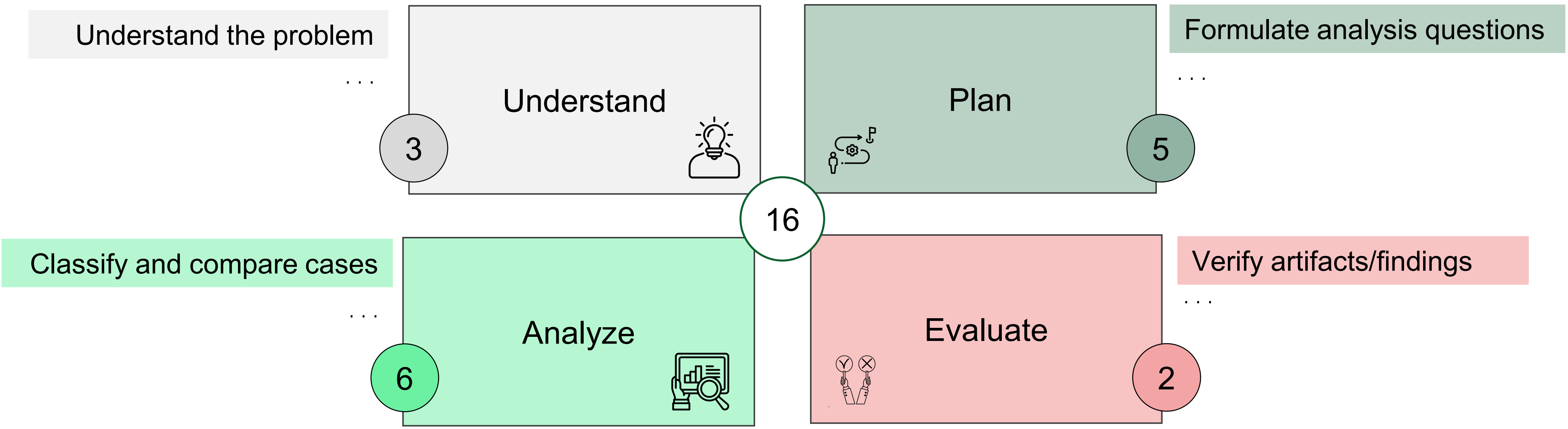
[00:09:38,3 – 00:11:09,9]
"I'm trying to filter the Payment activity to see all the cases that we don't have a payment. I've tried using the filter forbidden..."



ID	Tool Function	Tool	Start	End
P27	PDF Reader	Acrobat Reader	00:04:50,3	00:06:17,4
…	…		…	…
P27	Case Filter	Disco	00:09:38,3	00:11:09,9
P27	Statistics	Disco	00:11:46,1	00:12:34,3
P27	Case Filter	bupaR	00:14:00,7	00:15:09,9
P27	Statistics	bupaR	00:16:37,1	00:16:59,8
P27	Statistics	Disco	00:16:37,1	00:16:59,8
…	…	…	…	…

Providing Context to User Interaction Logs
Usage of Common Strategies

Process mining strategies derived from the analysis of interview data.



Source: F. Zerbato, P. Soffer, B. Weber, Process Mining Practices: Evidence from Interviews.

Providing Context to User Interaction Logs

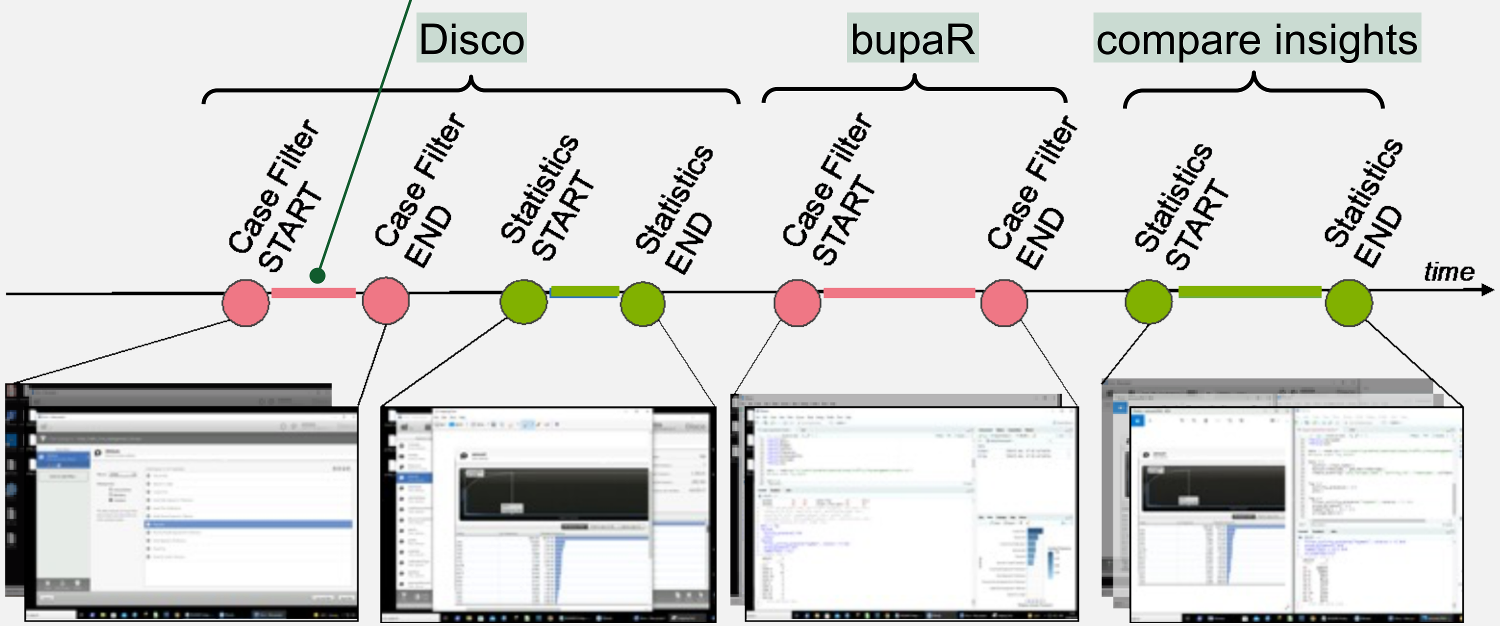
Strategy: Verify artifacts and findings

Think-Aloud Data

[00:09:38,3 – 00:11:09,9]
"I'm trying to filter the Payment activity to see all the cases that we don't have a payment. I've tried using the filter forbidden..."

"Often I try to combine different tools to understand for sanity check if we have the same insights in different tools."

Interview Data



ID	Tool Function	Tool	Start	End
P27	PDF Reader	Acrobat Reader	00:04:50,3	00:06:17,4
…	…		…	…
P27	Case Filter	Disco	00:09:38,3	00:11:09,9
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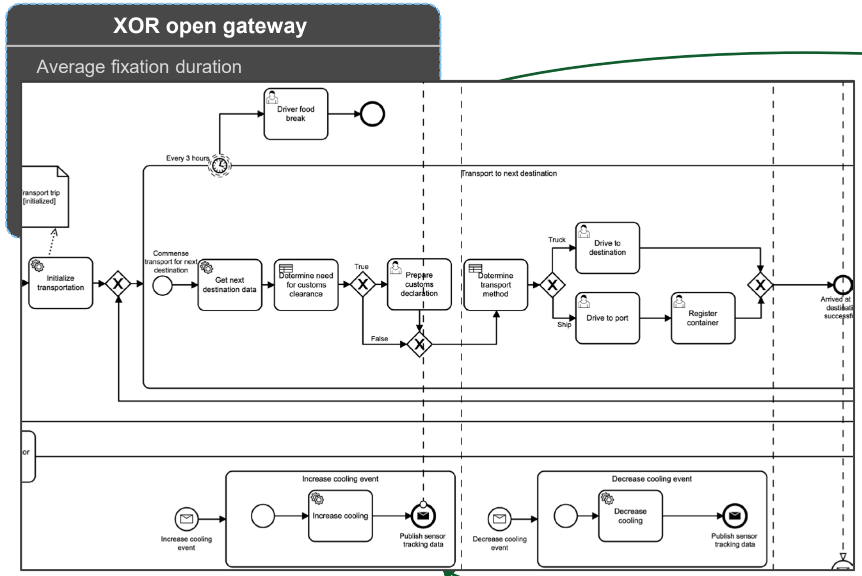
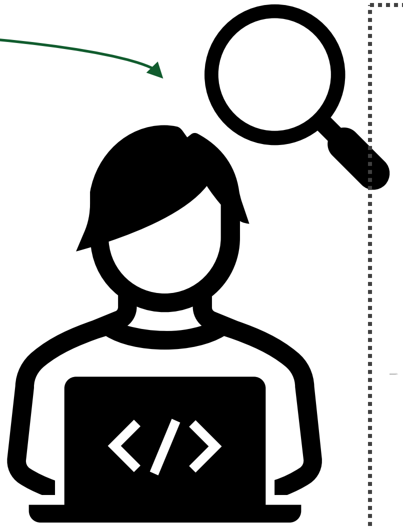
P27	Statistics	bupaR	00:16:37,1	00:16:59,8
P27	Statistics	Disco	00:16:37,1	00:16:59,8
…	…	…	…	…

Associating a User’s Cognitive and Affective State With a Software Design Artifact

changes user’s cognitive and affective state

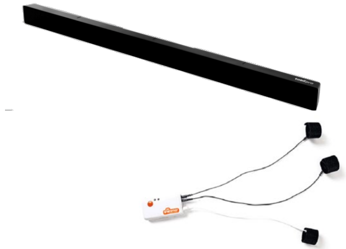




reads, creates, makes sense of, validates

Which parts of the model are perceived as difficult?

Neuro-physiological measures to continuously assess a user’s cognitive and affective state (e.g., cognitive load)



Eye-related measures

Skin-related measures

Heart-related measures

Brain-related measures

Source: Amine Abbad-Andaloussi, Thierry Sorg, Barbara Weber: Estimating Developers' Cognitive Load at a Fine-grained Level Using Eye-tracking Measures

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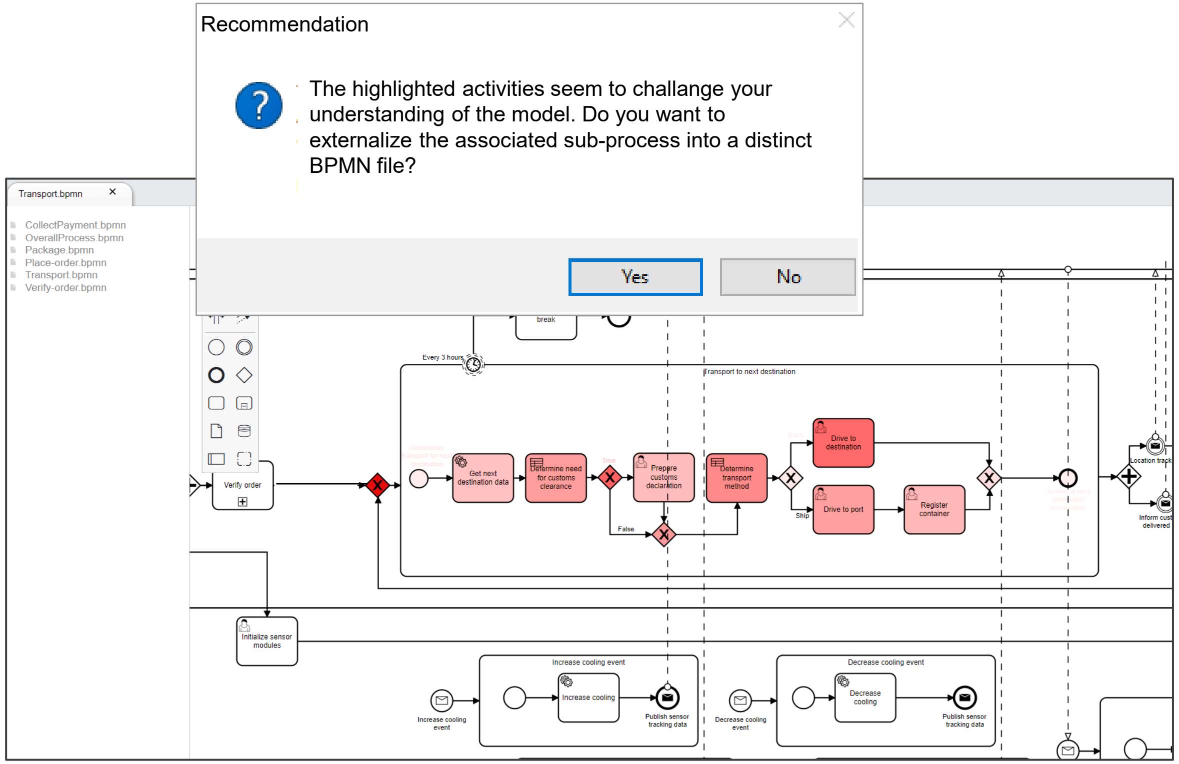
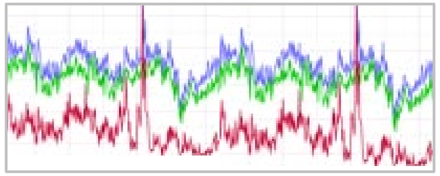
Biofeedback and Neuro-adaptive Software Systems

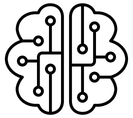




3.) System adapts on the base of the user's cognitive/affective state

1.) Biological Signal (e.g., EEG, pupil dilation, HRV, skin conductance) is recorded from the user

2.) Biological signal is analyzed to derive a mental state



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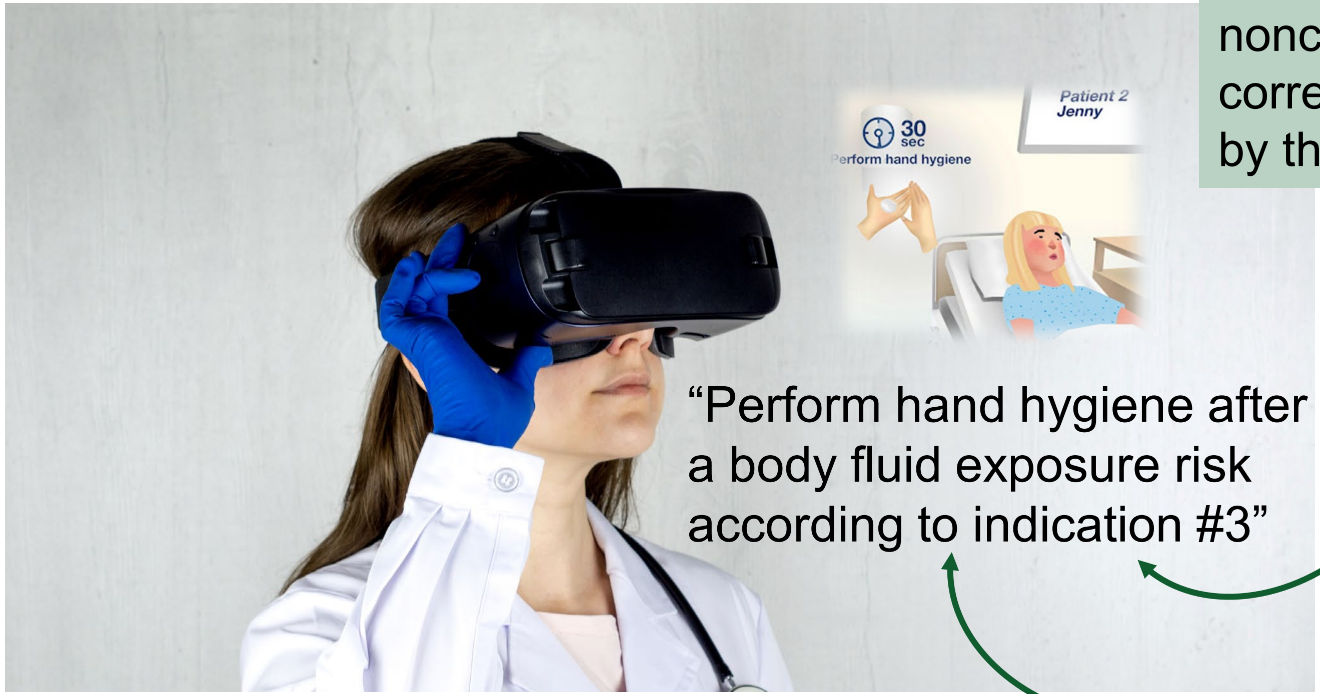
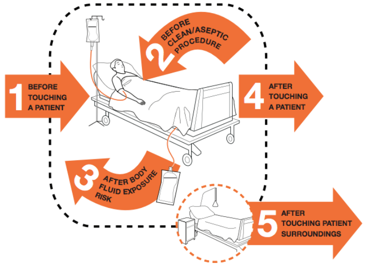
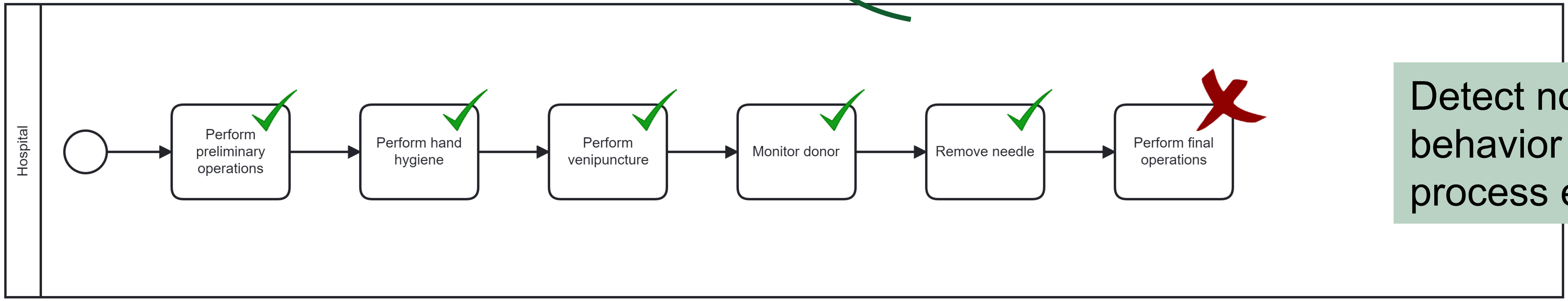
Interpretable Feedback

Inform the agent about nonconformance and indicate the correct course of action prescribed by the process description



“Perform hand hygiene after a body fluid exposure risk according to indication #3”





Detect nonconforming behavior during process execution

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Example of a recorded process mining analysis

	U	Id	Operation	I/O		Timestamp	User Annotations	Goals and Hypotheses
(A)	R	o_1	variantFilter(cases, keep, 75%)	L_0	L_1	07/10/22 10:01:18	filtered too much	G1: Reduce complexity
	R	v_1	nCases()	L_1	#cases	07/10/22 10:01:50		
	R	o_2	variantFilter(cases, keep, 85%)	L_0	L_2	07/10/22 10:02:03	filtered too much	
	R	v_2	nCases()	L_2	#cases	07/10/22 10:02:32		
	R	o_3	variantFilter(cases, keep, 90%)	L_0	L_3	07/10/22 10:03:11	good trade-off	
	R	o_7	activityFilter(cases, keep, "P")	L_6	L_{12}	07/10/22 10:33:18		G3: Validate combined filter
	R	o_4	activityFilter(cases, keep, "CC")	L_{12}	L_{13}	07/10/22 10:33:44	filter is correct	
	R	o_{11}	activityFilter(cases, remove, CC)	L_{12}	L_{14}	07/10/22 10:36:51		H4: Some partially paid cases do not include CC
(D)	R	Show results to business stakeholders and auditors						G4: Storytelling
(E)	J	o_5	activityFilter(cases, remove, "P")	L_3	L_{15}	14/10/22 08:33:17	order of filters checked	G5: Internal auditing
		o_4	activityFilter(cases, keep, "CC")	L_{15}	L_{16}	14/10/22 08:33:46		

Need to
(1) maintain provenance information about the analysis,
(2) trace analysis goals and insights,
(3) increase data awarenesss

Supporting Provenance and Data Awareness in Exploratory Process Mining

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Abstract. Like other analytic fields, process mining is complex and knowledge-intensive and, thus, requires the substantial involvement of human analysts. The analysis process unfolds into many steps, producing multiple results and artifacts that analysts need to validate, reproduce and potentially reuse. We propose a system supporting the validation, reproducibility, and reuse of analysis results via analytic provenance and data awareness. This aims at increasing the transparency and rigor of exploratory process mining analysis as a basis for its stepwise maturation. We outline the purpose of the system, describe the problems it addresses, derive requirements and propose a design satisfying these requirements. We then demonstrate the feasibility of the central aspects of the design.

Keywords: Process Mining · Exploratory Analysis · System Requirements and Design · Analytic Provenance · Data Awareness · User Support

1 Introduction

Process mining comprises methods to analyze event data generated in information systems during the execution of business processes. Process mining is quickly growing in adoption, and so is its business impact [9].

Like other data science disciplines, process mining requires the substantial involvement of humans, e.g., process analysts, to obtain insights from raw event data [7]. Analysts often freely explore the data with the available tools to gain a basic understanding of what it represents, investigate different scenarios, and create hypotheses. Hypotheses can then be tested using best practices, but more exploration is required if the test fails or the results are inconclusive [19]. Each insight that emerges during the analysis informs which subsequent analysis steps are chosen. On the one hand, the choices made during the analysis yield many possible reasonable results that need to be assessed. On the other hand, such choices might give rise to potential inconsistencies in the analysis process [14].

Due to its knowledge-intensive character and emergent course of action, an exploratory analysis includes many manual and error-prone steps that are often

Source: Francesca Zerbato, Andrea Burattin, Hagen Völzer, Paul Nelson Becker, Elia Boscaini, Barbara Weber: *Supporting Provenance and Data Awareness in Exploratory Process Mining.*

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Summary

- Consider leveraging digital trace data beyond traditional business processes
- Carefully planning data collection pays off!
- Going beyond traditional business processes offers great opportunities but brings challenges in terms of process observability, event correlation, and event abstraction

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Acknowlegements

ProMiSE: Process Mining Support for End-Users

FNSNF
FONDS NATIONAL SUISSE
DE LA RECHERCHE SCIENTIFIQUE
Grant No.: 200021 197032

Universität St.Gallen

University of Haifa

DTU

ProAmbitIon: Online Process Conformance Checking with Ambiguities Driven by the Internet of Things

FNSNF
FONDS NATIONAL SUISSE
DE LA RECHERCHE SCIENTIFIQUE
SPIRIT project 208497

Universität St.Gallen

Tecnológico de Monterrey

Kantonsspital St.Gallen

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Supporting Software Maintenance With Psycho-physiological Measures and Artifact Metrics

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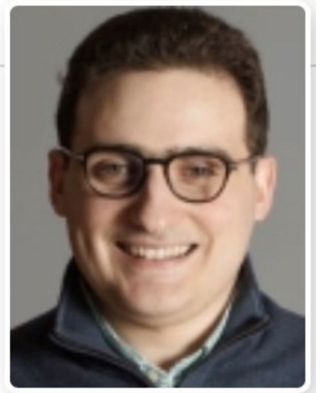
Thank You to My Team



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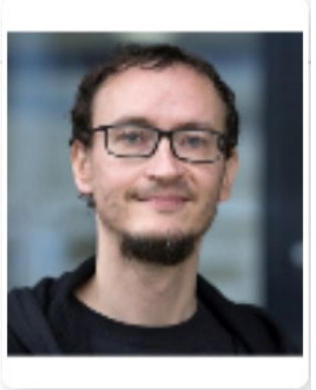

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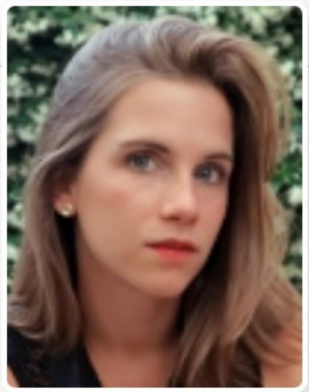

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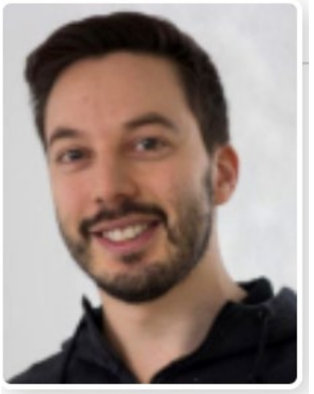

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Dr. Hagen Völzer
Scientific Project Manager

Lisa Zimmermann
PhD student

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References

- Amine Abbad Andaloussi, Thierry Sorg, Barbara Weber: *Estimating developers' cognitive load at a fine-grained level using eye-tracking measures.* ICPC 2022: 111-121
- Amine Abbad Andaloussi, Francesca Zerbato, Andrea Burattin, Tijs Slaats, Thomas T. Hildebrandt, Barbara Weber: *Exploring how users engage with hybrid process artifacts based on declarative process models: a behavioral analysis based on eye-tracking and think-aloud.* Softw. Syst. Model. 20(5): 1437-1464 (2021)
- Thomas H. Davenport and Andrew Spanyi. *What Process Mining Is, and Why Companies Should Do It*. https://hbr.org/2019/04/what-process-mining-is-and-why-companies-should-do-it. Harvard Business Review, 201
- Mangler, Juergen, Joscha Grüger, Lukas Malburg, Matthias Ehrendorfer, Yannis Bertrand, Janik-Vasily Benzin, Stefanie Rinderle-Ma, Estefania Serral Asensio, and Ralph Bergmann. 2023. *DataStream XES Extension: Embedding IoT Sensor Data into Extensible Event Stream Logs.* Future Internet 15, no. 3: 109. https://doi.org/10.3390/fi15030109
- Seiger, Ronny, Marco Franceschetti, and Barbara Weber. 2023. *An Interactive Method for Detection of Process Activity Executions from IoT Data.* Future Internet 15, no. 2: 77. https://doi.org/10.3390/fi15020077
- R. Seiger, L. Malburg, B. Weber, R. Bergmann, *Integrating process management and event processing in smart factories: A systems architecture and use cases.* Journal of Manufacturing Systems, Volume 63, April 2022, Pages 575-592.
- Wil M. P. van der Aalst, Josep Carmona: *Process Mining Handbook*. Lecture Notes in Business Information Processing 448, Springer 2022, ISBN 978-3-031-08847-6.
- van der Aalst, W. et al. (2012). *Process Mining Manifesto.* In: Daniel, F., Barkaoui, K., Dustdar, S. (eds) Business Process Management Workshops. BPM 2011. Lecture Notes in Business Information Processing, vol 99. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-28108-2_19
- vom Brocke, Jan and van der Aalst, Wil MP and Grisold, Thomas and Kremser, Waldemar and Mendling, Jan and Pentland, Brian and Recker, Jan and Recker, Jan and Roeglinger, Maximilian and Rosemann, Michael and Weber, Barbara, *Process Science: The Interdisciplinary Study of Continuous Change* (September 3, 2021). Available at SSRN: https://ssrn.com/abstract=3916817 or http://dx.doi.org/10.2139/ssrn.3916817
- Francesca Zerbato, Andrea Burattin, Hagen Völzer, Paul Nelson Becker, Elia Boscaini, Barbara Weber: *Supporting Provenance and Data Awareness in Exploratory Process Mining.* Accepted for CAiSE.
- Francesca Zerbato, Pnina Soffer, Barbara Weber: *Process Mining Practices: Evidence from Interviews.* BPM 2022: 268-285