

# Opportunities of Process Mining Research in Software Engineering

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# About this presentation

- Aimed to provide a basic understanding of process mining.
- Overview of process mining applications in our lab.

# Process mining

- Discipline proposed to give a better understanding of the processes by extracting knowledge from event logs.
- **Process:** a series of related activities that are performed in a specific sequence to achieve a particular goal within an organization.
- **Event log:** a structured collection of data that captures all the relevant events that occur during the execution of a process.

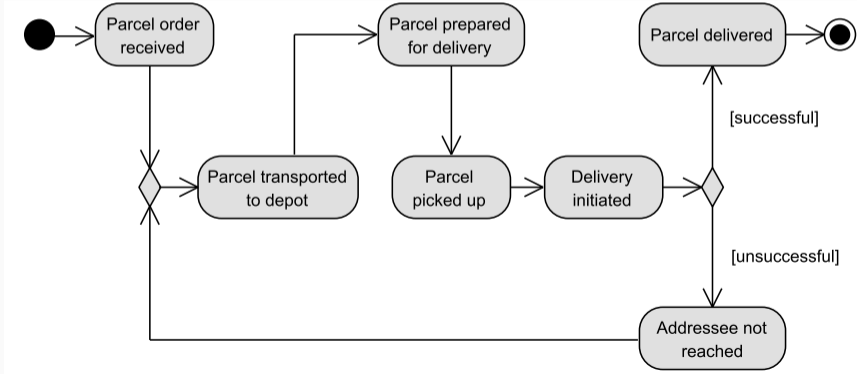
# Why is process mining important?

- We assume how the process is performed.
- However, how the real process looks like?



# Process model

- A visual representation of a process.
- UML Activity diagram, BPMN, Petri net, ...



# Event log

- **Case ID:** a unique identifier associated with a single process instance.
- **Activity:** a specific step in the process.
- **Timestamp**

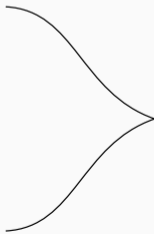


Event log		
id	activity	timestamp
23	order received	2023-12-06 06:28:25
16	parcel picked up	2023-12-06 07:12:38
23	depot transport	2023-12-06 08:47:19
16	delivery started	2023-12-06 08:50:06
41	order received	2023-12-06 09:53:14
23	parcel prepared	2023-12-06 10:02:11

# Trace

- **Trace** is a representation containing only ordered activities of a given case.
- A collection of traces is called **workflow log**.

Event log		
id	activity	timestamp
23	order received	2023-12-06 06:28:25
16	parcel picked up	2023-12-06 07:12:38
23	depot transport	2023-12-06 08:47:19
16	delivery started	2023-12-06 08:50:06
41	order received	2023-12-06 09:53:14
23	parcel prepared	2023-12-06 10:02:11
41	depot transport	2023-12-06 10:07:42
41	parcel prepared	2023-12-06 10:49:55
23	parcel picked up	2023-12-06 11:30:00
41	parcel picked up	2023-12-06 11:30:00
23	delivery started	2023-12-06 12:10:16



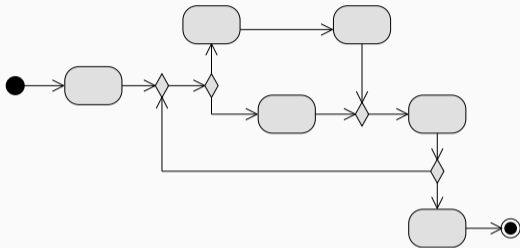
Workflow log
<order received, depot transport, parcel prepared, parcel picked up, delivery started>
<parcel picked up, delivery started>
<order received, depot transport, parcel prepared, parcel picked up>

# Process mining types



event log

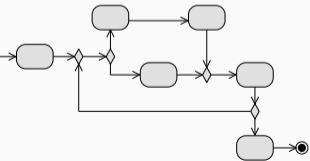
process discovery



process model



event log + process model



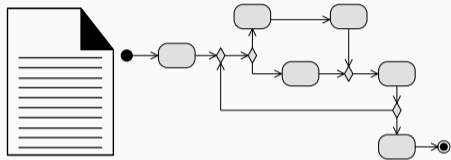
conformance checking



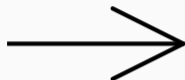
diagnostics



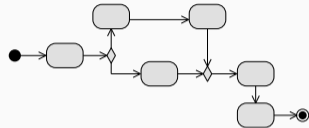
# Process mining types



event log + process model



performance  
mining



enhanced process model

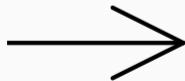


event log

+



event log



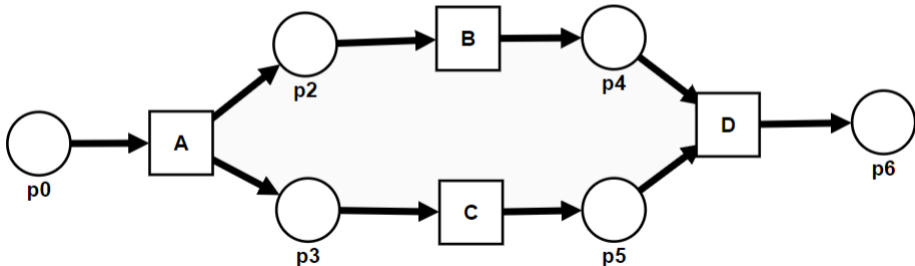
variants analysis



diagnostics

# Process discovery – Alpha algorithm

- Takes a workflow log.
- Outputs a Petri net.
- Petri net is a triplet  $N = (P, T, F)$  where:
  - $P$  is a finite set of **places**,
  - $T$  is a finite set of **transitions** such that  $P \cap T = \emptyset$ ,
  - $F \subseteq (P \times T) \cup (T \times P)$  is a set of directed arcs, called the **flow relation**.



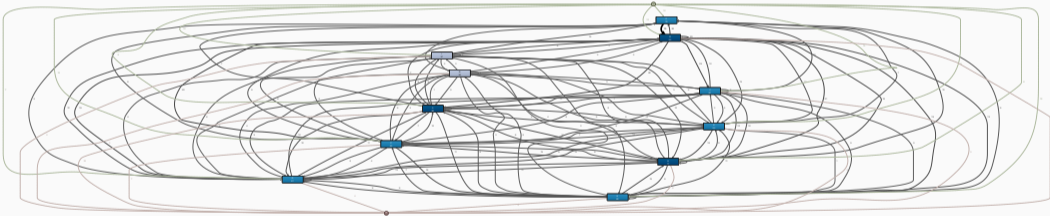
# ProcessM.NET

- For implementation of process mining algorithms, you can check our .NET process mining library: <https://github.com/lasaris/ProcessM.NET>.

# Declarative process mining



# Declarative process mining



# Declarative process mining

- If **C** occurs, then **A** occurs.
- Each time **F** occurs, then **D** occurs immediately after **F**.
- **B** occurs only if preceded by **C**.
- Each time **E** occurs, then **G** occurs afterward before **E** recurs.
- **I** and **J** never occur together.

$$\diamond(C) \rightarrow \diamond(A)$$

$$\square(F \rightarrow \circ(D))$$

$$(\neg B \cup C) \vee \square(\neg B)$$

$$\square(E \rightarrow \circ(\neg E \cup G))$$

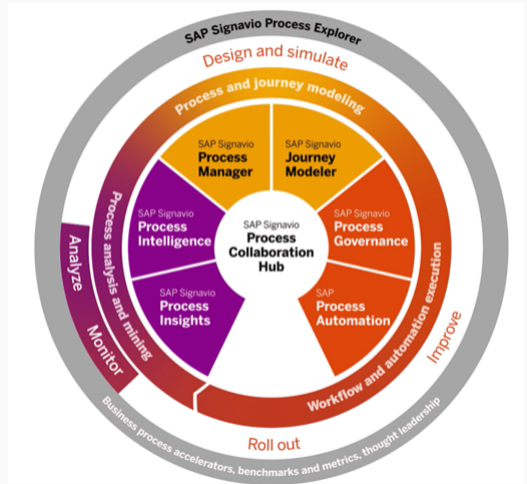
$$\neg(\diamond(I) \wedge \diamond(J))$$

# Lasaris Process Mining Projects

- ERP processes
- Car sharing
- Software development
- Education
- Smartphone usage

# ERP processes

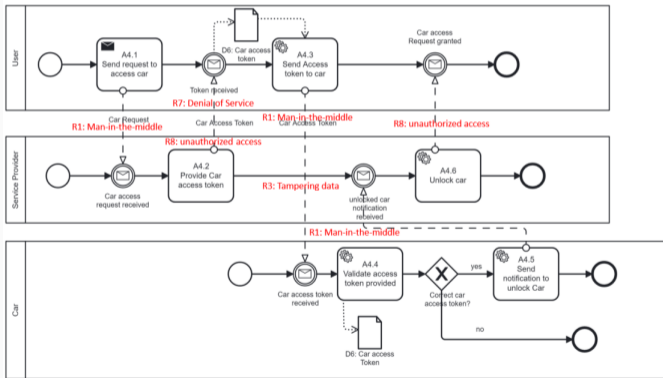
- Cooperation with SAP Signavio
- process metrics
- process querying
- process atoms





# Car sharing

- Cooperation with Autonapul and University of Tartu



# Software Development

- Git logs
- ChatGPT utilization

# Education

- Software development education
- Cybersecurity training sessions

# Smartphone usage

- Cooperation with social scientists

# Conclusion

- Process mining is fun!
- You can join the existing research or we can find a new area.

