

Analysis of Business Processes with Enterprise Ontology and Process Mining

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- Business process modelling and model analysis.
- Processes executed by a **collaborative** network of people and systems.
- Processes that are (**semi**) **automated** by IT systems.

Collaborative processes introduce analytical challenges, such as determining

- **who is authorized to do what?**
who can execute this activity? who can request this service?
- **who is responsible to do what?**
who shall execute this activity?
- **which activities are delegated to whom?**
who has delegated what to whom? who can delegate?
- **who communicates with whom?**
who makes requests? who replies?

Proposal & Approach

- Analysis of the patterns of **actor collaboration** in **(semi) automated** business processes.
- Application of **process mining** to discover processes from their execution traces.
- Application of **PSI-theory/DEMO** to analyse actor collaboration patterns.

Extracts information about the **run-time behaviour** of business processes from **event logs** as recorded by information systems.

1. Discovery

What is the process?

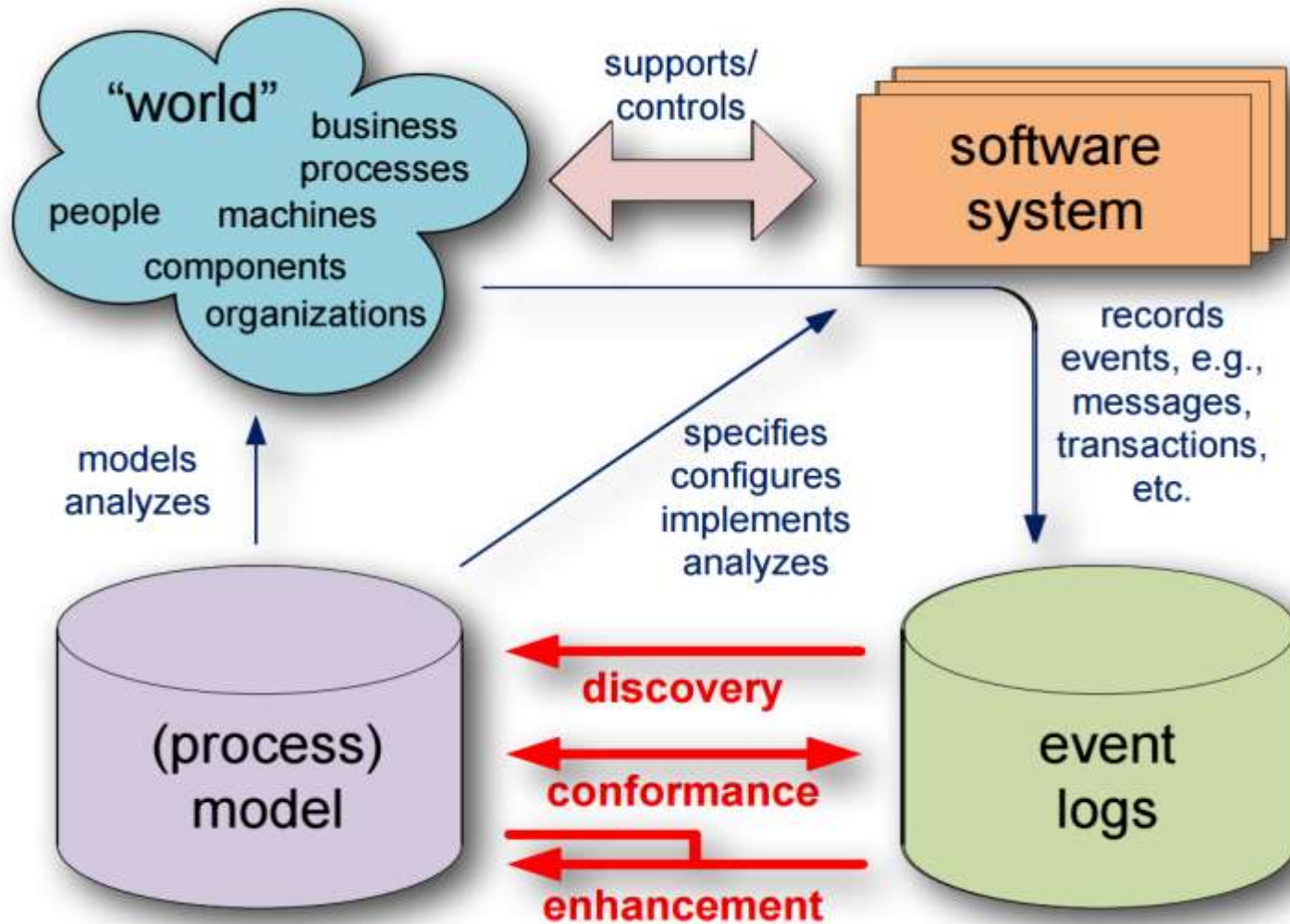
2. Conformance

Is the process doing what was specified?

3. Enhancement

How can the process be improved/redesigned?

Process Mining

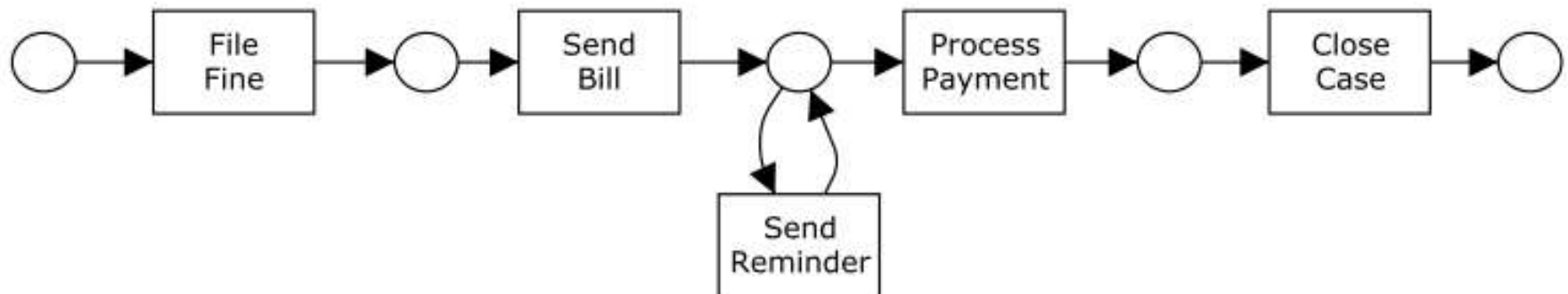


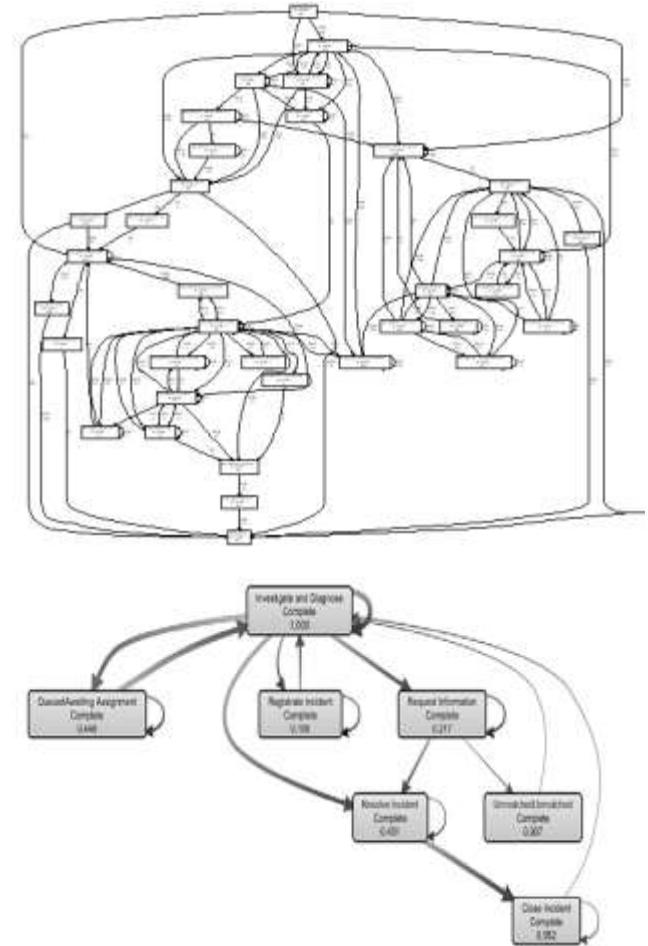
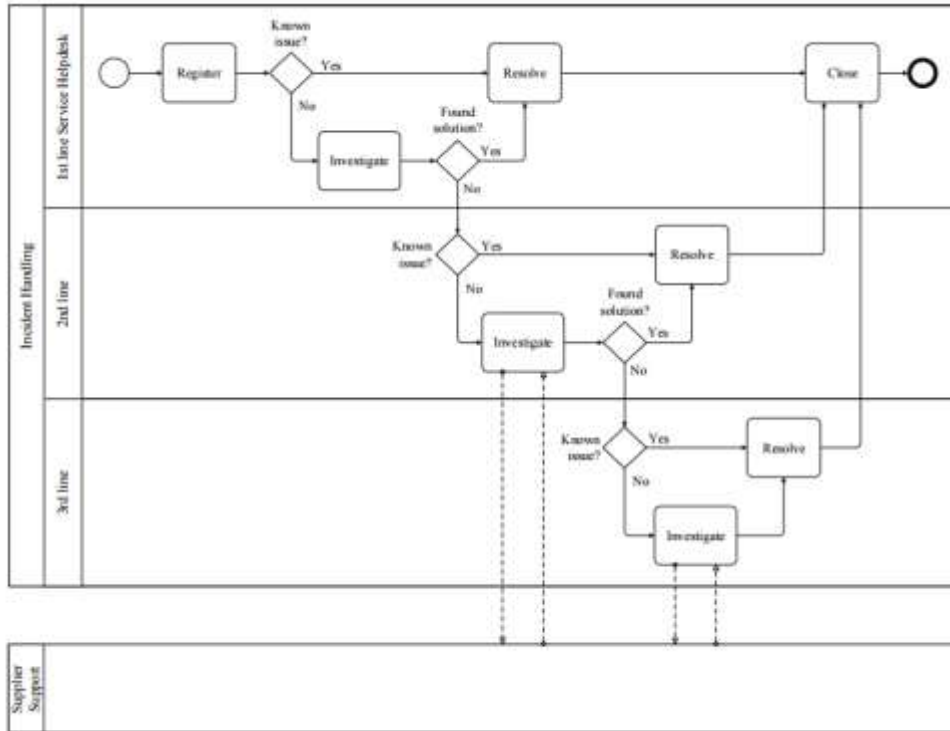
(W. Aalst et al.. Process Mining Manifesto. BPM 2011 Workshops, LNBP 99, Springer, 2012)

Process Mining

From event logs to process models

Case ID	Task Name	Event Type	Originator	Timestamp	Extra Data
1	File Fine	Completed	Anne	20-07-2004 14:00:00	...
2	File Fine	Completed	Anne	20-07-2004 15:00:00	...
1	Send Bill	Completed	system	20-07-2004 15:05:00	...
2	Send Bill	Completed	system	20-07-2004 15:07:00	...
3	File Fine	Completed	Anne	21-07-2004 10:00:00	...
3	Send Bill	Completed	system	21-07-2004 14:00:00	...
4	File Fine	Completed	Anne	22-07-2004 11:00:00	...
4	Send Bill	Completed	system	22-07-2004 11:10:00	...
1	Process Payment	Completed	system	24-07-2004 15:05:00	...
1	Close Case	Completed	system	24-07-2004 15:06:00	...
2	Send Reminder	Completed	Mary	20-08-2004 10:00:00	...
3	Send Reminder	Completed	John	21-08-2004 10:00:00	...
2	Process Payment	Completed	system	22-08-2004 09:05:00	...
2	Close case	Completed	system	22-08-2004 09:06:00	...
4	Send Reminder	Completed	John	22-08-2004 15:10:00	...



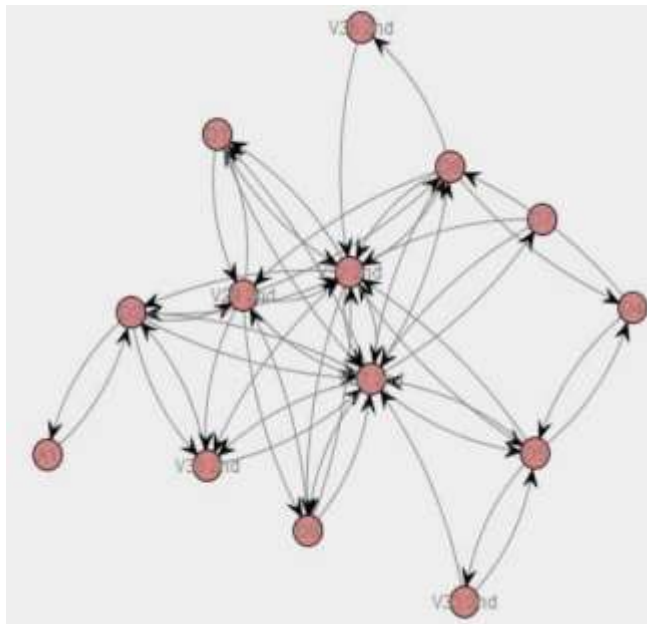


("Incident Management Process", 9th International Workshop on Business Process Intelligence, 2013)

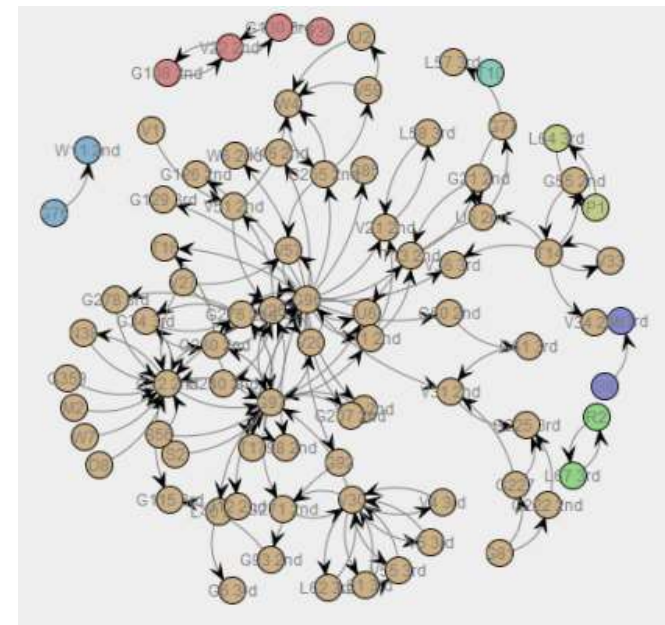
Social Network Analysis

Example: Handover of Work

Handover of work from actor i to j occurs when activity a is completed by actor i , activity b by actor j , and a, b are subsequent activities.



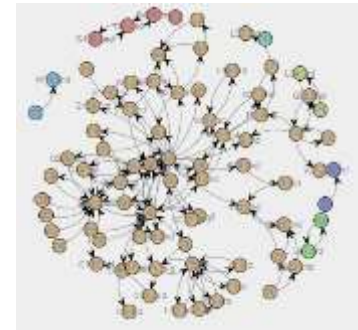
HoW between 14 support teams
in scenario A (57 cases)



HoW between 82 support teams
in scenario B (253 cases)

(BPI Challenge 2013. 9th International Workshop on Business Process Intelligence, 2013)

- Process mining discovers process models and actor interaction networks. But...
 - why are the actors communicating?
 - who is authorized to do what?
 - who is responsible to do what?
- Answering these questions requires adding **semantics** to the process analysis context.



PSI-Theory and DEMO

- DEMO (ISO/CD 29481-2) is a method for modelling and (re)designing organizations.
- DEMO is grounded on the PSI-theory.
- The PSI-theory explains how and why actors cooperate and establish commitments to bring about the business of an organization.

Distinction & Operation

Distinction

Coordination

Production

Datalogical
(form)

reading, writing,
speaking, listening

storing, transmitting,
copying, destroying

Infological
(content)

formulating,
interpreting

deducing, reasoning,
computing

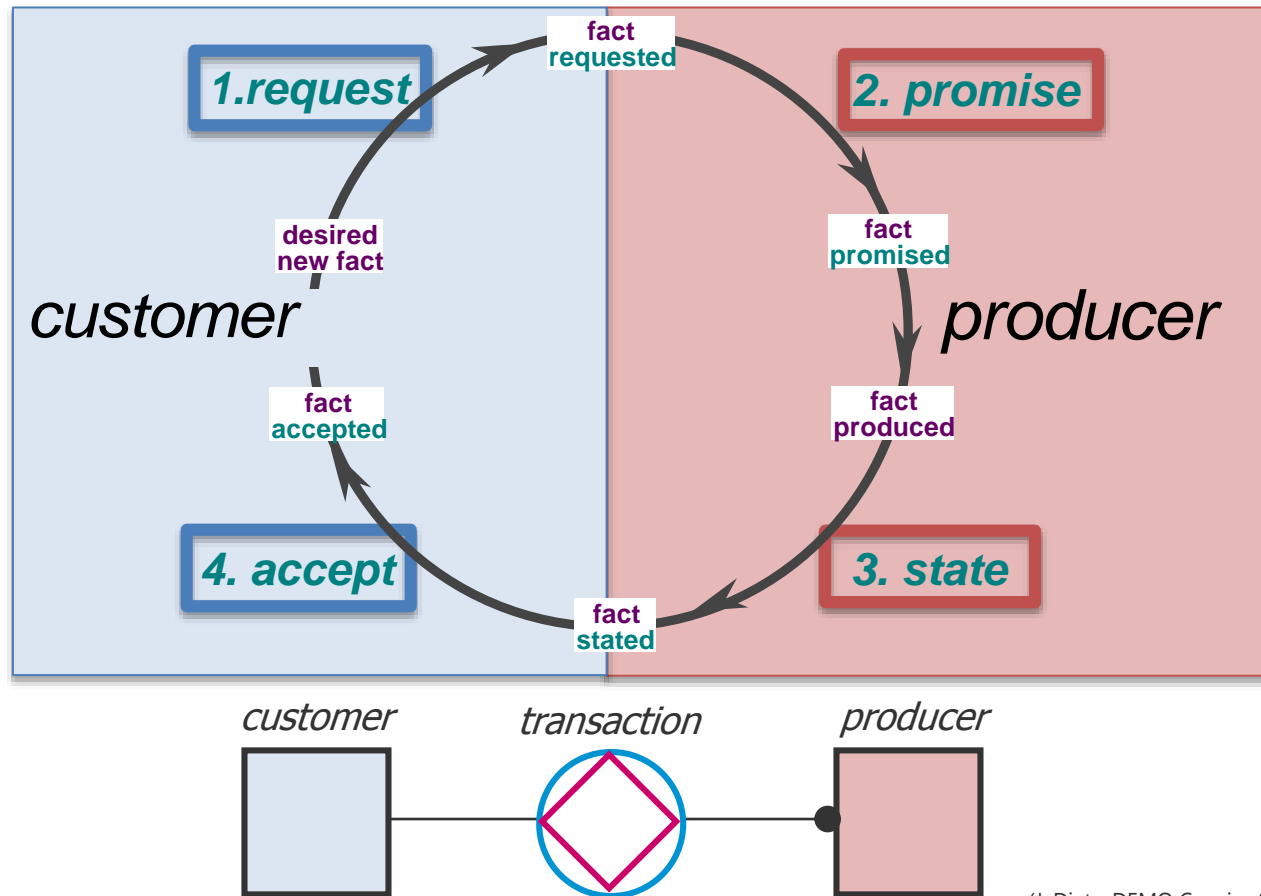
Ontological
(intent)

exposing commitment,
entering commitment

deciding, judging

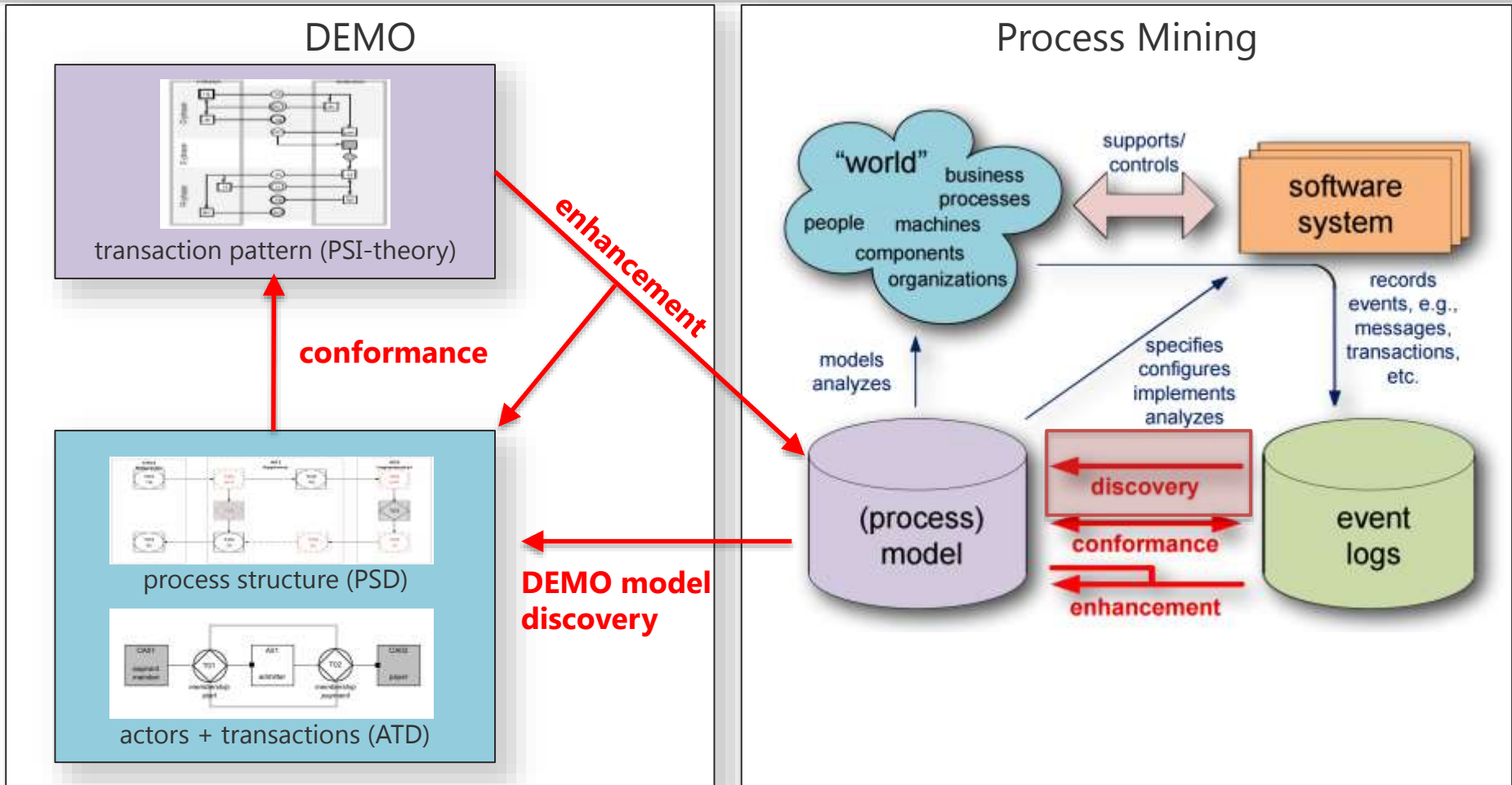
(Basic) Transaction pattern

The transaction pattern defines a sequencing of **acts** and the actors responsible for performing them.

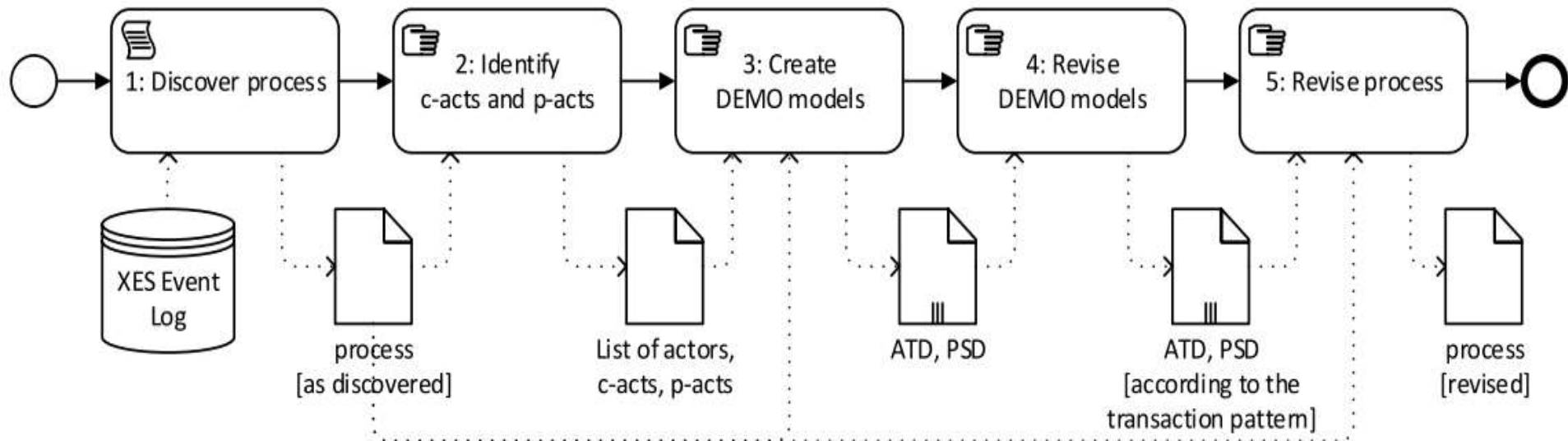


(J. Dietz. DEMO Concise Summary. <http://www.demo.nl/>)

DEMO + Process Mining



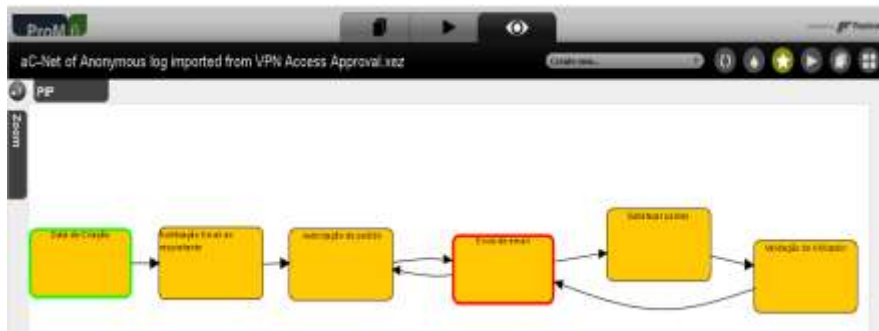
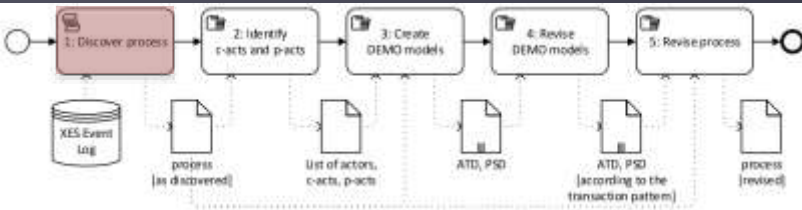
(adapted from J. Dietz. Enterprise Ontology - Theory and Methodology. Springer, 2006; W. Aalst et al.. Process Mining Manifesto. BPM 2011 Workshops, LNBP 99, Springer, 2012)



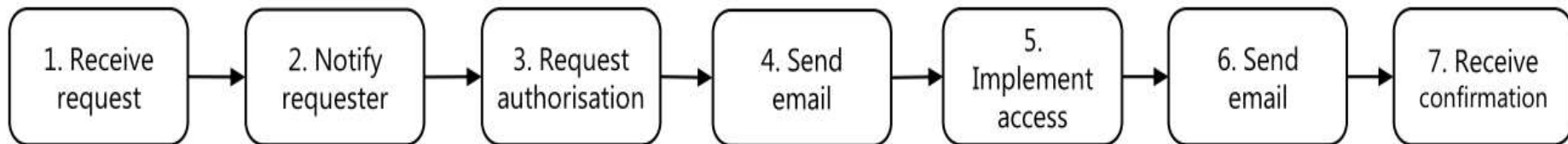
- VPN access approval process within a central defence governmental institution.
- Semi-automated process.
- Performed by three actors:
 - external requester,
 - access approver,
 - access implementer (IT teams).

Receive request → Send ticket → Approve request →
Implement access → Send access data →
Receive confirmation

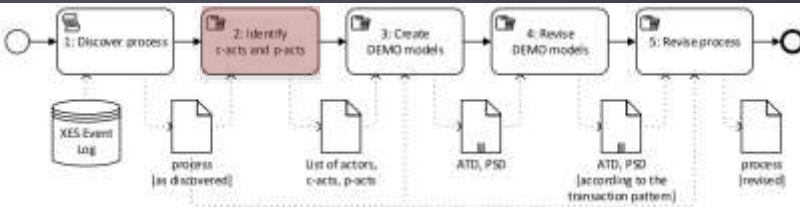
Step 1: discover process



ProM 6 tool
 Flexible Heuristics Miner (FHM)
 Log with 53 cases, ~2000 events



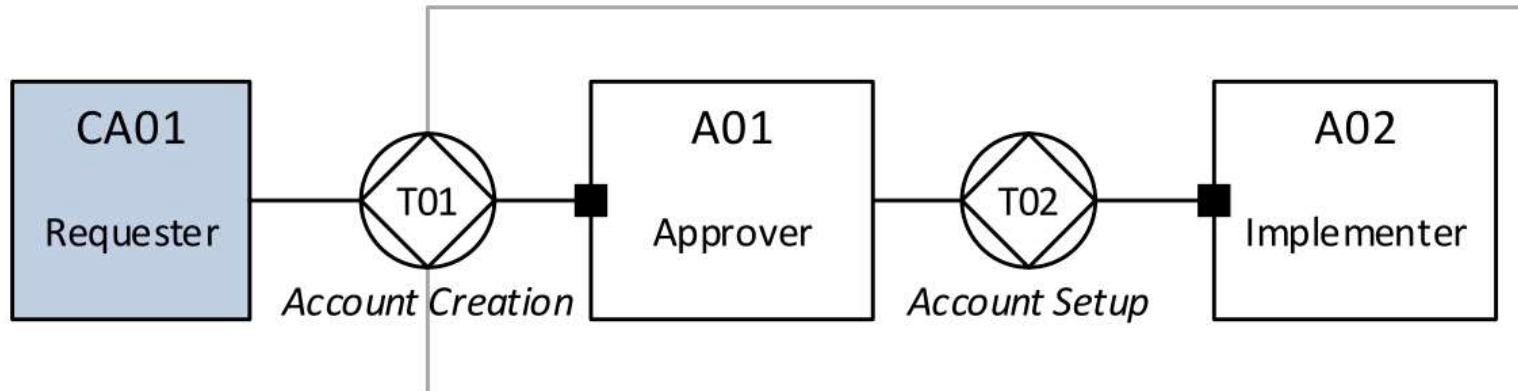
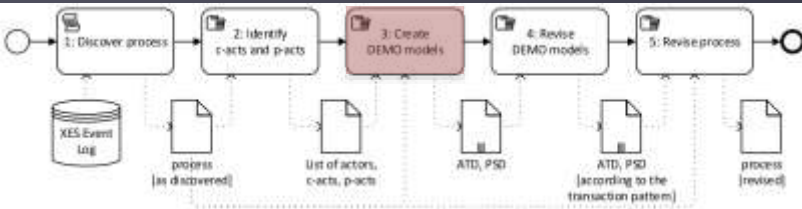
Step 2: identify O/I/D and c/p-acts



Activity	Distinction	Operation	Transaction
1 receive request	ontological	c-act	T01/request
2 notify requester	info/datalogical		
3 request authorization	info/datalogical		
4 send email	ontological	c-act	T02/request
5 implement access	ontological	p-act	T02/execute
6 send email	ontological	c-act	T01/state
7 receive confirmation	ontological	c-act	T01/accept

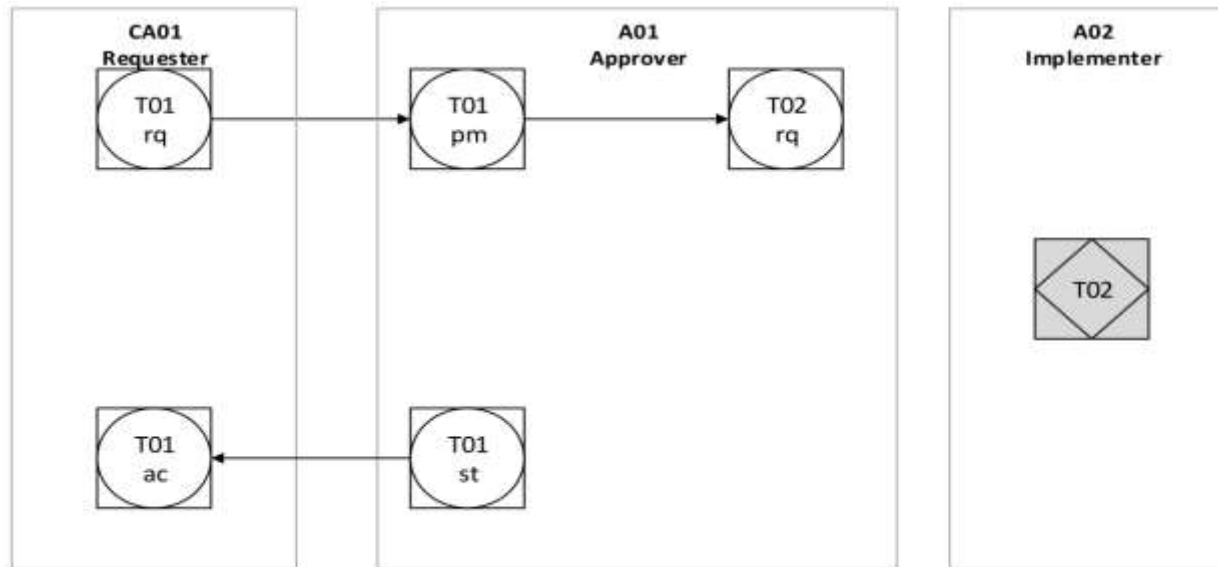
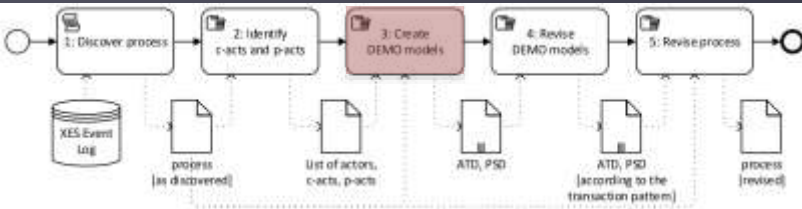
- Classification of discovered activities is a manual task.
- Classification is always **context-dependent**.

Step 3a: create DEMO ATD



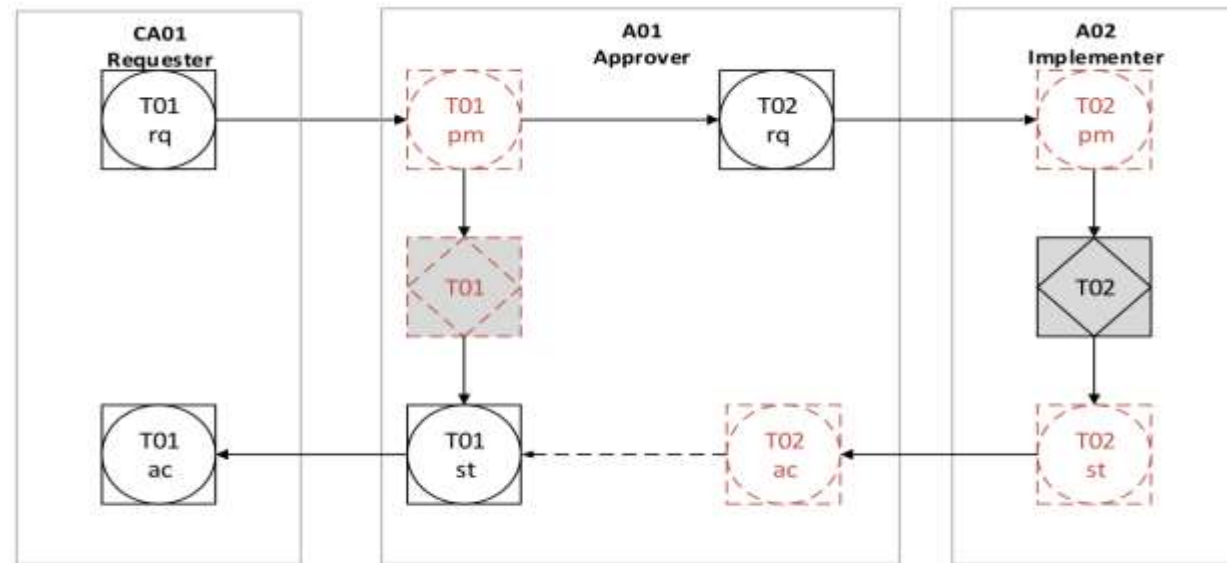
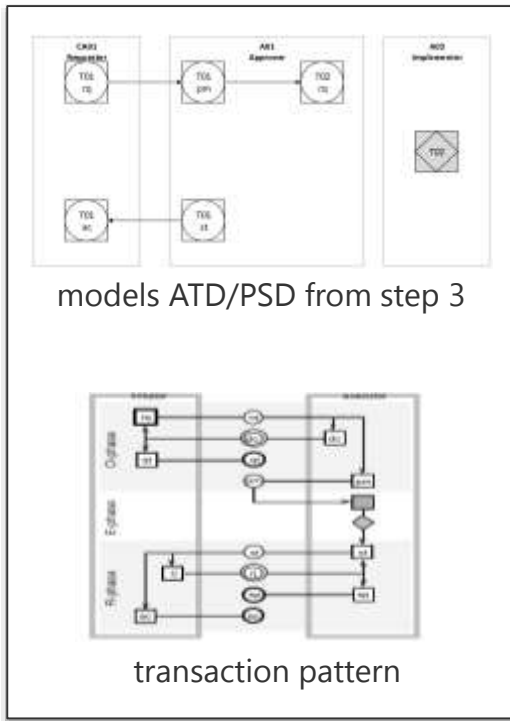
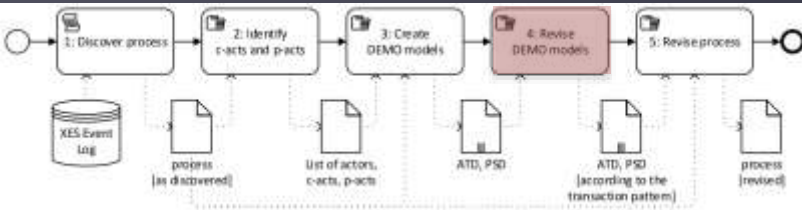
- ATD identifies actor roles and transactions.
- Classification of actor roles as internal or external depends on the semantics of the event types.

Step 3b: create DEMO PSD



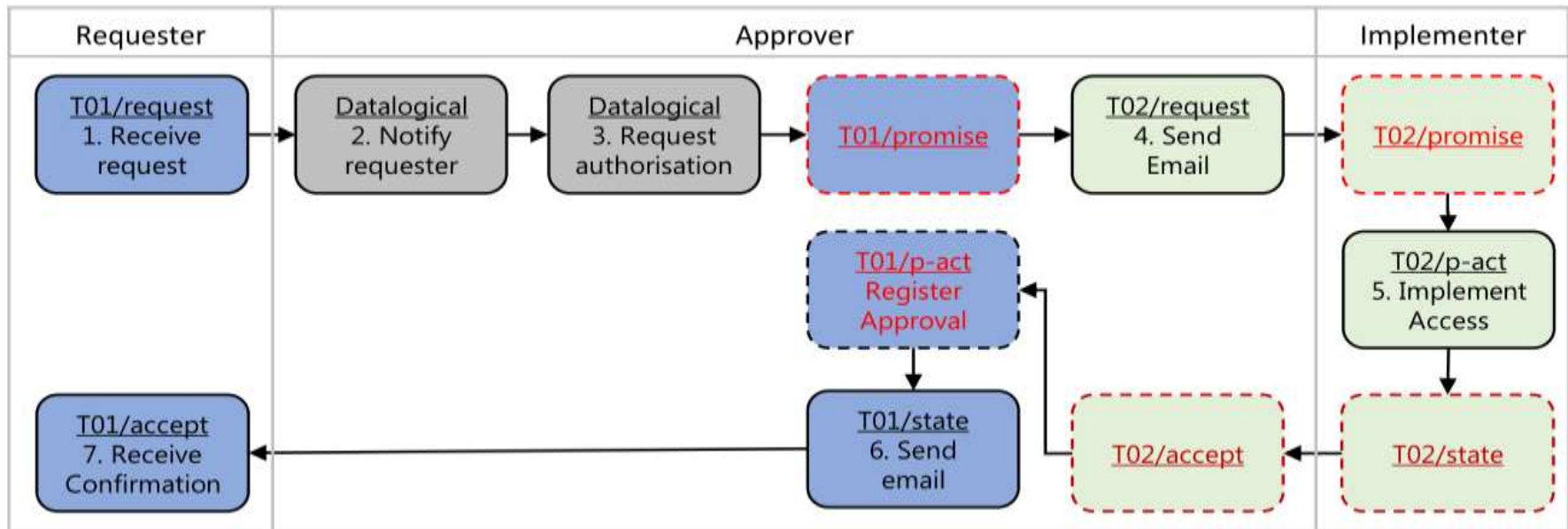
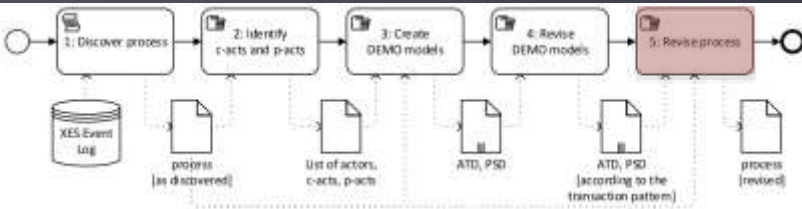
- PSD identifies the **process structure**, **production acts** and **coordination acts**.
- This step may lead to an incomplete and/or inconsistent PSD since it is generated from the discovered process.

Step 4: revise DEMO models (conformance)



- Revise PSD so that it conforms to the transaction pattern.
- Act dependencies are derived from the event relationships.

Step 4: redesign process (optional; enhancement)



- Ensure the process is **complete** (add/remove/modify activities)
- Ensure the process is **consistent** (review control flow)
- Several process redesign strategies are possible (wrt design principles)

- **Conformance checking** of the discovered process model wrt the transaction pattern:
 - **Consistent** if actors collaborate according to the structure of the transaction pattern.
 - **Complete** if process contains all transaction pattern steps (acts).
- **Analysis of actor collaboration.**
- **Model enhancement:**
 - Redesign of the DEMO model.
 - Redesign of the discovered process model.
 - Redesign of the process implementation.

Conclusions & Challenges

- The feasibility of DEMO model generation depends on the qualities of the discovered process model.
 - Low-level event logs produce low-level process models.
- Discovery of data objects and data flow contributes to identify production acts and transactions.
 - But process mining mainly focus on discovering control flow.
- Normalized vocabularies help classifying activities and semi-automating the task.

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1. Process mining generates models with the same level of abstraction of the events. How to bridge the semantic gap between low-level events and high-level models?
2. Which event types are required to classify the discovered activities (O/I/D, c-act/p-act)?
3. How to automate event and activity classification?
4. Some approaches to “semantic process mining”:
 - pre-process (e.g. cluster, prune) events *before* discovery
 - cluster activities *after* discovery
 - use semantic/ontological classification of events and/or activities to enhance mining algorithms (e.g. FHM/GM+ML)
 - apply NLP (e.g. BabelNet) to classify events and/or activities

1. How to “integrate” the DEMO BPM Engine with actual BPM engines and/or service-oriented environments from where events can be logged from?
2. Is such integration seamless? Or does it require changing the existing process/service infrastructure?

Flexible Heuristics Miner

- Deals with processes that
 - have a low degree of structuring
 - are derived from noisy event logs.
- Improves how splits and joins are handled and represented.
- Manages to reduce the complexity of the discovered models.
- Is a control flow mining algorithm (based on causal nets).

A.J.M.M. Weijters, J.T.S. Ribeiro (2011). Flexible Heuristics Miner (FHM). In: Proceedings of the IEEE Symposium on Computational Intelligence and Data Mining, CIDM 2011.