

THE COVERT ONTOLOGY OF PROCESS MINING: DATA-DRIVEN EVENT SEMANTICS

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A UNIQUE LENS ON EVENTS

What is an event?

- How to approach this question from a data and application driven perspective?

The process mining lens

- Analysis of event logs
- Application of process knowledge to answer varied questions

Process mining relies on diverse kinds of process knowledge

- Process discovery¹
- Process data quality^{2,3}
- Concept drift⁴
- Predictive process monitoring^{5,6}



The interpretation of events in process mining are flexible, described as:

- States
 - Closed
 - Running
 - Obsolete
- Transitions
 - Schedule
 - Withdraw
 - Suspend

WHY PROCESS MINING?

Process Mining Applications

- Improved data standards^{7,8}
- Movement towards object-centric analysis⁹
- Automated reasoning for mining tasks

Knowledge Representation Application

- Unique understanding of events
- Grounds process knowledge to real applications

- 1 The ontology of events, as defined in the practice of process mining, forms a useful and novel ontology of process knowledge.
- 2 Current event and process mining ontologies fail to capture the ontological commitments of the practice of process mining.
- 3 Real-world business process questions and associated data from the practice of process mining fulfill the role of guiding challenges in the development of practical process ontologies.



- 1 DISCOVERING A COVERT EVENT ONTOLOGY
- 2 UNIQUE LENS OF EVENTS
- 3 A FRAMEWORK FOR NEW EVENT ONTOLOGIES

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MOTIVATING PROCESS MINING

Process mining tasks begin from some information need

REAL QUESTIONS FROM BPI CHALLENGES

- What is the average increase/decrease of Closed Interactions once a new steady state is reached?¹⁰
- What is the influence on the frequency of incompleteness to the final outcome?¹¹

What concepts are necessary to understand and answer these questions based on event logs?

“What is the influence on the frequency of incompleteness to the final outcome?”

CONCEPTUAL BREAK-DOWN

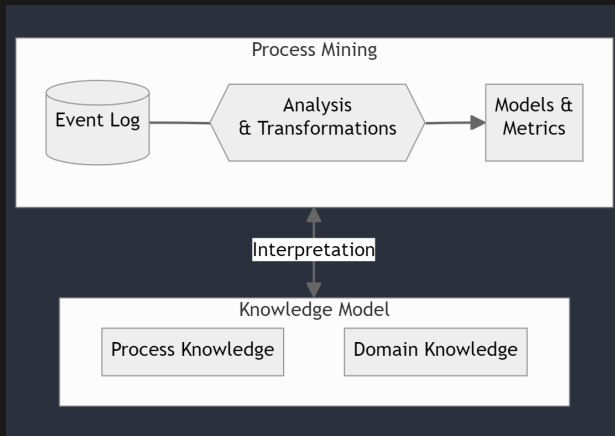
- Causal relationships
- Process outcomes
- Measuring frequency

What is required to axiomatize these concepts?

How do events fit into these axiomatizations?

PROCESS MINING IN PRACTICE

The dialectic nature of analysis and process knowledge



ONTOLOGICAL COMMITMENTS

Ontological Commitments are obfuscated by analysis

EXAMPLES FROM BPI CHALLENGES

- “We will switch between two levels of abstraction: low-level activities and phase-level activities”
- “We added paths and activities to our Petri net model, until we arrived at a final model, which considers most activities with high precision and fitness values.”

Event abstraction, intended process models, process flow

What ontologies are being applied?

EVENT REIFICATION

An event represents an “atomic granule of activity that has been observed”⁷

Where are the events?

Activity	Timestamp	Lifecycle
Process Application	2024-06-01 10:00:00	Start
Process Application	2024-06-01 11:00:00	In Progress
Conduct Review	2024-06-02 12:00:00	Complete

TO REIFY OR NOT

- Should observations be reified as events?
- What are data artefacts, what are objects?

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DISTINCTIONS VS PROCESS MINING MODELS

SEMANTIC BPM APPROACHES^{12,13,14}

- Limited expressiveness
- Scope limited by specific domains and modelling languages

SEMI-FORMAL EVENT MODELLING^{15,16,17}

- Flexibility is a double-edged sword
- No formal semantics

DISTINCTIONS: ONTOLOGIES

EVENT ONTOLOGIES^{18,19,20,21}

- Limited expressiveness
- Narrow Scope on Processes

UPPER ONTOLOGIES^{22,23,24}

- Conceptual Bloat
- Unclear Application for PM

PROCESS SPECIFICATION LANGUAGE^{25,26}

- Lacks extensions to model atypical and abstracted occurrences

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Application and Data Driven

FORMALIZING GUIDING CHALLENGES

- 1 \mathcal{T} - a formal ontology of events and process mining concepts, relevant to the query
- 2 \mathcal{T}_D - a domain ontology that is a Conservative extension of \mathcal{T}
- 3 \mathcal{A} - a set of facts representing the event log(s) and domain process knowledge, expressed in the language of $\mathcal{T} \cup \mathcal{T}_D$
- 4 A query Q in the language of $\mathcal{T} \cup \mathcal{T}_D$, such that proving

$$\mathcal{T} \cup \mathcal{T}_D \cup \mathcal{A} \models Q$$

provides the suitable answer to the challenge problem.

FUTURE WORK & EXTENSIONS

- Direct Process Mining Applications
 - Submitted to ICPM
- Ontology Development
 - Extending existing ontologies
 - New event ontology
- Data driven framework in other domains
 - Data and application driven ontology development



Process Mining obfuscates a unique ontological perspective on events

Questions from real process mining applications serve as guiding challenges for the development of robust process ontologies

Application and Data driven process ontology development is useful for knowledge representation and practical process mining



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