Decoupling Process Abstraction Levels

Advanced Process Discovery and Automated Business Process Redesign Support

Background

Business Processes and Process Models

- *Business process* = finite set of activities that are executed in a coordinated manner to achieve a business goal
- Structured vs. unstructured processes
- *Process models* visually represent process behavior using *modeling languages*

Automated Process Discovery

- Extract activity dependencies from event logs to create a process model
- Algorithms extract an intermediate process representation first, e.g., directly-follows graphs (DFGs), before deriving the process model

Business Process Redesign (BPR)

- BPR provides concepts and techniques to change business processes
- Lacks in automated support

Activity Relationships Notation

- Differentiation between
  - *Temporal* dependency: activity ordering
  - *Existential* dependency: activity occurrences based on Boolean Algebra

$$Relationship\ (a, b) = (<_d, \Leftrightarrow)$$

temporal dependency: a happens directly before b

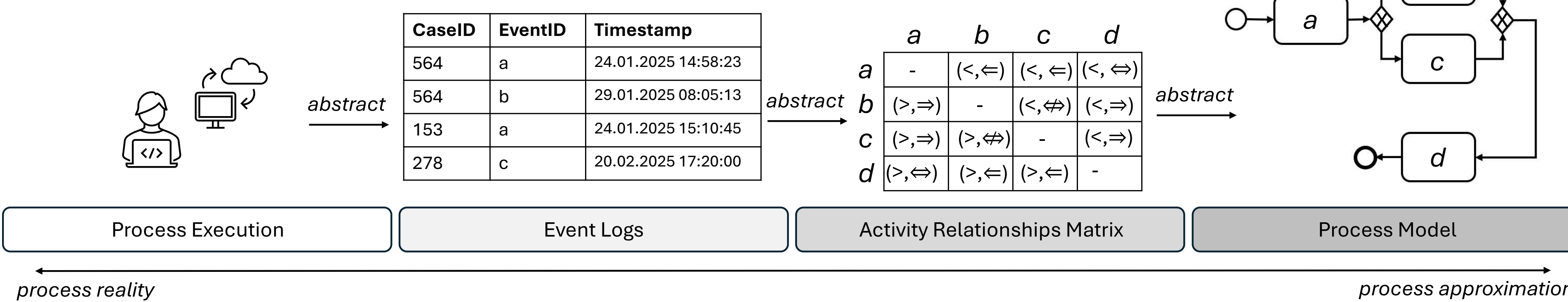existential dependency: either a and b or none of them occur

Fig. 1: Process Abstraction Levels

process reality ← → process approximation

Process Execution — Event Logs — Activity Relationships Matrix — Process Model

Research Problem & Approach

As shown in Fig. 1, there are different process abstraction levels to which different process representations can be assigned. The core artifact of BPM is the process model used for comprehension, implementation, and automation. However, the process model abstracts most from real process execution and, thus, lacks details of process behavior encoded in the event log.
We advocate for making use of intermediate process representations, particularly, the activity relationships matrix, for implementing BPM techniques:

- Process models for human-centered settings, e.g., for idea generation in the context of BPR
- Matrix as a foundation for implementing BPM techniques
  - Artifact for advanced process discovery
  - Classify processes regarding their level of structuredness to find the most appropriate modeling language
  - Translation to a visual process model

Research Objectives (RO)

RO1 Automated activity relationships discovery algorithm to extract activity dependencies from event logs
RO2 Classification algorithm measuring the level of structuredness of a process
RO3 A framework to assess change operations in terms of structural consequences and risks
RO4 Automated support for implementing change operations
RO5 Prototypical tool combining advanced process discovery and automated process redesign

General Approach

- Discovered matrix is enhanced with information about the contextual origin of each relationship (see Fig. 2)
- Using process classification, processes are appropriately represented to support end users in understanding which relationships were discovered and why they exist
- Idea generation for change operations that are automatically assessed and implemented based on the activity relationships matrix
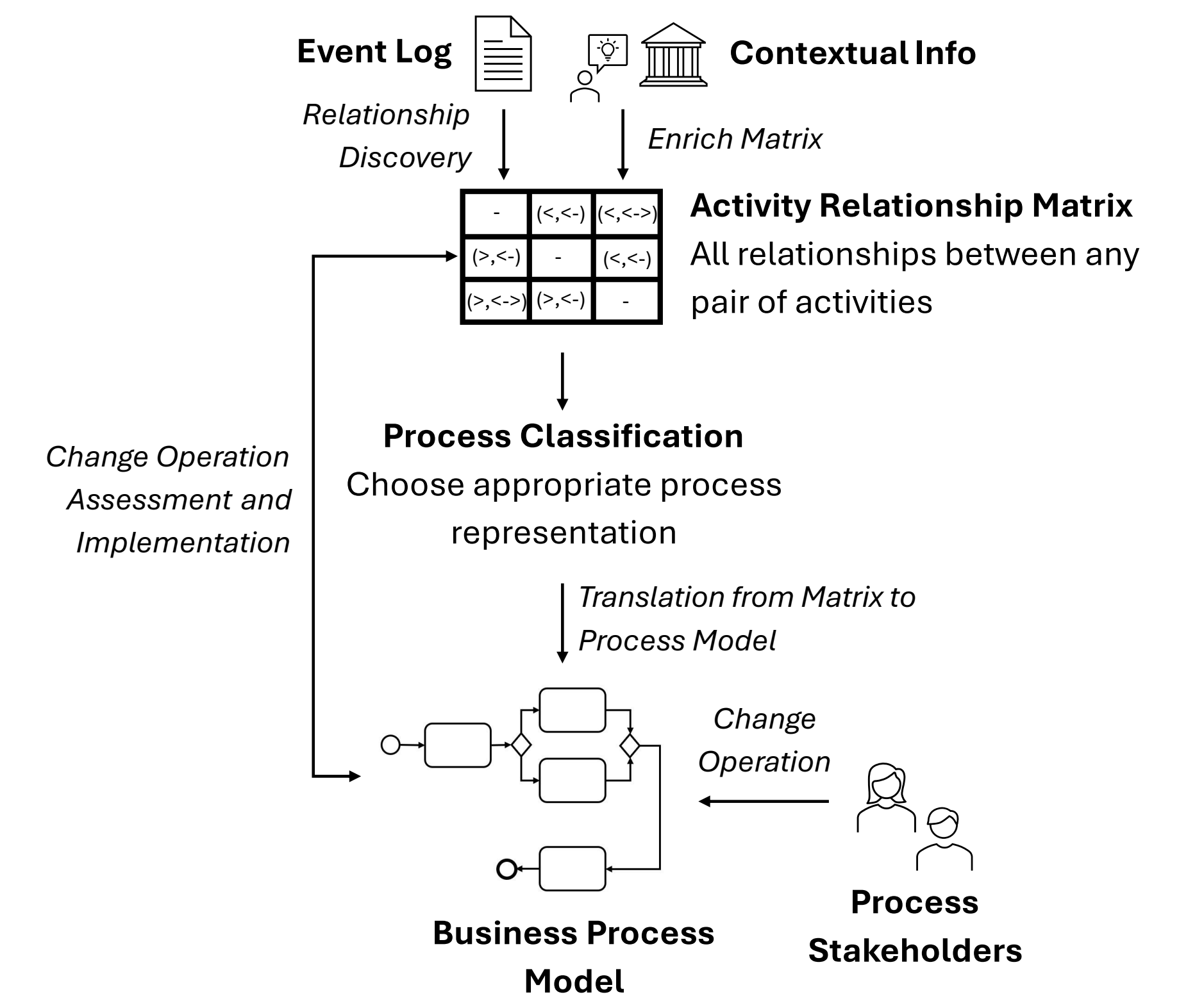

Fig. 2: General approach for advanced process discovery and automated change operation assessment

Relationships Discovery

- Discovery algorithm for activity relationships
- Temporal and existential dependency are discovered separately by iterating through the set of traces
- Frequency-based noise handling
- Feasibility shown using synthetic event (see Fig. 3)
- Comparison to BPMN diagrams, DFGs, and LTL formulae shows: matrix provides higher precision
- Further information available in a preprint:

Log	Parallelism	XOR	NAND	Multi-Choice	Looping	Nesting	Block-Structure	Skipping	Excl. Noise	Incl. Noise
L01	✓		✓				✓		(1.00,1.00)	(0.60,1.00)
L08	✓	✓					✓		(1.00,1.00)	(0.87,0.93)
L03		✓					✓		(1.00,1.00)	(0.73,0.87)
L04	✓	✓		✓	✓				(1.00,1.00)	(0.80,0.80)
L05	✓	✓					✓		(1.00,1.00)	(0.60,0.80)
L06	✓	✓	✓*		✓	✓			(1.00,0.50)	(1.00,0.50)
L07	✓	✓							(1.00,1.00)	(1.00,1.00)
L08	✓	✓		✓*	✓	✓			(0.88,0.88)	(0.88,0.88)
L09	✓	✓	✓			✓			(1.00,1.00)	(0.73,0.80)
L10	✓		✓			✓	✓		(1.00,1.00)	(0.67,0.83)
L11	✓		✓*			✓	✓		(1.00,0.60)	(0.30,0.30)

Fig. 3: Results of evaluating the relationships discovery algorithm based on synthetic logs (✓: behavior covered by log, ✓*: behavior not being discovered, percentages indicate how many dependencies were discovered correctly)

Change Operation Assessment

- Metamodel for business process redesign (see Fig. 4)
- Overview of entities that need to be taken into account to assess a change operation
- Four explanatory rationales for activity relationships that explain their contextual origin and vulnerability
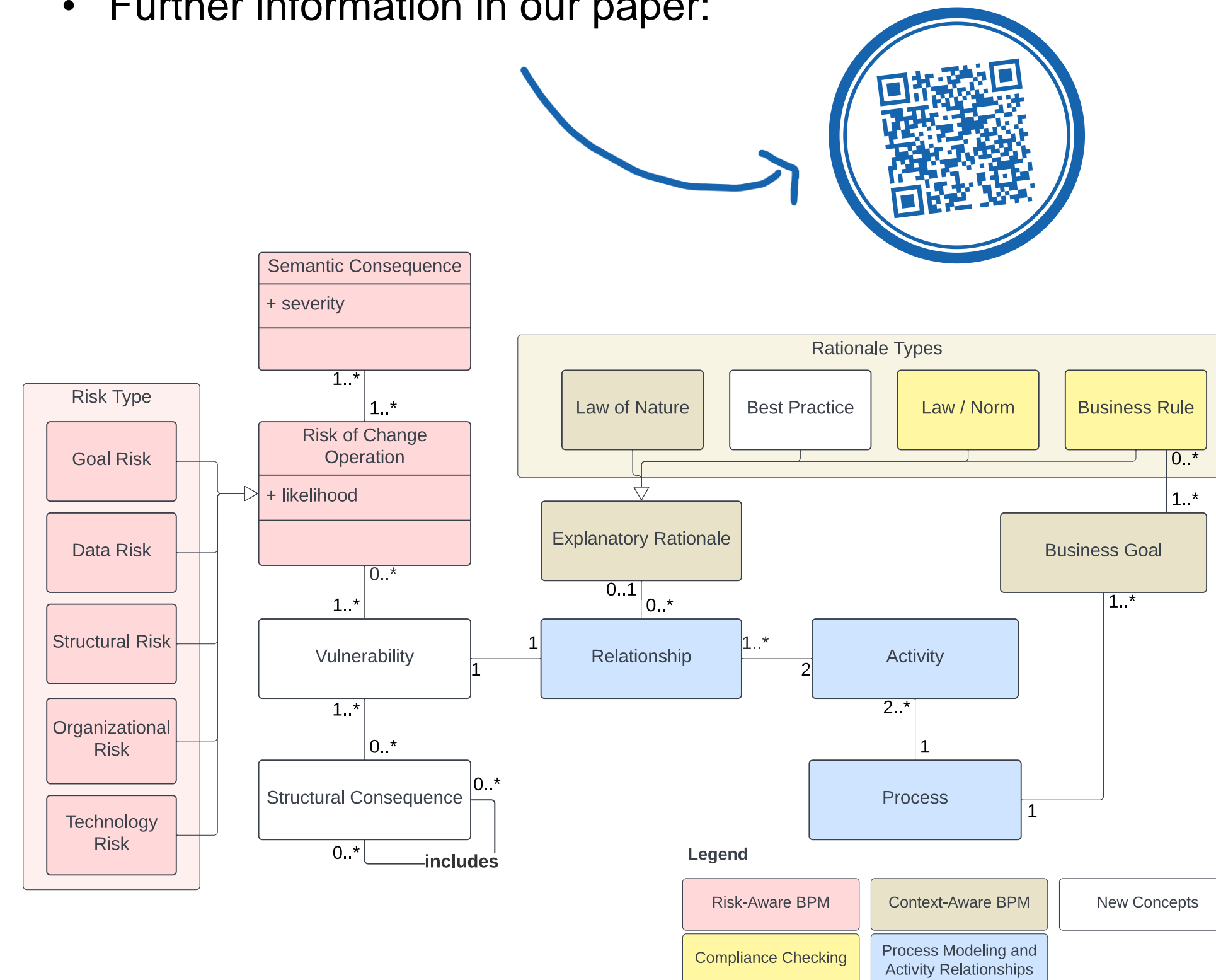- Further information in our paper:

Fig. 4: Metamodel for business process redesign

Process Classification

- Classify processes according to their structuredness based on a discovered activity relationships matrix
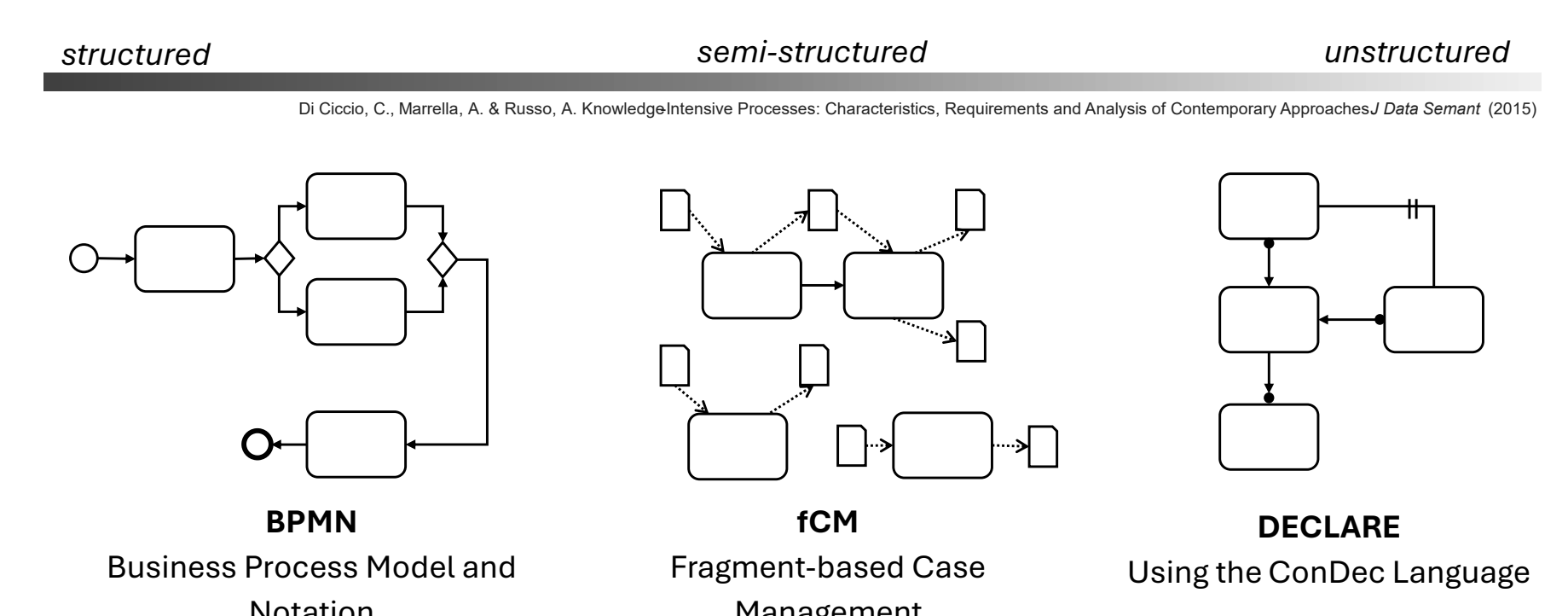- Find the most appropriate modeling lanugage for a log

structured — semi-structured — unstructured

Di Ciccio, C., Marrella, A. & Russo, A. Knowledge-Intensive Processes: Characteristics, Requirements and Analysis of Contemporary Approaches/Data Semant (2015)

BPMN Business Process Model and Notation

fCM Fragment-based Case Management

DECLARE Using the ConDec Language

Fig. 5: Spectrum of process structuredness and assignment to modeling languages

Coming soon

Support for Business Process Redesign

- Formal definition of change operation
- Implementating change operations based on the activity relationships matrix
- Development of a prototypical tool that includes implementation and assessment of change operations

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Check out our website!
Check out our tools on GitHub!