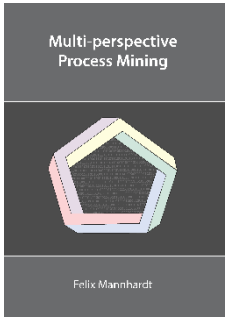
About me

TU/e Technische Universiteit Eindhoven University of Technology

Where innovation starts

PhD – Multi-perspective Process Mining

Hajo Reijers, Wil van der Aalst



2017

SINTEF

Research Scientist

Lærings og beslutningsstøtte

2019

NTNU

Adjunct Associate Professor (20%)

Institutt for datateknologi og informatikk

2019

KIT·AR

Co-founder

Data Scientist (80%)

One of Europe’s largest independent research organisations

Kr

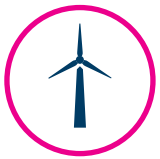
NOK 3.2 billion
Revenues

NOK 450 MILL
International sales

SINTEF

Applied research, technology and innovation

Expertise from ocean space to outer space:


Renewable energy


Ocean space


Industry


Buildings and infrastructure


Materials


Micro-, nano- and biotechnology


Climate and environment


Oil and gas


Health and welfare

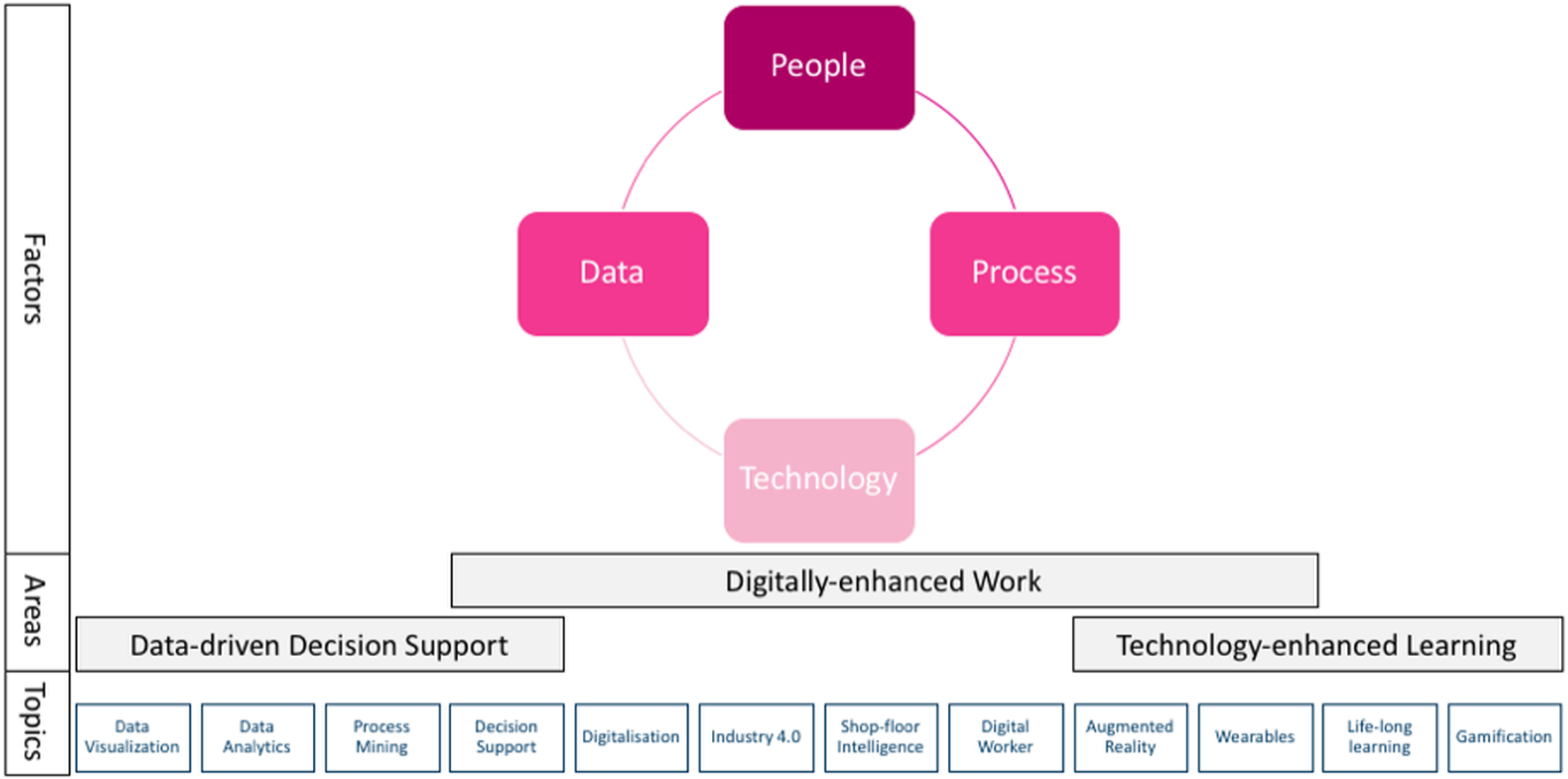

Society


Digitalization


Transport

SINTEF

Technology Management Department



https://www.sintef.no/en/technology-and-society/industrial_management/#/

SINTEF

Multi-Perspective Conformance Checking

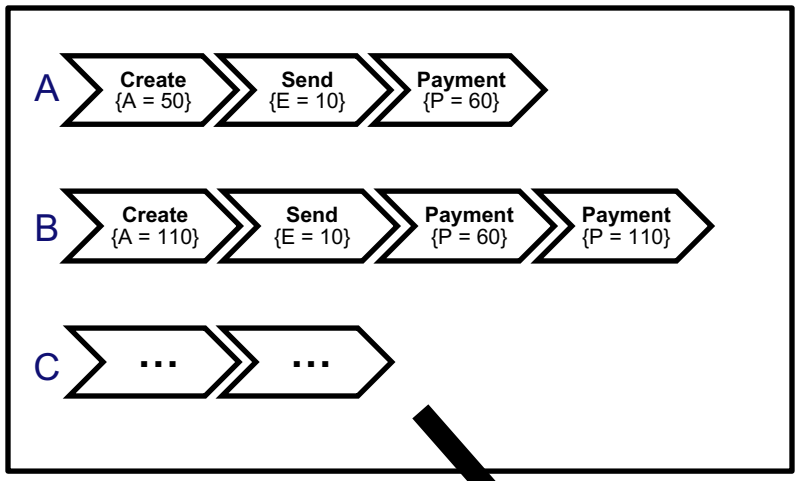
Felix Mannhardt, Massimiliano de Leoni,
Hajo A. Reijers, Wil M.P. van der Aalst

Technische Universiteit
Eindhoven
University of Technology

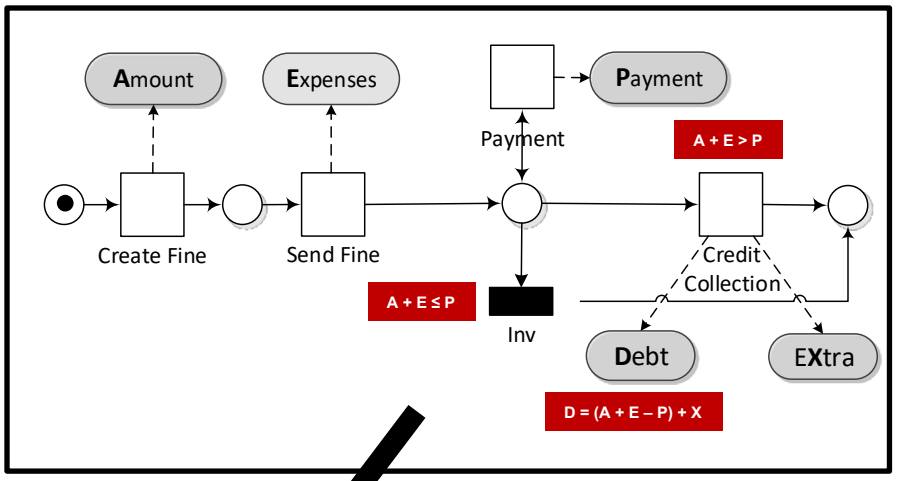
Where innovation starts

Overview & Problem

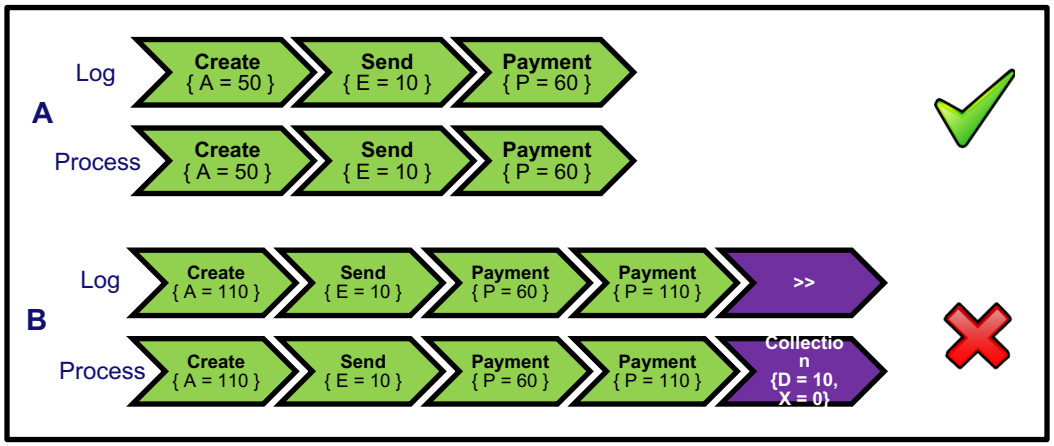
Event Log



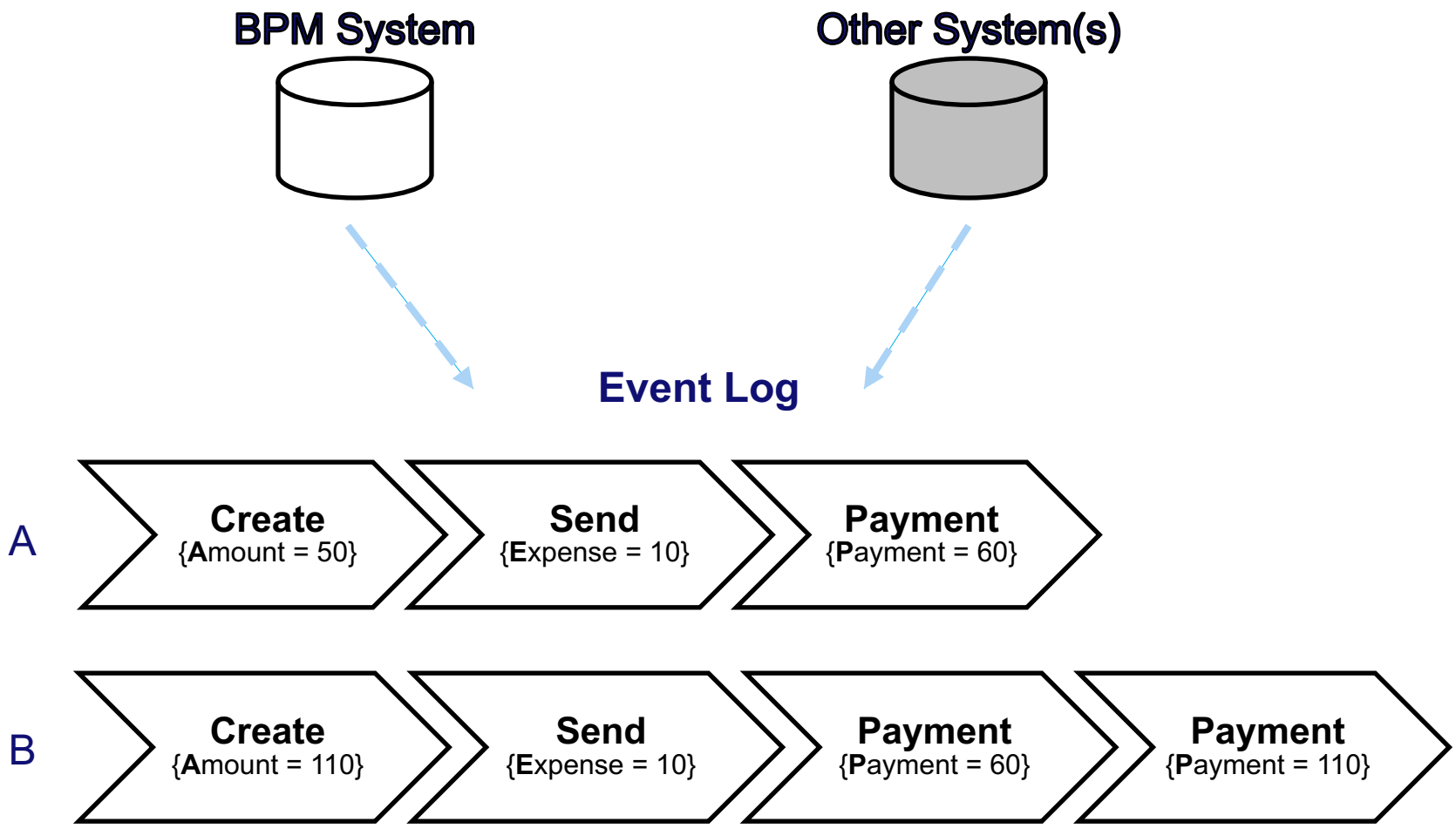
Process Model



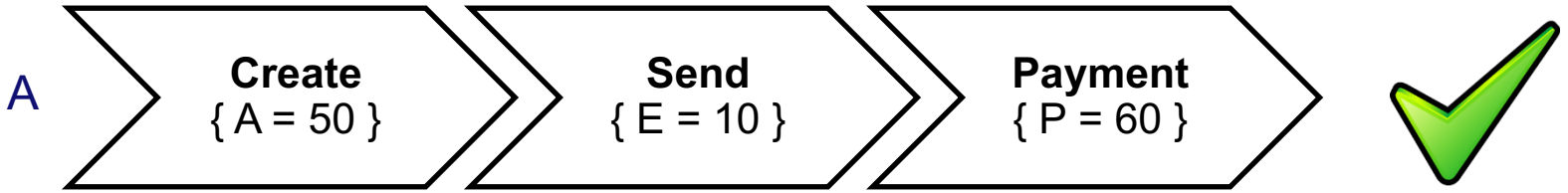
Alignment

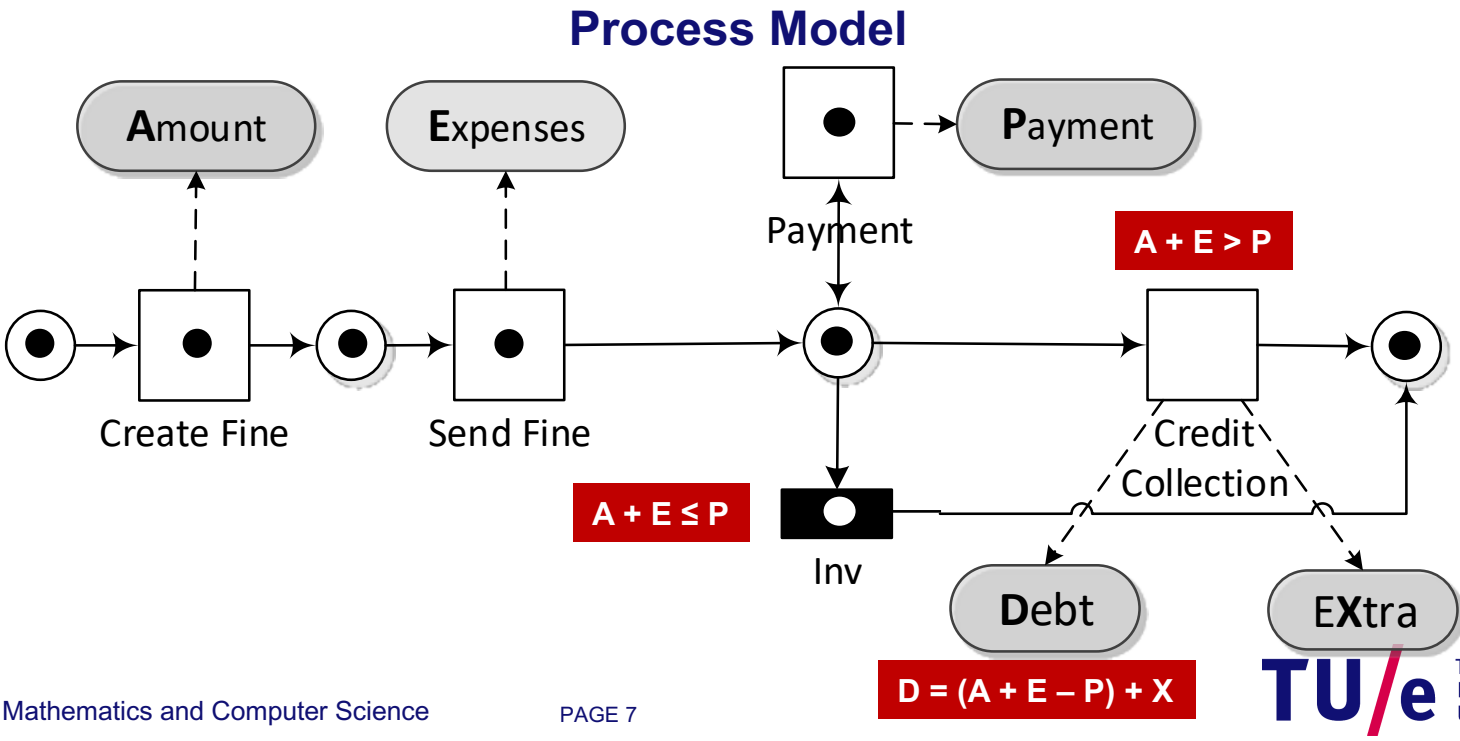


Event Log: Enriched with Data

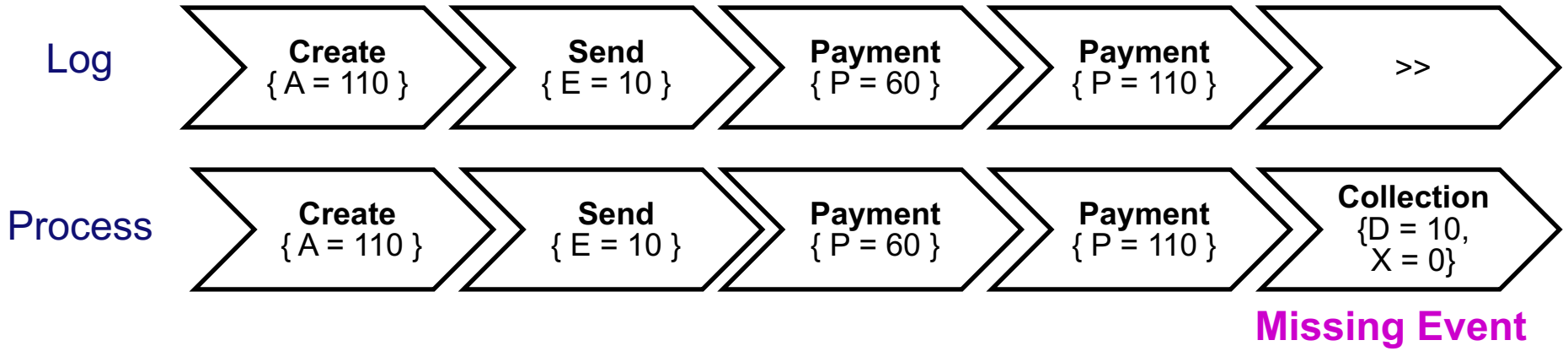


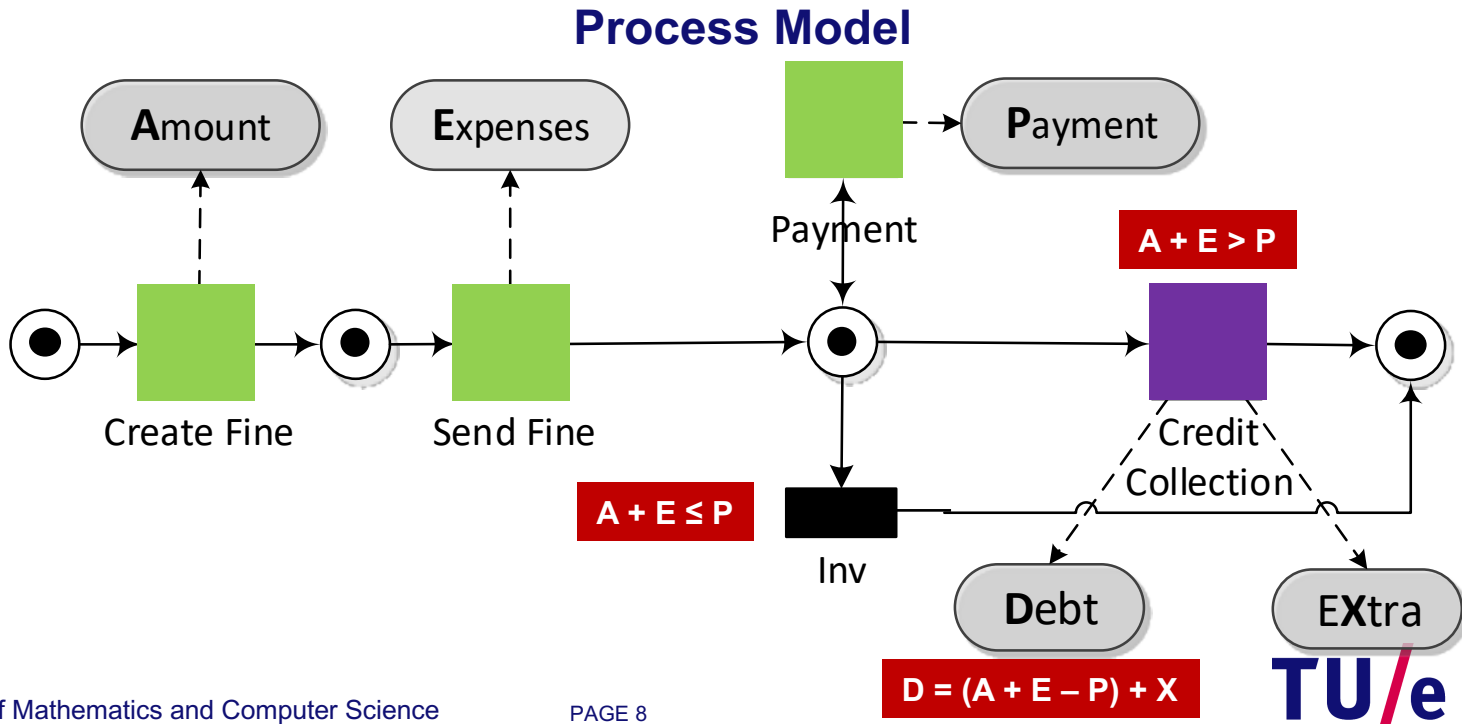
Process Model: Data Petri Nets



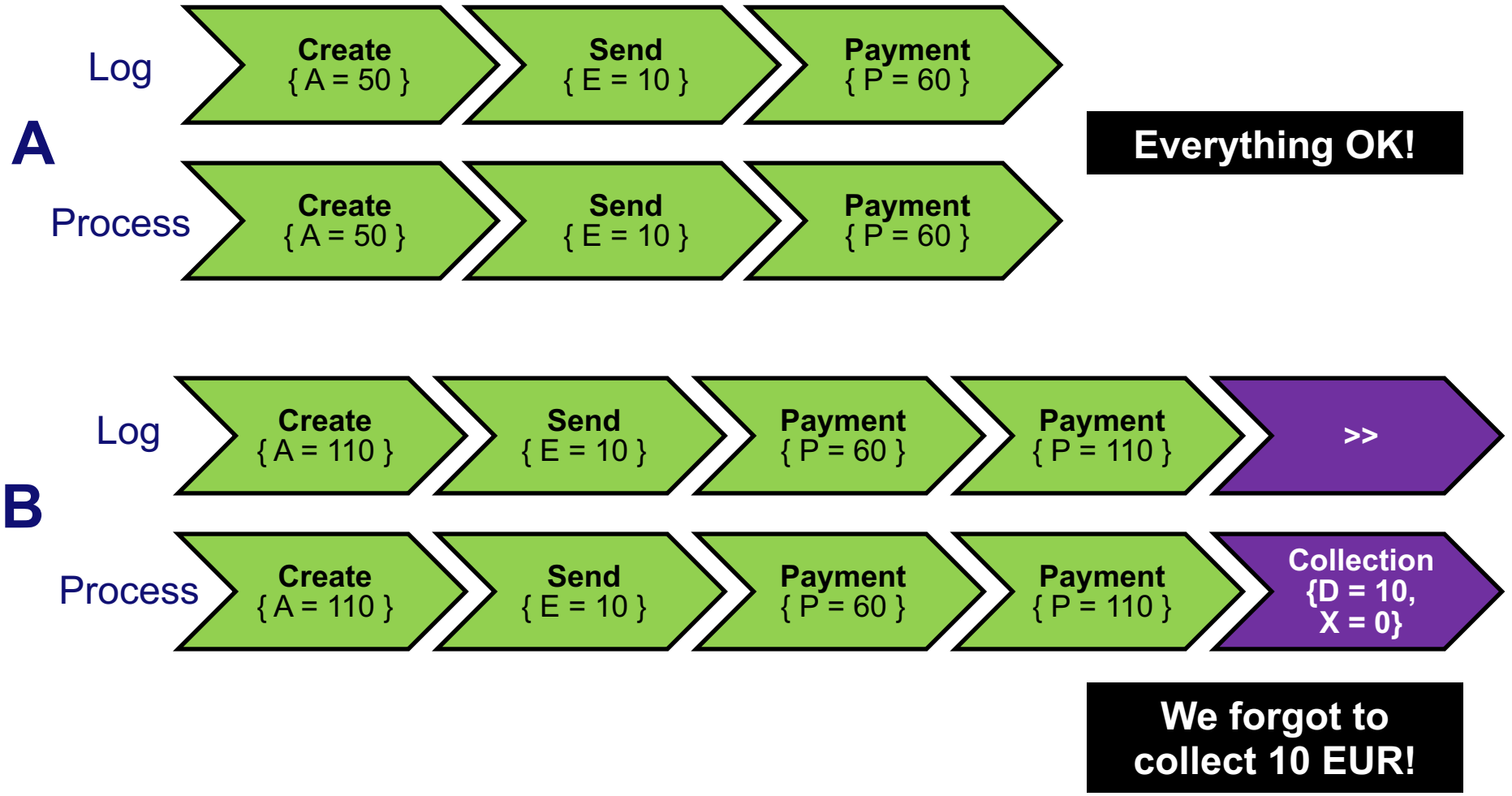


Alignment: Searching for a likely Explanation

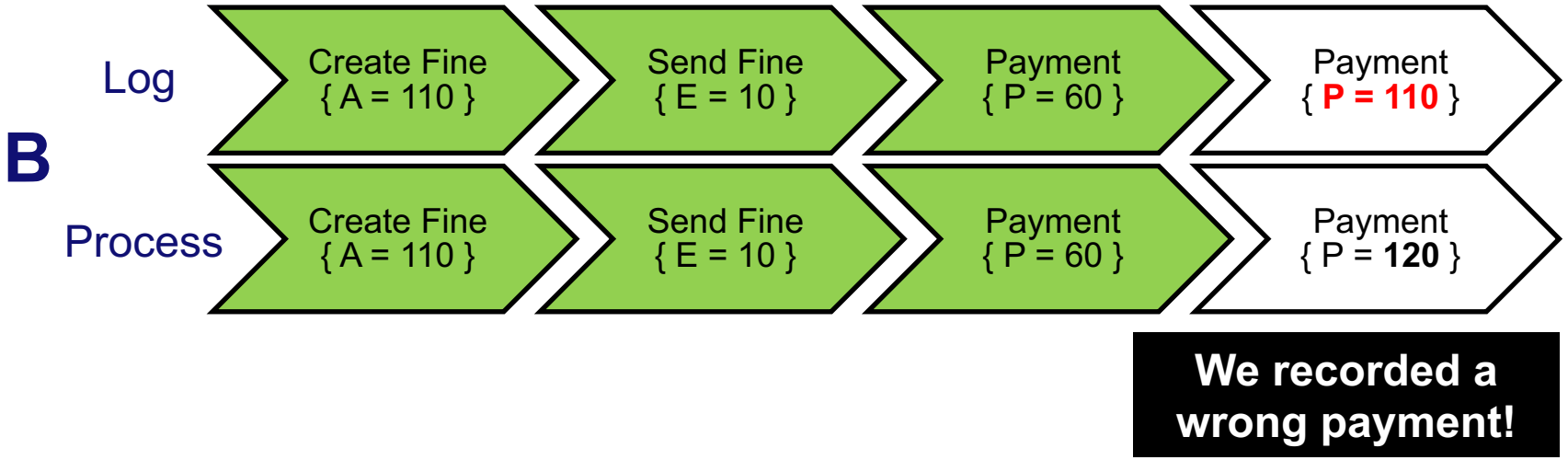




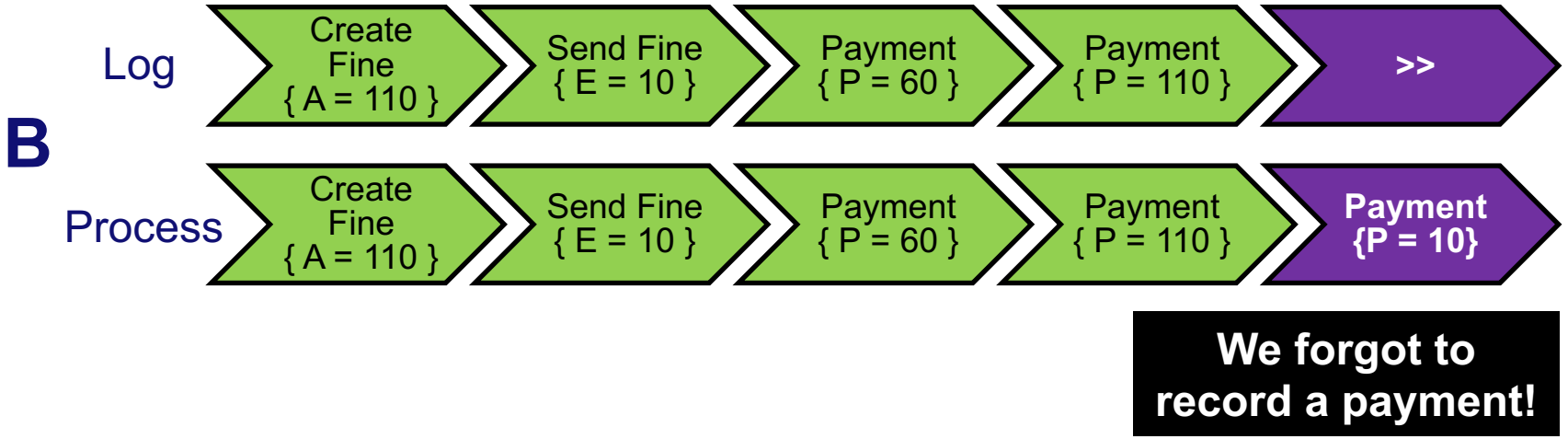
An Alignment of the Event Log



More Alignments / Explanations?

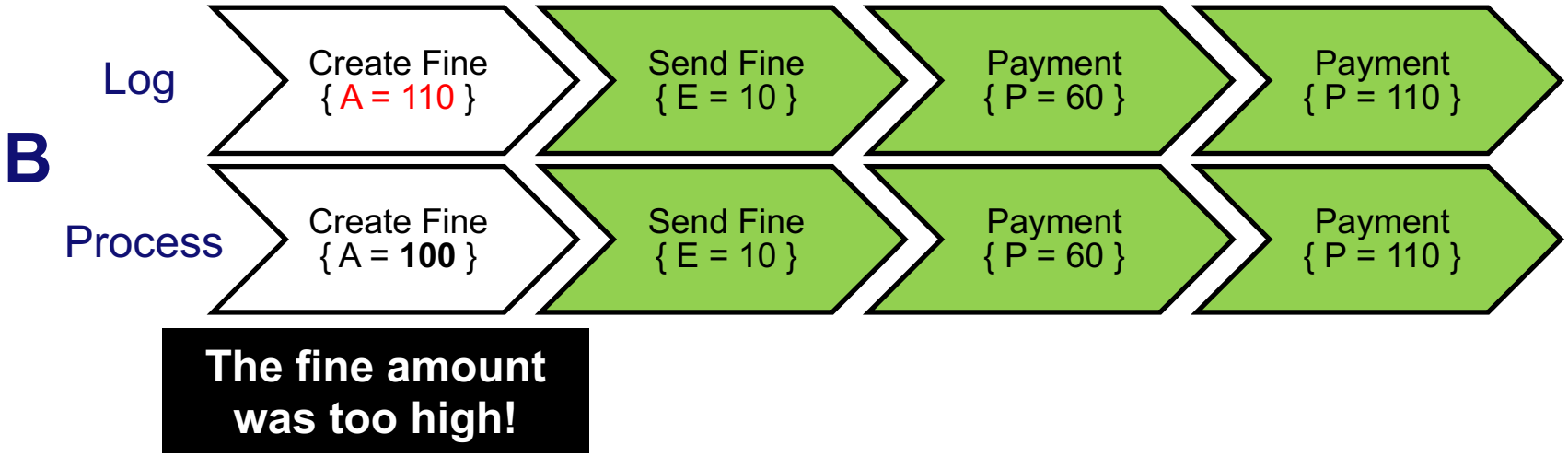


We recorded a wrong payment!

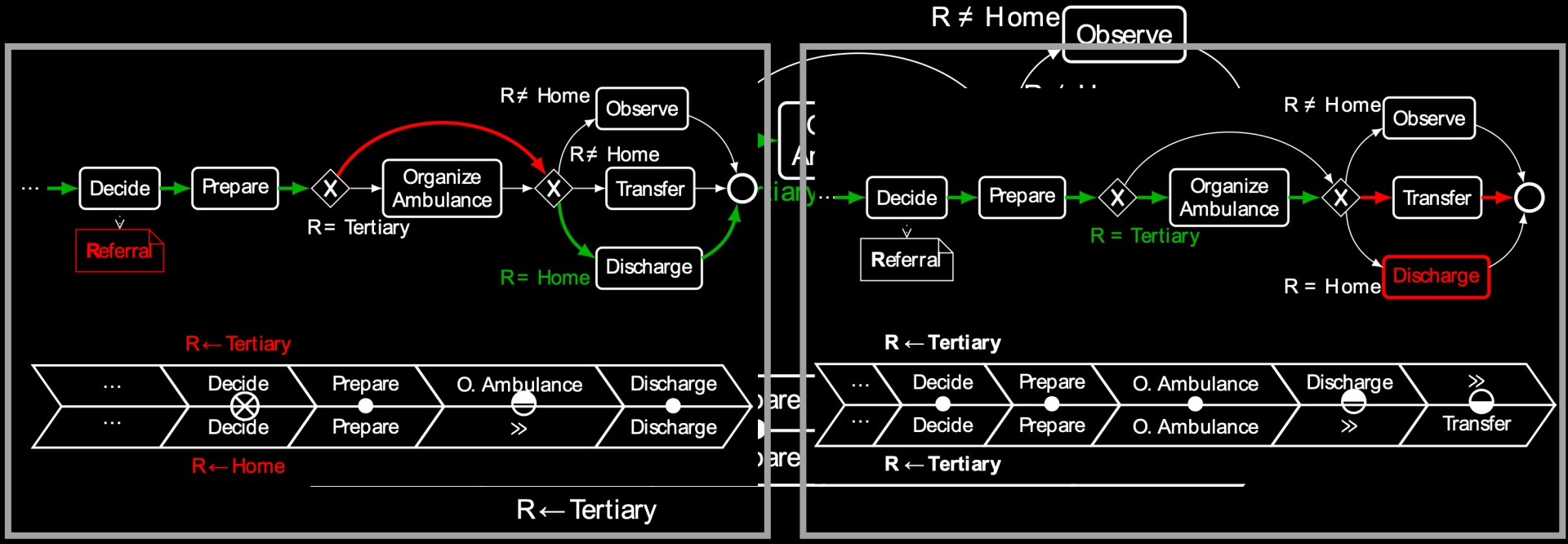


We forgot to record a payment!

There is even more!

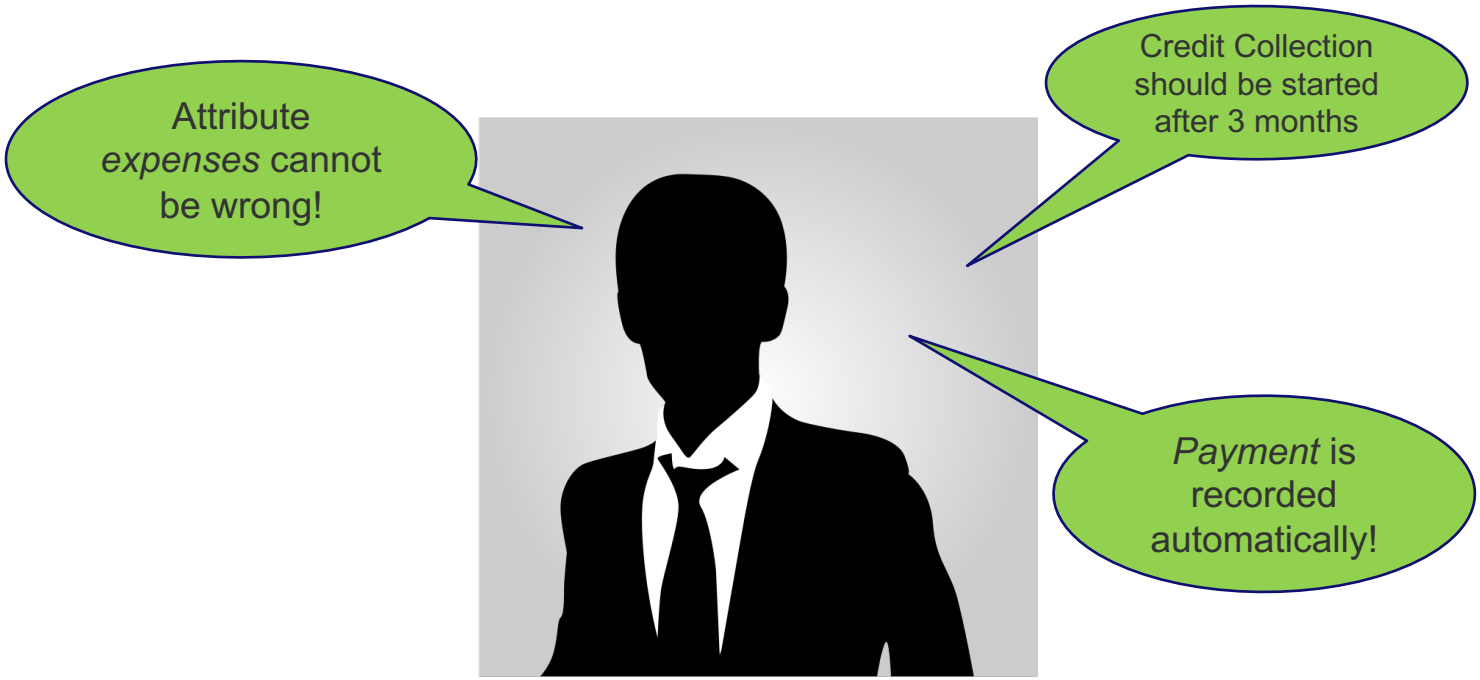


Multi-perspective Conformance Checking



Computation of an Optimal Alignment for Log Traces
Given a Multi-perspective Process Model and Deviation Costs

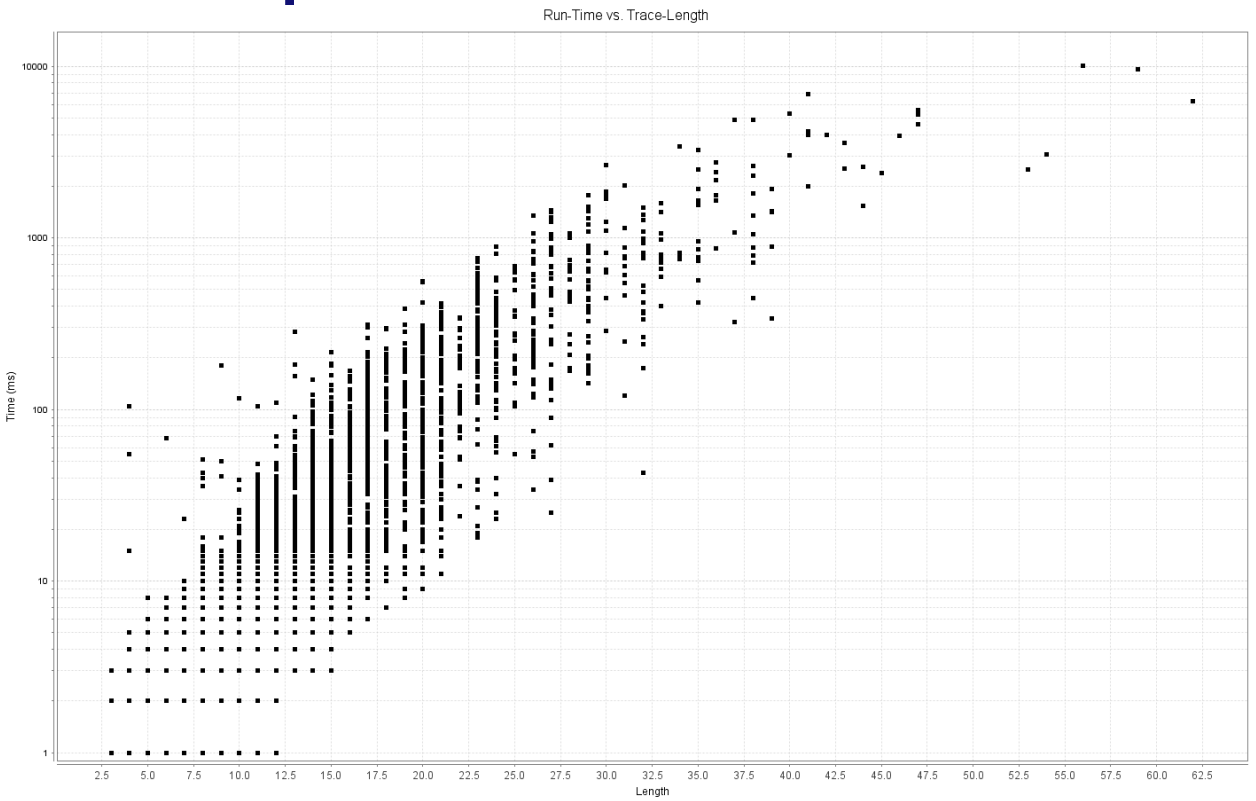
How to decide?



Cost Function

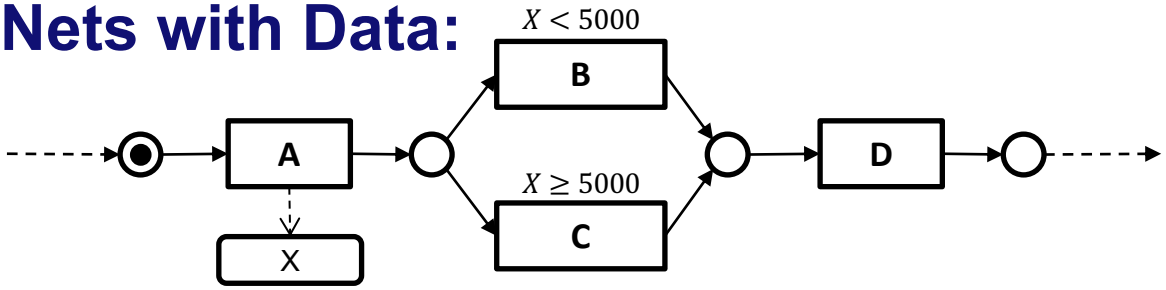
Current Technique

- **Search for an optimal alignment wrt. cost function:**
  - **A* search based on the classical Alignment framework**
  - **Solving MILP problems to *align* the data perspective**
- **Theoretically very expensive, but works well for moderate examples:**



Multi-perspective Alignments – A Sketch

- **Petri Nets with Data:**



- **Two new "Moves" with associated "Costs":**
  - **Move with incorrect write operation**
  - **Move with missing write operation**
- **Formulation of an MILP problem for CF Alignment:**
  - $\boldsymbol{min\ \hat{x}_1}$
  - $\boldsymbol{x - M\hat{x}_1 \leq 2000\ \wedge -x - M\hat{x}_1 \leq -2000\ \wedge x \geq 5000}$
  - $\boldsymbol{\hat{x}_1 \in \{0,1\}, x\ \in \mathbb{Z}}$

Multi-perspective Alignments – A Sketch II

(**a**; {A = 3000;R = Michael});
(**b**; {V = NOK});
(**c**; {I = 530;D = OK});
(**f**);

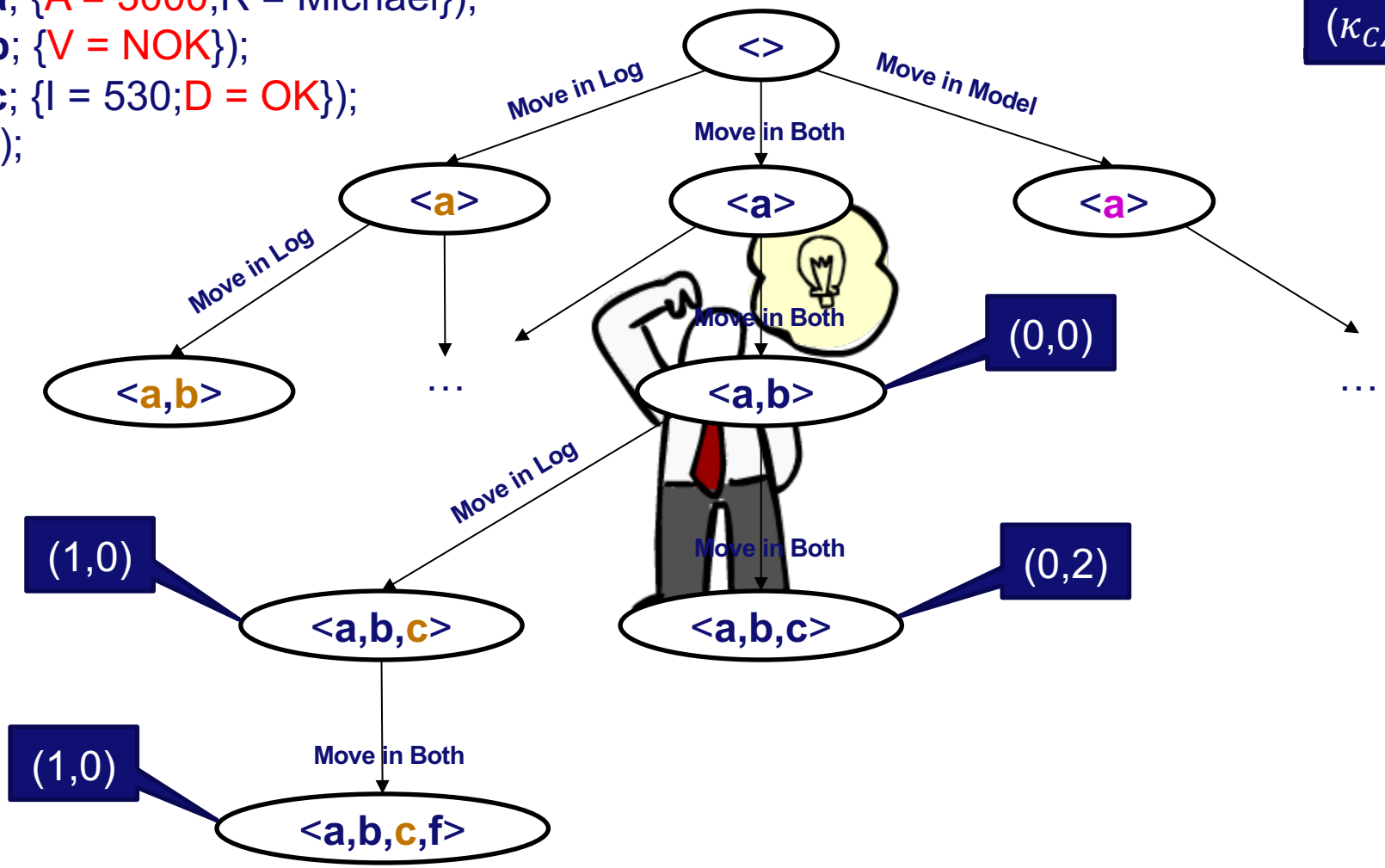


Image source: http://commons.wikimedia.org/wiki/File:Pictofigo_-_Idea.png

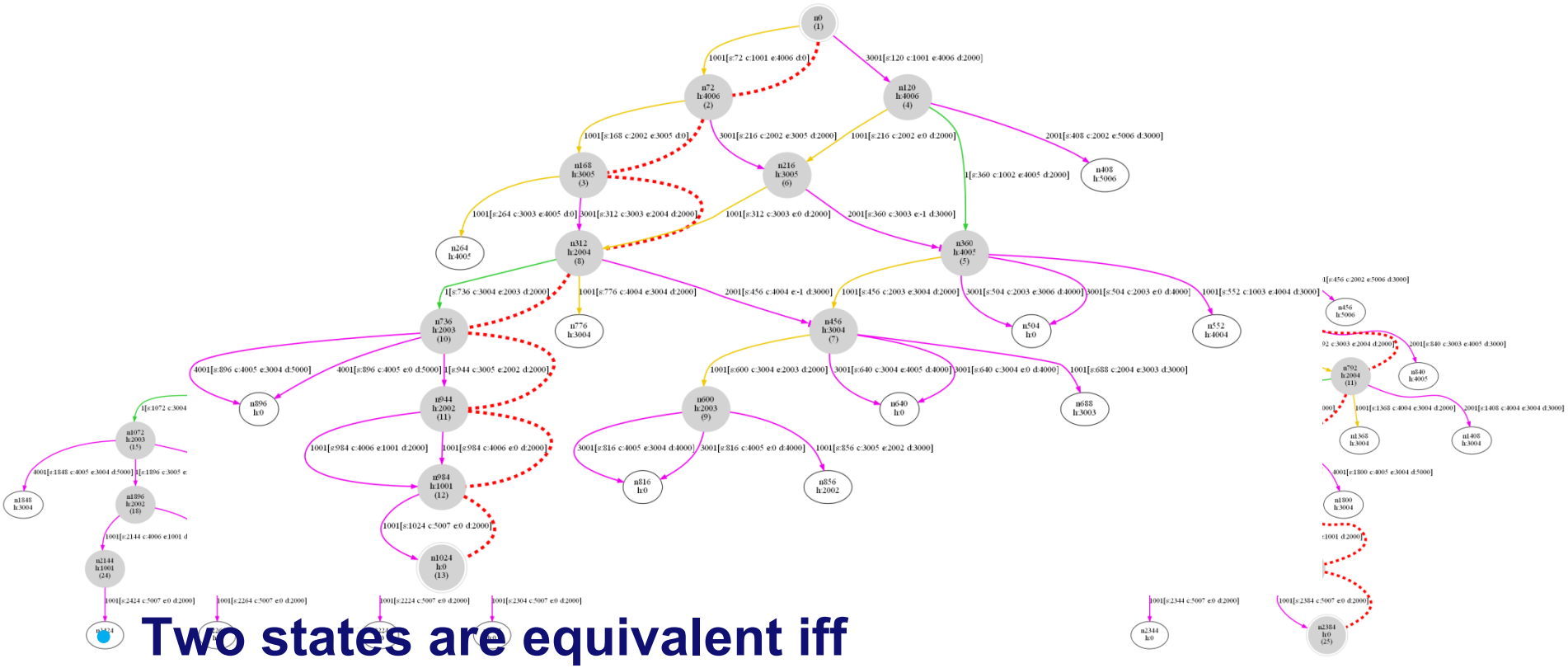
Multi-perspective Alignments – A Sketch III

- For each node in the search space
  - Compute a Data Alignment (MILP) for the prefix
  - Remember κ_{DA} and the variable assignment
  - Use the variable assignment to check if an MILP needed

- A best-first search on the overall cost ($\kappa_{DA} + \kappa_{CA}$) returns one optimal Data Alignment
  - Use of ILP heuristic for A* [2] still possible
  - $\kappa_{DA} + \kappa_{CA}$ never gets better (no negative edges!)
  - But, our search space is bigger!

[2] A. Adriansyah, B. F. van Dongen, W. M. P. van der Aalst (2011). Conformance checking using cost-based fitness analysis.

Multi-perspective Alignments – A Sketch IV



- **Two states are equivalent iff**
  - **Same marking of “Event Net” & Process Model as in [2]**
  - **Same variable assignment wrt. all guards**

[2] A. Adriansyah, B. F. van Dongen, W. M. P. van der Aalst (2011). Conformance checking using cost-based fitness analysis.

Conclusion

- Not only control-flow is relevant for conformance
- Root cause for non-conformance can be:
  - Control-flow
    - log move (wrong)
    - model move (missing)
  - Data
    - wrong variable/attribute value (would violate guard)
    - missing variables value
- Very difficult computational problem in general

Image source: http://commons.wikimedia.org/wiki/File:Pictofigo_-_Idea.png