Dirk **Fahland**

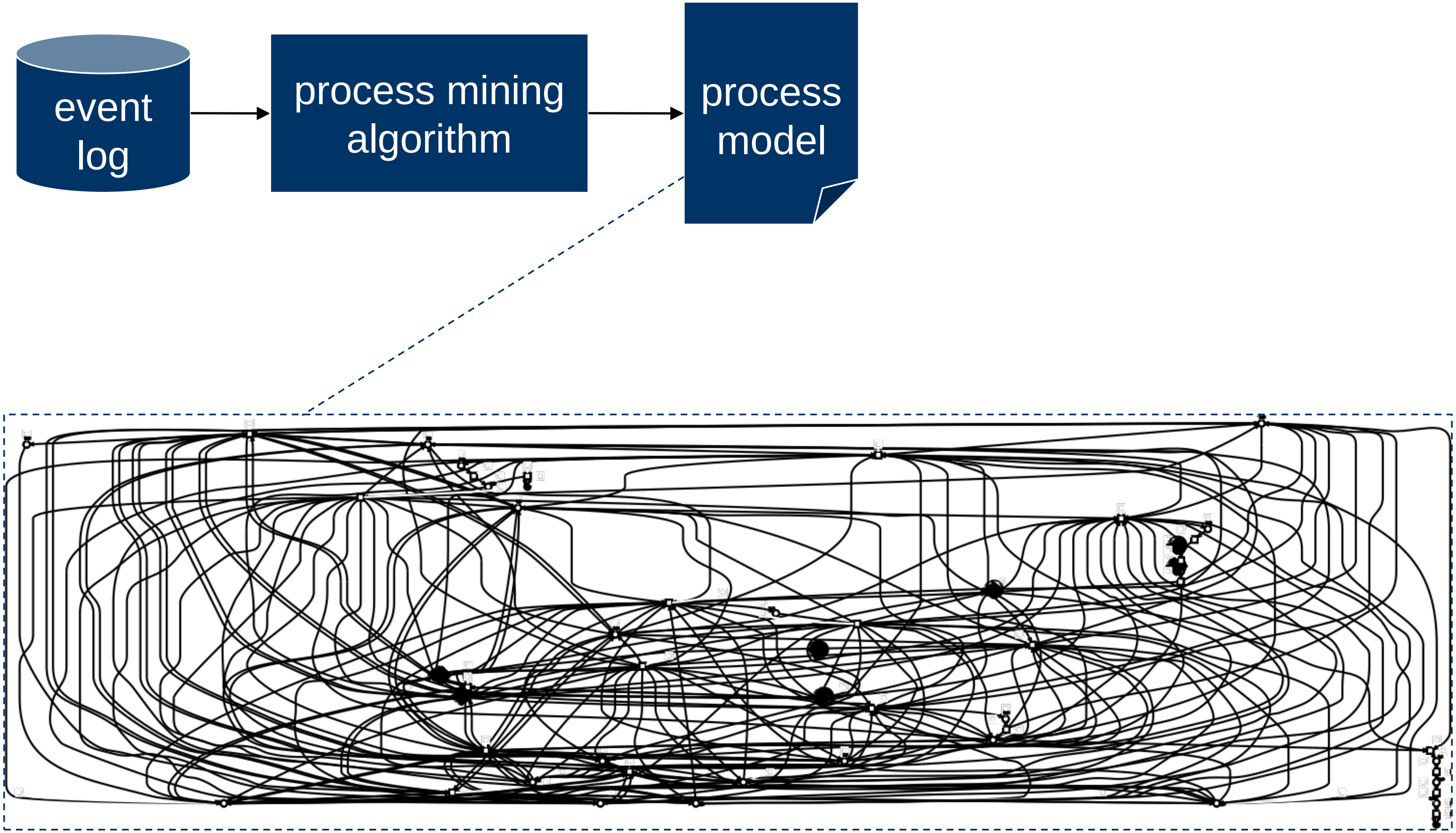
Wil M.P. **van der Aalst**

Simplifying Mined Process Models

Technische Universiteit **Eindhoven** University of Technology

Where innovation starts

Process Mining, Currently

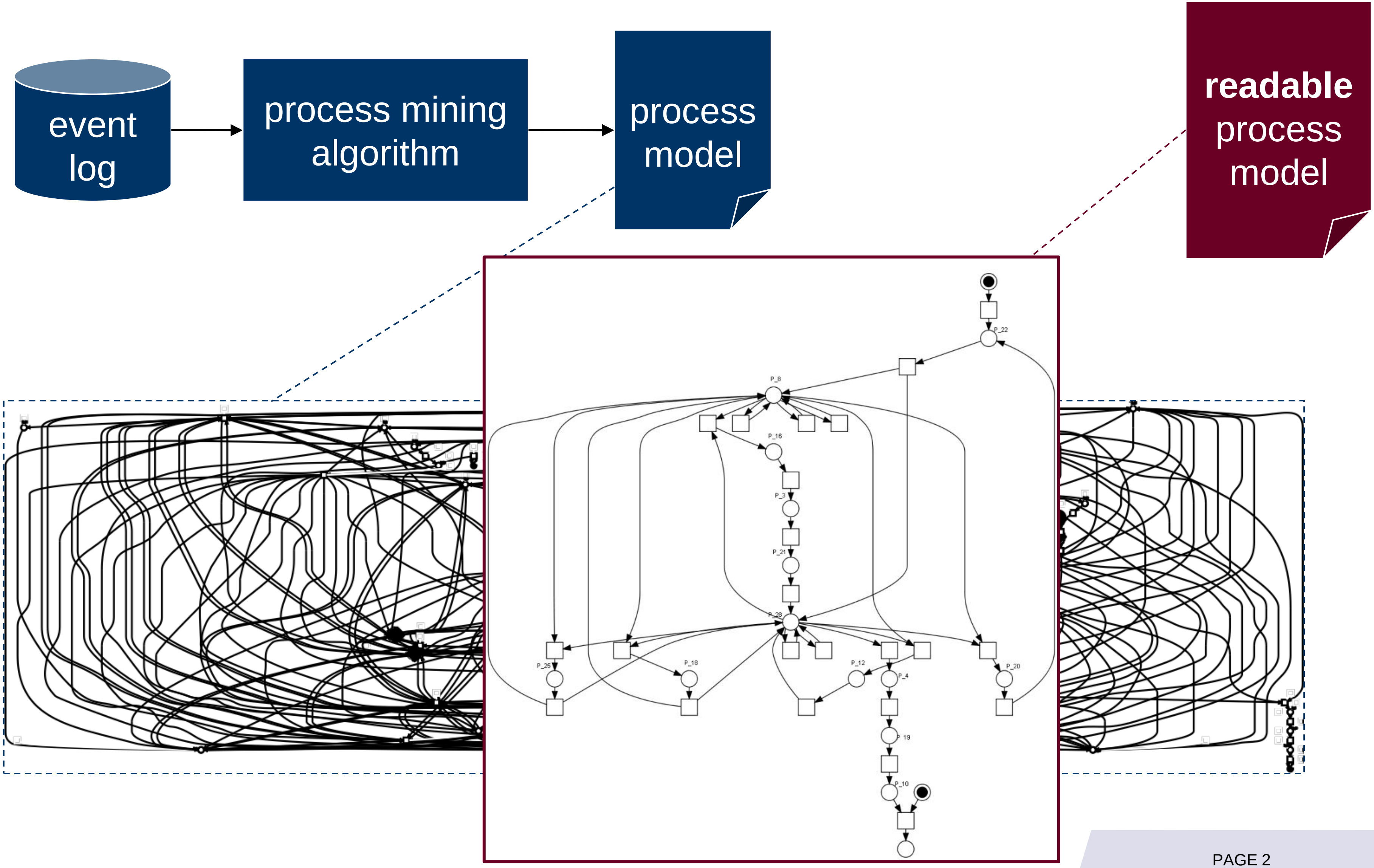


event log

process mining algorithm

process model

Process Mining, Currently



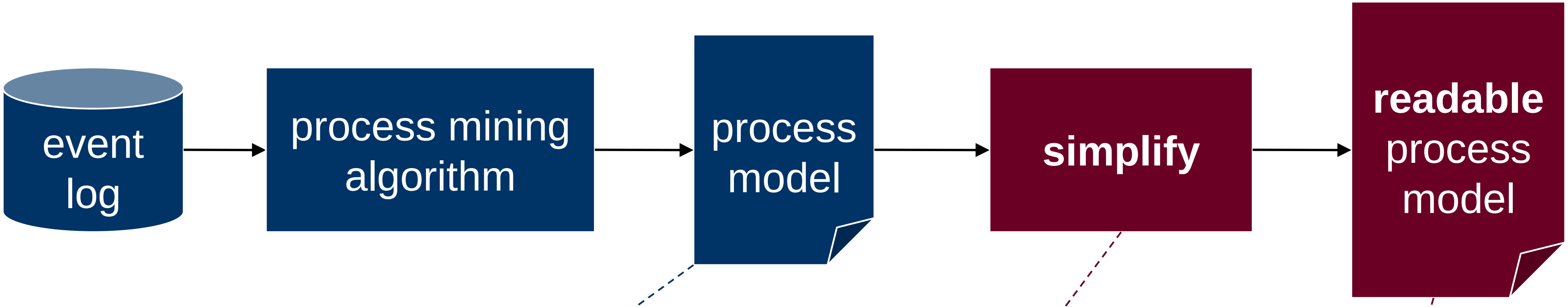
event log

process mining algorithm

process model

readable process model

Post-Process the Model

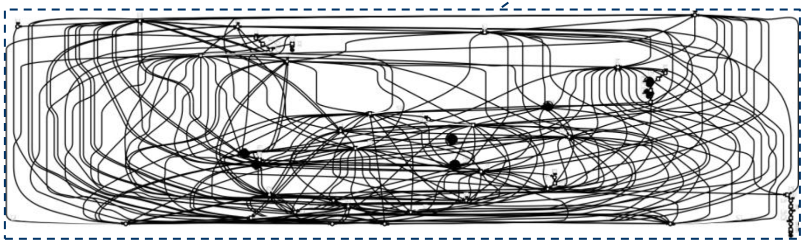

event log

process mining algorithm

process model

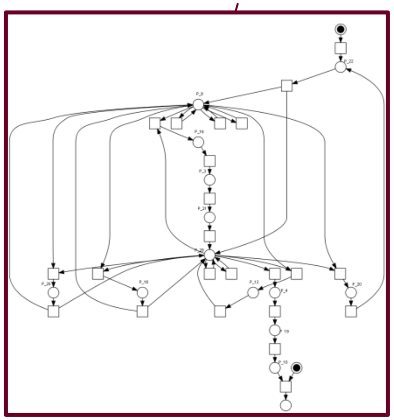
simplify

readable process model



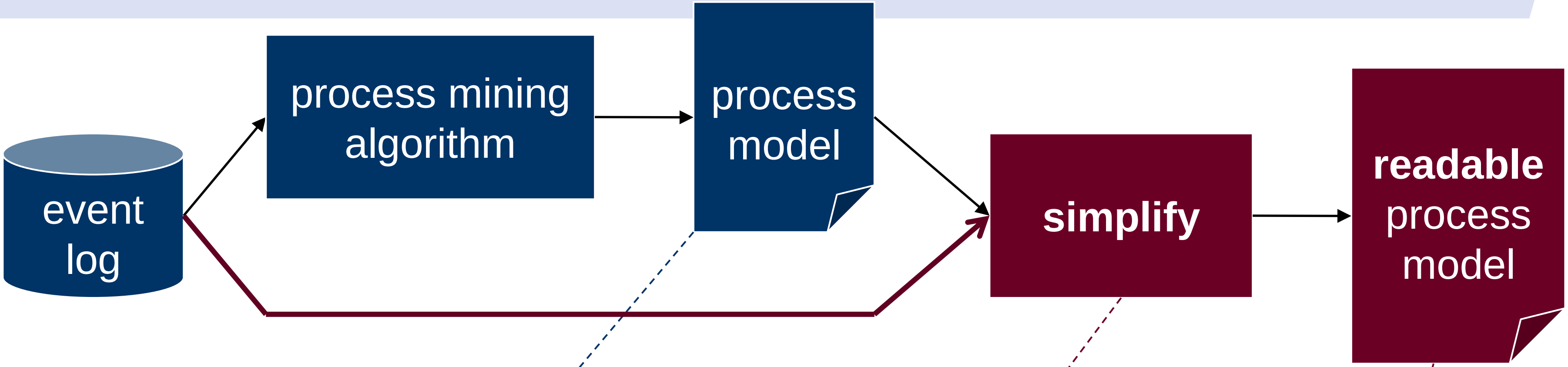
can replay the entire log

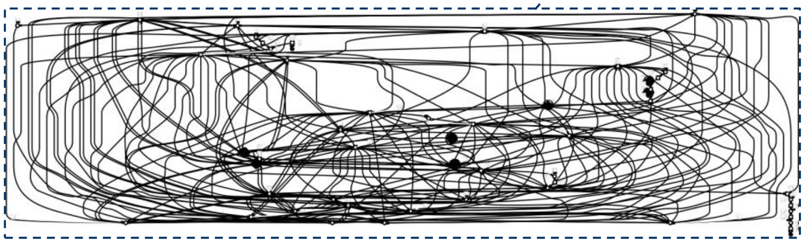
introduce:
post-processing operations on the mined model



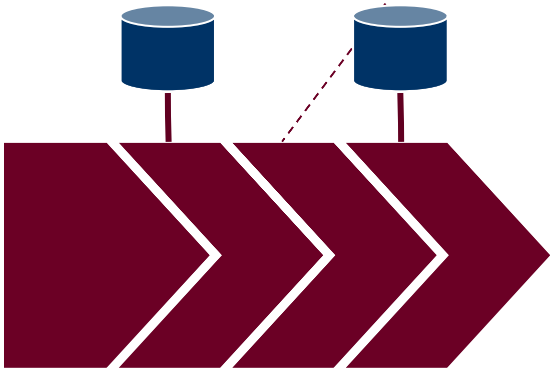
can replay the entire log

…Based on Original Event Log

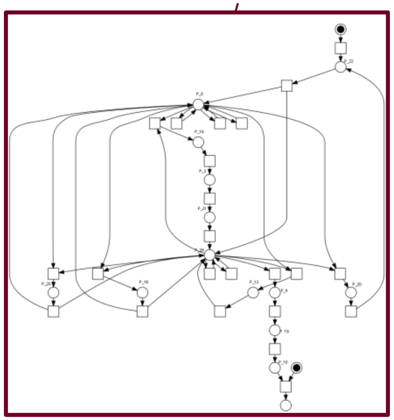




can replay the entire log

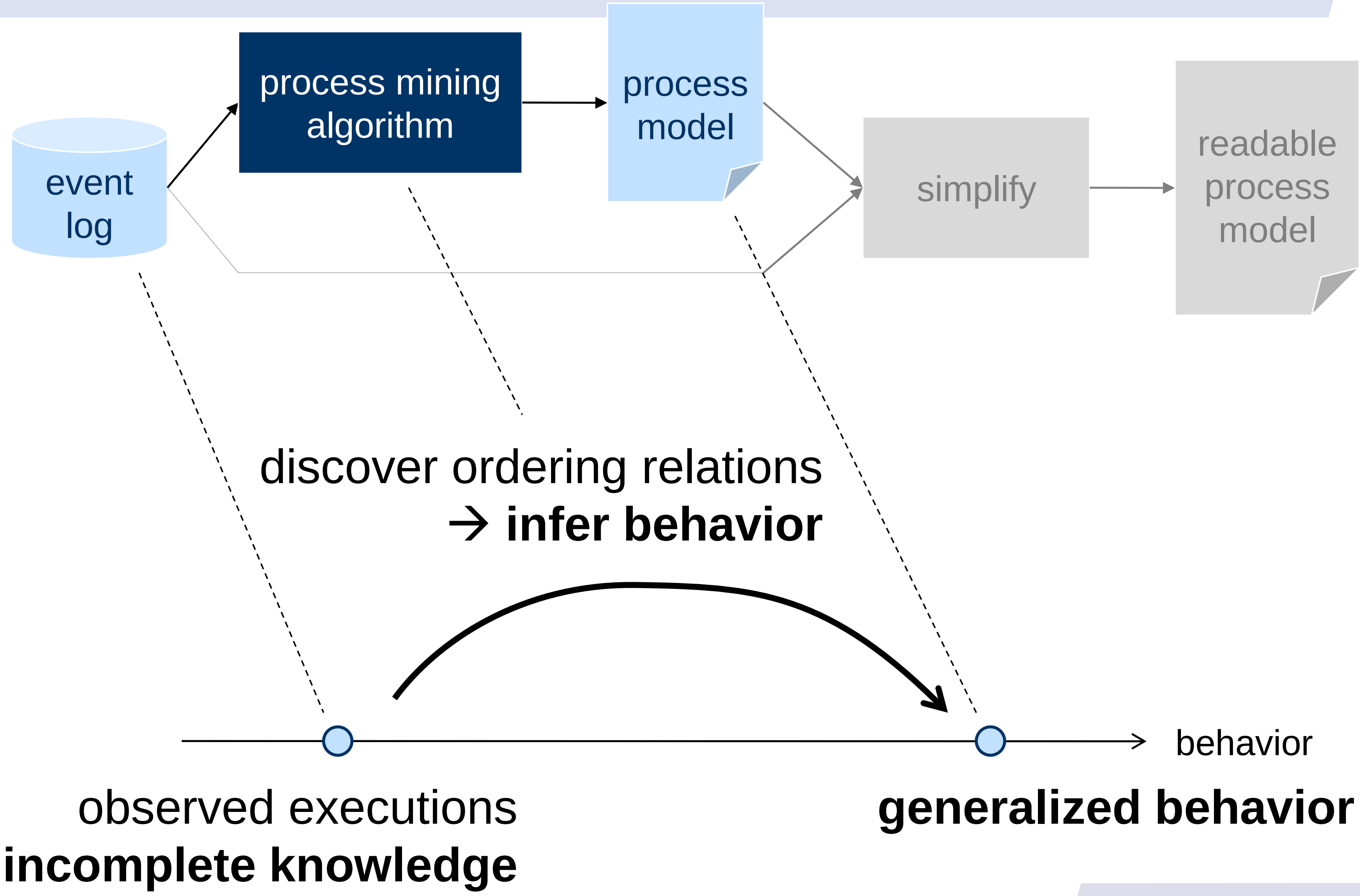


introduce: **post-processing operations on the mined model**



can replay the entire log

Analysis



event log

process mining algorithm

process model

simplify

readable process model

discover ordering relations

→ **infer behavior**

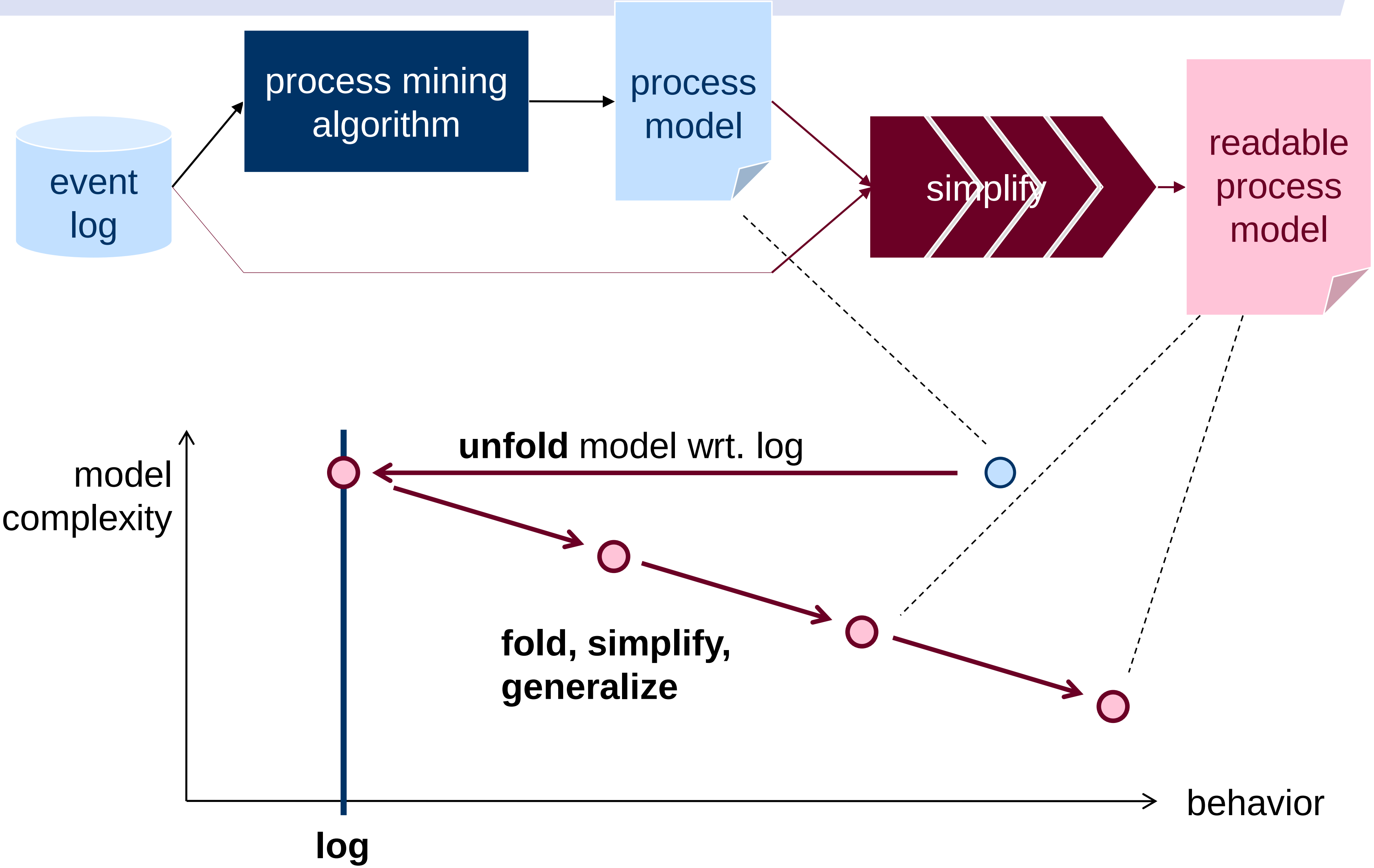
behavior

observed executions

incomplete knowledge

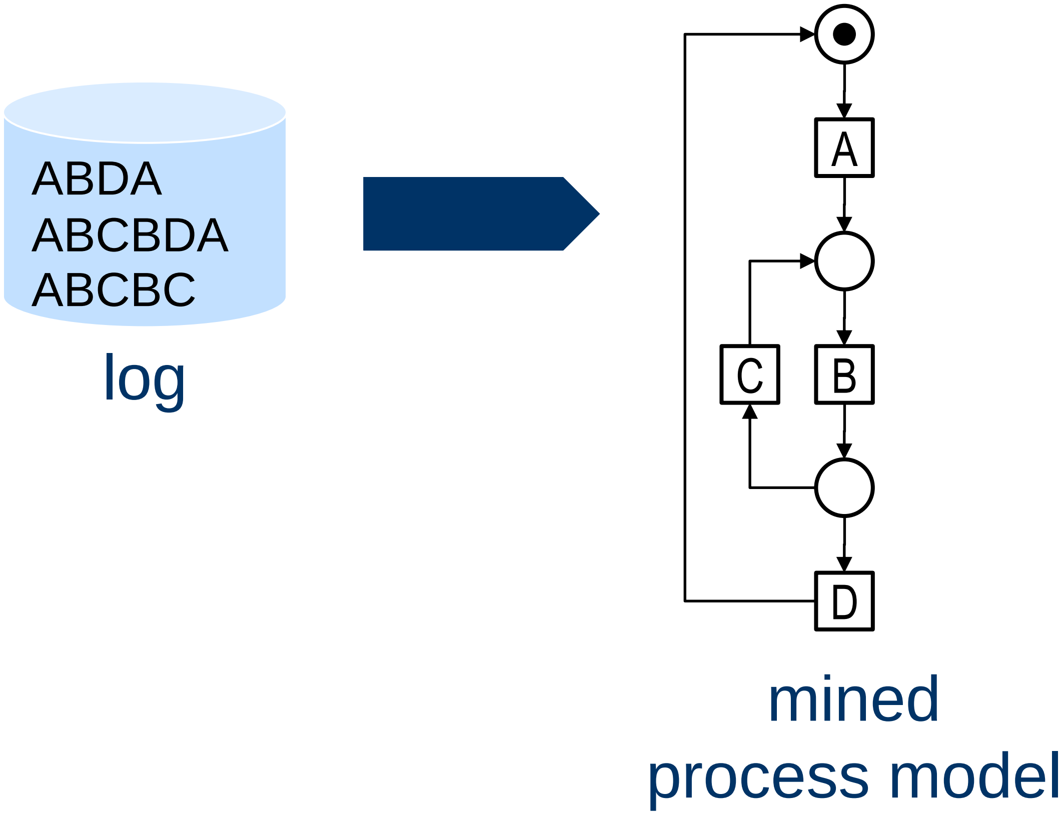
generalized behavior

Idea: Re-Adjust Generalization



Unfold a Spaghetti-Model

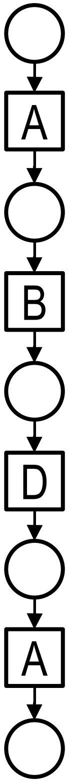
Unfold Model wrt. a Log


ABDA
ABCBDA
ABCBC

log

mined
process model

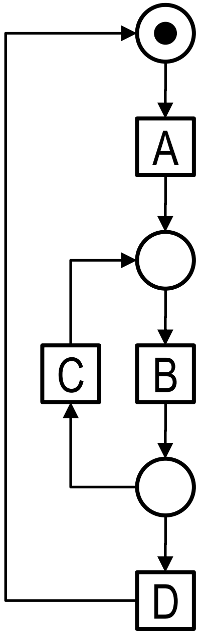
Unfold Model wrt. a Log



unfold

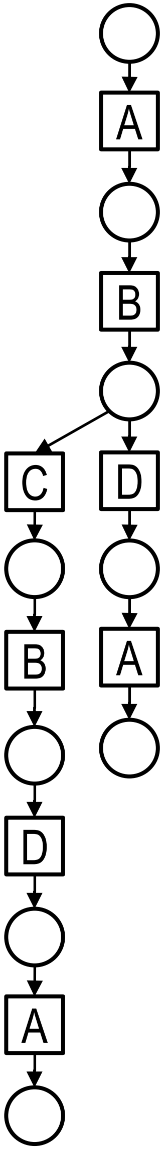
ABDA
ABCBDA
ABCBC

log



mined process model

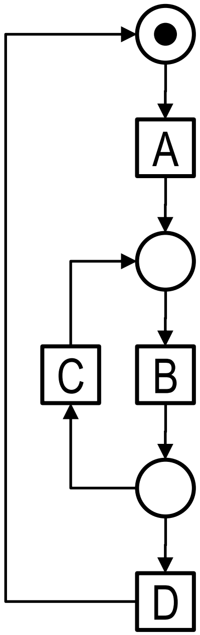
Unfold Model wrt. a Log



unfold

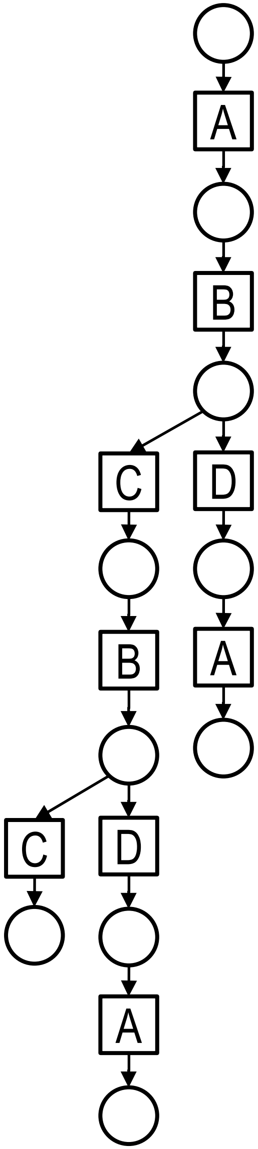
ABDA
ABCBDA
ABCBC

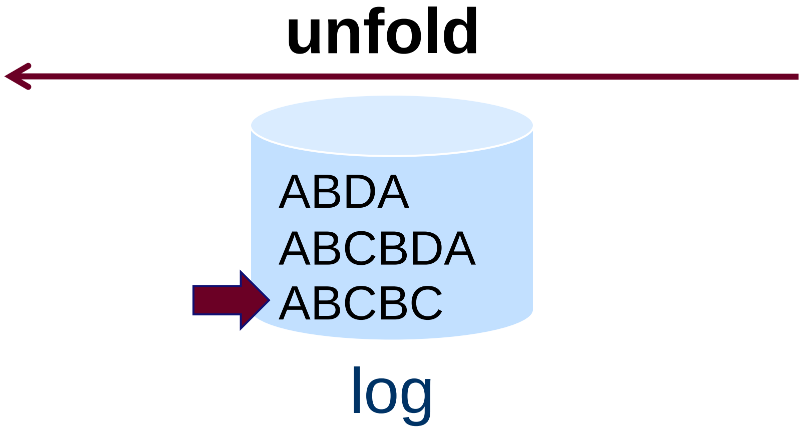
log



mined
process model

Unfold Model wrt. a Log




unfold

ABDA
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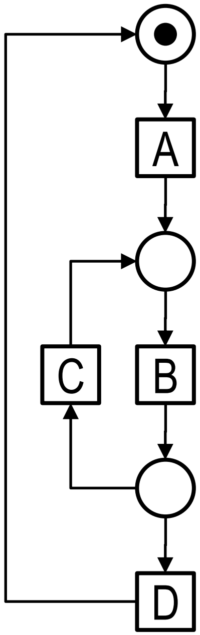
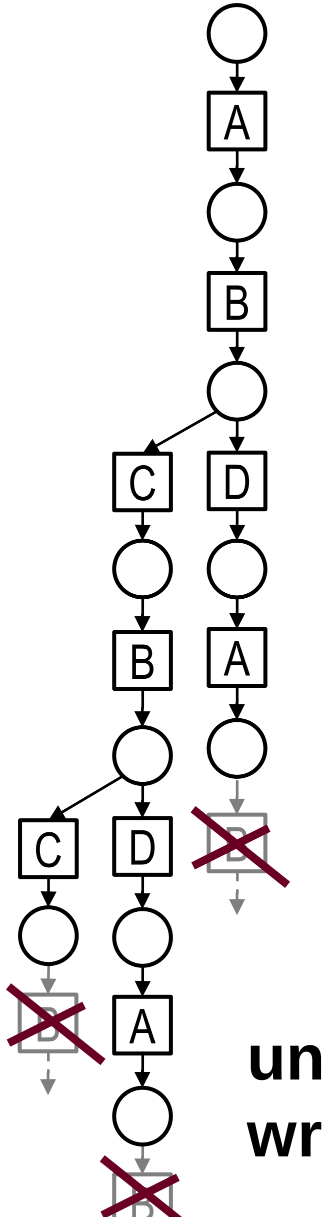
log

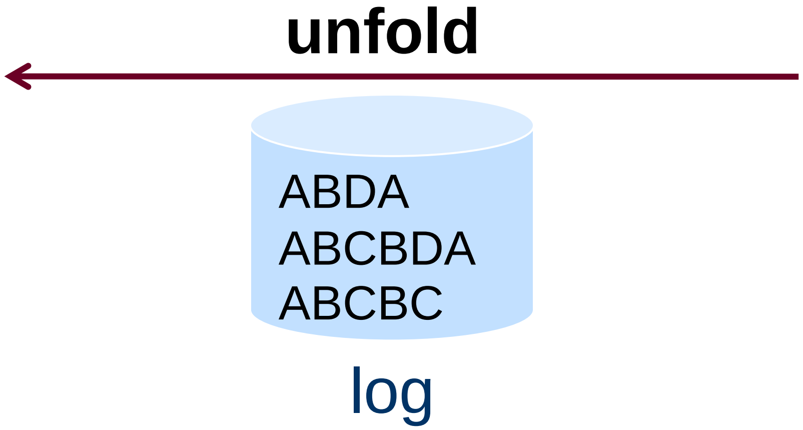


mined
process model

Unfold Model wrt. a Log



unfolding
wrt. the log


unfold

ABDA
ABCBDA
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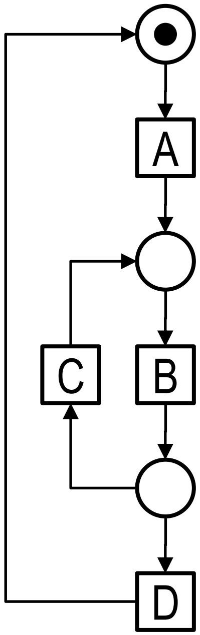
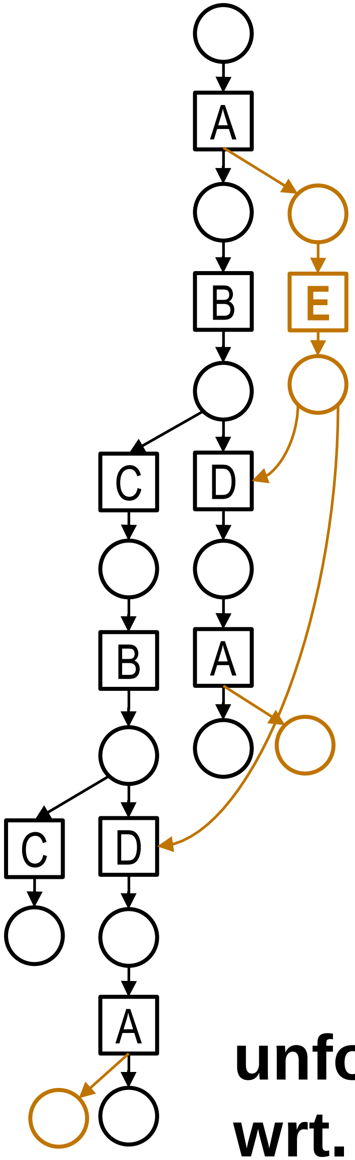
log



mined
process model

Represents Concurrency

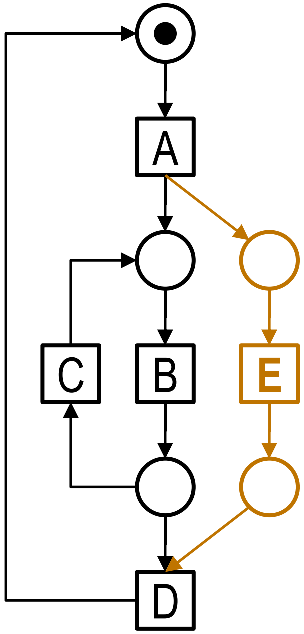


unfolding
wrt. the log

unfold

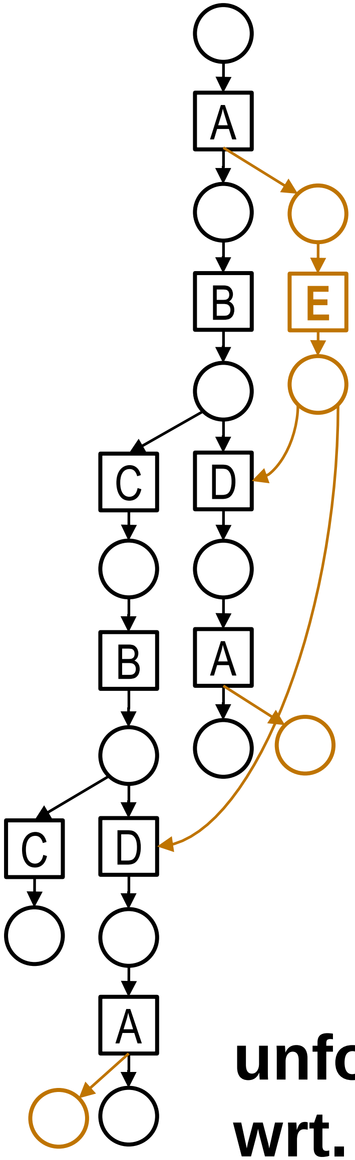
AEBDA
ABECBDA
ABCBC

log

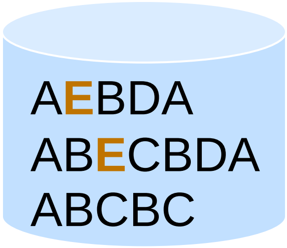


mined
process model

Represents Concurrency



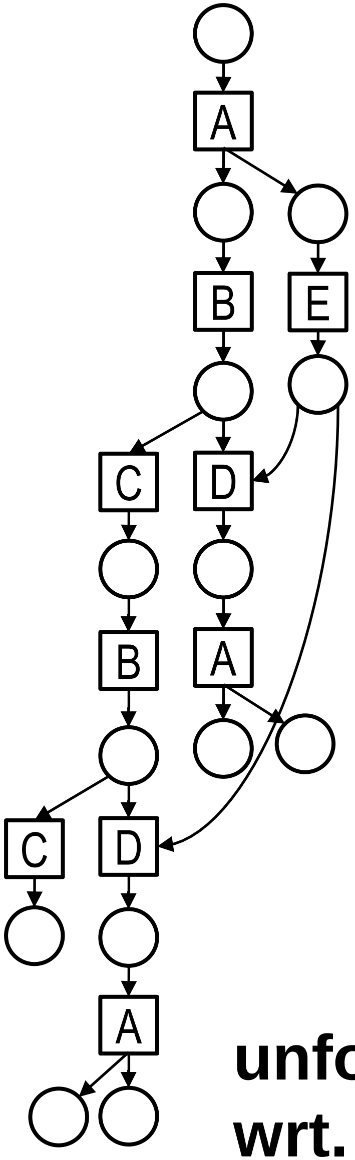
unfolding wrt. the log


AEBDA
ABECBDA
ABCBC

log

- **is a process model**
- contains only behavior in the log
- is acyclic
- represents concurrency explicitly
- labeled
  (several tasks with same label)

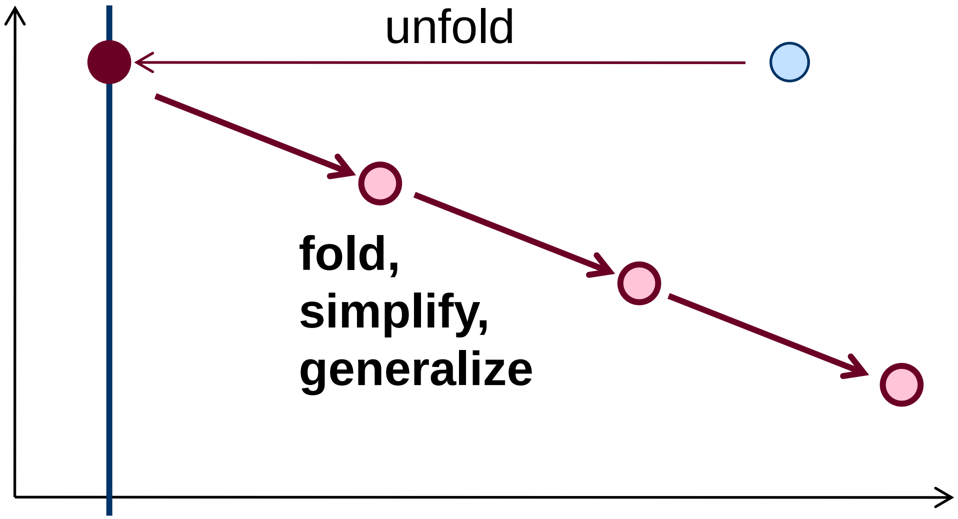
Represents Concurrency



unfolding wrt. the log

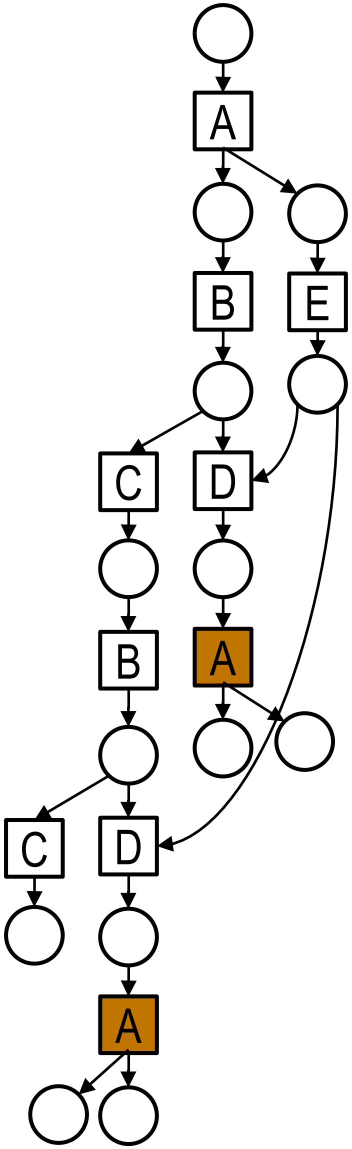
AEBDA
ABECBDA
ABCBC

log



fold, simplify, generalize

Fold an unfolded model

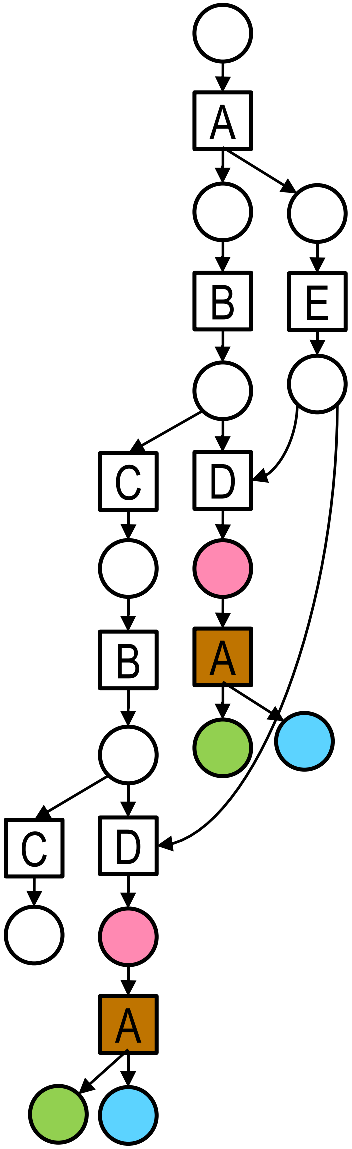


merge **equivalent** nodes

necessary condition on equivalent **transitions**

- same label

Fold an unfolded model

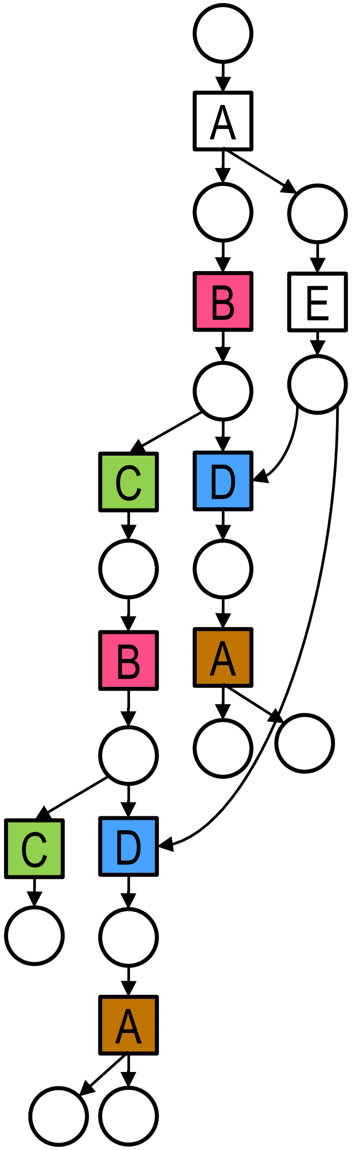


merge **equivalent** nodes

necessary condition on equivalent **transitions**

- same label
- equivalent pre-/post-places

Fold an unfolded model



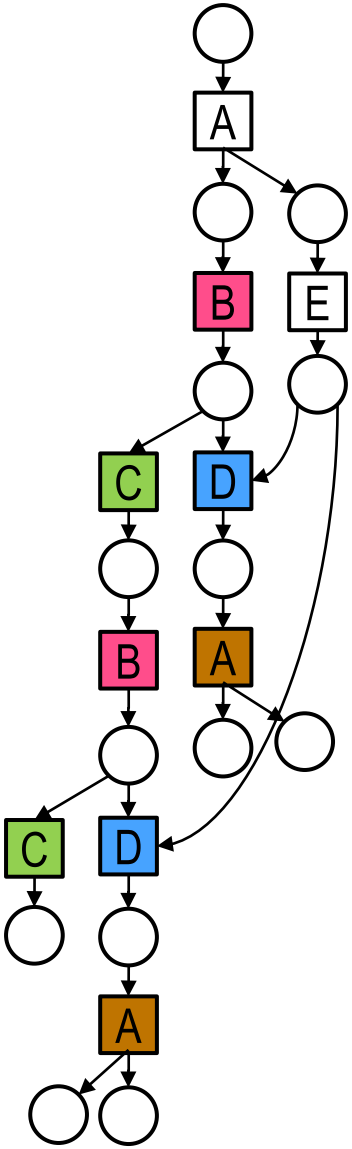
merge **equivalent** nodes

necessary condition on equivalent **transitions**

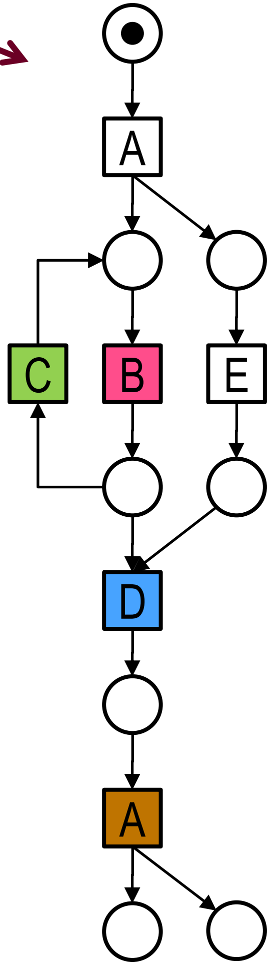
- same label
- equivalent pre-/post-places

various equivalences possible (see paper for some)

Fold an unfolded model

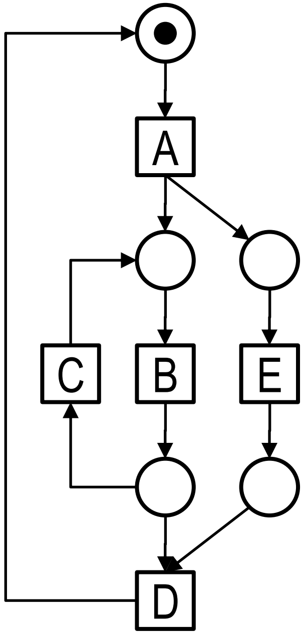


merge **equivalent** nodes

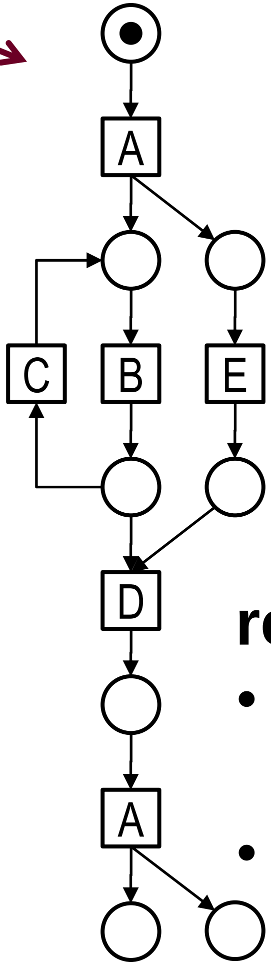


Unfolding and Refolding

unfold



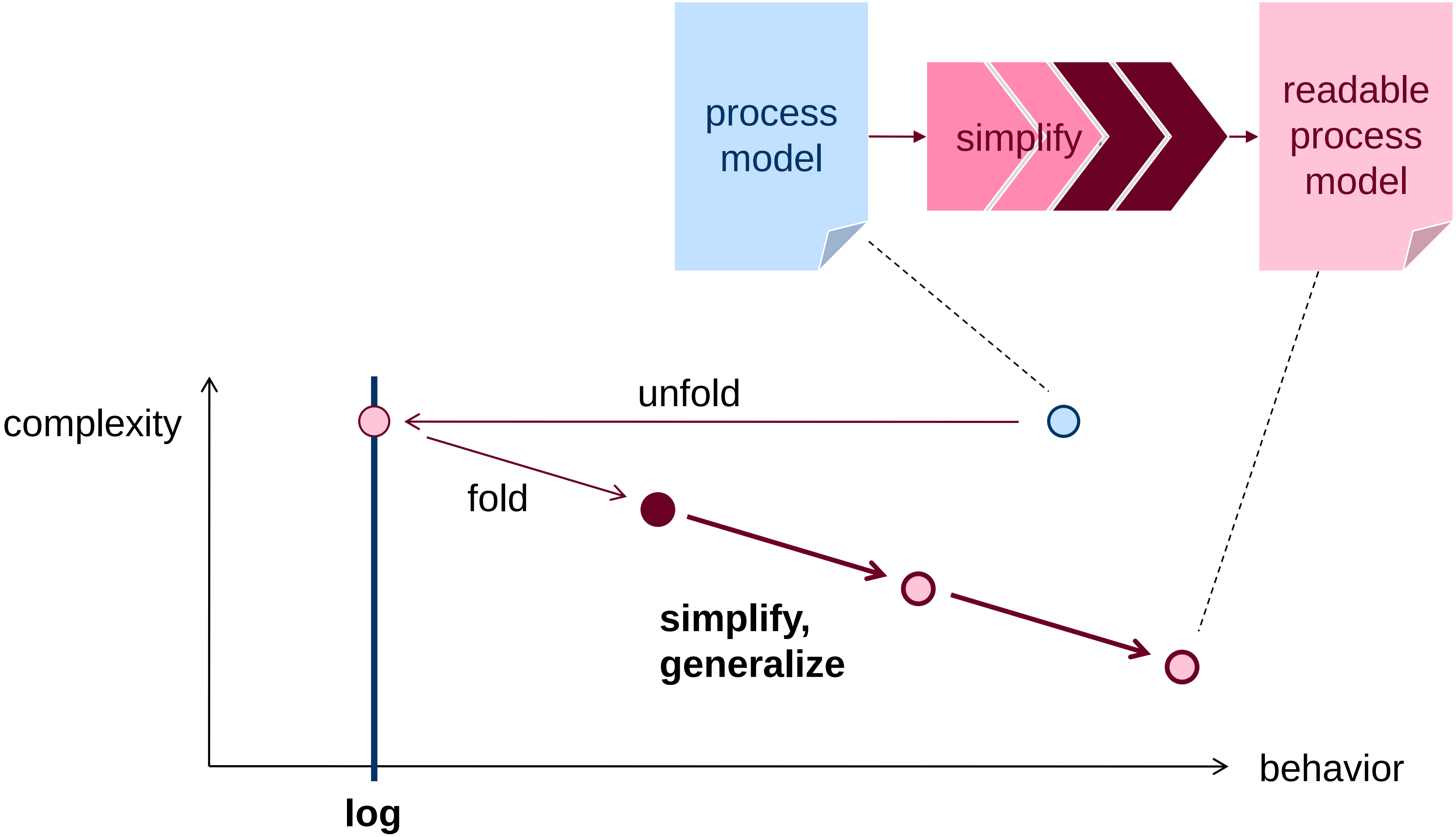
fold



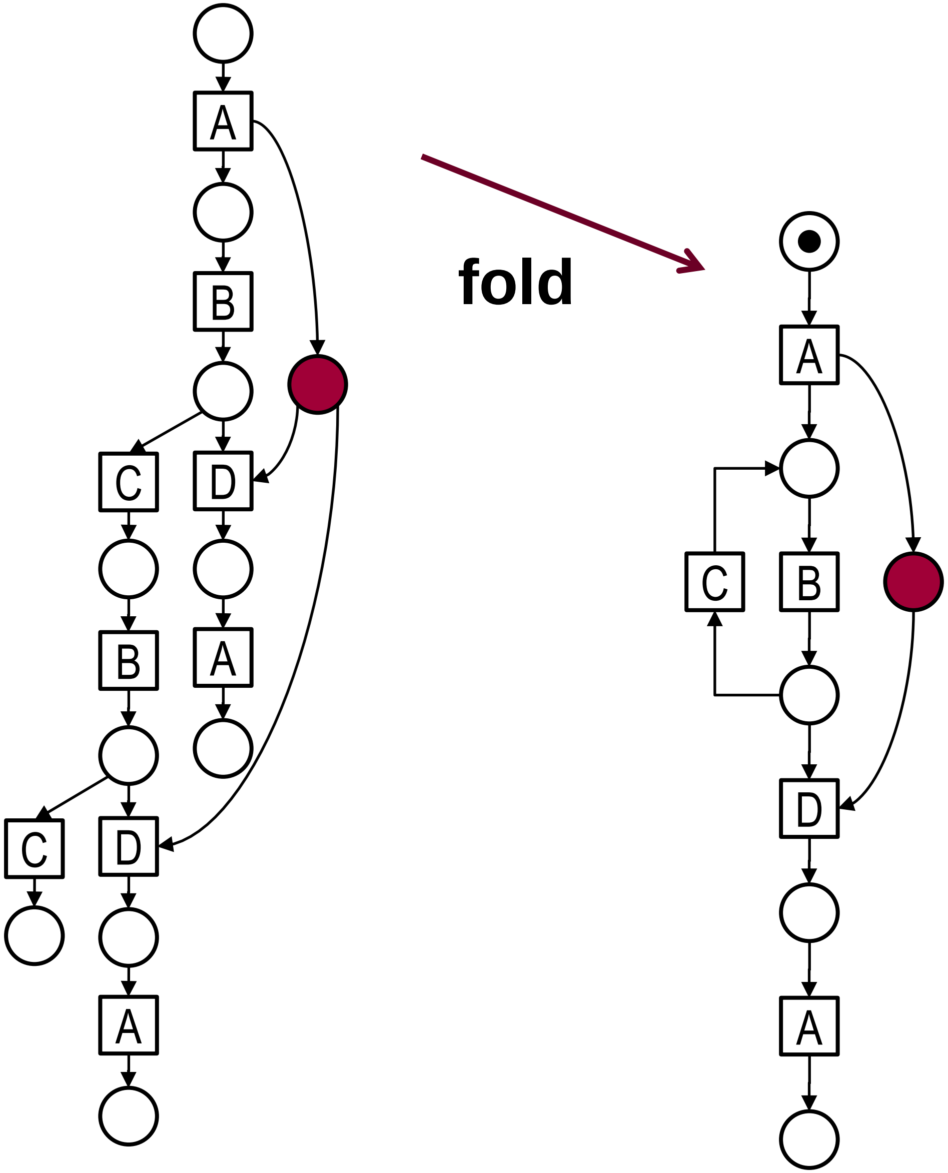
refolded vs. original model

- less behavior
  (replays the log and more)
- simpler structure

Next: Simplifying and Generalizing



Implied Places



fold

implied place

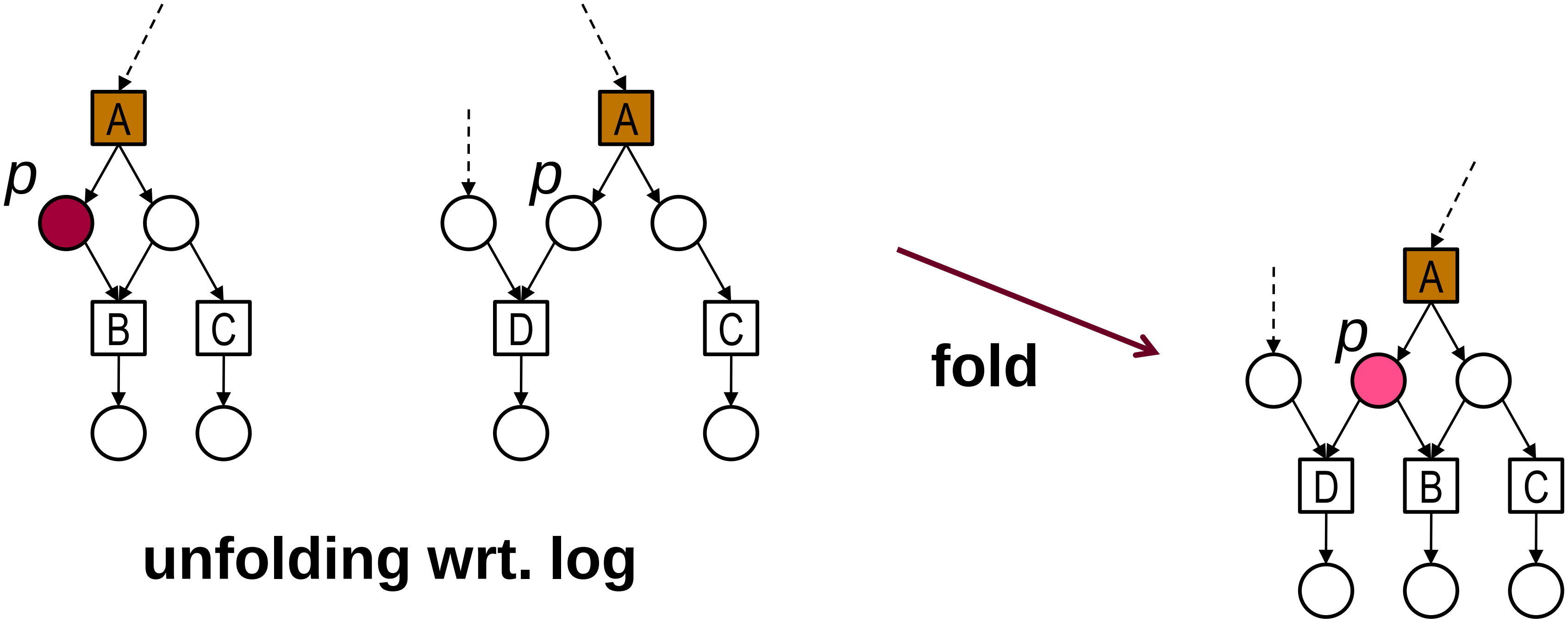
- does not restrict transitions

remove from folded model

- simpler model
- same behavior

various techniques to find implied places

Special: Implied Places and Folding

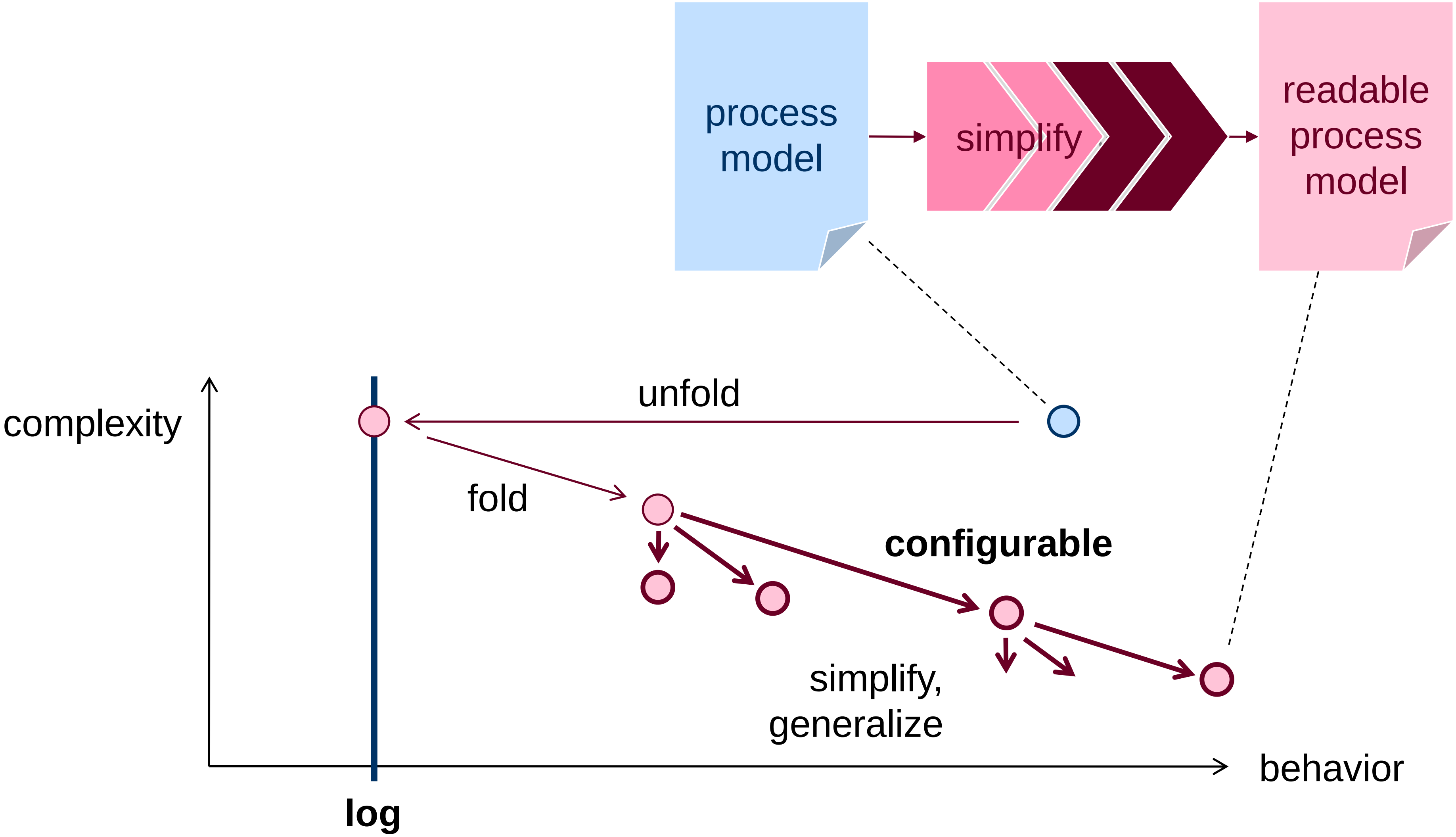


unfolding wrt. log

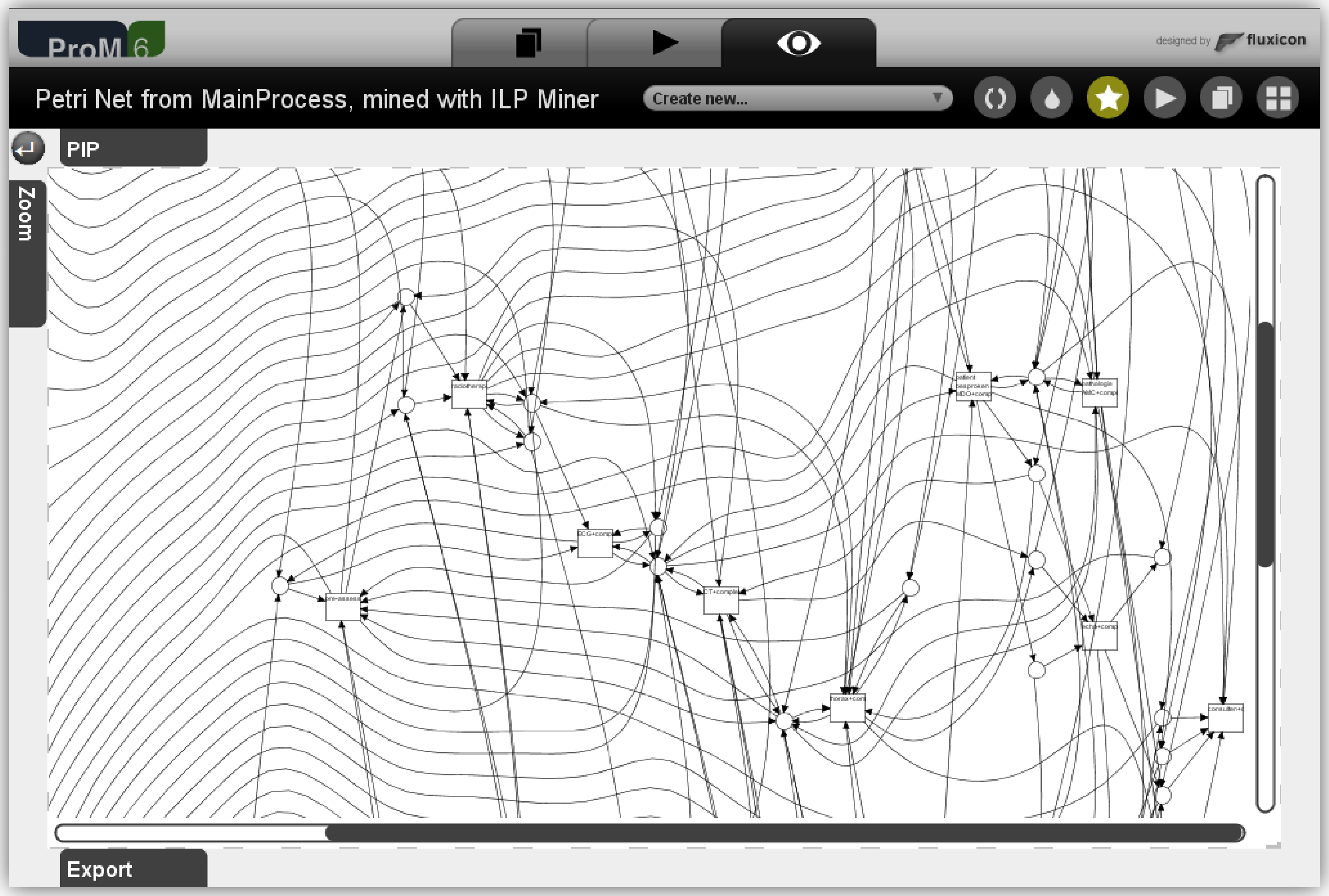
fold

- folding may merge implied and non-implied places
- remove *p*: simpler model,
  more behavior (generalization)
- **let user decide**

Configurable Simplification

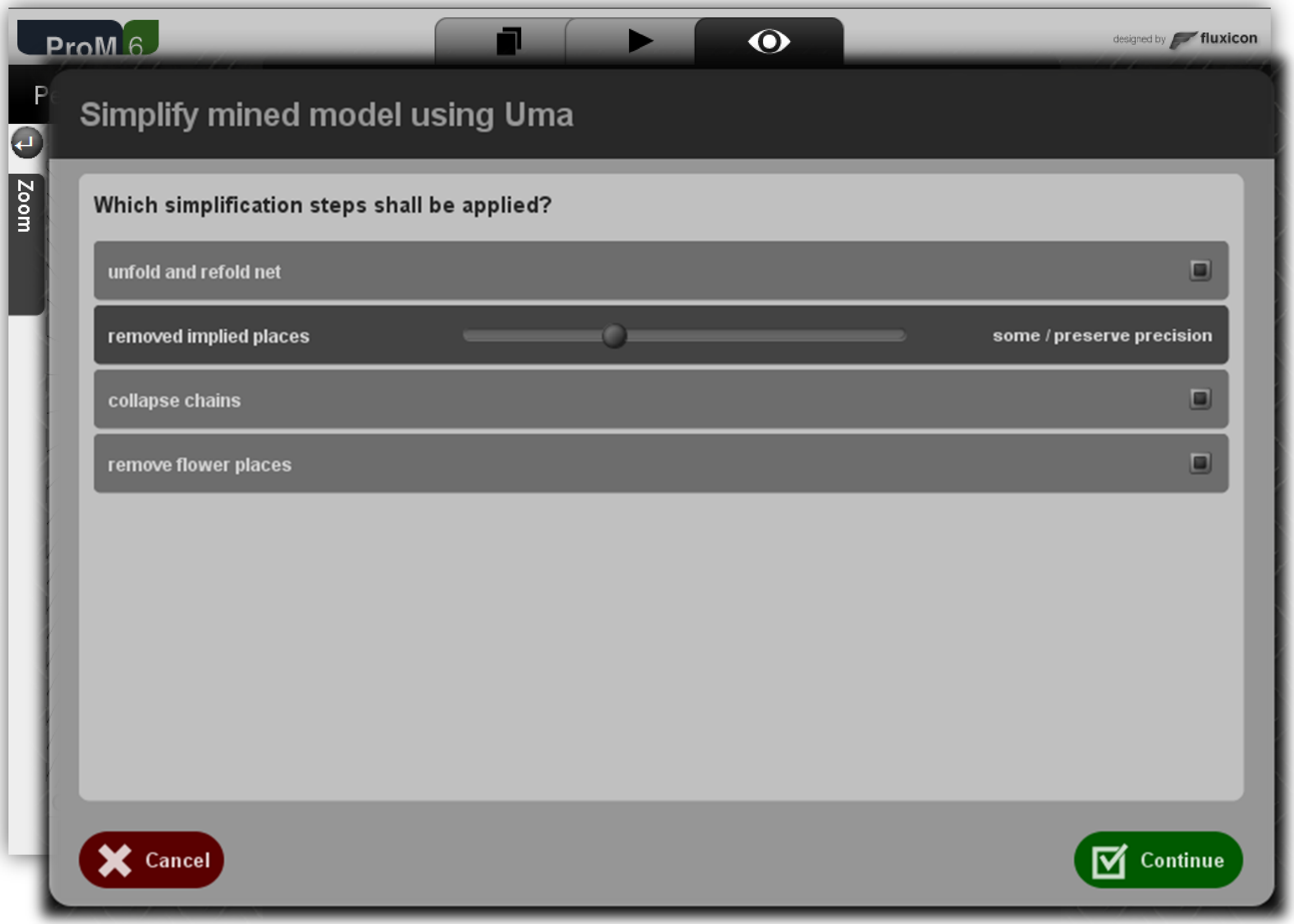


ProM6 / Uma > www.processmining.org



Petri Net from MainProcess, mined with ILP Miner

ProM6 / Uma > www.processmining.org

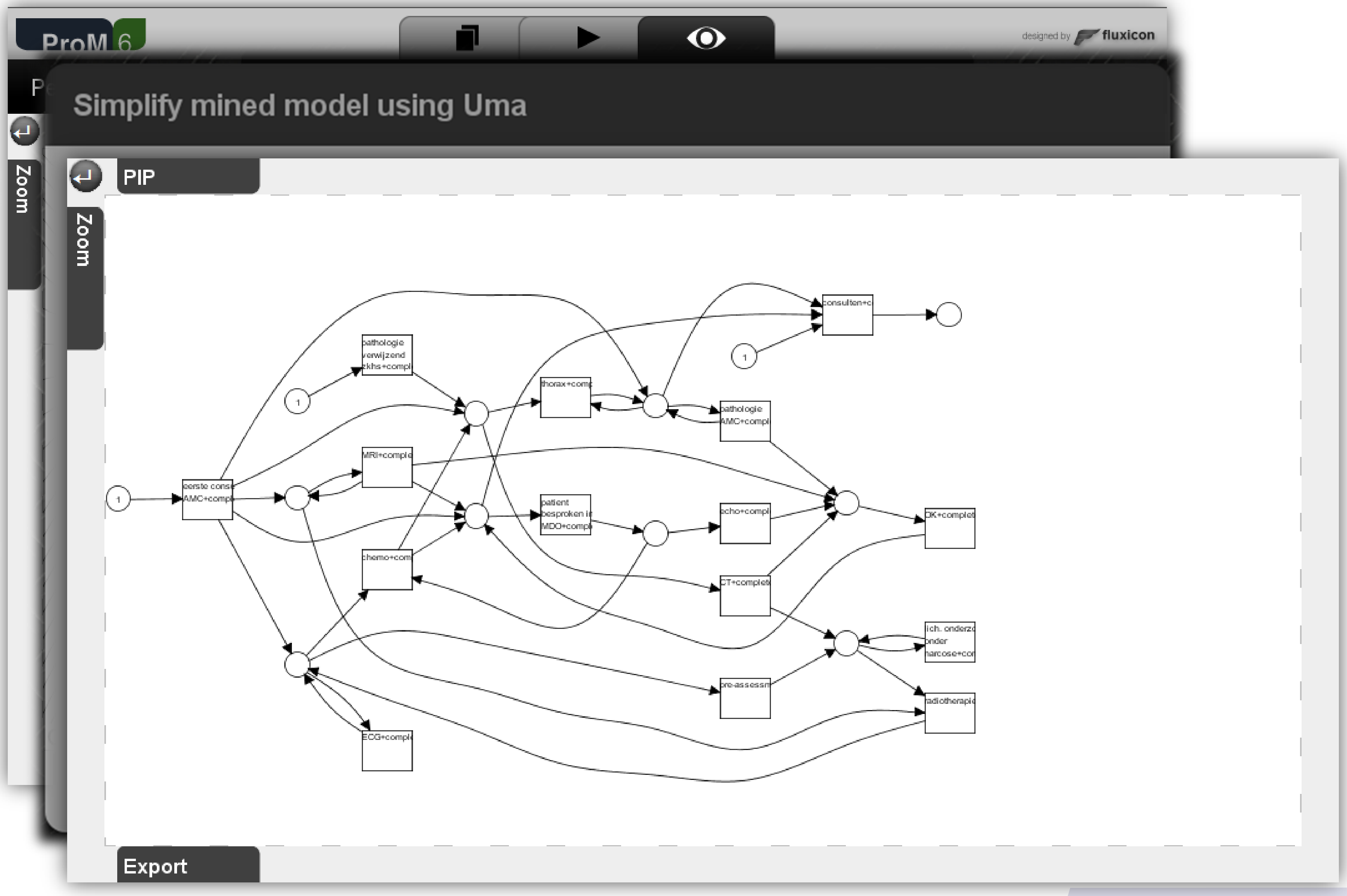


Simplify mined model using Uma

Which simplification steps shall be applied?

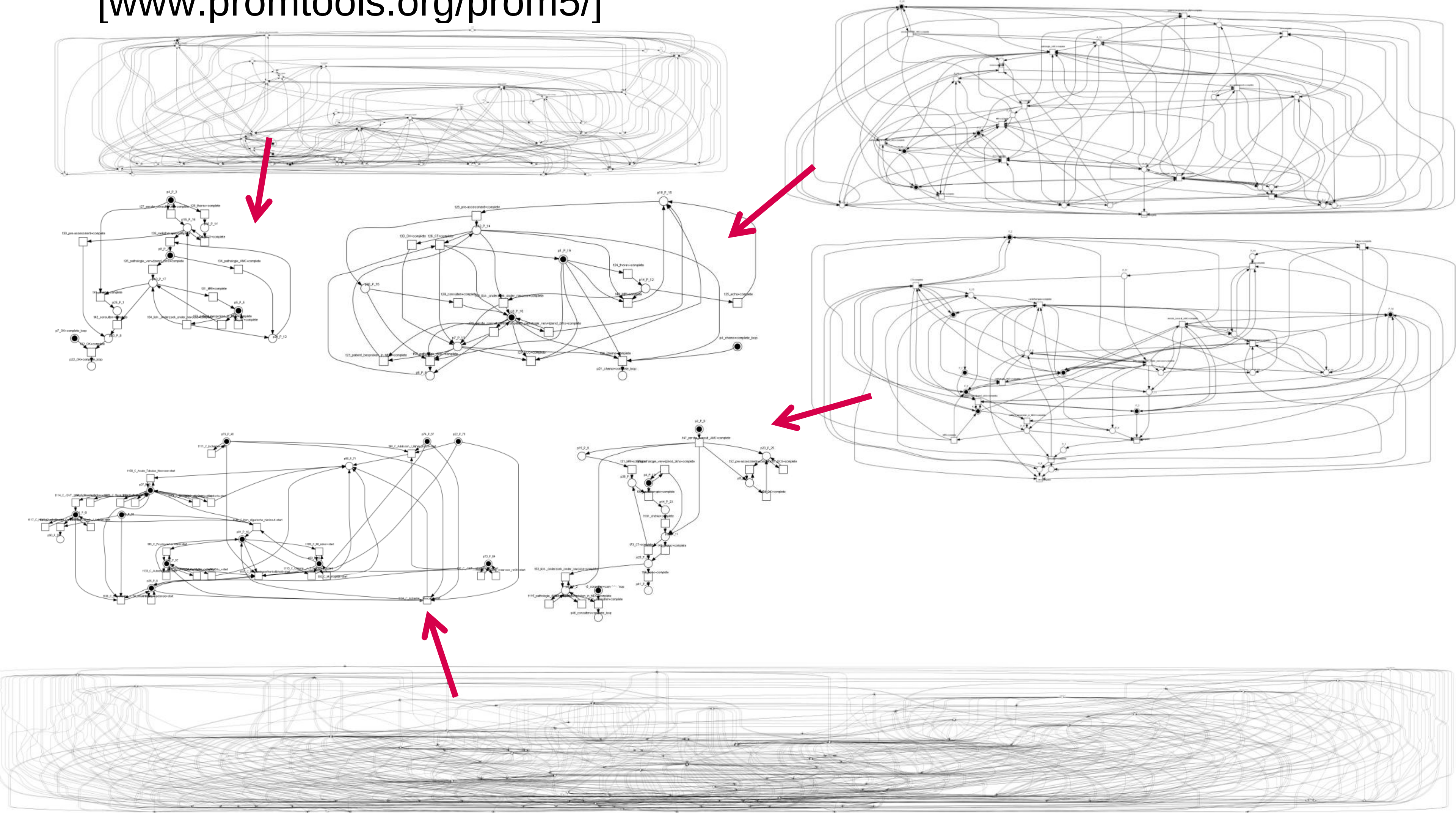
- unfold and refold net □
- removed implied places — some / preserve precision
- collapse chains □
- remove flower places □

ProM6 / Uma > www.processmining.org



Experimental Results

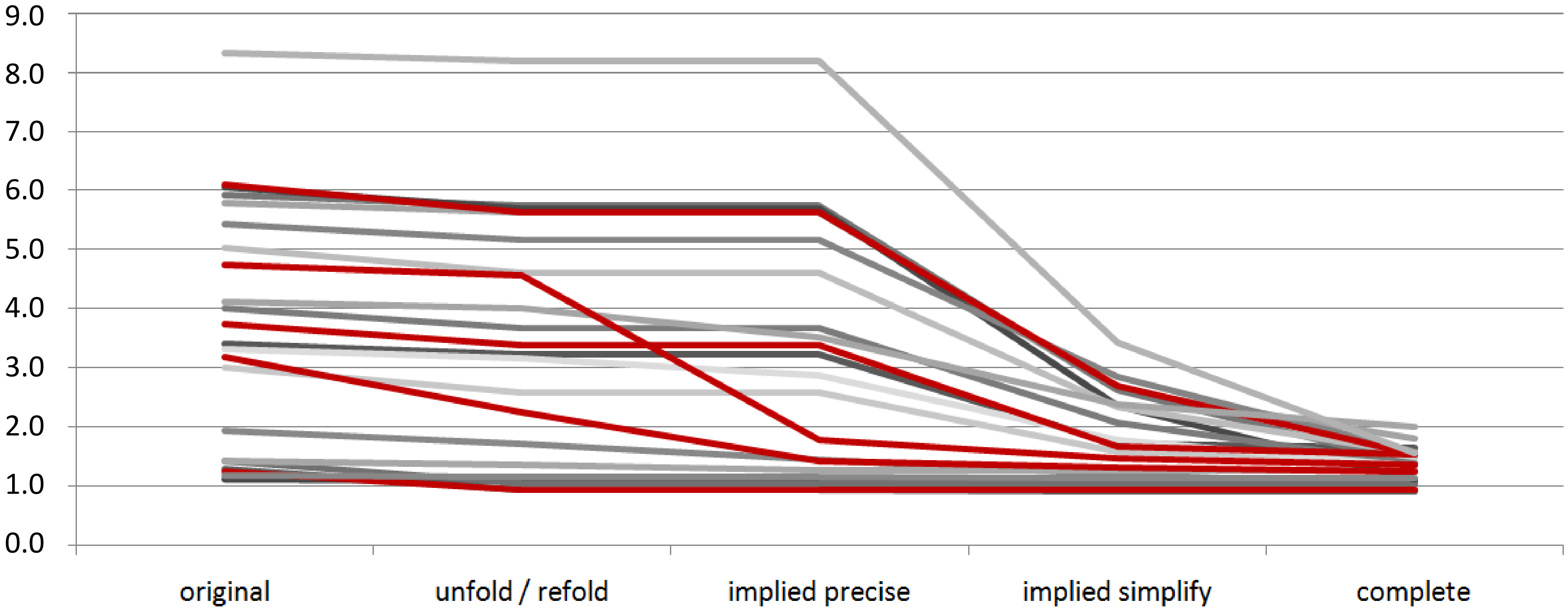
- 15 benchmark logs, 6 industrial logs
  [www.promtools.org/prom5/]



Experimental Results

- 15 benchmark logs, 6 industrial logs
  [www.promtools.org/prom5/]

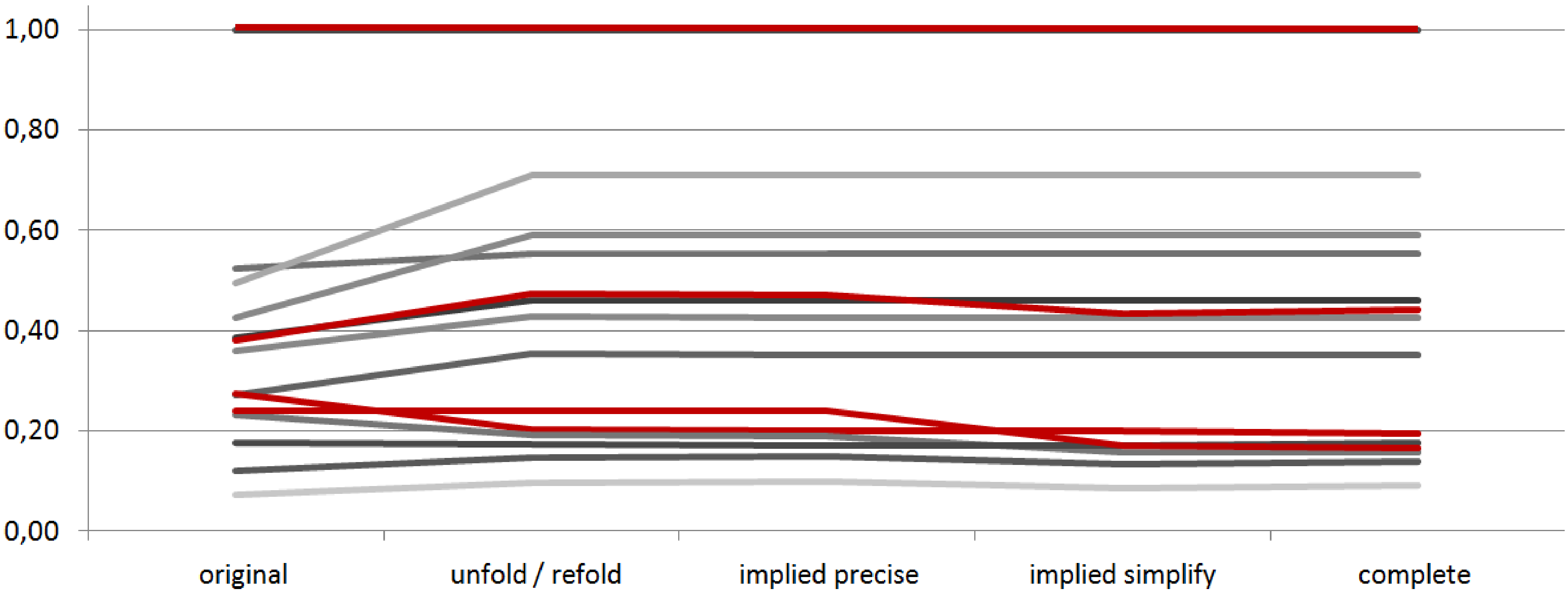
model complexity = #arcs / #nodes



time < 1 sec for industrial logs

Experimental Results

- **precision:** traces allowed by model and not in log
- 1.0 = only log behavior allowed



- rises/falls **within limits** (can be controlled)

from
spaghetti

to
lasagna?

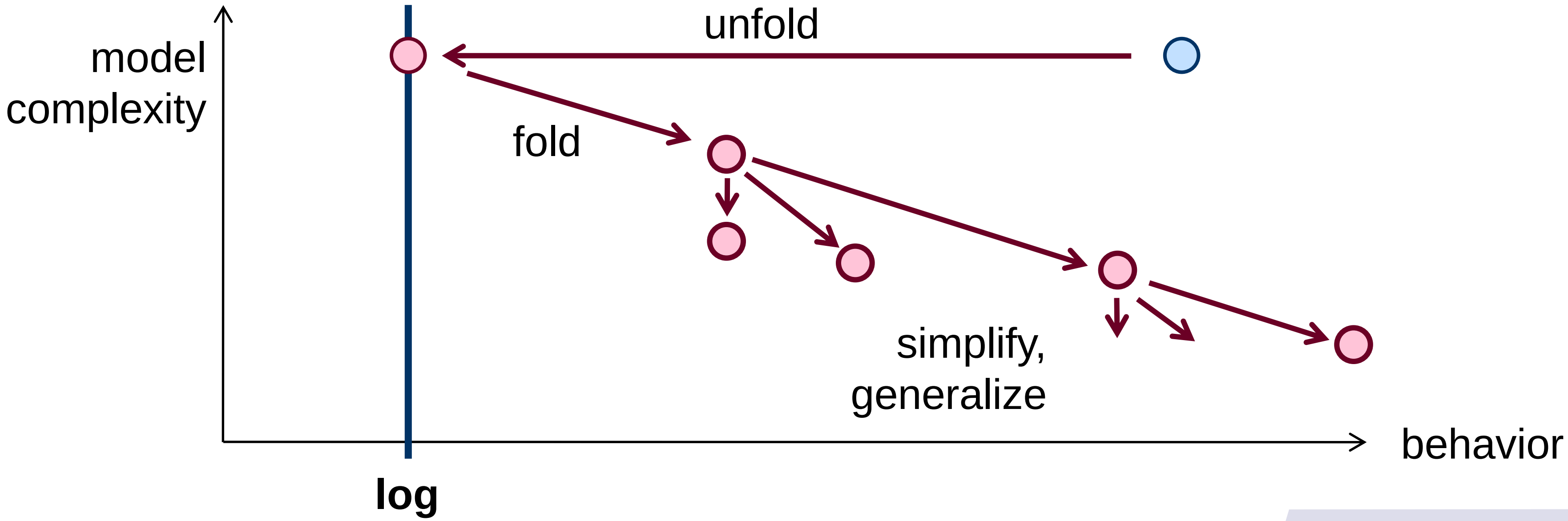
Genuss aus Bayern
Mit bestem Hartweizen und frischen Eiern aus kontrollierter Bodenhaltung
1898
Spaghetti
Bermbacher
Guten
Feine Frischei-Nudeln

from **spaghetti**

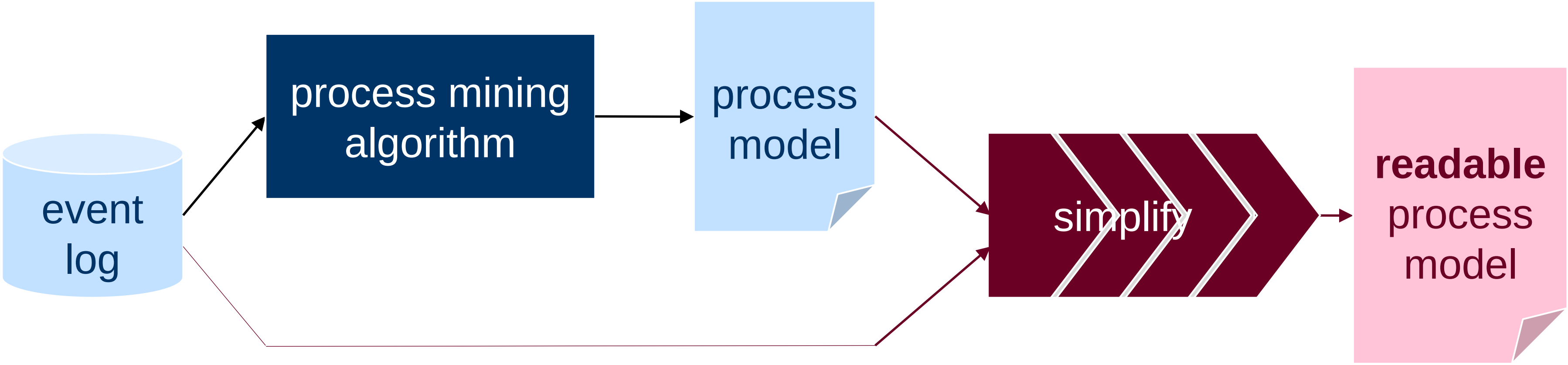
to **less complex spaghetti**

Lessons Learned

- techniques to navigate the **model/behavior space**
- use **model and log together**
- use **model unfoldings**
- break a rule and see what happens



And next?



- **process views**
most simple model covering 80% of the log

- **improve mining algorithms?**
we showed: there is room for improvement

Dirk **Fahland**

about.me/**dirk.fahland**

Simplifying Mined Process Models

Technische Universiteit **Eindhoven** University of Technology

Where innovation starts