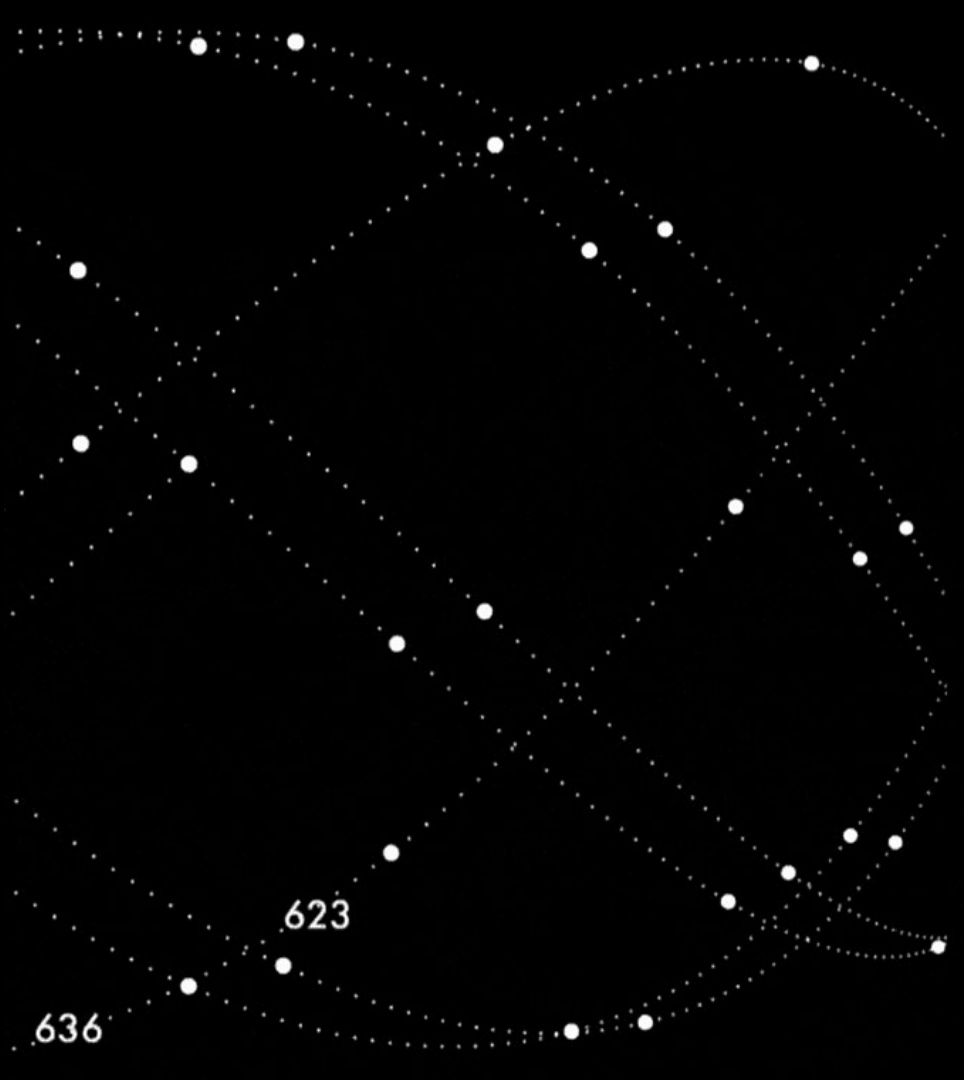
Query Explore Understand

Human-in-the-Loop Process Mining with Cortado and OCPQ

prof.dr.ir. Wil van der Aalst
professor at RWTH Aachen University &
chief scientist at Celonis



Chair of Process and Data Science

RWTH AACHEN UNIVERSITY

Current PhDs & Postdocs PADS (The keywords do not do justice to the work done!)

Wissenschaftlicher Mitarbeiter
Harry Beyel M.Sc.

Lucency and RPA

Wissenschaftlicher Mitarbeiter
Tobias Brockhoff M.Sc.

Comp. PM EMD

Wissenschaftliche Mitarbeiterin
Nina Graves M.Sc.

Quantity OCPM

Wissenschaftlicher Mitarbeiter
Tsung-Hao Huang M.Sc.

FCN PM

Wissenschaftlicher Mitarbeiter
Benedikt Knopp M.Sc.

OC-Simulation

Wissenschaftlicher Mitarbeiter
Dr. rer. nat. **István Koren**

IoP – Data Eng.

Wissenschaftlicher Mitarbeiter
Aaron Küsters M.Sc.

OC querying

Wissenschaftliche Mitarbeiterin
Chiao-Yun Li M.Sc.

Abstractions

Wissenschaftlicher Mitarbeiter
Lukas Liß M.Sc.

Novel OCPM

Wissenschaftliche Mitarbeiterin
Lisa Mannel M.Sc.

Discovery

Wissenschaftlicher Mitarbeiter
Ali Norouzifar M.Sc.

L+ L-

Wissenschaftliche Mitarbeiterin
Viki Peeva M.Sc.

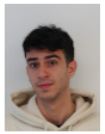
PMS

Wissenschaftlicher Mitarbeiter
Marco Pegoraro M.Sc.

Uncertainty

Wissenschaftlicher Mitarbeiter
Christian Rennert M.Sc.

Federated PM



Wissenschaftlicher Mitarbeiter
Eduardo Goulart Rocha M.Sc.

Scalable PM

Wissenschaftlicher Mitarbeiter
Christopher Schwanen M.Sc.

Opt. and Conf.

Wissenschaftliche Mitarbeiterin
Leah Tacke genannt Unterberg M.Sc.

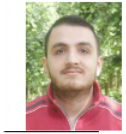
MitM – Time series

Softwareentwickler
Alessandro Berti M.Sc.

OCPM LLM

Wissenschaftlicher Mitarbeiter
Gyunam Park Dr. rer. nat.

Action-Oriented PM



Wissenschaftlicher Mitarbeiter - Fraunhofer FIT
Humam Kourani M.Sc.

POWL

PhD Student
Dina Kretzschmann M.Sc.

Log. PM Fressnapf

Sicherheitsbeauftragte
Ebi Bebi Dr. Wuff

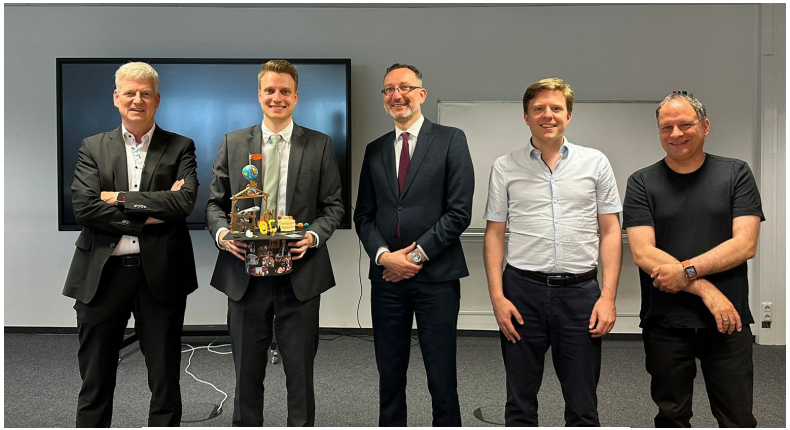
Management

New PhDs:

- Cameron Pitsch
- Rudo Mtengwa

Last PhD at TU/e as first promotor (Jan 2025)

Two recent PADS PhD theses worth reading



Object-Centric Process Mining
Concepts and Advancements

Der Fakultät für Mathematik, Informatik und Naturwissenschaften der RWTH Aachen University vorgelegte Dissertation zur Erlangung des akademischen Grades eines Doktors der Naturwissenschaften von

Jan Niklas Adams, M. Sc.
aus Aachen

Incremental Process Discovery

Der Fakultät für Mathematik, Informatik und Naturwissenschaften der RWTH Aachen University vorgelegte Dissertation zur Erlangung des akademischen Grades eines Doktors der Naturwissenschaften von

Daniel Schuster, M. Sc.
aus Kassel

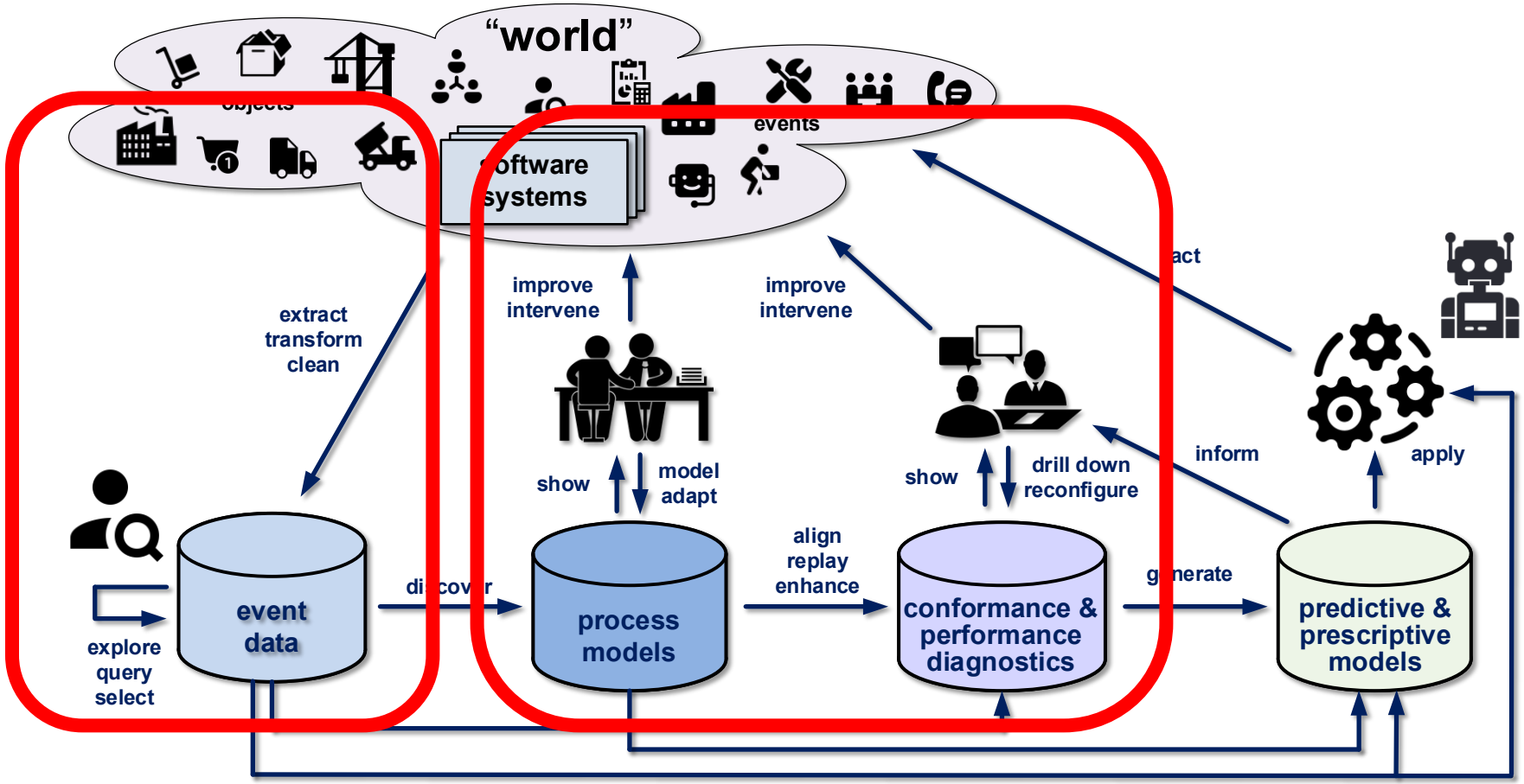
ICPM 2024
6th International Conference on Process Mining
October 14-18, 2024, Kgs. Lyngby, Denmark

Presents the
Best PhD Thesis
to
Daniel Schuster
for the thesis entitled
Incremental Process Discovery

IEEE

Query, Explore, Understand, Interact, Use Knowledge, …

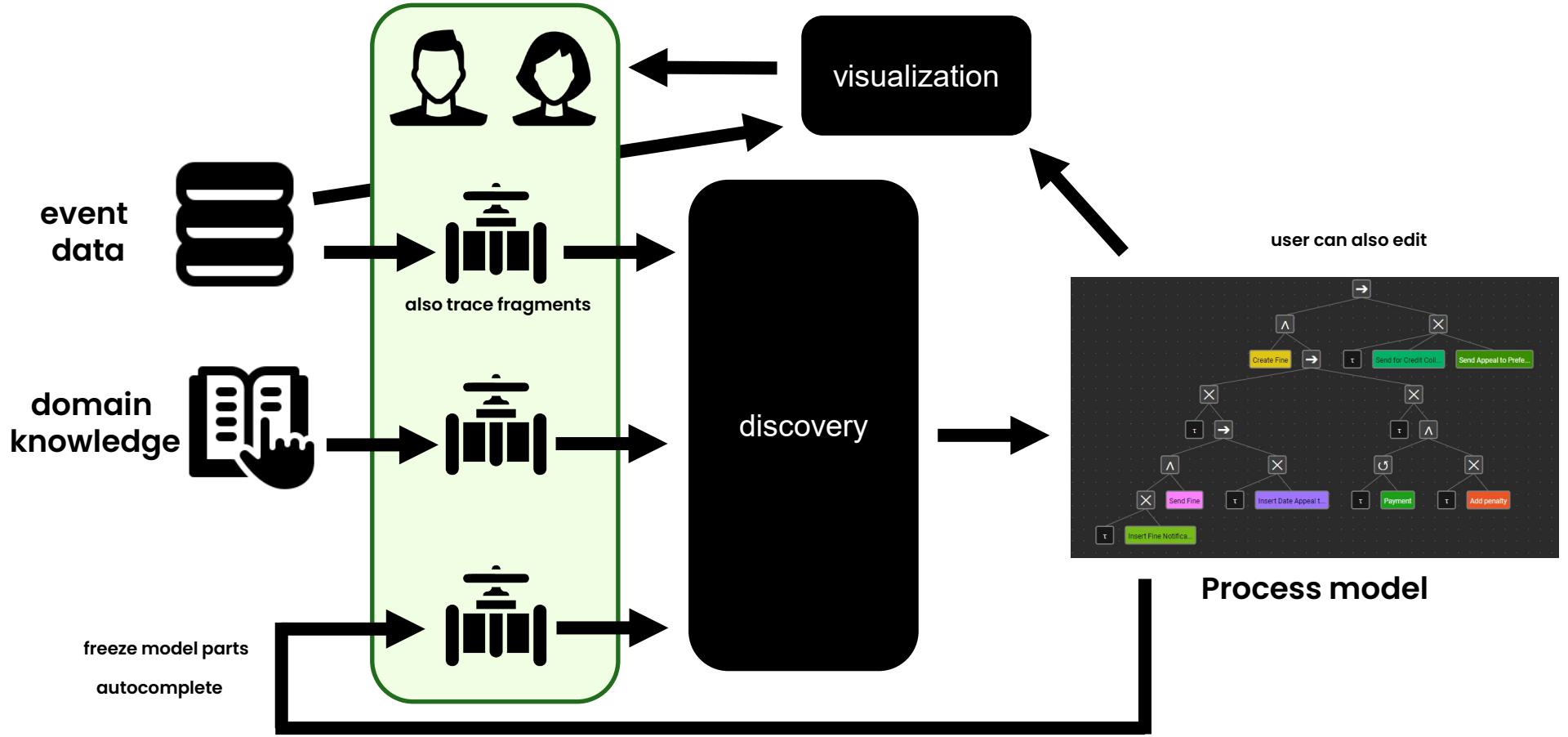
Human-in-the-loop: Query, Explore, Understand, Interact, Use Knowledge, …



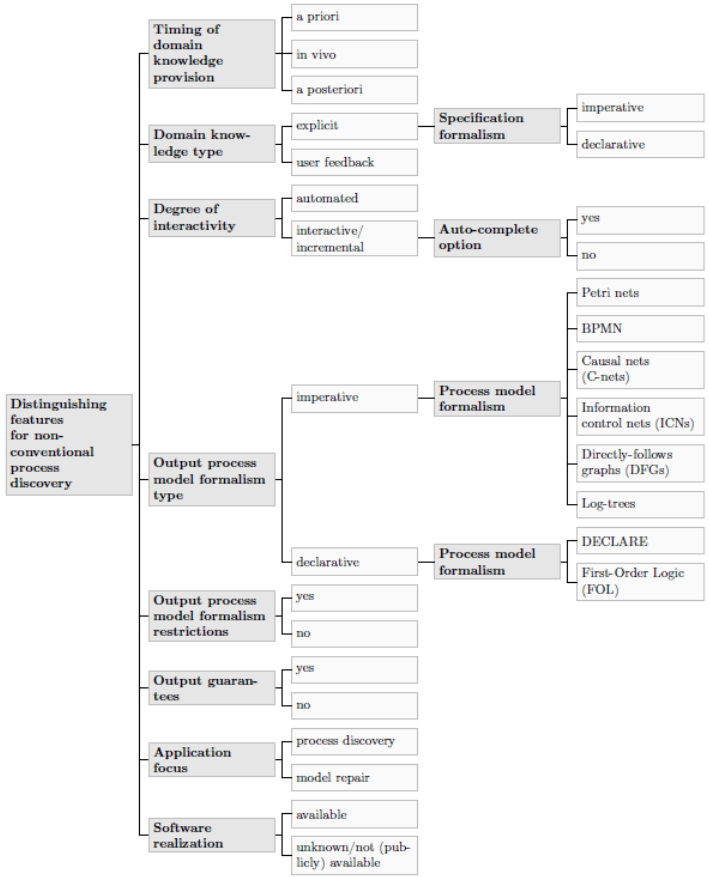
Cortado

Thanks to Daniel Schuster

User Guided & Incremental



Related approaches (most related is the work of Alok Dixit using FCN)



Distinguishing feature (1st level) **Distinguishing feature** (2nd level)	**Characteristic**	**Number of Approaches****
Timing of domain knowledge*	a priori	9 (75%)
	in vivo	6 (50%)
	a posteriori	1 (8%)
Domain knowledge type*	explicit	11 (92%)
Specification formalism	imperative	6 (55%)
	declarative	5 (45%)
	user feedback	4 (33%)
Degree of interactivity	automated	5 (42%)
	interactive/incremental	7 (58%)
Auto-complete option	yes	5 (71%)
	no	2 (29%)
Output process model formalism	imperative	10 (83%)
Process model formalism	Petri nets	4 (40%)
	BPMN	1 (10%)
	Causal nets (C-nets)	1 (10%)
	Information control nets	1 (10%)
	Directly follows graphs	2 (20%)
	Log-trees	1 (10%)
	declarative	2 (17%)
Process model formalism	DECLARE	1 (50%)
	FOL	1 (50%)
Output process model formalism restrictions	yes	3 (25%)
	no	9 (75%)
Output guarantees	yes	7 (58%)
	no	5 (42%)
Application focus	process discovery	10 (83%)
	model repair	2 (17%)
Software realization	available	7 (58%)
	unknown/not (publicly) available	5 (42%)

Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling

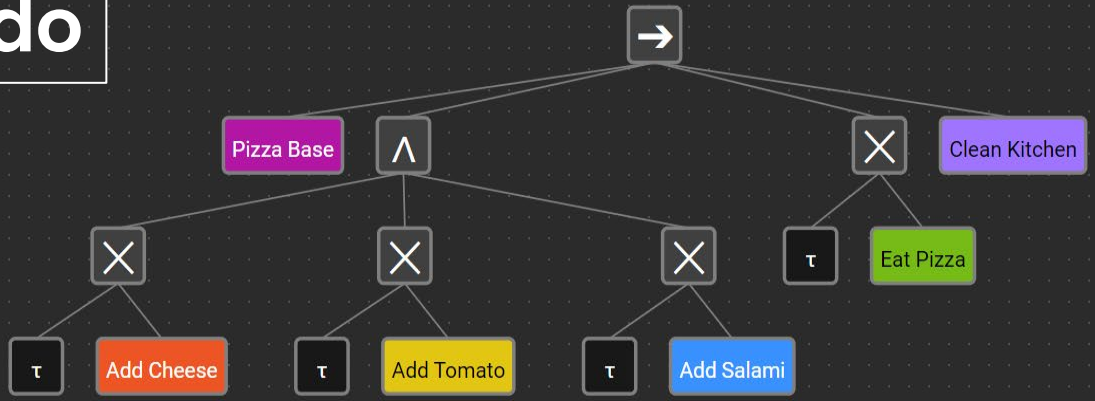
Files Settings Editors Documentation

(10) clear selection (un)freeze subtrees

shift selected node(s) to right

Process Tree Editor

Cortado



syntax correct

Expert Mode

Variant Explorer

conformance check | add variant(s) to model | discover initial model

No.	Info	Sub-Variants	Variant (16)
1.	24.7% (494)	1	Pi.. Ad.. Ad.. Cl..
2.	14.1% (282)	1	Pi.. Ad.. Cl..
3.	8.7% (174)	1	Pi.. Ad.. Ad.. Cl..
4.	8.3% (166)	1	Pi.. Ad.. Cl..
5.	7% (140)	1	Pi.. Ad.. Ad.. Ad.. Ea.. Cl..
6.	7% (140)	1	Pi.. Ad.. Ad.. Ad.. Ea.. Cl..

Filter

fitting traces: 2,000 / 2,000 (100.0%) fitting variants: 16 / 16 (100.0%) selected variants: 15

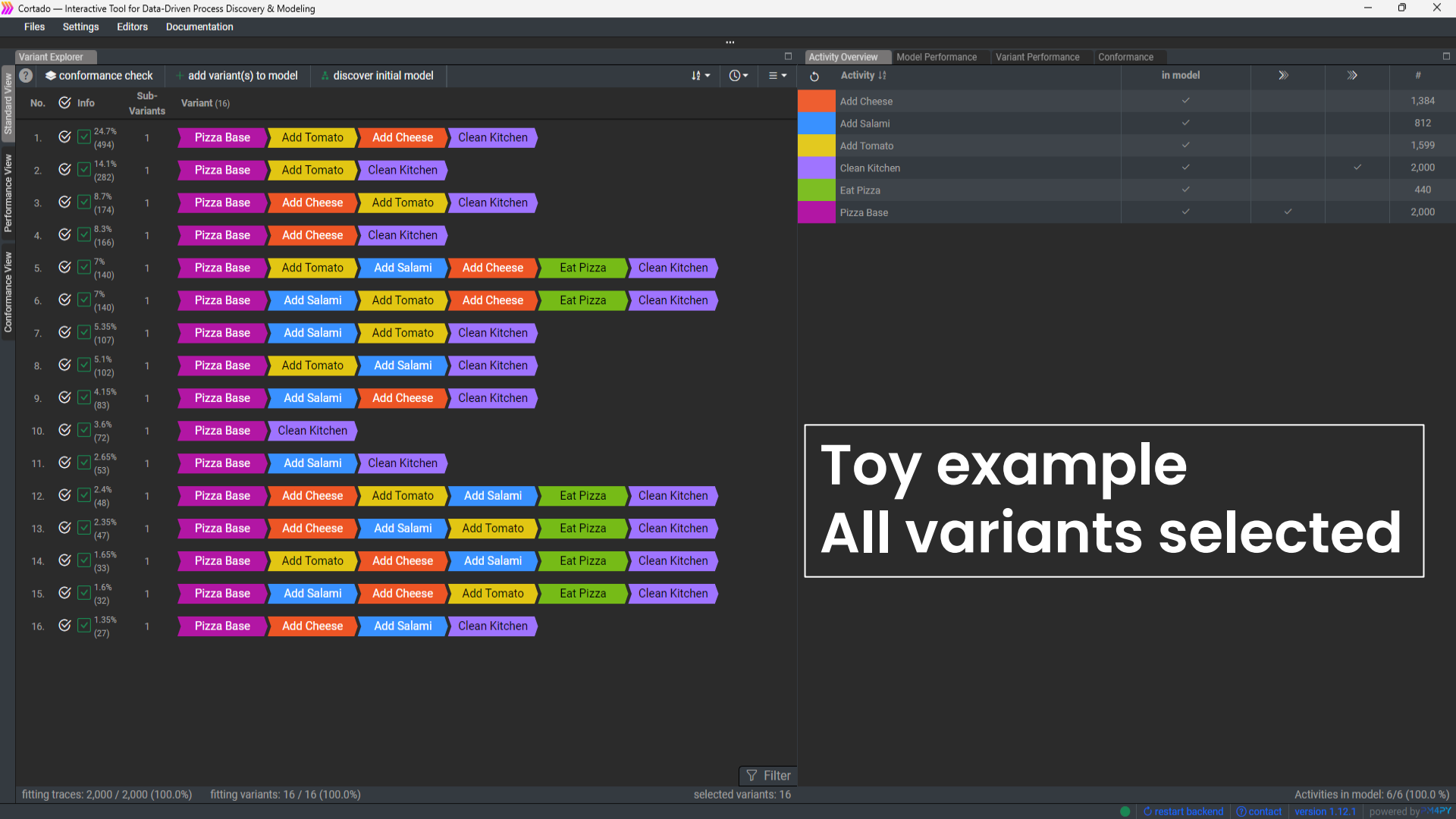
Activity Overview | Model Performance | Variant Performance | Conformance

Activity	in model			#
Add Cheese	✓			1,384
Add Salami	✓			812
Add Tomato	✓			1,599
Clean Kitchen	✓		✓	2,000
Eat Pizza	✓			440
Pizza Base	✓	✓		2,000

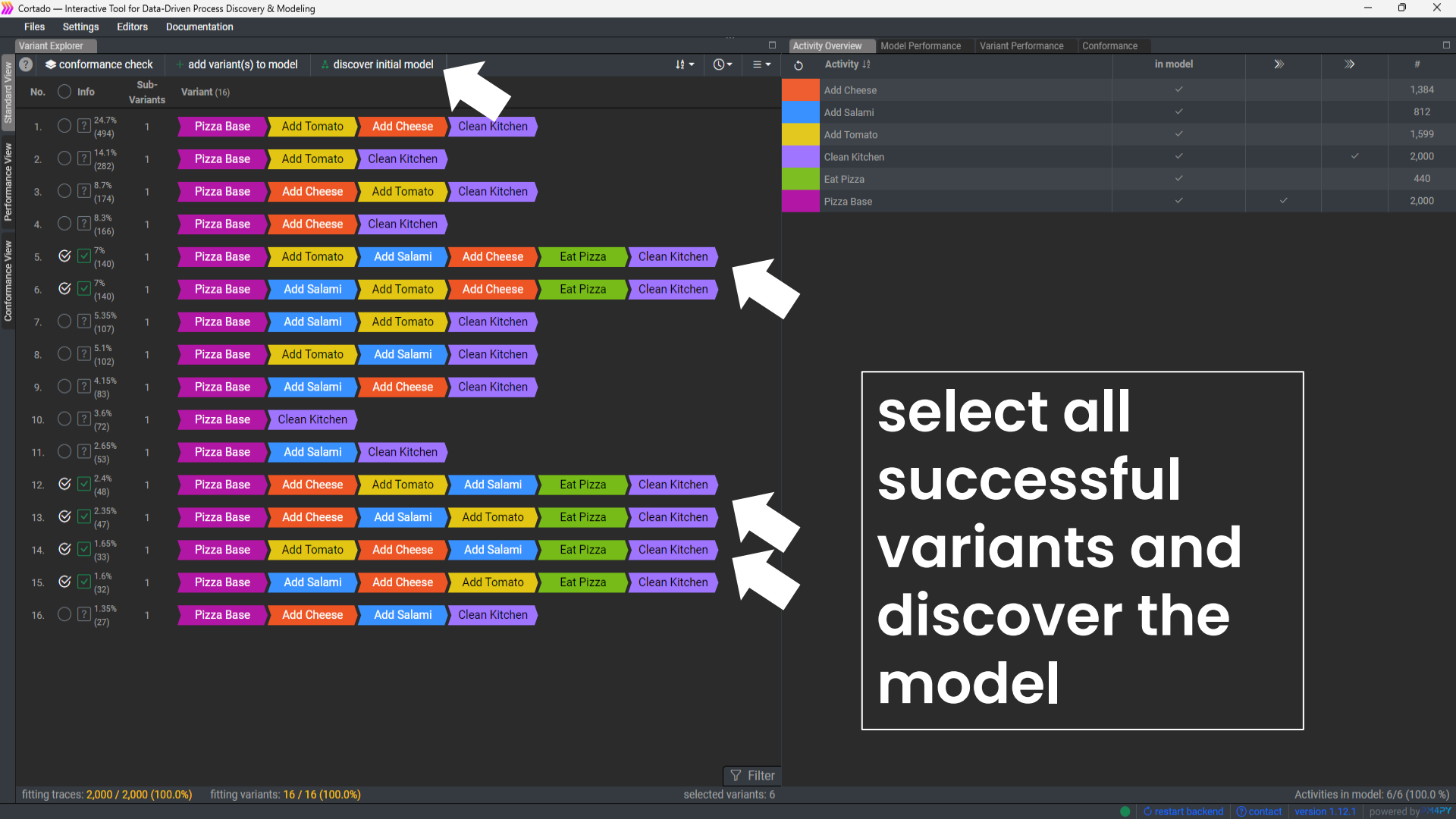
Activities in model: 6/6 (100.0 %)

Standard View | Performance View | Conformance View

restart backend | contact | version 1.12.1 | powered by pm4py



Toy example
All variants selected

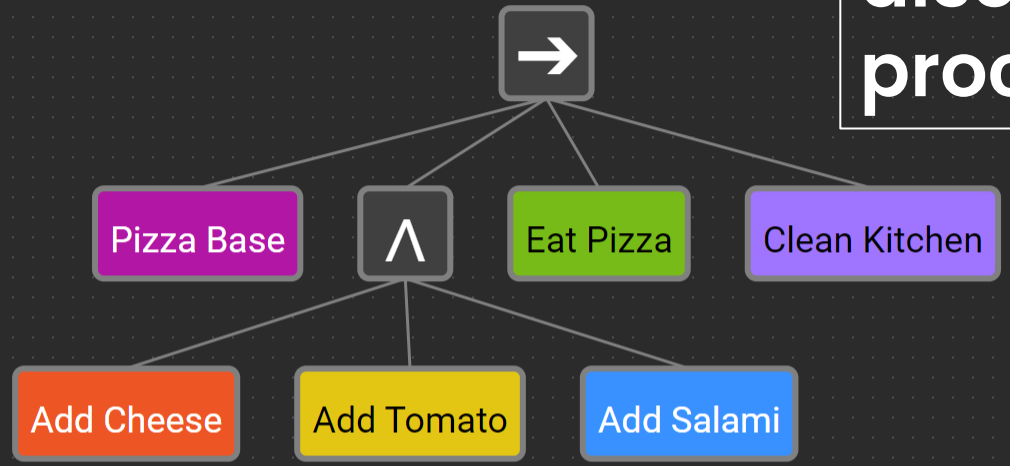

Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
Variant Explorer
Activity Overview
Model Performance
Variant Performance
Conformance
Standard View
Performance View
Conformance View
conformance check
add variant(s) to model
discover initial model
No.
Info
Sub-Variants
Variant (16)
1. 24.7% (494) 1 Pizza Base Add Tomato Add Cheese Clean Kitchen
2. 14.1% (282) 1 Pizza Base Add Tomato Clean Kitchen
3. 8.7% (174) 1 Pizza Base Add Cheese Add Tomato Clean Kitchen
4. 8.3% (166) 1 Pizza Base Add Cheese Clean Kitchen
5. 7% (140) 1 Pizza Base Add Tomato Add Salami Add Cheese Eat Pizza Clean Kitchen
6. 7% (140) 1 Pizza Base Add Salami Add Tomato Add Cheese Eat Pizza Clean Kitchen
7. 5.35% (107) 1 Pizza Base Add Salami Add Tomato Clean Kitchen
8. 5.1% (102) 1 Pizza Base Add Tomato Add Salami Clean Kitchen
9. 4.15% (83) 1 Pizza Base Add Salami Add Cheese Clean Kitchen
10. 3.6% (72) 1 Pizza Base Clean Kitchen
11. 2.65% (53) 1 Pizza Base Add Salami Clean Kitchen
12. 2.4% (48) 1 Pizza Base Add Cheese Add Tomato Add Salami Eat Pizza Clean Kitchen
13. 2.35% (47) 1 Pizza Base Add Cheese Add Salami Add Tomato Eat Pizza Clean Kitchen
14. 1.65% (33) 1 Pizza Base Add Tomato Add Cheese Add Salami Eat Pizza Clean Kitchen
15. 1.6% (32) 1 Pizza Base Add Salami Add Cheese Add Tomato Eat Pizza Clean Kitchen
16. 1.35% (27) 1 Pizza Base Add Cheese Add Salami Clean Kitchen
Activity
in model
#
Add Cheese 1,384
Add Salami 812
Add Tomato 1,599
Clean Kitchen 2,000
Eat Pizza 440
Pizza Base 2,000
Filter
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 6
Activities in model: 6/6 (100.0 %)
restart backend
contact
version 1.12.1
powered by
select all successful variants and discover the model

Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling

Files Settings Editors Documentation

shift selected node(s) to left

discovered process tree



syntax correct

Expert Mode

Variant Explorer

conformance check | add variant(s) to model | discover initial model

No.	Info	Sub-Variants	Variant (16)
1.	24.7% (494)	1	Pizza Base → Add Tomato → Add Cheese → Clean Kitchen
2.	14.1% (282)	1	Pizza Base → Add Tomato → Clean Kitchen
3.	8.7% (174)	1	Pizza Base → Add Cheese → Add Tomato → Clean Kitchen
4.	8.3% (166)	1	Pizza Base → Add Cheese → Clean Kitchen
5.	7% (140)	1	Pizza Base → Add Tomato → Add Salami → Add Cheese → Eat Pizza → Clean Kitchen
6.	7% (140)	1	Pizza Base → Add Salami → Add Tomato → Add Cheese → Eat Pizza → Clean Kitchen
	5.35%		

Filter

Activity Overview | Model Performance | Variant Performance | Conformance

Activity	in model			#
Add Cheese	✓			1,384
Add Salami	✓			812
Add Tomato	✓			1,599
Clean Kitchen	✓		✓	2,000
Eat Pizza	✓			440
Pizza Base	✓	✓		2,000

fitting traces: 2,000 / 2,000 (100.0%) fitting variants: 16 / 16 (100.0%) selected variants: 6 Activities in model: 6/6 (100.0 %)

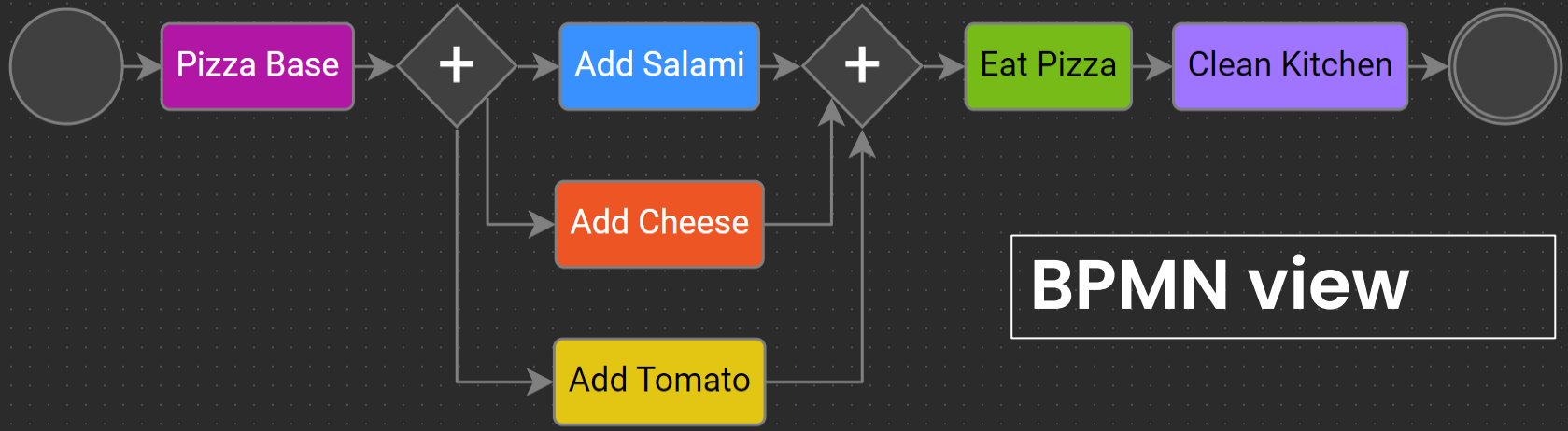
restart backend | contact | version 1.12.1 | powered by PM4PY

Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling

Files Settings Editors Documentation

(11) clear selection (un)freeze subtrees

(un)freeze *entire* subtree to prevent them from being changed when adding variants



Process Tree Editor | BPMN Editor

Variant Explorer

conformance check | add variant(s) to model | discover initial model

No.	Info	Sub-Variants	Variant (16)
1.	24.7% (494)	1	Pizza Base → Add Tomato → Add Cheese → Clean Kitchen
2.	14.1% (282)	1	Pizza Base → Add Tomato → Clean Kitchen
3.	8.7% (174)	1	Pizza Base → Add Cheese → Add Tomato → Clean Kitchen
4.	8.3% (166)	1	Pizza Base → Add Cheese → Clean Kitchen
5.	7% (140)	1	Pizza Base → Add Tomato → Add Salami → Add Cheese → Eat Pizza → Clean Kitchen
6.	7% (140)	1	Pizza Base → Add Salami → Add Tomato → Add Cheese → Eat Pizza → Clean Kitchen
	5.35%		

Filter

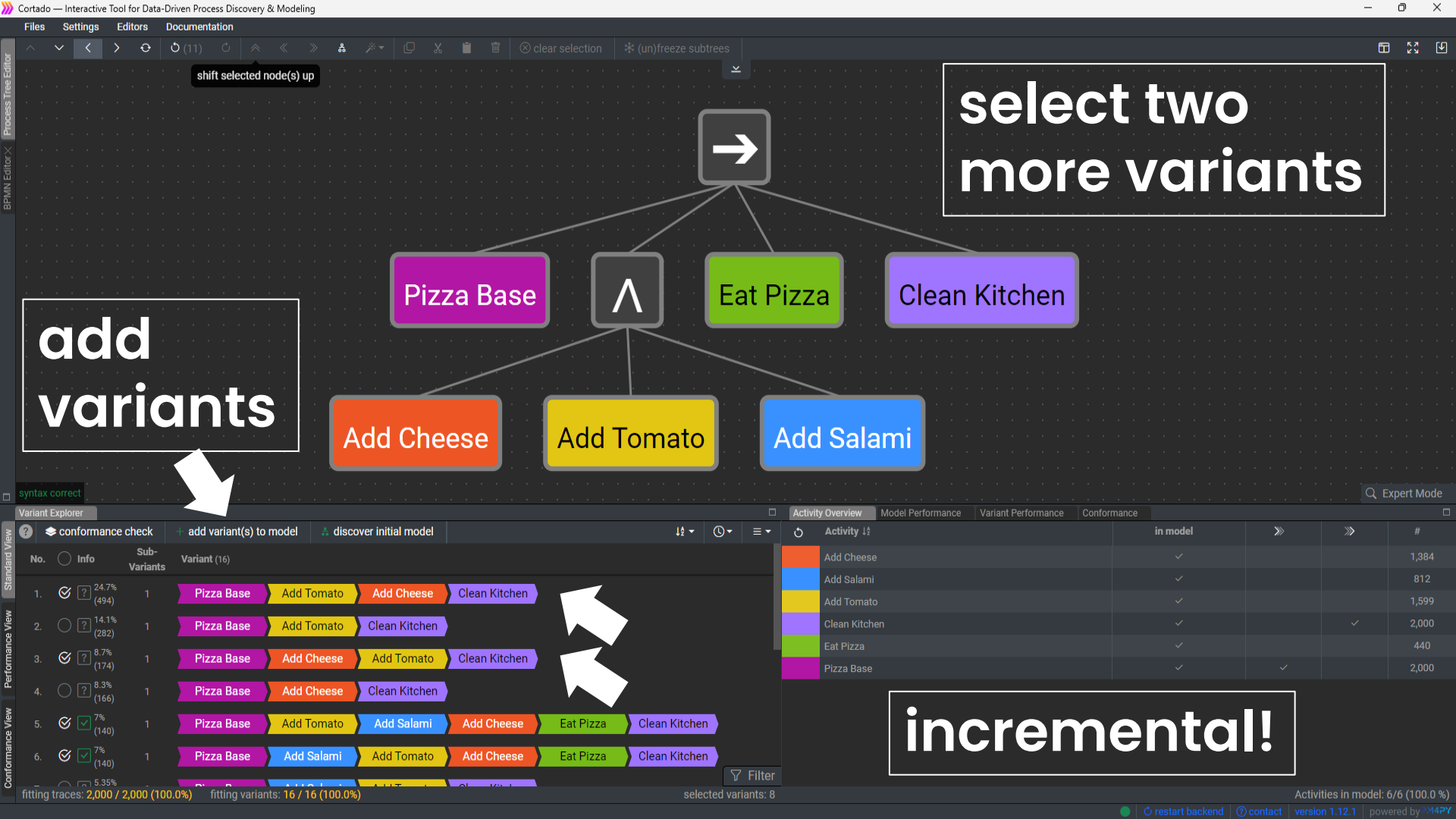
Activity Overview | Model Performance | Variant Performance | Conformance

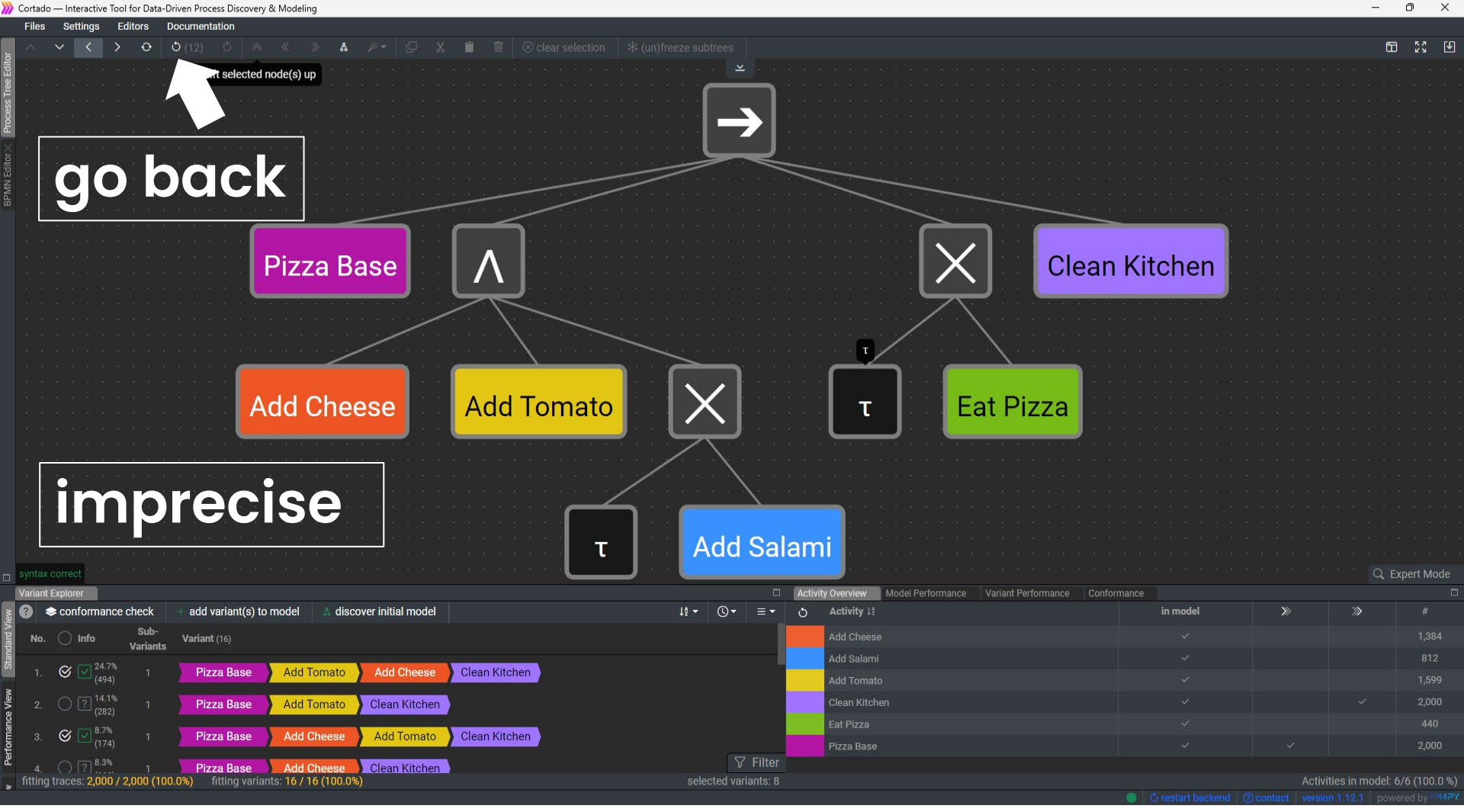
Activity	in model			#
Add Cheese	✓			1,384
Add Salami	✓			812
Add Tomato	✓			1,599
Clean Kitchen	✓		✓	2,000
Eat Pizza	✓			440
Pizza Base	✓	✓		2,000

Standard View | Performance View | Conformance View

fitting traces: 2,000 / 2,000 (100.0%) fitting variants: 16 / 16 (100.0%) selected variants: 6 Activities in model: 6/6 (100.0 %)

restart backend | contact | version 1.12.1 | powered by PM4PY


Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
shift selected node(s) up
clear selection
(un)freeze subtrees
Process Tree Editor
BPMN Editor
select two more variants
Pizza Base
Eat Pizza
Clean Kitchen
add variants
Add Cheese
Add Tomato
Add Salami
syntax correct
Expert Mode
Variant Explorer
conformance check
add variant(s) to model
discover initial model
No.
Info
Sub-Variants
Variant (16)
1. 24.7% (494) 1 Pizza Base Add Tomato Add Cheese Clean Kitchen
2. 14.1% (282) 1 Pizza Base Add Tomato Clean Kitchen
3. 8.7% (174) 1 Pizza Base Add Cheese Add Tomato Clean Kitchen
4. 8.3% (166) 1 Pizza Base Add Cheese Clean Kitchen
5. 7% (140) 1 Pizza Base Add Tomato Add Salami Add Cheese Eat Pizza Clean Kitchen
6. 7% (140) 1 Pizza Base Add Salami Add Tomato Add Cheese Eat Pizza Clean Kitchen
Filter
Activity Overview
Model Performance
Variant Performance
Conformance
Activity
in model
#
Add Cheese 1,384
Add Salami 812
Add Tomato 1,599
Clean Kitchen 2,000
Eat Pizza 440
Pizza Base 2,000
incremental!
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 8
Activities in model: 6/6 (100.0 %)
restart backend
contact
version 1.12.1


Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
clear selection
(un)freeze subtrees
selected node(s) up
go back
Pizza Base
Clean Kitchen
Add Cheese
Add Tomato
τ
Eat Pizza
τ
Add Salami
imprecise
syntax correct
Expert Mode
Variant Explorer
Activity Overview
Model Performance
Variant Performance
Conformance
conformance check
add variant(s) to model
discover initial model
No.
Info
Sub-Variants
Variant (16)
Activity
in model
#
Add Cheese 1,384
Add Salami 812
Add Tomato 1,599
Clean Kitchen 2,000
Eat Pizza 440
Pizza Base 2,000
Filter
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 8
Activities in model: 6/6 (100.0 %)
restart backend
contact
version 1.12.1

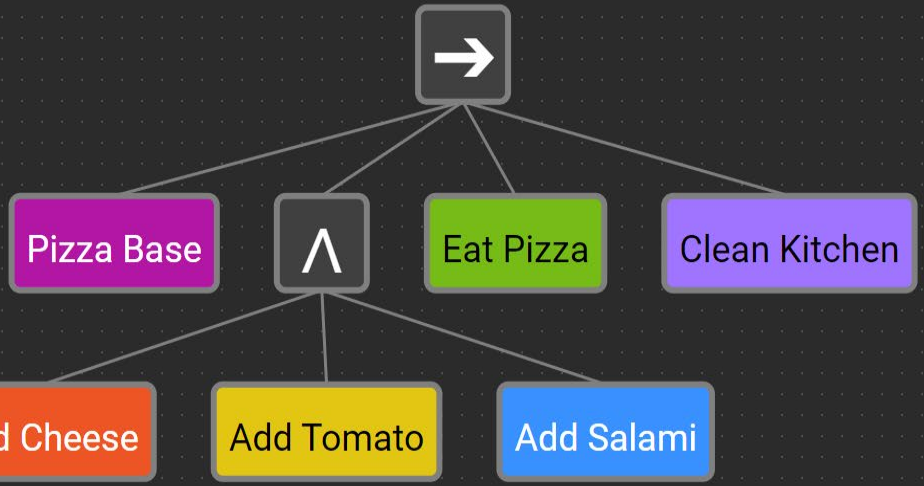
Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling

Files Settings Editors Documentation

(11) (1) clear selection (un)freeze subtrees

shift selected node(s) to left

Process Tree Editor BPMN Editor



syntax correct

Expert Mode

Variant Explorer

conformance check | add variant(s) to model | discover initial model

No.	Info	Sub-Variants	Variant (16)
1.	24.7% (494)	1	Pizza Base → Add Tomato → Add Cheese → Clean Kitchen
2.	14.1% (282)	1	Pizza Base → Add Tomato → Clean Kitchen
3.	8.7% (174)	1	Pizza Base → Add Cheese → Add Tomato → Clean Kitchen
4.	8.3%	1	Pizza Base → Add Cheese → Clean Kitchen

Filter

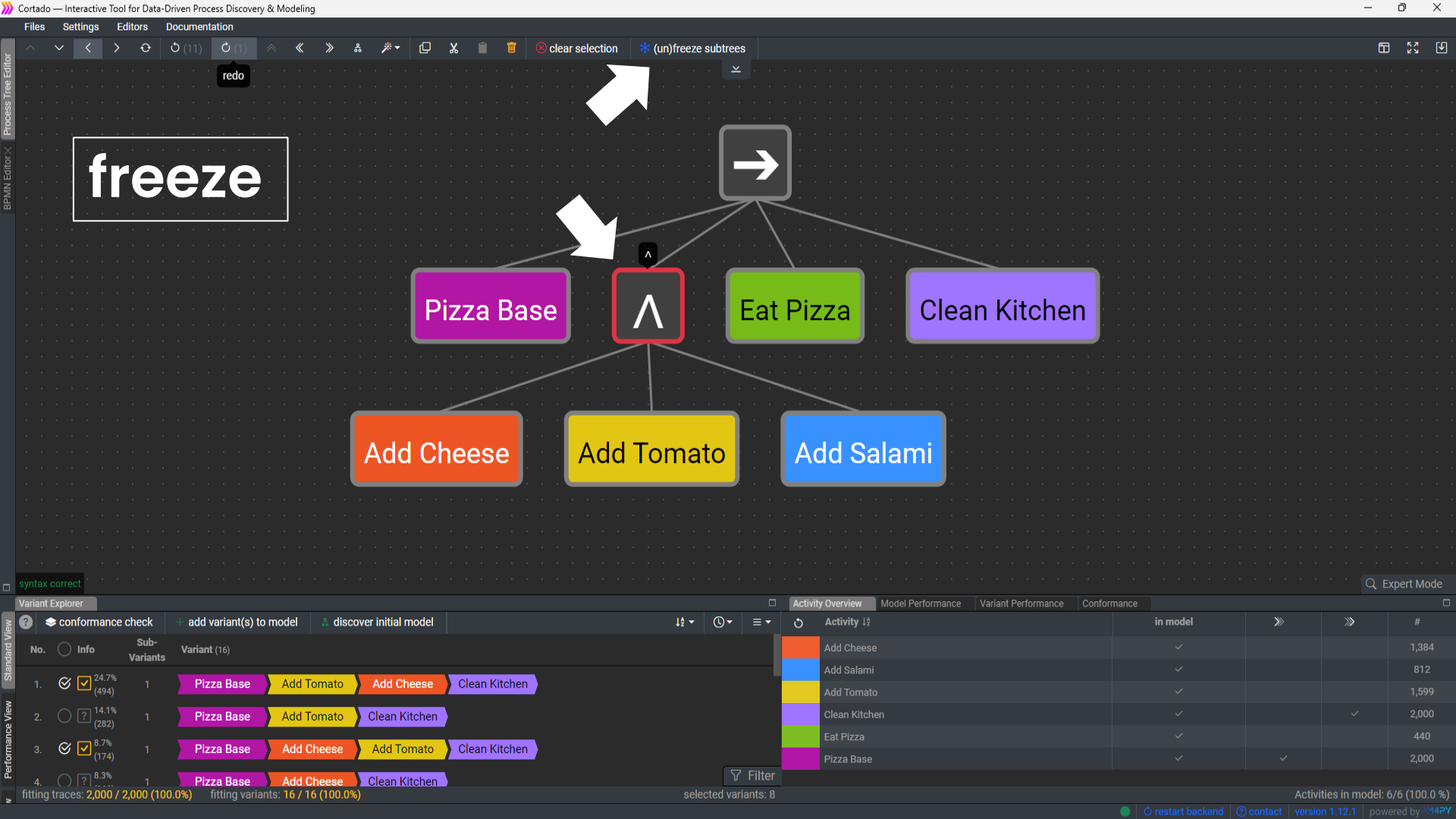
Activity Overview | Model Performance | Variant Performance | Conformance

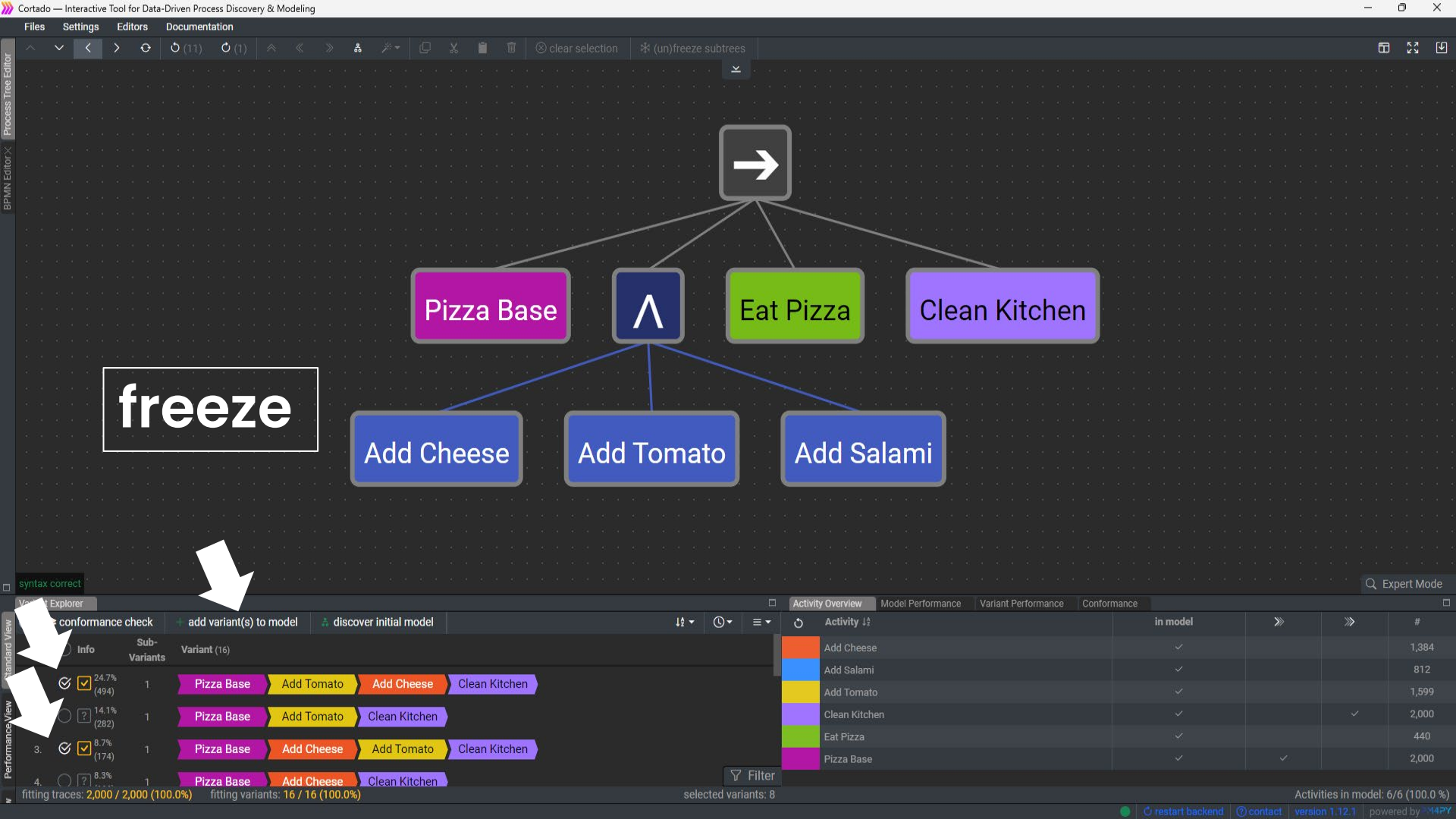
Activity	in model			#
Add Cheese	✓			1,384
Add Salami	✓			812
Add Tomato	✓			1,599
Clean Kitchen	✓		✓	2,000
Eat Pizza	✓			440
Pizza Base	✓	✓		2,000

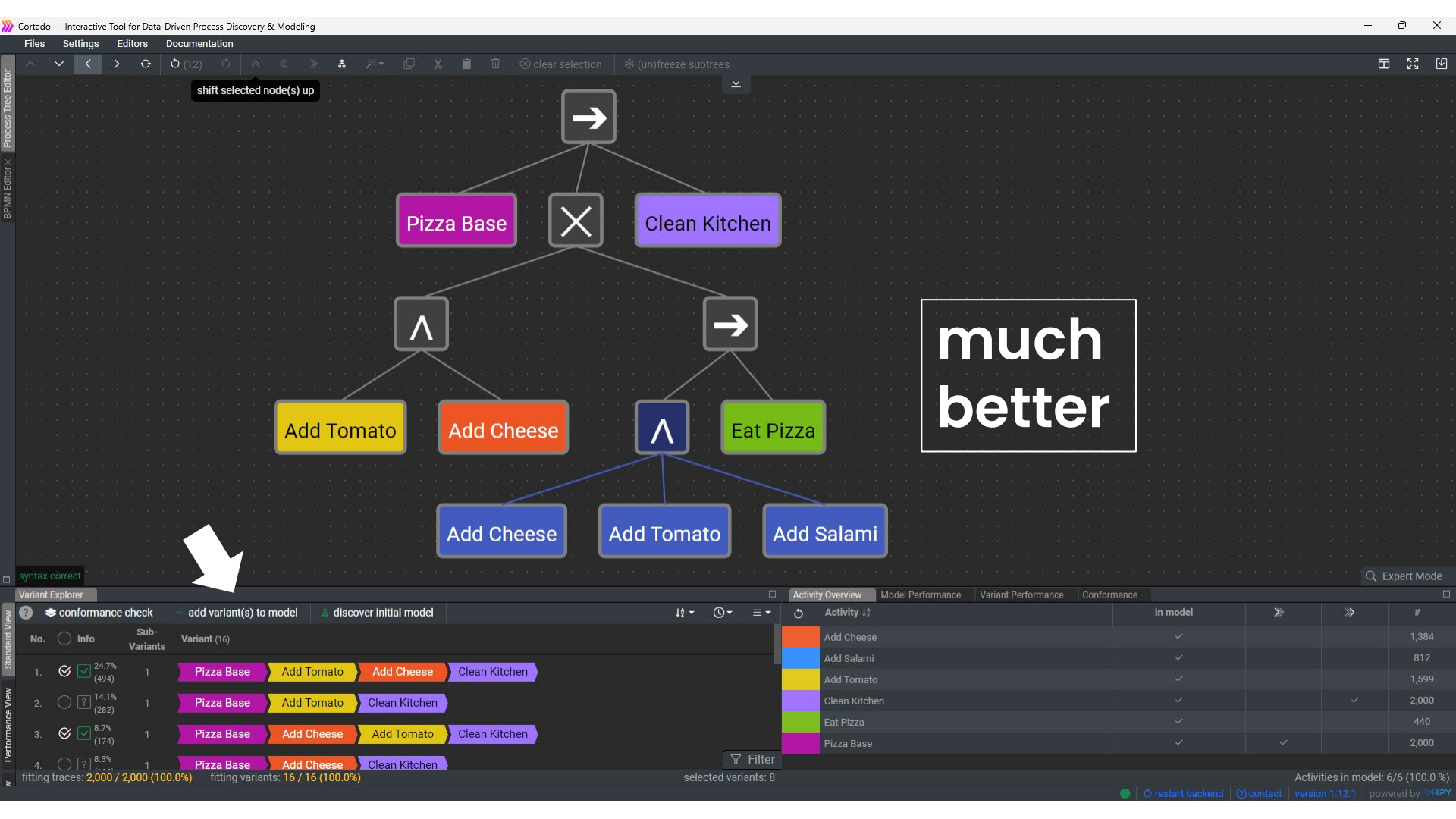
Standard View Performance View

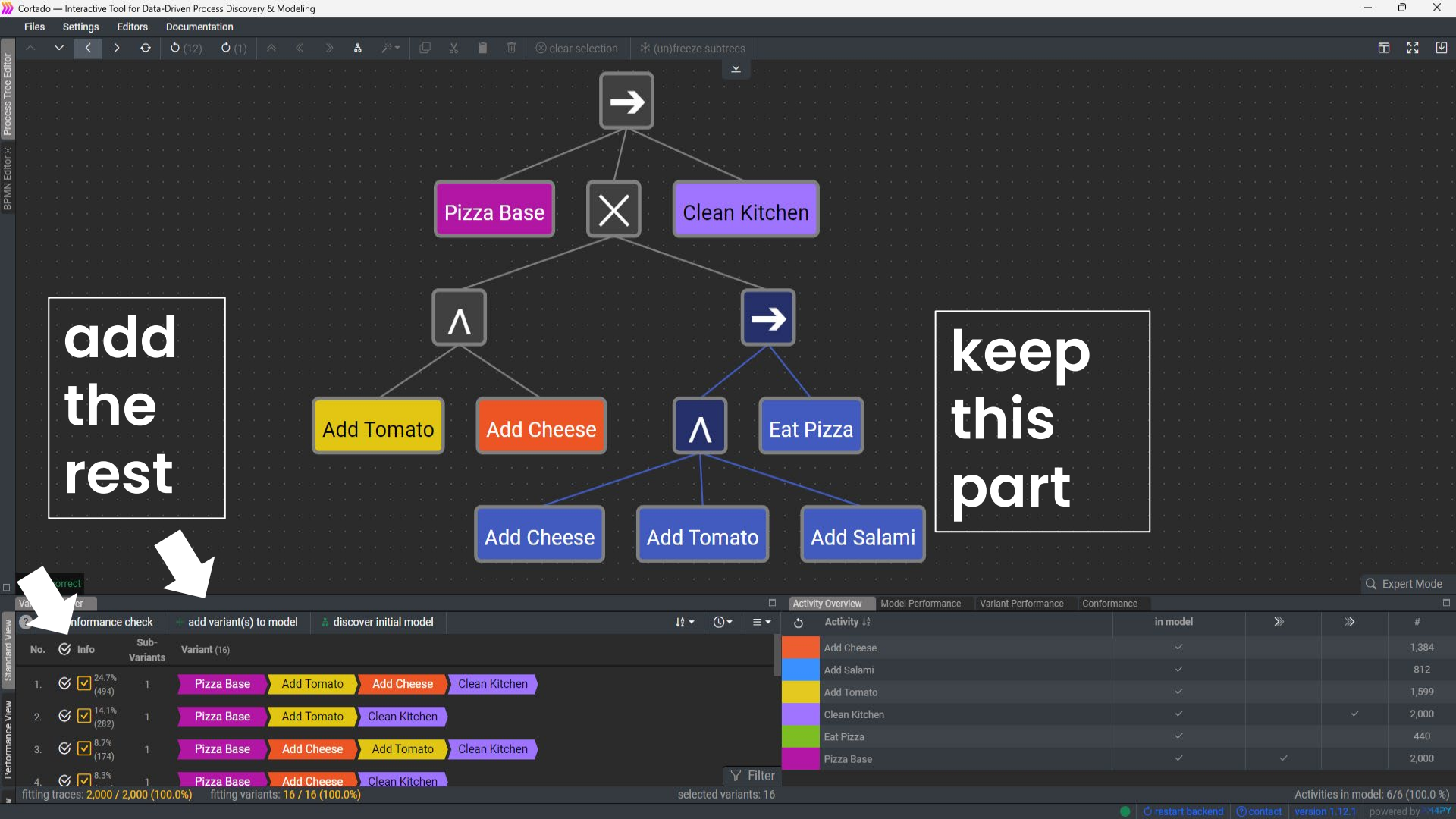
fitting traces: 2,000 / 2,000 (100.0%) fitting variants: 16 / 16 (100.0%) selected variants: 8 Activities in model: 6/6 (100.0 %)

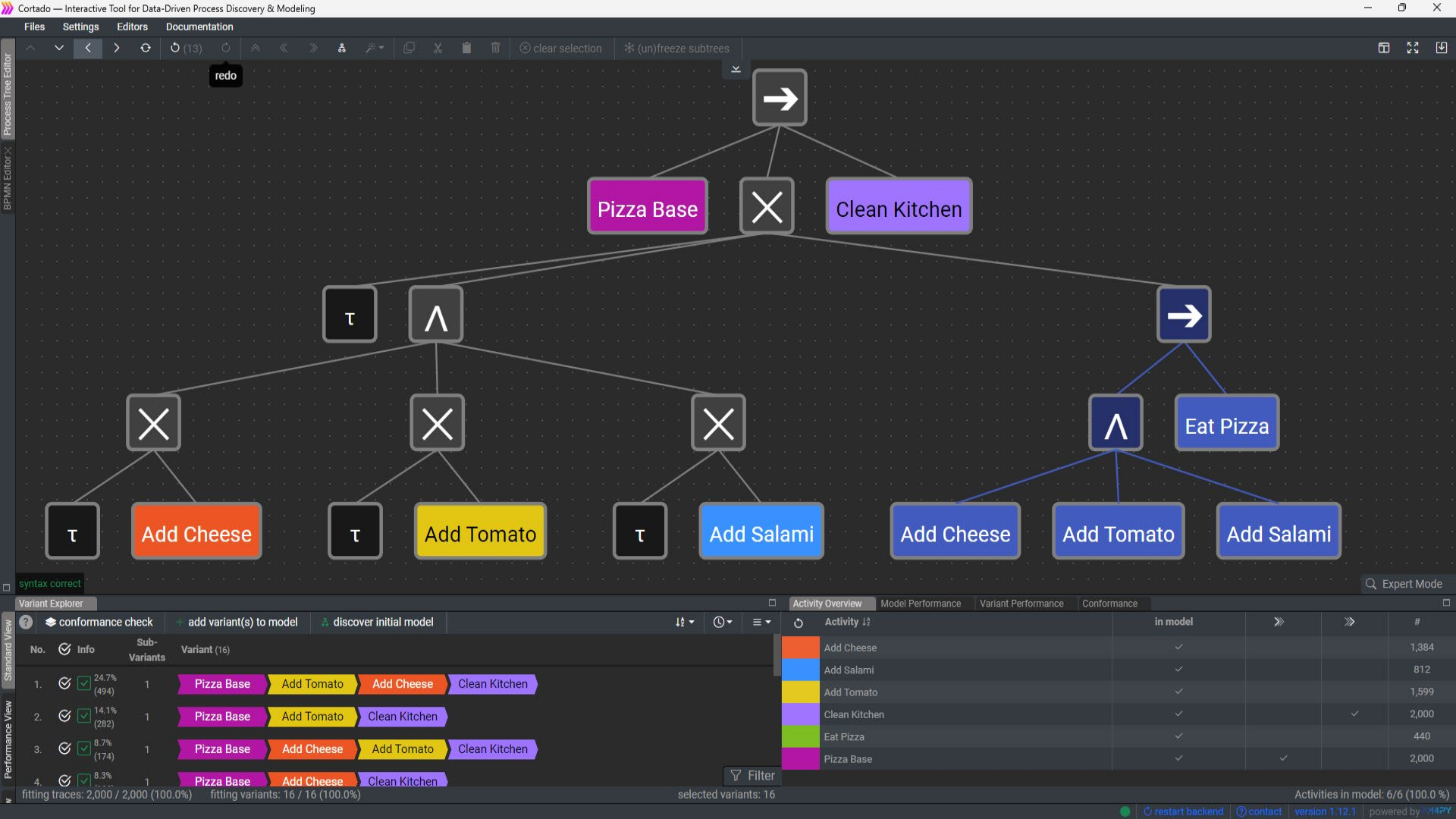
restart backend contact version 1.12.1 powered by PM4PY

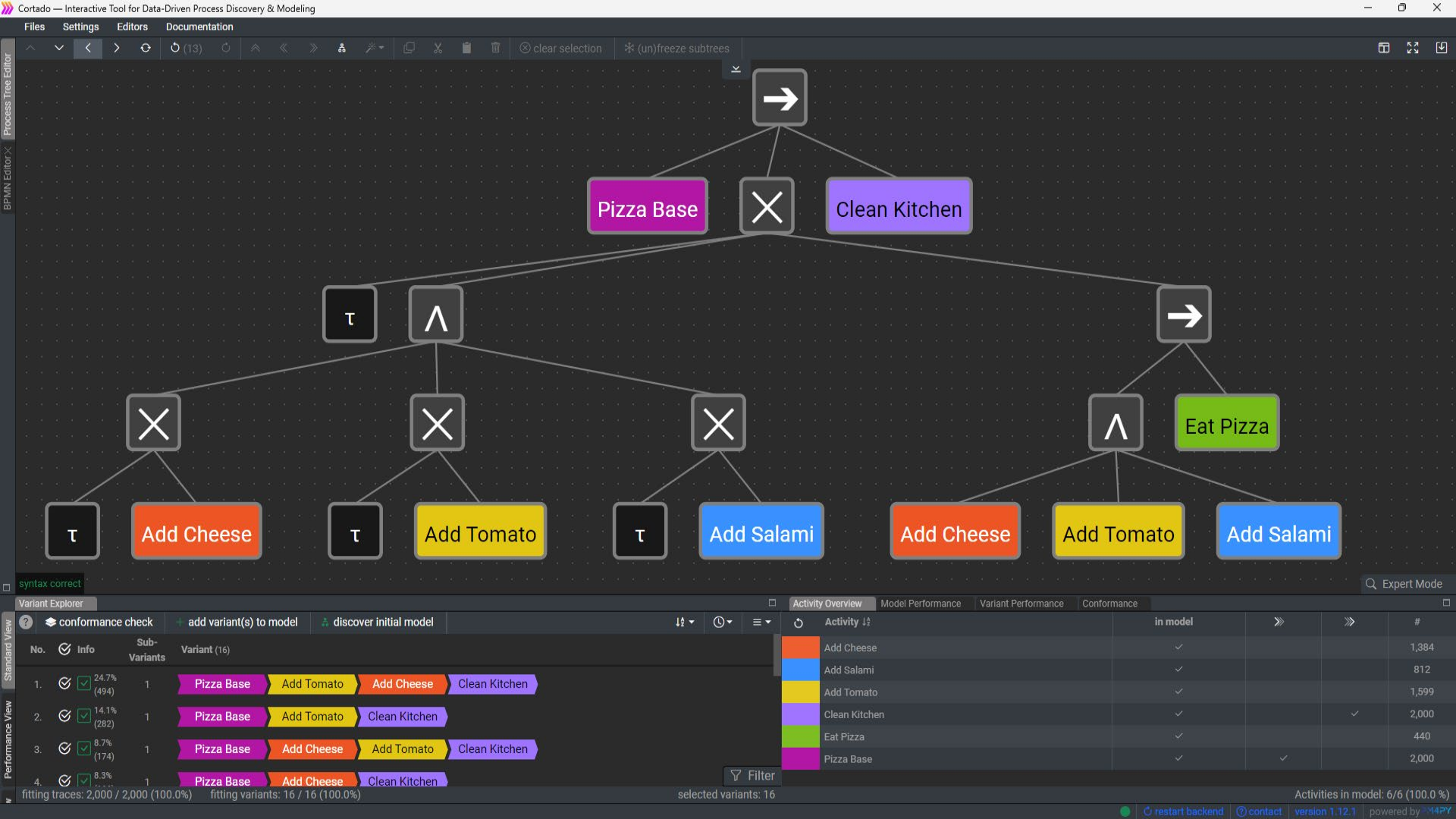

Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
clear selection
(un)freeze subtrees
redo
freeze
Pizza Base
Eat Pizza
Clean Kitchen
Add Cheese
Add Tomato
Add Salami
syntax correct
Expert Mode
Variant Explorer
conformance check
add variant(s) to model
discover initial model
Activity Overview
Model Performance
Variant Performance
Conformance
Activity
in model
Add Cheese 1,384
Add Salami 812
Add Tomato 1,599
Clean Kitchen 2,000
Eat Pizza 440
Pizza Base 2,000
Filter
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 8
Activities in model: 6/6 (100.0 %)
restart backend
contact
version 1.12.1

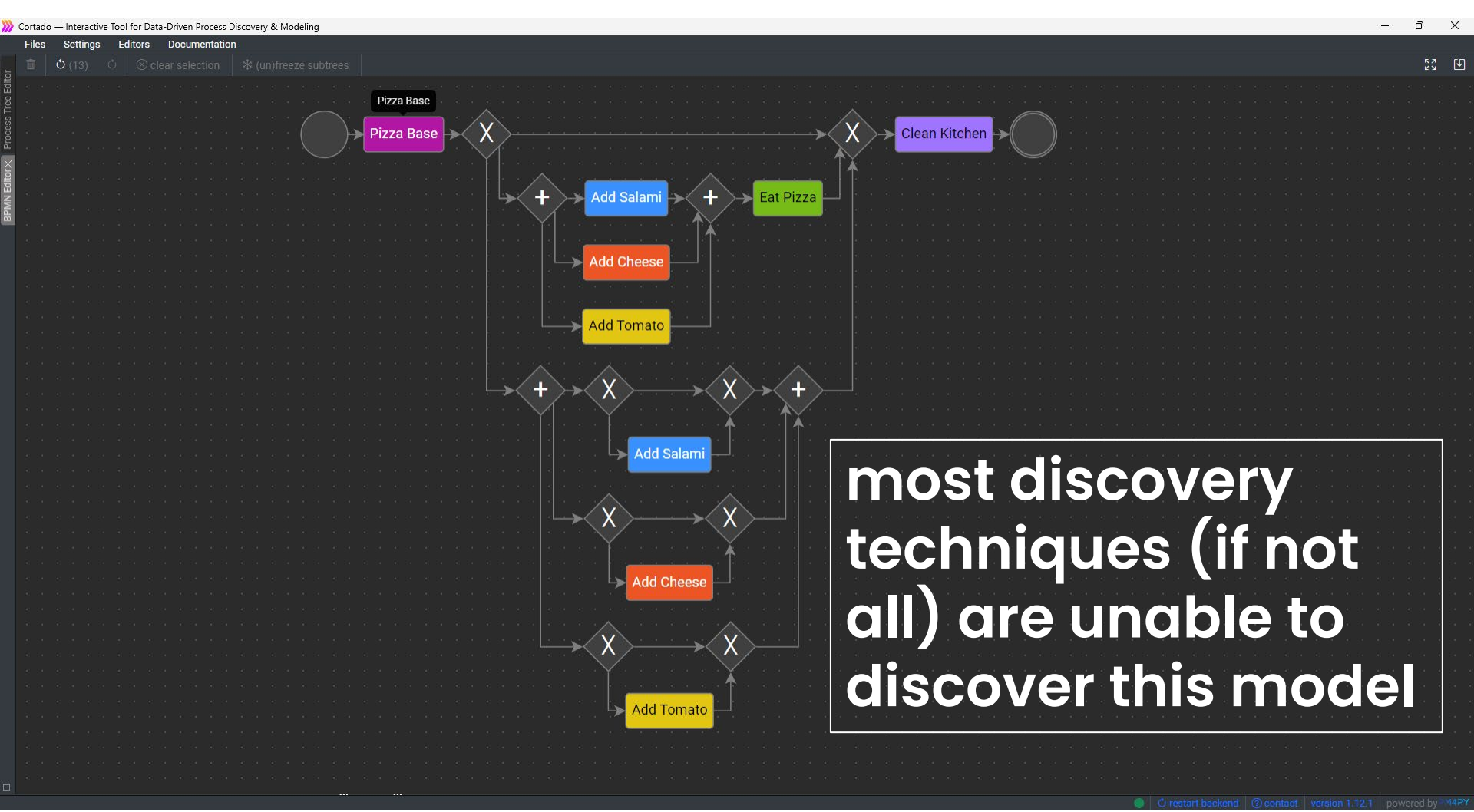

Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
clear selection
(un)freeze subtrees
Process Tree Editor
BPMN Editor
Pizza Base
Eat Pizza
Clean Kitchen
freeze
Add Cheese
Add Tomato
Add Salami
syntax correct
Expert Mode
Activity Explorer
conformance check
add variant(s) to model
discover initial model
Info
Sub-Variants
Variant (16)
24.7% (494)
14.1% (282)
8.7% (174)
8.3%
Add Tomato
Add Cheese
Clean Kitchen
Filter
Activity Overview
Model Performance
Variant Performance
Conformance
Activity
in model
Add Cheese
Add Salami
Add Tomato
Clean Kitchen
Eat Pizza
Pizza Base
1,384
812
1,599
2,000
440
2,000
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 8
Activities in model: 6/6 (100.0 %)
restart backend
contact
version 1.12.1
powered by

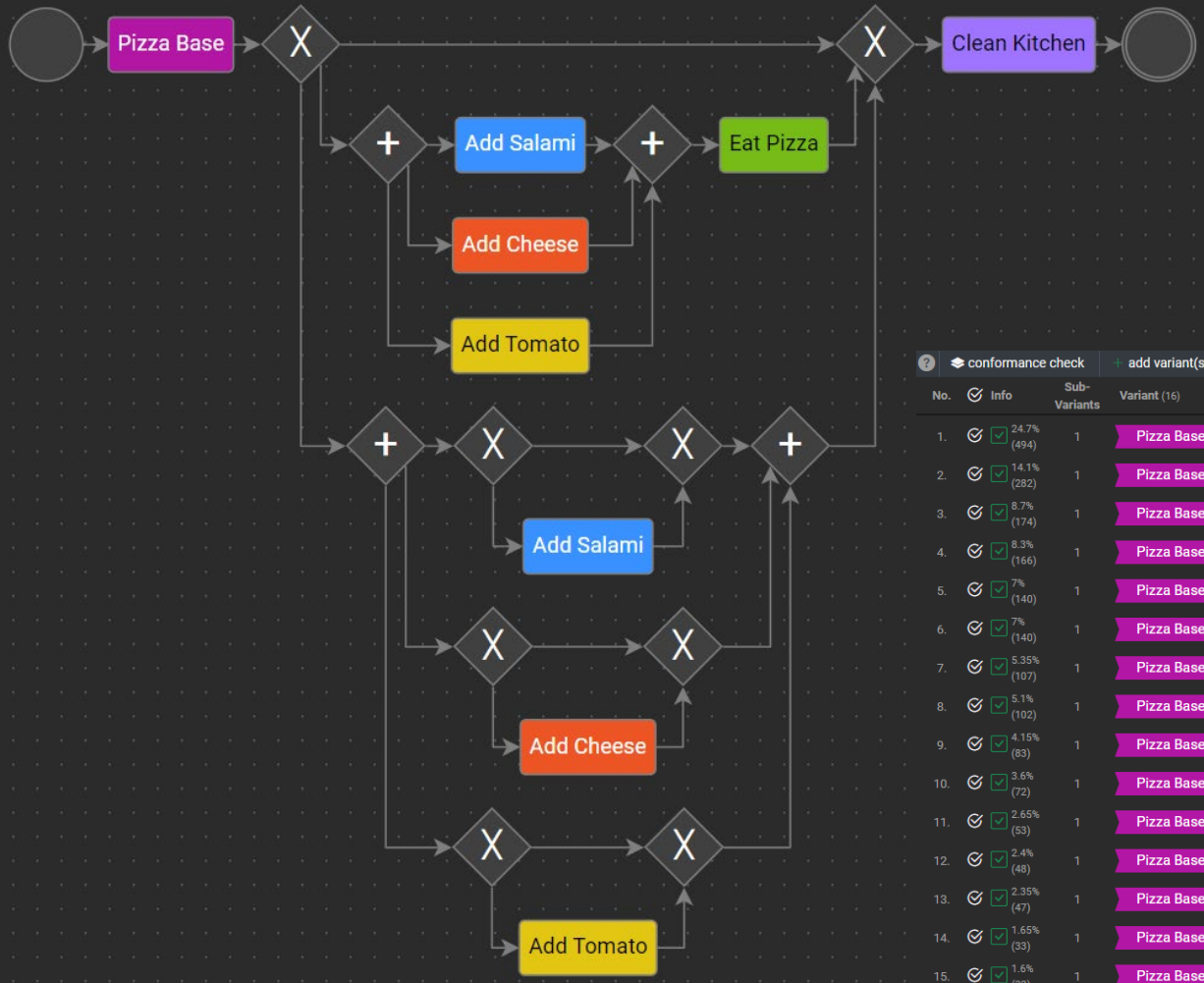

Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
shift selected node(s) up
clear selection
(un)freeze subtrees
Process Tree Editor
BPMN Editor
Pizza Base
Clean Kitchen
Add Tomato
Add Cheese
Eat Pizza
Add Cheese
Add Tomato
Add Salami
much better
syntax correct
Expert Mode
Variant Explorer
conformance check
add variant(s) to model
discover initial model
No.
Info
Sub-Variants
Variant (16)
1. 24.7% (494) 1 Pizza Base Add Tomato Add Cheese Clean Kitchen
2. 14.1% (282) 1 Pizza Base Add Tomato Clean Kitchen
3. 8.7% (174) 1 Pizza Base Add Cheese Add Tomato Clean Kitchen
4. 8.3% 1 Pizza Base Add Cheese Clean Kitchen
Filter
Activity Overview
Model Performance
Variant Performance
Conformance
Activity
in model
#
Add Cheese 1,384
Add Salami 812
Add Tomato 1,599
Clean Kitchen 2,000
Eat Pizza 440
Pizza Base 2,000
Standard View
Performance View
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 8
Activities in model: 6/6 (100.0 %)
restart backend
contact
version 1.12.1
powered by pm4py


Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
clear selection
(un)freeze subtrees
Process Tree Editor
BPMN Editor
Pizza Base
Clean Kitchen
Add Tomato
Add Cheese
Eat Pizza
Add Cheese
Add Tomato
Add Salami
add the rest
keep this part
Expert Mode
Activity Overview
Model Performance
Variant Performance
Conformance
add variant(s) to model
discover initial model
No.
Info
Sub-Variants
Variant (16)
Activity
in model
Add Cheese
Add Salami
Add Tomato
Clean Kitchen
Eat Pizza
Pizza Base
1,384
812
1,599
2,000
440
2,000
Filter
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 16
Activities in model: 6/6 (100.0 %)
restart backend
contact
version 1.12.1
powered by


Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
(13)
redo
clear selection
(un)freeze subtrees
Process Tree Editor
BPMN Editor
Pizza Base
Clean Kitchen
τ
Add Cheese
τ
Add Tomato
τ
Add Salami
Eat Pizza
Add Cheese
Add Tomato
Add Salami
syntax correct
Expert Mode
Variant Explorer
conformance check
add variant(s) to model
discover initial model
No.
Info
Sub-Variants
Variant (16)
1. 24.7% (494) 1 Pizza Base Add Tomato Add Cheese Clean Kitchen
2. 14.1% (282) 1 Pizza Base Add Tomato Clean Kitchen
3. 8.7% (174) 1 Pizza Base Add Cheese Add Tomato Clean Kitchen
4. 8.3% 1 Pizza Base Add Cheese Clean Kitchen
Filter
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 16
Activity Overview
Model Performance
Variant Performance
Conformance
Activity
in model
#
Add Cheese 1,384
Add Salami 812
Add Tomato 1,599
Clean Kitchen 2,000
Eat Pizza 440
Pizza Base 2,000
Activities in model: 6/6 (100.0 %)
Standard View
Performance View
restart backend
contact
version 1.12.1
powered by

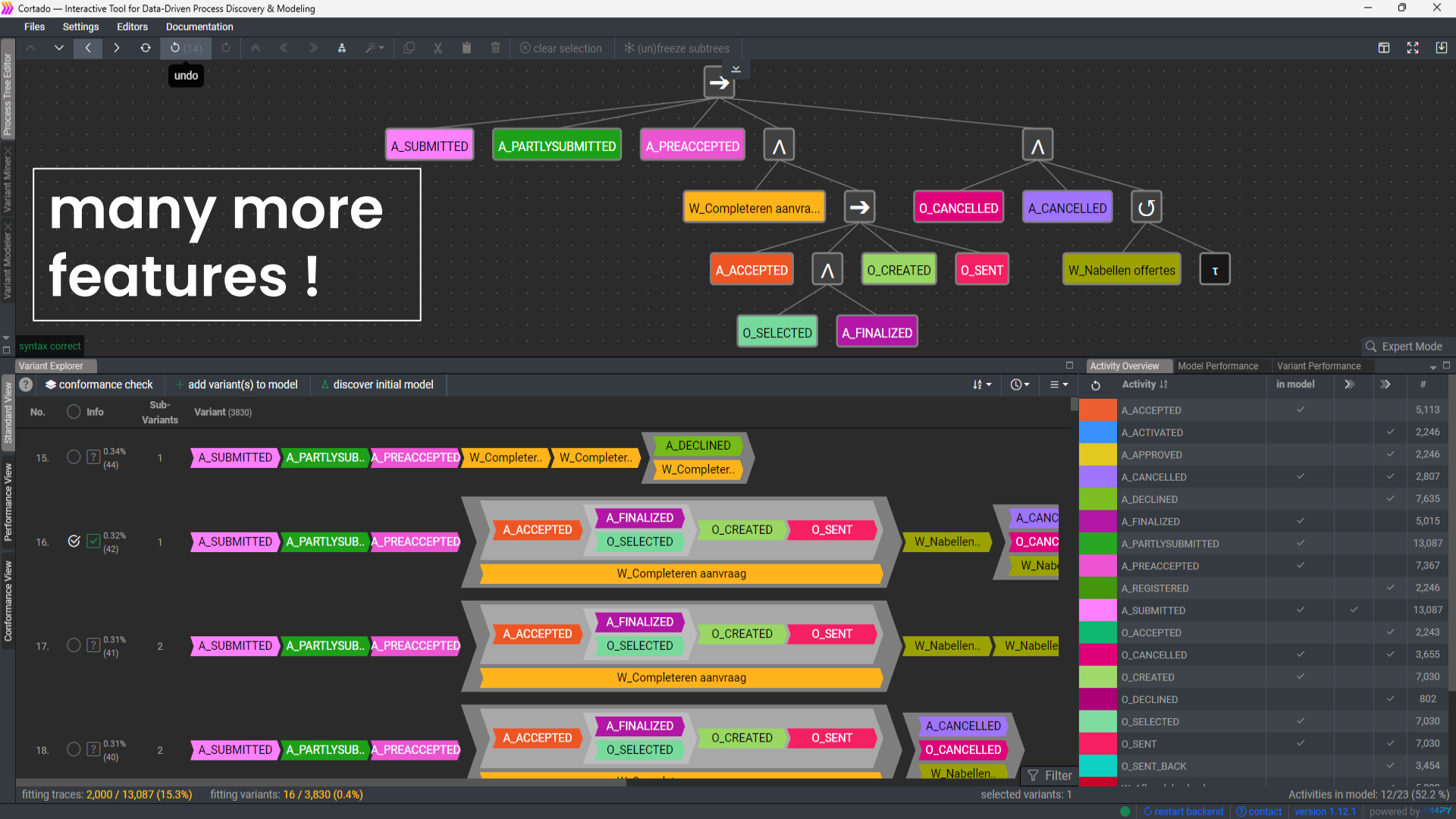

Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
clear selection
(un)freeze subtrees
Process Tree Editor
BPMN Editor
Pizza Base
Clean Kitchen
τ
Add Cheese
τ
Add Tomato
τ
Add Salami
Eat Pizza
Add Cheese
Add Tomato
Add Salami
syntax correct
Expert Mode
Variant Explorer
conformance check
add variant(s) to model
discover initial model
No.
Info
Sub-Variants
Variant (16)
1. 24.7% (494) 1 Pizza Base Add Tomato Add Cheese Clean Kitchen
2. 14.1% (282) 1 Pizza Base Add Tomato Clean Kitchen
3. 8.7% (174) 1 Pizza Base Add Cheese Add Tomato Clean Kitchen
4. 8.3% 1 Pizza Base Add Cheese Clean Kitchen
Filter
Activity Overview
Model Performance
Variant Performance
Conformance
Activity
in model
#
Add Cheese 1,384
Add Salami 812
Add Tomato 1,599
Clean Kitchen 2,000
Eat Pizza 440
Pizza Base 2,000
fitting traces: 2,000 / 2,000 (100.0%)
fitting variants: 16 / 16 (100.0%)
selected variants: 16
Activities in model: 6/6 (100.0 %)
Standard View
Performance View
restart backend
contact
version 1.12.1
powered by


Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
(13)
clear selection
(un)freeze subtrees
Process Tree Editor
BPMN Editor
Pizza Base
Pizza Base
Clean Kitchen
Add Salami
Eat Pizza
Add Cheese
Add Tomato
Add Salami
Add Cheese
Add Tomato
most discovery techniques (if not all) are unable to discover this model
restart backend
contact
version 1.12.1
powered by



conformance check | add variant(s) to model | discover initial model

No.	Info	Sub-Variants	Variant (16)
1.	24.7% (494)	1	Pizza Base → Add Tomato → Add Cheese → Clean Kitchen
2.	14.1% (282)	1	Pizza Base → Add Tomato → Clean Kitchen
3.	8.7% (174)	1	Pizza Base → Add Cheese → Add Tomato → Clean Kitchen
4.	8.3% (166)	1	Pizza Base → Add Cheese → Clean Kitchen
5.	7% (140)	1	Pizza Base → Add Tomato → Add Salami → Add Cheese → Eat Pizza → Clean Kitchen
6.	7% (140)	1	Pizza Base → Add Salami → Add Tomato → Add Cheese → Eat Pizza → Clean Kitchen
7.	5.35% (107)	1	Pizza Base → Add Salami → Add Tomato → Clean Kitchen
8.	5.1% (102)	1	Pizza Base → Add Tomato → Add Salami → Clean Kitchen
9.	4.15% (83)	1	Pizza Base → Add Salami → Add Cheese → Clean Kitchen
10.	3.6% (72)	1	Pizza Base → Clean Kitchen
11.	2.65% (53)	1	Pizza Base → Add Salami → Clean Kitchen
12.	2.4% (48)	1	Pizza Base → Add Cheese → Add Tomato → Add Salami → Eat Pizza → Clean Kitchen
13.	2.35% (47)	1	Pizza Base → Add Cheese → Add Salami → Add Tomato → Eat Pizza → Clean Kitchen
14.	1.65% (33)	1	Pizza Base → Add Tomato → Add Cheese → Add Salami → Eat Pizza → Clean Kitchen
15.	1.6% (32)	1	Pizza Base → Add Salami → Add Cheese → Add Tomato → Eat Pizza → Clean Kitchen
16.	1.35% (27)	1	Pizza Base → Add Cheese → Add Salami → Clean Kitchen


Cortado — Interactive Tool for Data-Driven Process Discovery & Modeling
Files
Settings
Editors
Documentation
undo
clear selection
(un)freeze subtrees
Process Tree Editor
Variant Miner
Variant Modeler
A_SUBMITTED
A_PARTLYSUBMITTED
A_PREACCEPTED
W_Completeren aanvra...
O_CANCELLED
A_CANCELLED
A_ACCEPTED
O_CREATED
O_SENT
W_Nabellen offertes
O_SELECTED
A_FINALIZED
many more features !
syntax correct
Expert Mode
Variant Explorer
Activity Overview
Model Performance
Variant Performance
conformance check
add variant(s) to model
discover initial model
Standard View
Performance View
Conformance View
No.
Info
Sub-Variants
Variant (3830)
15. 0.34% (44) 1
A_DECLINED
W_Completer..
16. 0.32% (42) 1
A_FINALIZED
O_SELECTED
W_Completeren aanvraag
W_Nabellen..
17. 0.31% (41) 2
18. 0.31% (40) 2
Activity
in model
#
A_ACCEPTED 5,113
A_ACTIVATED 2,246
A_APPROVED 2,246
A_CANCELLED 2,807
A_DECLINED 7,635
A_FINALIZED 5,015
A_PARTLYSUBMITTED 13,087
A_PREACCEPTED 7,367
A_REGISTERED 2,246
A_SUBMITTED 13,087
O_ACCEPTED 2,243
O_CANCELLED 3,655
O_CREATED 7,030
O_DECLINED 802
O_SELECTED 7,030
O_SENT 7,030
O_SENT_BACK 3,454
Filter
fitting traces: 2,000 / 13,087 (15.3%)
fitting variants: 16 / 3,830 (0.4%)
selected variants: 1
Activities in model: 12/23 (52.2 %)
restart backend
contact
version 1.12.1
powered by

SoftwareX
Volume 22, May 2023, 101373

Original software publication

Cortado: A dedicated process mining tool for interactive process discovery

Daniel Schuster, Sebastiaan J. van Zelst, Wil M.P. van der Aalst

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Abstract

Process discovery is an essential discipline within process mining, which deals with the data-driven generation of insights into operational processes. From event data that capture historical process executions, process discovery algorithms learn a process model describing the execution of the various activities involved. Such discovered models are crucial artifacts used by many process mining techniques. Most existing process discovery approaches can be classified as conventional—they function like a black-box approach and often learn models of poor quality from event data. Cortado is a software

Cortado

Lint passing Test passing

Cortado is a process mining tool dedicated for interactive/incremental process discovery

Overview Functionality

- Import event logs `.xes` and initial process models `.ptml`
- Visually explore event logs with the variant explorer
- Discover initial process models from user-selected process behavior
- Incrementally extend process models by user-selected process behavior
- Manually edit process models under construction any time
- Export discovered process models as `.ptml` or `.pnml` files
- Temporal performance analysis, both model-based and model-independent

Downloads

Standalone builds for **Windows 10/11**, **Linux**, and **macOS** (Apple Silicon only) are available from the GitHub Releases Page.

https://github.com/cortado-tool/cortado

https://doi.org/10.1016/j.softx.2023.101373

OCPM

High speed

It all starts with event data

Case ID	Activity	Resource	Timestamp	Product	Prod-price	Quantity	Address
...	...	....	...	....	...	...	...
6350	place order	Aiden	2018/02/13 14:29:45.000	APPLE iPhone 6 16 GB	639,00 €	5	NL-7751DG-21
6283	pay	Lily	2018/02/13 14:39:25.000	SAMSUNG Galaxy S6 32 GB	543,99 €	3	NL-7828AM-11a
6253	prepare delivery	Sophia	2018/02/13 15:01:33.000	APPLE iPhone	639,00 €	3	NL-7887AC-13
6257	prepare delivery	Aiden	2018/02/13 15:03:43.000	SAMSUNG Galaxy S6 32 GB	543.99 €	1	NL-9521KJ-34
6185	confirm payment	Emily	2018/02/13 15:05:36.000	SAMSUNG Galaxy S4	329,00 €	1	NL-9521GC-32
6218	confirm payment	Emily	2018/02/13 15:08:11.000	APPLE iPhone 6s 64 GB	969,00 €	2	NL-7948BX-10
6245	make delivery	Michael	2018/02/13 15:14:04.000	APPLE iPhone 6 16 GB	639,00 €	3	NL-7905AX-38
6272	pay	Emily	2018/02/13 15:20:36.000	APPLE iPhone 6 16 GB	639,00 €	1	NL-7821AC-3
6269	pay	Charlotte	2018/02/13 15:25:21.000	SAMSUNG Galaxy S4	329,00 €	1	NL-7907EJ-42
6212	prepare delivery	Sophia	2018/02/13 15:43:39.000	HUAWEI P8	329,00 €	1	NL-7905AX-38
6323	send invoice	Alexander	2018/02/13 15:46:08.000	APPLE iPhone 6 16 GB	639,00 €	1	NL-7833HT-15
6246	confirm payment	Jack	2018/02/13 15:56:03.000	SAMSUNG Galaxy S4	329,00 €	3	NL-7833HT-15
6347	send invoice	Jack	2018/02/13 15:57:42.000	SAMSUNG Galaxy S4	329,00 €	3	NL-7905AX-38
6351	place order	Zoe	2018/02/13 16:17:37.000	APPLE iPhone 6 16 GB	639,00 €	3	NL-9521GC-32
6204	prepare delivery	Sophia	2018/02/13 16:31:28.000	SAMSUNG Core Prime G361	135,00 €	1	NL-7828AM-11a
6204	make delivery	Kaylee	2018/02/13 16:51:54.000	SAMSUNG Core Prime G361	135,00 €	1	NL-7828AM-11a
6265	confirm payment	Lily	2018/02/13 16:55:55.000	SAMSUNG Galaxy S4	329,00 €	4	NL-9521GC-32
6250	confirm payment	Jack	2018/02/13 17:03:26.000	MOTOROLA Moto G	199,00 €	4	NL-7942GT-2
6328	send invoice	Lily	2018/02/13 17:30:16.000	APPLE iPhone 6s 64 GB	858,00 €	4	NL-9514BV-16
6352	place order	Aiden	2018/02/13 17:53:22.000	APPLE iPhone 6 16 GB	639,00 €	2	NL-9514BV-16
6317	send invoice	Jack	2018/02/13 18:45:30.000	APPLE iPhone 6s 64 GB	858,00 €	5	NL-7907EJ-42
6353	place order	Sophia	2018/02/13 20:16:20.000	APPLE iPhone 5s 16 GB	449,00 €	4	NL-7751AR-19
...	...	....	...	....	...	...	...

event =
case +
activity +
timestamp +
...

It all starts with event data

Case ID	Activity	Resource	Timestamp	Product	Prod-price	Quantity	Address
...	...	....	...	....	...	...	...
6350	place order	Aiden	2018/02/13 14:29:45.000	APPLE iPhone 6 16 GB	639,00 €	5	NL-7751DG-21
6283	pay	Lily	2018/02/13 14:39:25.000	SAMSU	54 99 €	3	NL-7828A
6253	prepare delivery	Sophia	2018/02/13 15:01:33.000	APPLE iPhone 6 16 GB	639,00 €	3	NL-7887AC-13
6257	prepare delivery	Aiden	2018/02/13 15:03:43.000	SAMSUNG Galaxy S6 32 GB	543.99 €	1	NL-9521KJ-34
6185	confirm payment	Emily	2018/02/13 15:05:36.000	SAMSUNG Galaxy	329,00 €	1	NL-9521GC-32
6218	confirm payment	Emily	2018/02/13 15:08:11.000	APPLE iP	2	2	NL-7948BX-10
6245	make delivery	Michael	2018/02/13 15:14:04.000	APPLE iP	3	3	NL-7905AX-38
6272	pay	Emily	2018/02/13 15:20:36.000	APPLE iPhone 6 16 GB	639,00 €	1	NL-7821AC-3
6269	pay	Charlotte	2018/02/13 15:25:21.000	SAMSUNG Galaxy S4	329,00 €	1	NL-7907EJ-42
6212	prepare delivery	Sophia	2018/02/13 15:43:39.000	HUAWEI P8 Lite	234,00 €	1	NL-7905AX-38
6323	send invoice	Alexander	2018/02/13 15:46:08.000	APPLE i	00 €	1	NL-7833HT-15
6246	confirm payment	Jack	2018/02/13 15:56:03.000	SAMSUNG Galaxy S4	9,00 €	3	NL-7833HT-15
6347	send invoice	Jack	2018/02/13 15:57:42.000	SAMSUNG Galaxy S4	329,00 €	3	NL-7905AX-38
6351	place order	Zoe	2018/02/13 16:17:37.000	APPLE i	3	3	L-9521GC-32
6204	prepare delivery	Sophia	2018/02/13 16:31:28.000	SAMSU	1	1	7828AM-11a
6204	make delivery	Kaylee	2018/02/13 16:51:54.000	SAMSUNG Core Prime G361	135,00 €	1	NL-7828AM-11a
6265	confirm payment	Lily	2018/02/13 16:55:55.000	SAMSUNG Galaxy S4	329,00 €	4	NL-9521GC-3
6250	confirm payment	Jack	2018/02/13 17:03:26.000	MOTOROLA Moto G	199,00 €	4	NL-7942GT-2
6328	send invoice	Lily	2018/02/13 17:30:16.000	APPLE i e 6s 64 GB	858,00 €	4	NL-9514BV-16
6352	place order	Aiden	2018/02/13 17:53:22.000	APPLE iPhone 6 16 GB	639,00 €	2	NL-9514BV-16
6317	send invoice	Jack	2018/02/13 18:45:30.000	APPLE iPhone 6s 64 GB	858,00 €	5	NL-7907EJ-42
6353	place order	Sophia	2018/02/13 20:16:20.000	APPLE iPhone 5s 16 GB	449,00 €	4	NL-7751AR-19
...	...	....	...	....	...	...	...

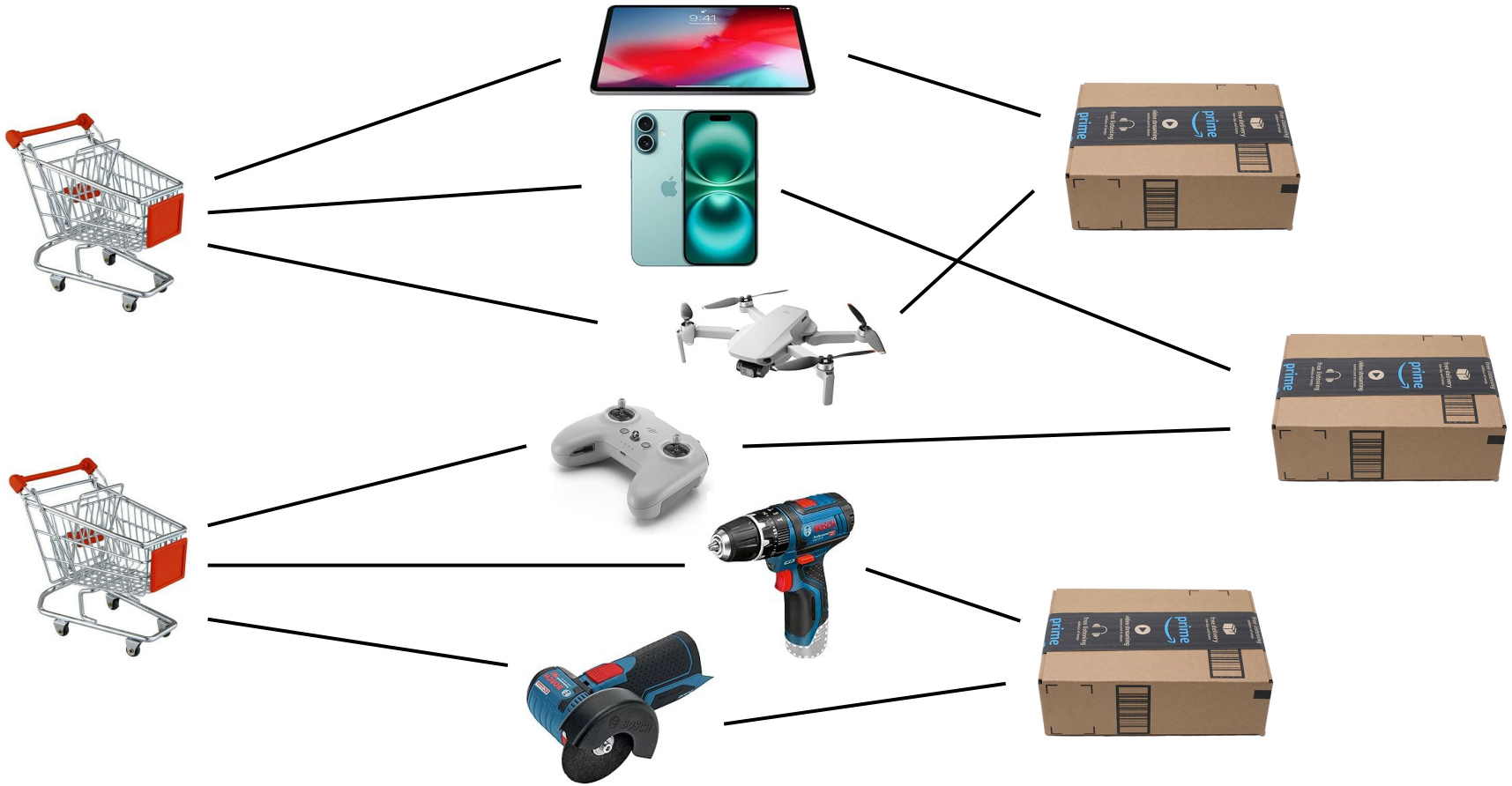
event = objects + activity + timestamp +

- customers
- items
- orders
- suppliers
- invoices
- machines
- shipments
- ...

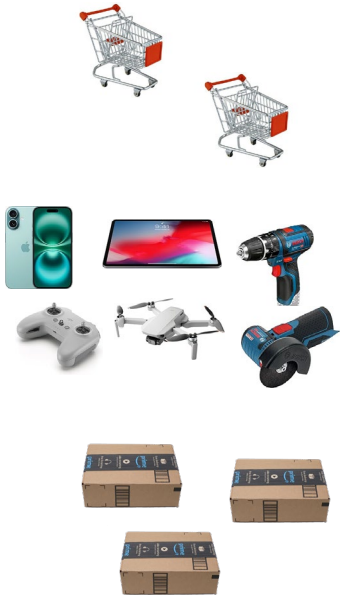
We cannot squeeze this reality into cases, we need a multitude of interconnected objects and events

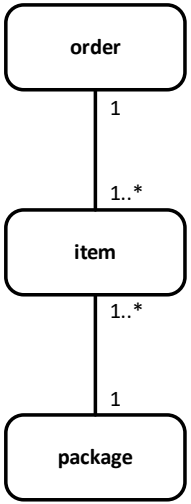
Image generated using DALL E3

Minimal Example: On Time In Full (OTIF) Score?

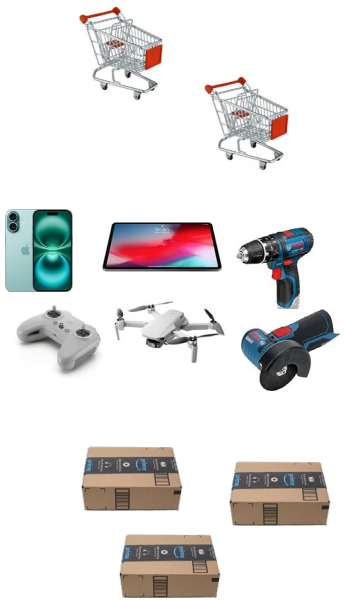


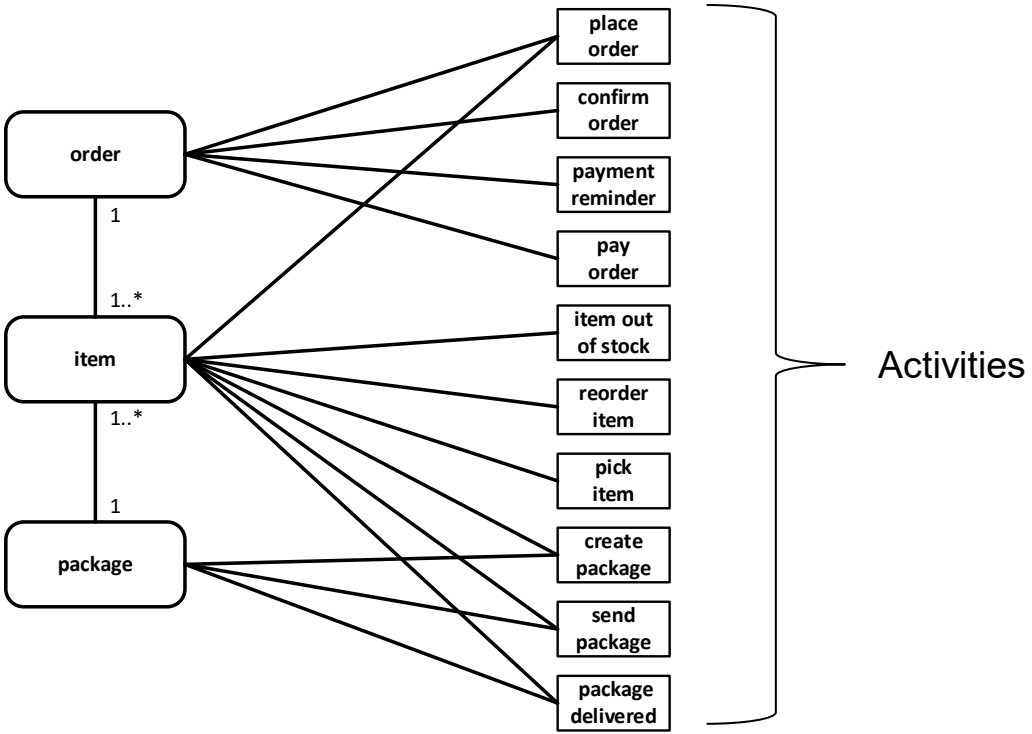
Object Types



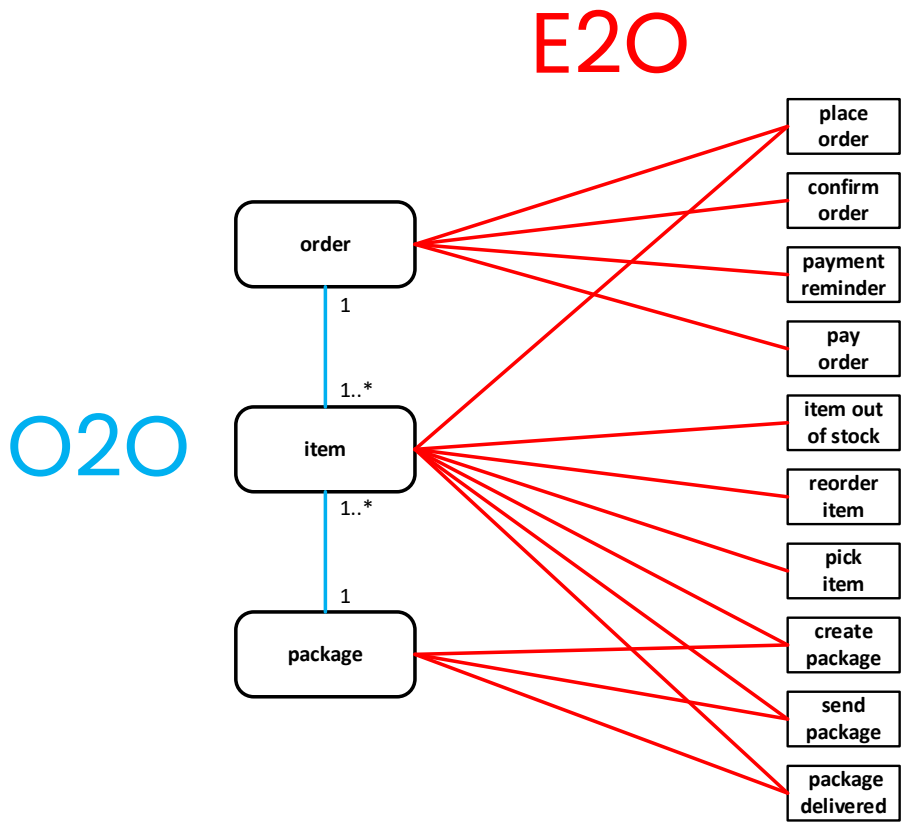


Object Types and Event Types (Activities)

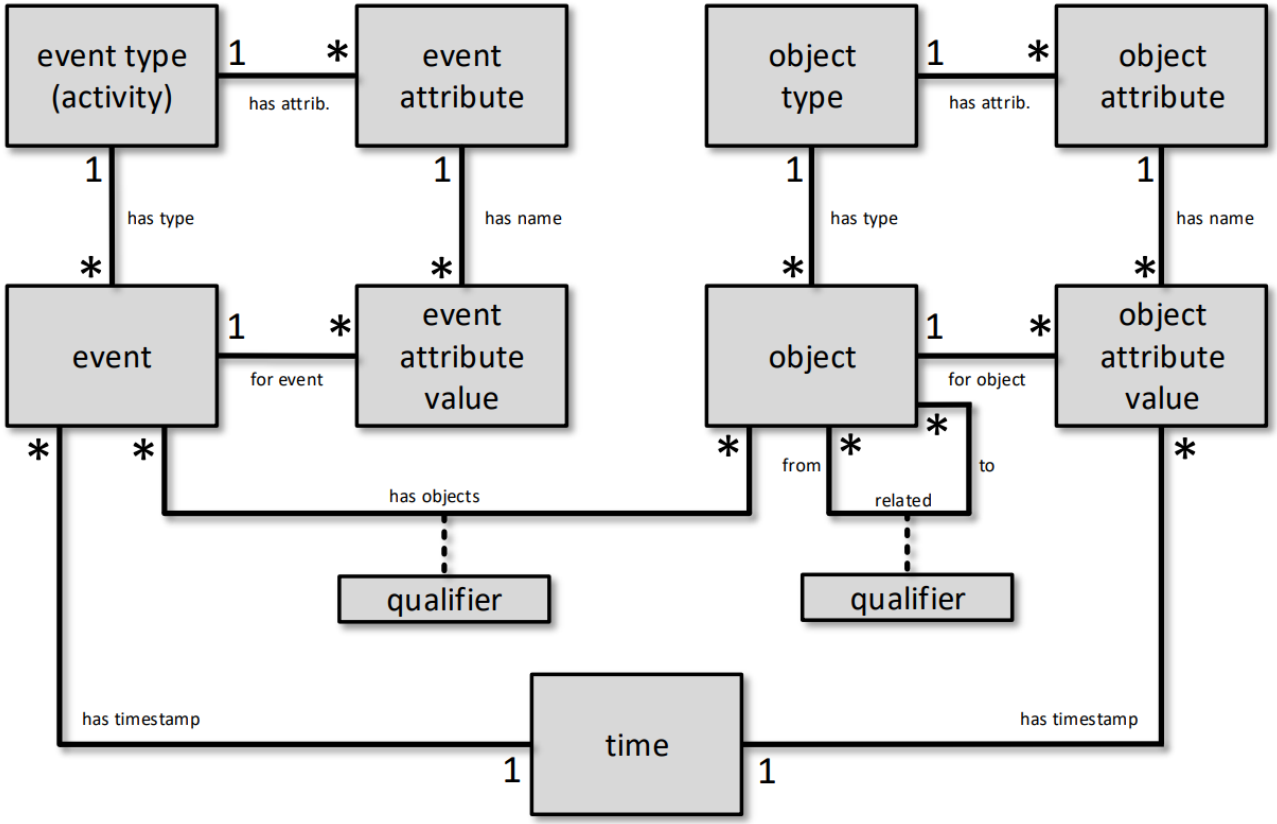




Relating Object Types and Event Types

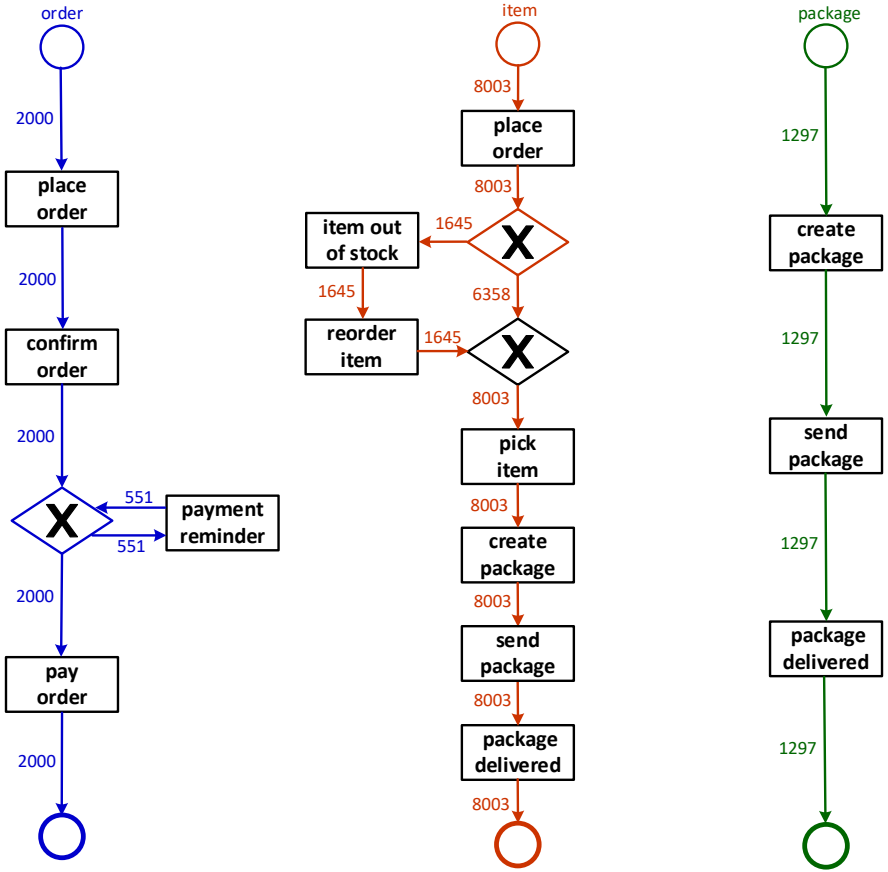


OCEL 2.0

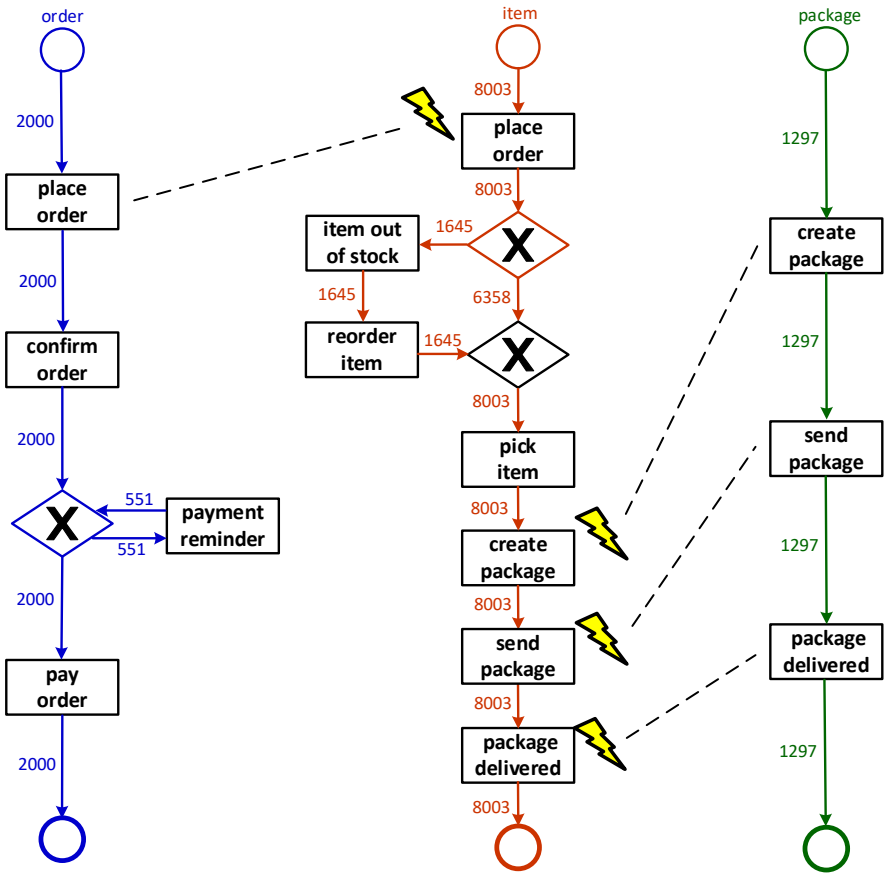


https://www.ocel-standard.org/

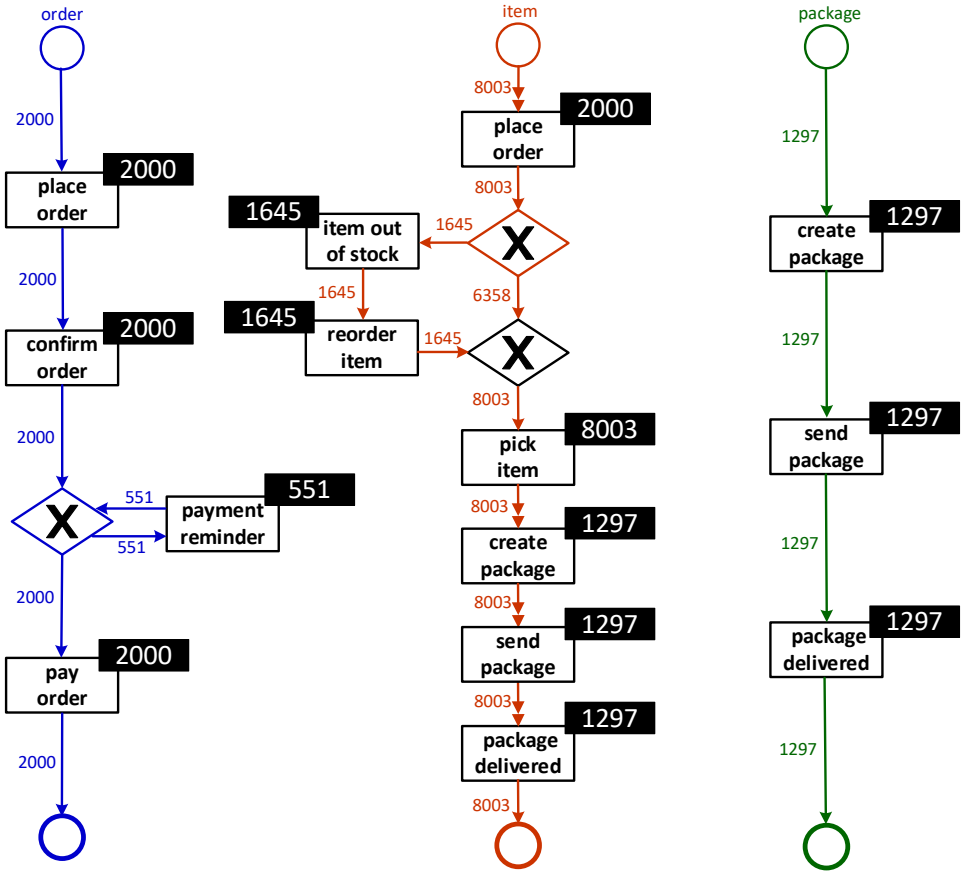
Discovering a Traditional Process Model Per Object Type



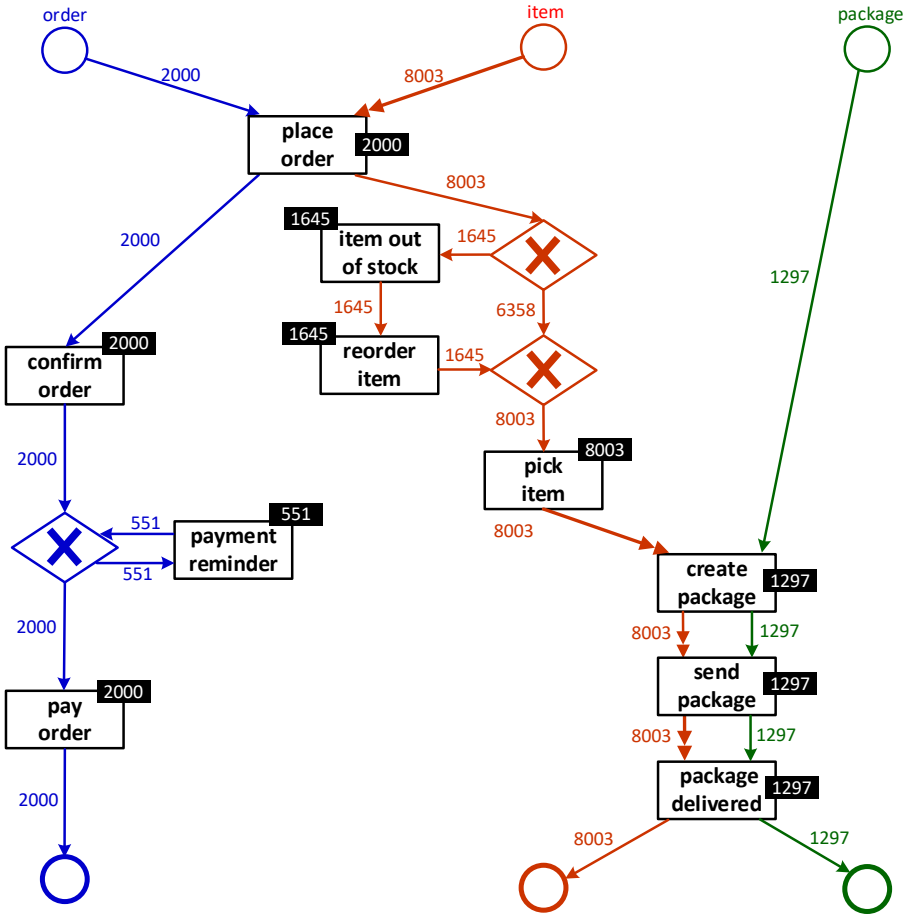
Misalignment Due To Flattening



Correcting Frequencies Before Merging



Discovered Object-Centric Process Model



Why Object-Centric Process Mining?

01

Avoid repeatedly going back to your source systems

- Offers a single system-agnostic source of truth
- Saves time and helps to capture real-live events and objects

02

Avoid distortions due to the single-case assumption

- Squeezing reality into simple event logs creates distortions
- This includes the unintentional replication of events (convergence) and loss of causal relations (divergence)

03

See and understand the interactions between different object types

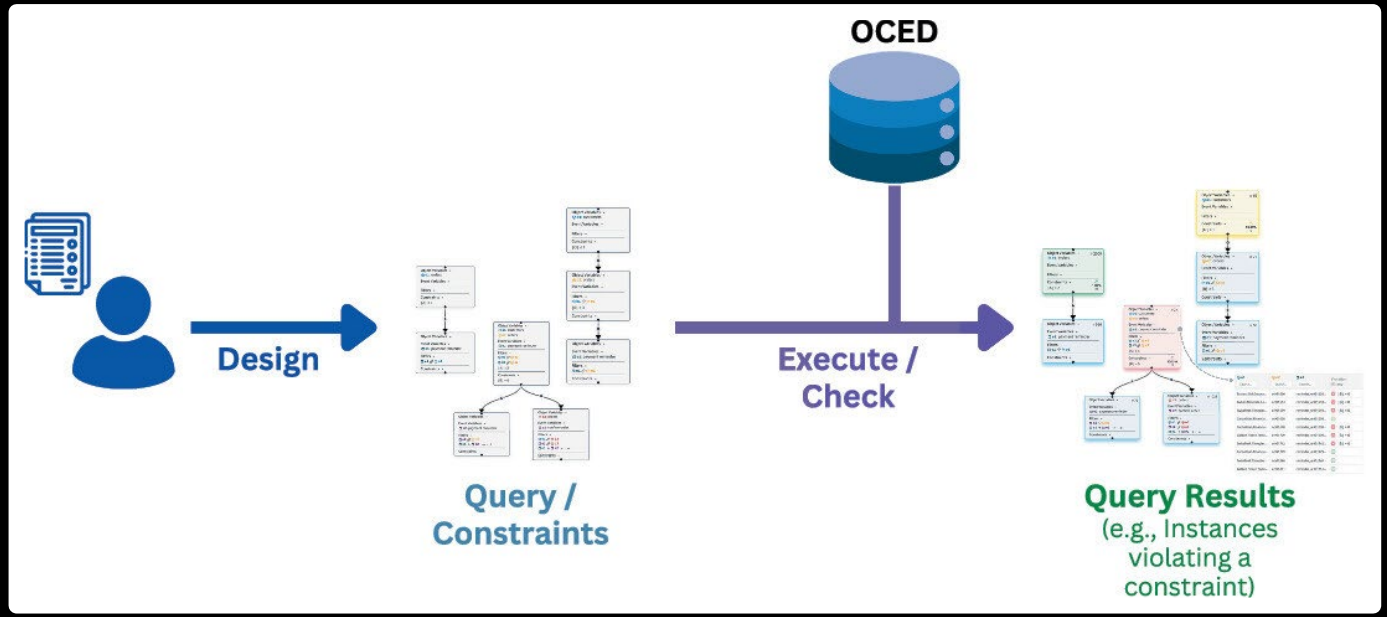
- Problems live at the intersections of processes and organizational entities
- E.g. low On-Time-In-Full (OTIF) scores may be caused by sales, production, procurement, logistics, etc.

OCPQ

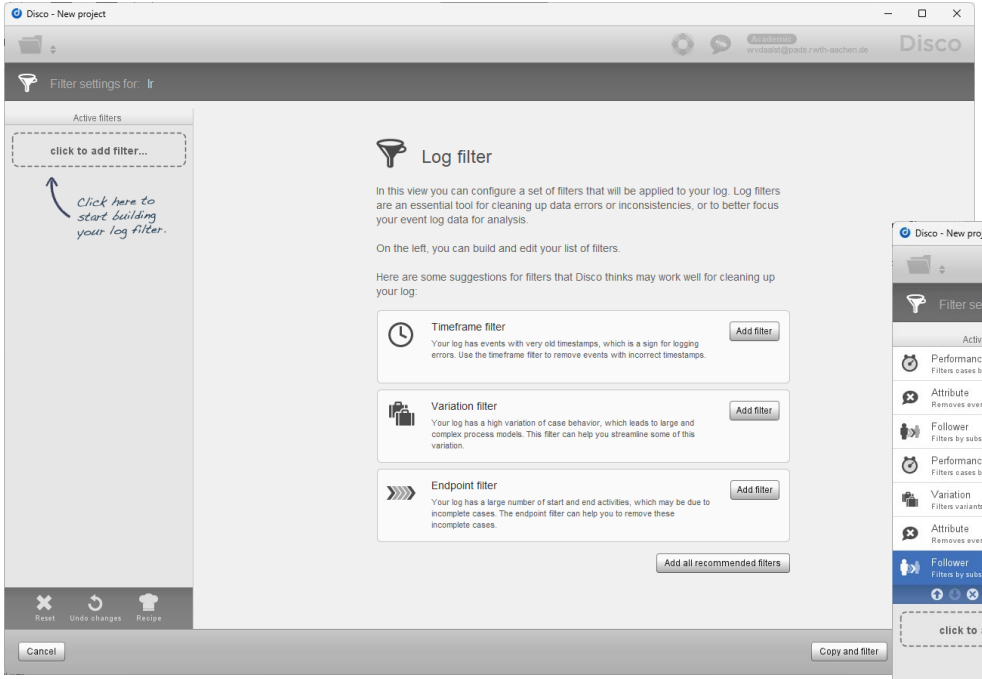
Thanks to Aaron Küsters

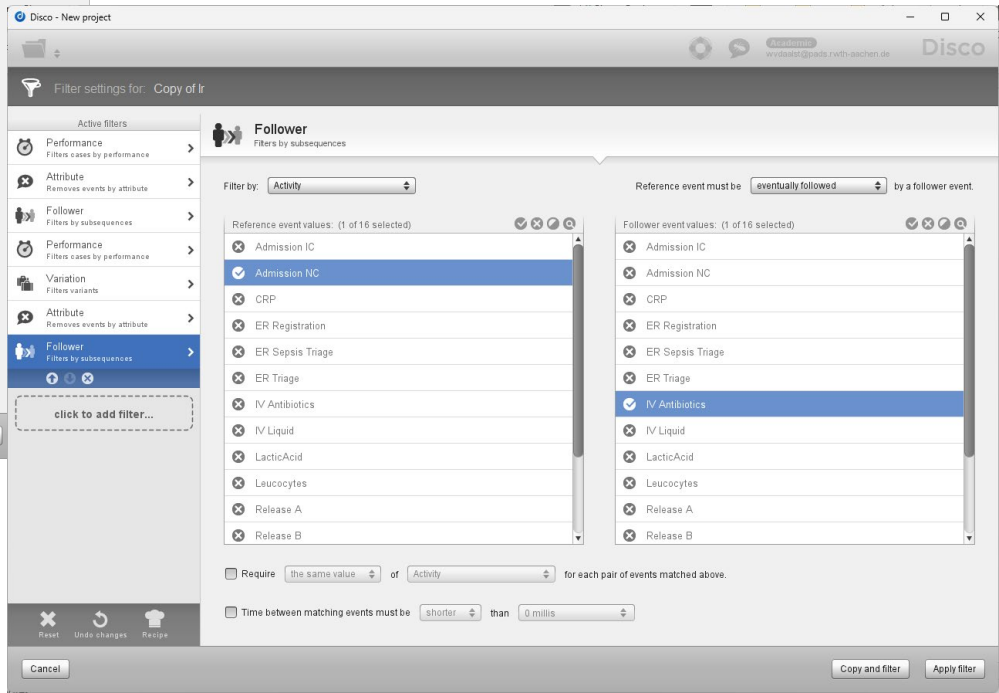
Motivation

Querying case-centric event data is already challenging, but querying object-centric event data is much more complicated!

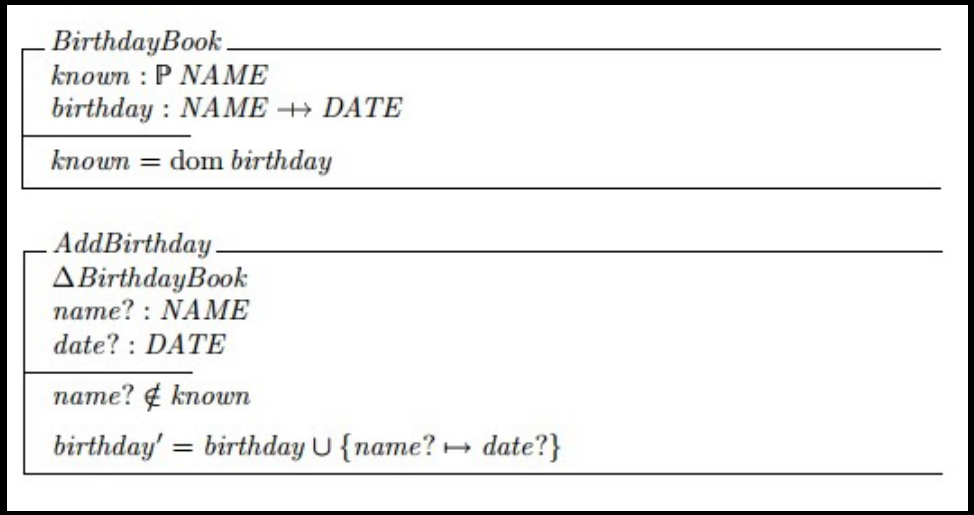


Querying and Constraint Checking Are Related





Inspiration: Z notation



BirthdayBook

$known : \mathbb{P}\ NAME$

$birthday : NAME \pfun DATE$

$known = \mathrm{dom}\ birthday$

AddBirthday

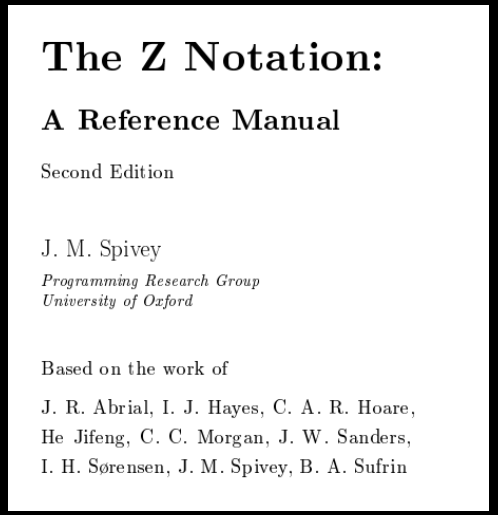
$\Delta BirthdayBook$

$name? : NAME$

$date? : DATE$

$name? \notin known$

$birthday' = birthday \cup \{name? \mapsto date?\}$



The Z Notation:

A Reference Manual

Second Edition

J. M. Spivey

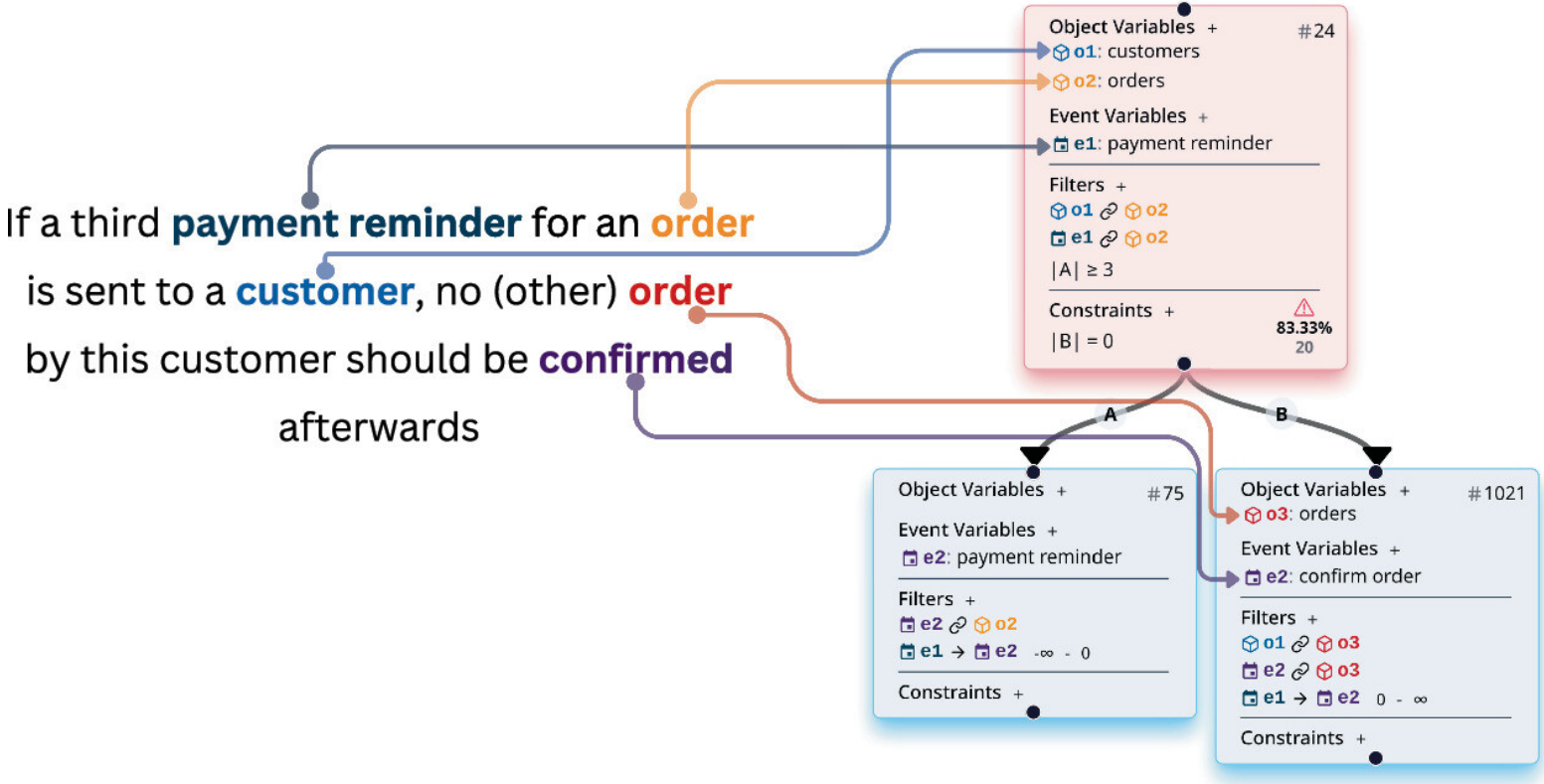
Programming Research Group
University of Oxford

Based on the work of

J. R. Abrial, I. J. Hayes, C. A. R. Hoare,
He Jifeng, C. C. Morgan, J. W. Sanders,
I. H. Sørensen, J. M. Spivey, B. A. Sufrin

- Initially introduced by Jean-Raymond Abrial in the 1970s, it evolved into an ISO standard, but few people today are still familiar with it.
- Ideas reused: explicit variables, constraints over these variables, nesting/reusing Z schemata.

Example from [1]



[1] Küsters, A., van der Aalst, W.M.P. (2025). OCPQ: Object-Centric Process Querying and Constraints. In: Grabis, J., Vos, T.E.J., Escalona, M.J., Pastor, O. (eds) Research Challenges in Information Science. RCIS 2025. Lecture Notes in Business Information Processing, vol 547. Springer, Cham. https://doi.org/10.1007/978-3-031-92474-3_23

OCPQ

Backend online

OCEL loaded
21008 Events
10840 Objects

OCEL Info

Graph

Queries & Constraints

Back

Backend Mode: local

OCEL Info

Number of Event Types: 11
Number of Events: 21008
Number of Object Types: 6
Number of Objects: 10840

General

21008 Events
10840 Objects

Event Types 11

pay order | package delivered | place order | create package | confirm order | item out of stock | pick item | send package | payment reminder | reorder item | failed delivery

Object Types 6

orders
.00 price (float)

items
.00 weight (float)
.00 price (float)

packages
.00 weight (float)

customers

products
.00 weight (float)
.00 price (float)

employees
Aa role (string)

OCPQ

Backend online

OCEL loaded
21008 Events
10840 Objects

OCEL Info

Graph

Queries & Constraints

Back

Backend Mode: local

OCEL Graph

Root ID o-990003 Object Event

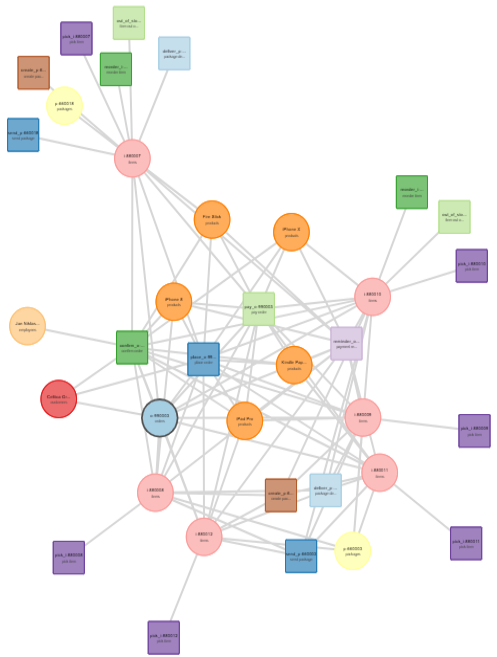
Max Distance 2

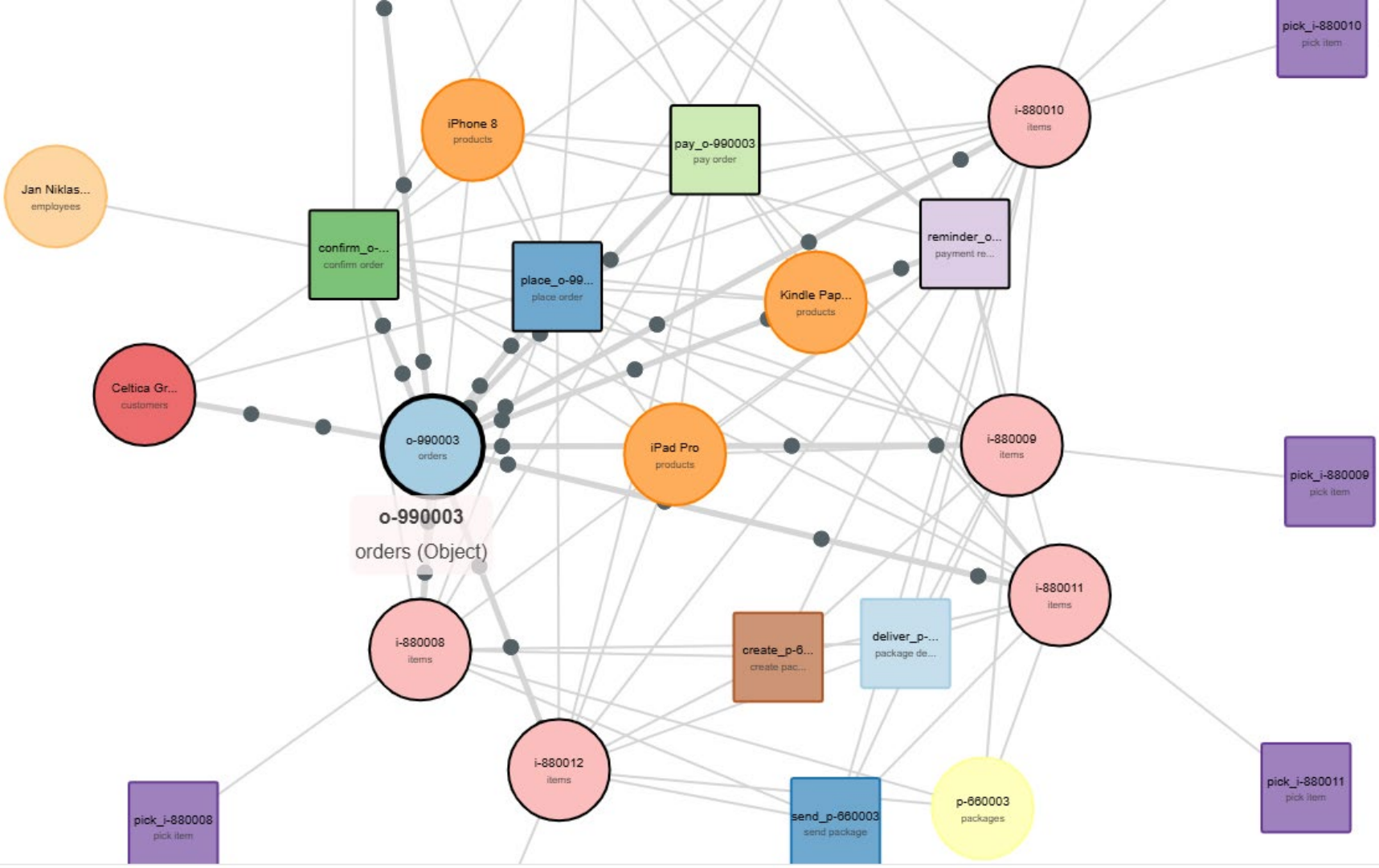
Maximum Neighbors 100

Spanning Tree

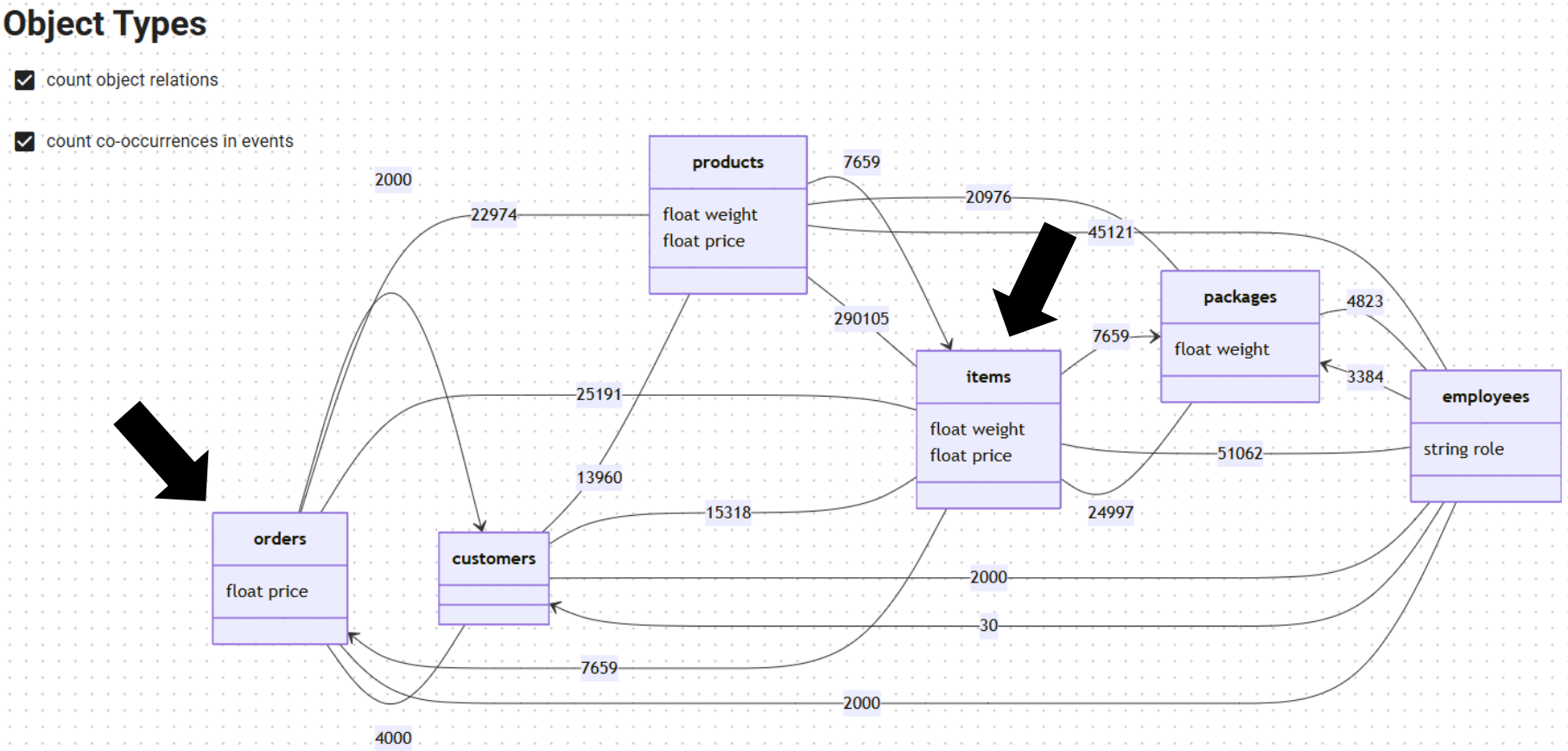
Apply

OCPQ support

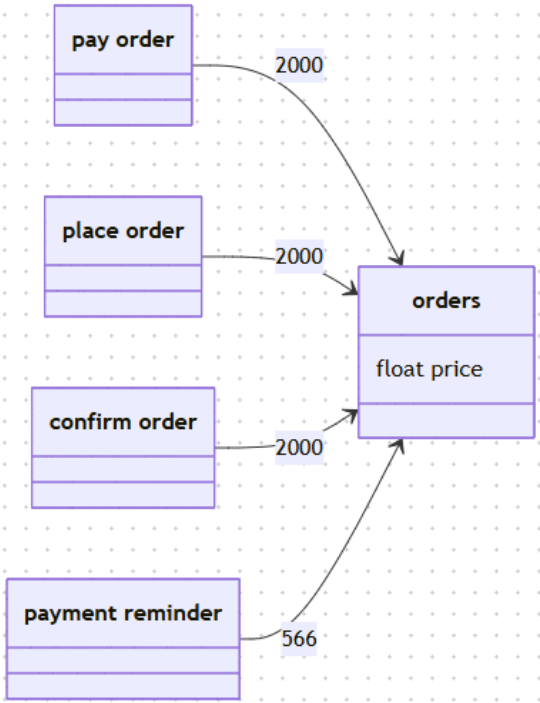


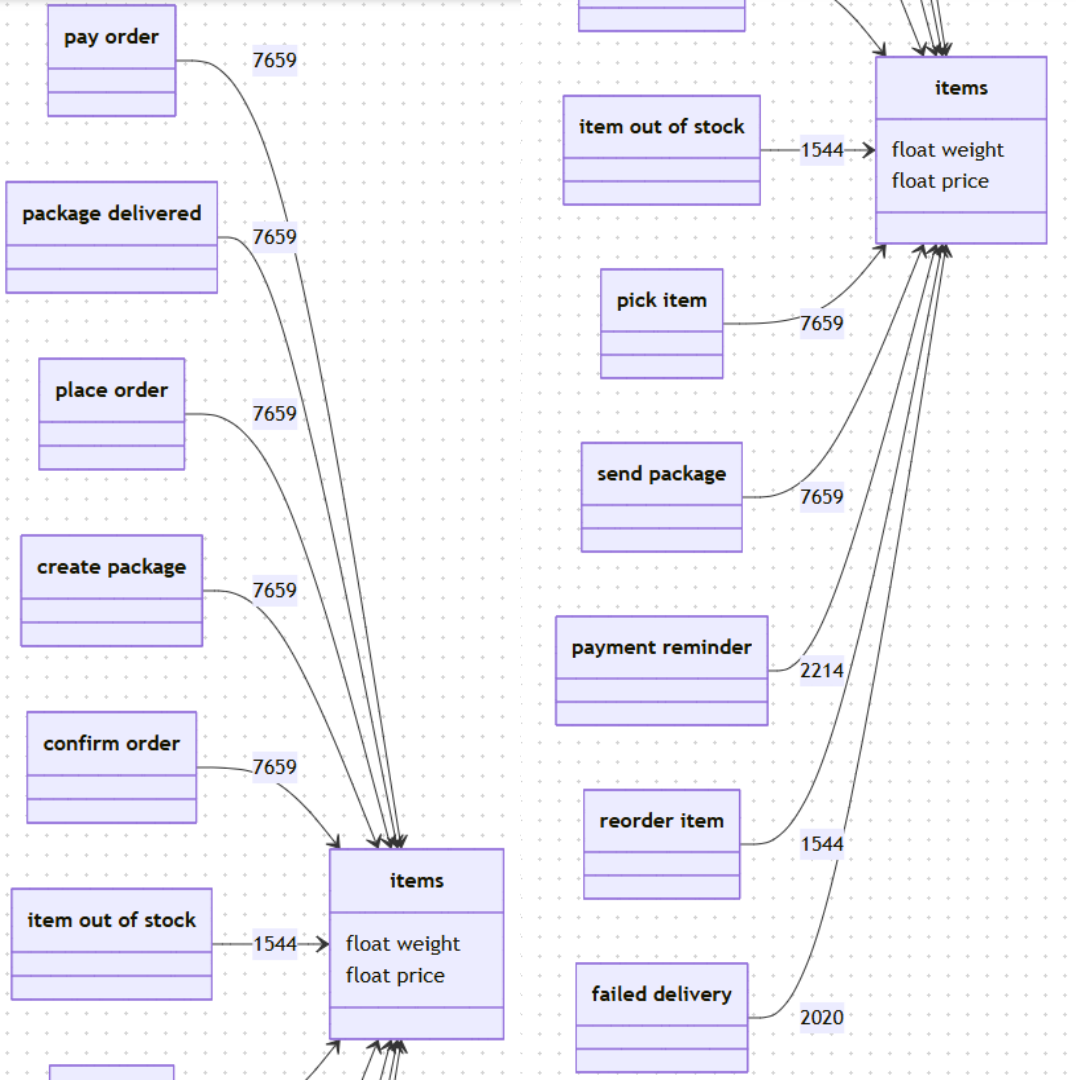

pick_i-880010
pick item
iPhone 8
products
pay_o-990003
pay order
i-880010
items
Jan Niklas...
employees
confirm_o-...
confirm order
place_o-99...
place order
reminder_o...
payment re...
Kindle Pap...
products
Celtica Gr...
customers
o-990003
orders
iPad Pro
products
i-880009
items
pick_i-880009
pick item
o-990003
orders (Object)
i-880011
items
i-880008
items
create_p-6...
create pac...
deliver_p-...
package de...
i-880012
items
pick_i-880008
pick item
send_p-660003
send package
p-660003
packages
pick_i-880011
pick item

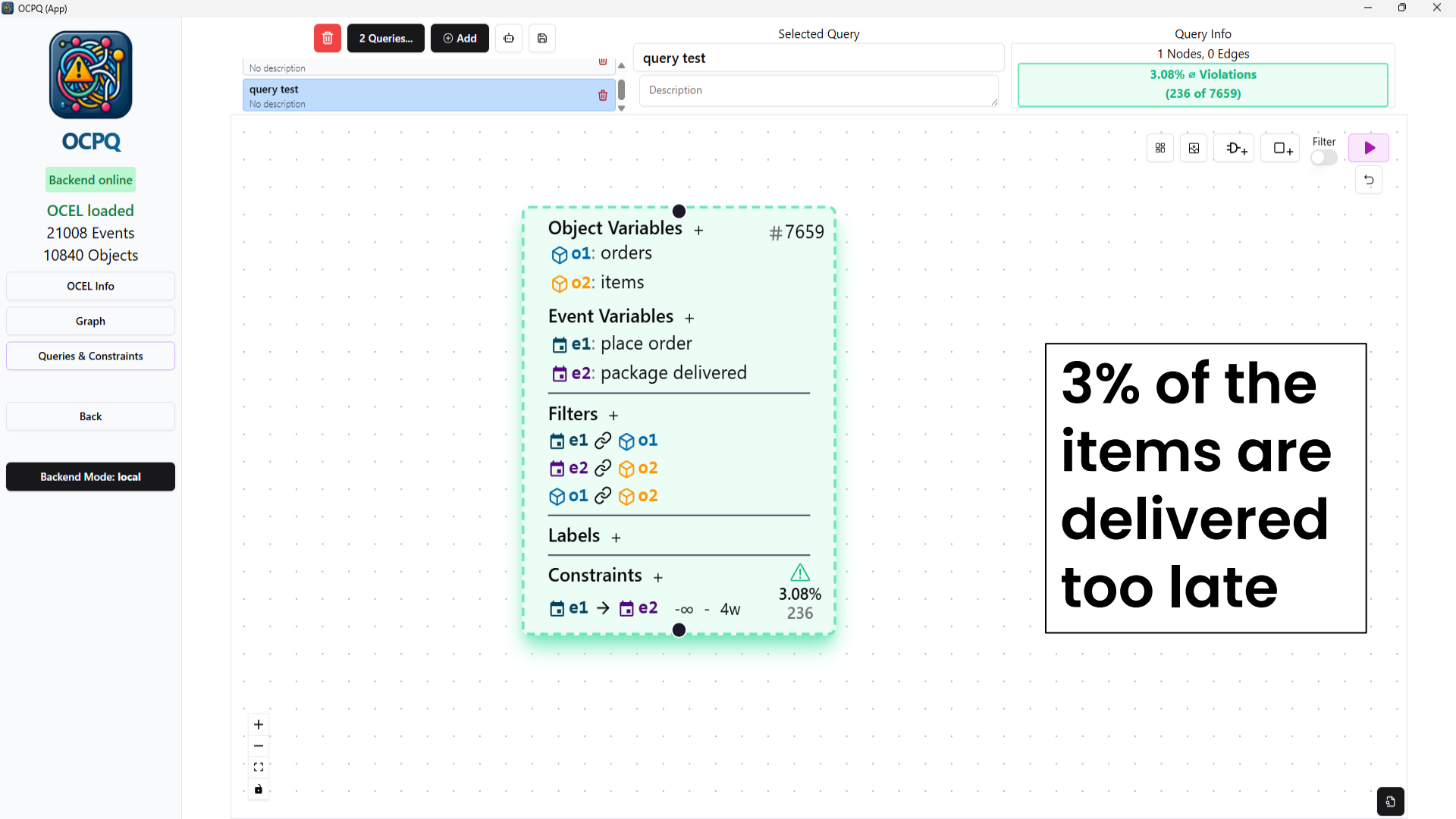
Let’s focus on orders and items



Let’s focus on just orders and items






OCPQ (App)
2 Queries...
Add
No description
query test
No description
Selected Query
query test
Description
Query Info
1 Nodes, 0 Edges
3.08% ⌀ Violations
(236 of 7659)
OCPQ
Backend online
OCEL loaded
21008 Events
10840 Objects
OCEL Info
Graph
Queries & Constraints
Back
Backend Mode: local
Filter
Object Variables +
#7659
o1: orders
o2: items
Event Variables +
e1: place order
e2: package delivered
Filters +
e1 o1
e2 o2
o1 o2
Labels +
Constraints +
e1 → e2 -∞ - 4w
3.08%
236
3% of the items are delivered too late

OCPQ (App)

Output Bindings

7659 Bindings
236 Violations

o1	o2	e1	e2	Violation
Search...	Search...	Search...	Search...	any
o-990001	i-880002	place_o-990001	deliver_p-660001	
o-990001	i-880003	place_o-990001	deliver_p-660001	
o-990001	i-880001	place_o-990001	deliver_p-660001	
o-990002	i-880004	place_o-990002	deliver_p-660001	
o-990002	i-880005	place_o-990002	deliver_p-660001	
o-990002	i-880006	place_o-990002	deliver_p-660001	
o-990003	i-880012	place_o-990003	deliver_p-660003	
o-990003	i-880007	place_o-990003	deliver_p-660018	
o-990003	i-880011	place_o-990003	deliver_p-660003	
o-990003	i-880008	place_o-990003	deliver_p-660003	

Rows per page 10 Page 1 of 766

Add

Selected Query

query test

Description

Query Info

1 Nodes, 0 Edges

3.08% ⌀ Violations
(236 of 7659)

Filter

Object Variables + #7659
o1: orders
o2: items

Event Variables +
e1: place order
e2: package delivered

Filters +
e1 o1
e2 o2
o1 o2

Labels +

Constraints +
e1 → e2 -∞ - 4w
3.08%
236

OCPQ (App)

Output Bindings

7659 Bindings
236 Violations

o1	o2	e1	e2	Violation viol.
o-990026	i-880114	place_o-990026	deliver_p-660065	e1 → e2
o-990031	i-880135	place_o-990031	deliver_p-660091	e1 → e2
o-990036	i-880157	place_o-990036	deliver_p-660074	e1 → e2
o-990047	i-880202	place_o-990047	deliver_p-660121	e1 → e2
o-990061	i-880262	place_o-990061	deliver_p-660108	e1 → e2
o-990061	i-880261	place_o-990061	deliver_p-660108	e1 → e2
o-990078	i-880330	place_o-990078	deliver_p-660120	e1 → e2
o-990085	i-880361	place_o-990085	deliver_p-660132	e1 → e2
o-990087	i-880377	place_o-990087	deliver_p-660165	e1 → e2
o-990094	i-880408	place_o-990094	deliver_p-660147	e1 → e2
o-990103	i-880434	place_o-990103	deliver_p-660136	e1 → e2
o-990109	i-880469	place_o-990109	deliver_p-660146	e1 → e2
o-990114	i-880484	place_o-990114	deliver_p-660149	e1 → e2
o-990114	i-880488	place_o-990114	deliver_p-660169	e1 → e2
o-990133	i-880545	place_o-990133	deliver_p-660152	e1 → e2
o-990153	i-880626	place_o-990153	deliver_p-660169	e1 → e2
o-990153	i-880627	place_o-990153	deliver_p-660185	e1 → e2
o-990160	i-880662	place_o-990160	deliver_p-660175	e1 → e2
o-990183	i-880753	place_o-990183	deliver_p-660196	e1 → e2

Rows per page 30 Page 1 of 8

Add

Selected Query

query test

Description

Query Info

1 Nodes, 0 Edges

3.08% ⌀ Violations (236 of 7659)

Filter

Object Variables + #7659

o1: orders

o2: items

Event Variables +

e1: place order

e2: package delivered

Filters +

e1 o1

e2 o2

o1 o2

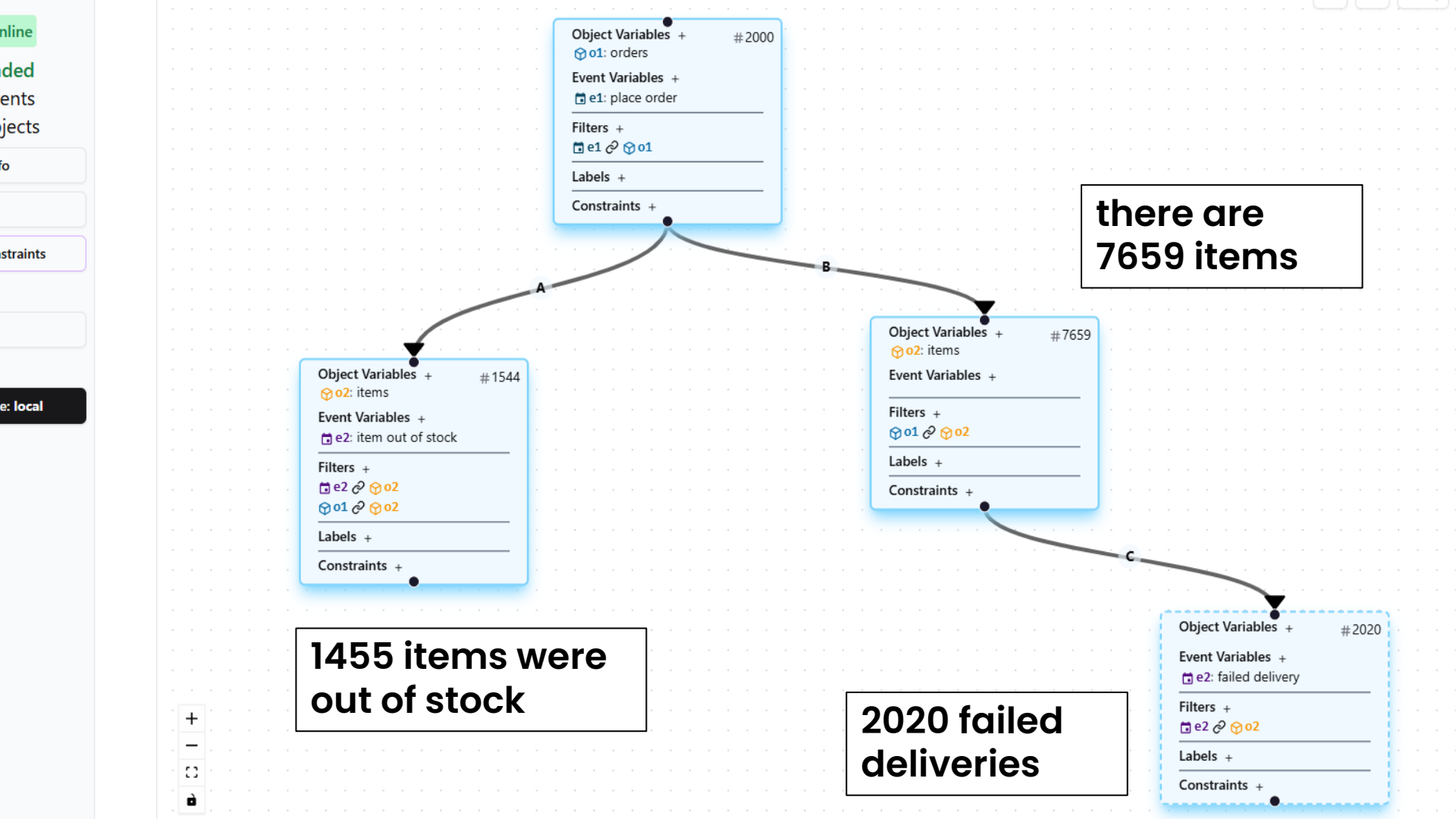
Labels +

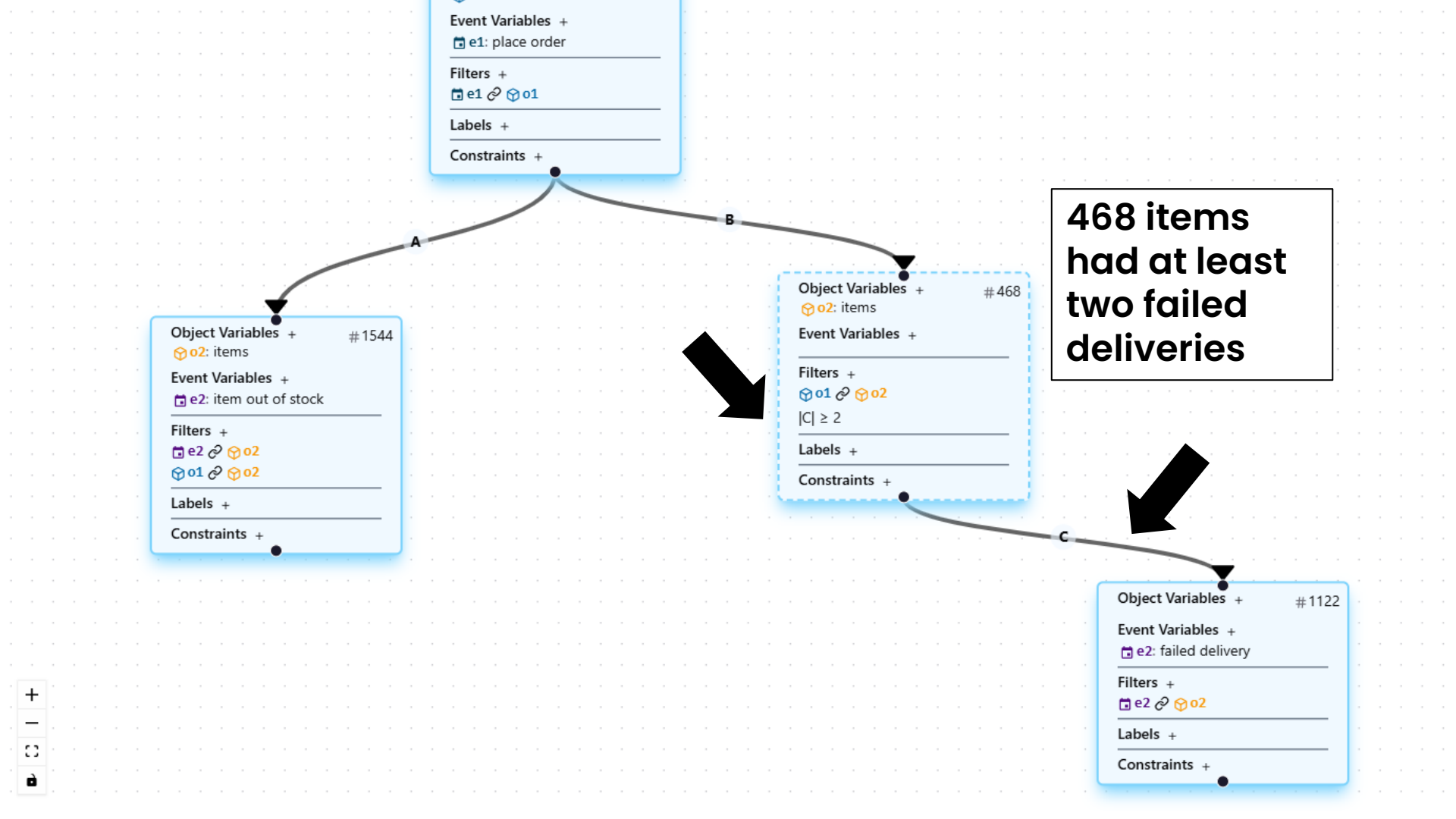
Constraints +

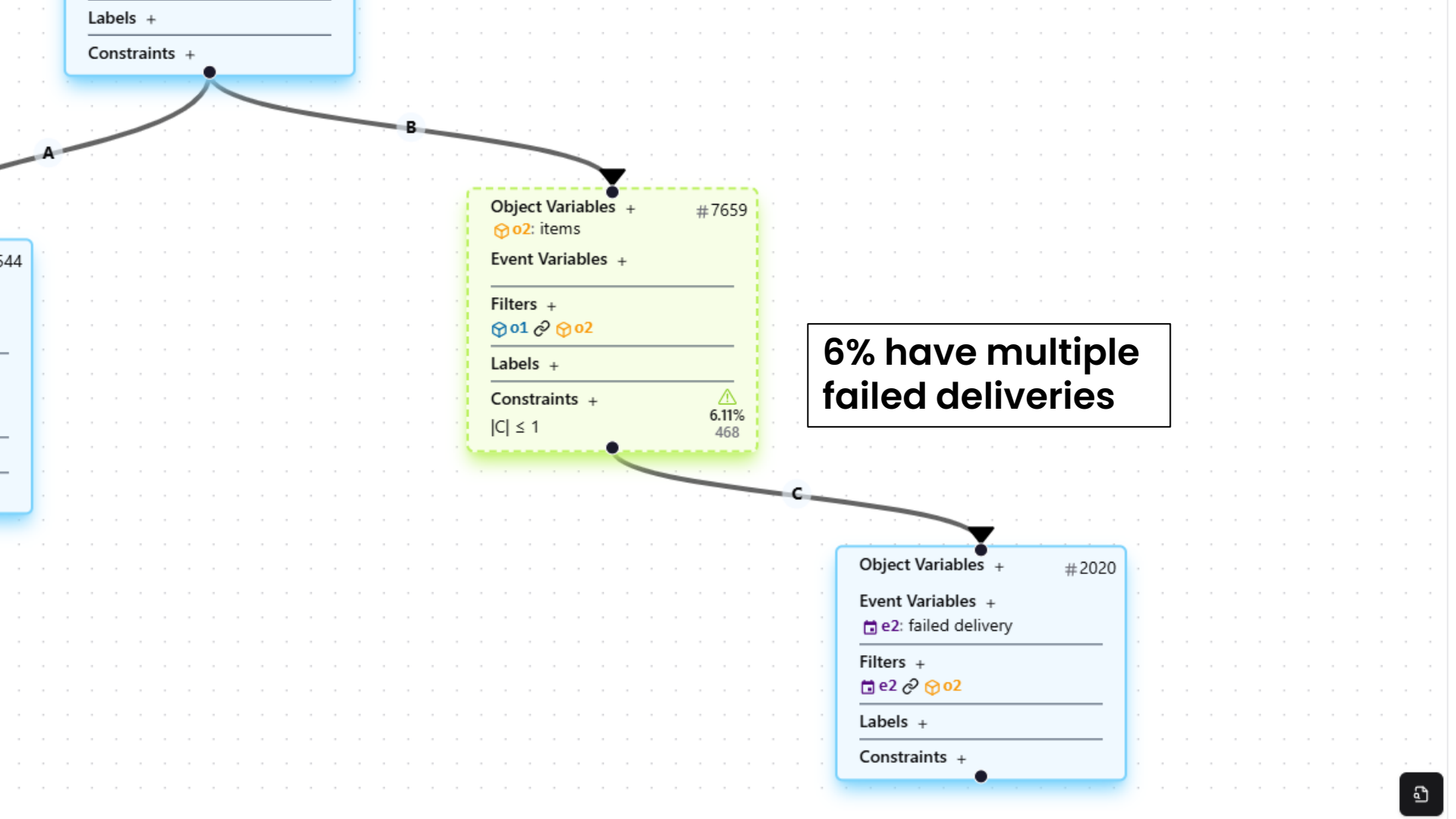
e1 → e2 -∞ - 4w

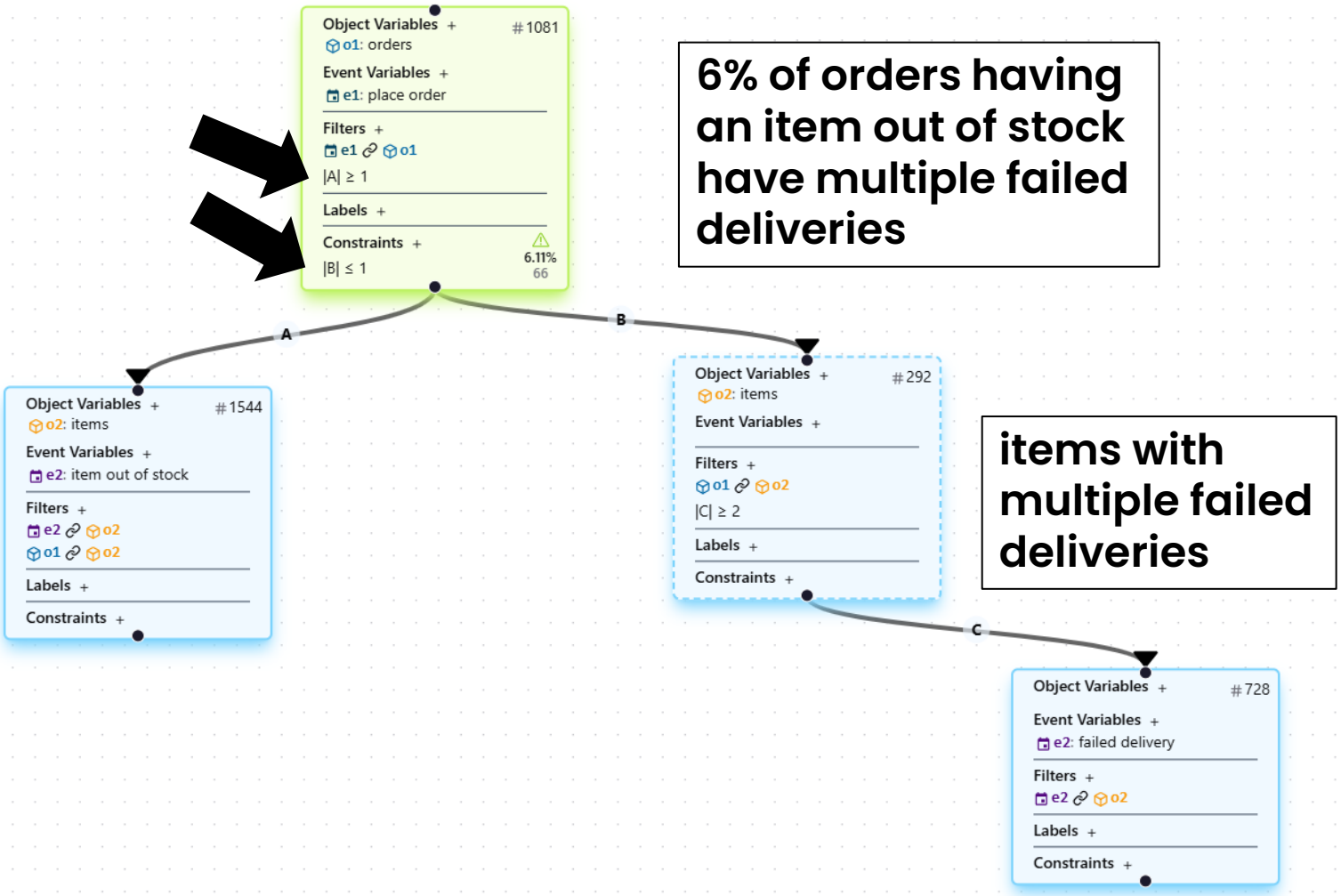
3.08%

236

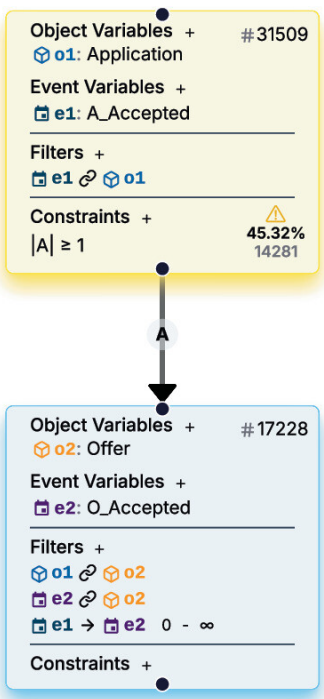

Object Variables + #2000
o1: orders
Event Variables +
e1: place order
Filters +
e1 o1
Labels +
Constraints +
A
B
there are 7659 items
Object Variables + #1544
o2: items
Event Variables +
e2: item out of stock
Filters +
e2 o2
o1 o2
Labels +
Constraints +
Object Variables + #7659
o2: items
Event Variables +
Filters +
o1 o2
Labels +
Constraints +
C
1455 items were out of stock
Object Variables + #2020
Event Variables +
e2: failed delivery
Filters +
e2 o2
Labels +
Constraints +
2020 failed deliveries


Event Variables +
e1: place order
Filters +
e1 o1
Labels +
Constraints +
A
B
Object Variables +
#1544
o2: items
Event Variables +
e2: item out of stock
Filters +
e2 o2
o1 o2
Labels +
Constraints +
Object Variables +
#468
o2: items
Event Variables +
Filters +
o1 o2
|C| ≥ 2
Labels +
Constraints +
C
Object Variables +
#1122
Event Variables +
e2: failed delivery
Filters +
e2 o2
Labels +
Constraints +
468 items had at least two failed deliveries


Labels +
Constraints +
A
B
544
Object Variables +
#7659
o2: items
Event Variables +
Filters +
o1 o2
Labels +
Constraints +
|C| ≤ 1
6.11%
468
C
6% have multiple failed deliveries
Object Variables +
#2020
Event Variables +
e2: failed delivery
Filters +
e2 o2
Labels +
Constraints +


Object Variables + #1081
o1: orders
Event Variables +
e1: place order
Filters +
e1 o1
|A| ≥ 1
Labels +
Constraints +
6.11%
66
|B| ≤ 1
A
B
Object Variables + #1544
o2: items
Event Variables +
e2: item out of stock
Filters +
e2 o2
o1 o2
Labels +
Constraints +
Object Variables + #292
o2: items
Event Variables +
Filters +
o1 o2
|C| ≥ 2
Labels +
Constraints +
C
Object Variables + #728
Event Variables +
e2: failed delivery
Filters +
e2 o2
Labels +
Constraints +
6% of orders having an item out of stock have multiple failed deliveries
items with multiple failed deliveries

After an Application was accepted, there should be at least one associated Offer accepted afterwards



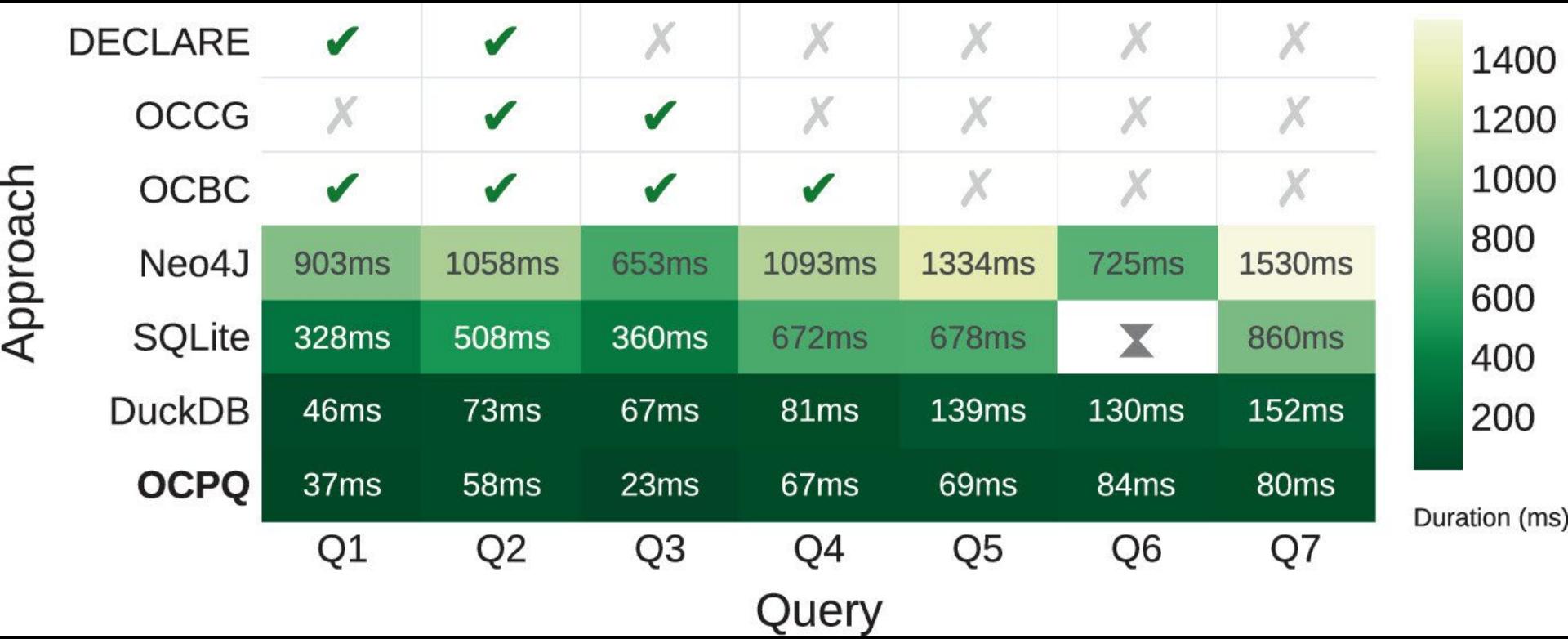
(a) Q4 in OCPQ

```sql
WITH
    AcceptedOffers AS (
        SELECT DISTINCT
            O2O.ocel_source_id,
            E2.ocel_id,
            E2.ocel_time
        FROM
            object_object AS O2O
            INNER JOIN object_Offer AS A2 ON O2O.ocel_target_id = A2.ocel_id
            INNER JOIN event_object AS E2O2 ON E2O2.ocel_object_id = A2.ocel_id
            INNER JOIN event_O_Accepted AS E2 ON E2O2.ocel_event_id = E2.ocel_id
    )
SELECT
    A1.ocel_id,
    E1.ocel_id,
    (
        SELECT
            COUNT(*)
        FROM
            AcceptedOffers AS AO
        WHERE
            AO.ocel_source_id = A1.ocel_id
            AND AO.ocel_source_id = A1.ocel_id
            AND E1.ocel_time <= AO.ocel_time
    ) >= 1 AS satisfied
FROM
    object_Application AS A1
    INNER JOIN event_object AS E2O ON E2O.ocel_object_id = A1.ocel_id
    INNER JOIN event_A_Accepted AS E1 ON E2O.ocel_event_id = E1.ocel_id;
```

(b) Q4 in SQL

```cypher
MATCH (o1:Entity { EntityType: "Application" }) <-[:CORR]- (e1:Event {Activity:
↪  "A_Accepted"})
OPTIONAL MATCH (e2:Event { Activity: "O_Accepted" }) -[:CORR]-> (o2:Entity {EntityType:
↪  "Offer"}) -[:REL]-> (o1)
WHERE e1.timestamp <= e2.timestamp
WITH o1, COUNT(e2) AS e2_c, COUNT(o2) AS o2_c
WHERE e2_c < 1 OR o2_c < 1
RETURN COUNT(o1) AS violationCount
```

(c) Q4 in Cypher (violation count only)



Comparison as fair as possible, e.g., for SQLite, the OCEL 2.0 database was completely loaded into memory, to be a more accurate comparison to OCPQ, and it was ensured that appropriate table indexes were created.

OCPQ: Object-Centric Process Querying and Constraints

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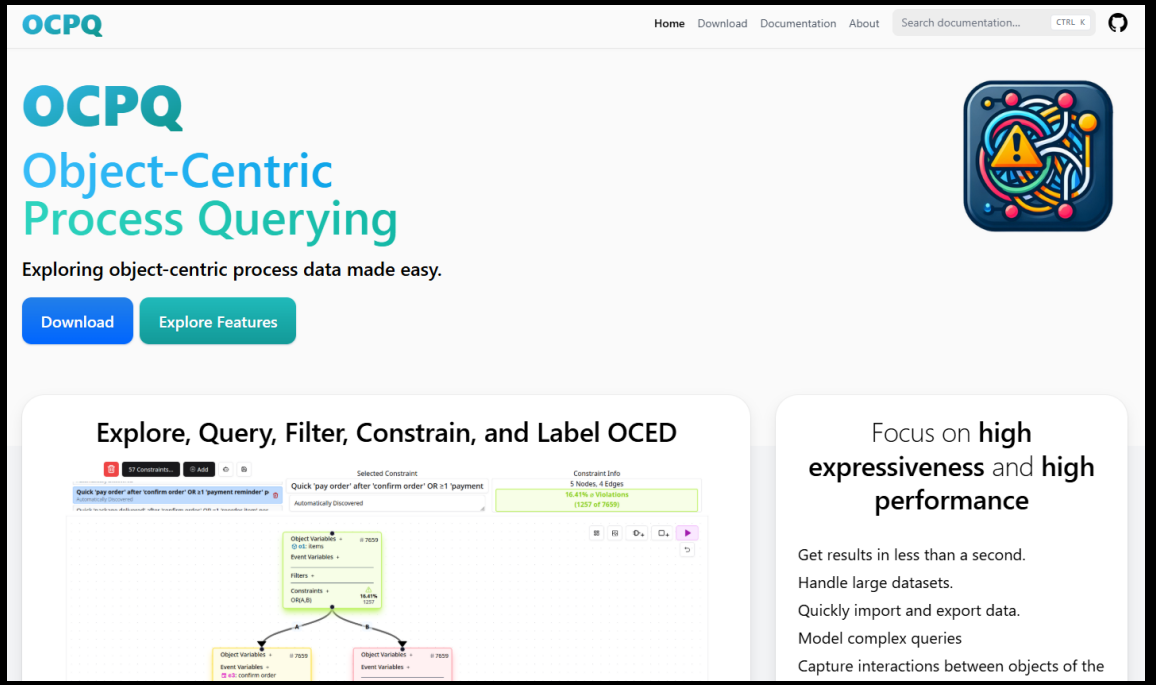
Abstract. Process querying is used to extract information and insights from process execution data. Similarly, process constraints can be checked against input data, yielding information on which process instances violate them. Traditionally, such process mining techniques use case-centric event data as input. However, with the uptake of Object-Centric Process Mining (OCPM), existing querying and constraint checking techniques are no longer applicable. Object-Centric Event Data (OCED) removes the requirement to pick a single case notion (i.e., requiring that events belong to exactly one case) and can thus represent many real-life processes much more accurately. In this paper, we present a novel highly-expressive approach for object-centric process querying, called *OCPQ*. It supports a wide variety of applications, including OCED-based constraint checking and filtering. The visual representation of nested queries in OCPQ allows users to intuitively read and create queries and constraints. We implemented our approach using (1) a high-performance execution engine backend and (2) an easy-to-use editor frontend. Additionally, we evaluated our approach on a real-life dataset, showing the lack in expressiveness of prior work and runtime performance significantly better than the general querying solutions SQLite and Neo4j, as well as comparable to the performance-focused DuckDB.

Keywords: Object-Centric Process Mining · Querying · Constraints

1 Introduction

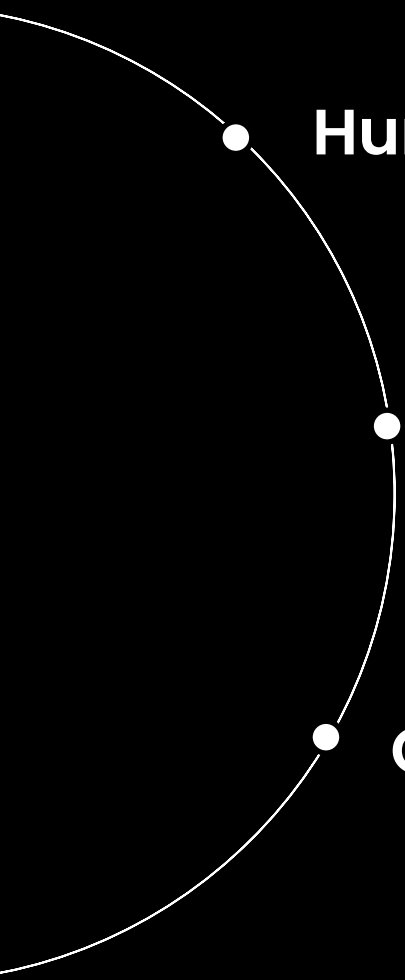
In organizations, process execution data contain valuable insights that are often not leveraged to their full extent. The domain of process querying is concerned with methods and techniques for extracting such insights from event data. For example, given data of an order management process, a simple query for interesting cases could be formulated in natural language as "Find all cases where `pay order` is executed more than once". Process querying of execution data also has a strong correspondence to process constraints: Identifying violations of a process constraint, e.g., "`pay order` should be executed exactly once per case", corresponds to querying its violations (i.e., a query with the negated constraint).

J. Grabis et al. (Eds.): RCIS 2025, LNBIP 547, pp. 383–400, 2025.
https://doi.org/10.1007/978-3-031-92474-3_23



https://ocpq.aarkue.eu/

Conclusion



- Human-in-the-loop
- Cortado
- OCPQ

www.vdaalst.com
www.processmining.org
www.pads.rwth-aachen.de