OC-DECLARE

Discovering Object-Centric Declarative Patterns with Synchronization

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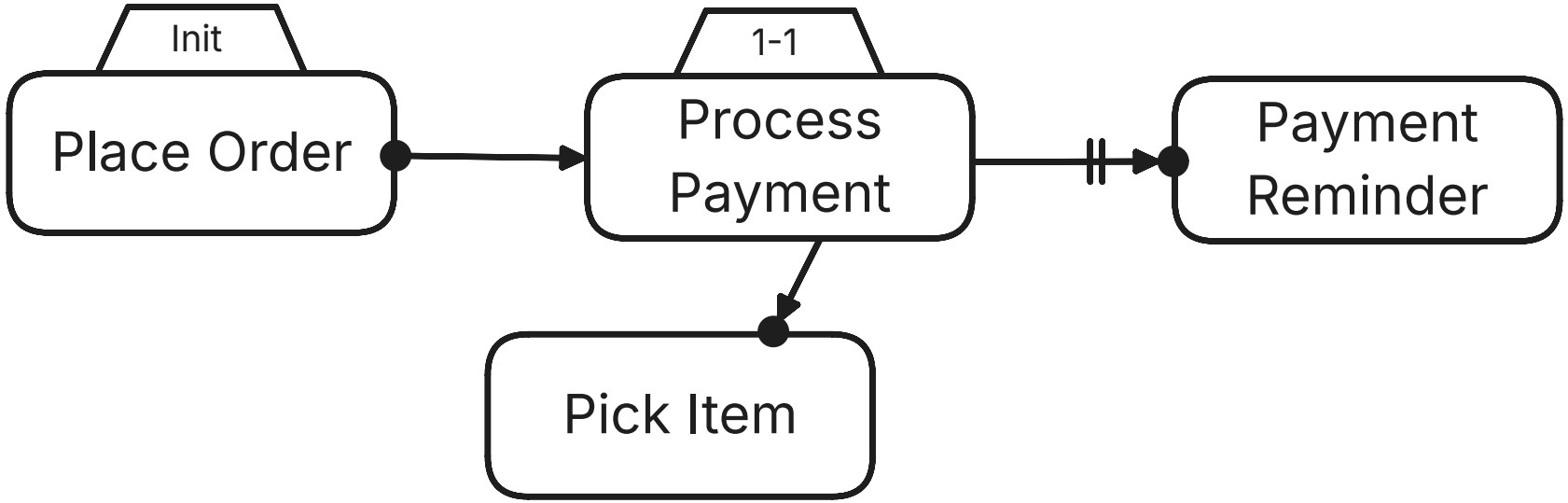
Chair of Process and Data Science

RWTH AACHEN UNIVERSITY

Declarative Process Mining

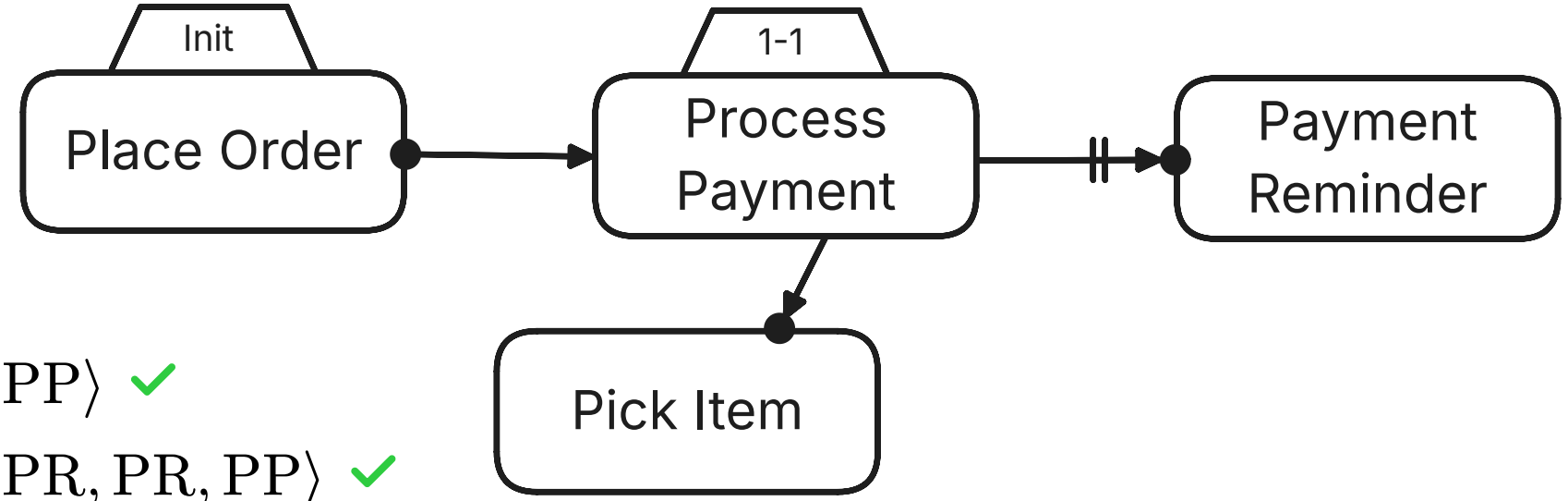
DECLARE

(Pesic et al., 2007)



DECLARE

(Pesic et al., 2007)



- $\langle \mathrm{PO}, \mathrm{PP} \rangle$ ✓
- $\langle \mathrm{PO}, \mathrm{PR}, \mathrm{PR}, \mathrm{PP} \rangle$ ✓
- $\langle \mathrm{PO}, \mathrm{PP}, \mathrm{PR} \rangle$ ✗
- $\langle \mathrm{PR}, \mathrm{PP}, \mathrm{PP} \rangle$ ✗

Object-Centric Event Data

Event Data

ID	Activity	Time	Case
1	Place Order	01.05.25 10:30	
2	Confirm Order	02.05.25 08:42	
3	Place Order	10.05.25 07:45	
4	Process Payment	12.05.25 12:54	
5	Pick Item	13.05.25 06:54	 ?
6	Confirm Order	13.05.25 08:31	
7	Pick Item	13.05.25 06:54	 ?
...	...	...	...

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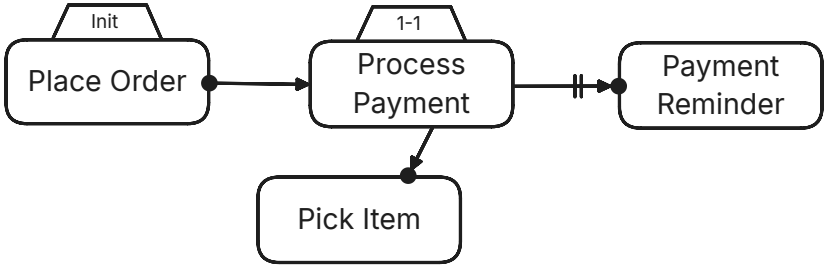

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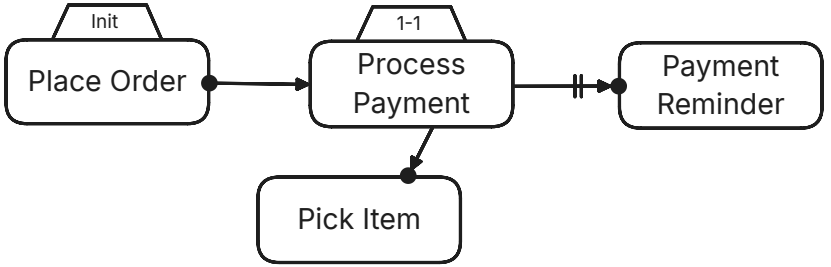

⟨Place Order,
Confirm Order,
Process Payment,
Pick Item,
Pick Item⟩

⟨Place Order,
Confirm Order⟩

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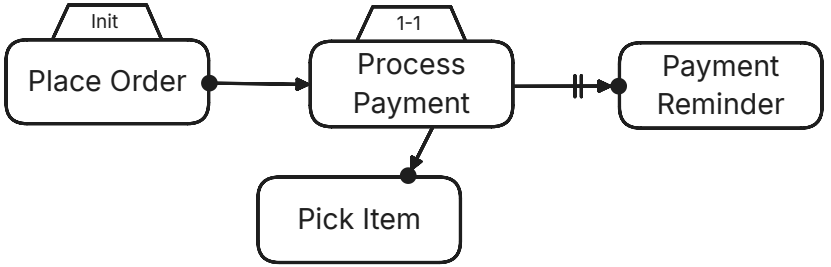

⟨Place Order, Confirm Order, Process Payment, Pick Item, Pick Item⟩ ✓

⟨Place Order, Confirm Order⟩ ✗

Object-Centric Event Data

Object Types

customer
order
item

ID	Activity	Time	Objects
1	Place Order	01.05.25 10:30	{customer, order, item, item}
2	Confirm Order	02.05.25 08:42	{order, item, item}
3	Place Order	10.05.25 07:45	{customer, order, item}
4	Process Payment	12.05.25 12:54	{order}
5	Pick Item	13.05.25 06:54	{item}
6	Confirm Order	13.05.25 08:31	{order, item}
7	Pick Item	13.05.25 06:54	{item}
...	...	...	...

Object-Centric Event Data

Object Types

customer

order

item

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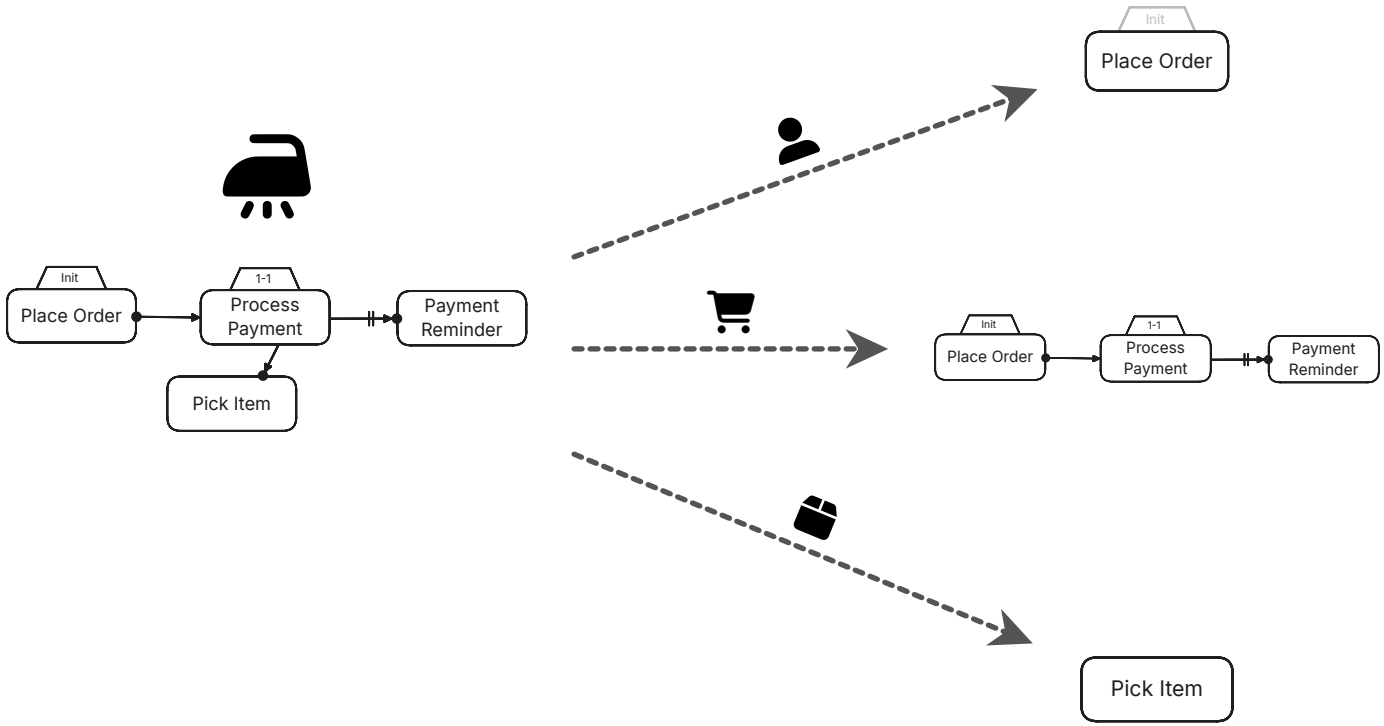
 ⟨Place Order, Place Order⟩

 ⟨Place Order, Confirm Order, Process Payment⟩

 ⟨Place Order, Confirm Order, Pick Item⟩

Flattening: Multi-Object DECLARE



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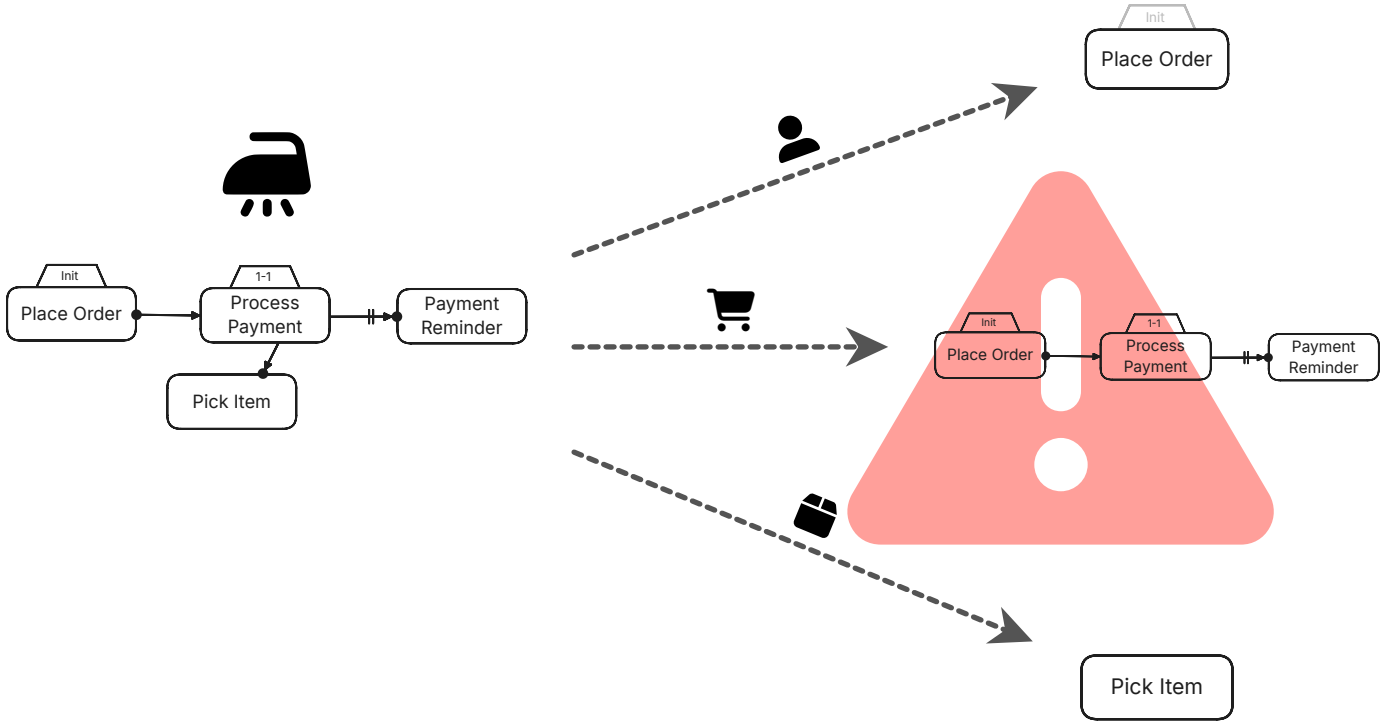

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⟨Place Order, Confirm Order, Process Payment⟩

⟨Place Order, Confirm Order, Pick Item⟩

Related Work

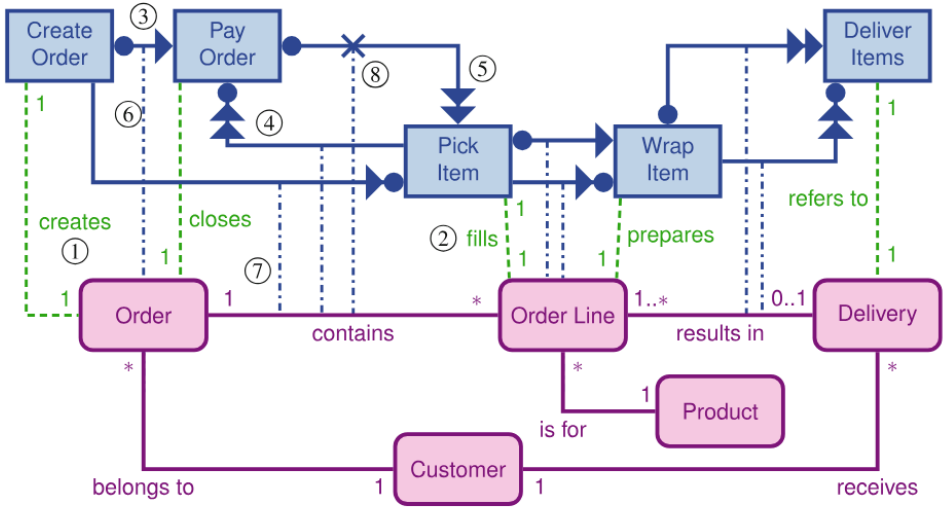


Fig. 2. Example of an OCBC model

(van der Aalst et al., 2017)
(Artale et al., 2019)

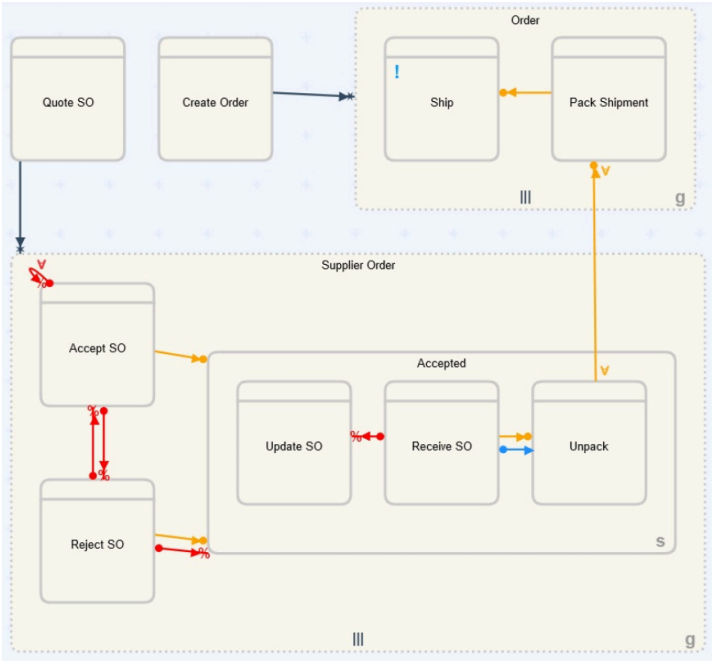


Fig. 2. An example OC-DCR Graph

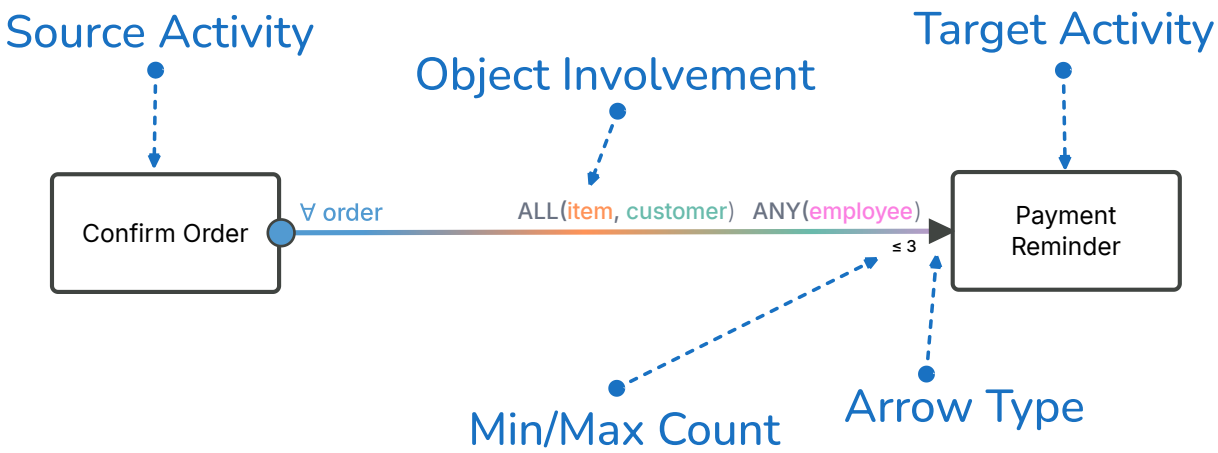
(Christfort et al., 2024)

OC-DECLARE

Fully Object-Centric DECLARE

Components of OC-DECLARE

1) Source Activity
2) Target Activity
3) Arrow Type
4) Object Involvement Label
5) Min. / Max. Counts

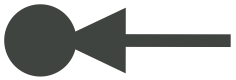


Arrow Types

Arrow types model temporal relations between events.


no temporal filter


target event **after** source event


target event **before** source event


target event **directly after** source event

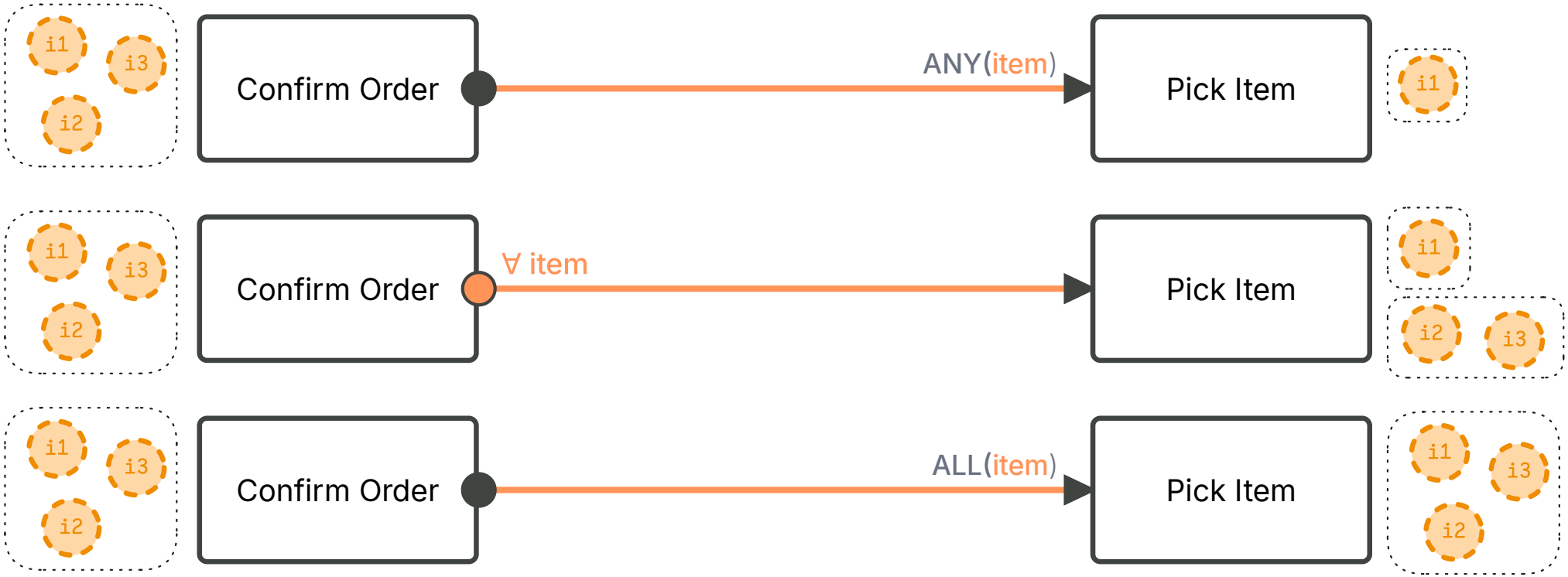

target event **directly before** source event

directly ≡ no events with matching object involvement in between

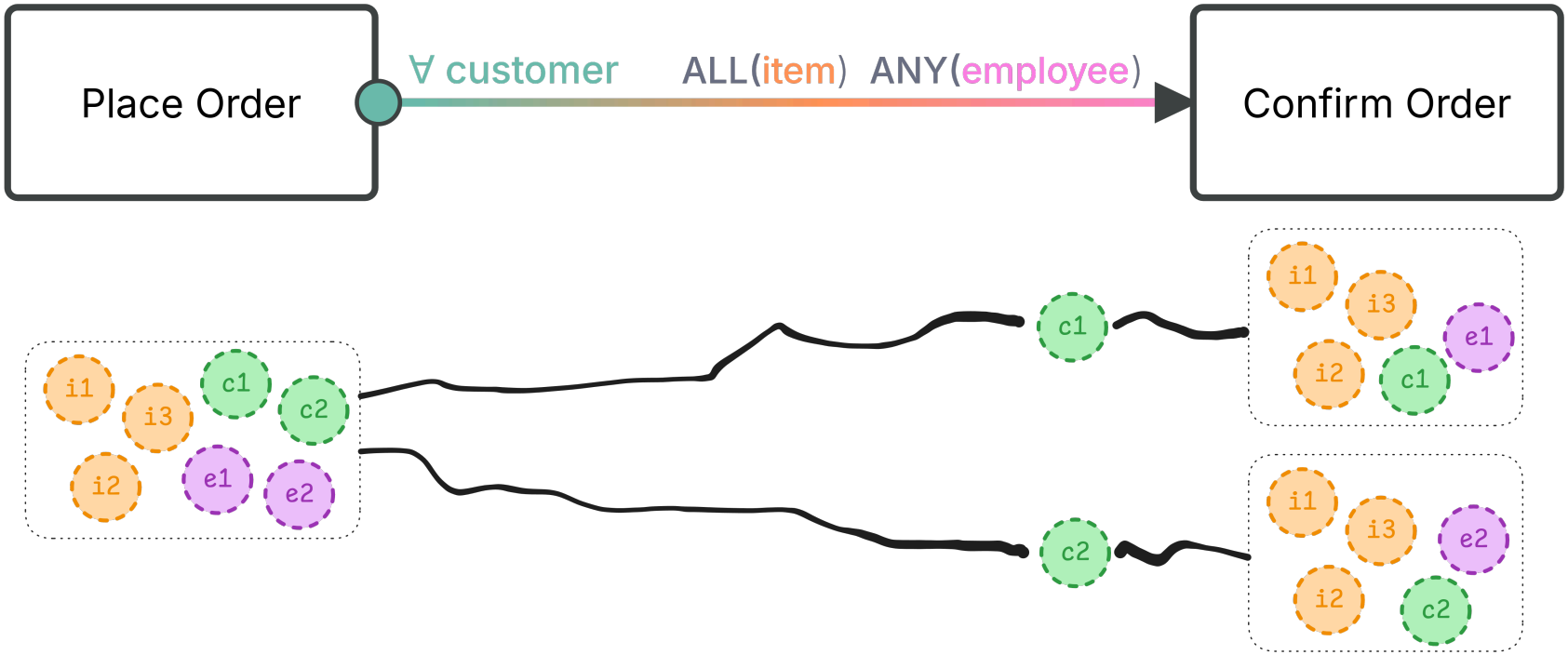
Object Involvements: Easy?

Object Involvements: Any, Each, All

Object Involvements: Any, Each, All



Each + All + Any


Place Order
∀ customer
ALL(item)
ANY(employee)
Confirm Order
i1
i3
c1
c2
i2
e1
e2
c1
c2
i1
i3
e1
i2
c1
i1
i3
e2
i2
c2

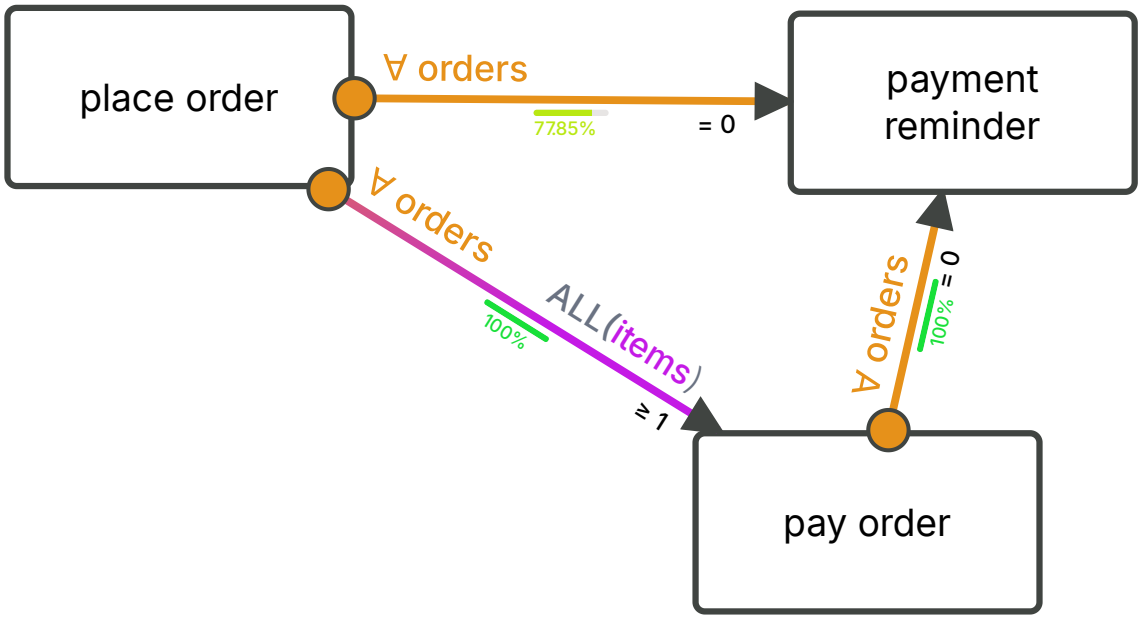
Counts & Negation

- Combination of $n_{\min}$ and $n_{\max}$ keeps approach flexible
- Common combinations:
  - Existence Constraints (i.e., $n_{\min} = 1$, $n_{\max} = \infty$)
  - Negation (i.e., $n_{\min} = n_{\max} = 0$)

Conformance

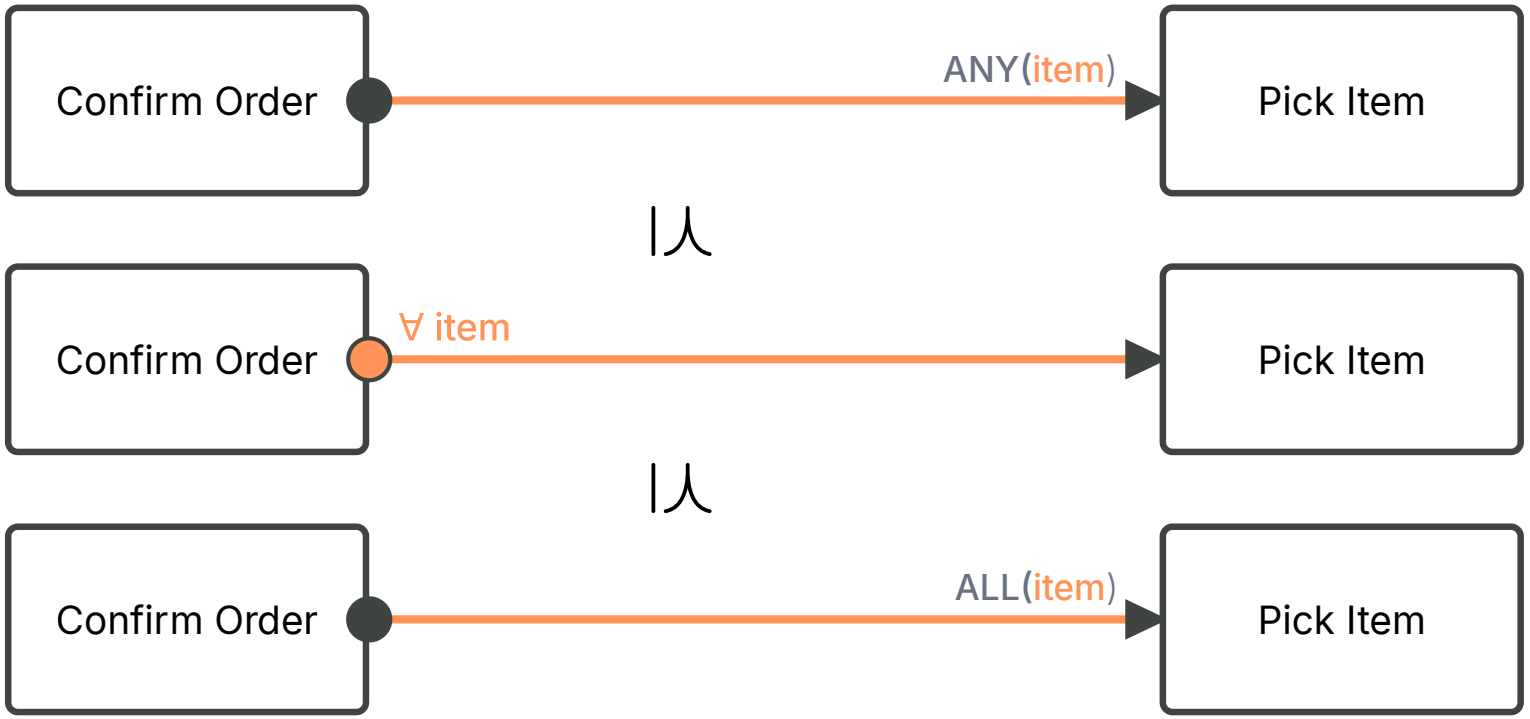
Confidence

... just count how many of the ‘trigger events’ are satisfied per constraint.



Discovery

Idea: Monotonicity Properties



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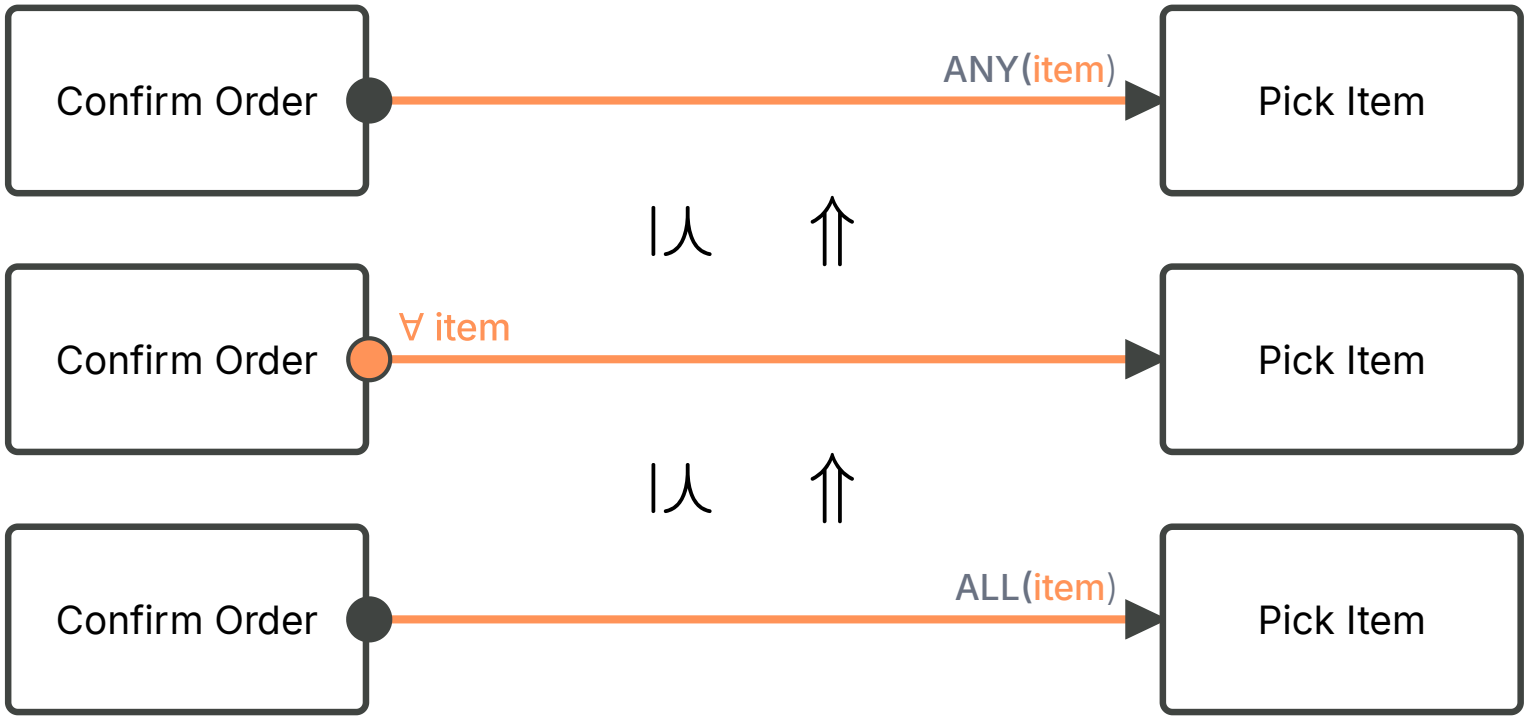

Idea: Monotonicity Properties

Disclaimer: We only look at existence-constraints here.

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Preference relation for OC-DECLARE constraints C and C':

- For C, C' with same activities and arrows:
  - Preference $\approx$ stricter object involvement
    - Prefer $\textsc{All}$ over $\textsc{Each}$ and $\textsc{Any}$, etc.
- Corresponds to Implied Constraints: If C' is preferred over C and satisfied for an event e, C is also satisfied for e

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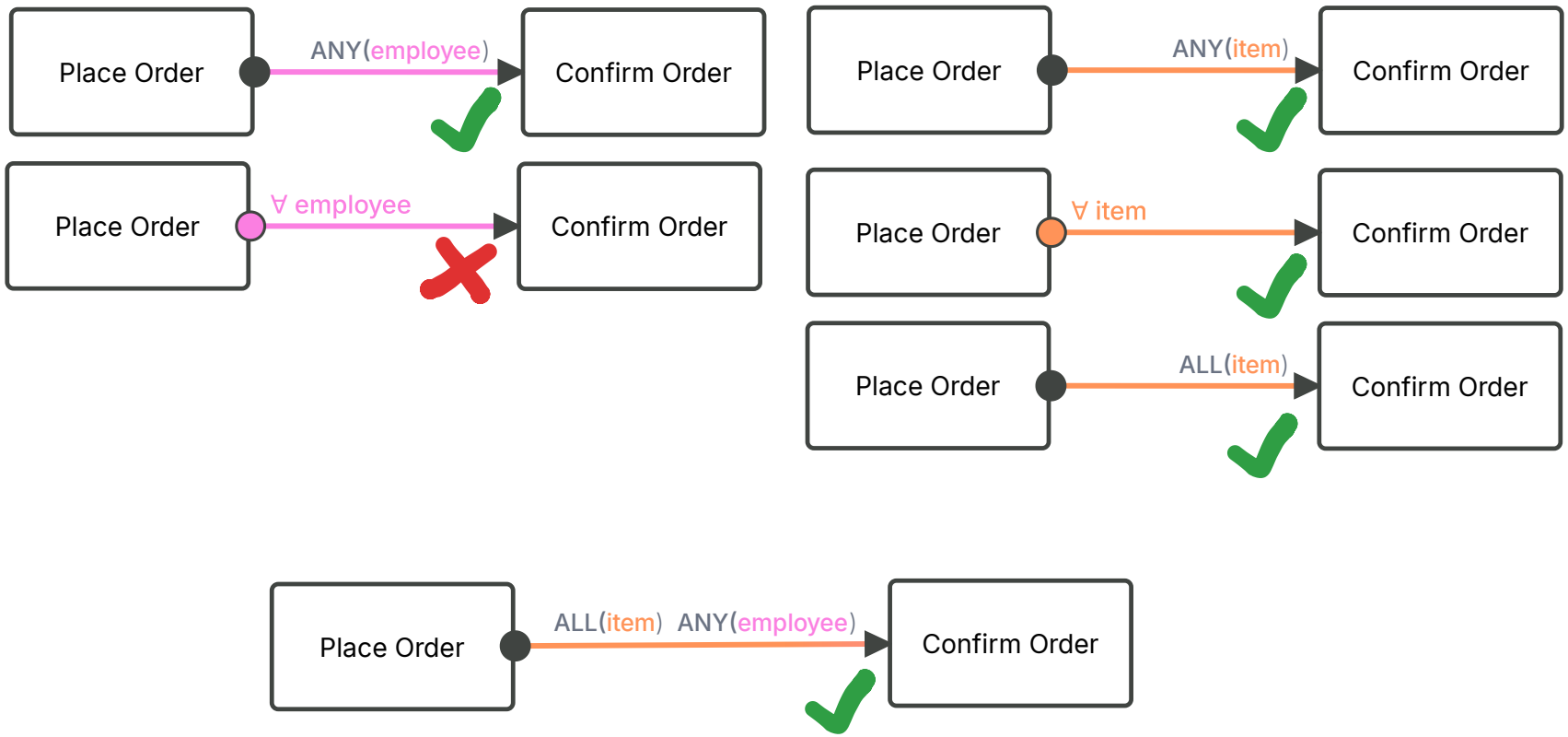
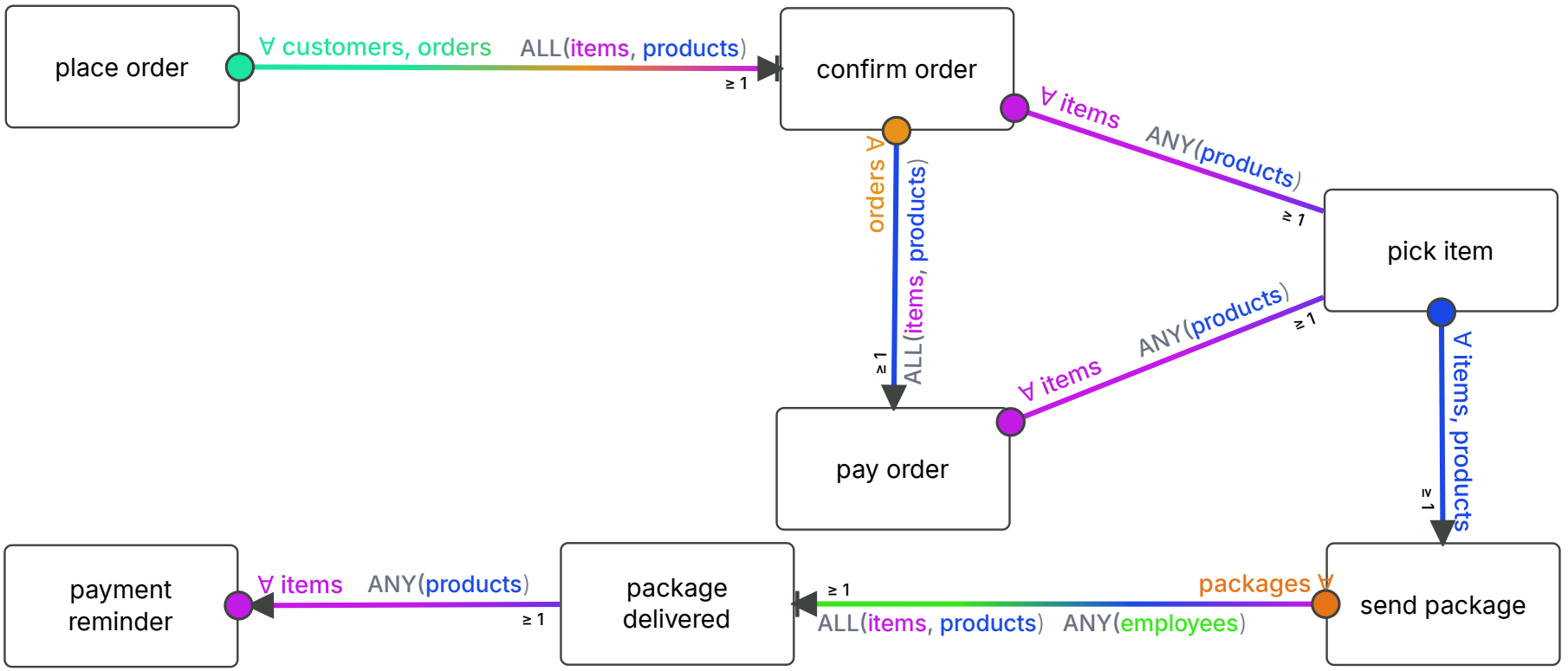
Monotonicity enables **Apriori-style discovery** of maximal constraints

Discovery Approach: Example



Order Management Discovery

Subset of discovered constraints



Bonus

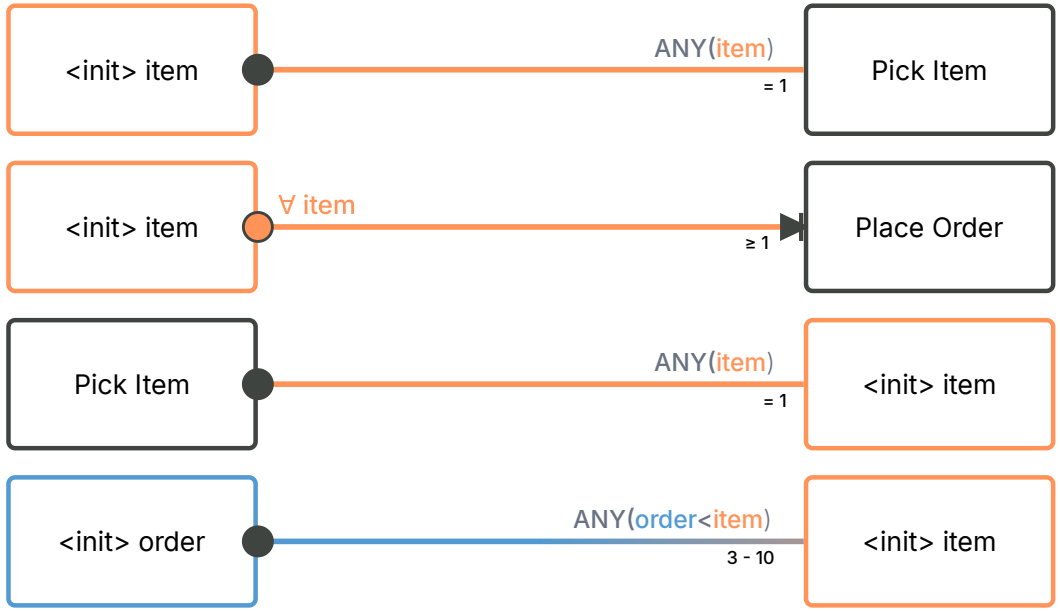
Object-to-Object Relationships

Object-to-object (O2O) Relationships can also be used for object involvement.

Example: An item has an O2O relation to the order it is part of.

Object Lifecycle Events: <init> and <exit>

Idea: Add artificial events before (<init>) and after (<exit>) the first/ last occurrence of an object.



AtLeastOne AtMostOne

Init

Thanks!

Questions or Comments?

References

Artale, A., Kovtunova, A., Montali, M., and van der Aalst, W. M. P. (2019). Modeling and Reasoning over Declarative Data-Aware Processes with Object-Centric Behavioral Constraints., in *Business Process Management - 17th International Conference, BPM 2019, Vienna, Austria, September 1-6, 2019, Proceedings*, eds.T. T. Hildebrandt, B. F. van Dongen, M. Rö glinger, and J. Mendling (Springer), 139–156. doi: 10.1007/978-3-030-26619-6_11

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Pesic, M., Schonenberg, H., and van der Aalst, W. M. P. (2007). DECLARE: Full Support for Loosely-Structured Processes., in *11th IEEE International Enterprise Distributed Object Computing Conference (EDOC 2007), 15-19 October 2007, Annapolis, Maryland, USA*, (IEEE Computer Society), 287–300. doi: 10.1109/EDOC.2007.14

van der Aalst, W. M. P., Artale, A., Montali, M., and Tritini, S. (2017). Object-Centric Behavioral Constraints: Integrating Data and Declarative Process Modelling., in *Proceedings of the 30th International Workshop on Description Logics, Montpellier, France, July 18-21, 2017*, eds.A. Artale, B. Glimm, and R. Kontchakov (CEUR-WS.org). Available at: https://ceur-ws.org/Vol-1879/paper51.pdf (Accessed May 27, 2024).