

Semantic Business Process Validation

SYSTEMATIC THOUGHT LEADERSHIP FOR INNOVATIVE BUSINESS



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Outline



- 1. Introduction**
- 2. Formalism**
- 3. Algorithms**
- 4. Conclusion**

■ Traditional BPs

- Workflow (AND/XOR splits/joins)
- Validation checks workflow soundness

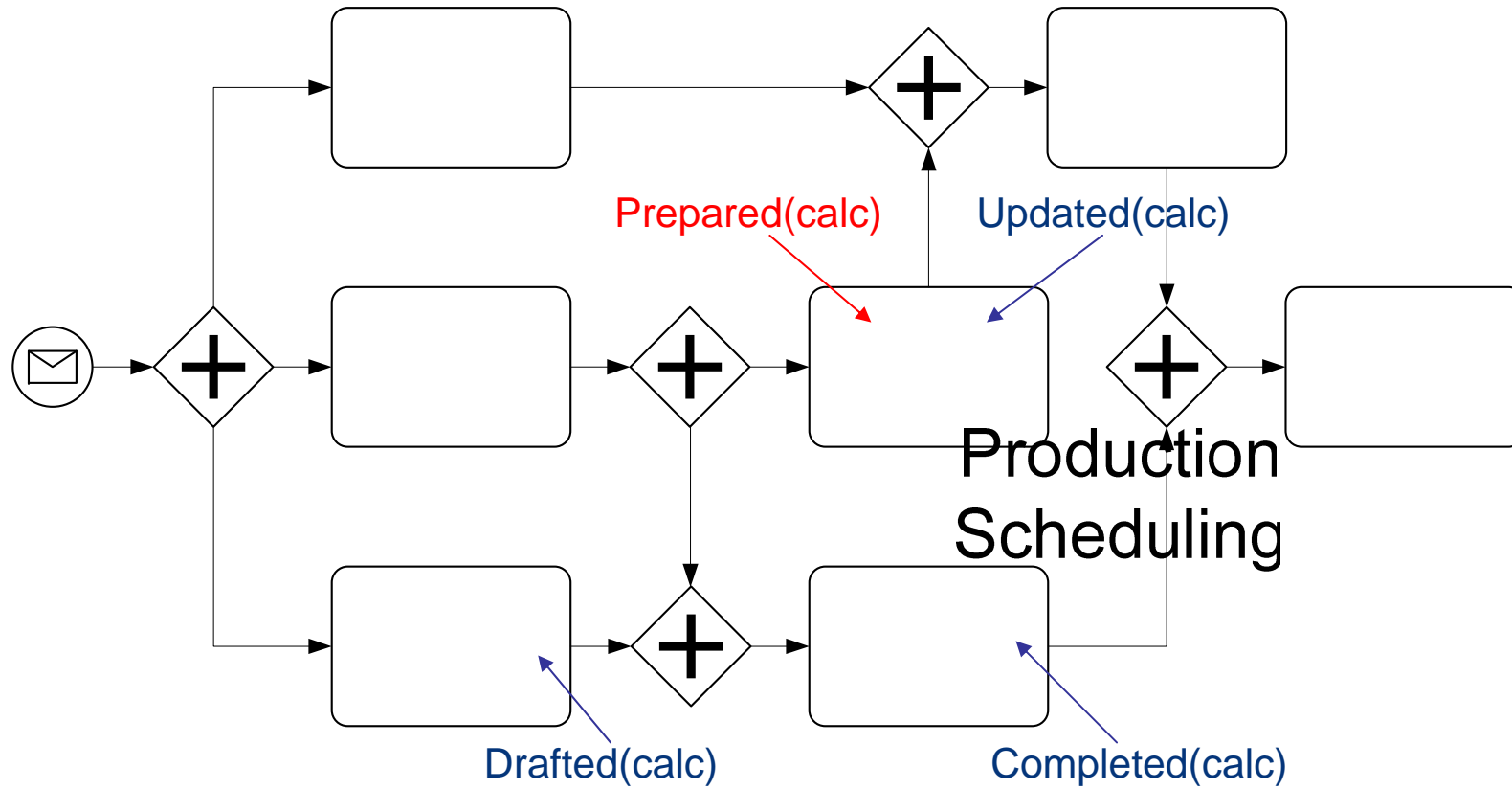
■ Semantic BPs

- Domain ontology formalizes the domain which the tasks in the process affect
- Each task annotated with precondition and effect
- Formal execution semantics combines workflow with AI actions&change

■ Semantic BP Validation

- Workflow and annotations interact!
- Is there a precondition that may be violated?
- Are there parallel (un-ordered) tasks with contradicting effects?
- Useful to debug high-level models and/or SWS implementations

An Example



Drafted **SubClassOf** Prepared
 Updated **SubClassOf** Prepared
 Completed **DisjointClasses** Prepared

DECIDE ON
Shipper

■ **SUPER [Hepp et al]**

- Our project
- Ontology (here) models the domain in which the process is executed

■ **TOVE [Fox]**

- Ontologies for modeling enterprises and processes
- Our work is mostly on the Generic Model Level of TOVE
- PSL (Process Specification Language) talks about tasks, time points, and constraints between tasks; no “execution in the presence of domain ontology”

■ **DEMO [Dietz]**

- Method to discover/mine the processes executed within an enterprise
- Essentially unrelated to our work (except a “process” occurs somewhere)

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■ Process Graph

- Traditional workflow
- Nodes: start/end, task, AND split/join, XOR split/join
- Simple token-passing semantics (borrowed from [Vanhatalo et al ICSOC'07])

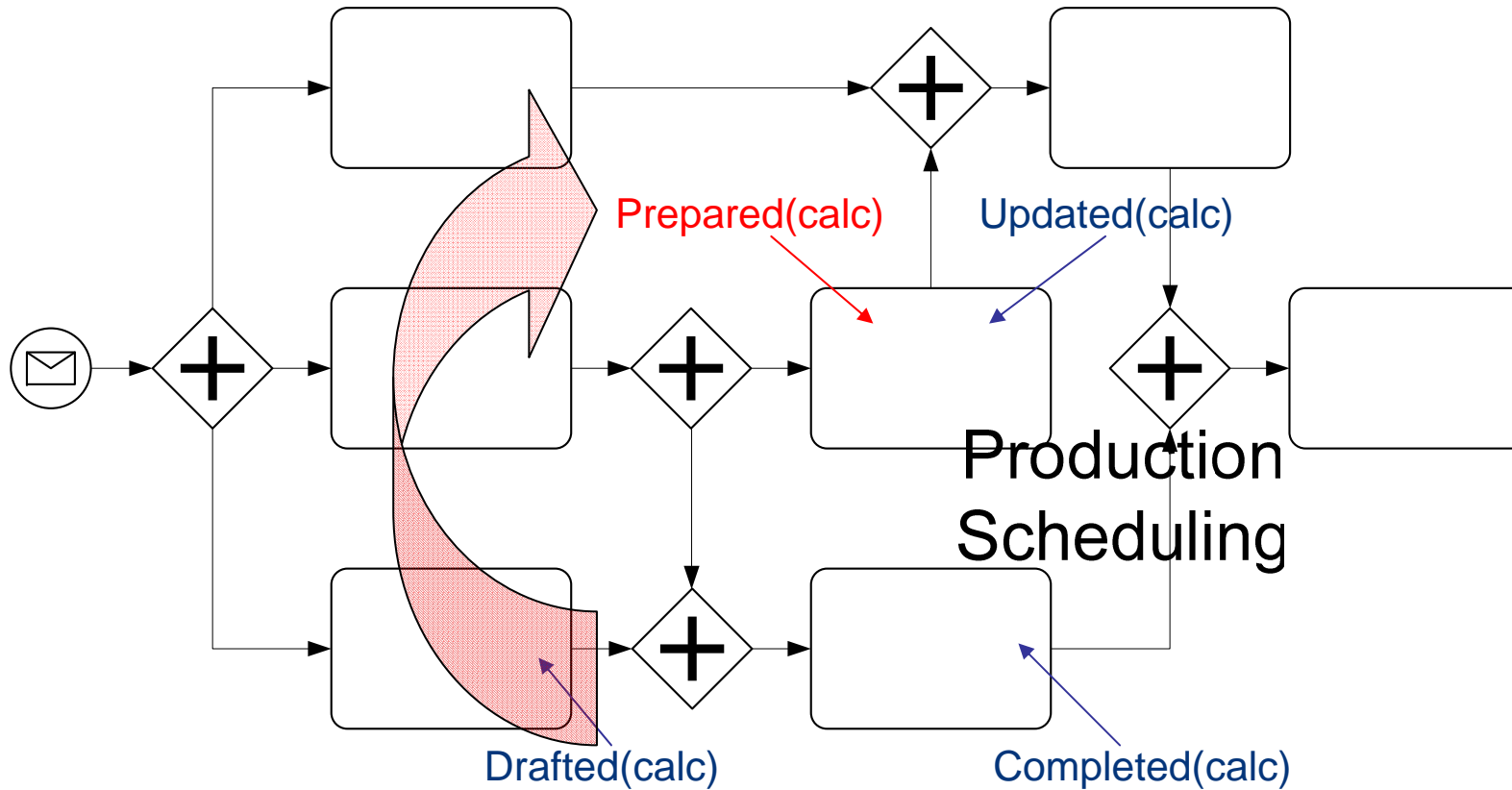
■ Semantic Annotation

- Ontology: universally quantified clauses -- $\forall x: \text{Drafted}(x) \Rightarrow \text{Prepared}(x)$
- Task node precondition/effect: conjunctions of literals -- $\text{Drafted}(\text{calc})$

■ Execution Semantics

- Combines token passing with AI “minimal change semantics” [Winslett AAI'89]
- In the presence of ontology Ω , if φ happens in state s , then any state s' may result that satisfies φ and Ω , and that differs minimally from s
- *“From the annotations, we can not always conclude with certainty what will happen; we assume that nothing changes without a reason”*

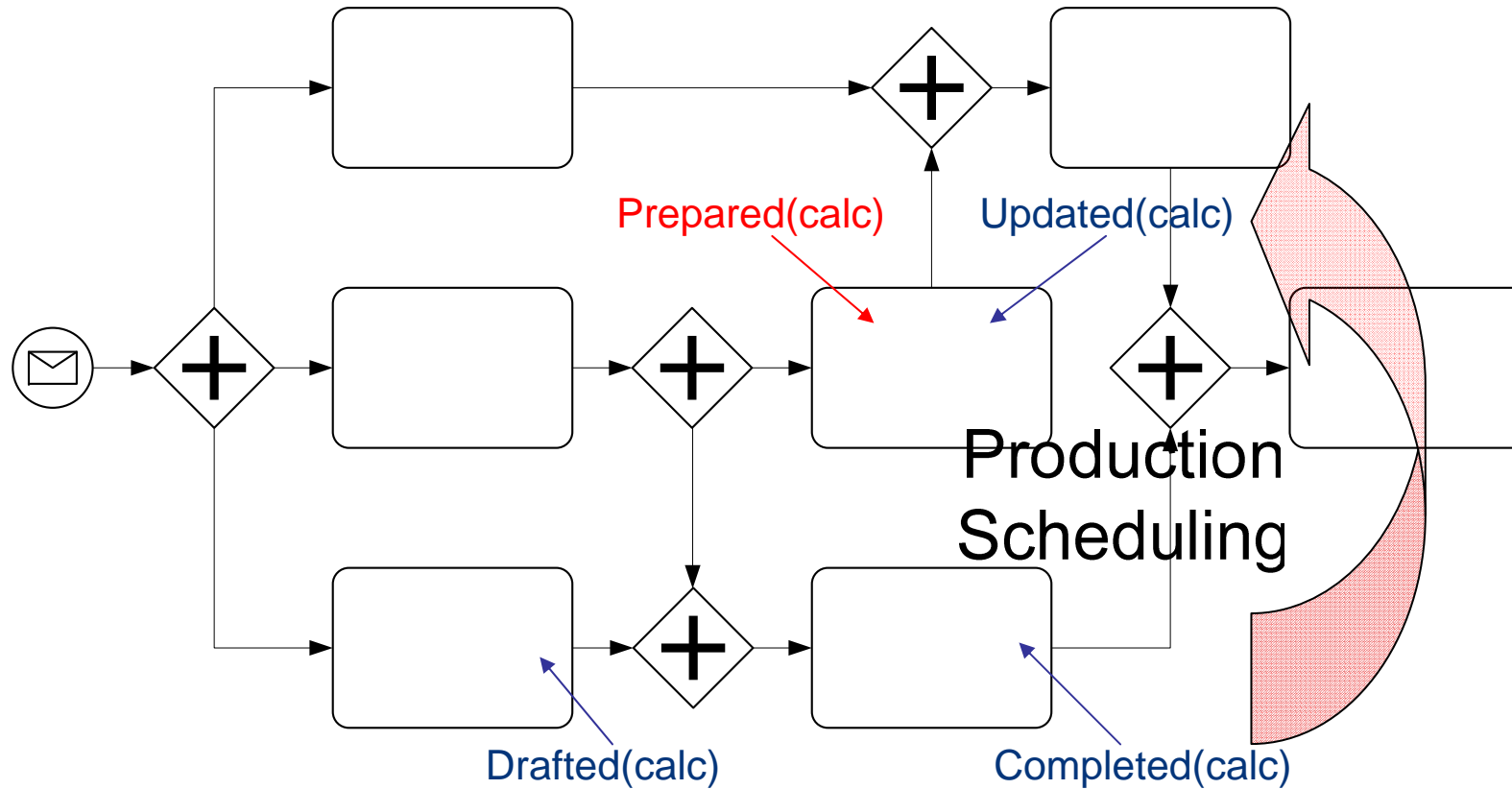
Non-Executable Tasks



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■ Semantic BP Validation

- Are there non-executable tasks?
- Are there effect conflicts?

■ Computational Complexity

- Validation is NP-hard if XOR splits have conditions
- Validation is NP-hard if ontology has Horn clauses
- Open question for loops

■ Basic Semantic BPs

- No XOR conditions, only 2-clauses, no loops
- E.g. the example
- Polynomial-time validation techniques
- Extension for loops currently investigated

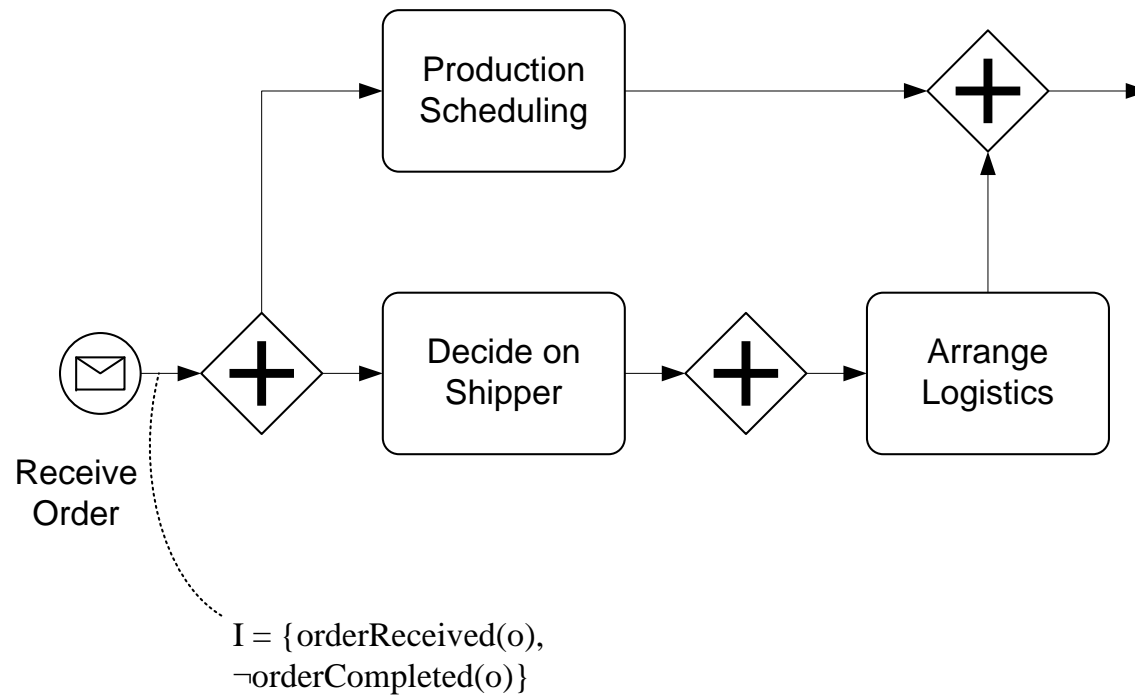
■ “Matrix”

- Determines “parallel task nodes”
- Propagates entries of a $|E| \times |E|$ matrix M
- Upon completion, task nodes with ingoing edges i, j parallel iff $M^i_j = 1$

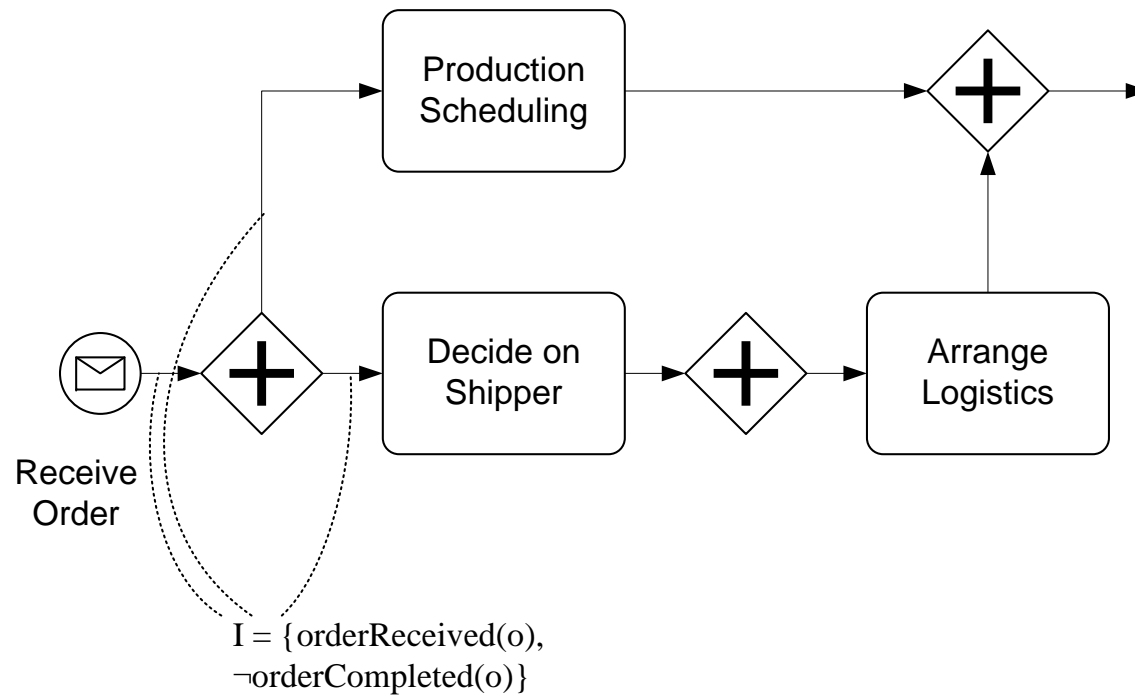
■ “I-Propagation”

- Determines “necessarily true literals”
- Propagates sets $I(e)$ annotated at edges e
 - AND/XOR joins propagate the union/intersection of their ingoing edges
 - Interference from parallel task node effects must be considered
 - 2-clauses can be “compiled into” extended preconditions & effects
- Upon completion, $I(e)$ contains exactly the set of literals that are true whenever edge e carries a token

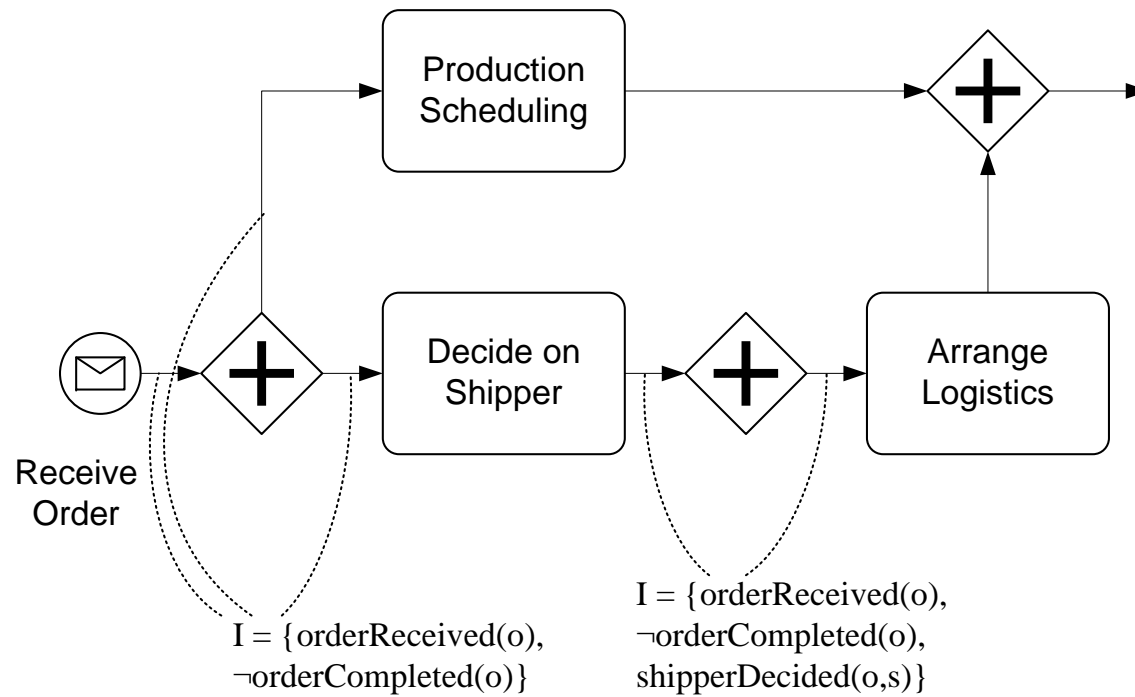
I-Propagation - Example (1)



I-Propagation - Example (2)



I-Propagation - Example (3)



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■ Semantic BP Validation

- Requires ontology formalizing the domain affected by process activities
- Validates interaction between semantic annotation and workflow
- Helps with high-level modeling
- Helps resolving implementation bugs in case of Semantic WS

■ Contribution

- Formal execution semantics combines workflow and AI actions&change
- (Almost) maximal tractable class: basic semantic BPs

■ Future Work

- Loops?
- Empirical evaluation
- Validation for more general (intractable) cases

Partially an outcome of
EU IP SUPER
<http://www.ip-super.org>

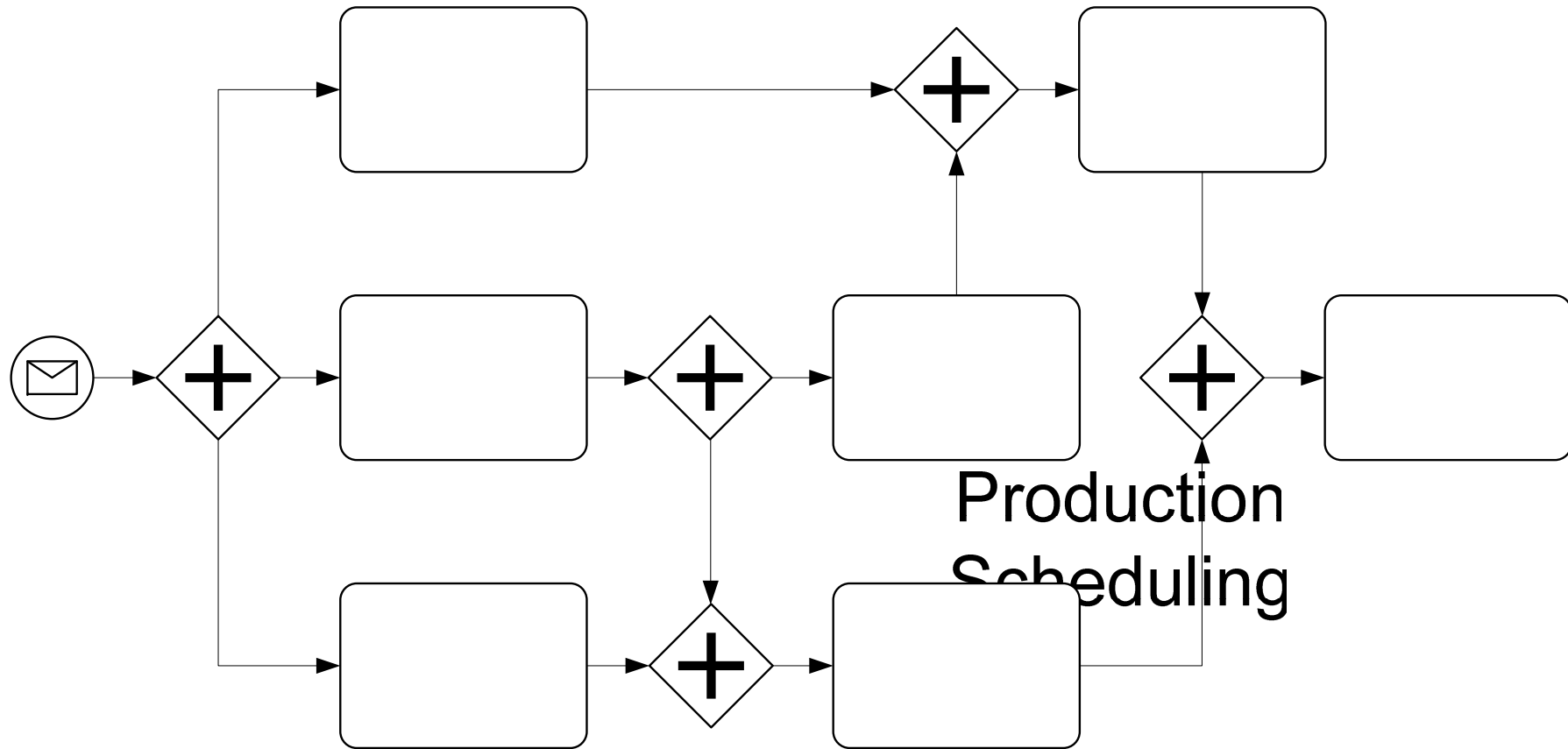
Thank you!



Backup Slides

Semantic Process Validation

example process



Semantic Process Validation

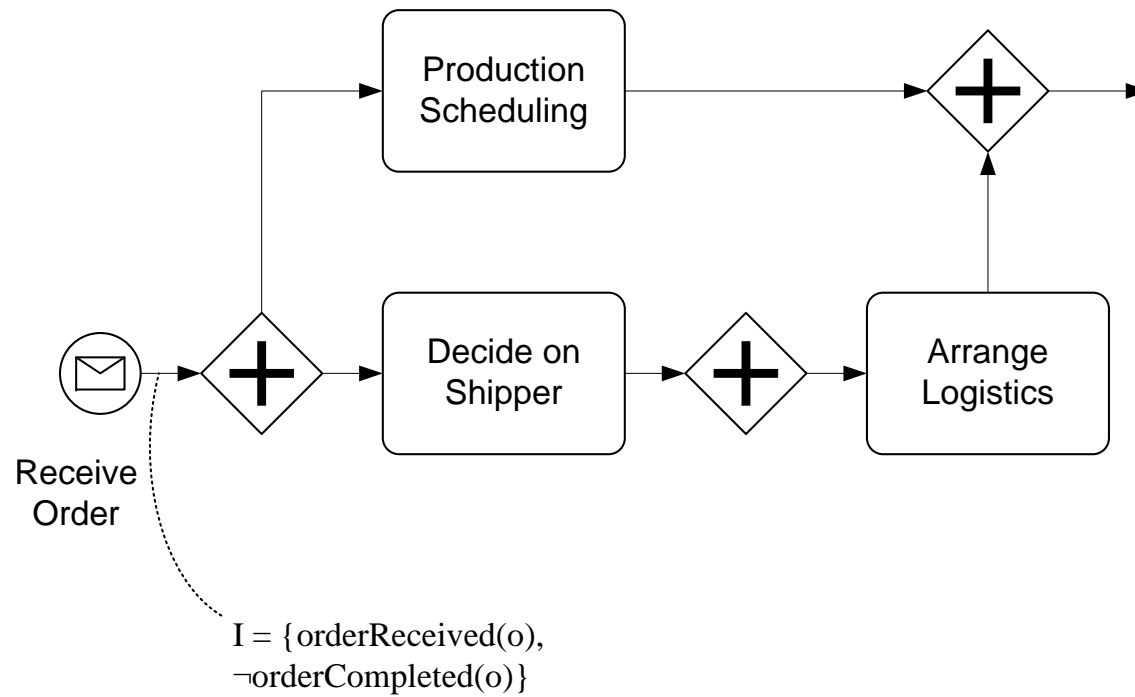
example preconditions / postconditions



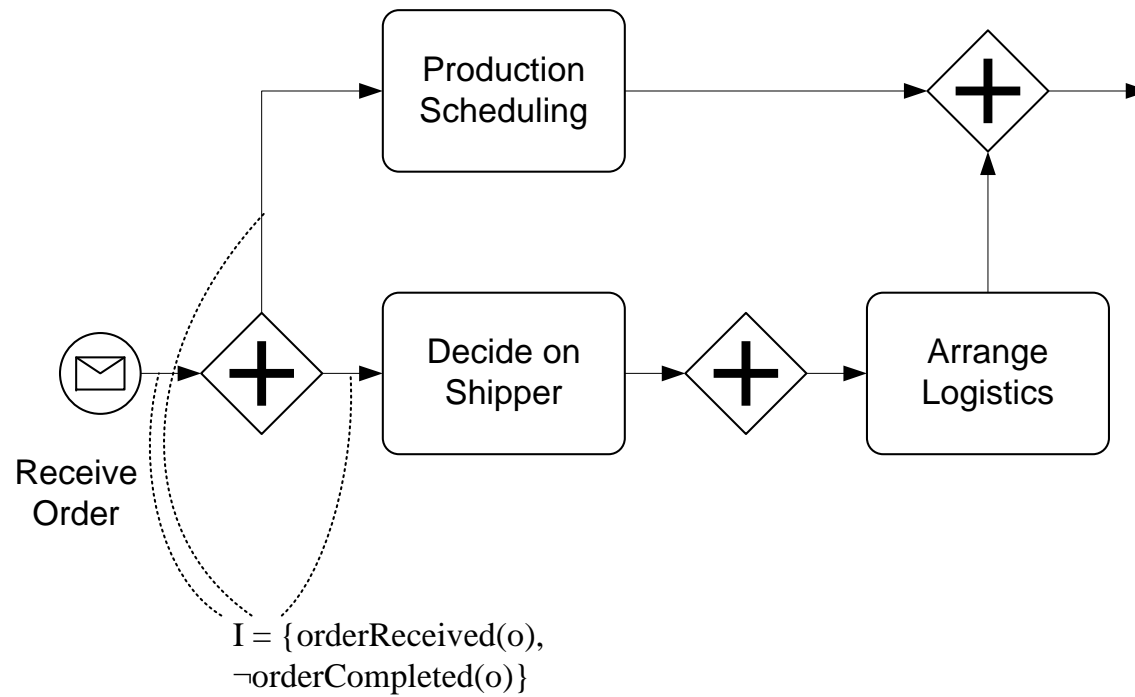
Task	Precondition	Postcondition
Receive Order		orderReceived(o)
Production Scheduling	orderReceived(o) orderApproved(o)	productionScheduled(o,p)
Production	productionScheduled(o,p) calculationPrepared(o,c)	productionCompleted(o,p) calculationUpdated(o,c)
Decide on Shipper	orderReceived(o)	shipperDecided(o,s)
Arrange Logistics	shipperDecided(o,s) calculationPrepared(o,c)	calculationUpdated(o,c) shipmentApproved(o,sh)
Draft Price Calculation	orderReceived(o)	calculationDrafted(o,c)
Complete Price Calculation	calculationPrepared(o,c)	calculationCompleted(o,c)
Invoice Processing	productionCompleted(o,p) calculationCompleted(o,c)	orderCompleted(o)

Purpose	Definition
Order status	<i>o</i> is at most one of <i>received</i> or <i>completed</i>
Production status	<i>p</i> is at most one of <i>scheduled</i> or <i>completed</i>
Calculation status	if <i>c</i> is <i>drafted</i> , then <i>c</i> is <i>prepared</i> if <i>c</i> is <i>updated</i> , then <i>c</i> is <i>prepared</i> <i>c</i> is at most one of <i>drafted</i> or <i>updated</i> or <i>completed</i> <i>c</i> is at most one of <i>prepared</i> or <i>completed</i>
Order approval	if shipment <i>sh</i> is <i>approved</i> for <i>o</i> , then <i>o</i> is <i>approved</i>

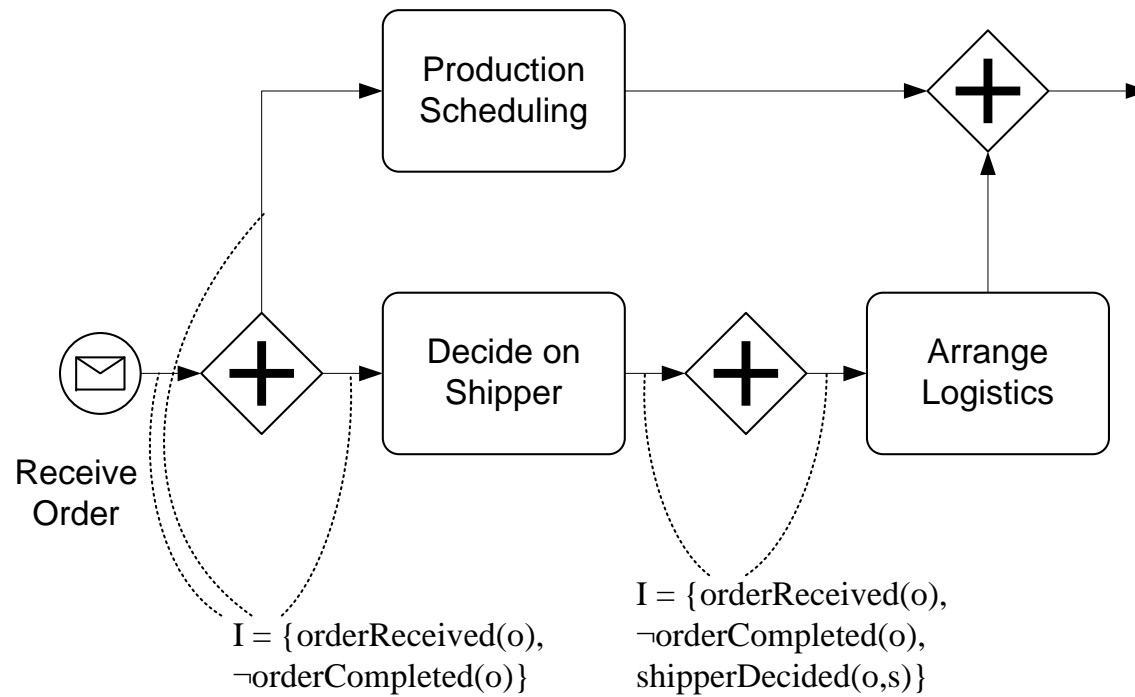
I-Propagation - Example (1)



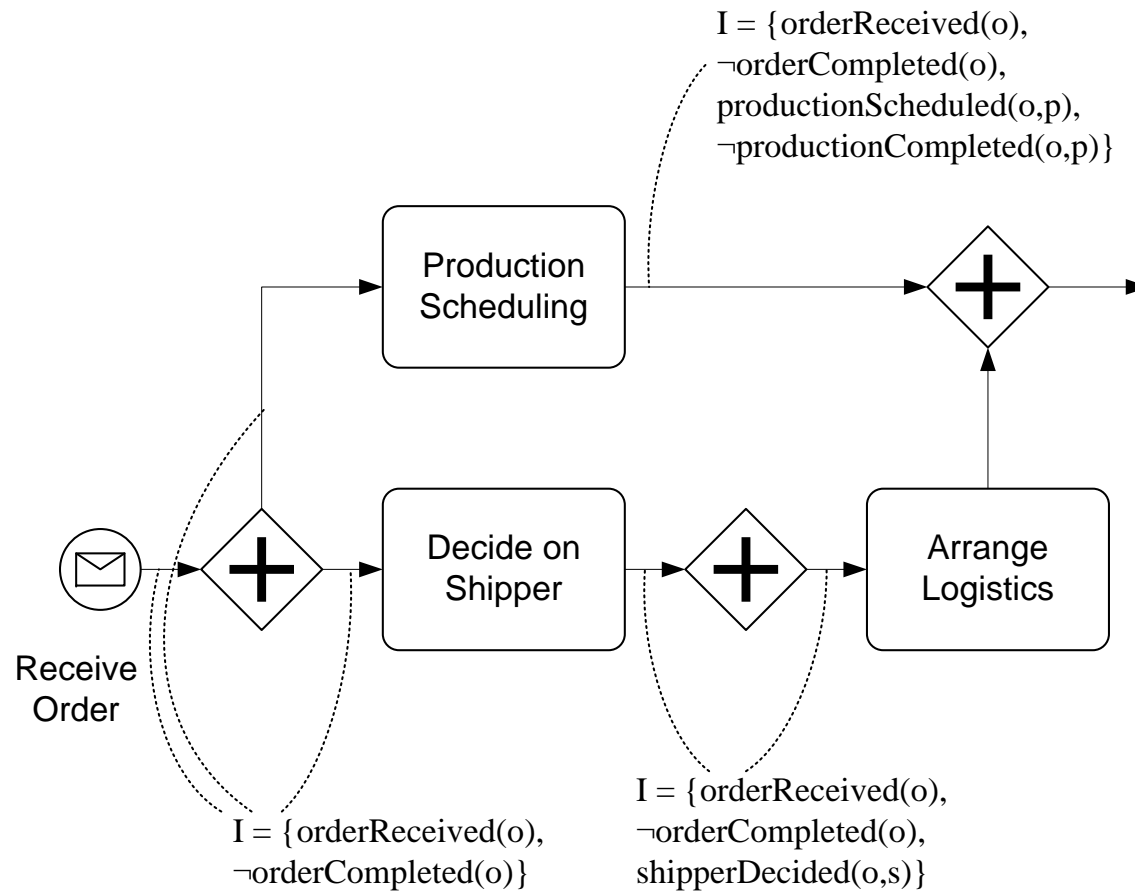
I-Propagation - Example (2)



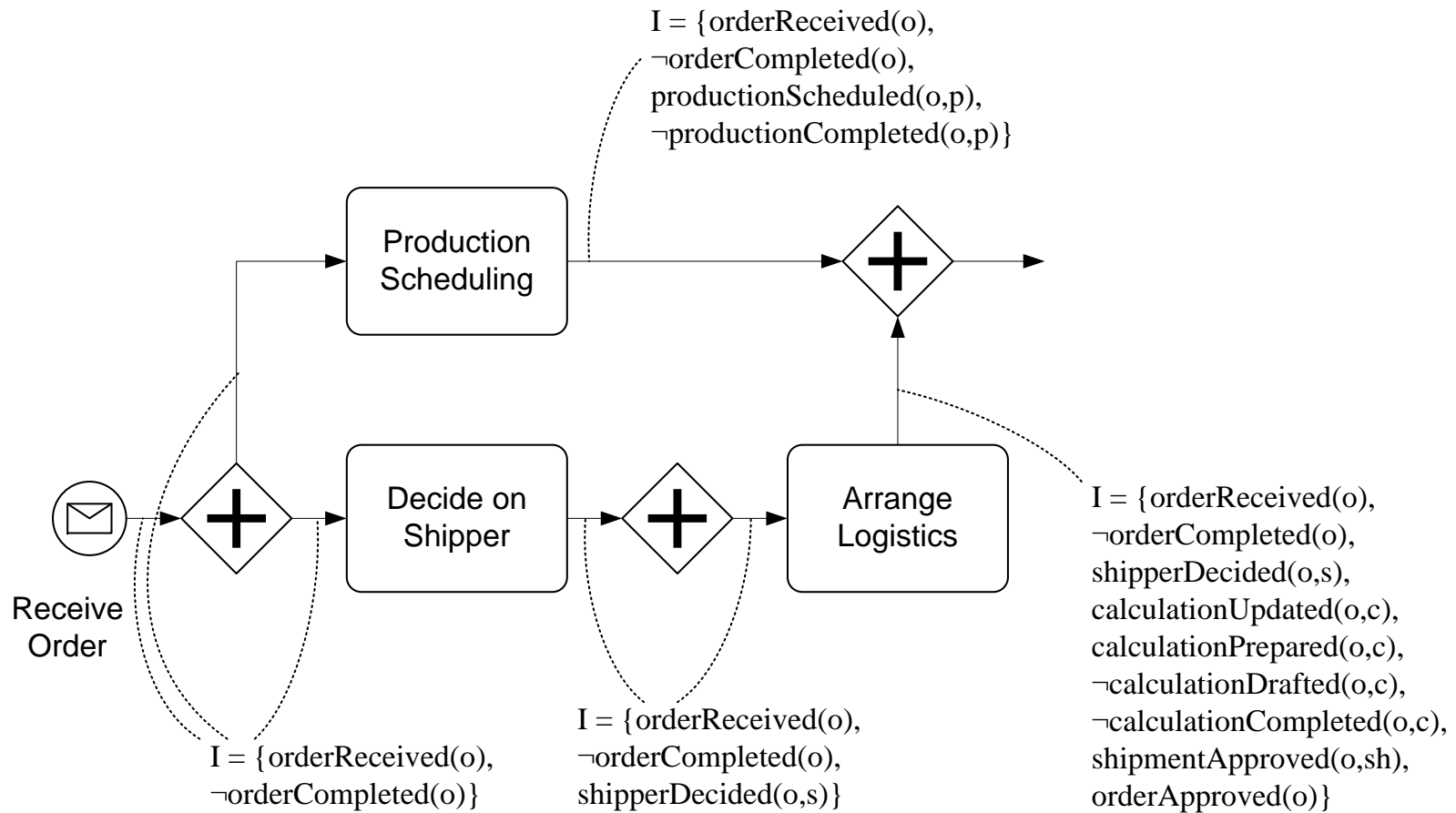
I-Propagation - Example (3)



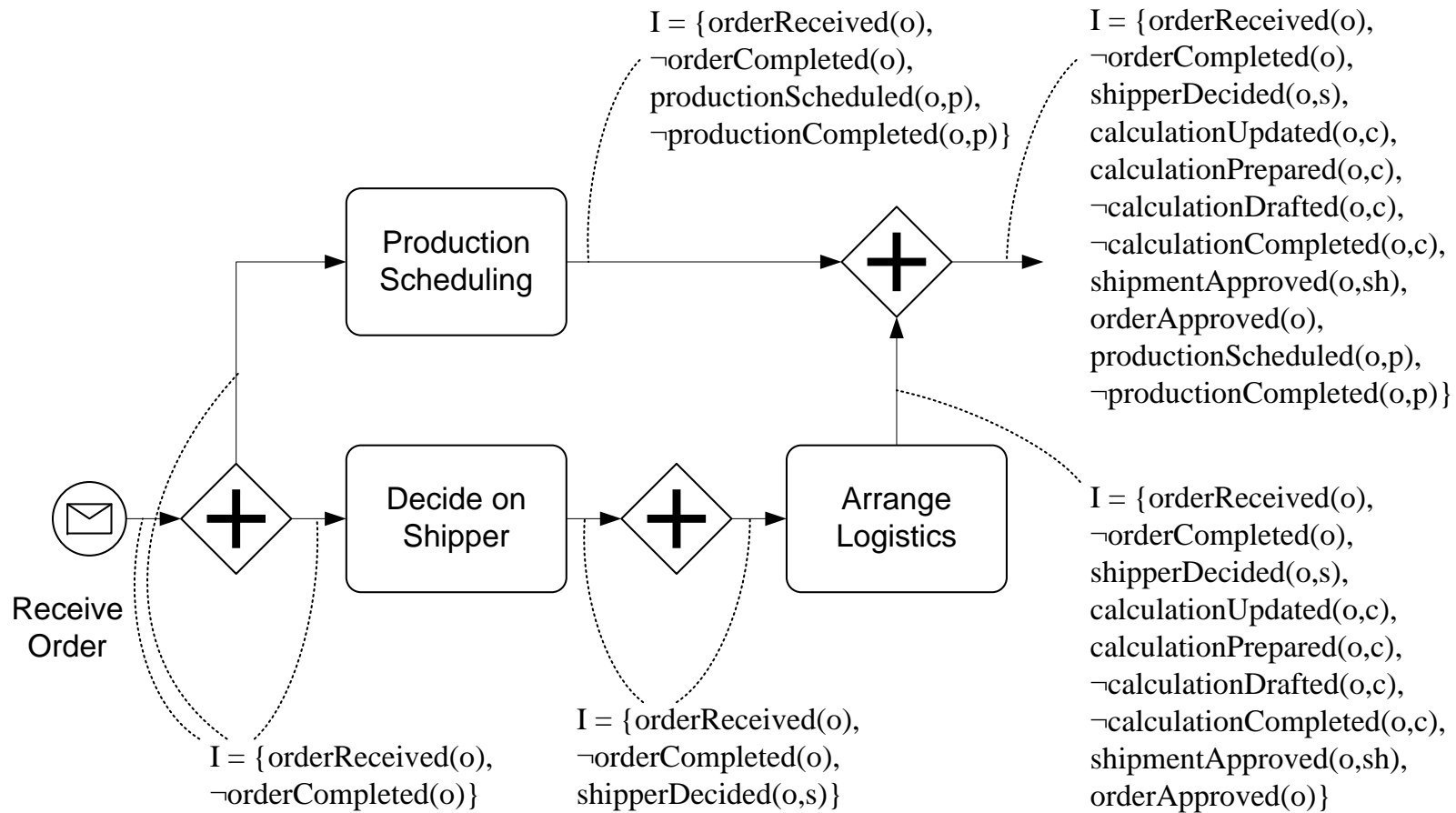
I-Propagation - Example (4)



I-Propagation - Example (5)



I-Propagation - Example (6)





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