Frameworks based on Templates for model-driven development

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Background (I)

- Model-driven development (MDD):
  - more emphasis on models rather than code
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- Formal vs semi-formal modelling techniques

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  - not widely used
  - models are precise, unambiguous and analysable
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- Semi-formal techniques:
  - the ones most SW engineers use
  - intuitive; provide good sketches of systems
  - defacto idioms among engineers
  - models are ambiguous, imprecise, not analysable

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  - very few explore refinement

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- Approach to build frameworks for rigorous MDD:
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- Thesis builds framework for seq systems: $UML + Z$

Outline

1. Templates and Meta-Proof
2. UML+Z framework using case study
   - Modelling
   - Analysis
   - Refinement
3. Conclusions

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Common in CS and Mathematics:

$$(P \wedge Q) \wedge R \equiv P \wedge (Q \wedge R)$$

P, Q and R stand for predicates, but do not belong to the language of predicates (*meta-linguistic variables*)

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$$(2 \geq 2 \wedge 1 < 2) \wedge 3 \leq 3 \equiv 2 \geq 2 \wedge (1 < 2 \wedge 3 \leq 3)$$

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- This conjecture is true: *Bank* is consistent.
- Can we generalise this result?

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- *Bank* instance of common structure: promoted ADT

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$$\vdash ?\ \exists \langle\!\langle P \rangle\!\rangle Init \bullet \mathrm{true}$$

- True for all well-formed instantiations of the template
- Initialisation of PADTs are true by construction

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$$\ll x \gg : \ll t \gg \qquad \{x \mapsto a, t \mapsto \mathbb{N}\} \qquad a : \mathbb{N}$$

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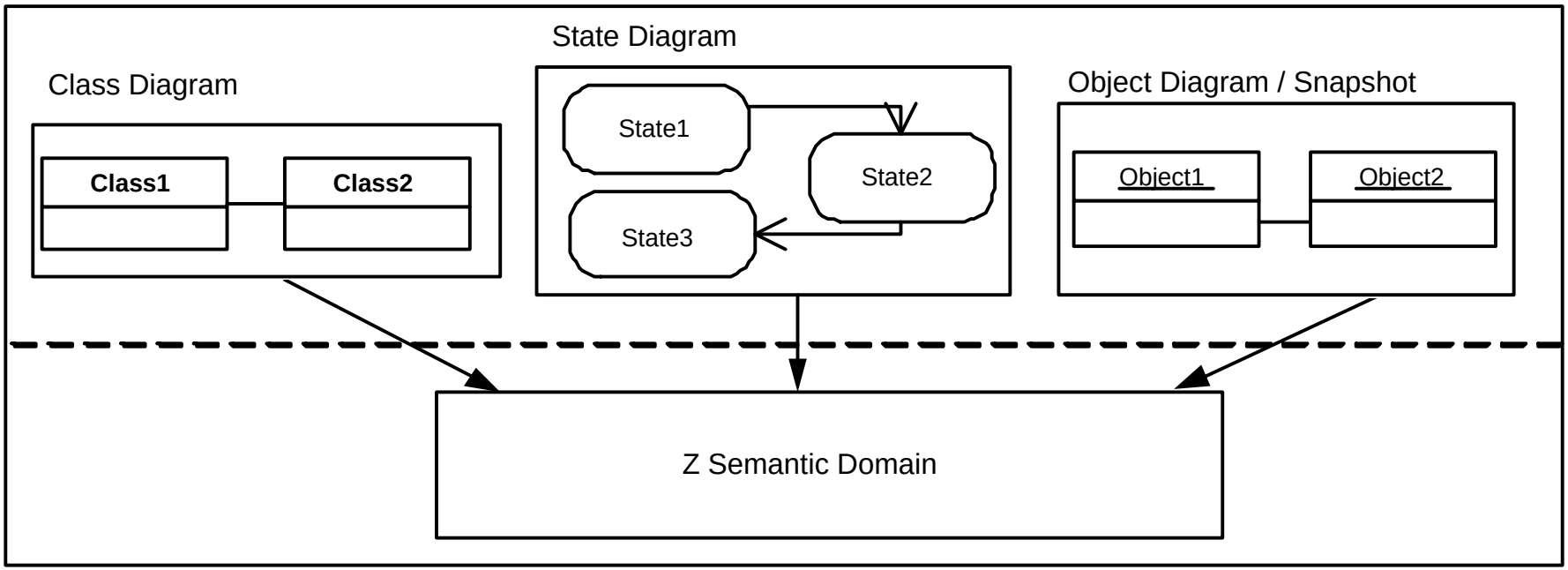
UML+Z Model



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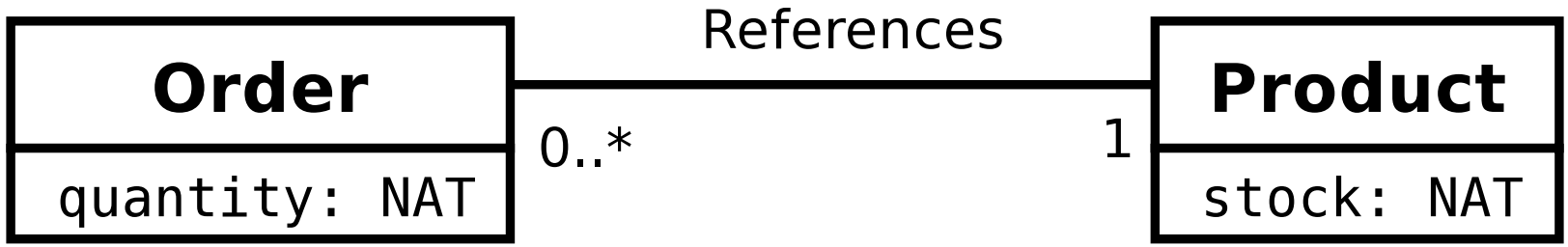
- one Z expert needed, but non experts can participate
- catalogue of templates and meta-theorems
- $UML + Z$ has 3 components:
  - Modelling
  - Analysis
  - Refinement

Modelling

- Modelling approach and semantics of diagrams
- Templates capture structure of Z OO models
- Meta-proof for model consistency-checking

Modelling (II)



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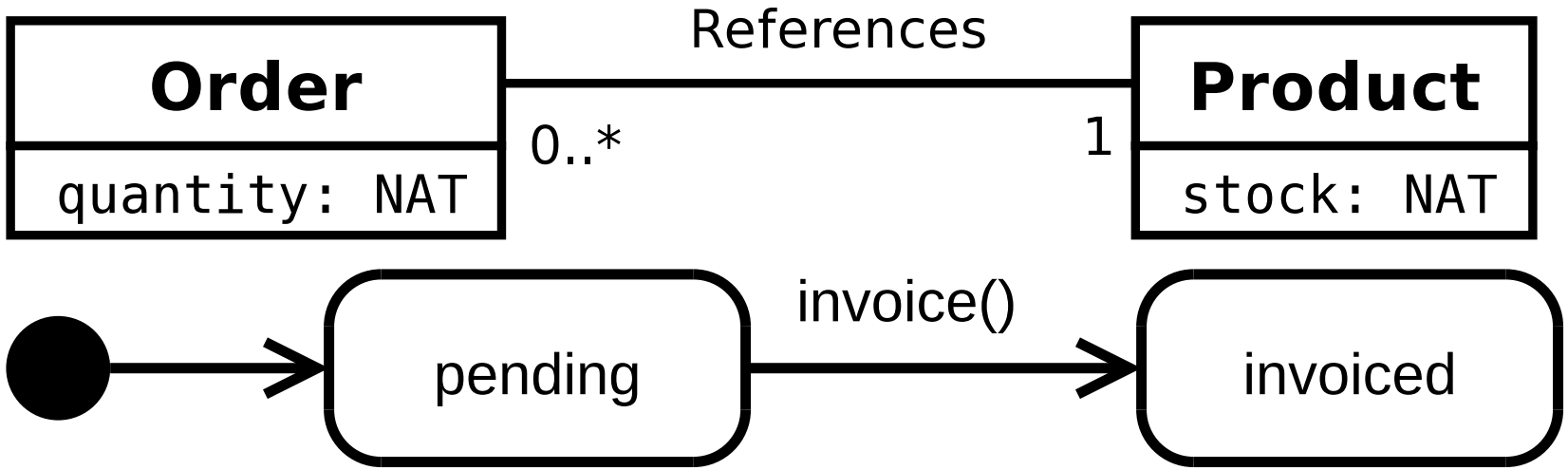

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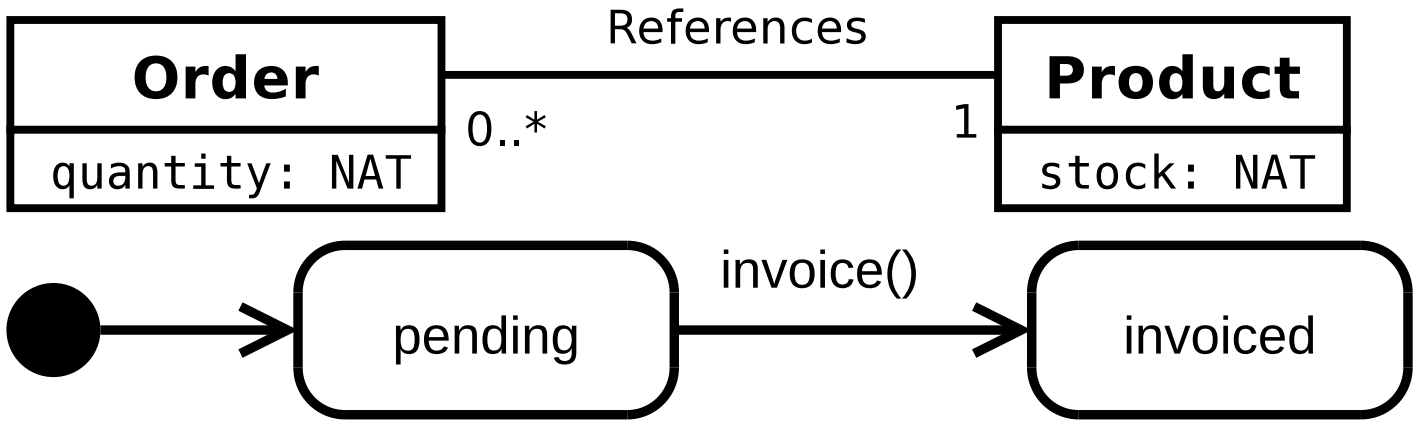

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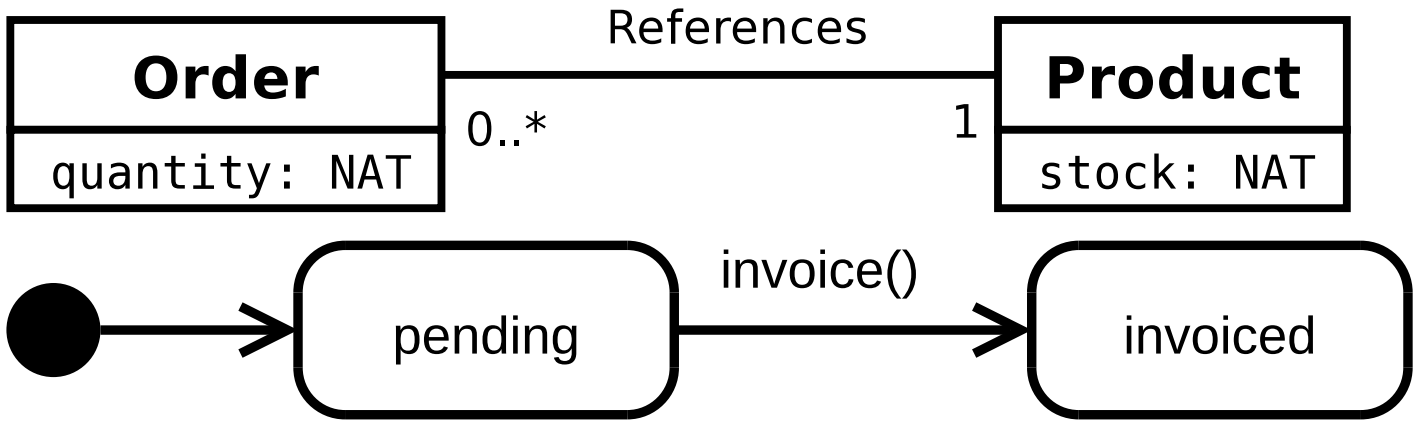

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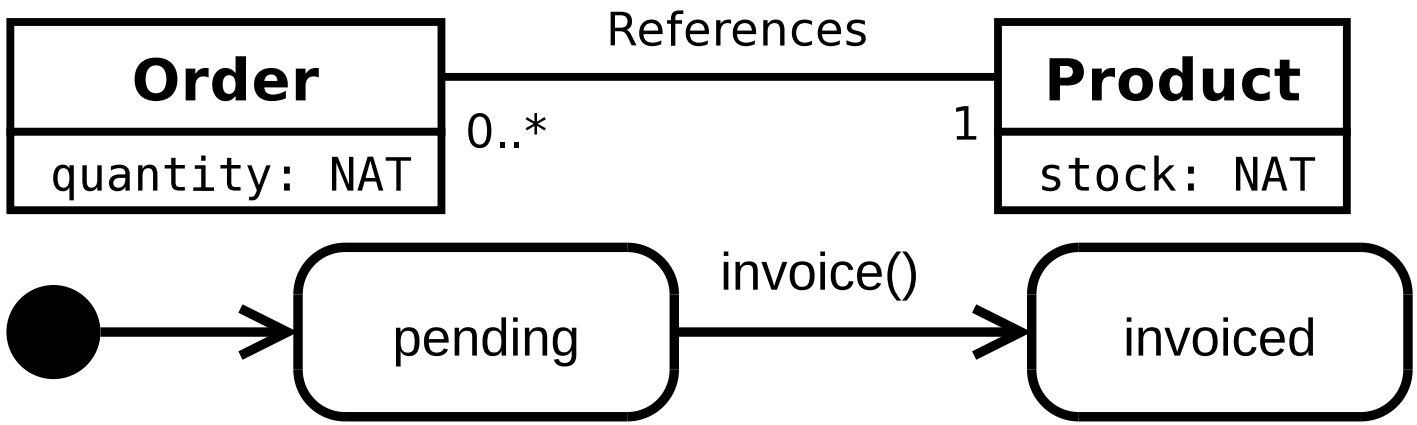

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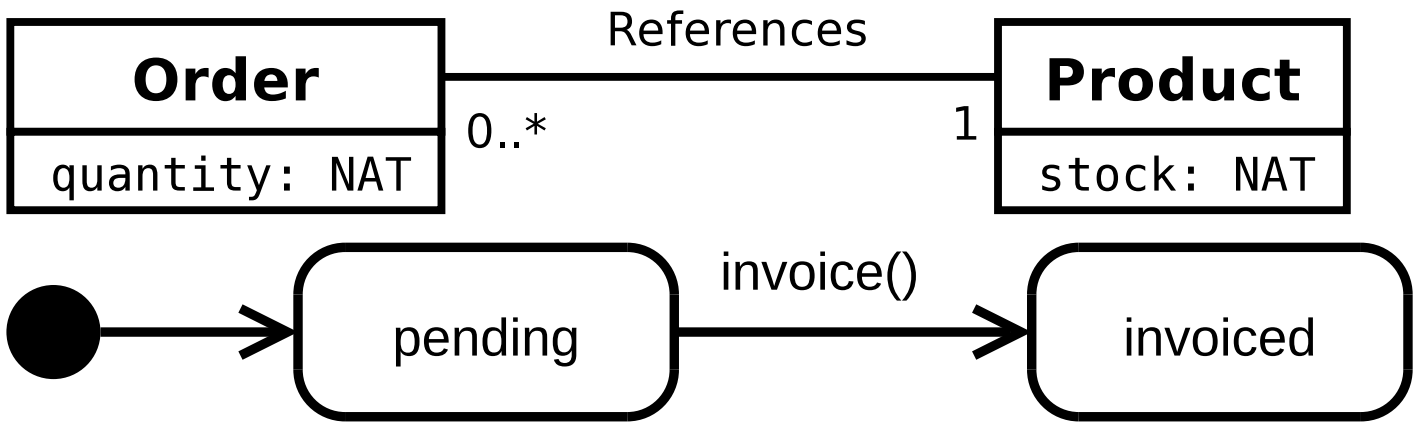

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- From snapshots, we get model-validation conjectures

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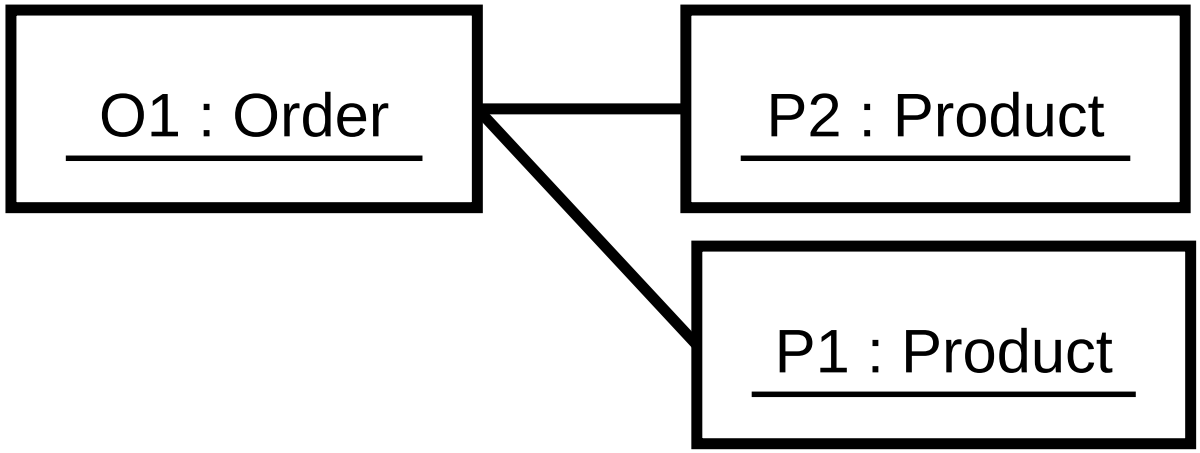

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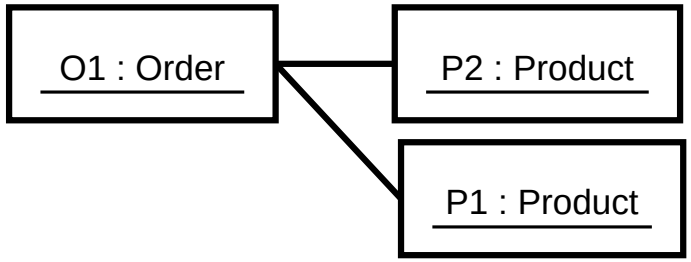

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System

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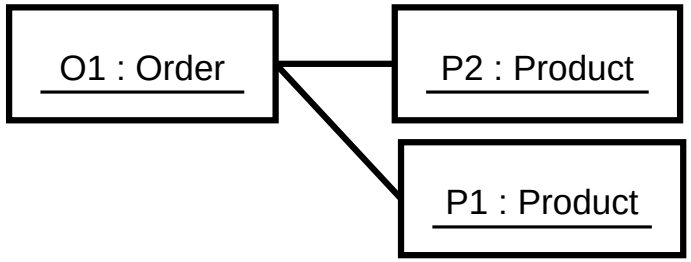

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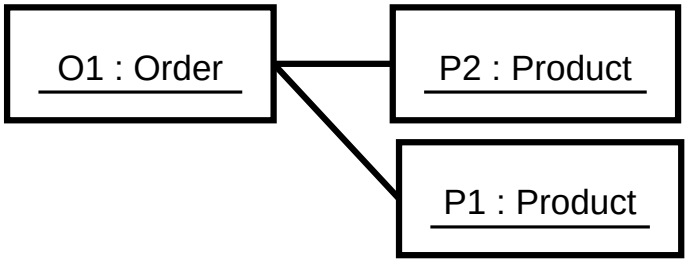

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Snapshot not accepted by model

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- Still under development

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- We would like to hide formal model
  - not possible in $UML + Z$, one Z expert is required
  - Analysis based on diagrams to involve customer