Model-Based Software Engineering

Lecture 10 – Transformation

Prof. Dr. Joel Greenyer

SOFTWARE ENGINEERING

June 28, 2016

Leibniz Universität Hannover

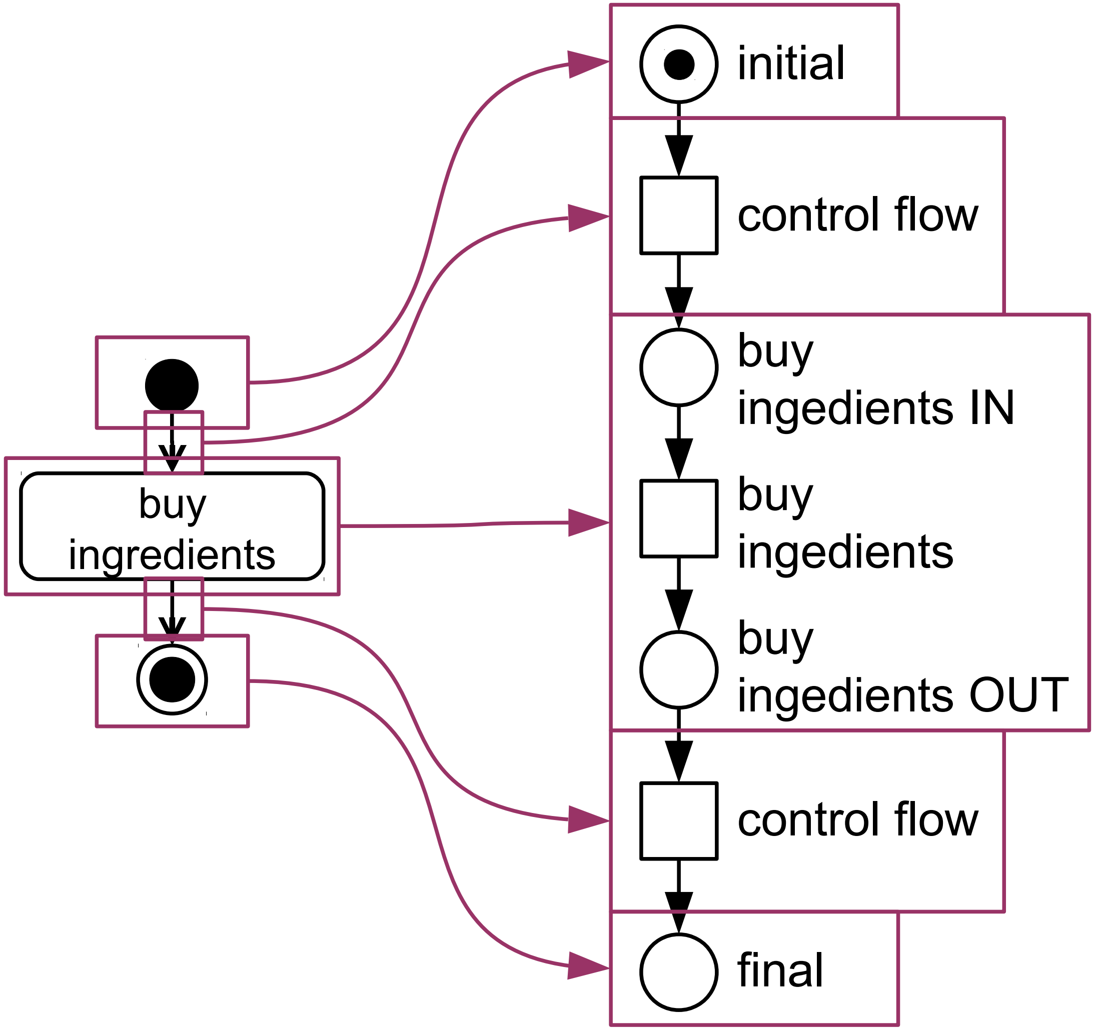
in the last lecture...

5.4. Model-to-model transformation – Triple Graph Grammars

Example:Transform Activity Diagrams to Petri nets

in the last lecture...

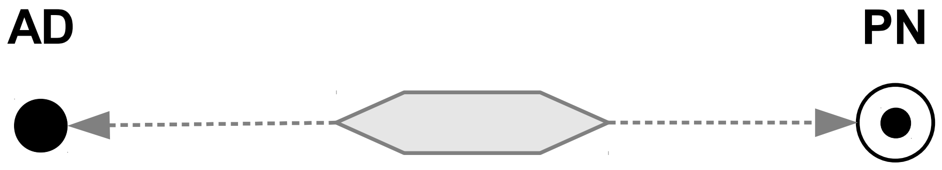
- Let's start simple: How to transform
  - Initial nodes?
  - Final nodes?
  - Action nodes?
  - Control flow edges?



Relations Between Model Patterns Example: Activity to Petri net

in the last lecture...

- Intial node ↔ Place with intial marking



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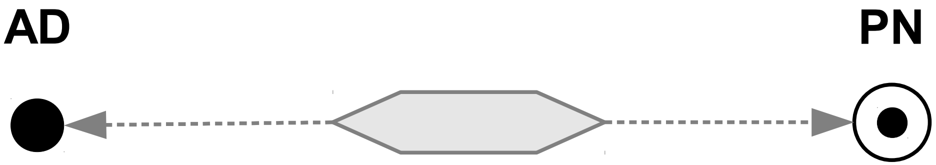

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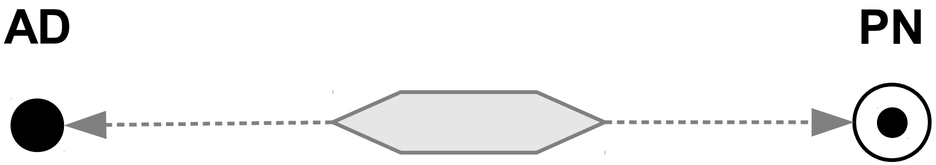

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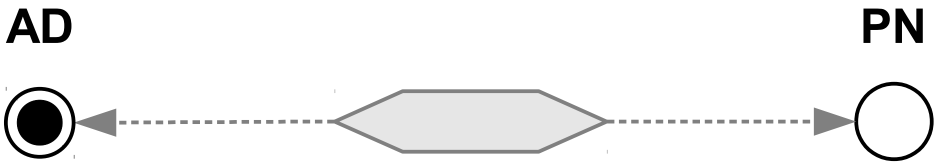

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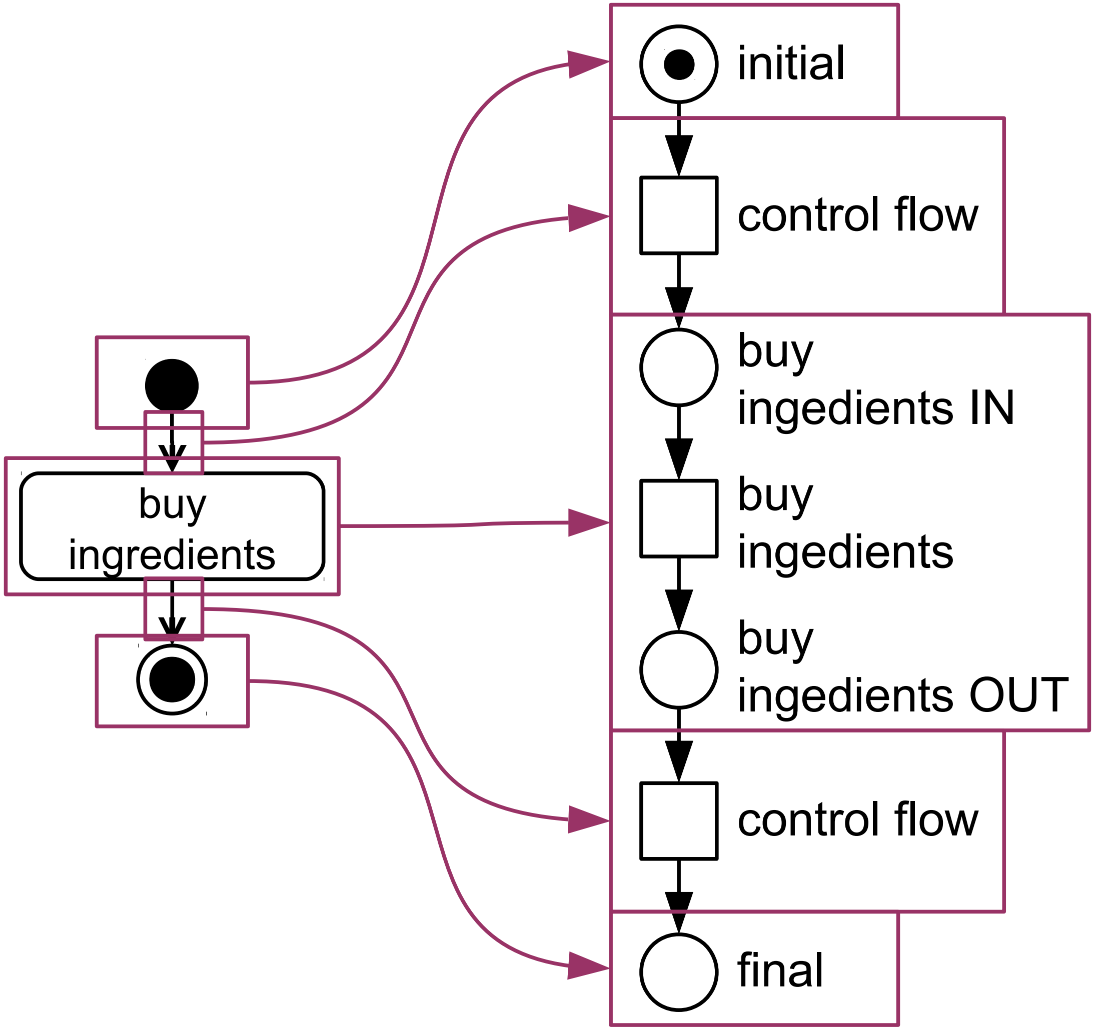

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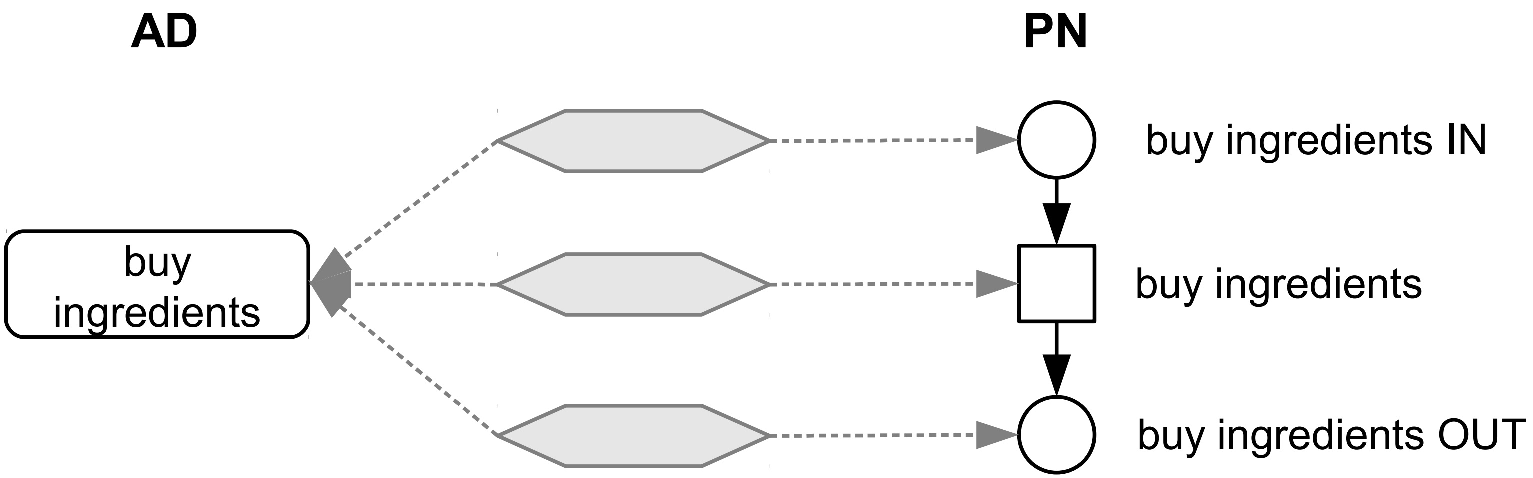
- Action node ↔ Transition with input and output place



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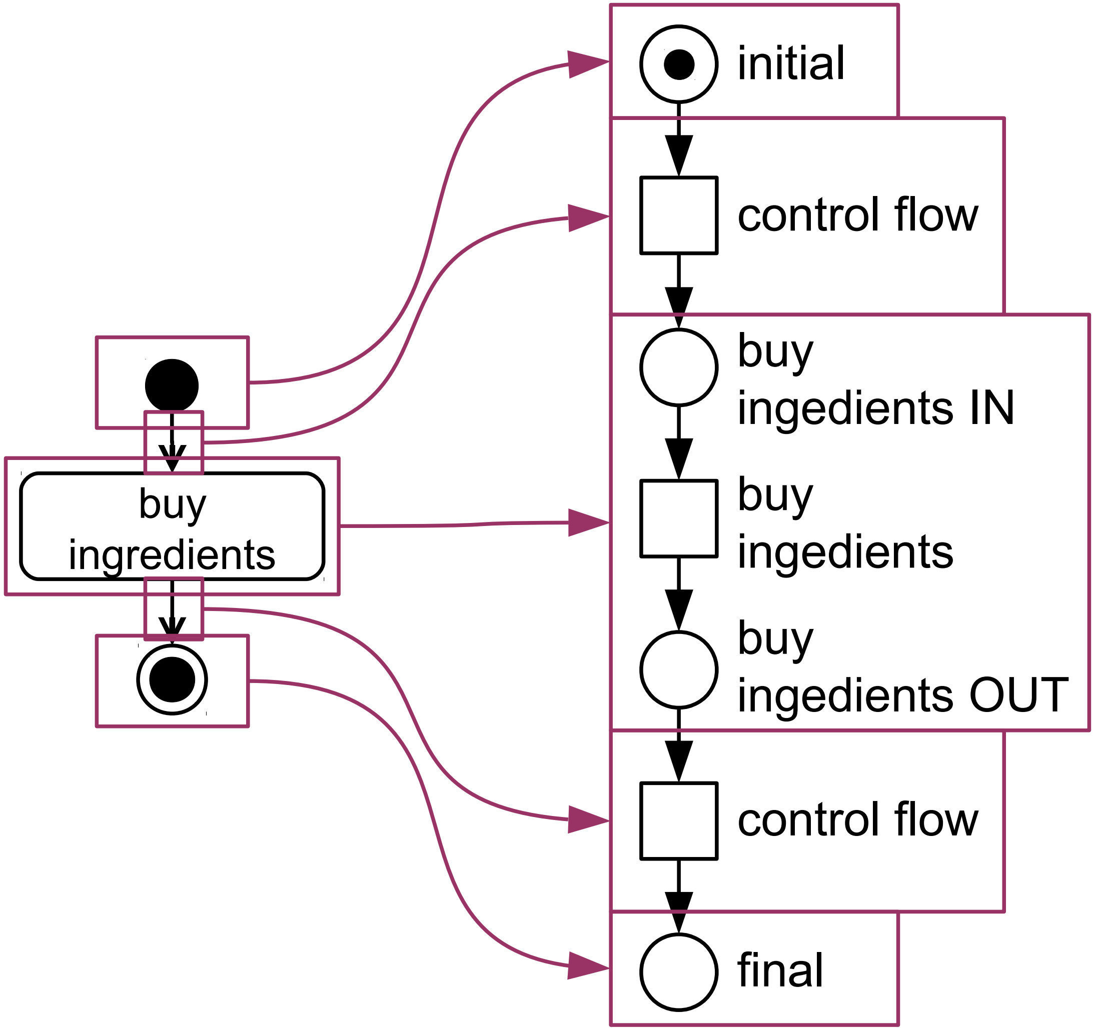

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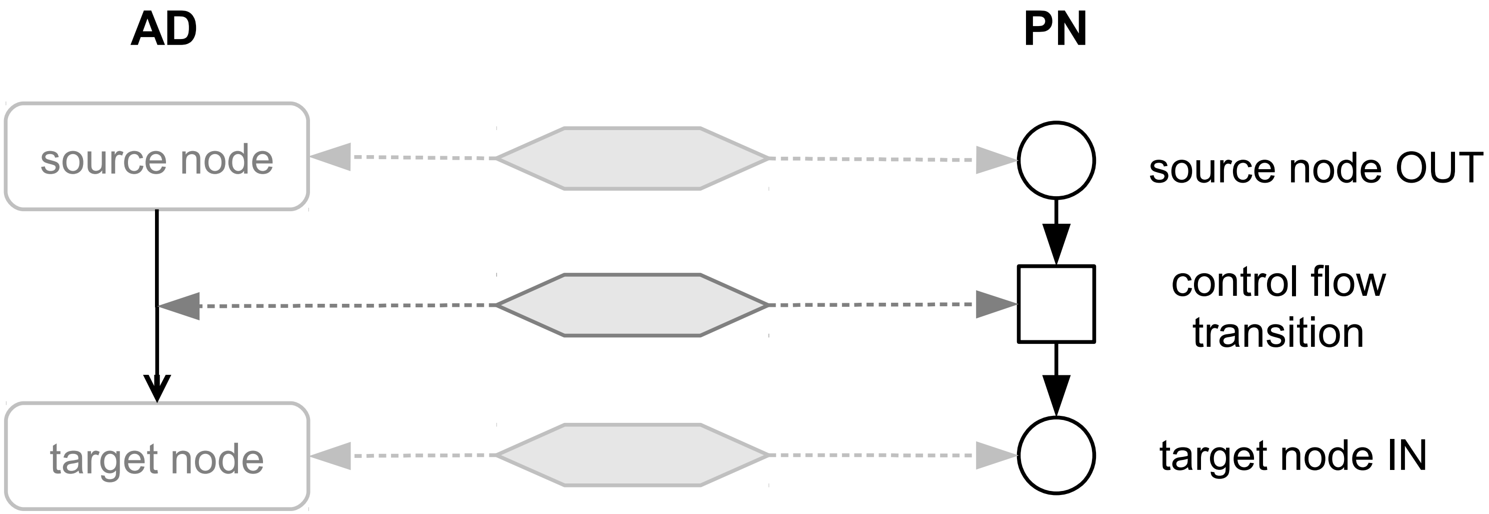

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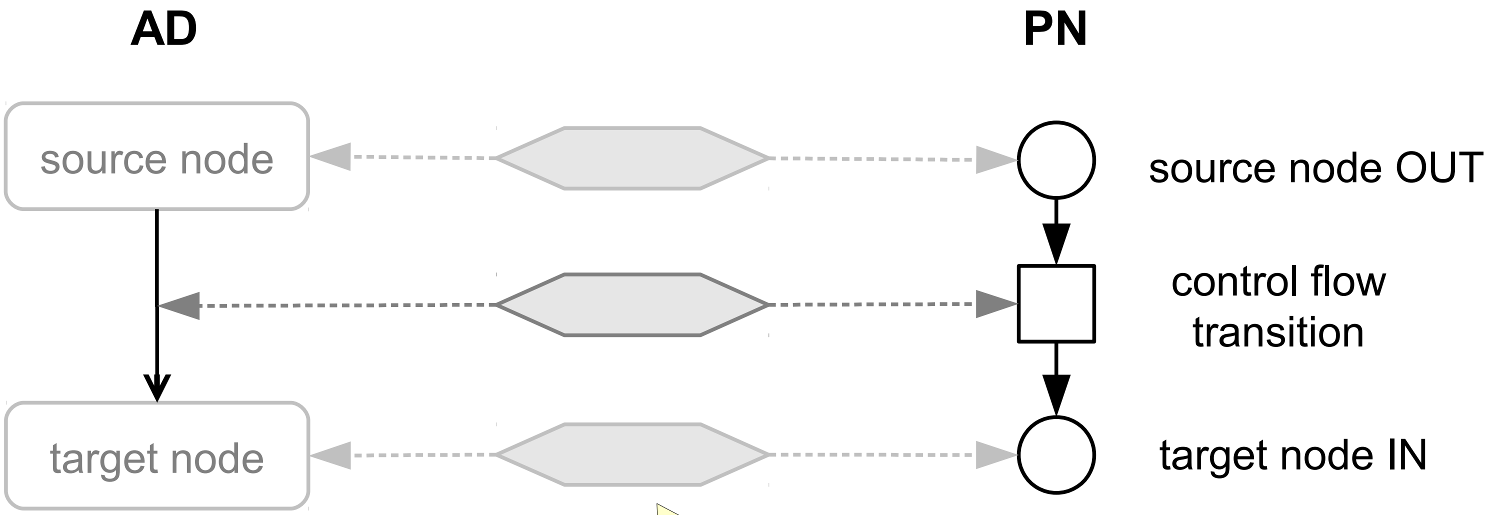
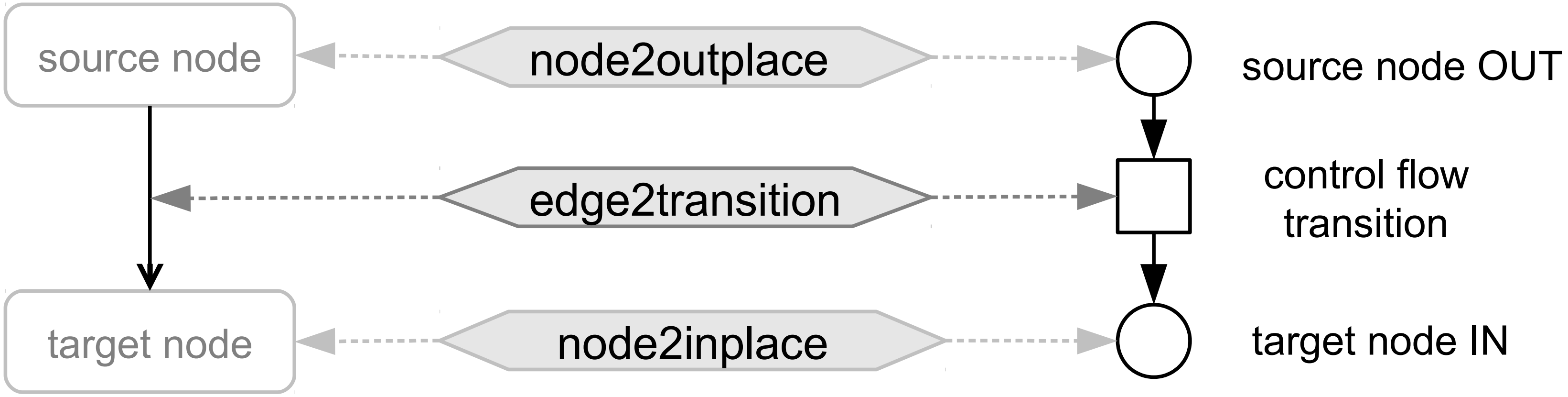


context: previously activity nodes and their mapping to petri net elements

Triple Graphs

in the last lecture...

- **Idea 1**: describe the mapping of models as a **triple graph**



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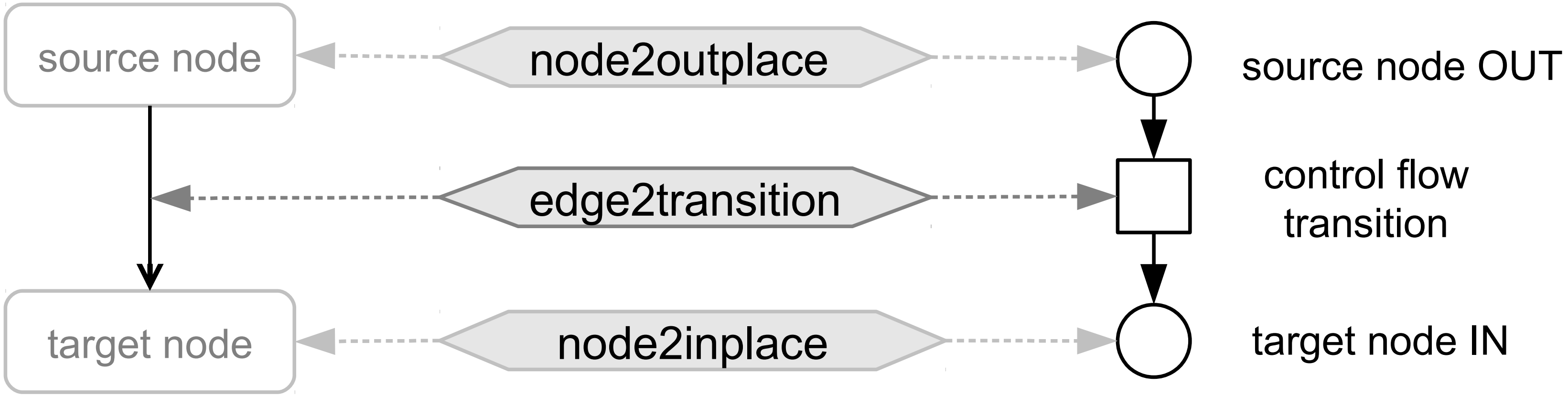

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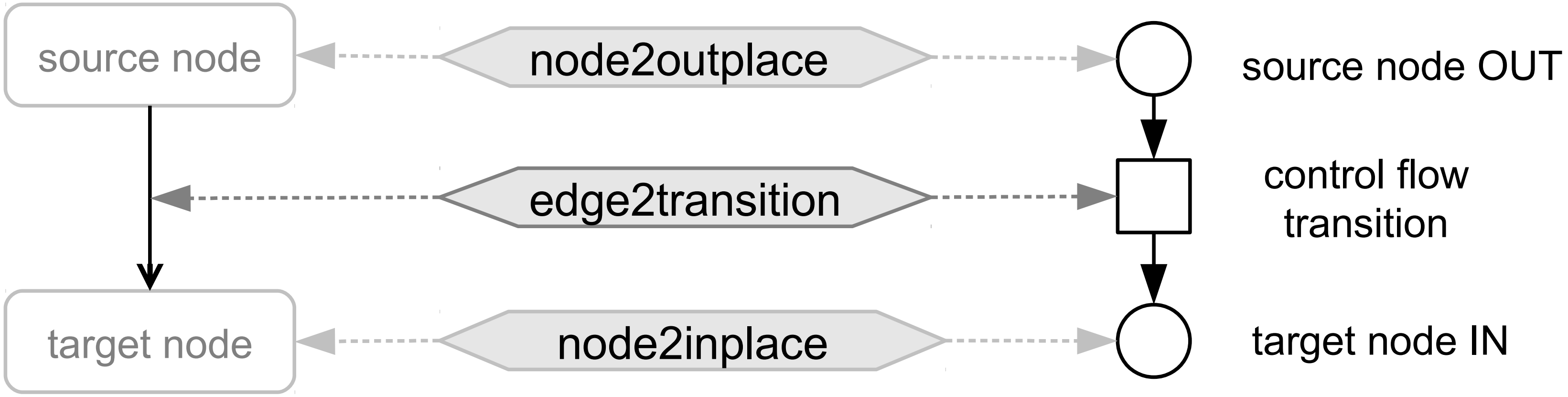

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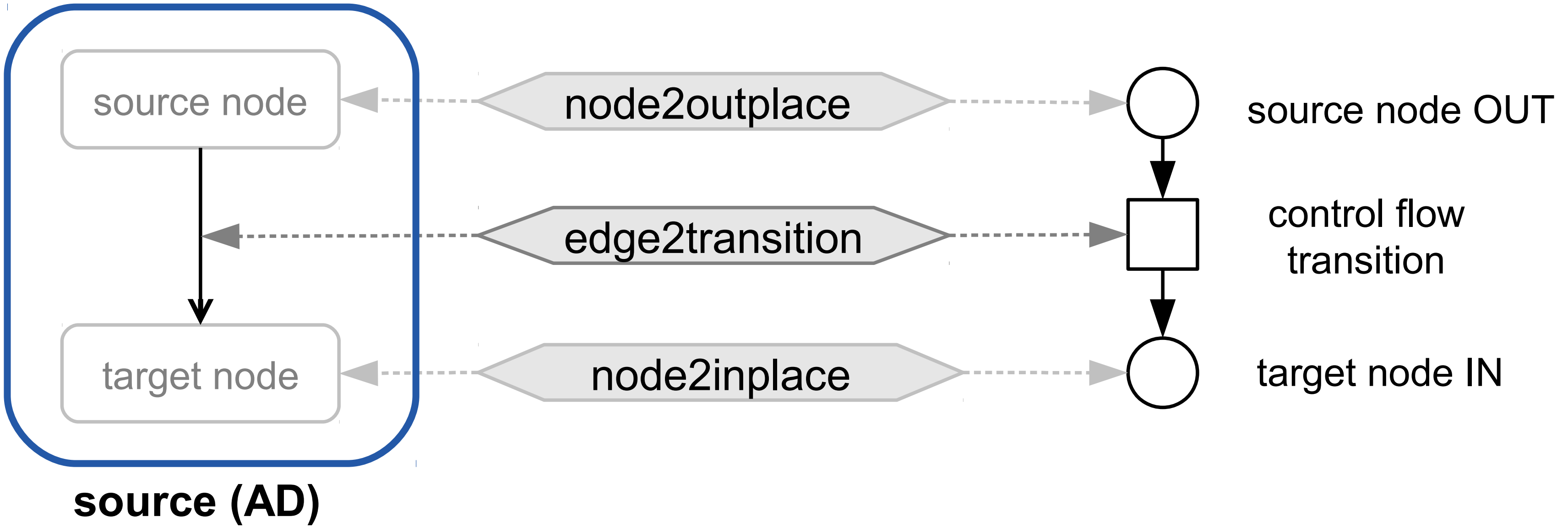

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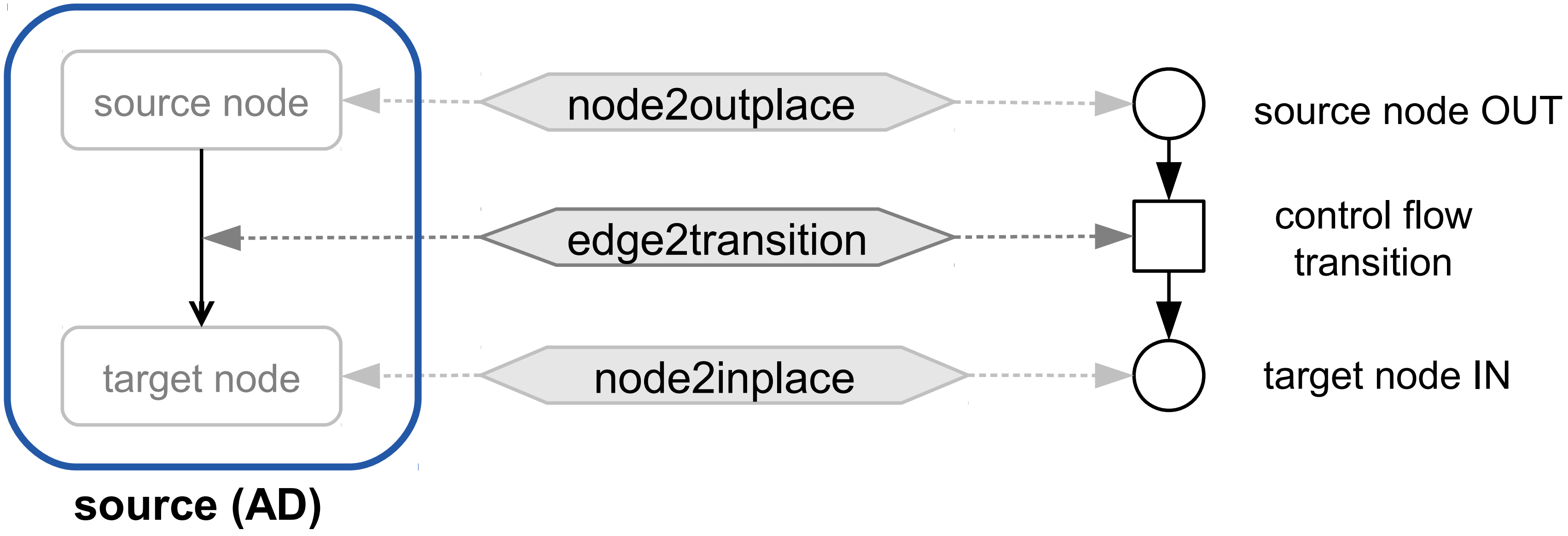

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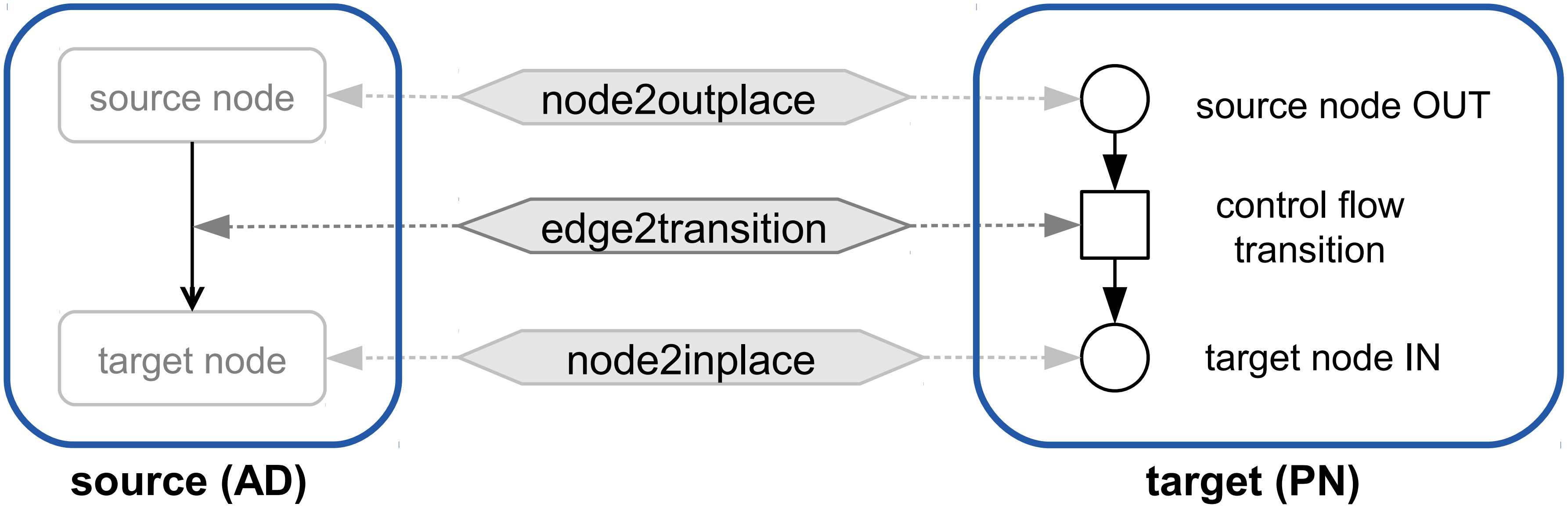

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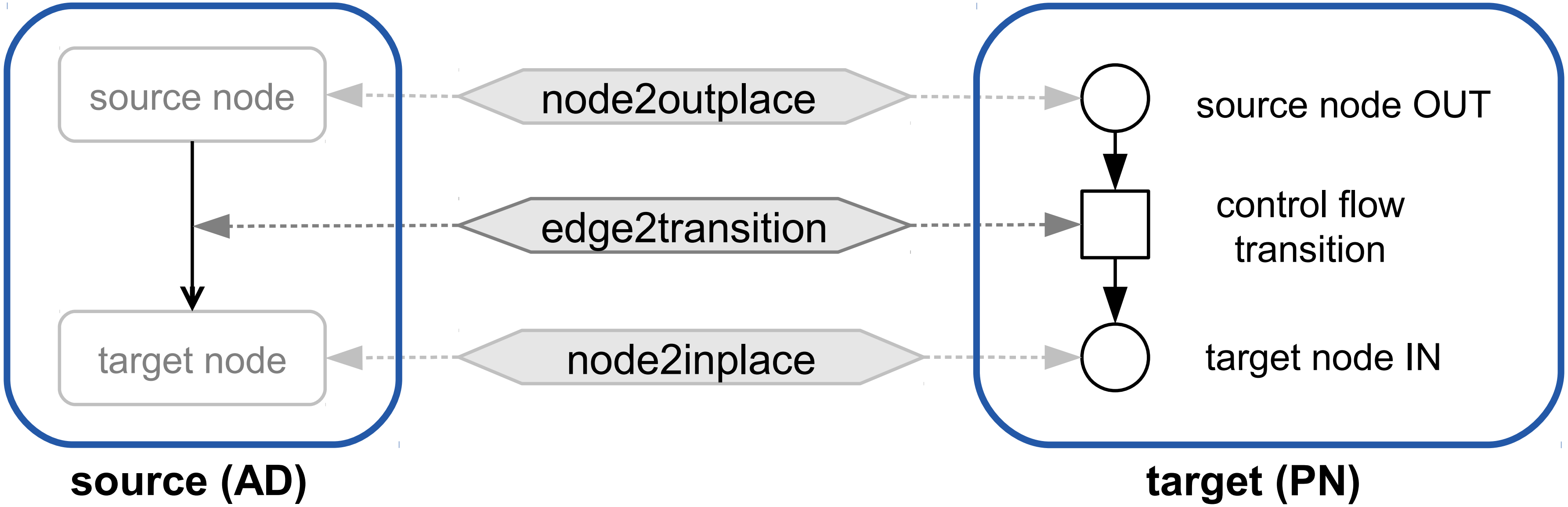

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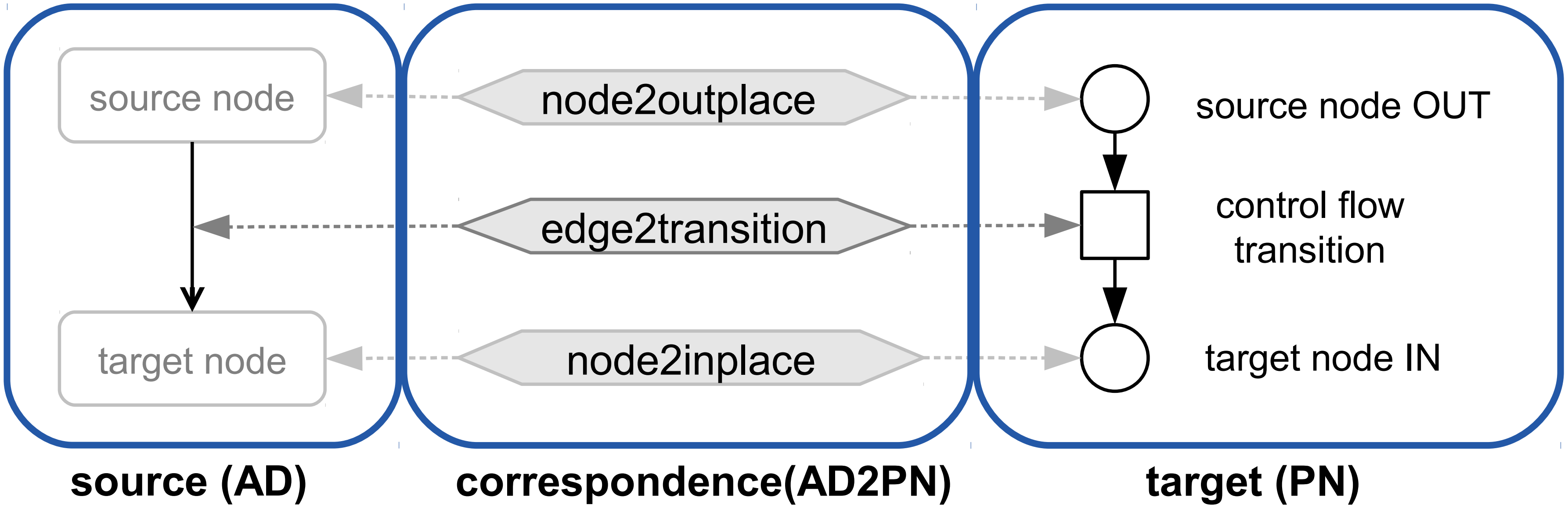

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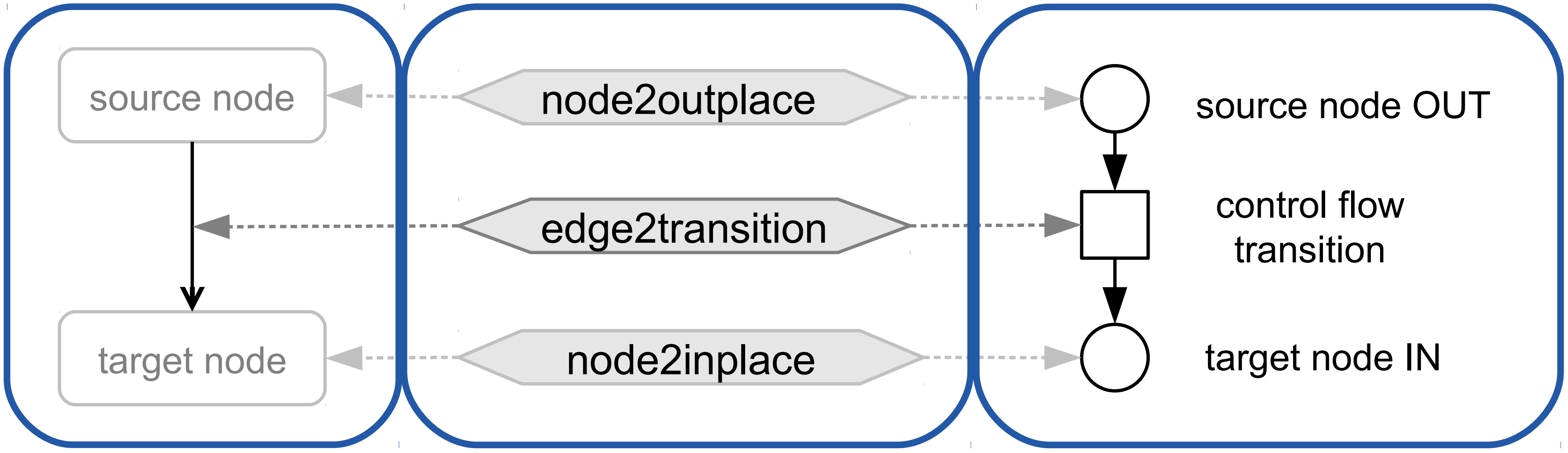

source (AD) **correspondence(AD2PN)** **target (PN)**

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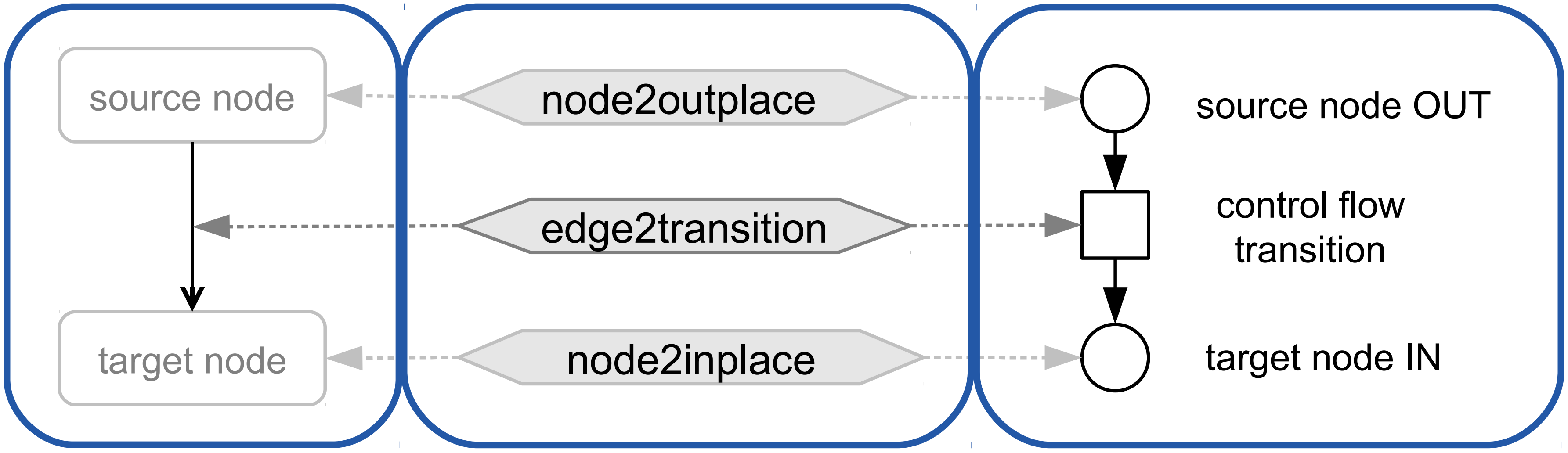

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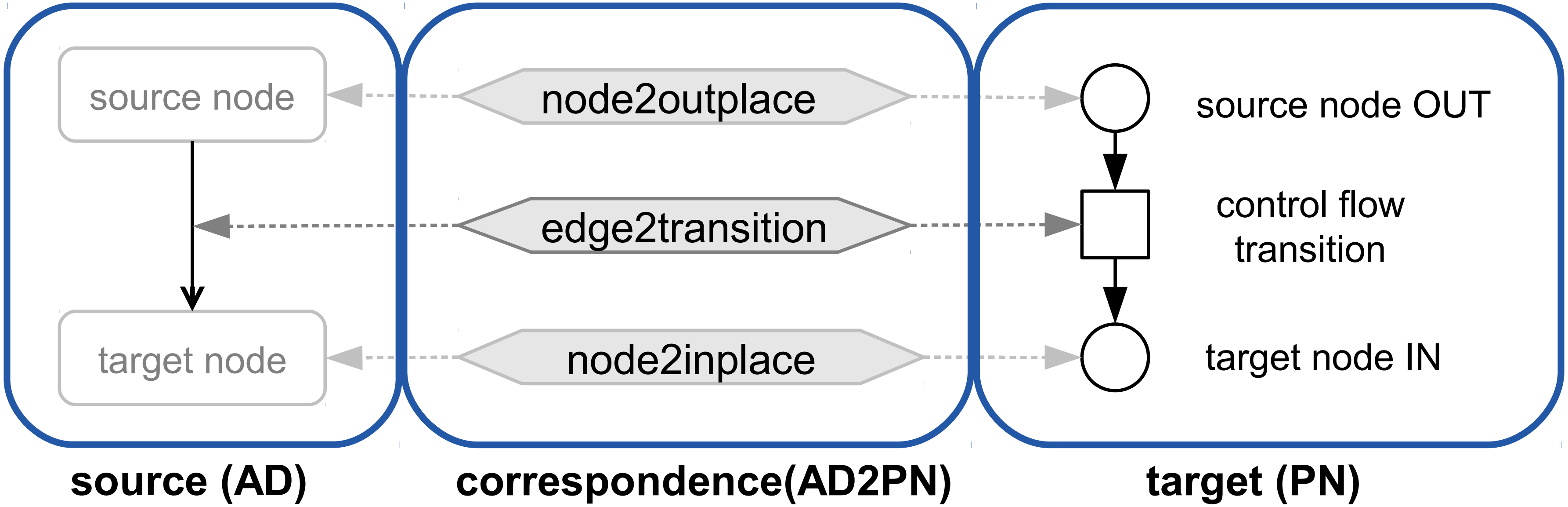

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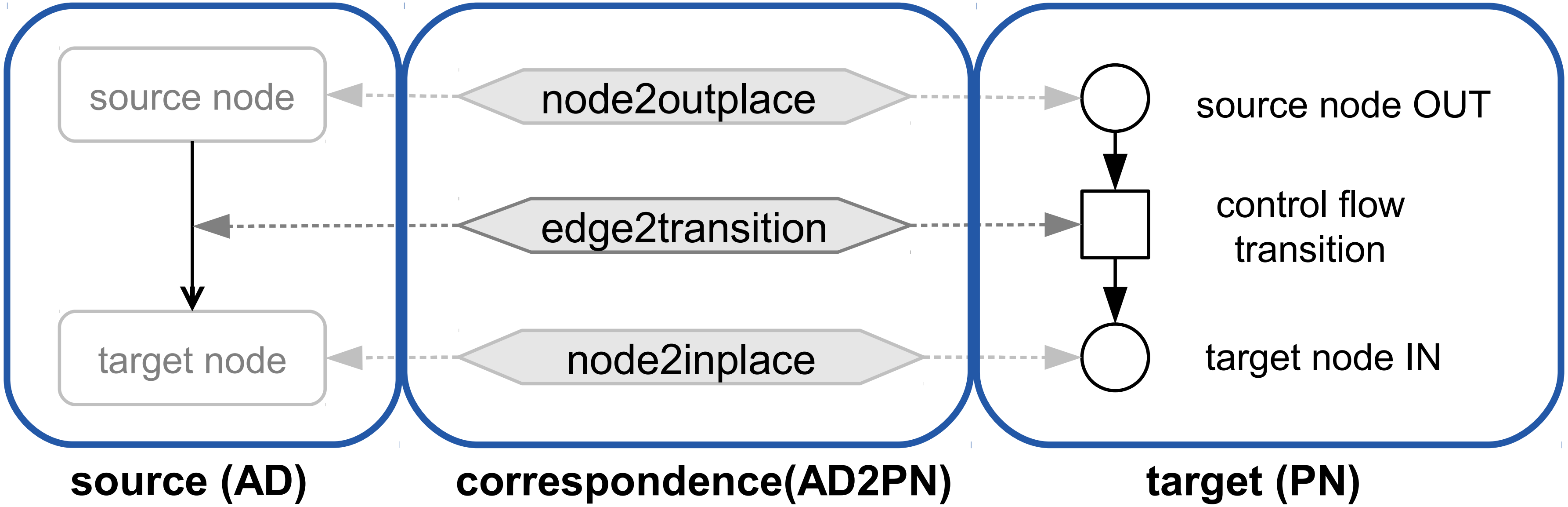

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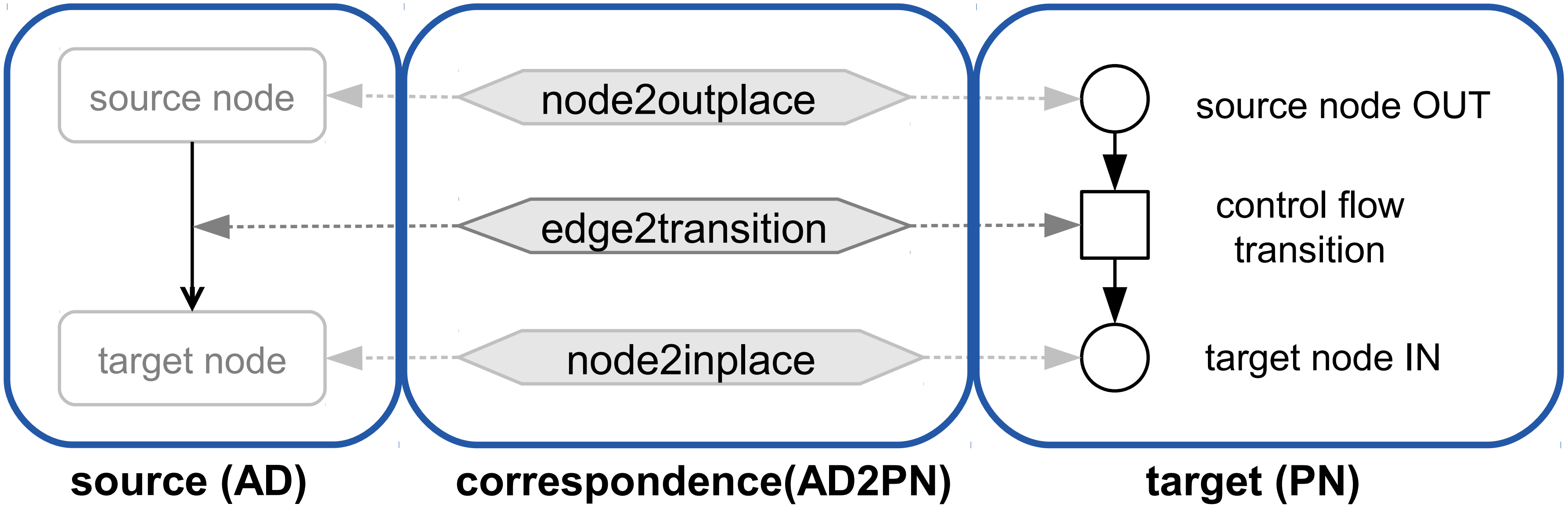
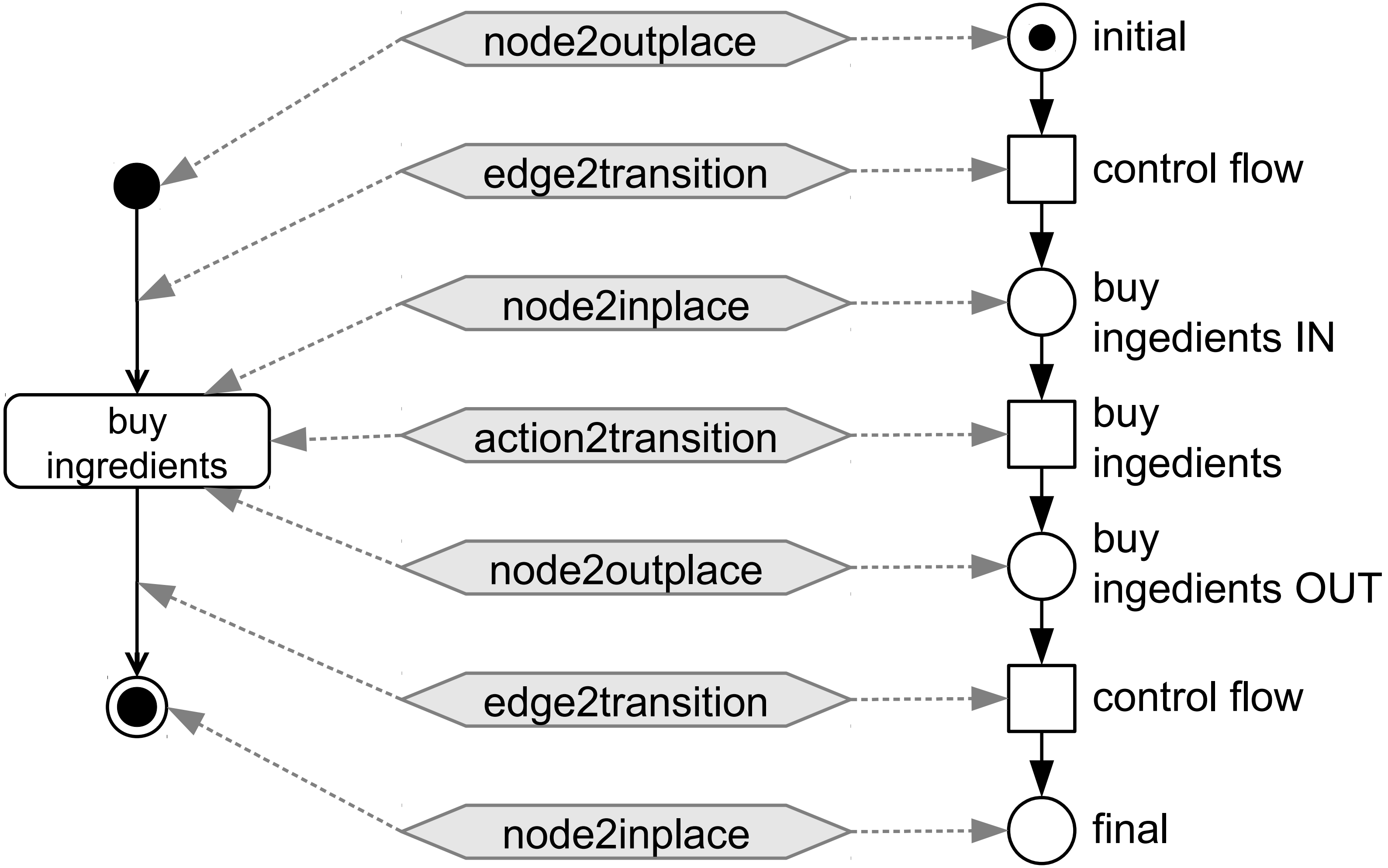


Triple Graphs

in the last lecture...

- Example of a bigger triple graph



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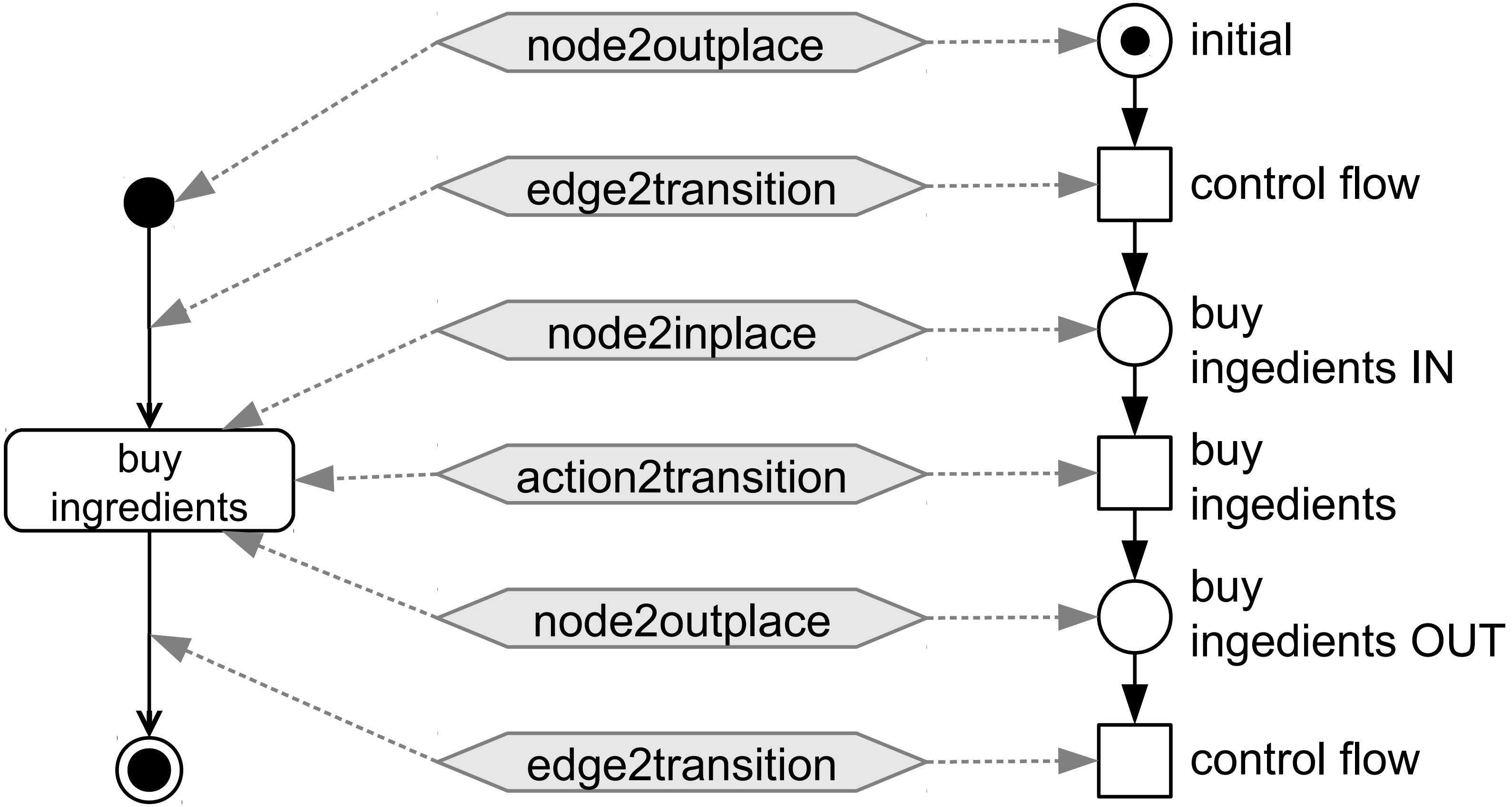

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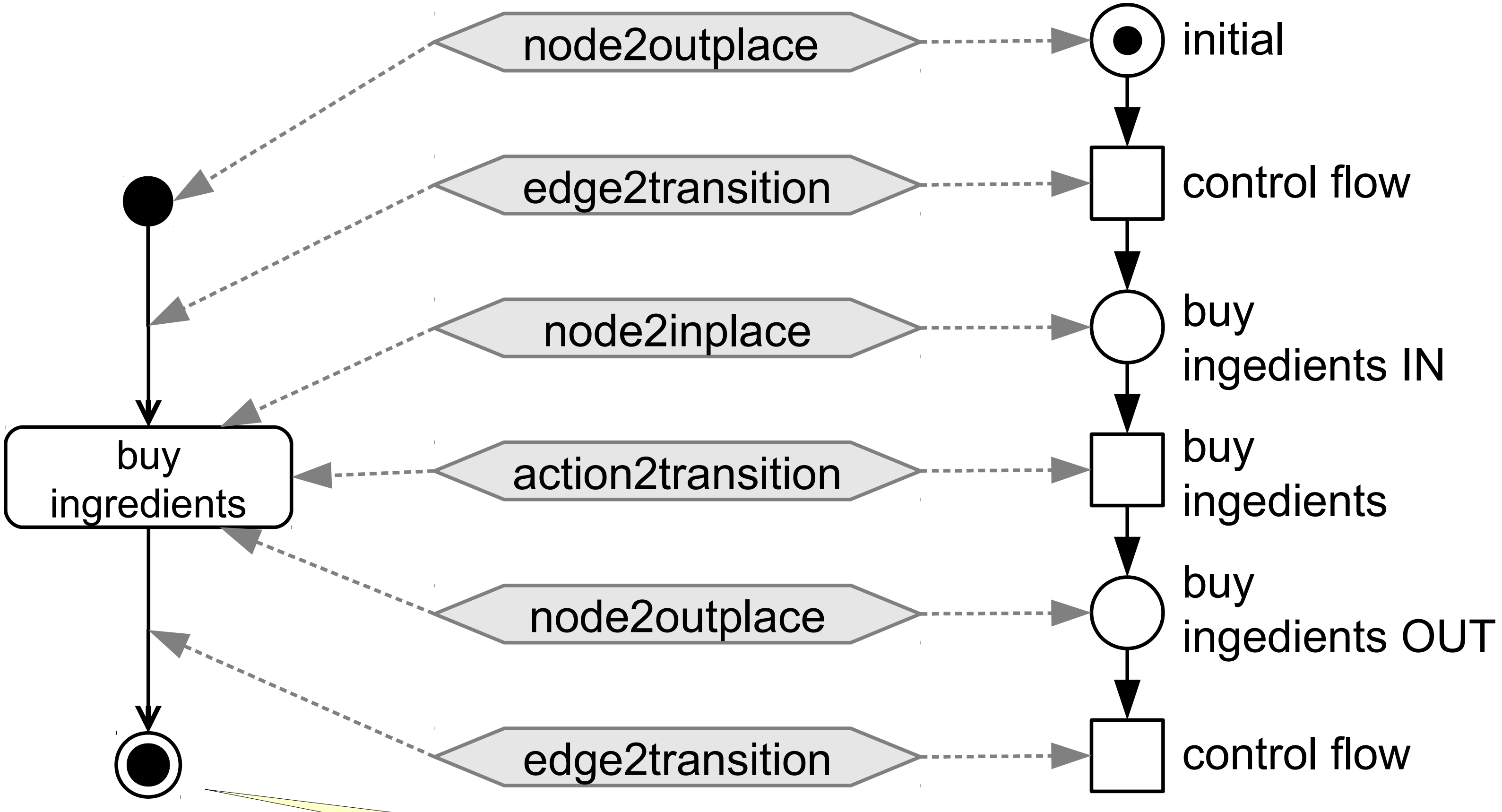

invalid: mapping of final node is missing

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in the last lecture...

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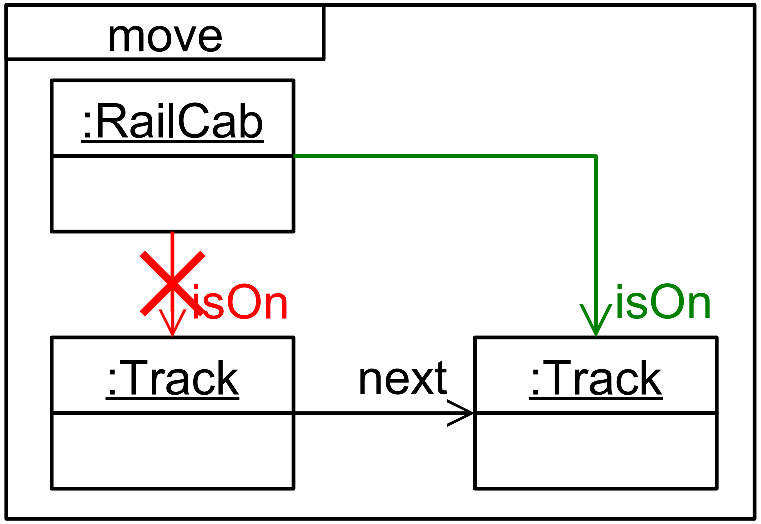

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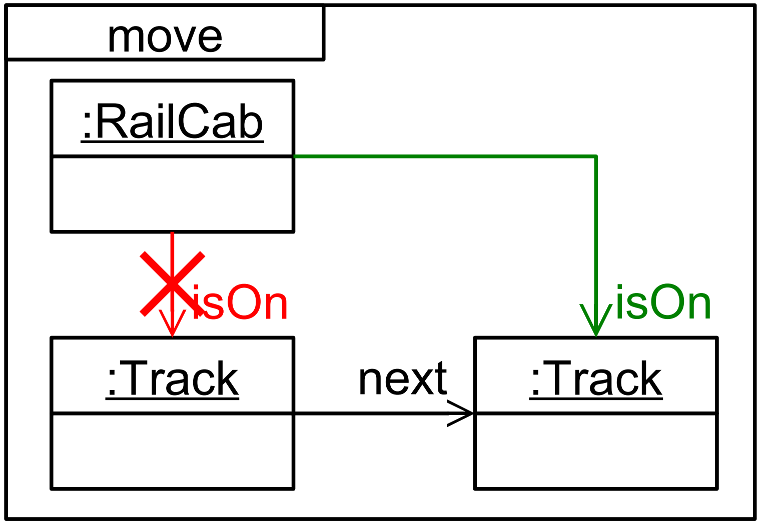

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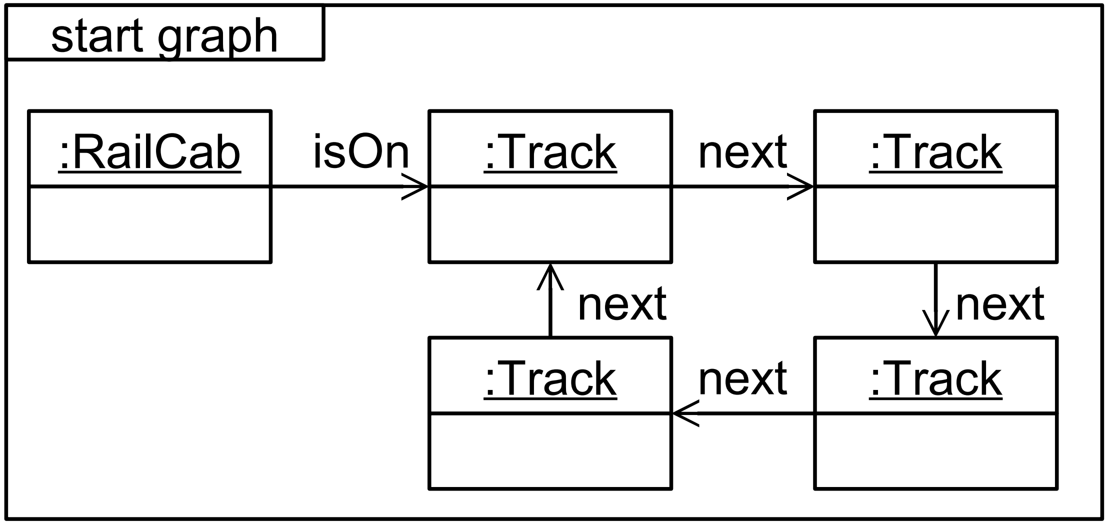

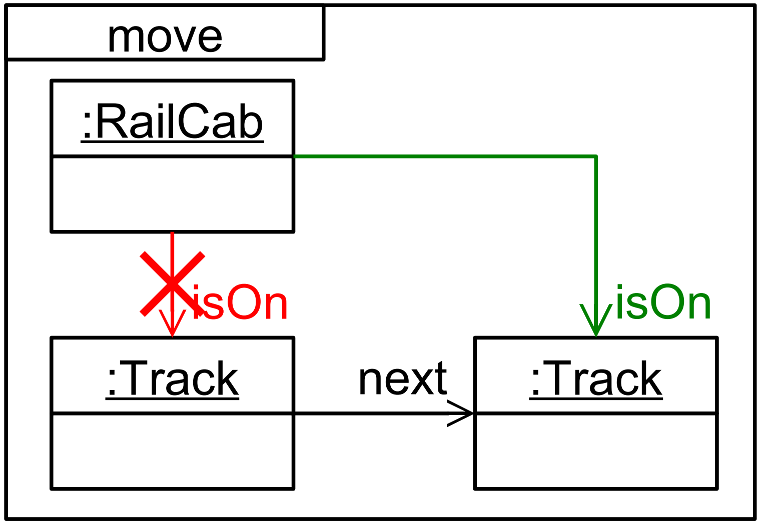

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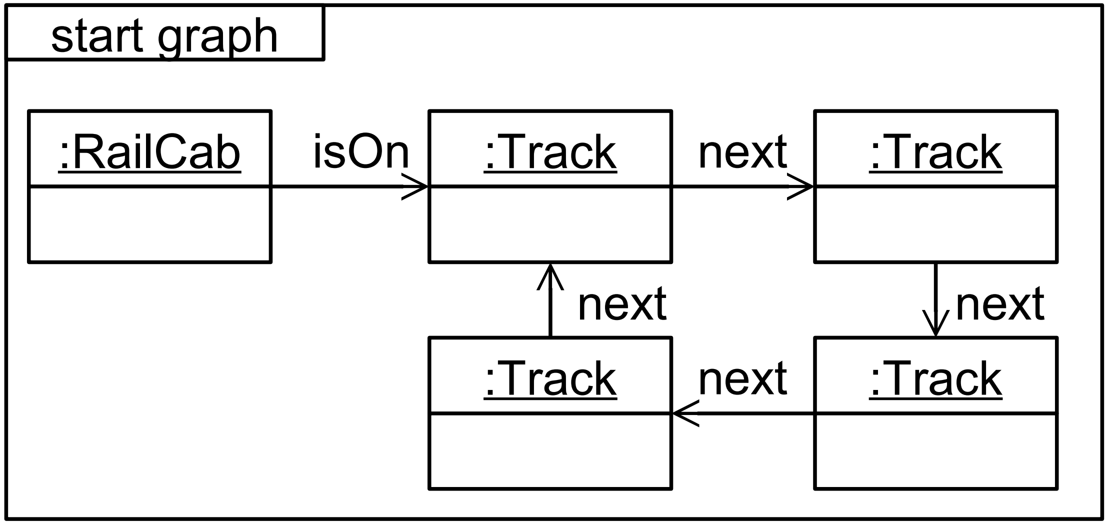

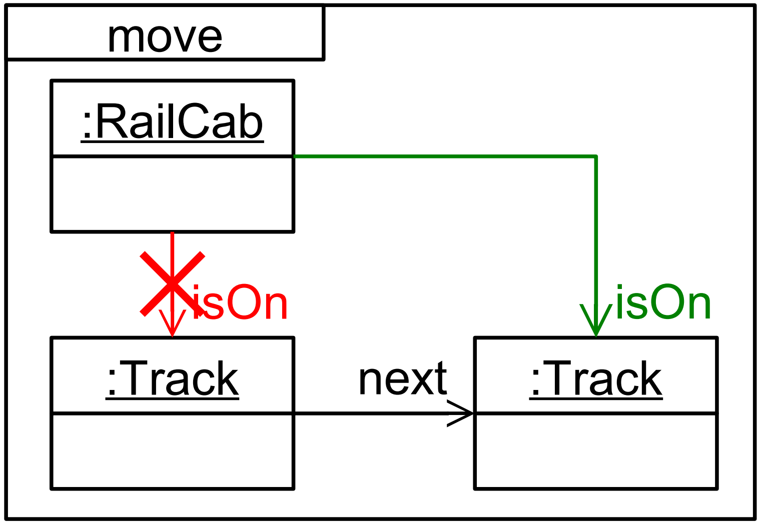

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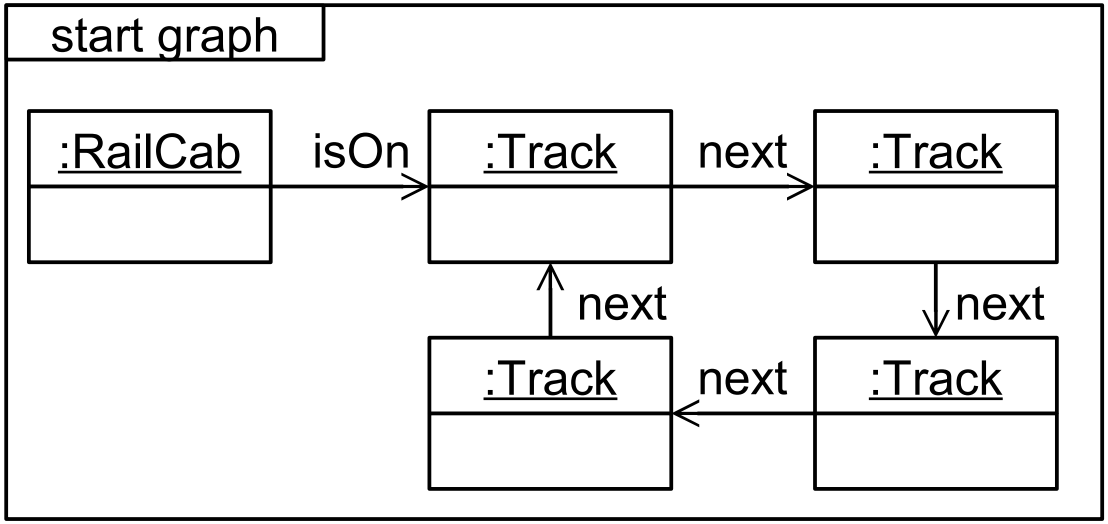

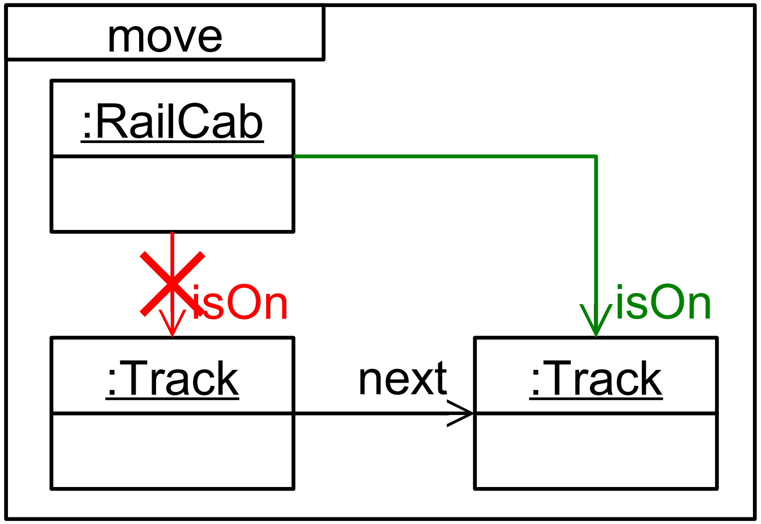

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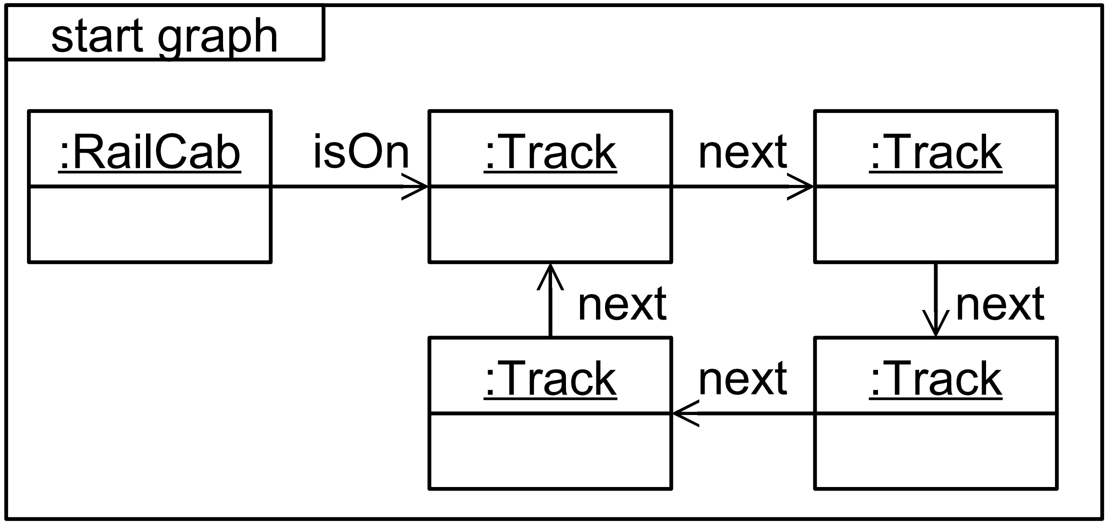

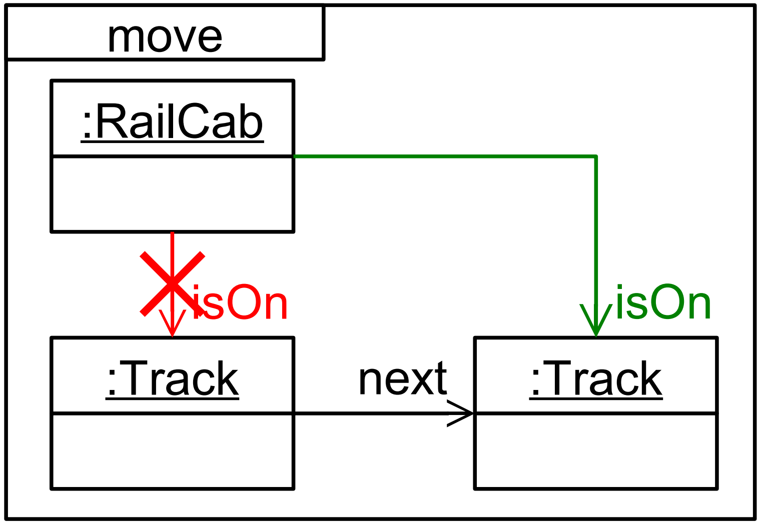

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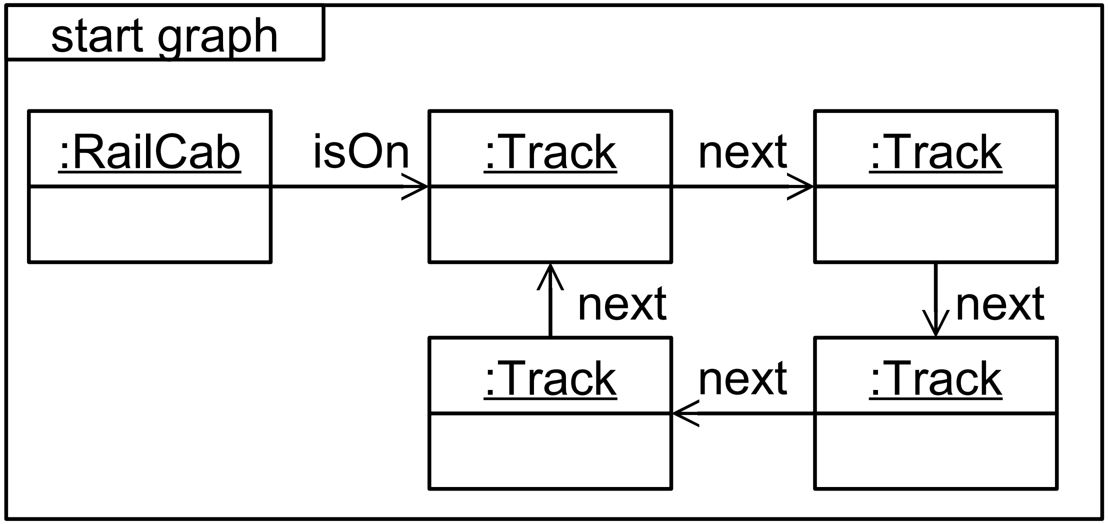
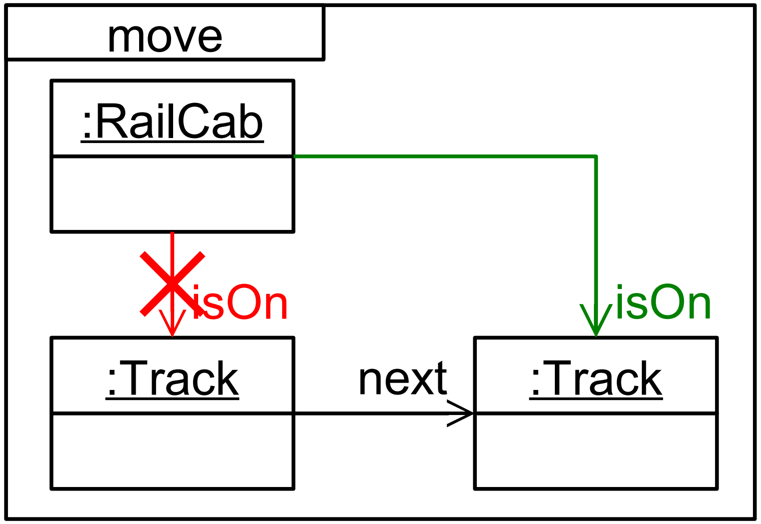
- Graph grammars are also called **Graph Transformation Systems**





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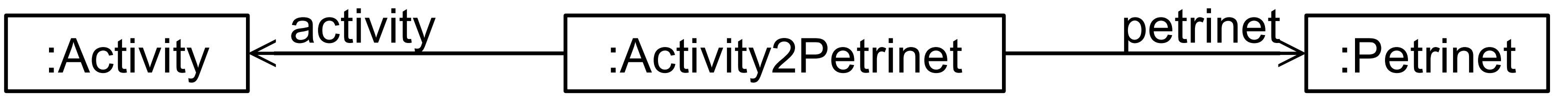

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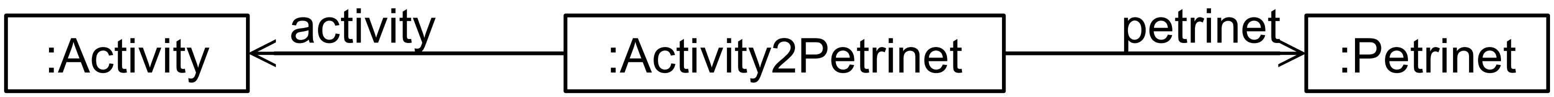

- The axiom is the smallest valid triple graph
  - as we will see, TGG rules are non-deleting

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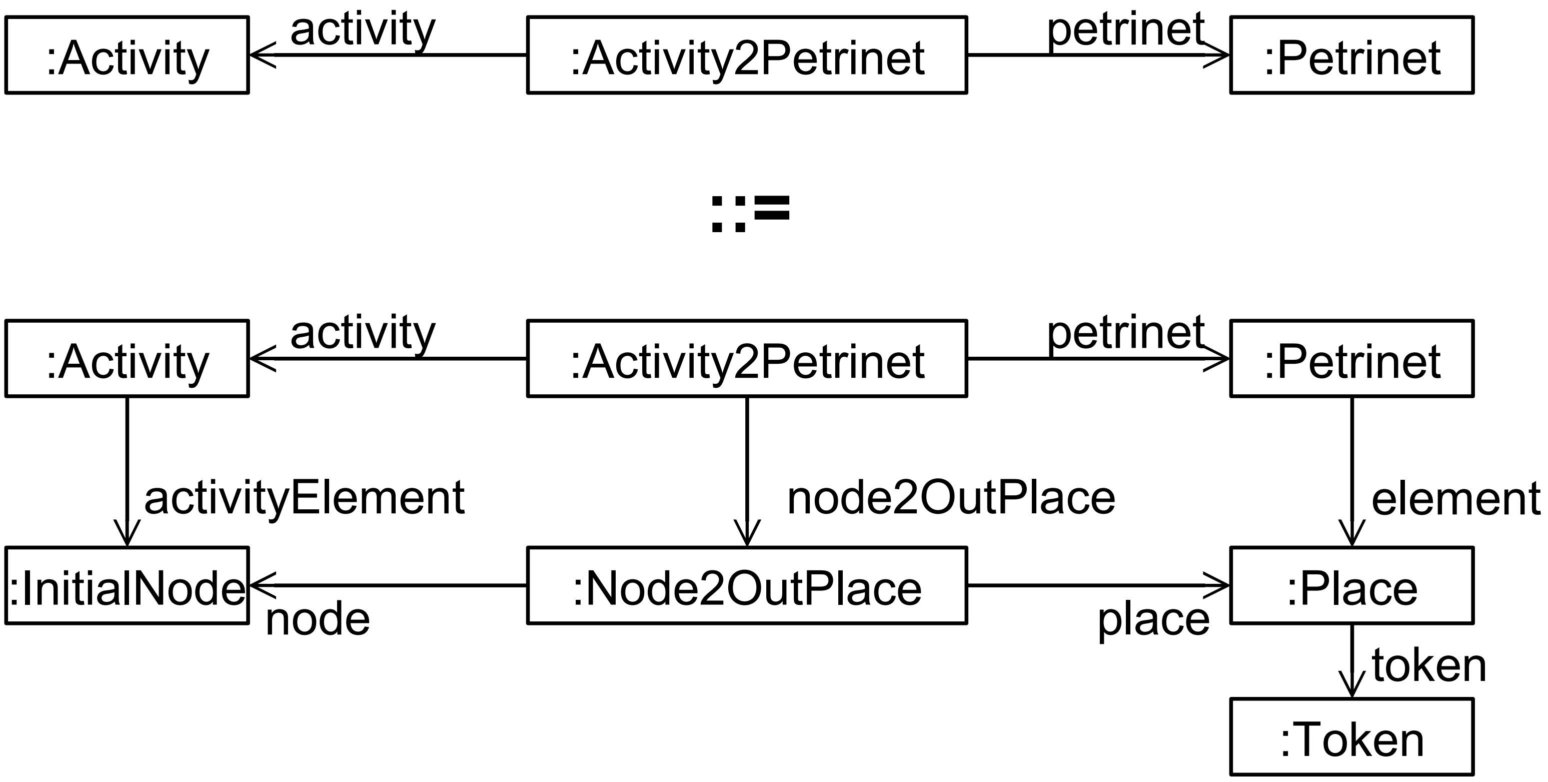

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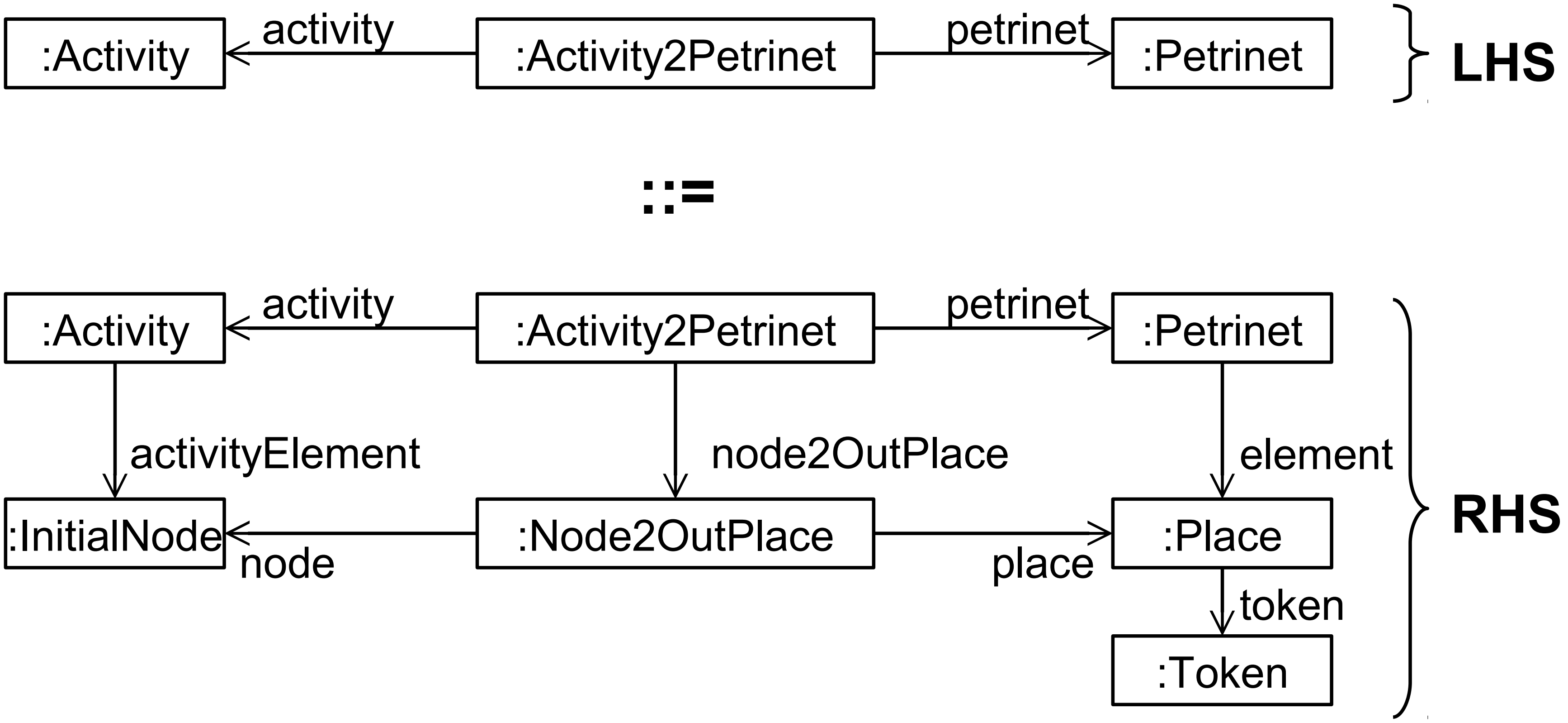

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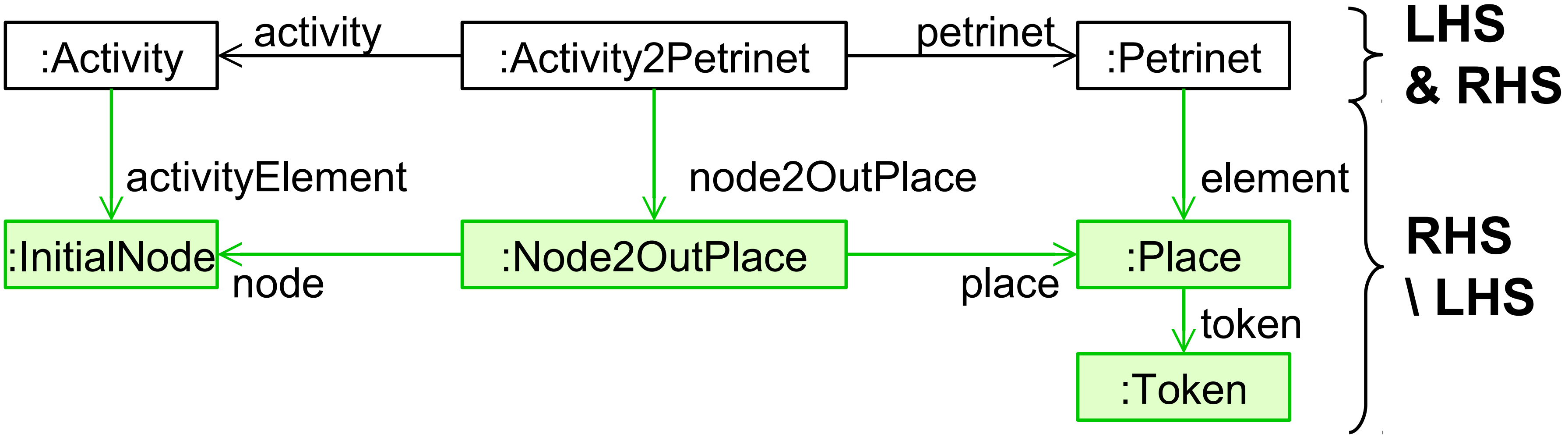

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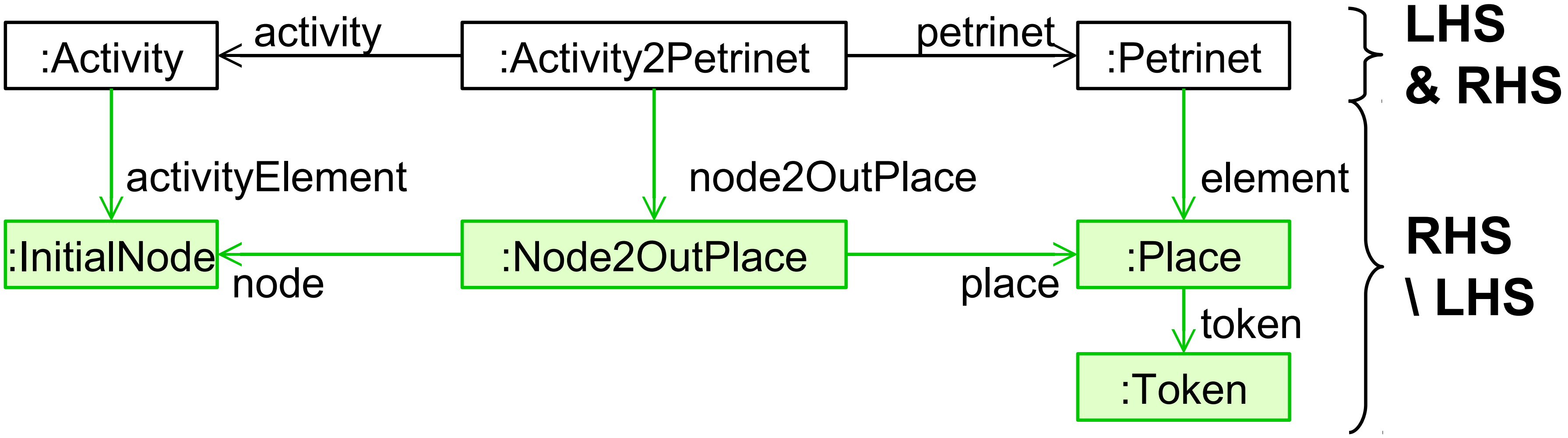

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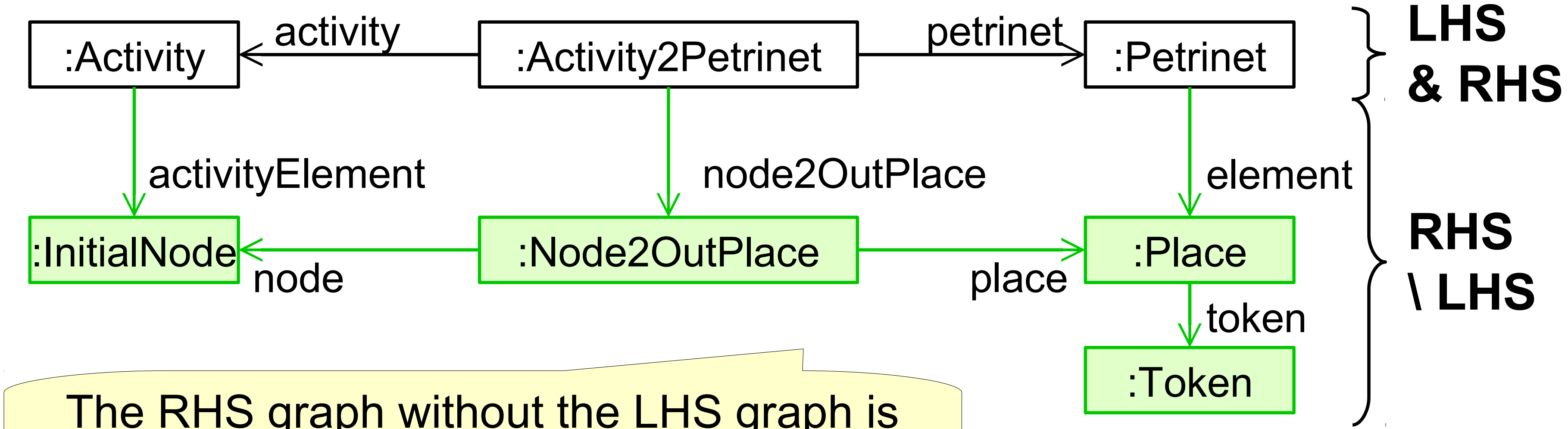
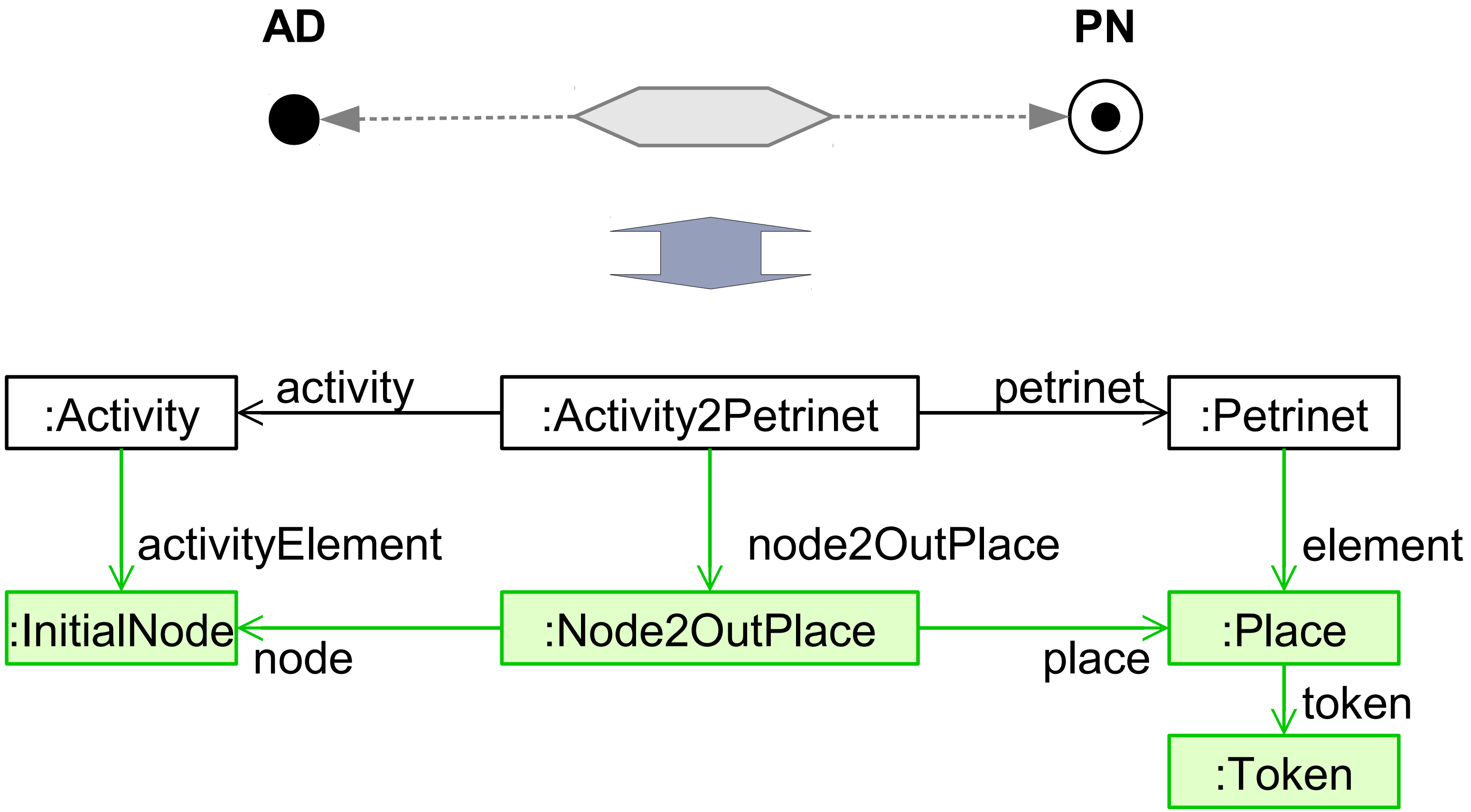


The RHS graph without the LHS graph is also called the rule's **produced graph**

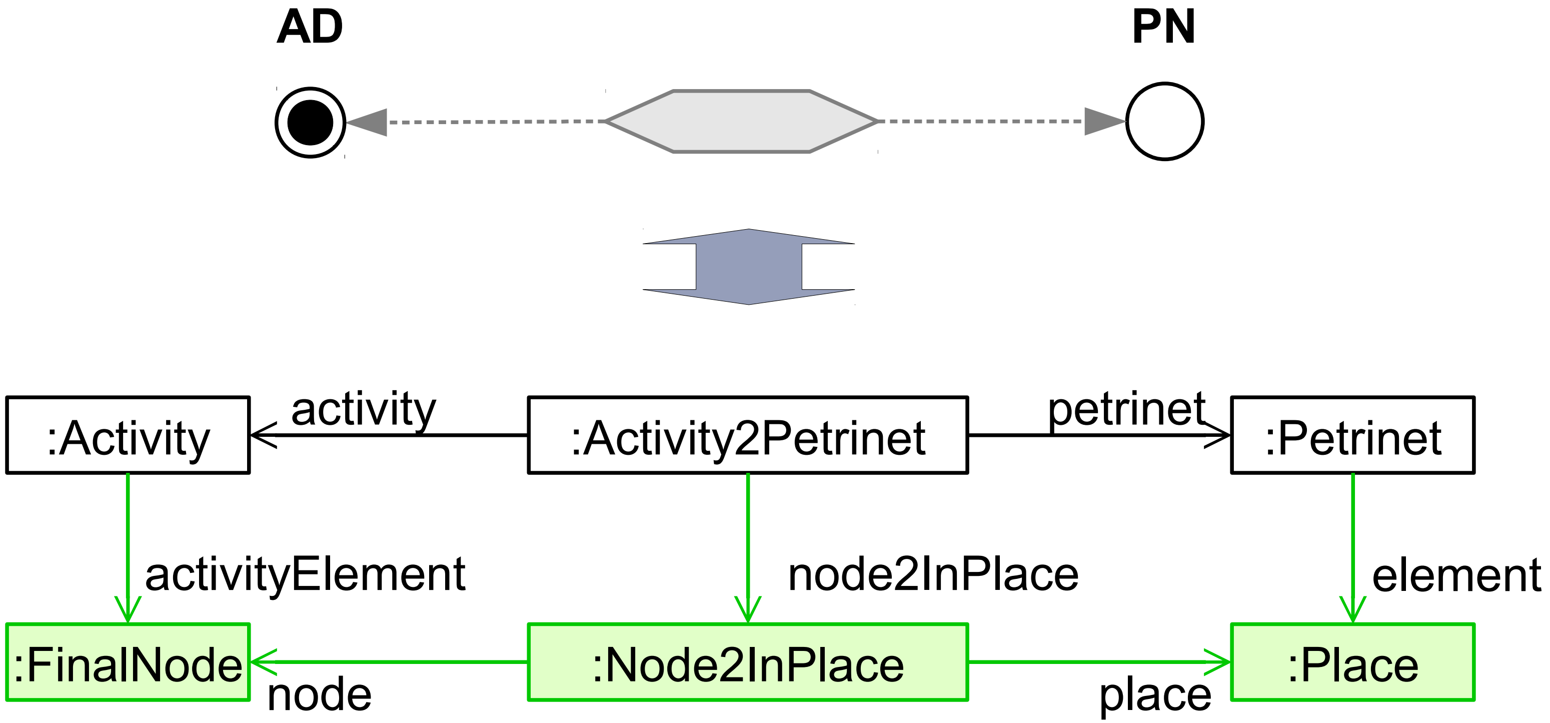
Intuitive Relation vs TGG Rule

- TGG rules are very close to the intuitive relation we described before



Intuitive Relation vs TGG Rule

- Final node ↔ Empty Place (similar to the rule before)



AD

PN

:Activity

activity

:Activity2Petrinet

petrinet

:Petrinet

activityElement

node2InPlace

element

:FinalNode

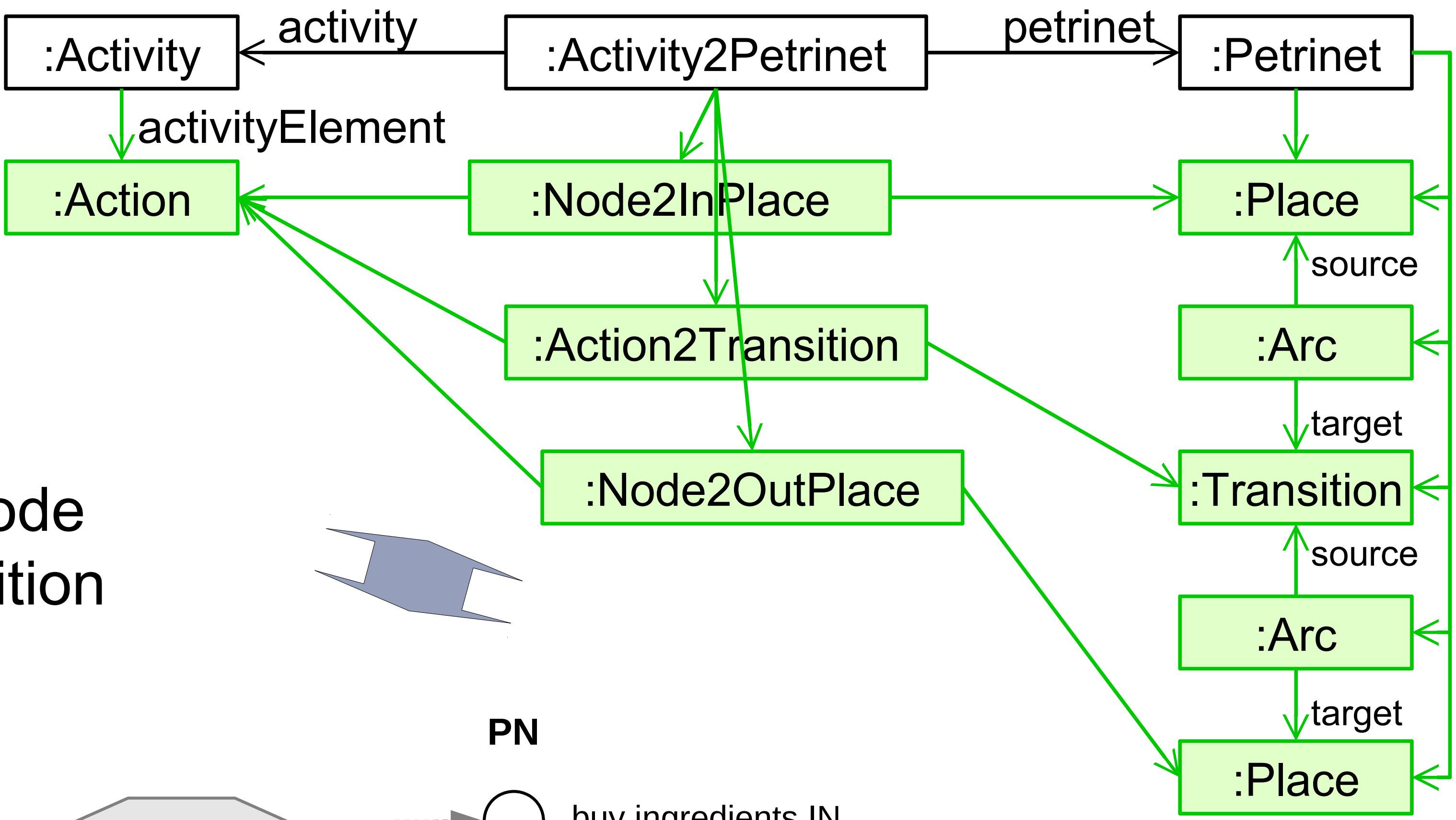
node

:Node2InPlace

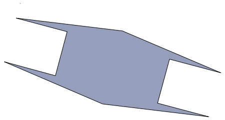
place

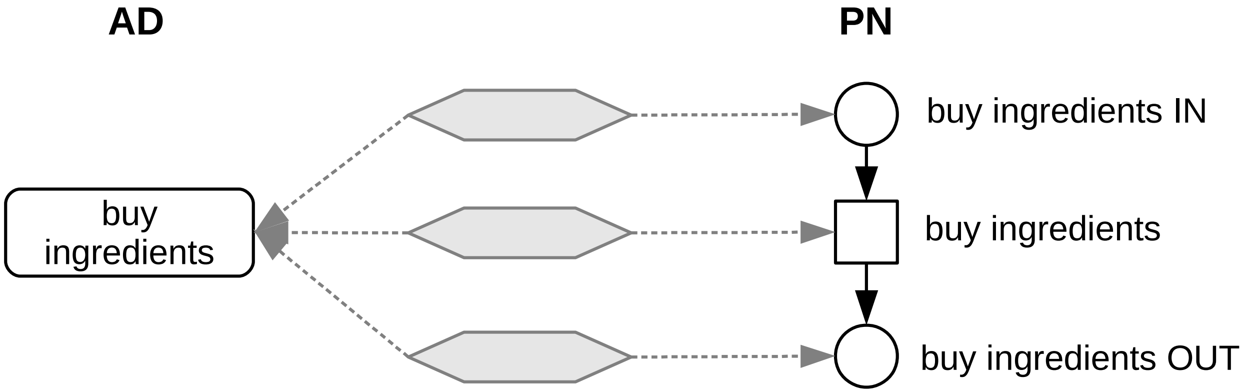
:Place

Intuitive Relation vs TGG Rule



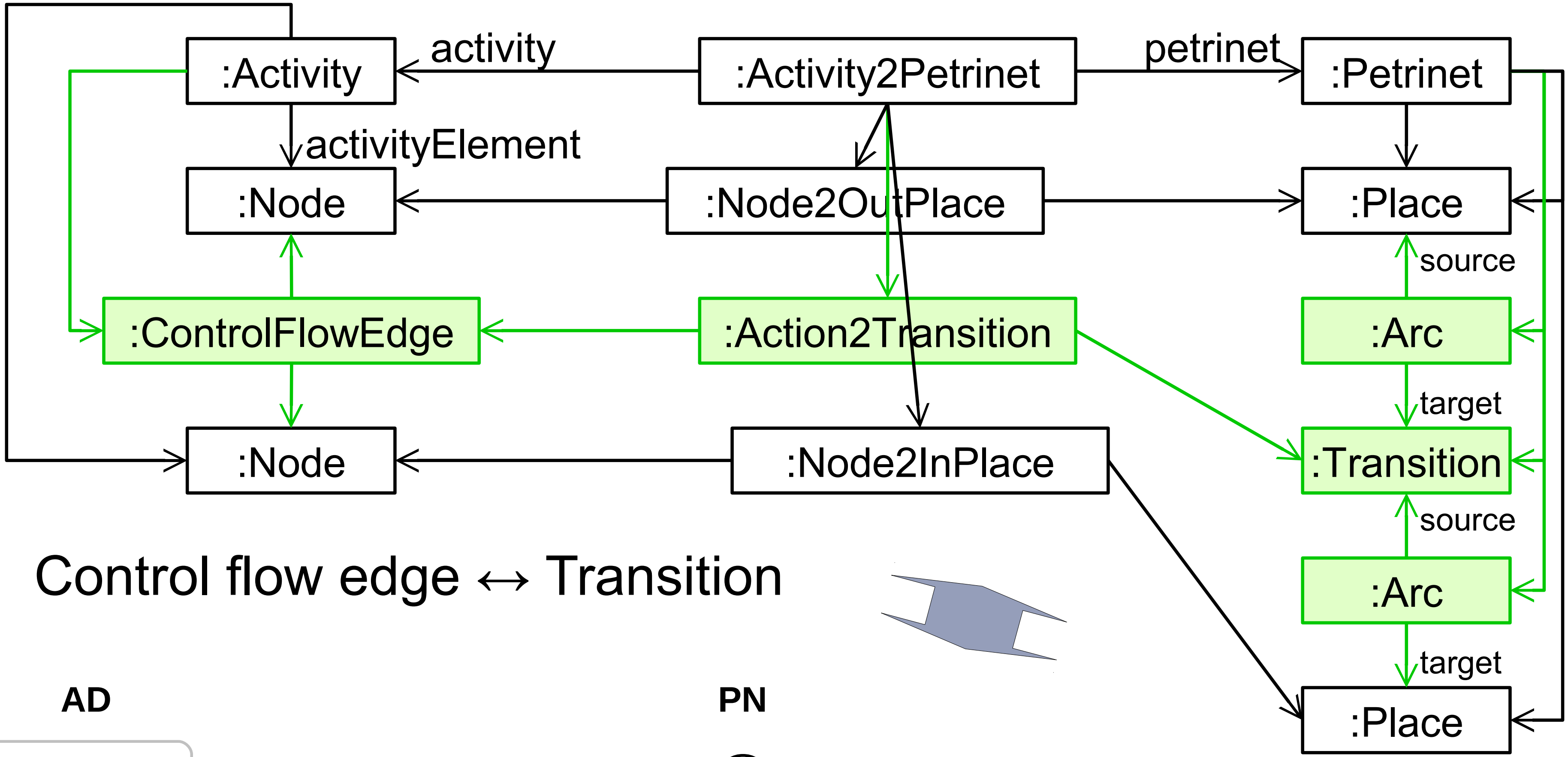
- Action node ↔ Transition



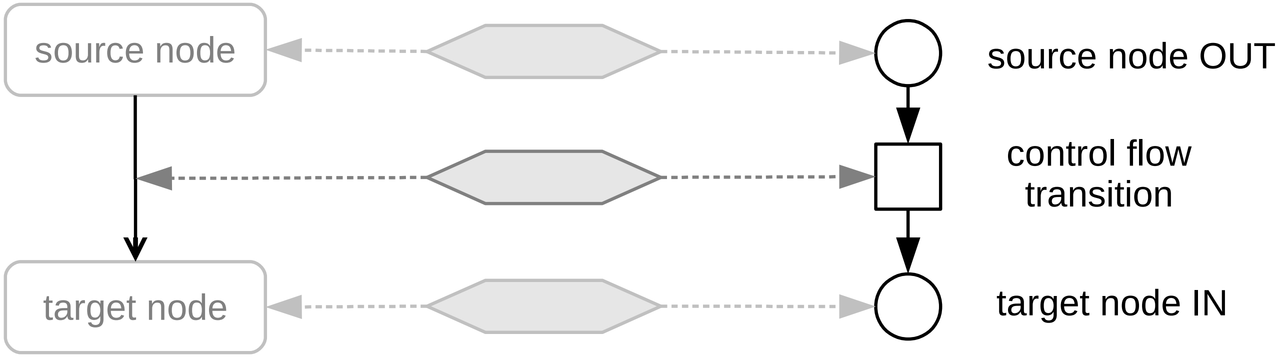


(ommitting some edge labels for space reasons)

Intuitive Relation vs TGG Rule



- Control flow edge ↔ Transition



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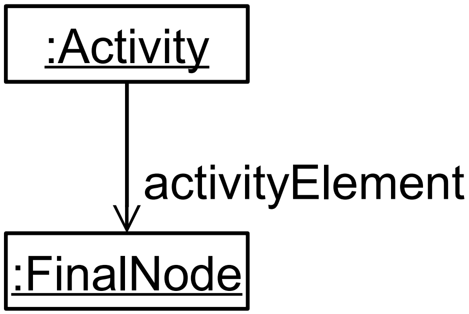
Forward Transformation Scenario

- Given is a source model



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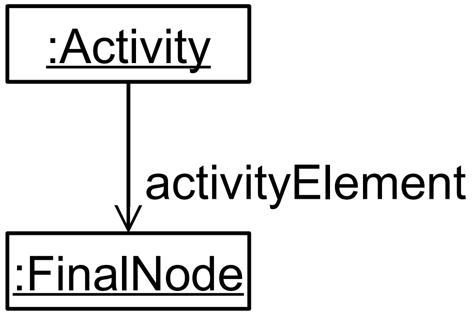

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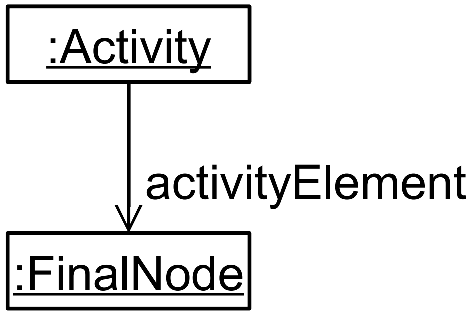

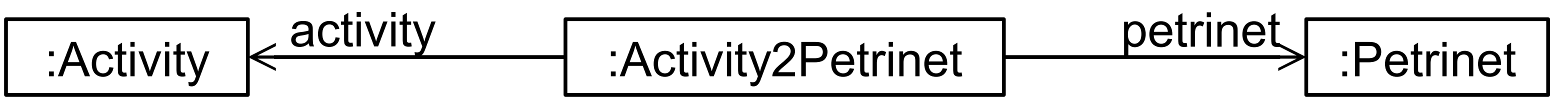

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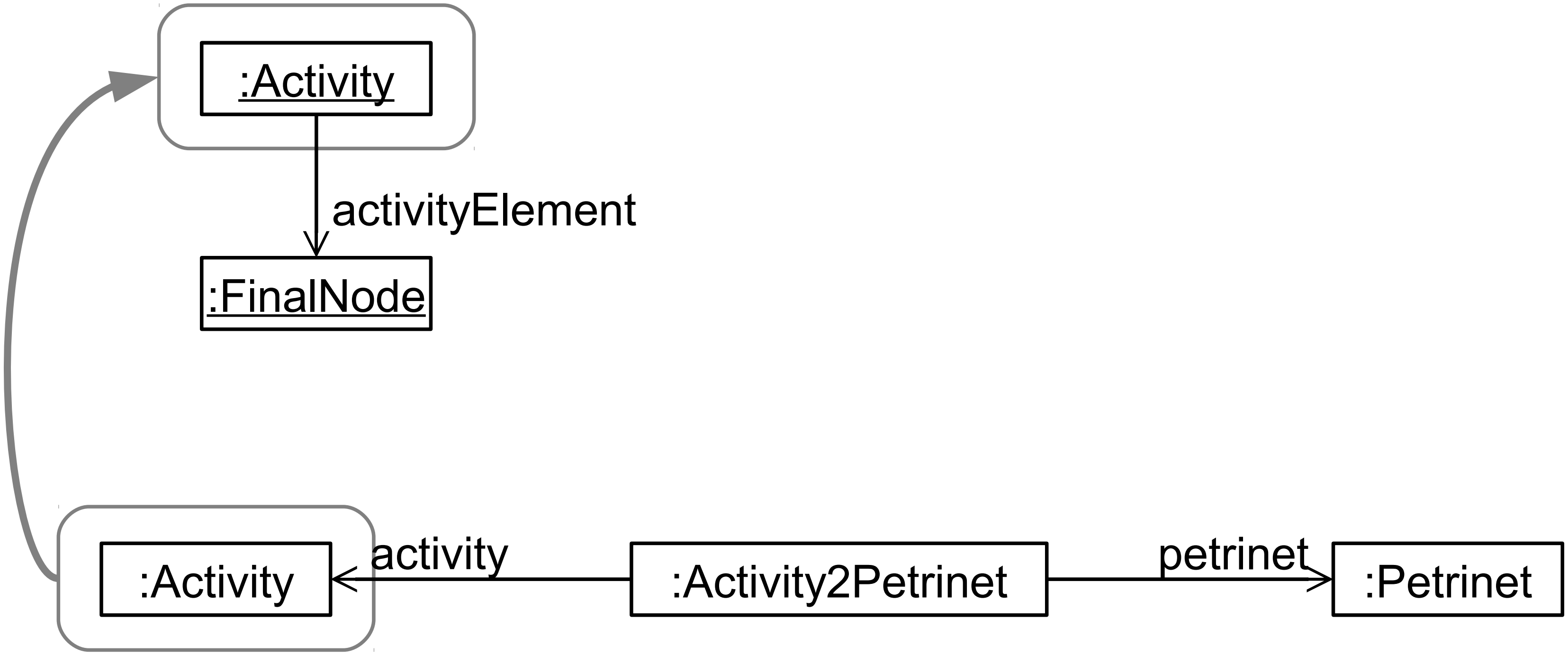

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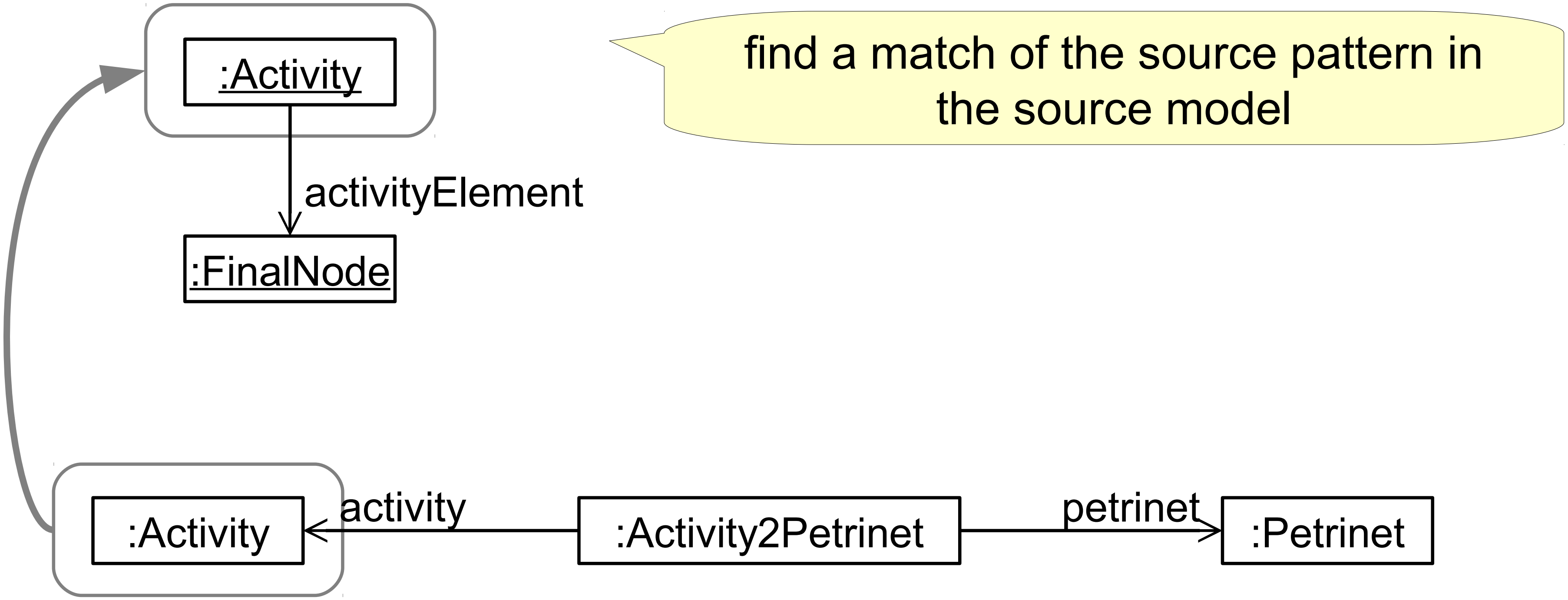

find a match of the source pattern in the source model

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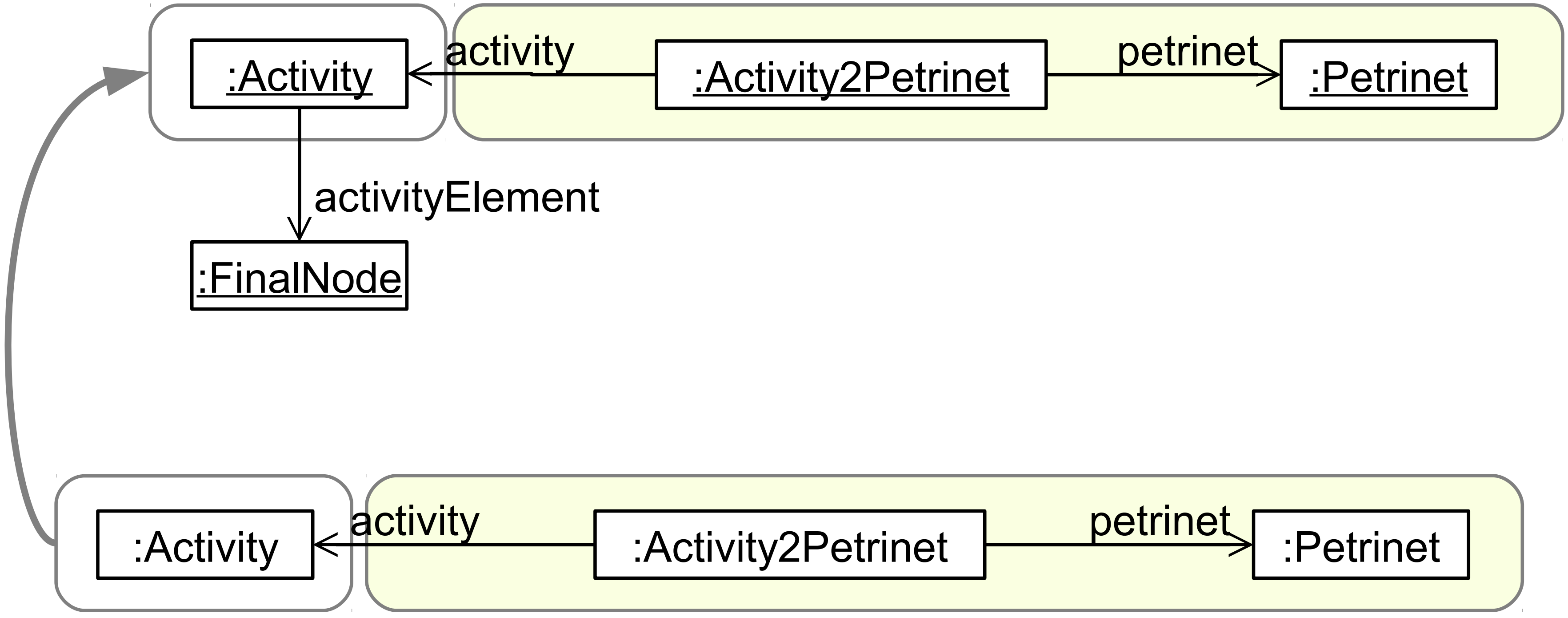

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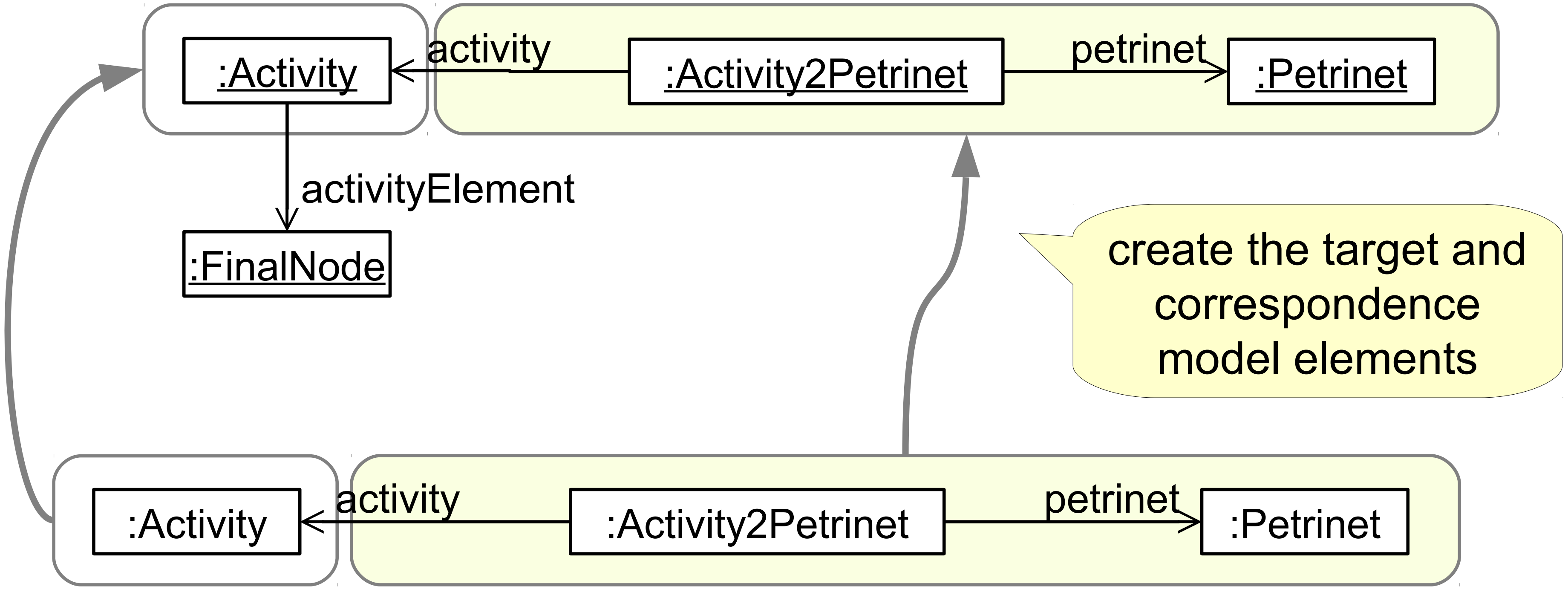

create the target and correspondence model elements

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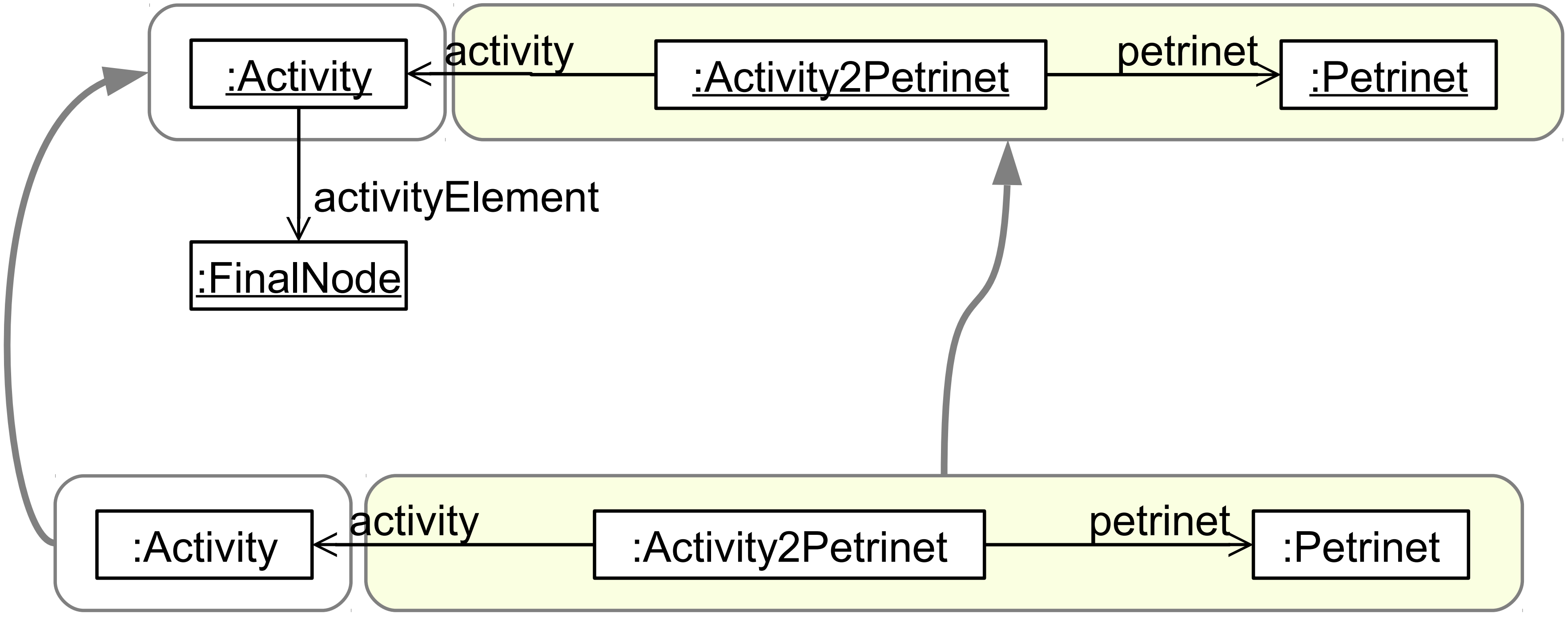

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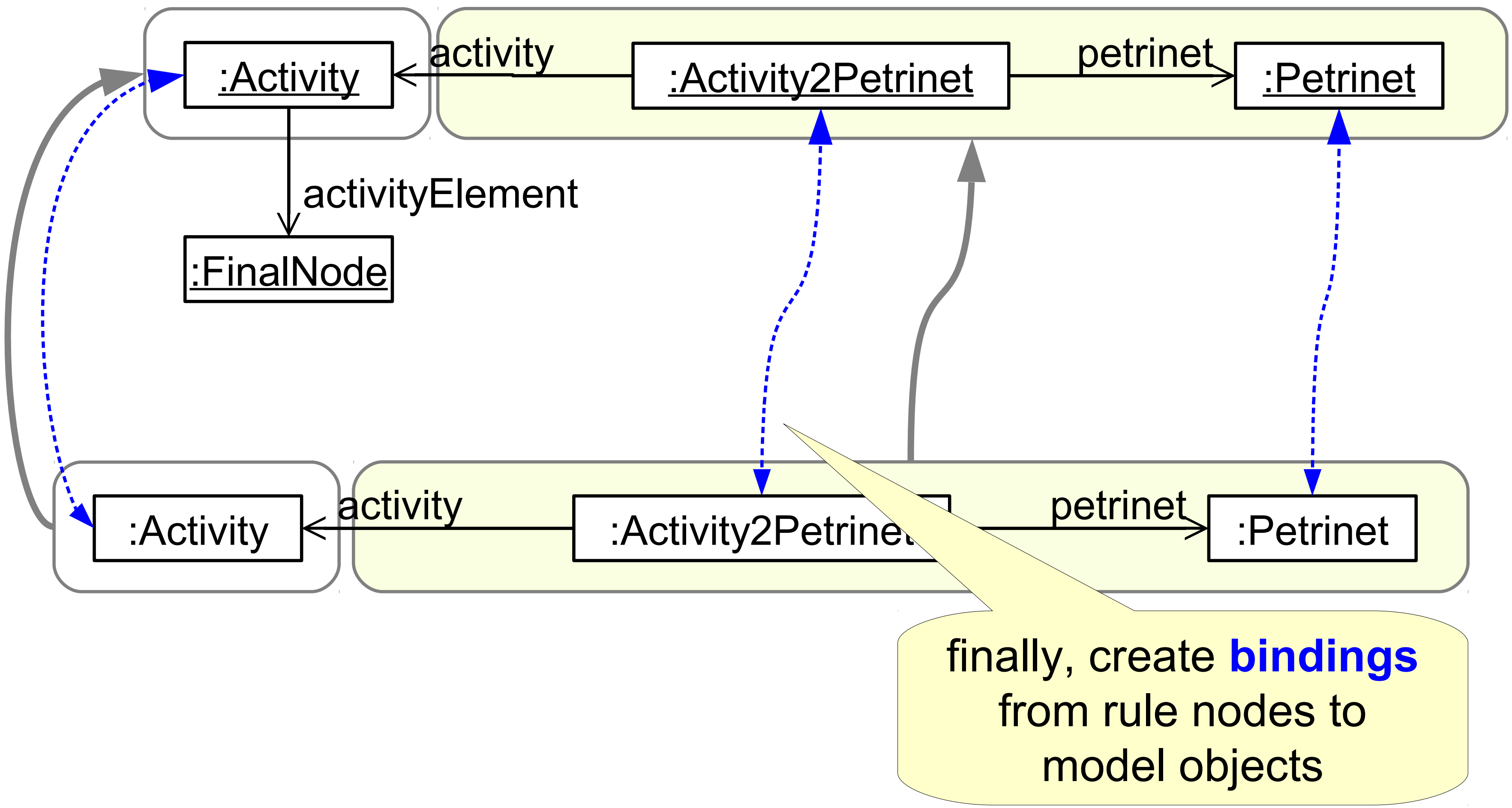
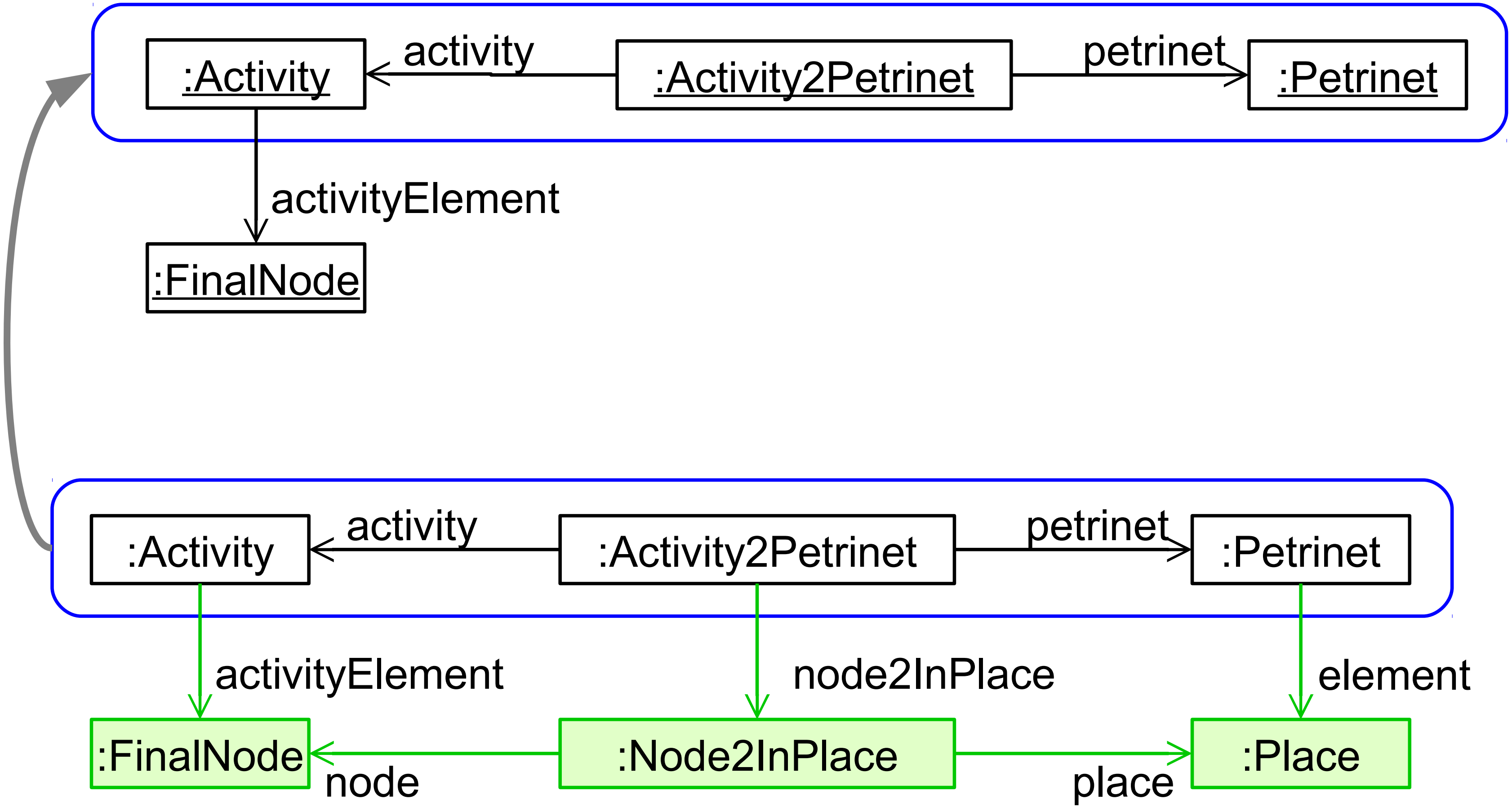


finally, create **bindings** from rule nodes to model objects

Forward Transformation Scenario

- Then, find TGG rule that can be applied as follows:



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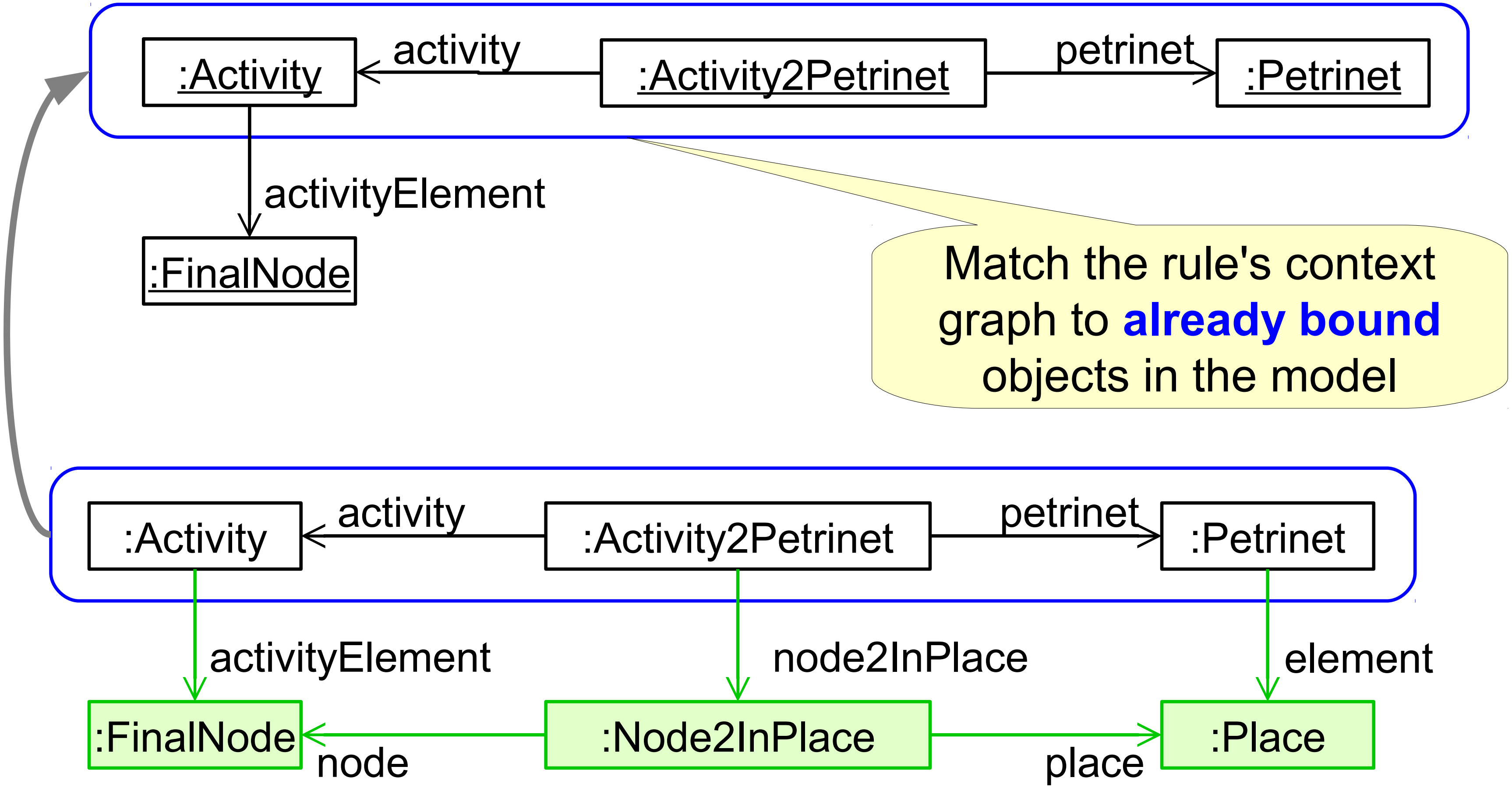

Match the rule's context graph to **already bound** objects in the model

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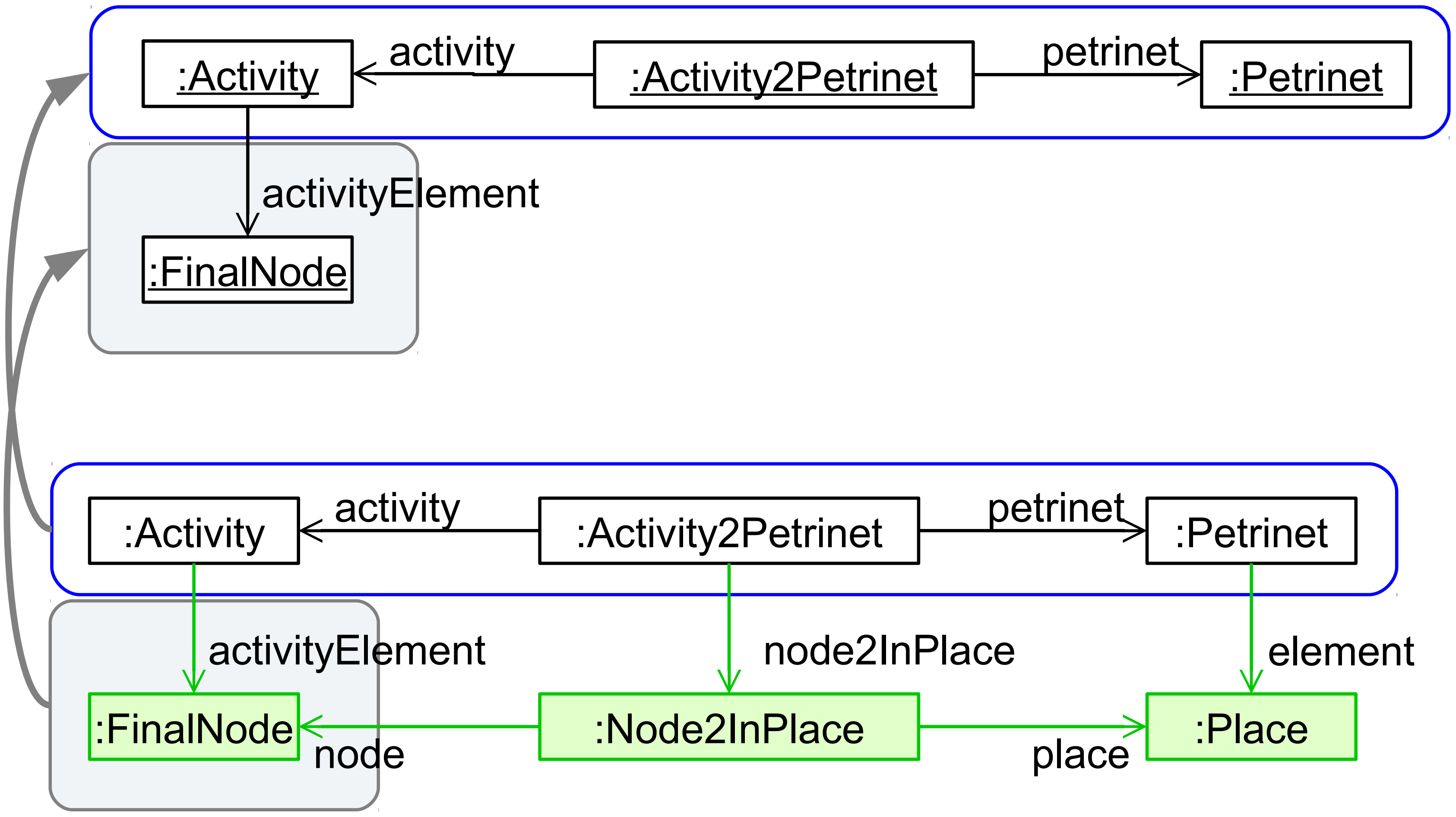

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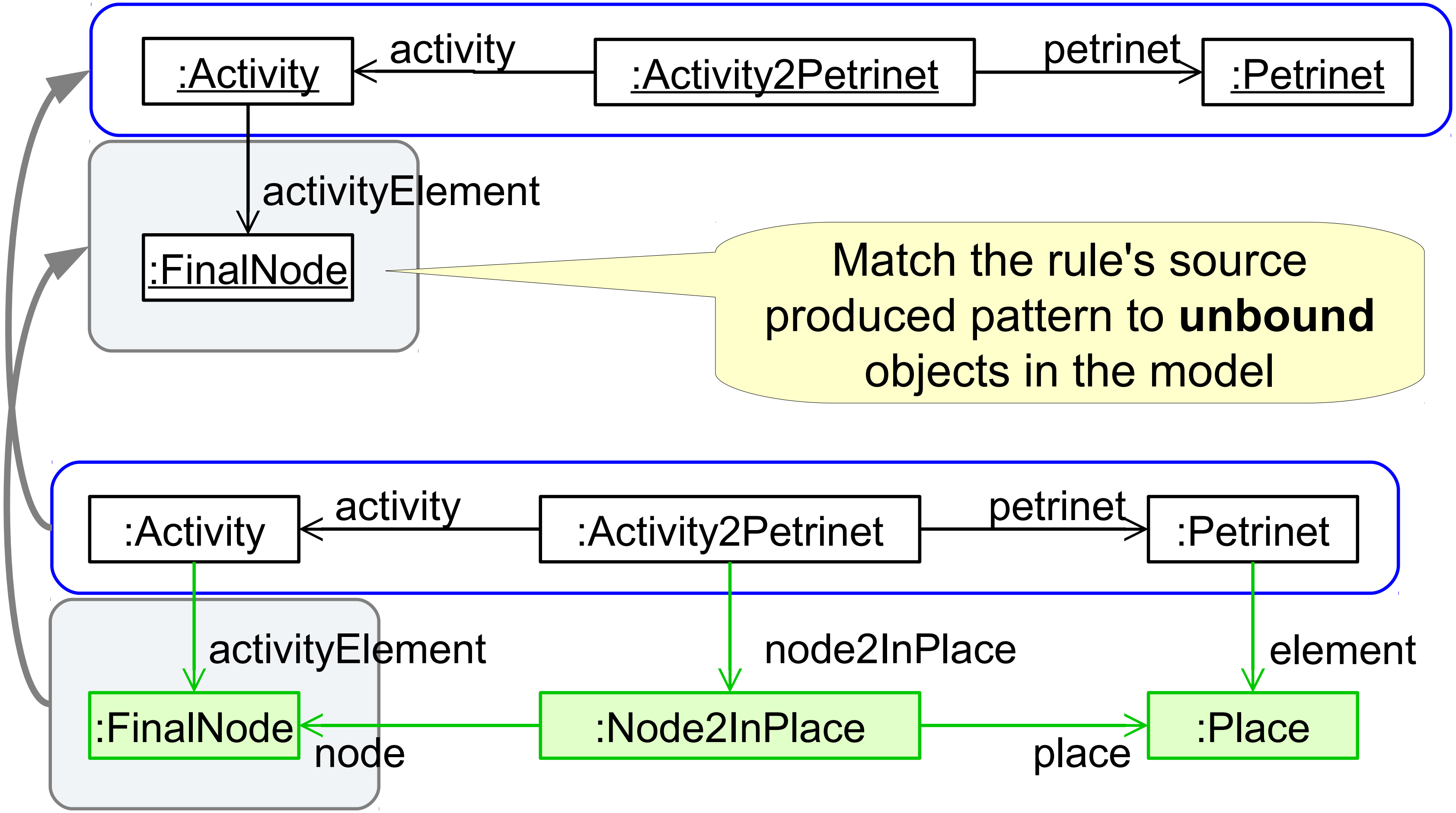

Match the rule's source produced pattern to **unbound** objects in the model

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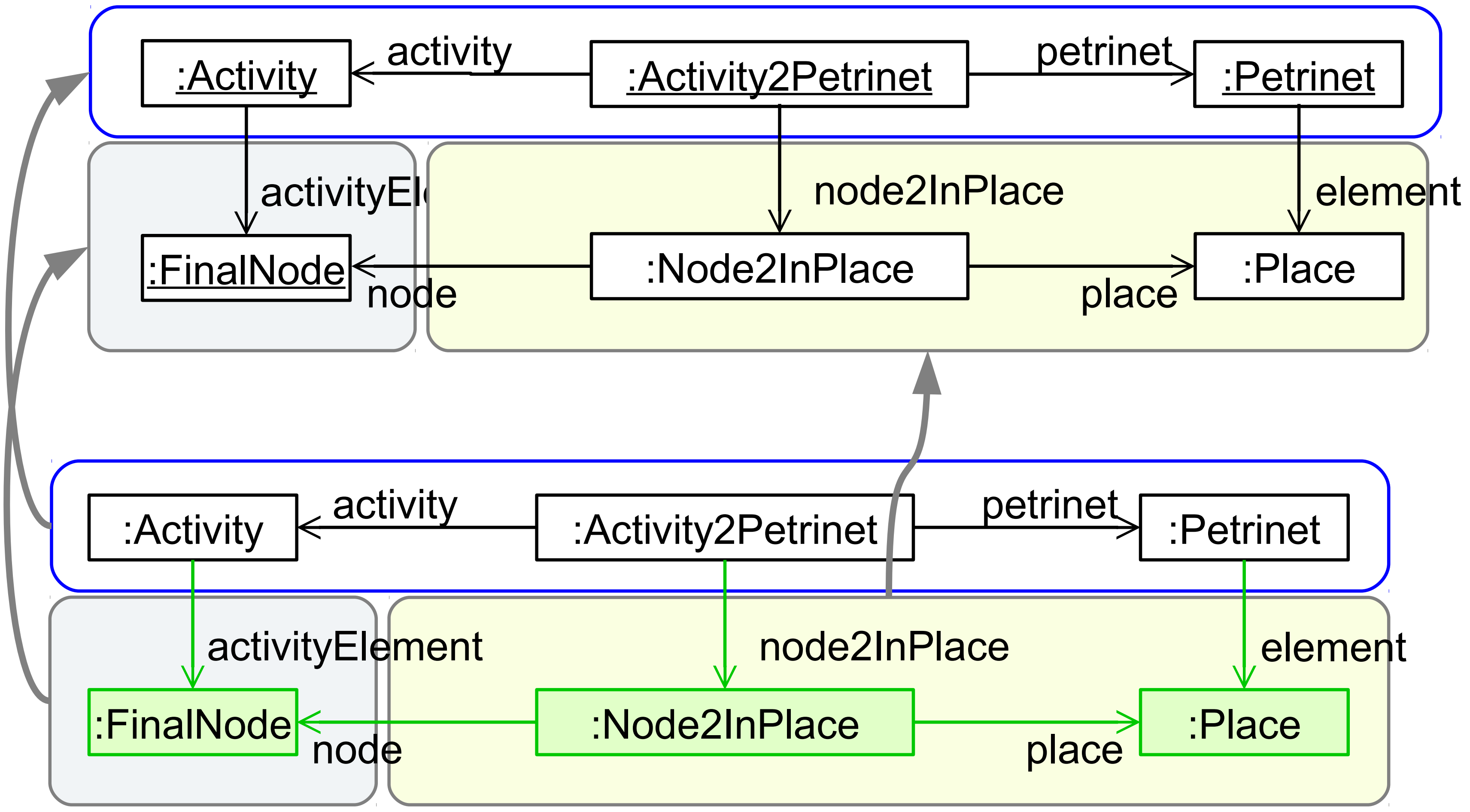

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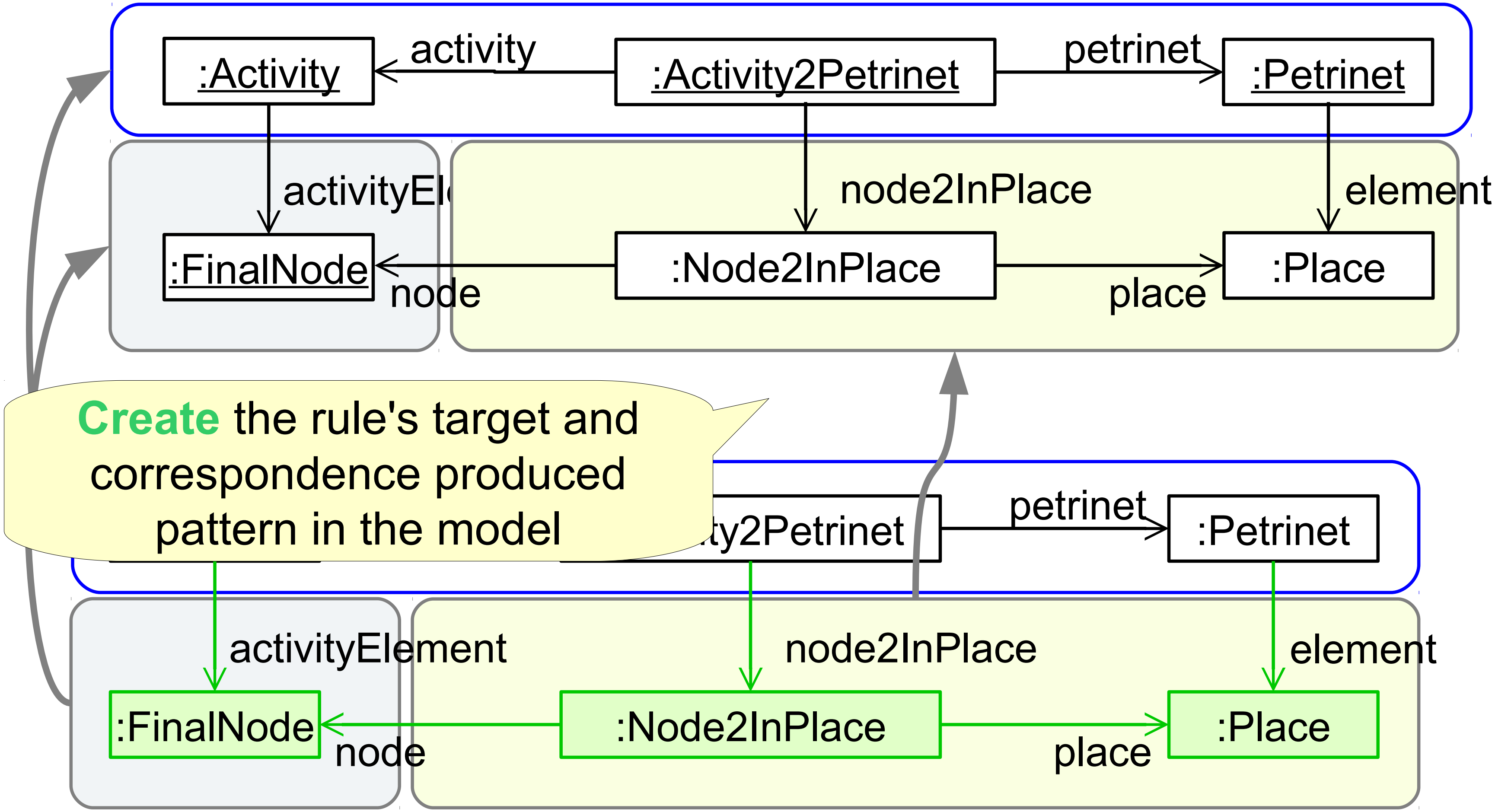

Create the rule's target and correspondence produced pattern in the model

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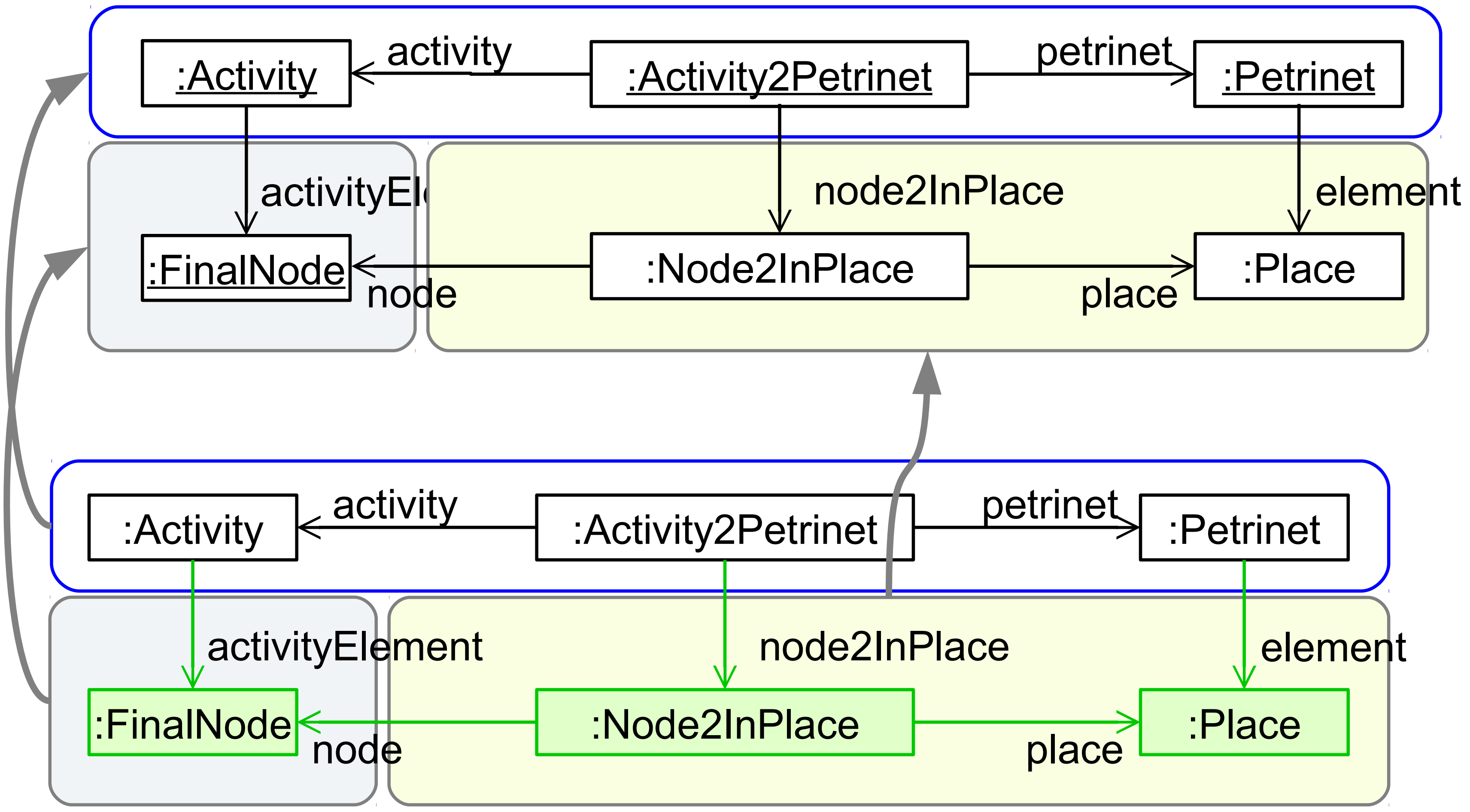

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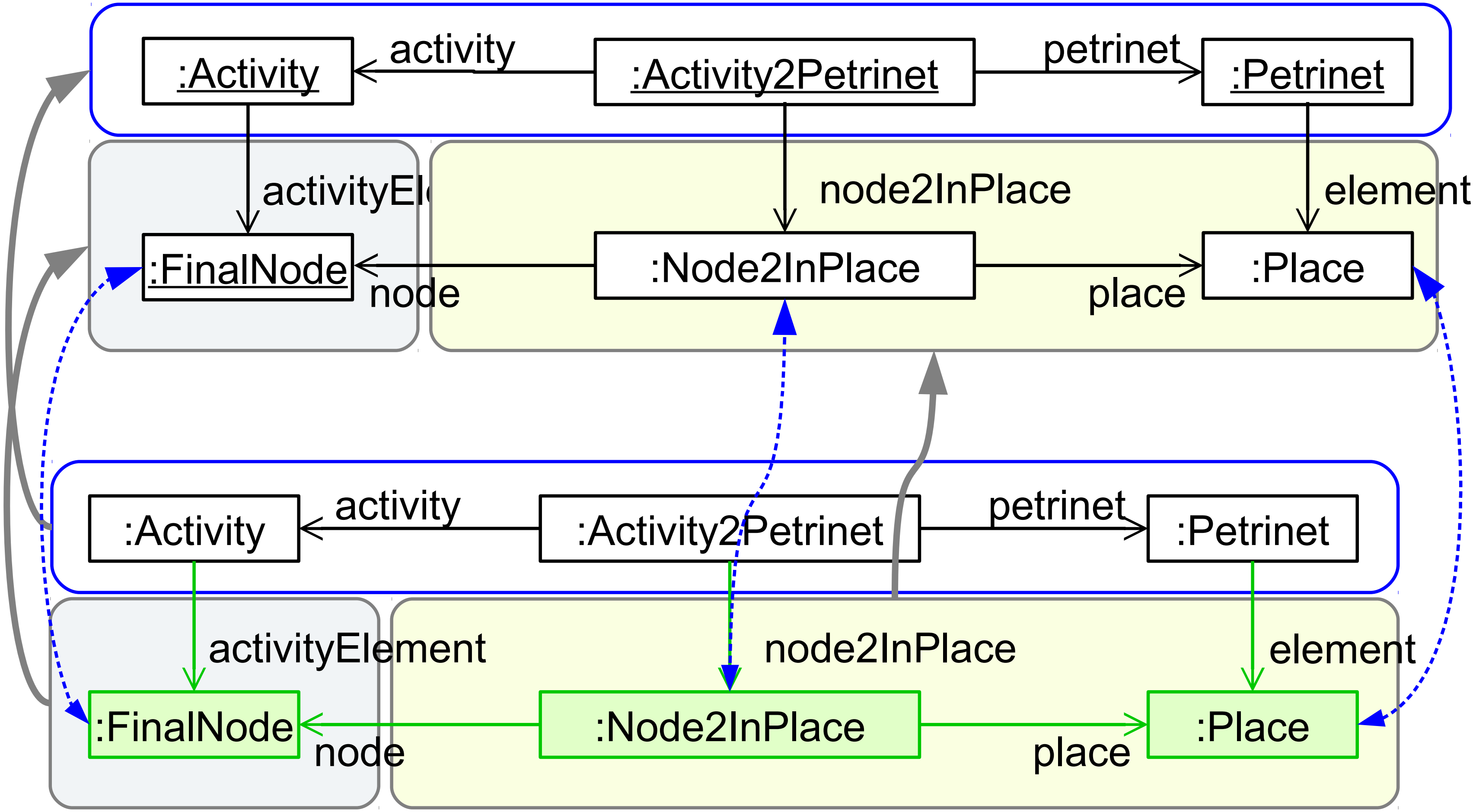

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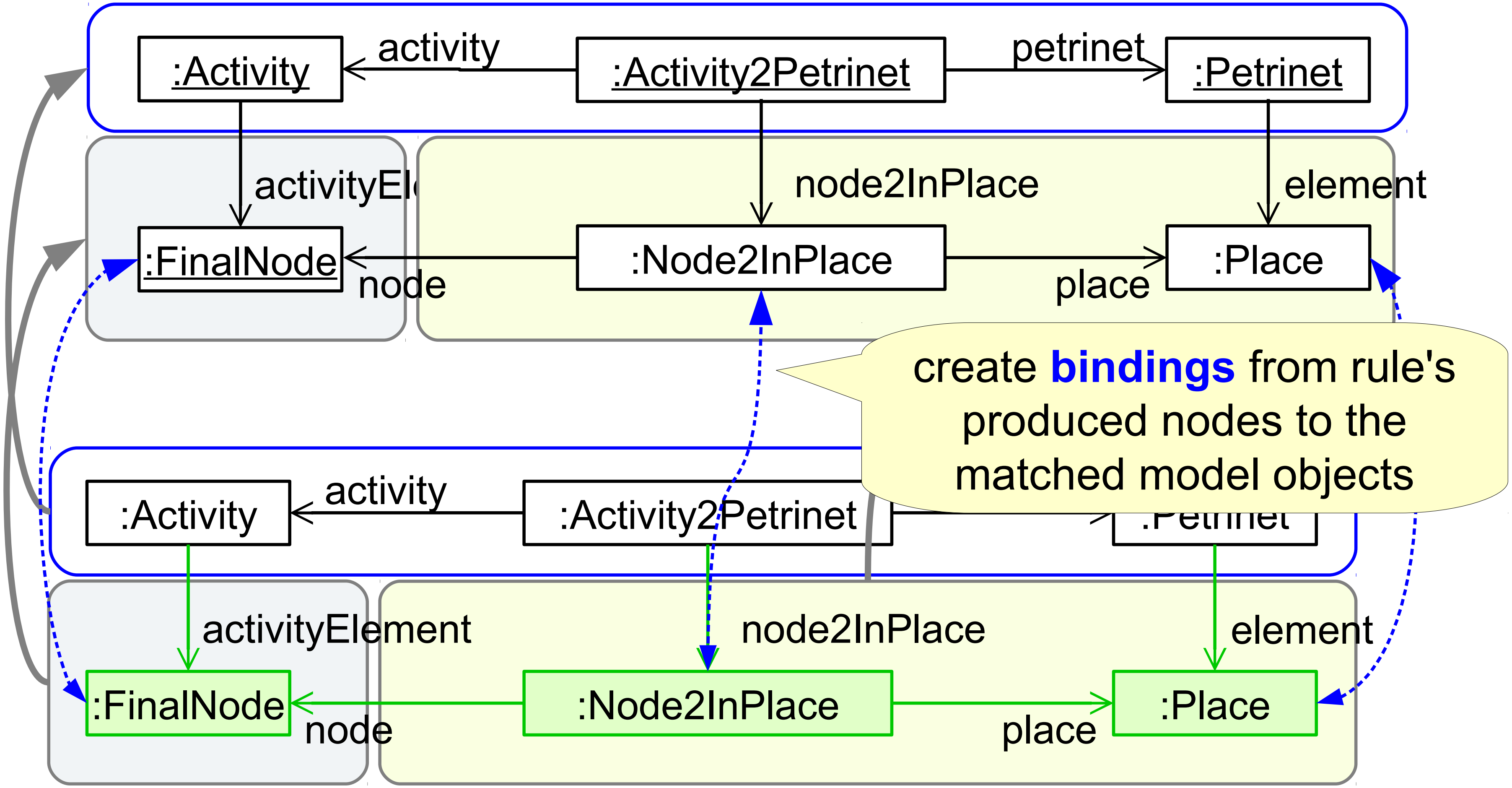

create **bindings** from rule's produced nodes to the matched model objects

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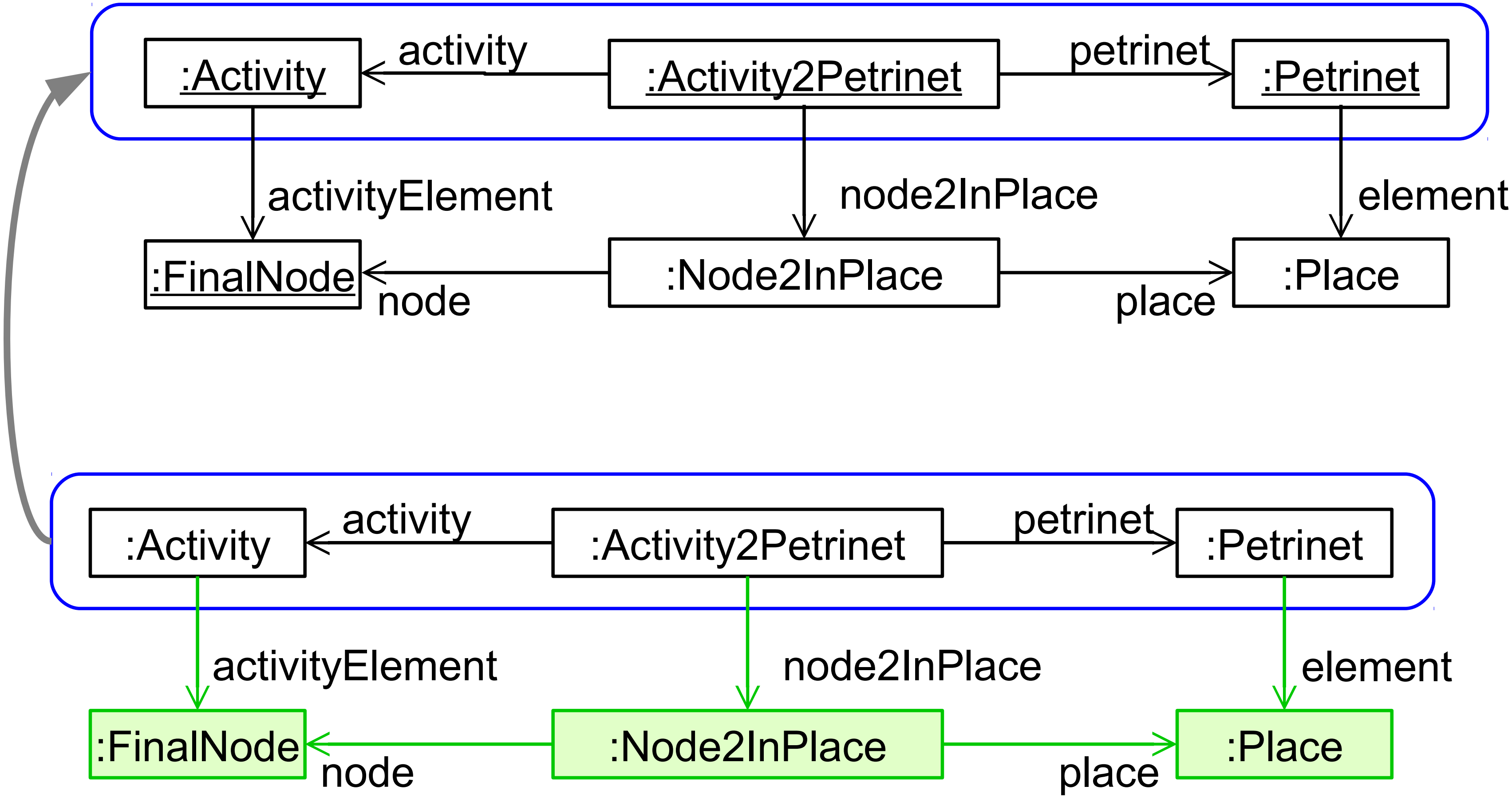
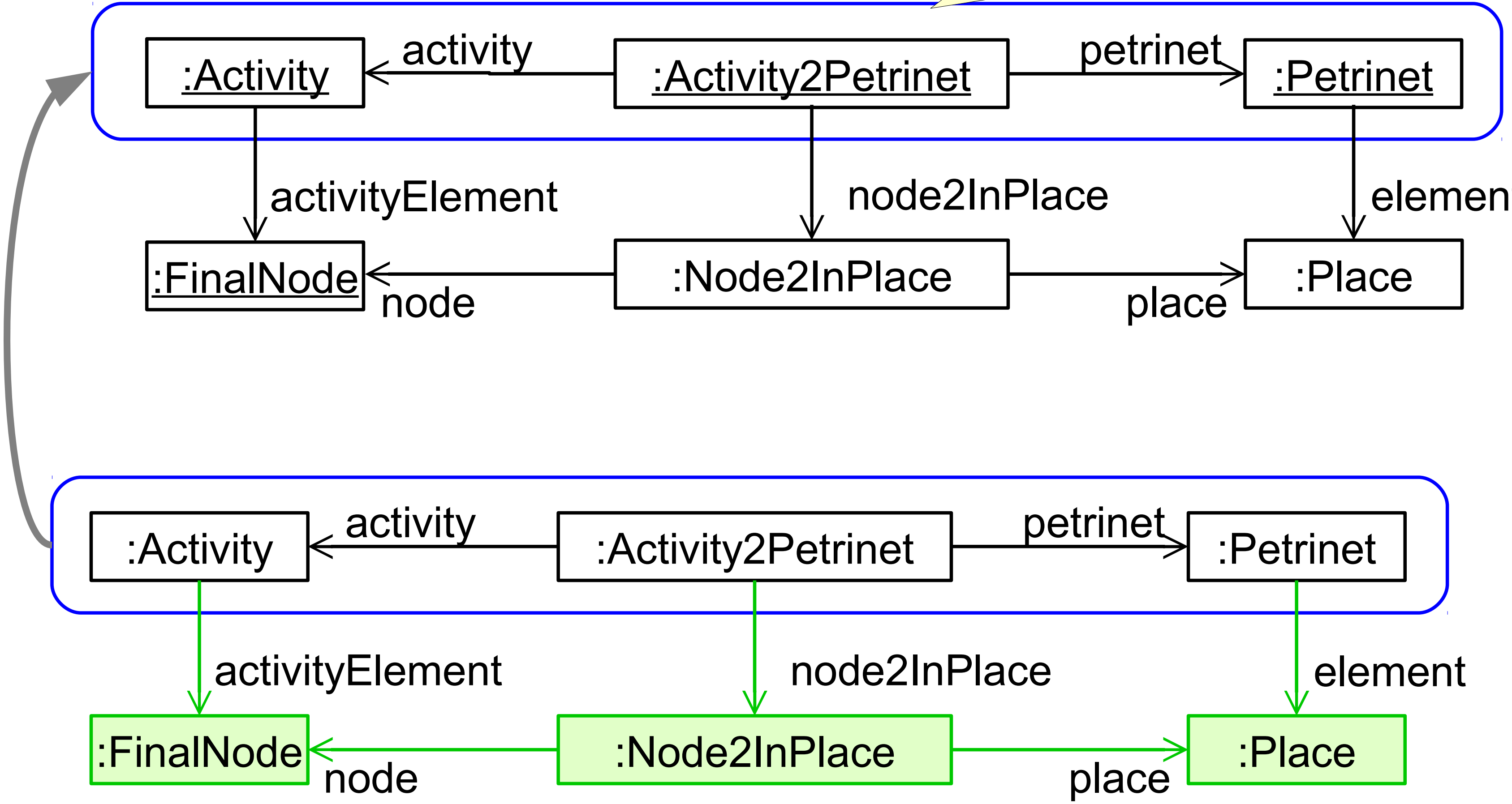
- Can we apply the rule again?



Forward Transformation Scenario

- Can we apply the rule again?

We can match the context graph pattern to already bound model elements, but...



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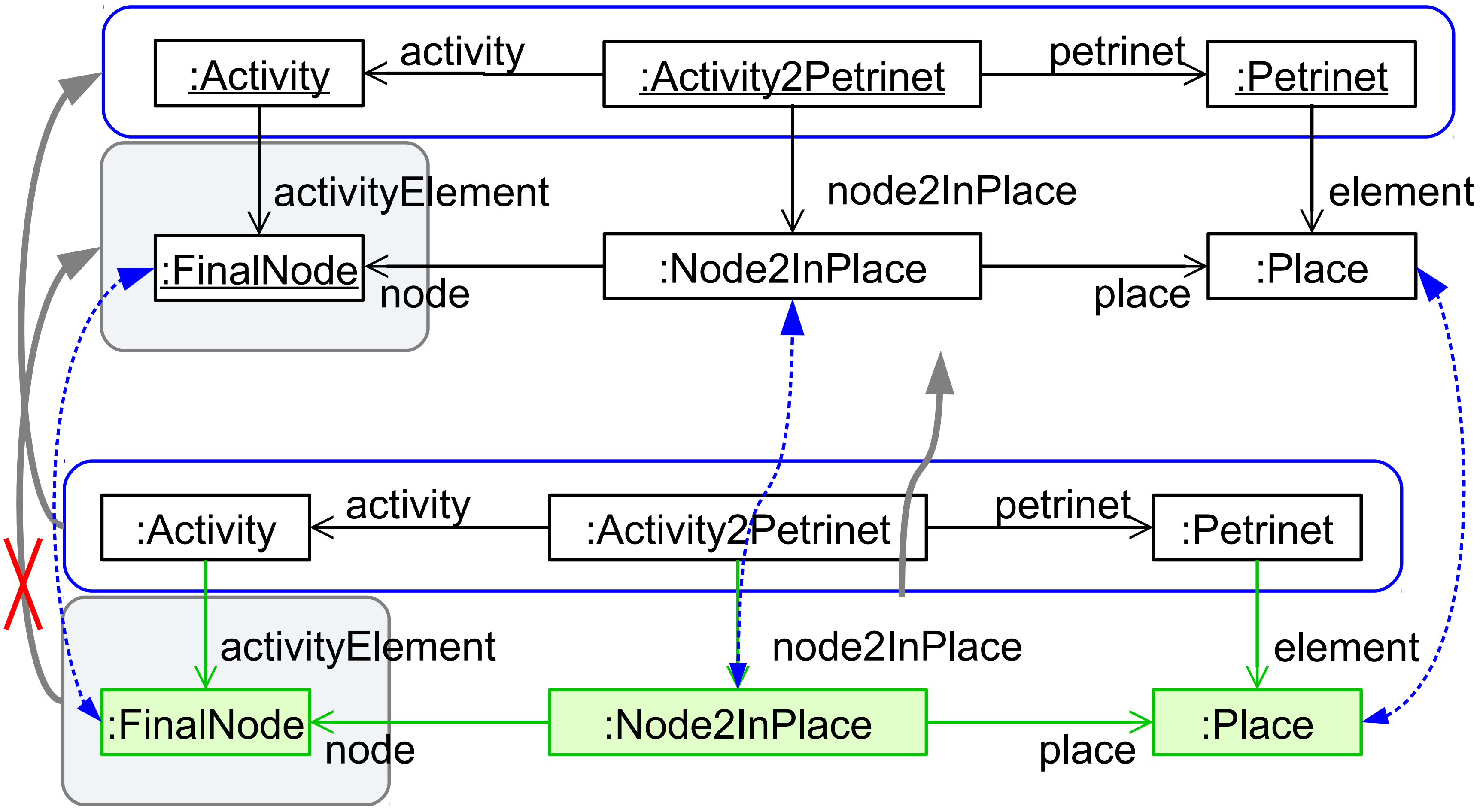

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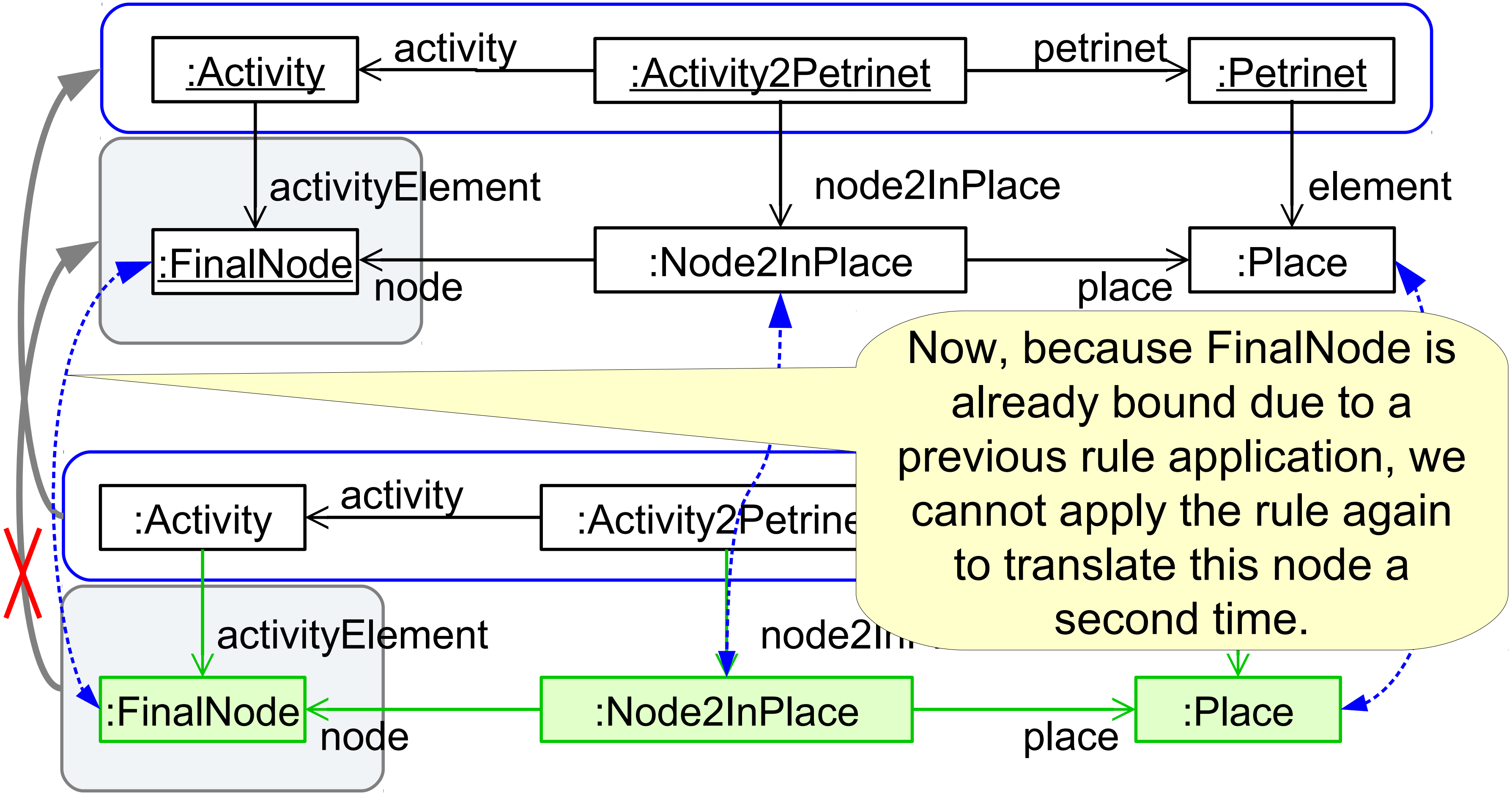

Now, because FinalNode is already bound due to a previous rule application, we cannot apply the rule again to translate this node a second time.

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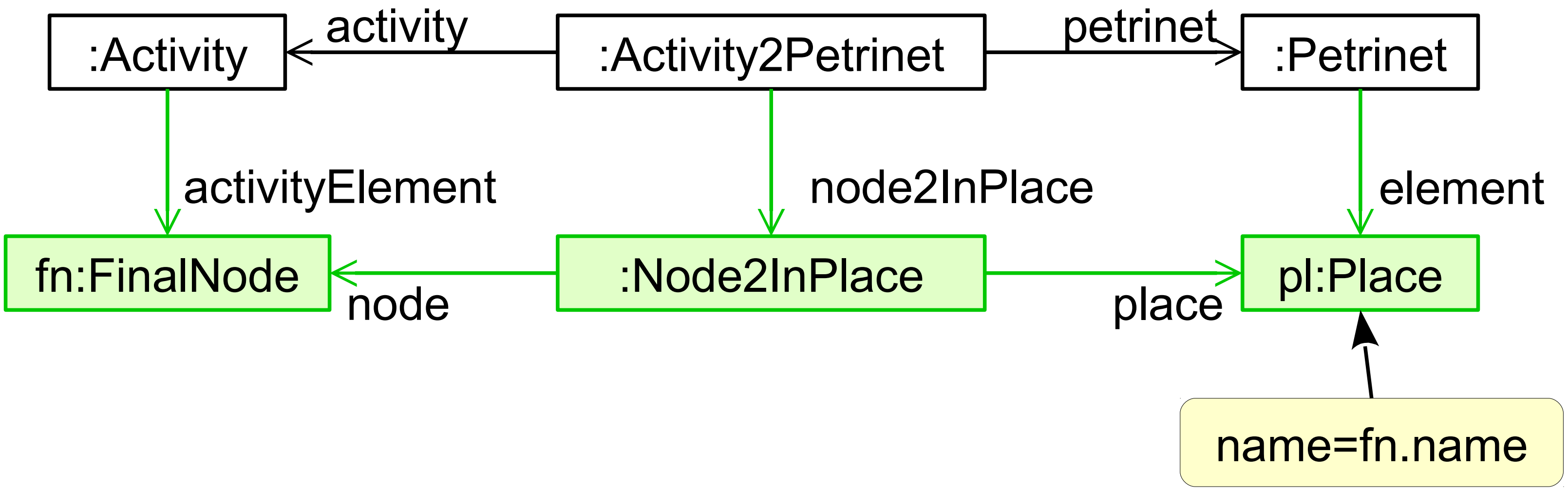

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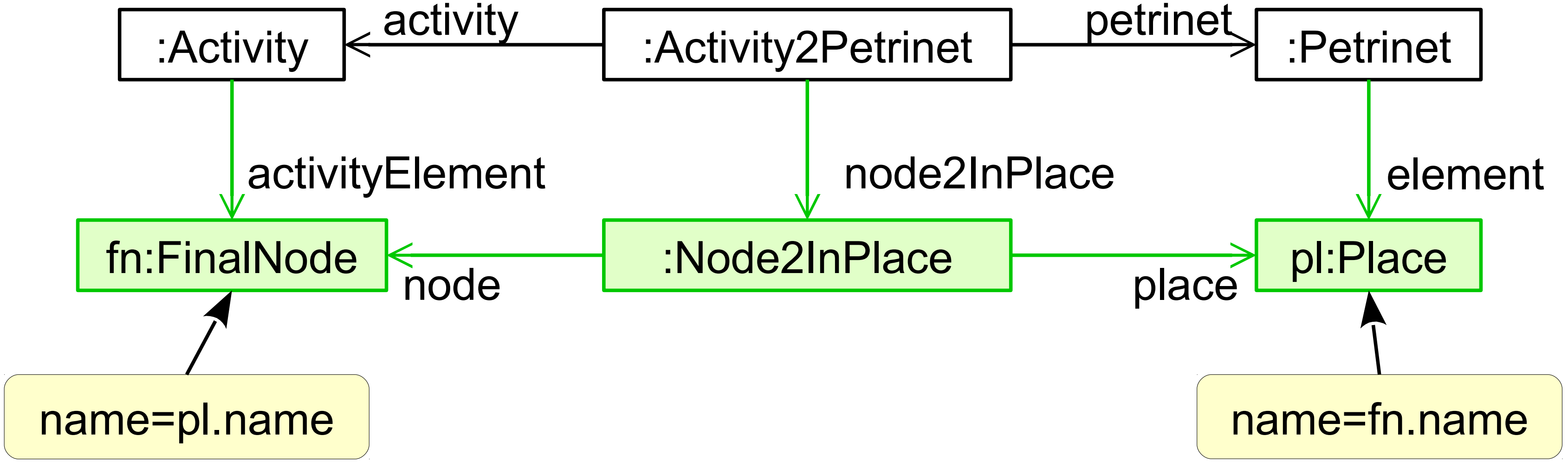

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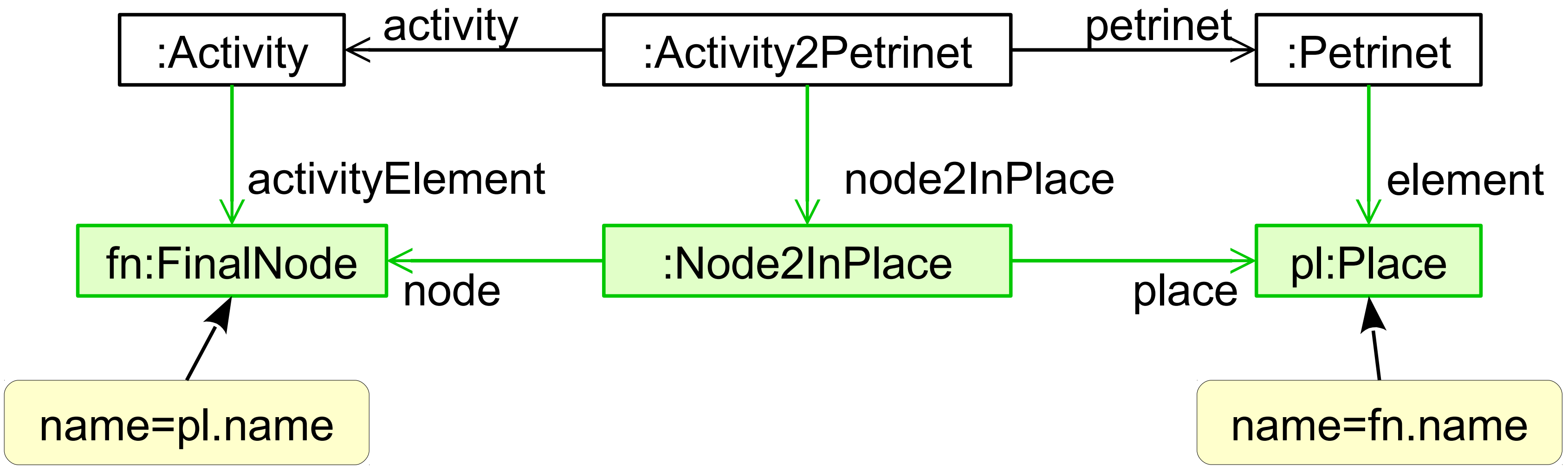


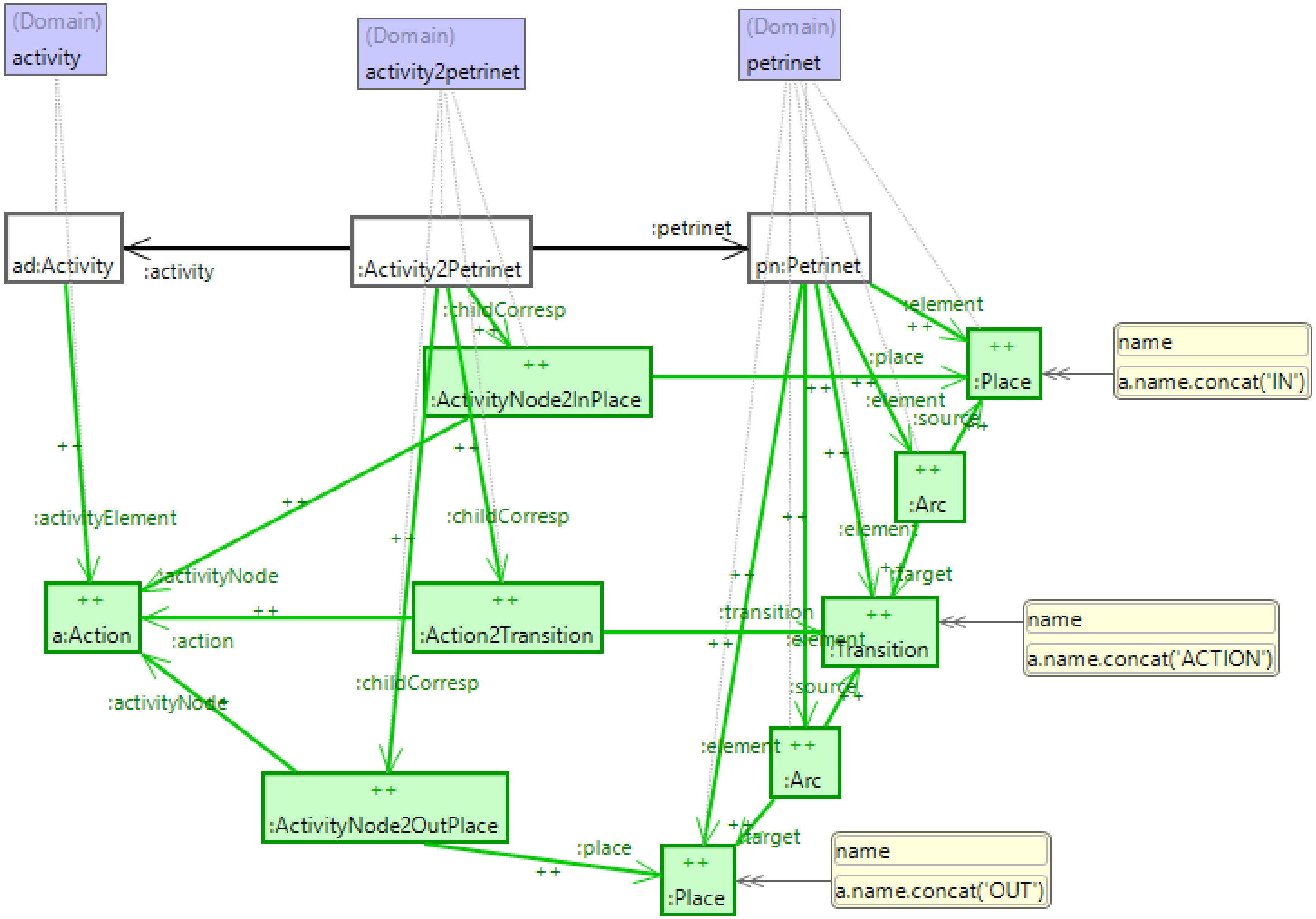
bidirectional assignments required for a bidirectional execution of the transformation

Tool Support

- Different academic and industrial tools exist:
  - TGG-Interpreter
  - eMOFLON
  - Fujaba
  - MDELab
  - EMorF

TGG Interpreter

- Screenshot of a TGG rule diagram in the editor of the TGG Interpreter tool:



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  - **Performance**: optimized engines exist, but rule matching is always potentially slower than an imperative program
  - Only works well if source and target models have a similar structure

5.5. Model-to-model transformation – Query/View/Transformation

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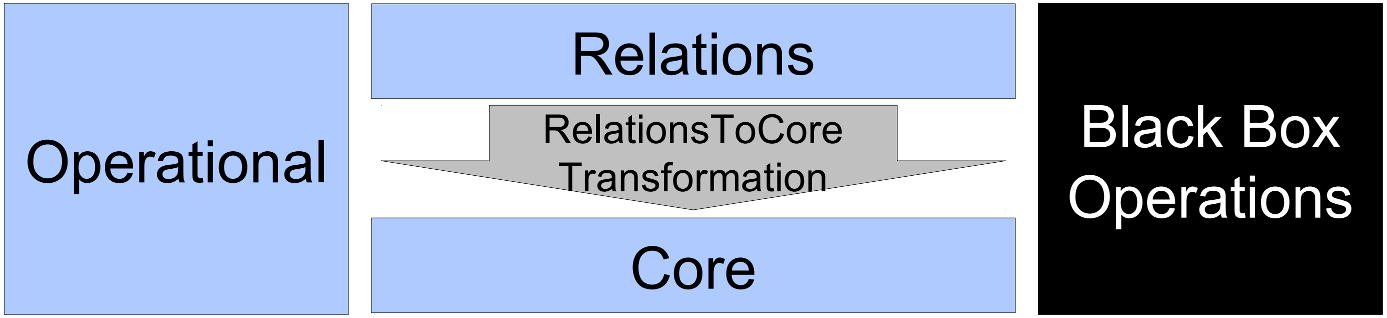

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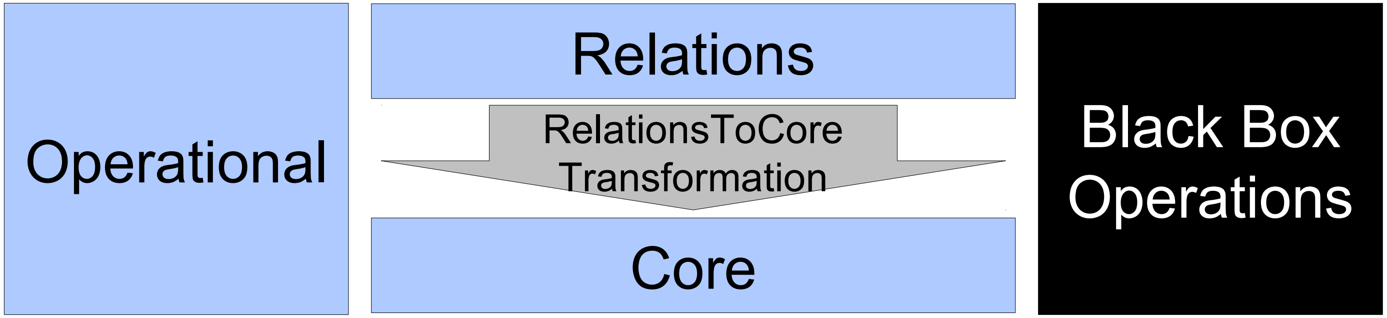

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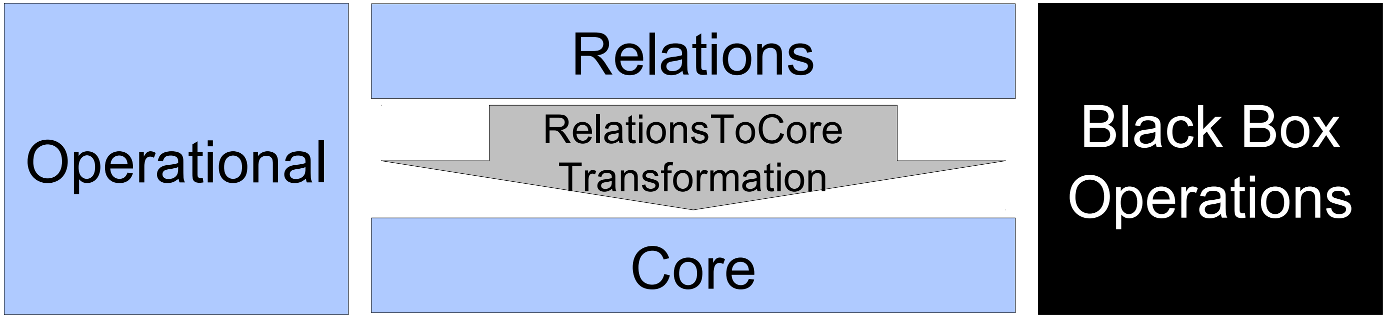

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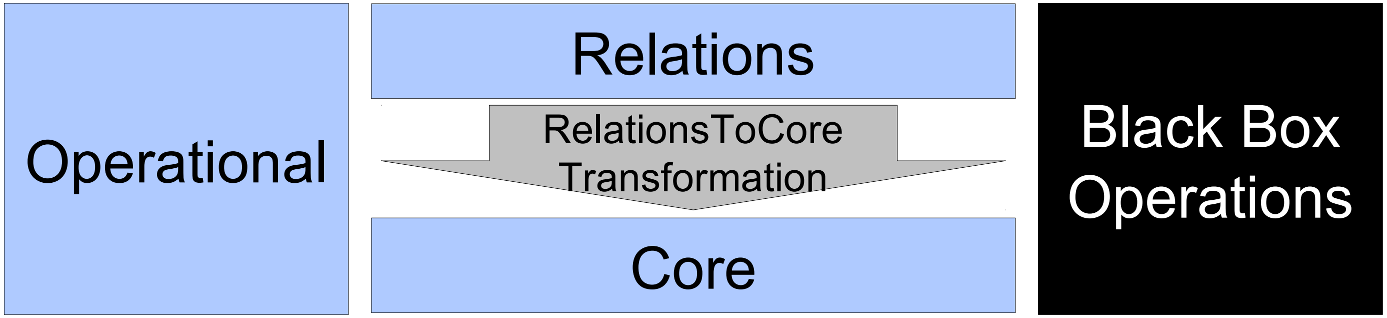
  - **QVT-Operational**: An imperative language



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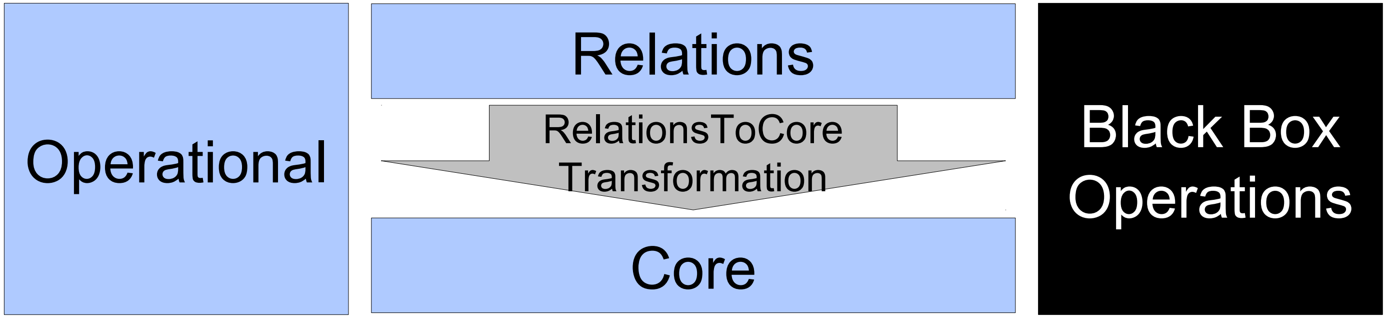
  - **QVT-Operational**: An imperative language
  - **Black-Box Operations**: Ability to integrate other model transformation or programming languages



Operational

Relations

RelationsToCore Transformation

Core

Black Box Operations