Technische Universität Braunschweig

ISF

Family Mining on Statecharts

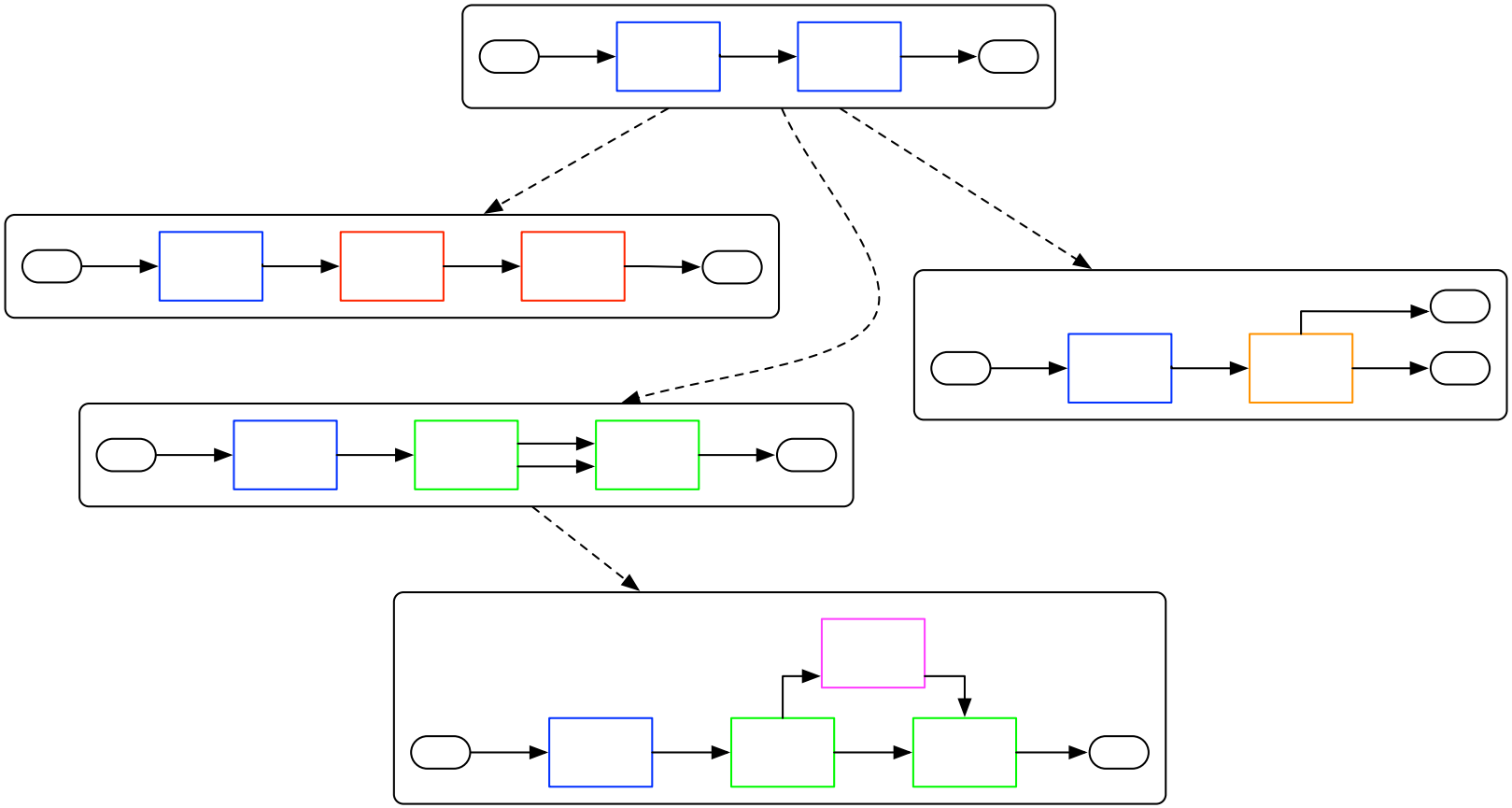
Master's thesis ideas

David Wille, May 5, 2014

Overview

- Motivation
- Background
- Current approach
- Ideas

Motivation

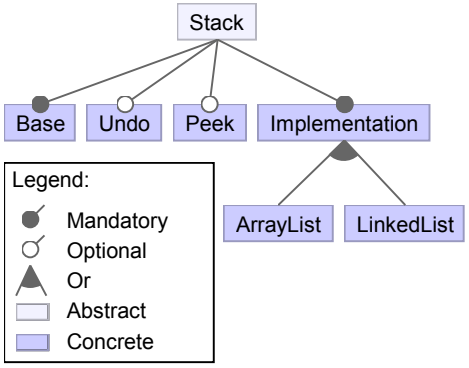


Identifying differences and commonalities is crucial!

Family Models vs. Feature Models

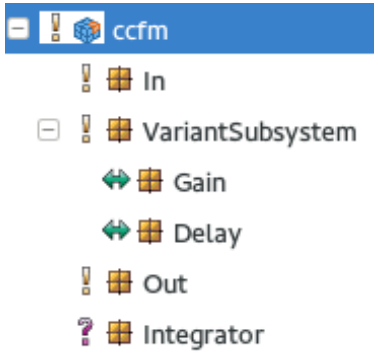
Feature Models

- *problem domain*
- only models variability
- without further details



Family Models

- *solution space*
- concrete design
- implementation details



Creating Compare Elements

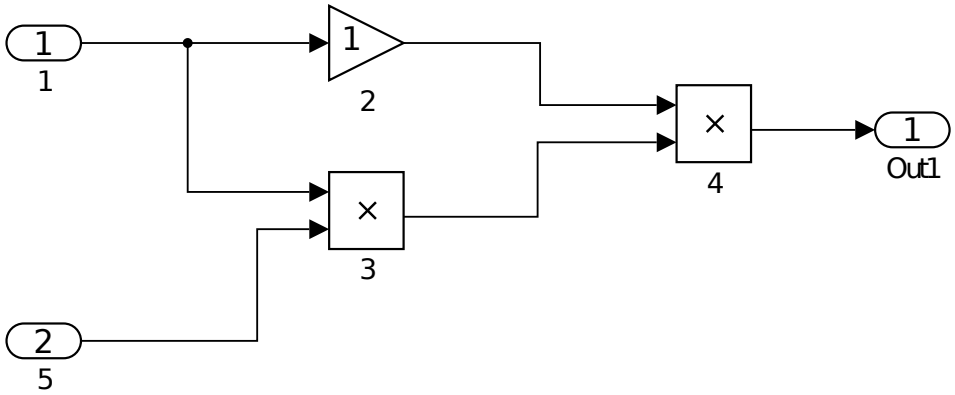


Figure 1: Variant 1

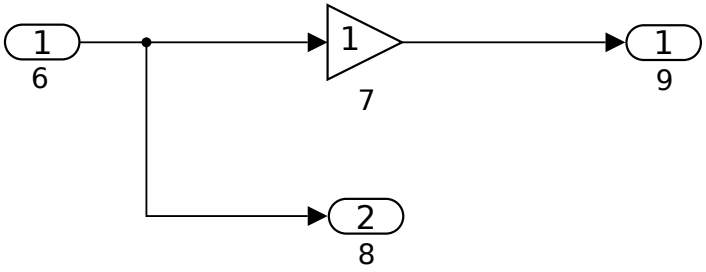


Figure 2: Variant 2

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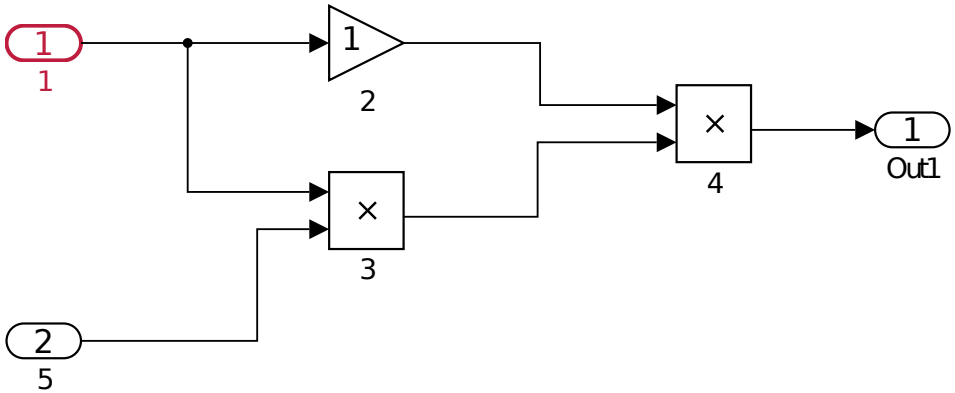

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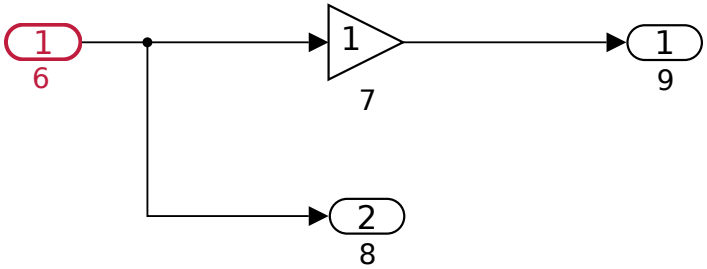

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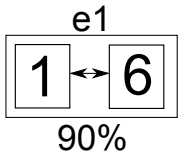

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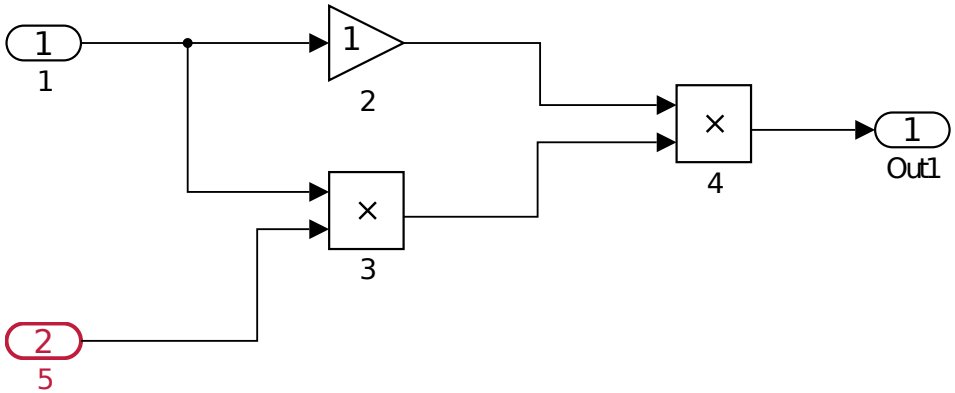

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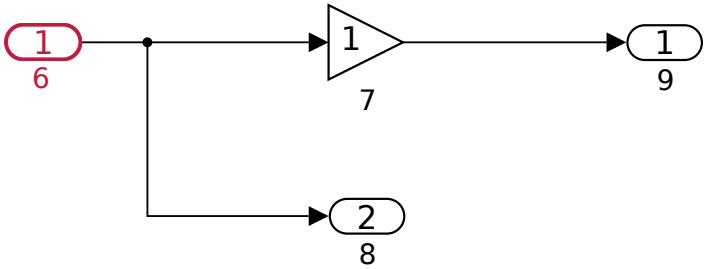

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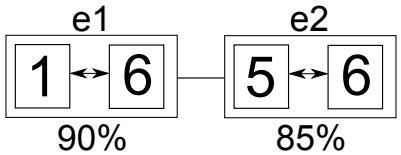

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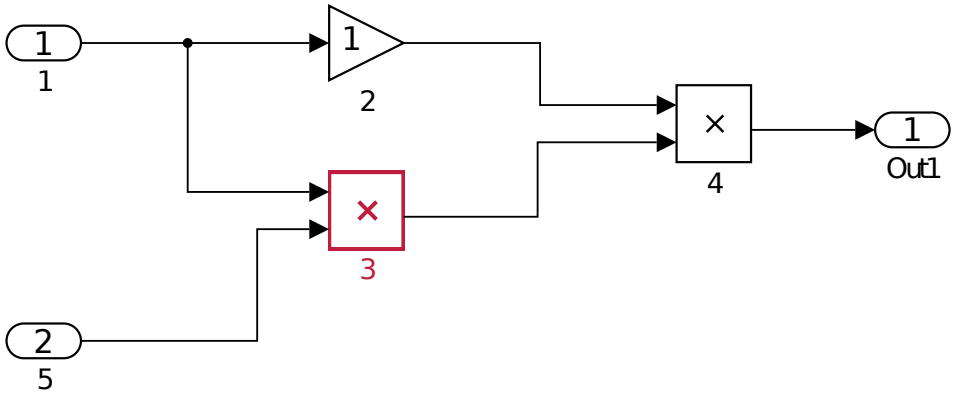
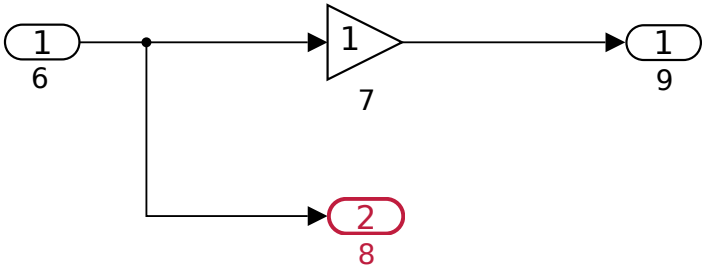


Figure 1: Variant 1



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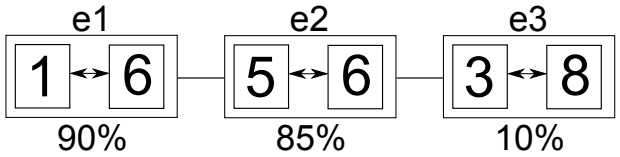

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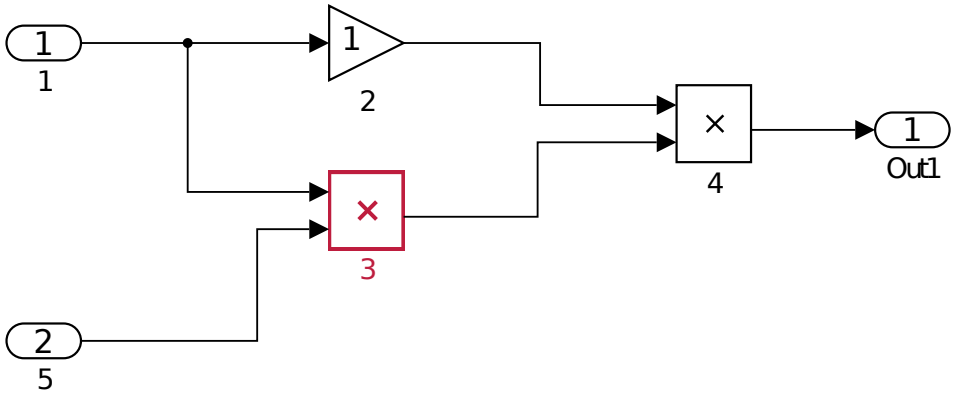
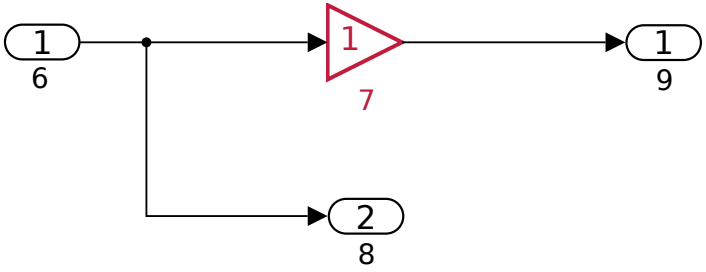


Figure 1: Variant 1



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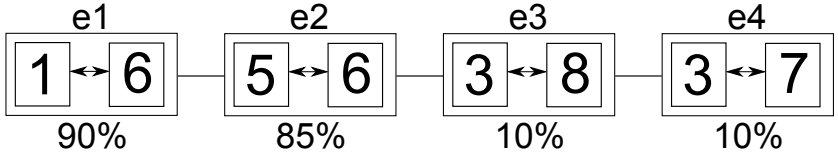

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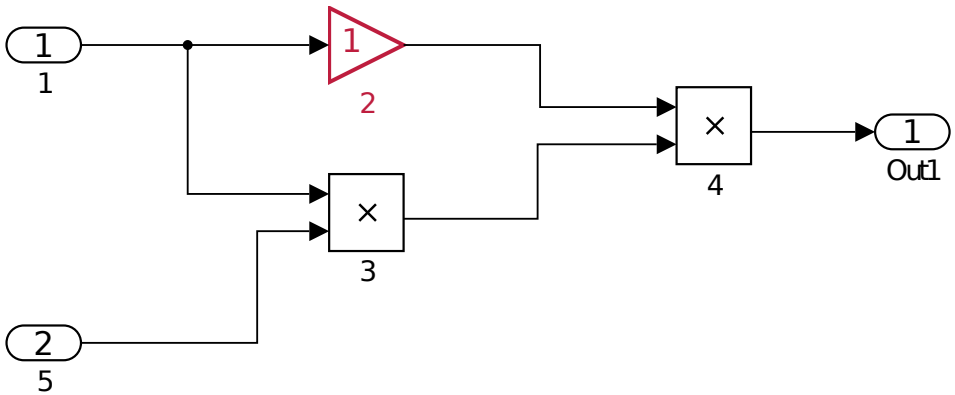

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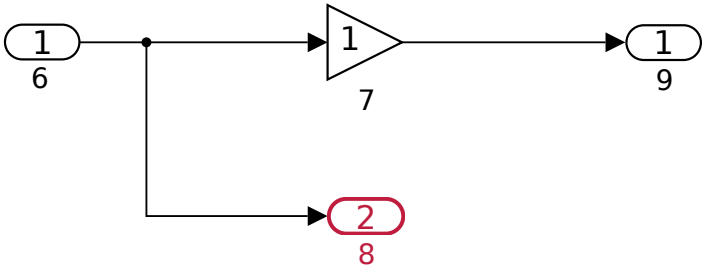

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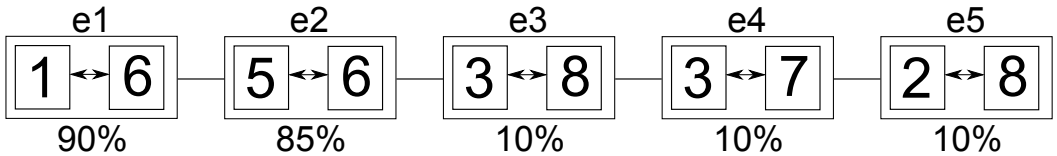

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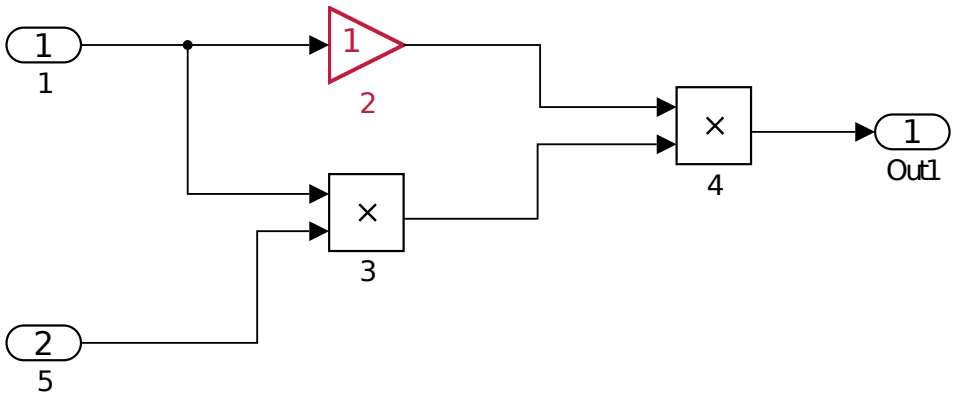
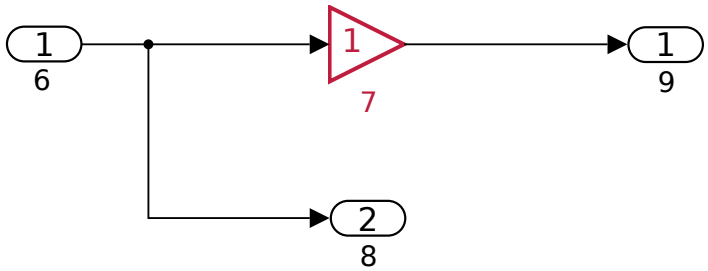


Figure 1: Variant 1



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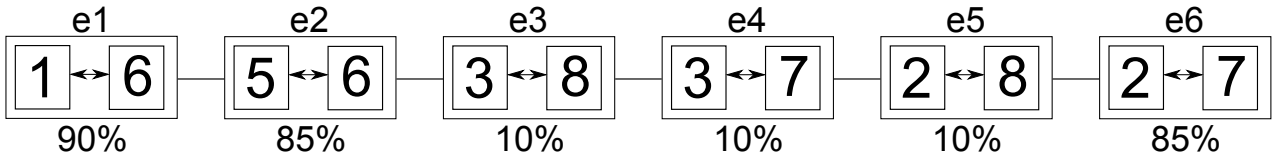

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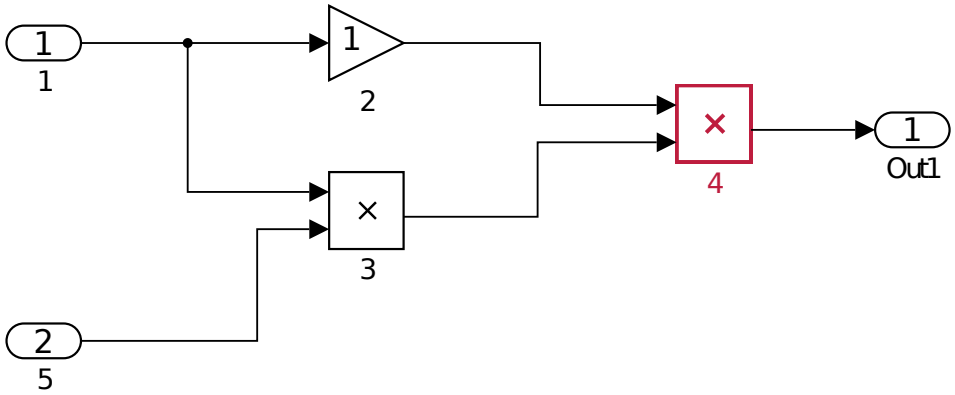
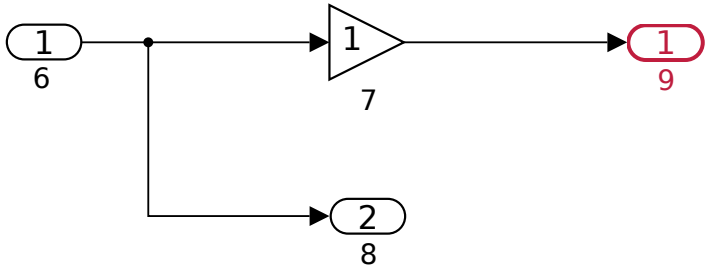


Figure 1: Variant 1



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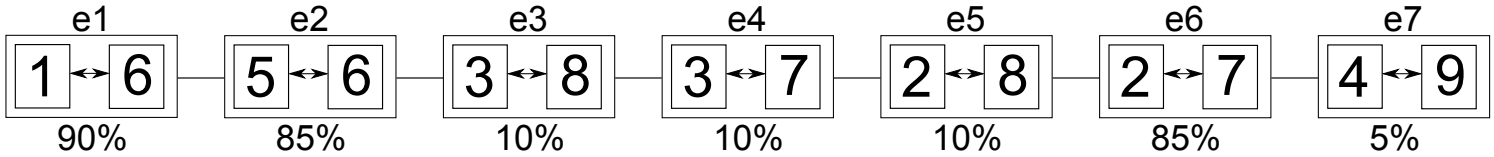

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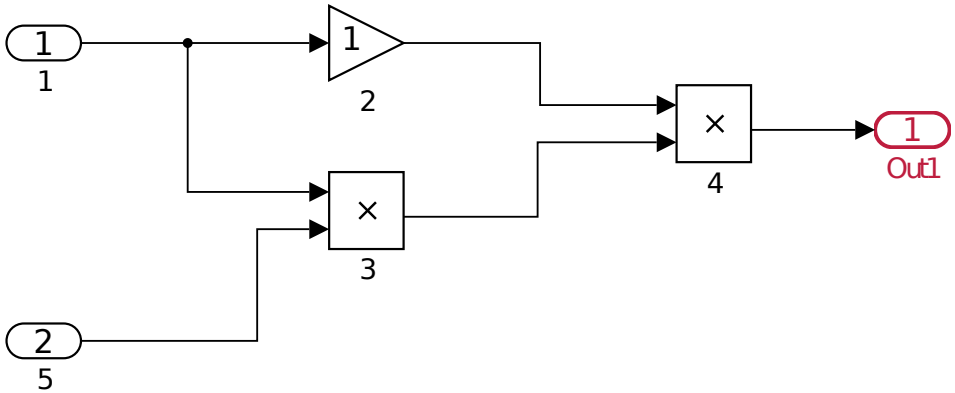
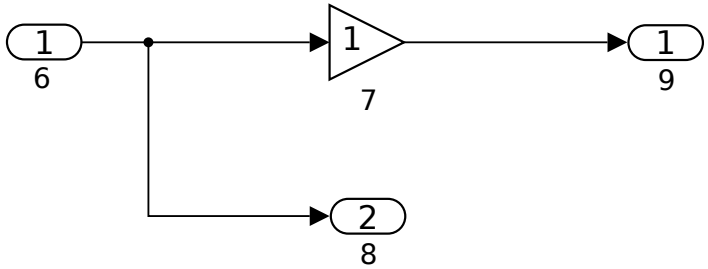


Figure 1: Variant 1



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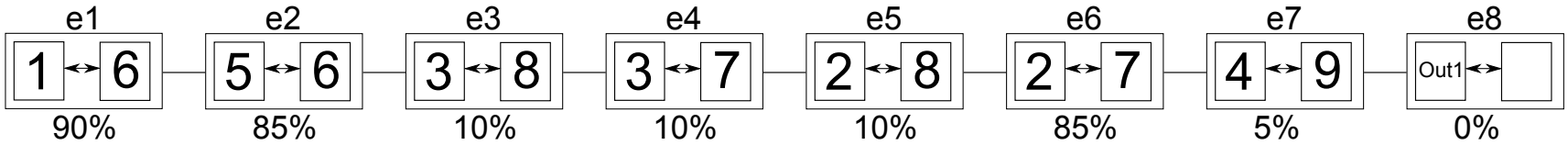
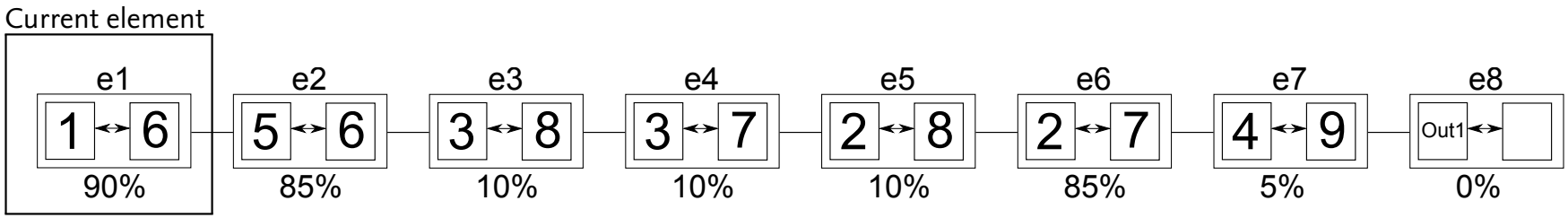
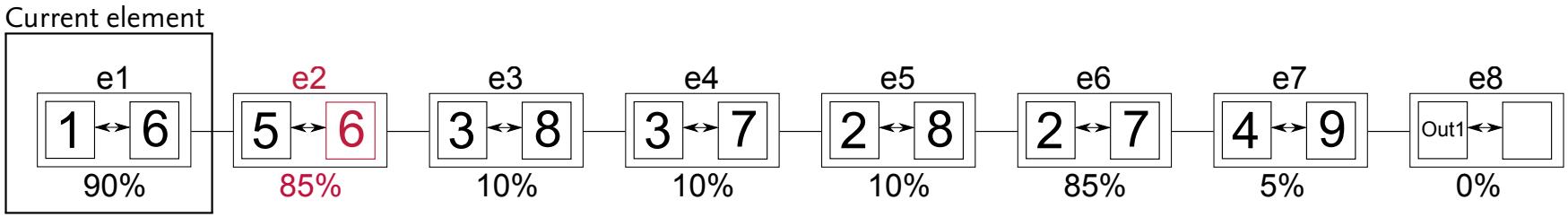


Matching

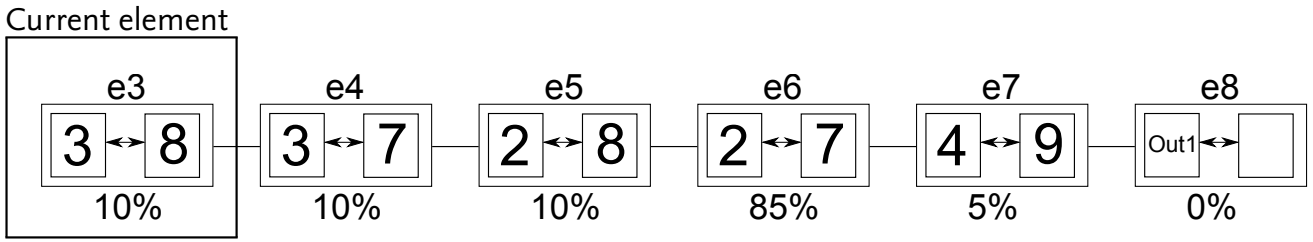

Current element
e1
1
6
90%
e2
5
6
85%
e3
3
8
10%
e4
3
7
10%
e5
2
8
10%
e6
2
7
85%
e7
4
9
5%
e8
Out1
0%

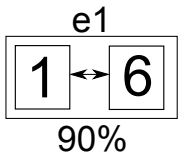
Matching



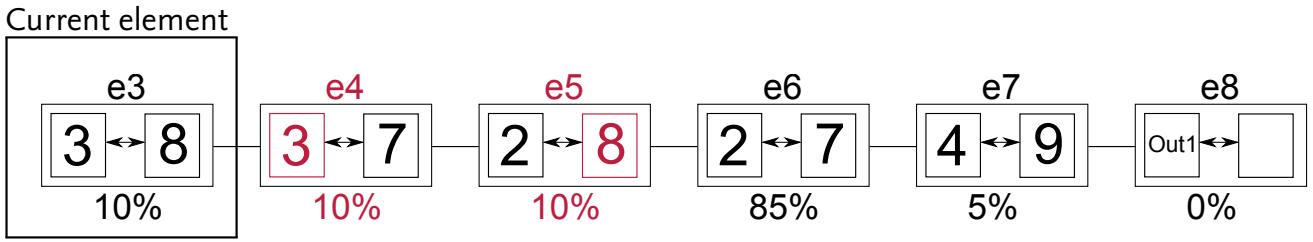
Found element e2 with same block, but less similarity. So e1 is optimal.

Matching

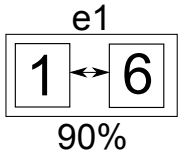

Current element
e3
3 ↔ 8
10%
e4
3 ↔ 7
10%
e5
2 ↔ 8
10%
e6
2 ↔ 7
85%
e7
4 ↔ 9
5%
e8
Out1 ↔
0%


e1
1 ↔ 6
90%

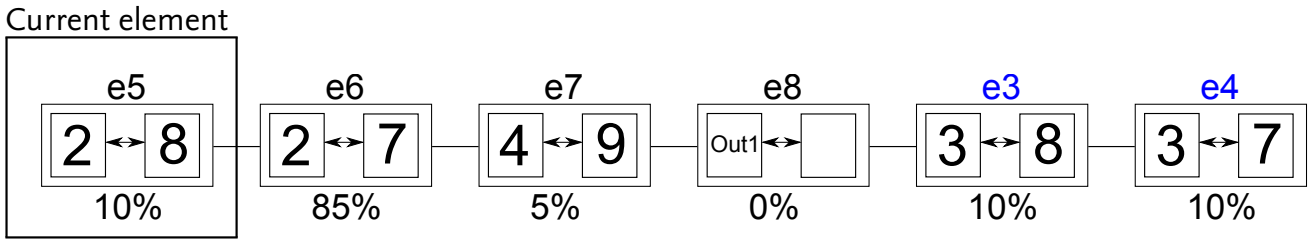
Matching



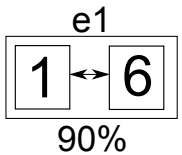
Found element e4 and e5. All have similarity of 10% so e3 and e4 are ambiguous.



Matching



Sorted e3 and e4 to the end of list.



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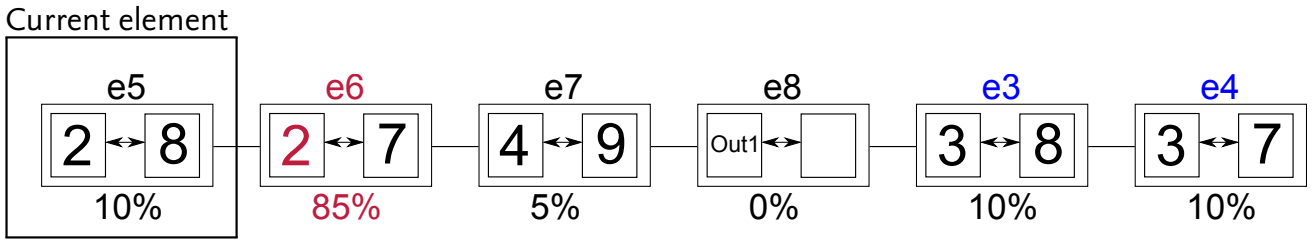
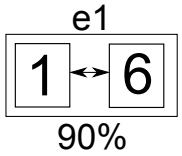


Found a better match. e6 > e5.



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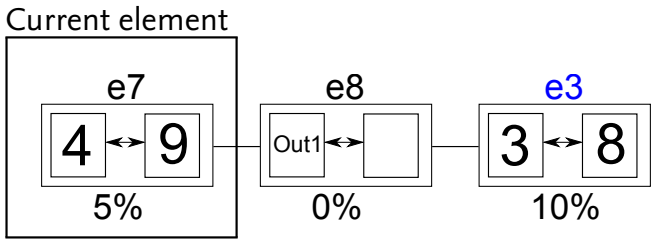

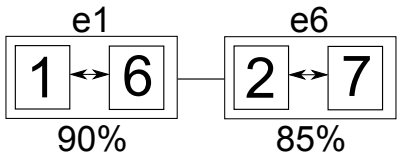

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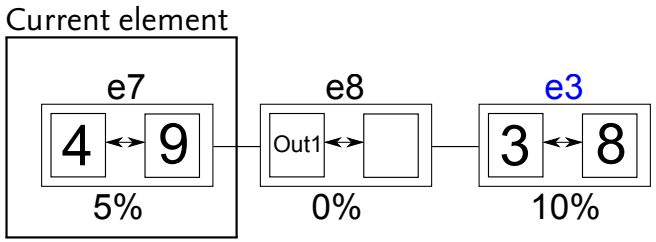
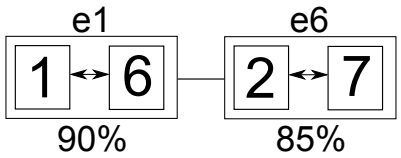
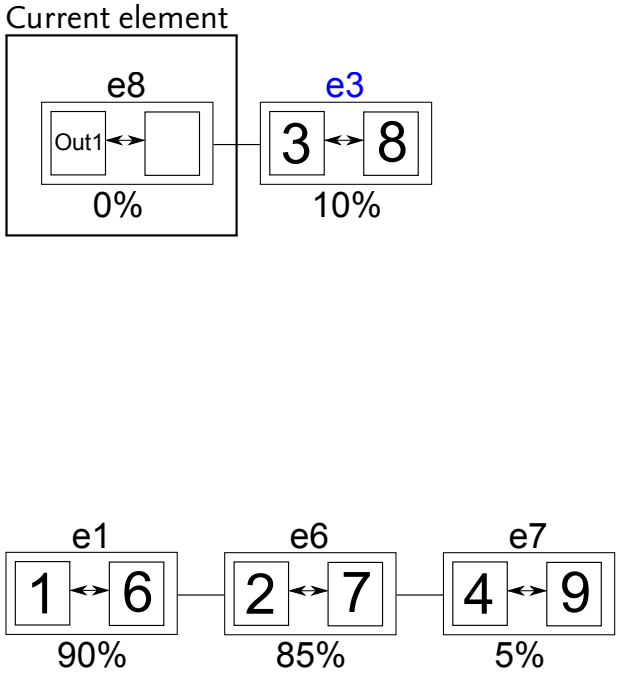


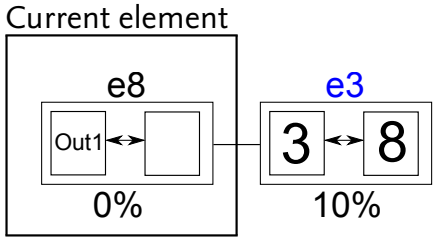
No better match found. e7 is optimal.



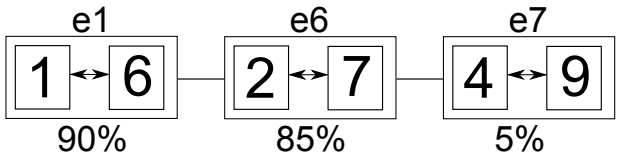
Matching



Matching



No better match found. e8 is optimal.



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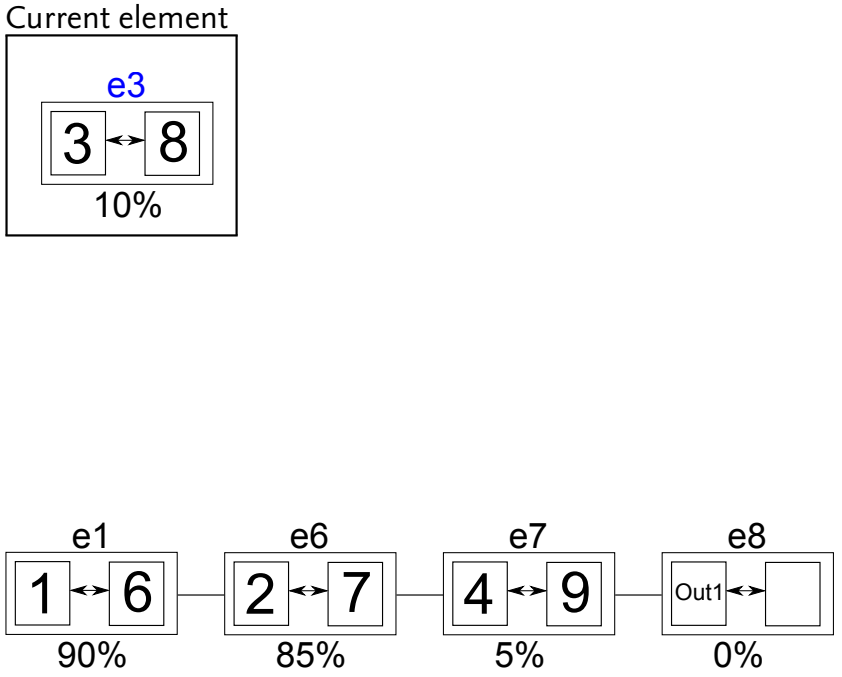
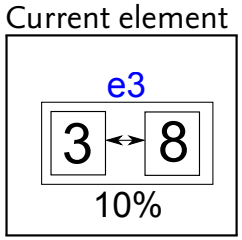
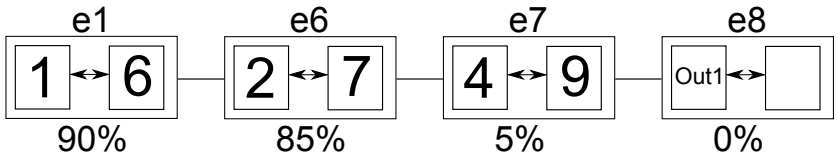


Matching

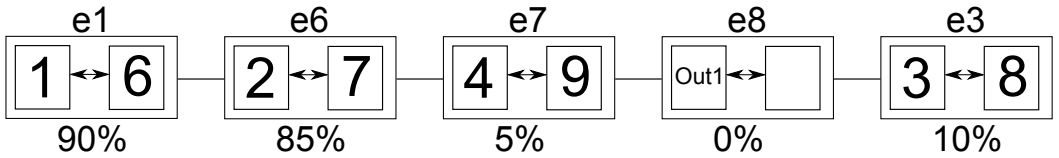


No better match found. e3 is optimal.



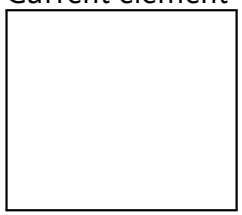
Matching

Current element

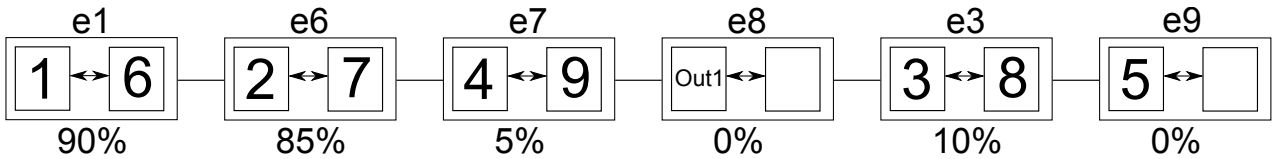


Matching

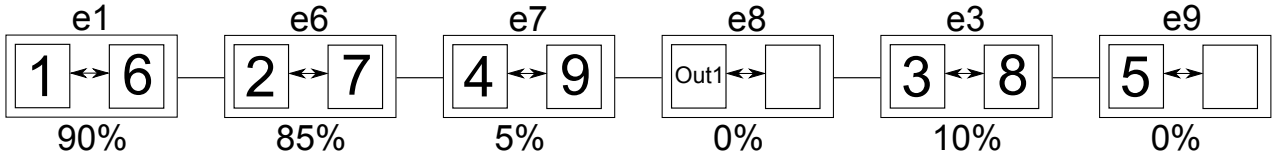
Current element

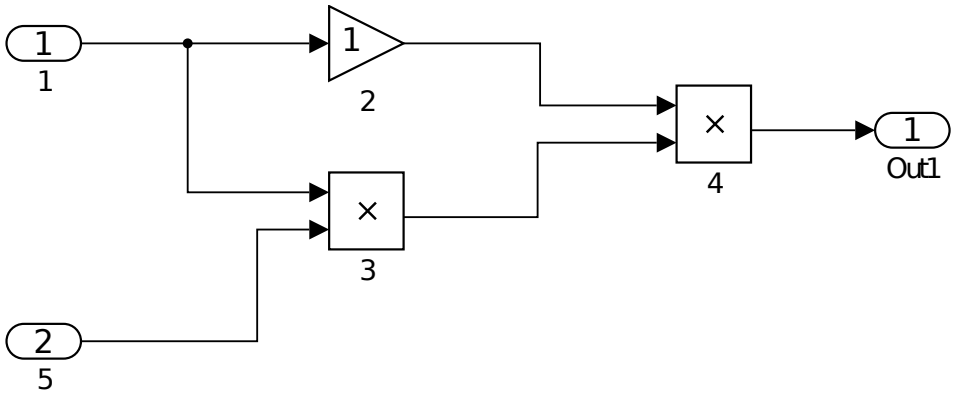


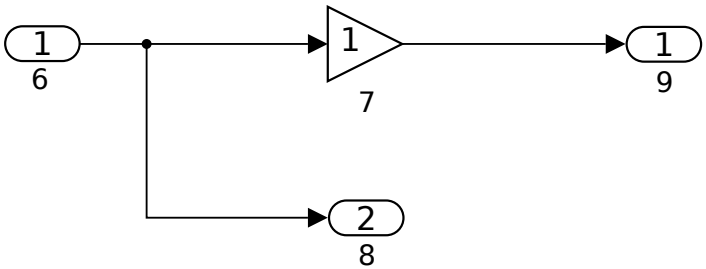
Block 5 was not yet considered, so it is an optional block.



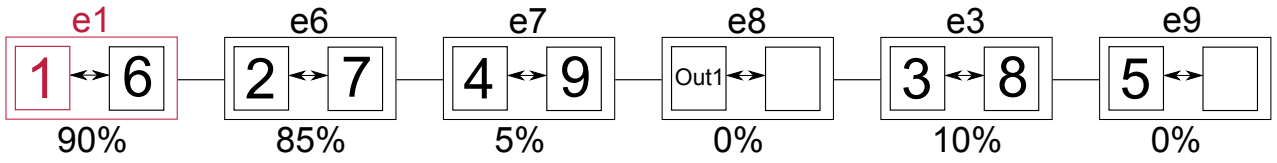
Merging

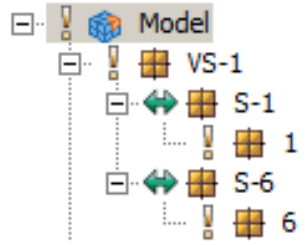

e1
1
6
90%
e6
2
7
85%
e7
4
9
5%
e8
Out1
0%
e3
3
8
10%
e9
5
0%


1
1
1
2
×
4
1
Out1
×
3
2
5


1
6
1
7
1
9
2
8

Merging


e1
1
6
90%
e6
2
7
85%
e7
4
9
5%
e8
Out1
0%
e3
3
8
10%
e9
5
0%


Model
VS-1
S-1
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S-6
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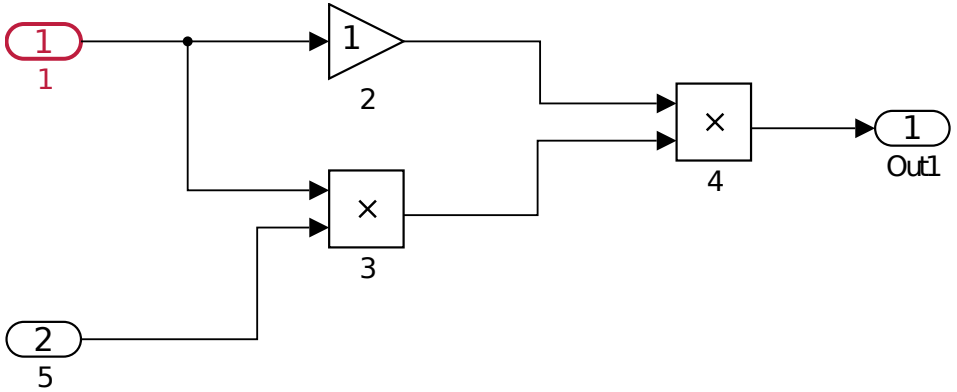
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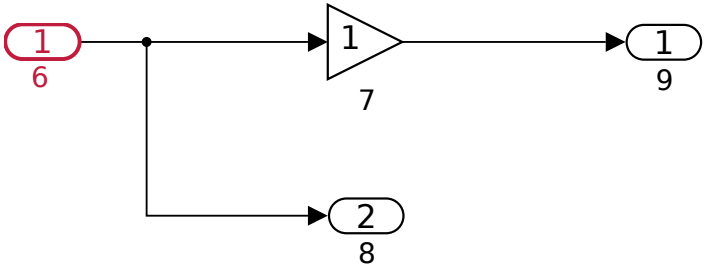
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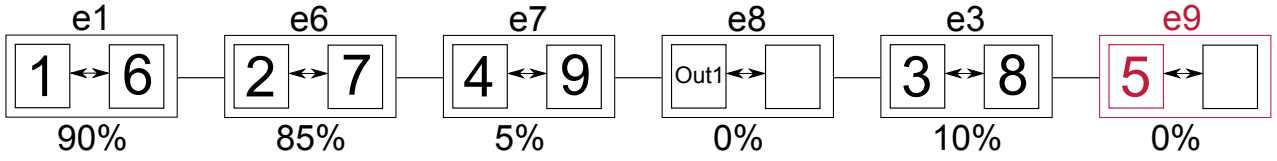
Merging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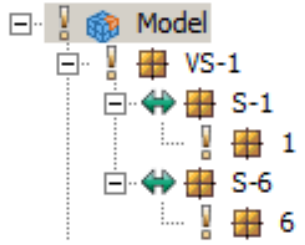
Model
VS-1
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S-6
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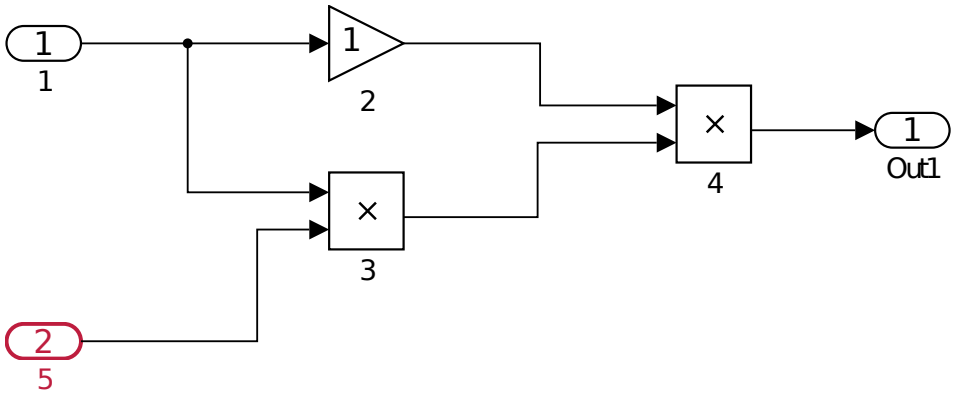
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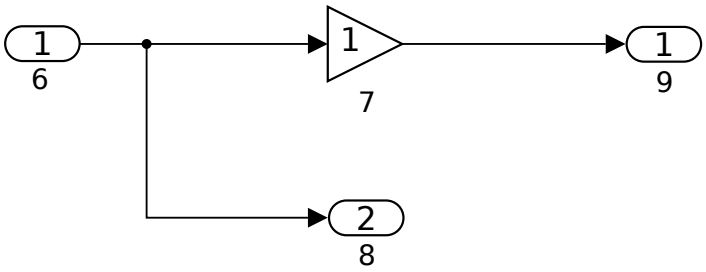
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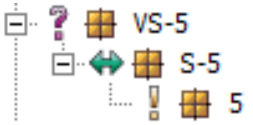
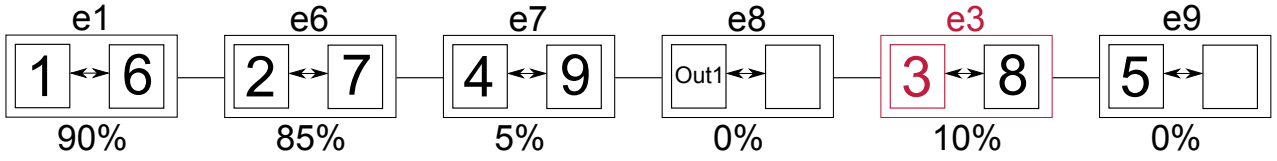

VS-5
S-5
5

Merging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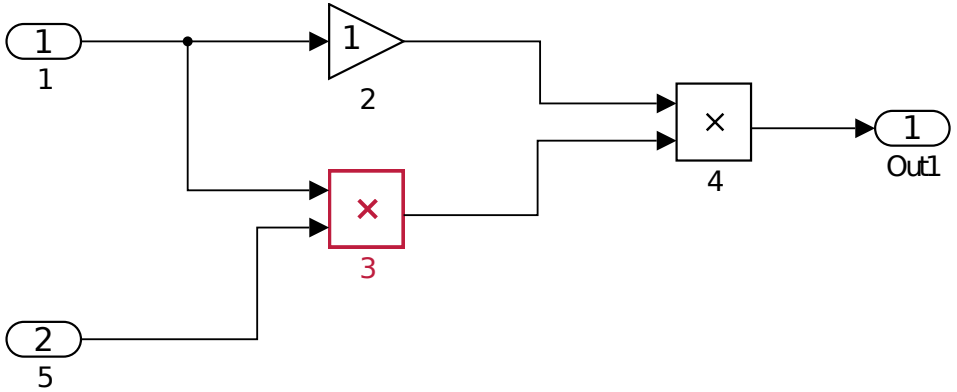
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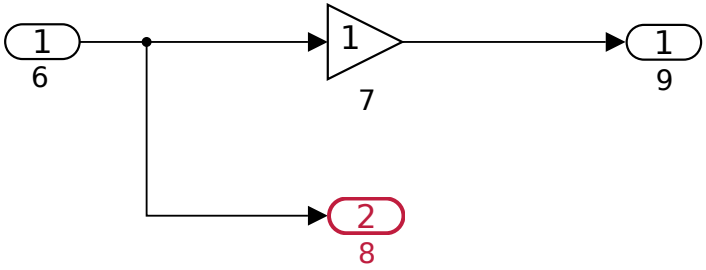
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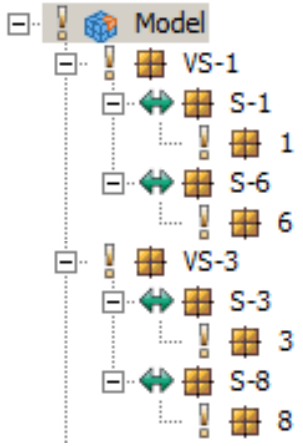
Model
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S-1
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S-6
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VS-3
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S-8
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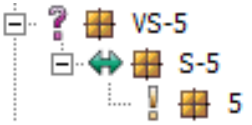
VS-5
S-5
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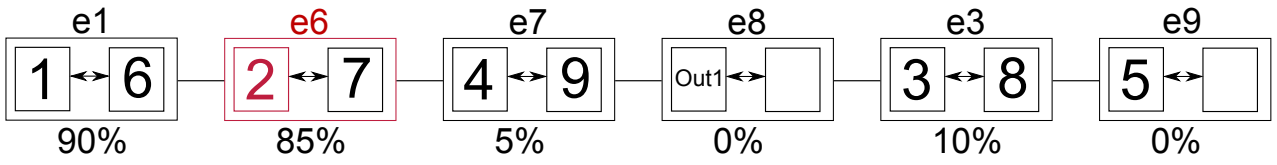
Merging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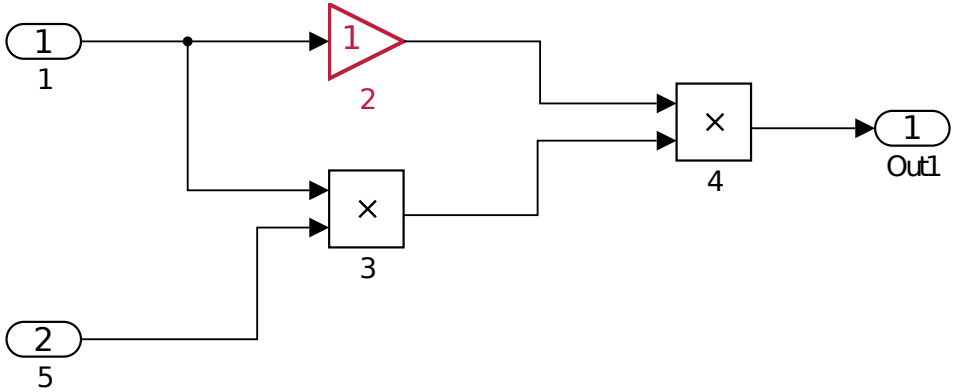
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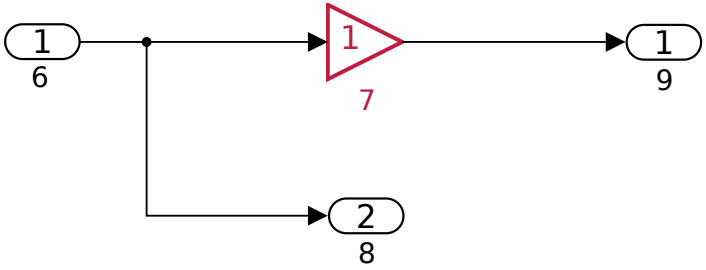
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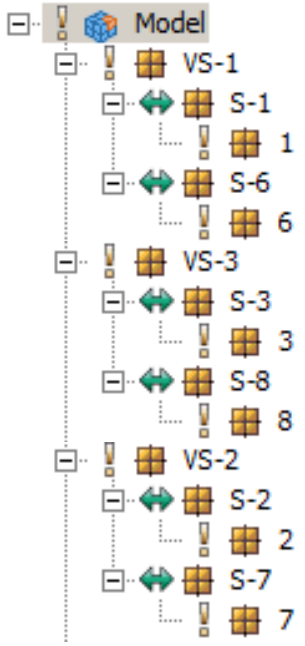
Model
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VS-3
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S-8
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VS-2
S-2
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S-7
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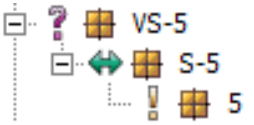
VS-5
S-5
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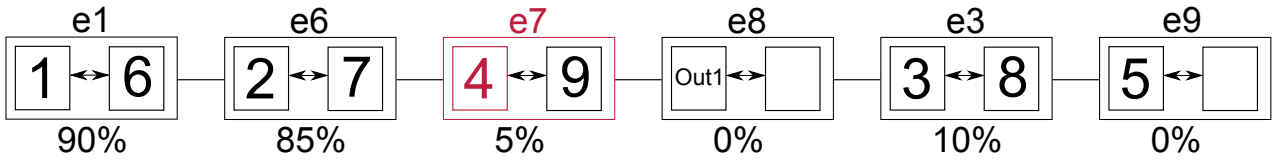
Merging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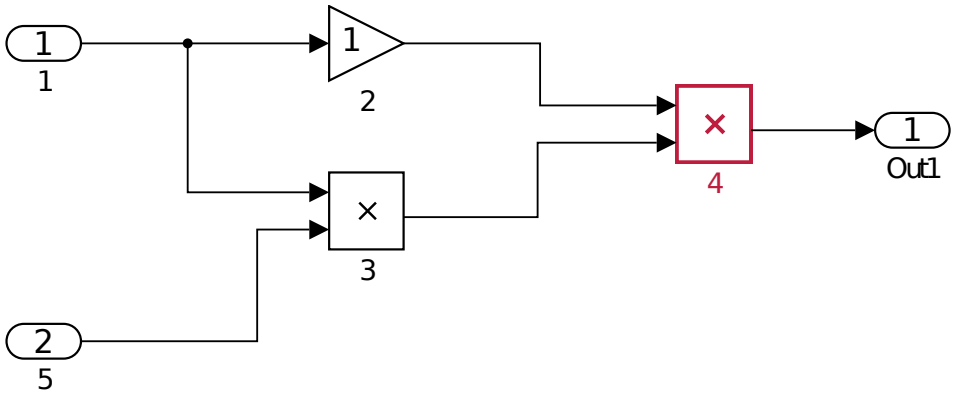
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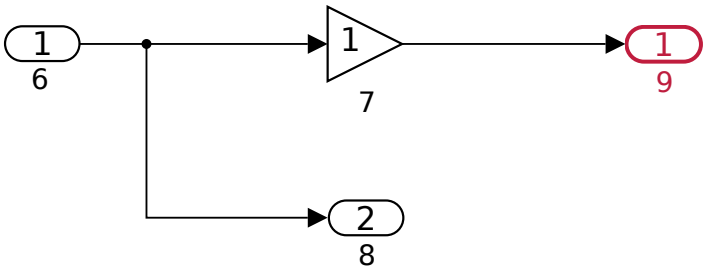
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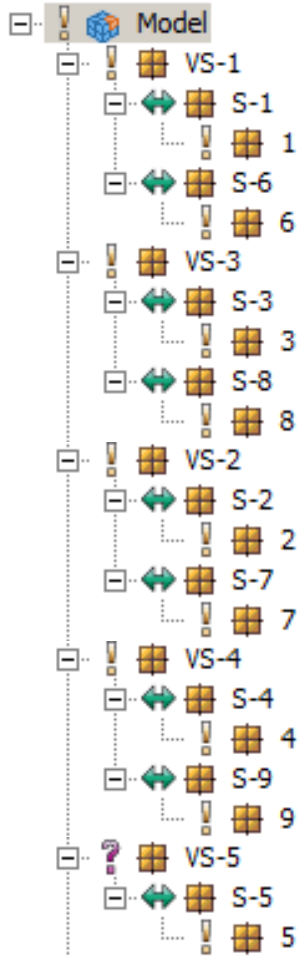
Model
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VS-3
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VS-2
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VS-5
S-5
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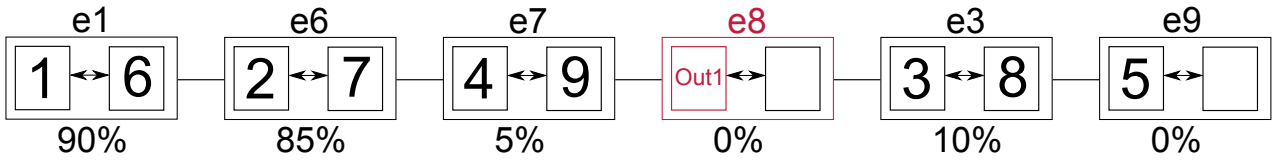
Merging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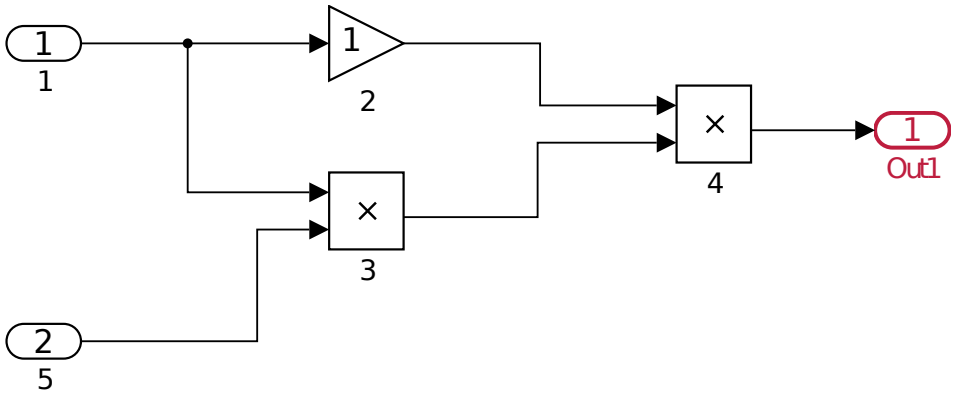
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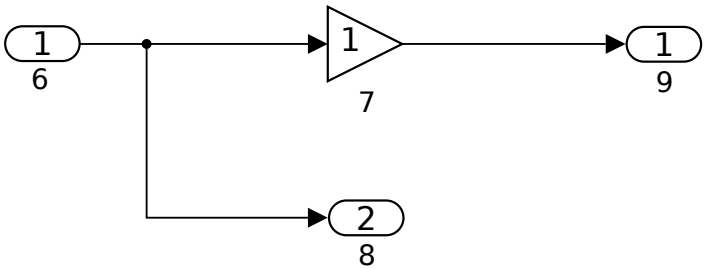
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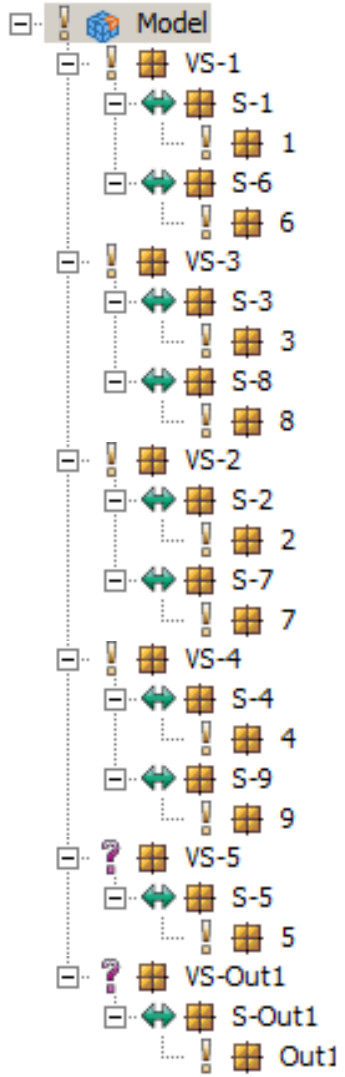
Model
VS-1
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S-6
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VS-3
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S-8
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VS-2
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S-7
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VS-4
S-4
4
S-9
9
VS-5
S-5
5
VS-Out1
S-Out1
Out1

Summary

What has been done?

- Approach applied to MATLAB/Simulink models
- Create family models:
  - Understand relations between compared models
  - Improves maintainability of models

Current work

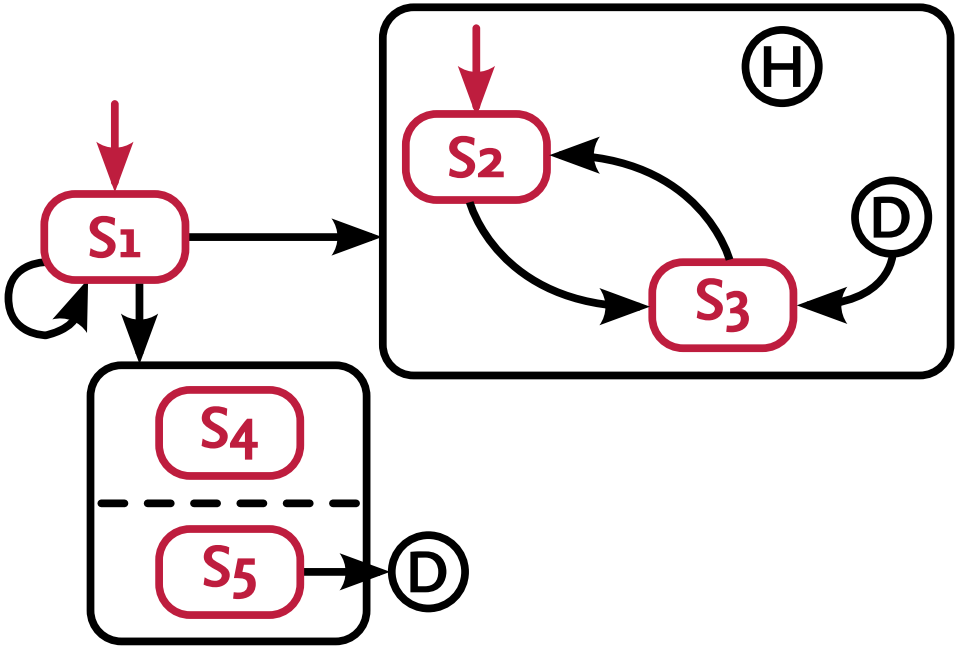
- Validation of the approach with industrial scale models:
  - The general approach, the metric, ...
- Logging for large models
- Refactoring in order to support multiple block-based languages:
  - e.g., MATLAB/Simulink, CoDeSys, ...

Analysis

- Analyze statechart representations of the following tools:
  - Esterel Technologies *SCADE*
  - Math Works *Stateflow*
  - ETAS *ASCET*
  - IBM *Rational Rhapsody*
- Also consider the journal article by *Harel*[1]

[1] David Harel, Statecharts: a visual formalism for complex systems, 1987

Identified concepts



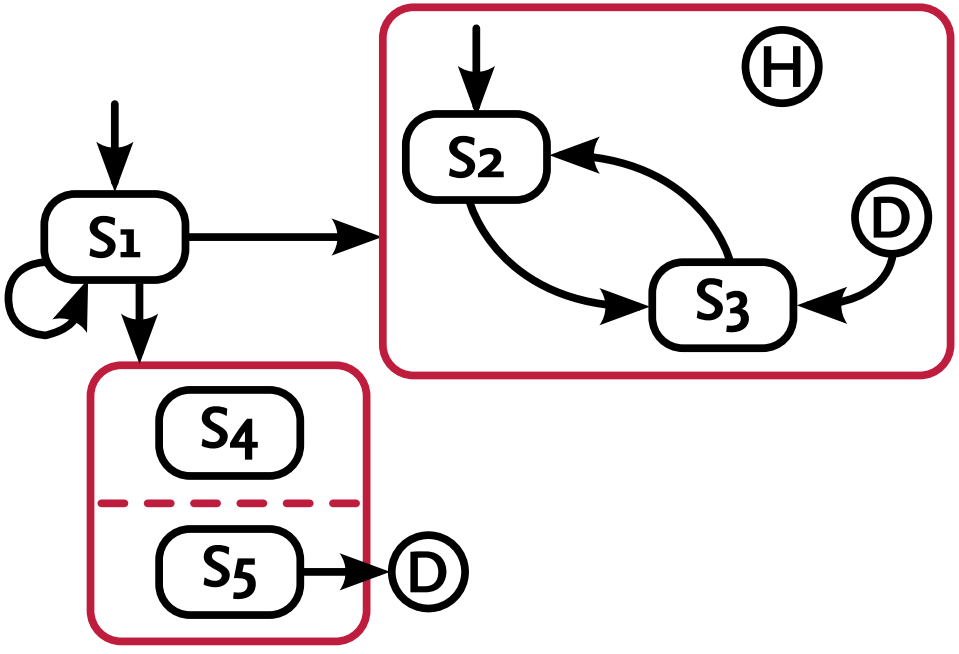
States

- Represented as a box
- Name is distinctive
- State actions:
  - e.g., entry, exit, during, ...
  - in *SCADE* defined by block-based models

Start States

- Different notations:
  - Marked with “S”
  - Default transition

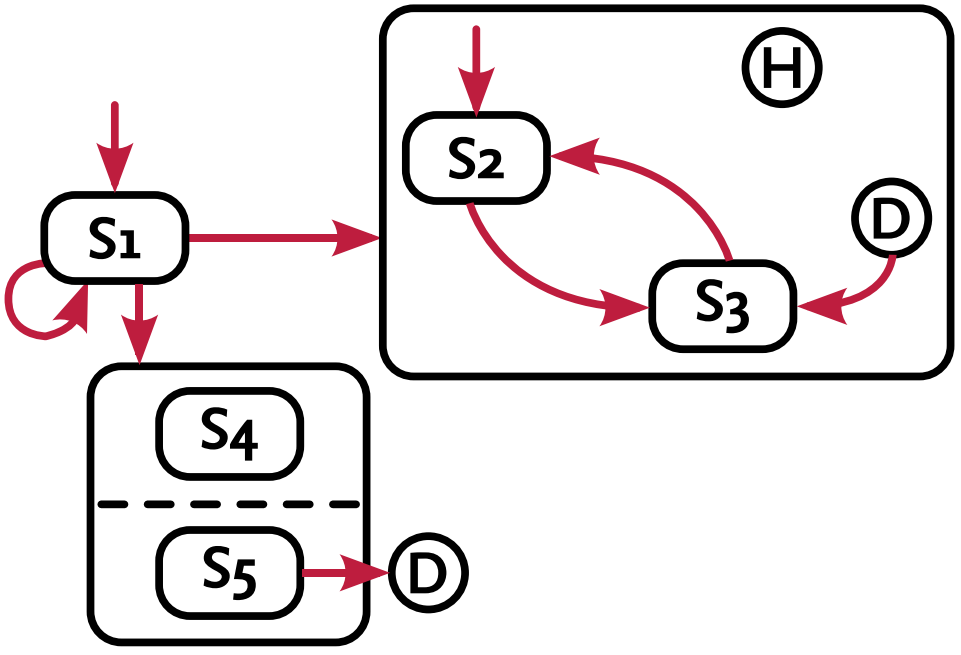
Identified concepts



Special States

- Hierarchical states
- Parallel states

Identified concepts



Transitions

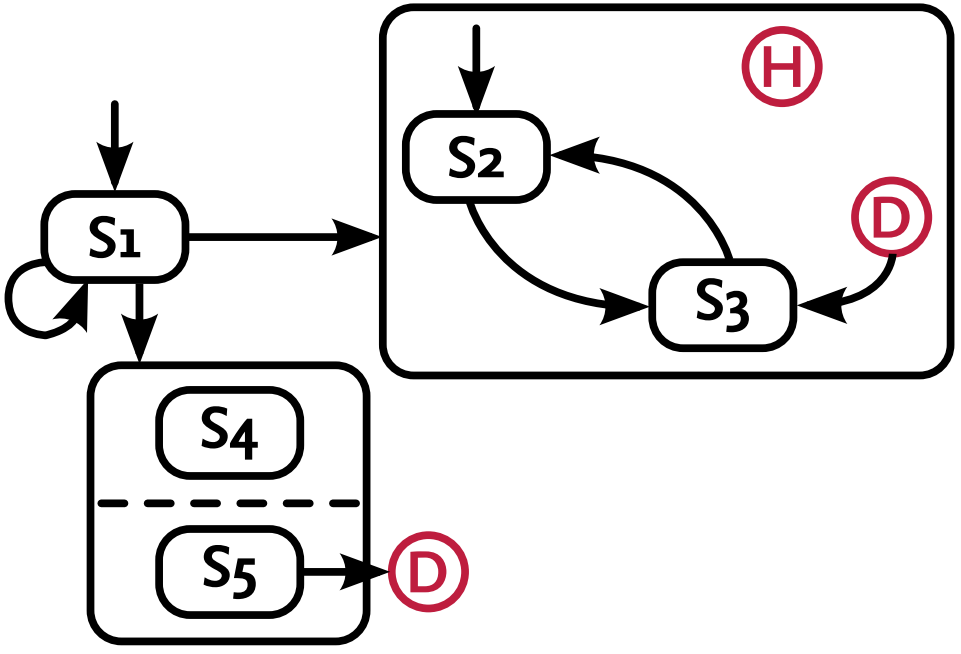
event [condition] / action

- *event:* triggering the transition
- *condition:* e.g., `x < 2`
- *action:* e.g., `x = 2`

Special Transitions

- Self-Loops
- Junctions
- Spontaneous transitions

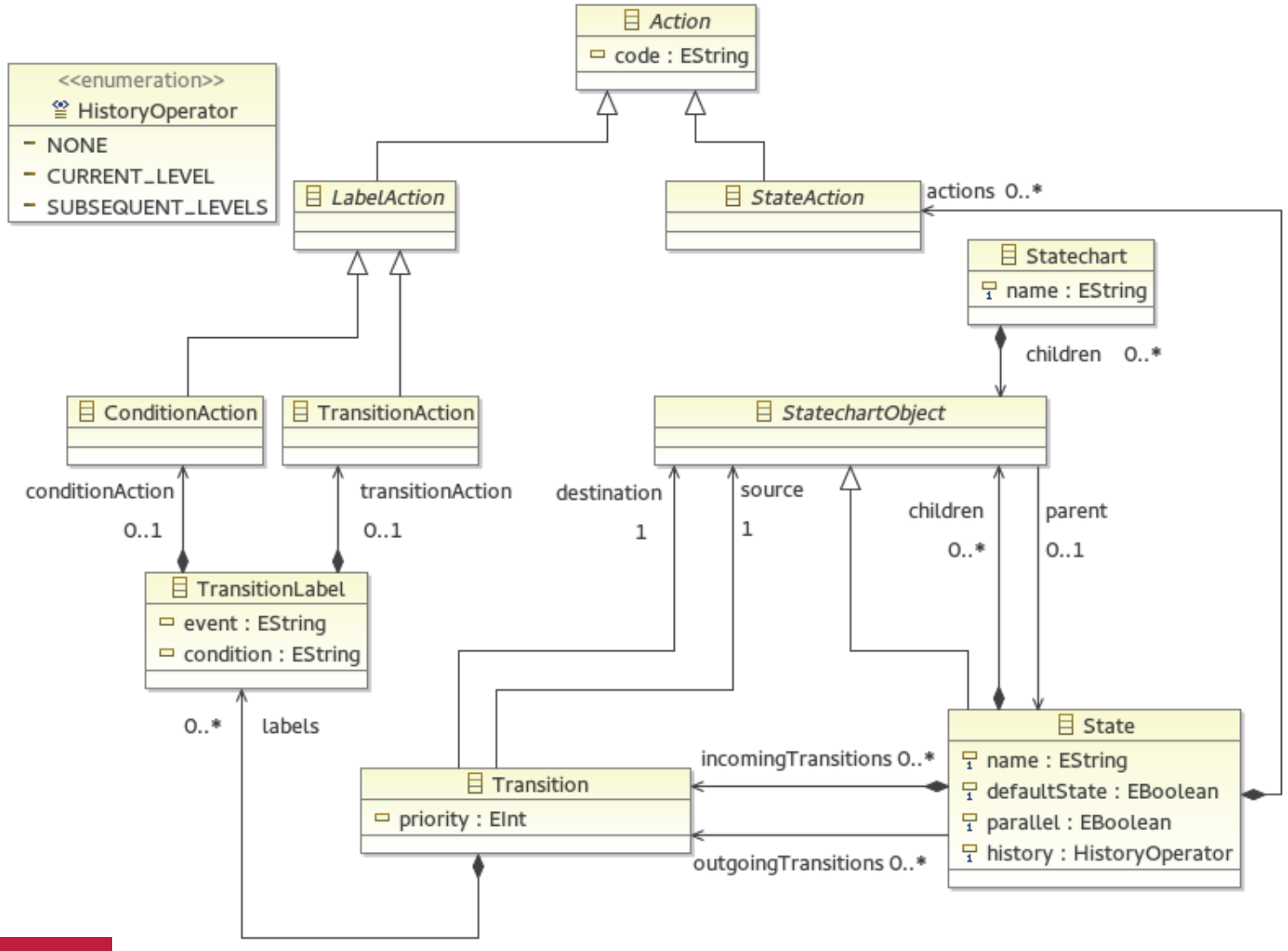
Identified concepts



Special concepts

- History junctions
- Diagram connectors “goto”
- Forks / Joins for parallel states

Create a Meta-Model



Identified challenges

No distinct attributes

- Names can change
- All elements have the same type (“state”) in contrast to Simulink with different types (e.g., Gain, Sum, Product, ...)
- Vocabulary can change between models (e.g., different names for the same event)
- Actions are defined by code and not by unique block types

$\Rightarrow$ Find a way to compare ambiguous elements and identify relations

Next steps: Approach & Evaluation

Metric

- Find a suitable metric to identify the variability of:
  - States
  - Transitions
- Should work with hierarchies and differing interfaces

Approach

- Find an approach with following requirements:
  - Efficient (preferably no $n \times m$ comparison)
  - Correct (i.e., meeting the stakeholders' expectations)
- Should work with all identified concepts

Next steps: Approach & Evaluation

Evaluation

- Extend the *architecture generator* developed at the ISF to generate
  - ... different related statecharts.
  - ... statecharts with differing complexity and size.
- Use the generated statecharts to evaluate the results of the approach

Thank you!

Thank you for your attention!