

GEODES Research Day and Symposium  
Montreal, 2022



# **Domain-specific Version Control System**

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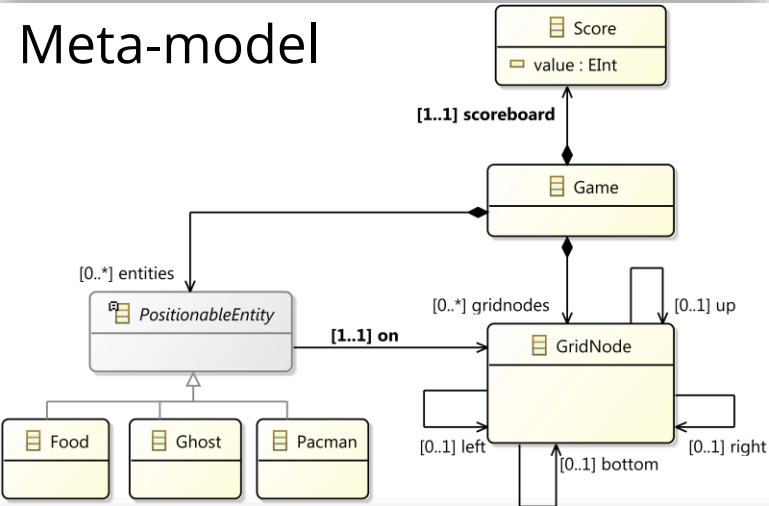
# Outline

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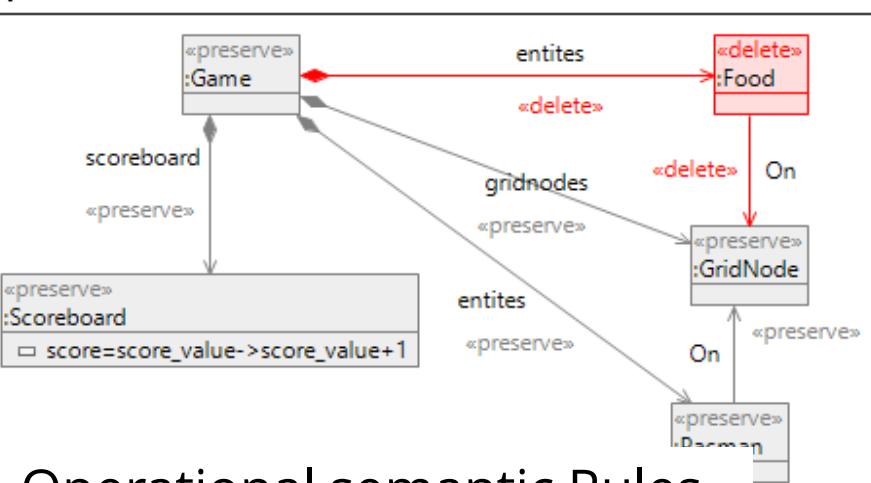
1. Current state of model comparison
2. Approach
3. Validation

# Domain-Specific Modeling

## Meta-model

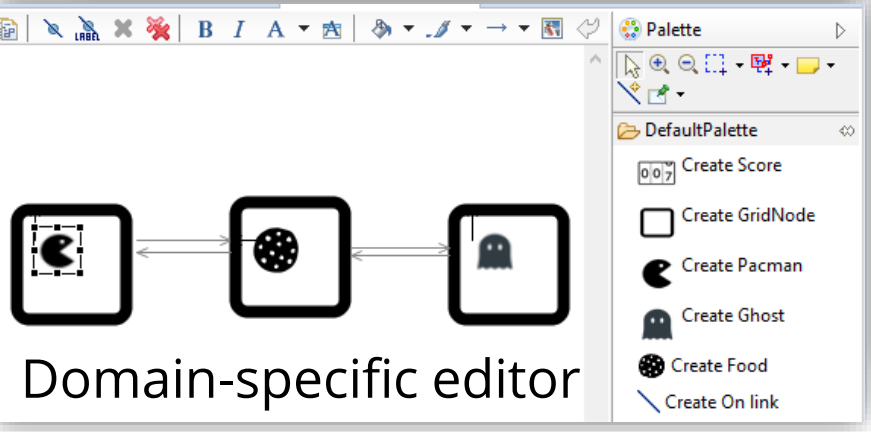
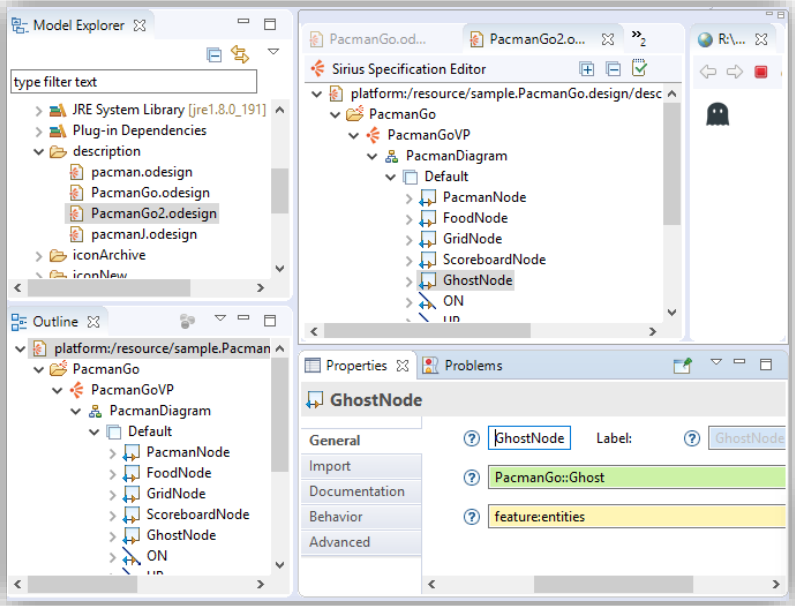


⇒ Rule eat(var score\_value)



## Operational semantic Rules

## Concrete syntax



```
<?xml version="1.0" encoding="UTF-8"?>
<PacmanGo:Game xmi:version="2.0" xmlns:xmi="
http://www.omg.org/XMI" xmlns:xsi="
http://www.w3.org/2001/XMLSchema-instance"
xmlns:PacmanGo="
http://www.zadahmad.org/dsmcompare/PacmanGo">
  <gridnodes right="//@gridnodes.1" id="1"/>
  <gridnodes left="//@gridnodes.0" id="5"/>
  <gridnodes up="//@gridnodes.3" id="GridNode_3"/>
  <gridnodes id="GridNode_4"/>
  <scoreboard value="1" id="7"/>
  <entities xsi:type="PacmanGo:Pacman"
on="//@gridnodes.0" id="2"/>
  <entities xsi:type="PacmanGo:Food"
on="//@gridnodes.0" id="3"/>
  <entities xsi:type="PacmanGo:Pacman"
on="//@gridnodes.1" id="4"/>
  <entities xsi:type="PacmanGo:Food"
on="//@gridnodes.1" id="6"/>
  <entities xsi:type="
on="//@gridnodes.2
</PacmanGo:Game>
```

## Serialization

# Text-based model comparison

- Relying on text-based differencing
  - May lead to false positives
  - User has to manually find the semantics of changes

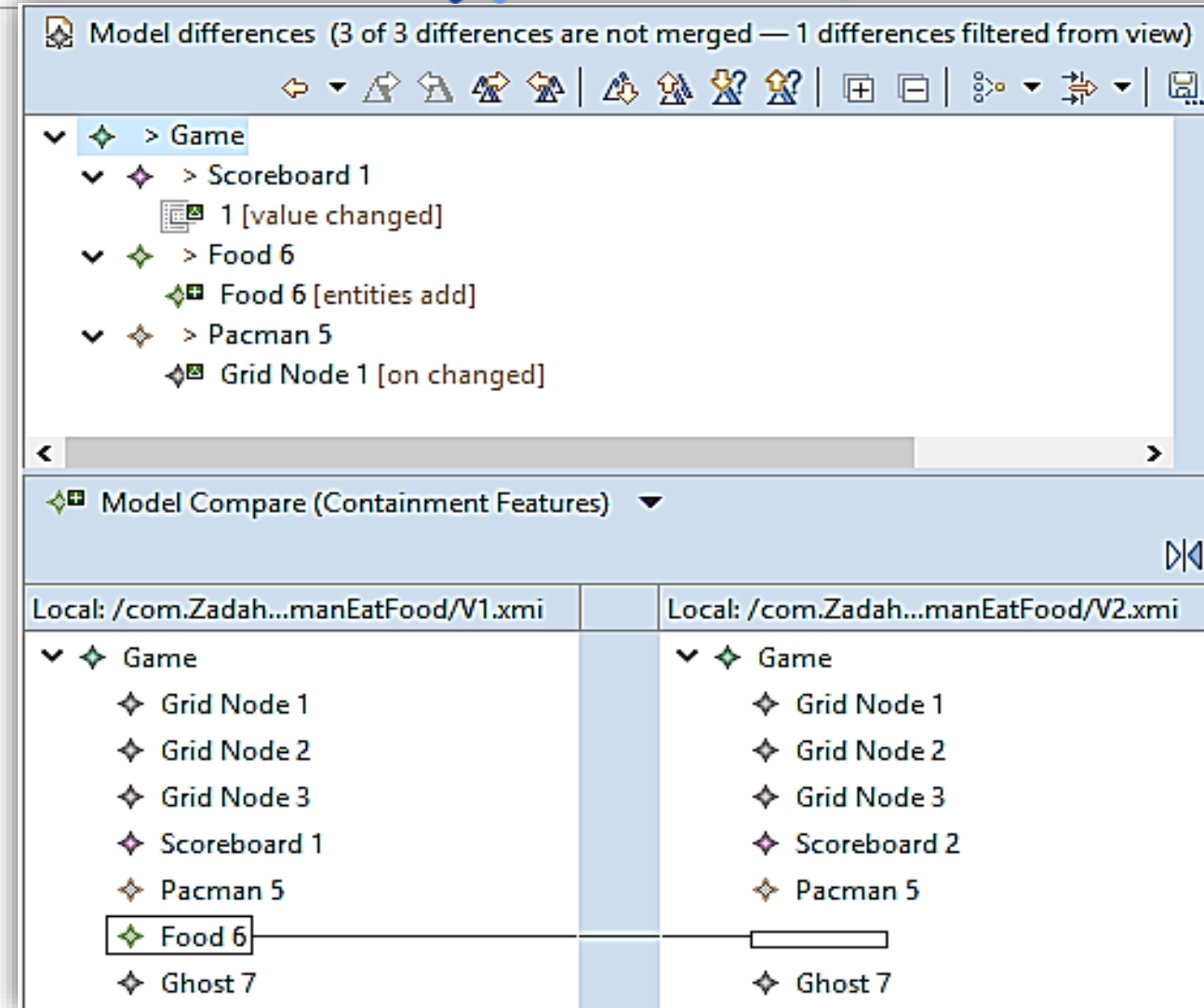


[Hunt, J. W., and McIlroy, D. 1976. An algorithm for differential file comparison. Tech. Rep. 41, AT&T Bell Laboratories.]

[Lin, Y., Gray, J. and Jouault, F., 2007. DSMDiff: a differentiation tool for domain-specific models. *European Journal of Information Systems*, 16(4), pp.349-

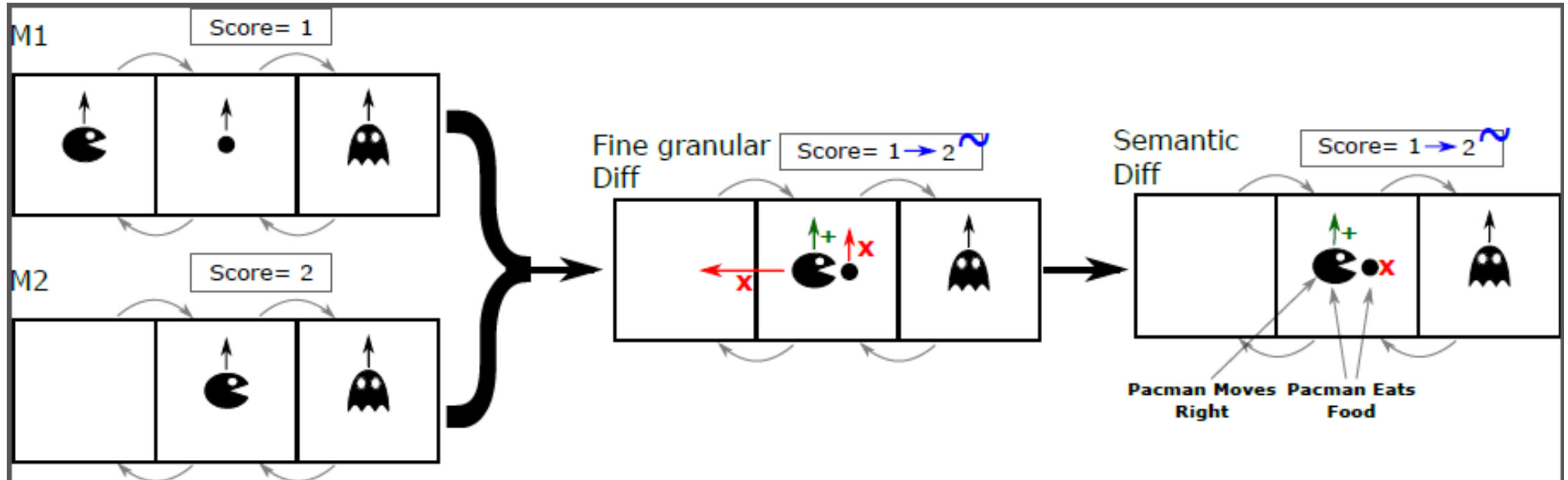
# Model-based comparison

- The most promising and used model comparison approach
  - EMFCompare
    - An example
  - Comprehension gap
    - What the results means for user: “on changed” ???
    - And sth happened for the “Food” in the Lower panel
    - But user doesn’t know OO principles !!!

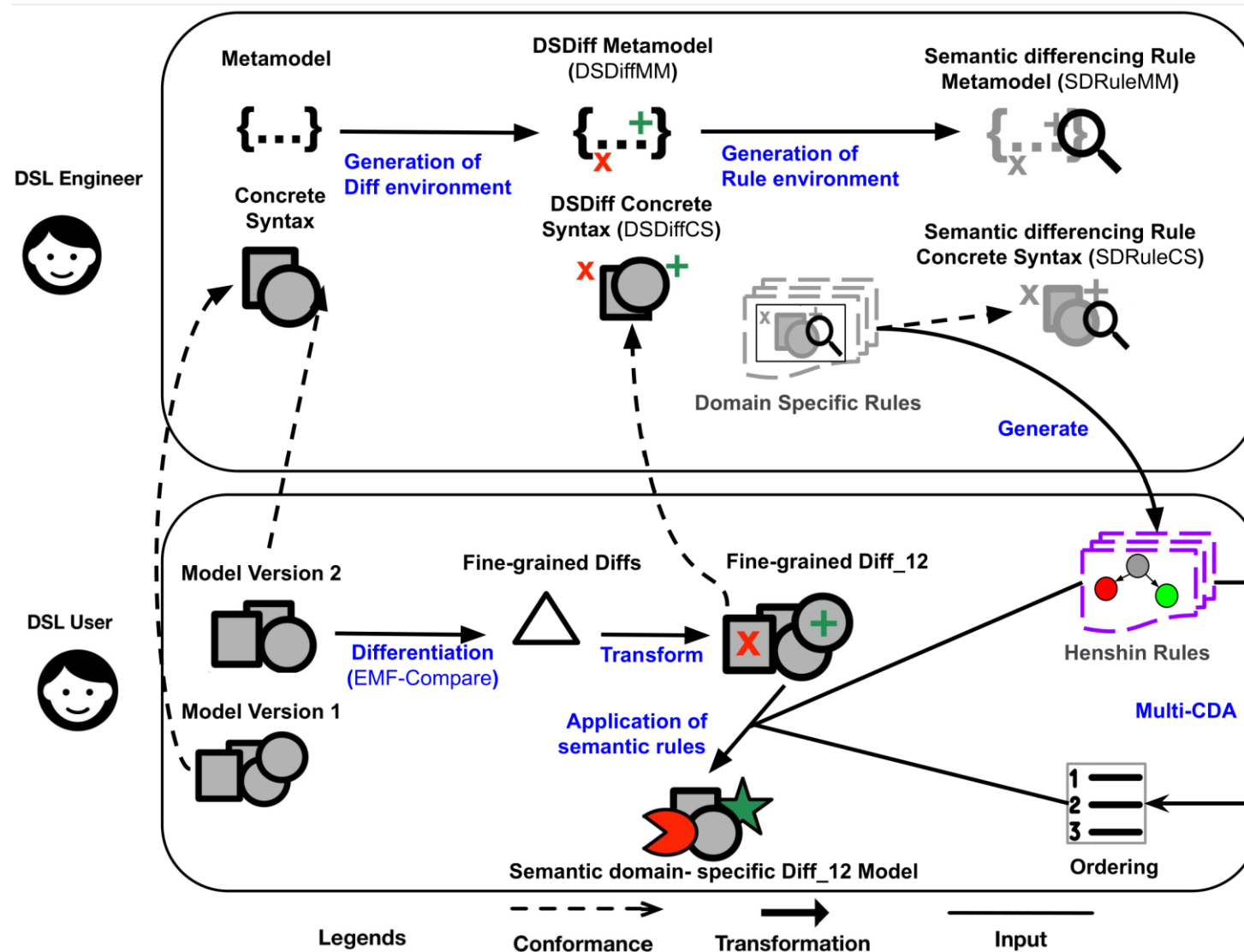


[EMFCompare: Toulmé, A., & Inc, I. (2006, October). Presentation of EMF compare utility. In *Eclipse Modeling Symposium* (pp. 1-8).]

# What we want instead

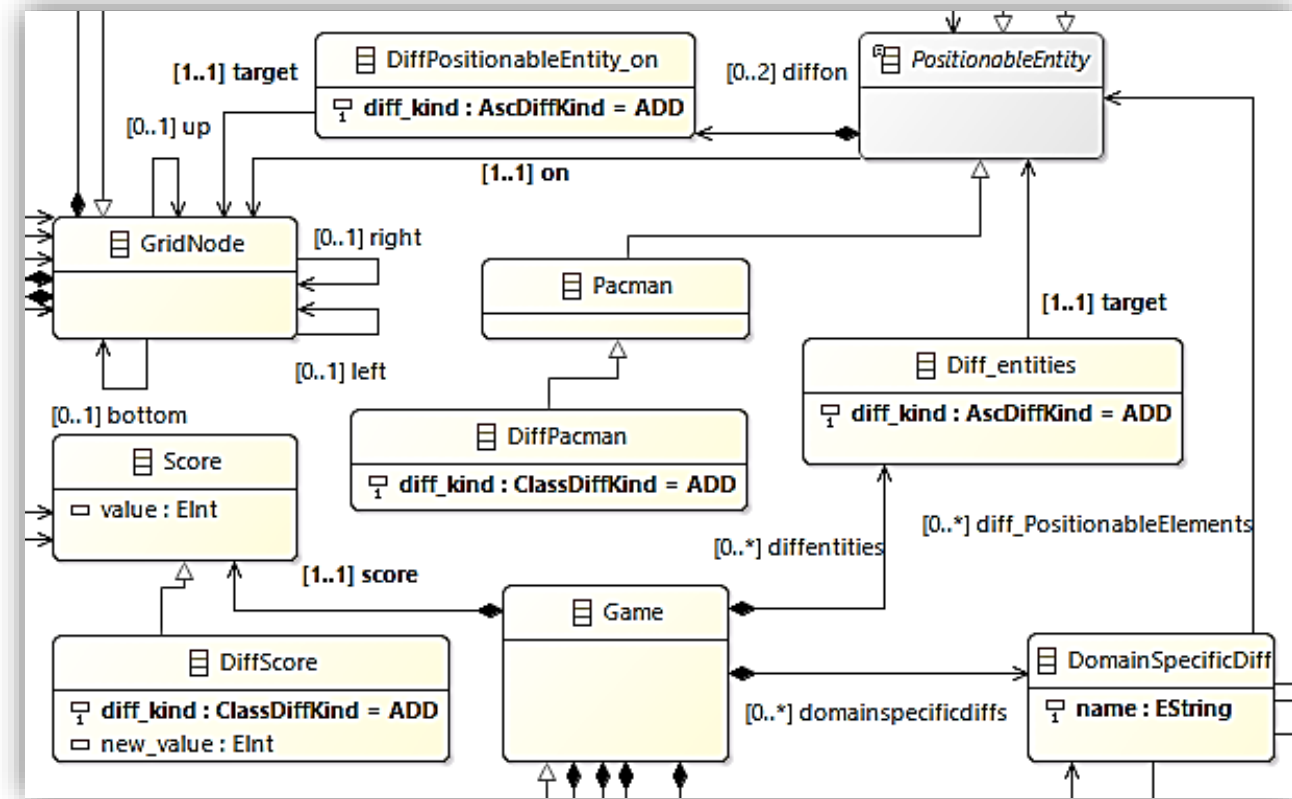
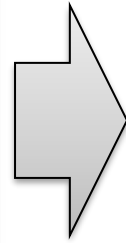
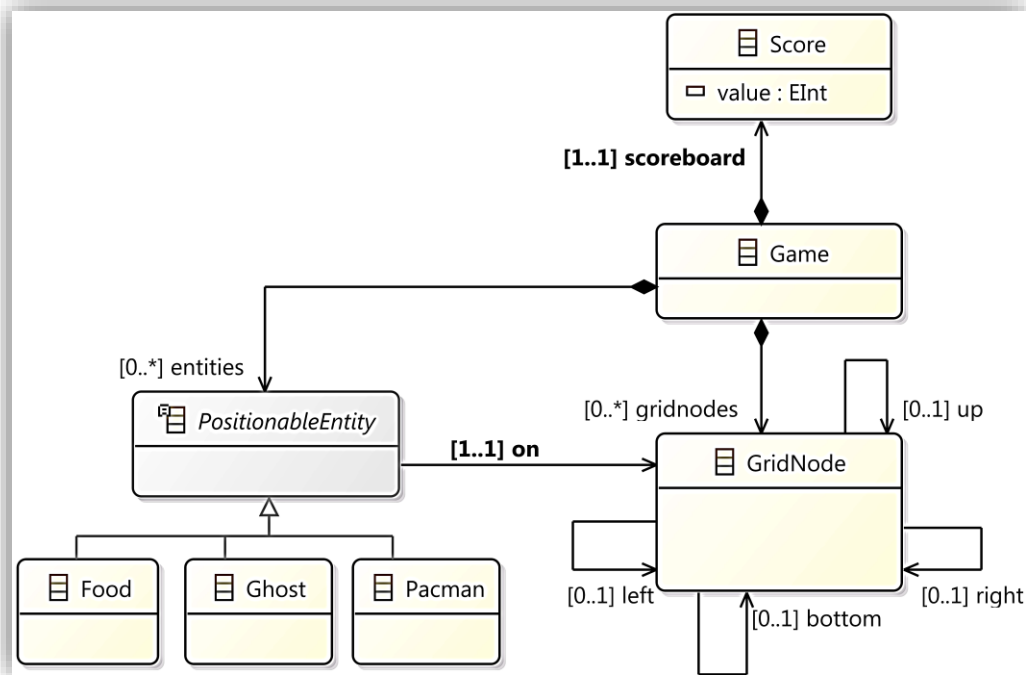


# DSMCompare approach



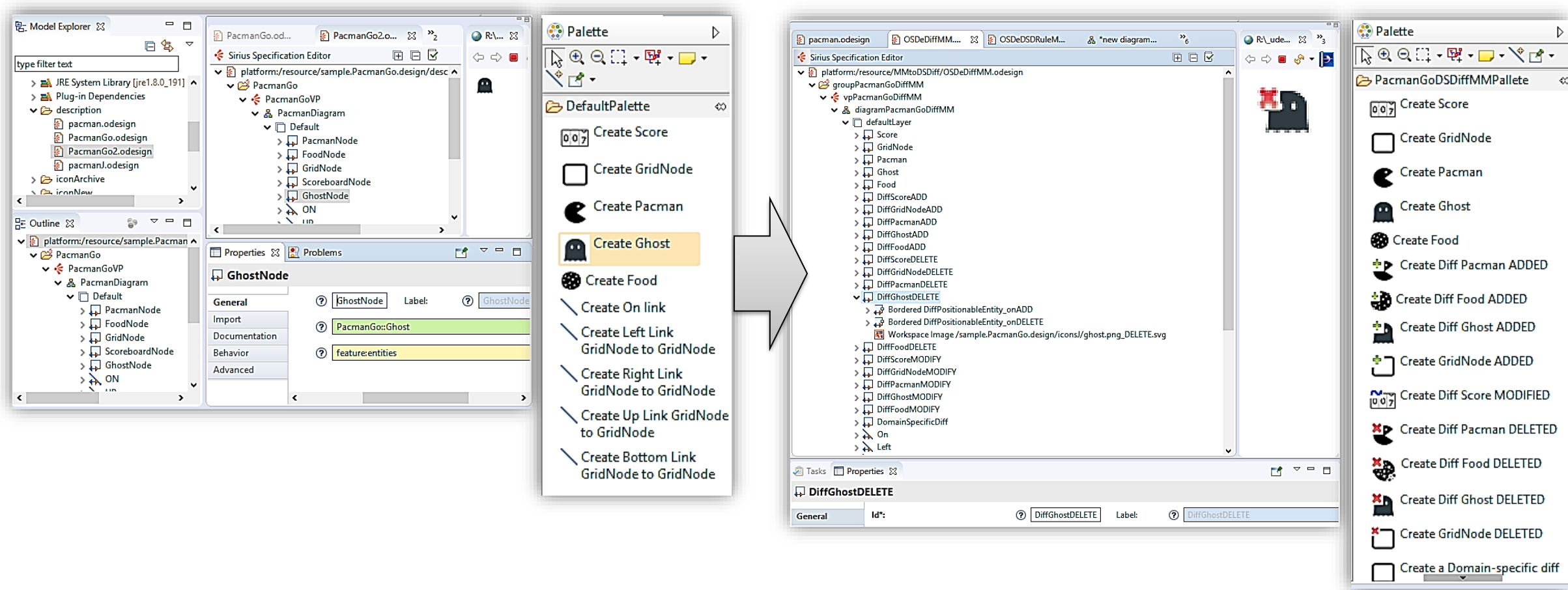
# From DSL to DSL-Diff metamodel

## Pacman example

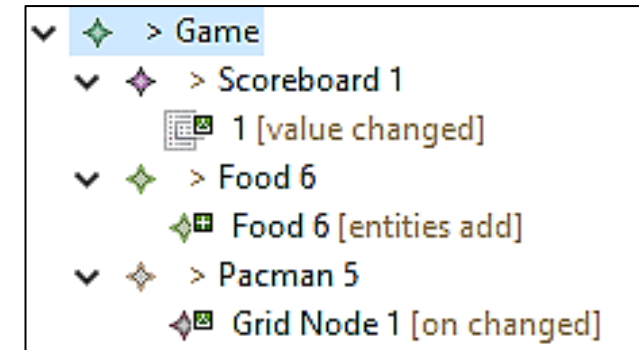
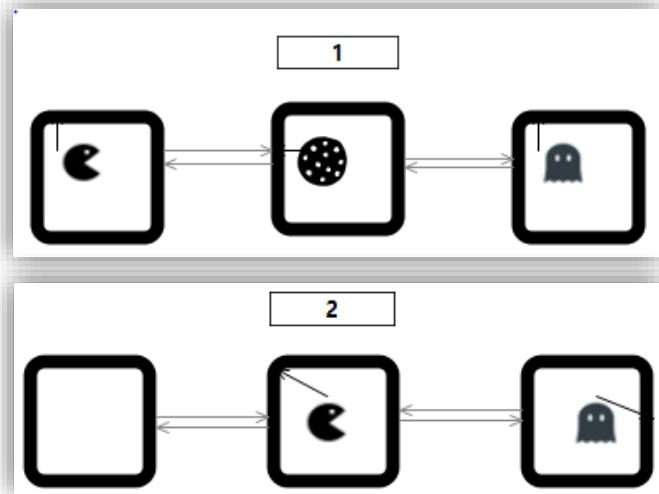


# From DSL to DSL-Diff concrete syntax

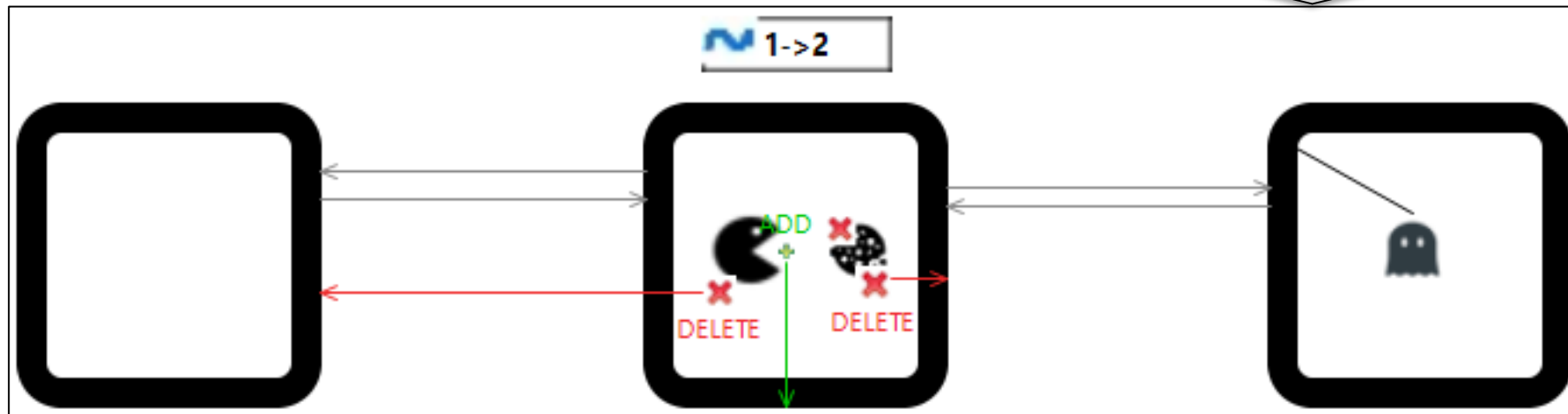
## Pacman example



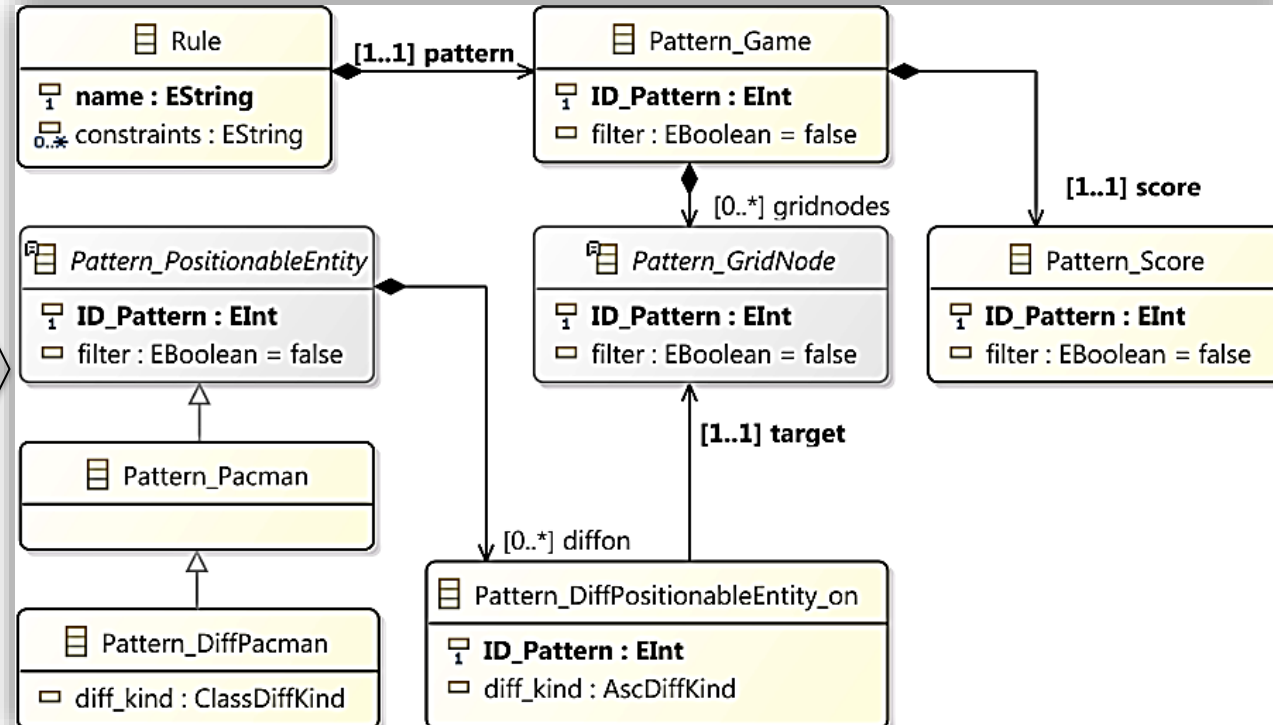
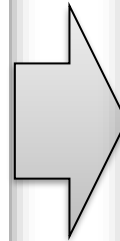
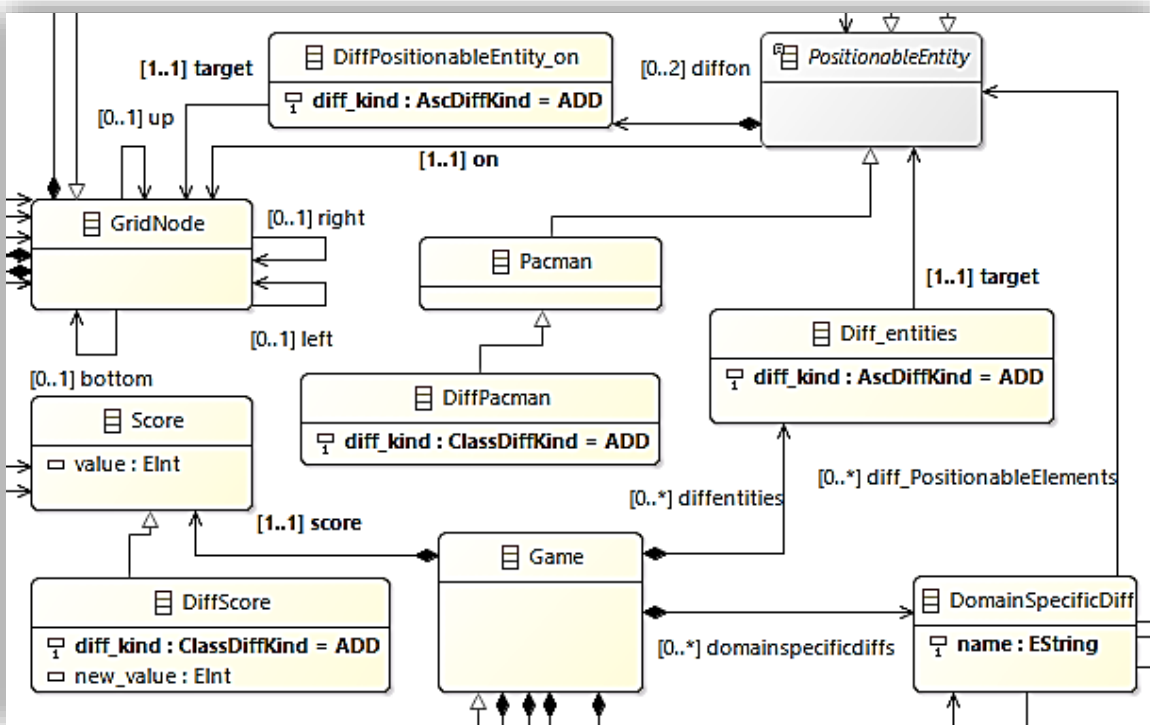
# Diff in concrete Syntax



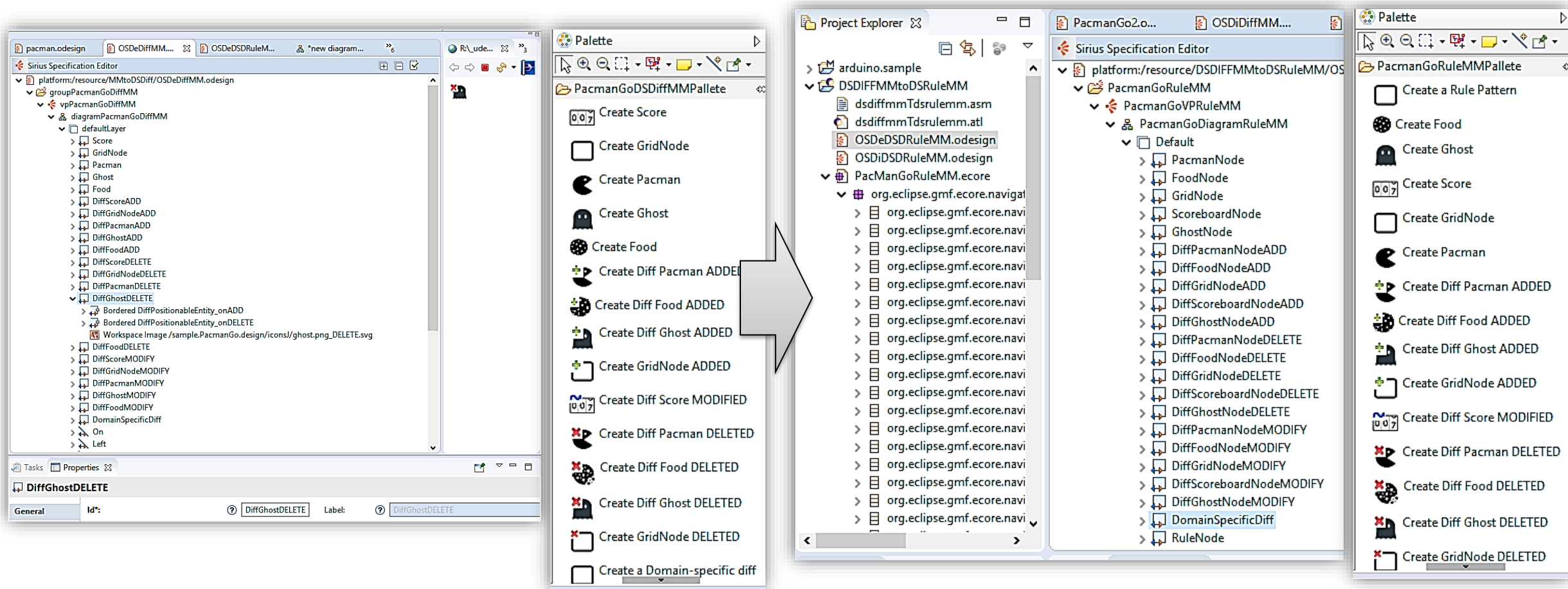
Automatic  
adaptation  
to DSL-Diff



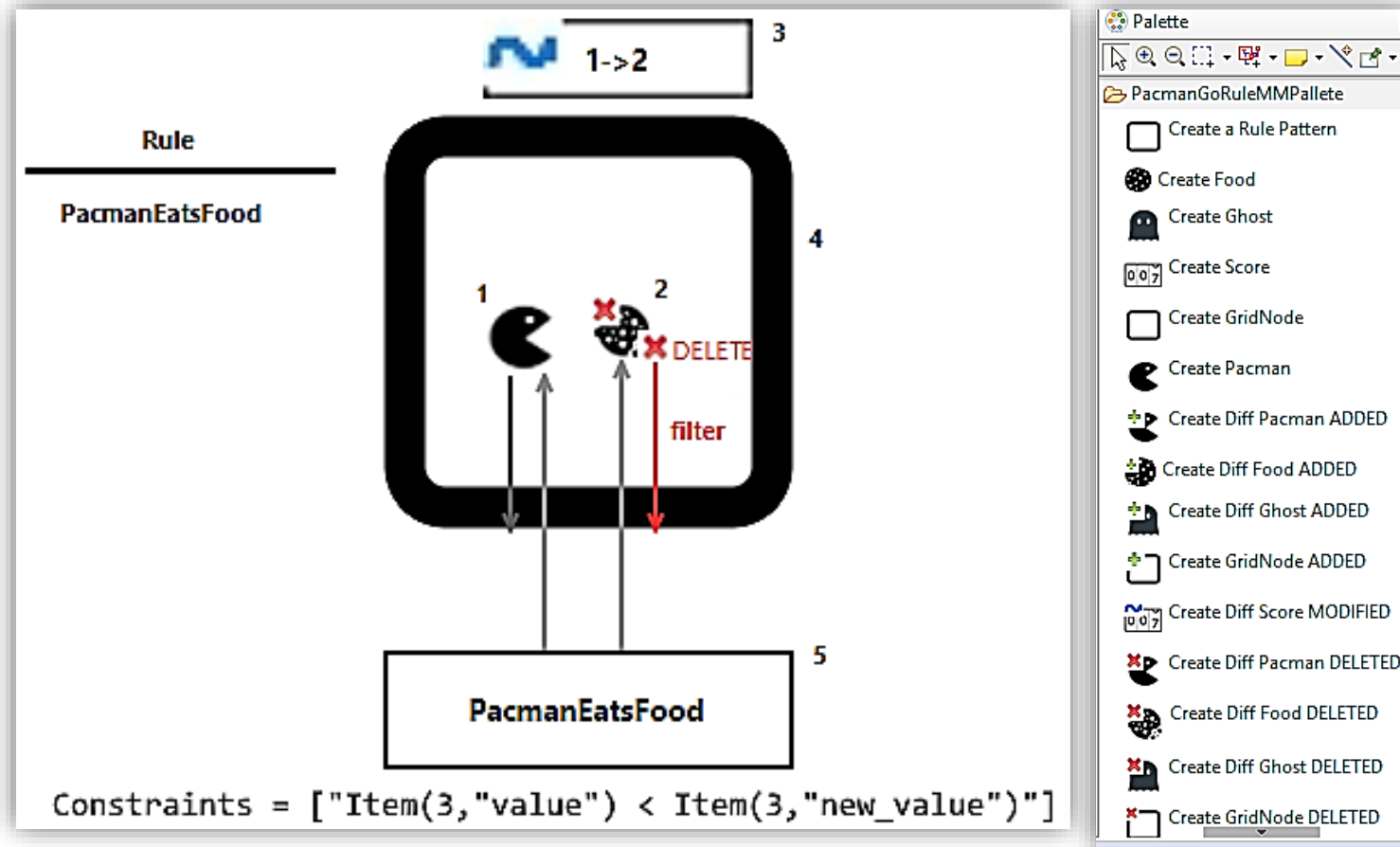
# From DSL-Diff to DSL-Diff-Rule metamodel



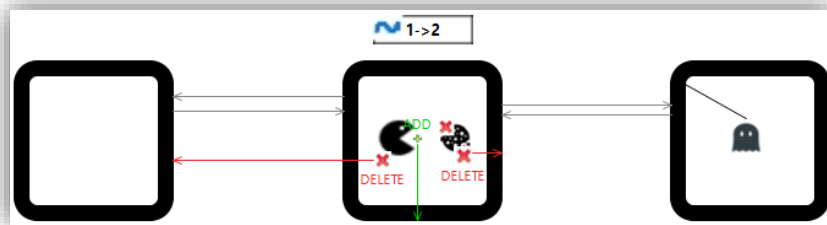
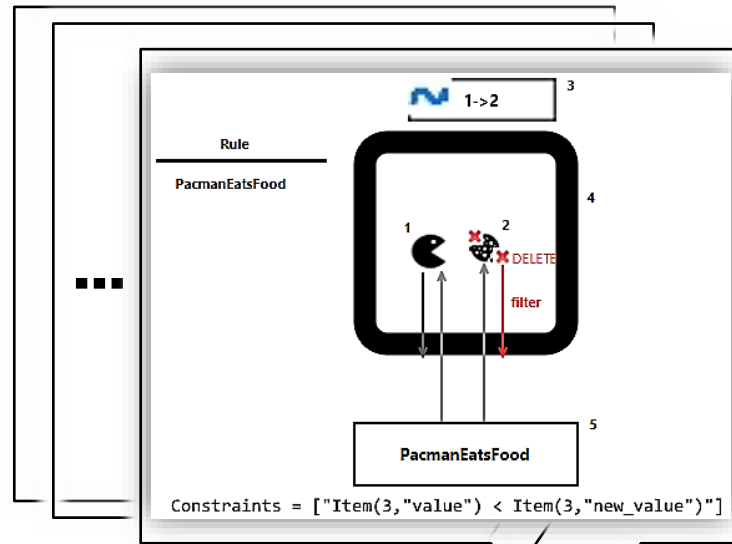
# From DSL-Diff to DSL-Diff-Rule concrete syntax



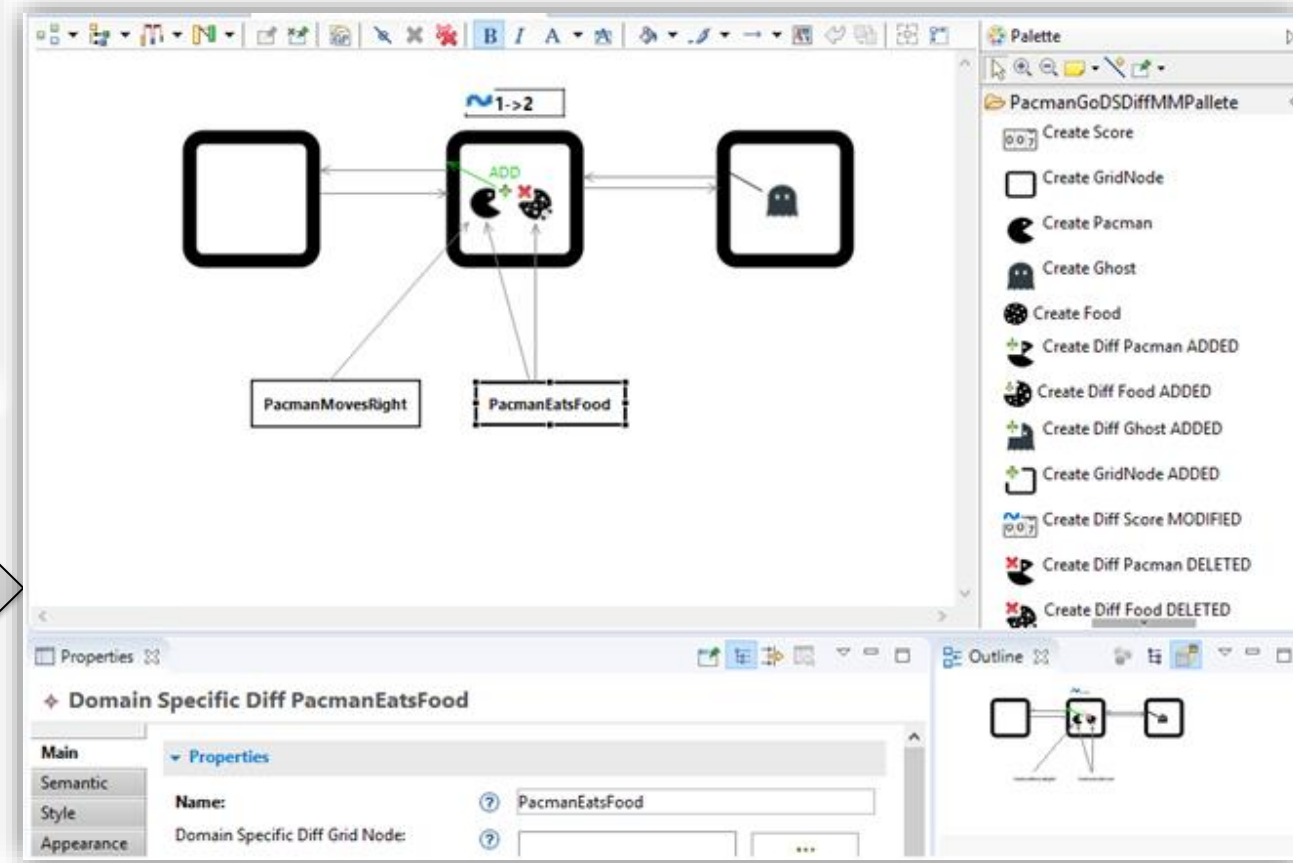
# Semantic diff rule editor



# Applying semantic rules



Semantic rule  
matching and  
rewriting



# Validation

## Research questions

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RQ1. Can we extract semantic diffs from fine granular diffs?

RQ2. Are fine granular diffs more verbose than semantic diffs?

RQ3. Are semantic diffs recurring?

# Case study


## Arduino Designer

- Open-source electronics DSL
  - Configurations (Hardware)
  - Programs (Sketch)
- Retrieved all versioned models (GitHub)
- Applied DSMCompare on it

History for [arduino](#) / [examples](#) / [fr.oceo.dsl.arduino.examples.fadelight](#) / [model.arduino](#)


Commits on Oct 16, 2013

**Migrate fadelight example to sirius**

 [mbats](#) committed on 16 Oct 2013

Commits on Oct 10, 2013

**Fadelight example**


 [mbats](#) committed on 10 Oct 2013

Commits on Oct 7, 2013

**Generate while**


 [mbats](#) committed on 7 Oct 2013

**Create variable, constant, math operator**

 [mbats](#) committed on 7 Oct 2013


Commits on Oct 6, 2013

**Sub instructions**

 [mbats](#) committed on 6 Oct 2013

Commits on Oct 4, 2013

**While**

 [mbats](#) committed on 4 Oct 2013

# Example of DS-Diff

## Without DSMCompare

- Diff reports many changes at AS level
- Developers have no notion of OO

```
@@ -16,12 +16,11 @@
<instructions xsi:type="arduino:Level"
next="//@sketch/@instructions.1/@instructions.1" level="//@sketch/@instructions.0">
  <module xsi:type="arduino:OutputModule"
href="//.../plugin/fr.oobe.dsl.arduino.design/resources/ArduBlockKit.arduino//@modules.
0"/>
</instructions>
- <instructions xsi:type="arduino:Variable" name="var1"/>
</instructions>
<instructions xsi:type="arduino:BooleanOperator" left="//@sketch/@instructions.0"
right="//@sketch/@instructions.8" operator="lower"/>
<instructions xsi:type="arduino:NumericalOperator"
left="//@sketch/@instructions.0" right="//@sketch/@instructions.4" operator="plus"/>
<instructions xsi:type="arduino:Constant" value="1"/>
- <instructions xsi:type="arduino:While" next="//@sketch/
condition="//@sketch/@instructions.6">
  <instructions xsi:type="arduino:Set"
next="//@sketch/@instructions.5/@instructions.1" variable="//@sketch/@instructions.0"
value="//@sketch/@instructions.7"/>
  <instructions xsi:type="arduino:Level"
next="//@sketch/@instructions.5/@instructions.2" level="//@sketch/@instructions.0">
    <module xsi:type="arduino:OutputModule"
href="//.../plugin/fr.oobe.dsl.arduino.design/resources/ArduBlockKit.arduino//@modules.
0"/>
@@ -32,10 +31,7 @@
<instructions xsi:type="arduino:NumericalOperator"
left="//@sketch/@instructions.0" right="//@sketch/@instructions.4" operator="minus"/>
<instructions xsi:type="arduino:Constant" value="255"/>
<instructions xsi:type="arduino:Constant" value="0"/>
- <instructions xsi:type="arduino:While" condition="//@sketch/@instructions.11"/>
- <instructions xsi:type="arduino:BooleanOperator" left="//@sketch/@instructions.14"
right="//@sketch/@instructions.13"/>
- <instructions xsi:type="arduino:Variable" name="var2"/>
- <instructions xsi:type="arduino:Variable" name="var3"/>
- <instructions xsi:type="arduino:BooleanOperator"/>
</sketch>
</arduino:Project>

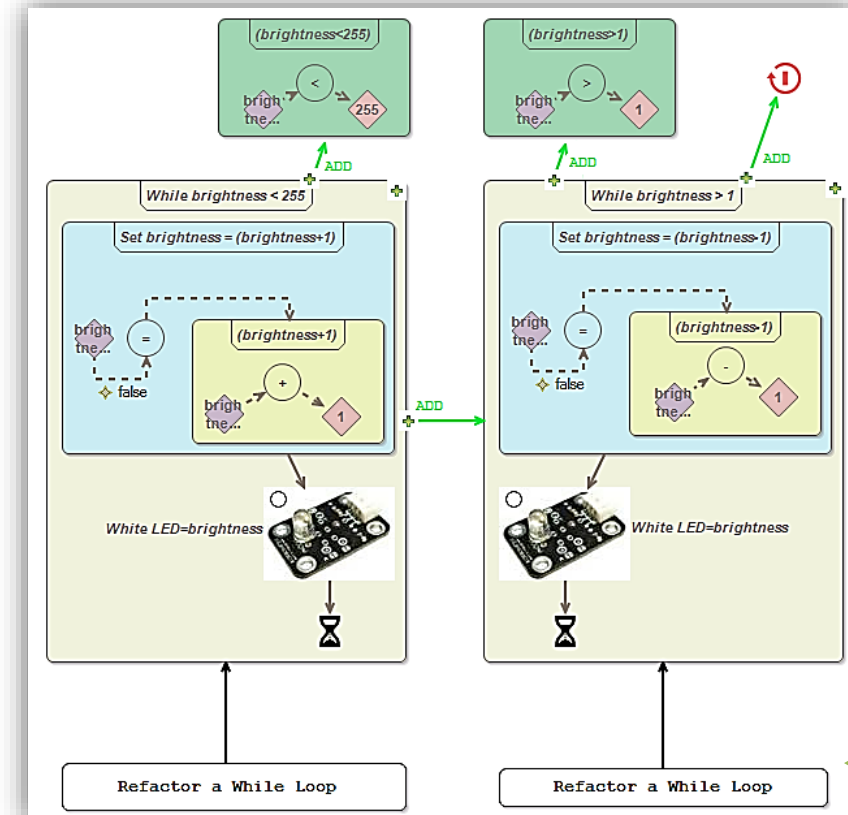
16 <instructions xsi:type="arduino:Level"
next="//@sketch/@instructions.1/@instructions.1" level="//@sketch/@instructions.0">
17 <module xsi:type="arduino:OutputModule"
href="//.../plugin/fr.oobe.dsl.arduino.design/resources/ArduBlockKit.arduino//@modules.
0"/>
18 </instructions>
19 </instructions>
20 <instructions xsi:type="arduino:BooleanOperator" left="//@sketch/@instructions.0"
right="//@sketch/@instructions.8" operator="lower"/>
21 <instructions xsi:type="arduino:NumericalOperator"
left="//@sketch/@instructions.0" right="//@sketch/@instructions.4" operator="plus"/>
22 <instructions xsi:type="arduino:Constant" value="1"/>
23 + <instructions xsi:type="arduino:While" next="//@sketch/@instructions.11"
condition="//@sketch/@instructions.6">
24 <instructions xsi:type="arduino:Set"
next="//@sketch/@instructions.5/@instructions.1" variable="//@sketch/@instructions.0"
value="//@sketch/@instructions.7"/>
25 <instructions xsi:type="arduino:Level"
next="//@sketch/@instructions.5/@instructions.2" level="//@sketch/@instructions.0">
26 <module xsi:type="arduino:OutputModule"
href="//.../plugin/fr.oobe.dsl.arduino.design/resources/ArduBlockKit.arduino//@modules.
0"/>

31 <instructions xsi:type="arduino:NumericalOperator"
left="//@sketch/@instructions.0" right="//@sketch/@instructions.4" operator="minus"/>
32 <instructions xsi:type="arduino:Constant" value="255"/>
33 <instructions xsi:type="arduino:Constant" value="0"/>
34 + <instructions xsi:type="arduino:NumericalOperator"
left="//@sketch/@instructions.0" right="//@sketch/@instructions.4" operator="plus"/>
35 + <instructions xsi:type="arduino:Delay" next="//@sketch" value="200"/>

36 </sketch>
37 </arduino:Project>
```

## With DSMCompare

- Diffs represented as hardware & sketch
- Improves comprehension and productivity



# Results

Project	Version one	Version two	<u>Fine Diffs</u> Class/Association	Semantic Diff	Occurrences	<u>Semantic Fine Diffs</u> Class/Association
/alarmlight	Initialize	Migrate alarmlight example to sirius	41/16	Refactor a Repeat Loop	3	1/1
	Repeat	Fix Generation For AlarmLight Exam	52/8	Increase Repeat iterations	2	1/0
/fadelight	While Fadelight example	Sub instructions Migrate alarmlight example to sirius	20/22 5/3	Refactor a Repeat Loop	1	1/1
				Delete a Repeat Loop	1	1/1
/functions	Initialize	Add functions example	39/24	Refactor a While Loop	2	1/2
				Incomplete While Loop Deleted	1	1/1
/infraredsensor	Initialize	Add servo	15/2	Add a function	1	1/0
				Function Call	2	1/1
/morsecode	Morse code	Migrate morsecode example to sirius	2/0	Servo Feature enabled	1	2/3
/reset	Initialize	Add reset example	6/0	Support infrared connections	1	1/2
/rotationsensor	Initialize	While	6/0	-	-	-/-
/servo	Initialize	Migrate morsecode example to sirius	14/2	Servo Feature enabled	1	2/3
				Support infrared connections	1	1/2
/simpleinput	simpleinput	Simple input example	3/0	-	-	-/-
/tigger.all	Add Tigger example	Update the tigger example	99/36	Refactor a Repeat Loop	1	1/1
				Refactor to an if condition	1	1/2
/tigger.bubble	Initialize	Add tigger bubble example	41/14	Refactor to an if condition	1	1/2
				Refactor a Repeat Loop	1	1/1
	Add tigger bubble example	Fix issue on bubble example	2/0	Refactor a Bubble machine	1	9/9
				-	-	-/-
/tigger.necklace	Initialize	Add tigger necklace example	36/15	Refactor to an if condition	1	1/2
				Refactor a Repeat Loop	1	1/1
/tigger.tail	Initialize	Update cat tail example to Add miaou sound	13/1	A cat necklace added	1	9/9
				Refactor to an if condition	1	1/2
	Add Tigger tail example	Update tail example	2/2	Add music player	1	3/2
				-	-	-/-

RQ2  
✓

RQ3  
✓

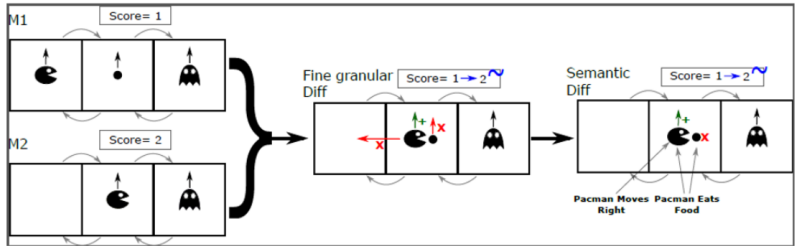
# Future work

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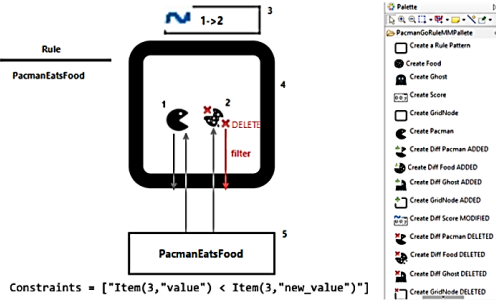
- Domain-specific Merge
- Controlled user study to evaluate the usefulness of DSMCompare
- Integrate in a model-based VCS

# Conclusion

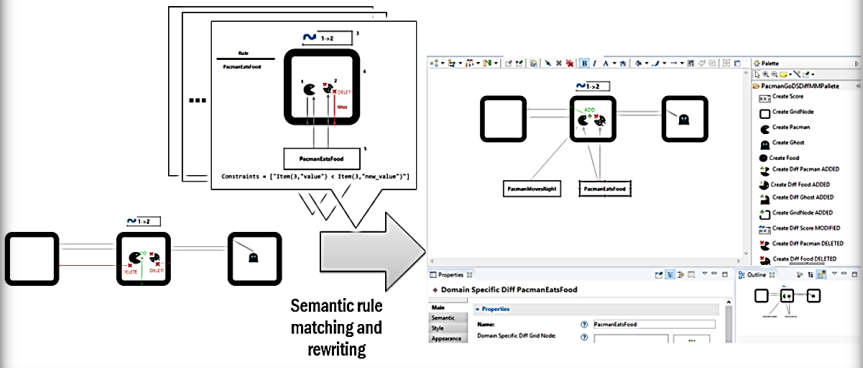
## What we want instead



## Semantic diff rule editor



## Applying semantic rules



## Example of DS-Diff

### Without DSMCompare

- Diff reports many changes at AS level
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### With DSMCompare

- Diffs represented as hardware & sketch
- Improves comprehension and productivity

