The Common Variablility Language (CVL)

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About SINTEF

- Largest independent research organisation in Scandinavia
- About 2000 employees
  - 1200 in Trondheim
  - 800 in Oslo
- 7 Divisions
  - ICT about 280 researchers

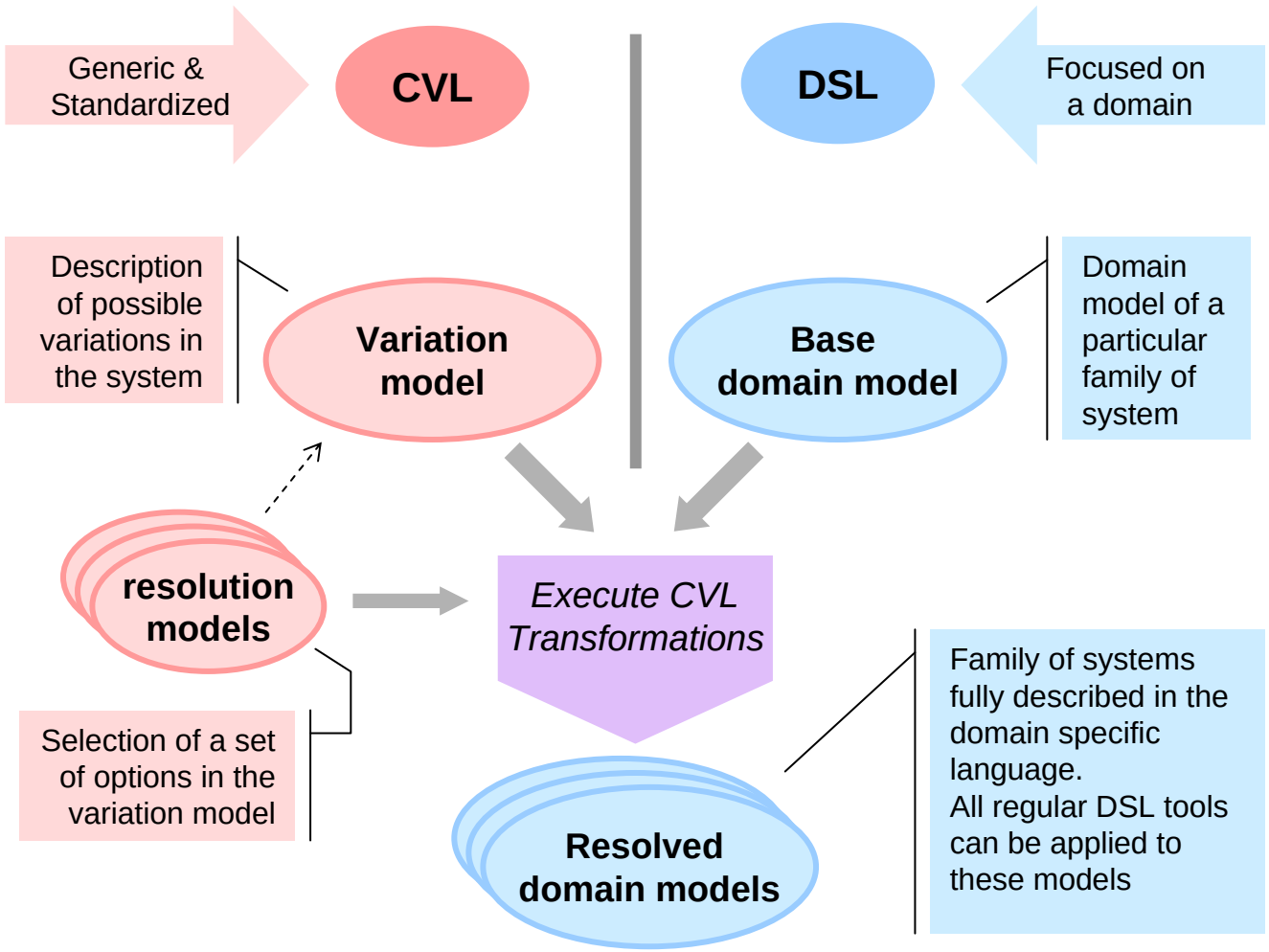
Motivation

- For the common variability language
  - More and more modeling DSLs
  - Need to express variability
  - Make a generic language to express variability
    - Based on capturing the differences between variants
  - Make generic tools to integrate with DSL tools
- For presenting it here
  - Similarity with AOM techniques
  - The core concepts of CVL
    - Fragments <-> Aspects ?
    - Substitution <-> Weaving ?

Outline

- **The Common Variability Language**
  - Overview of CVL
  - Basic concepts: Substitutions
  - A simple example
- Building generic tools
- Demo
- Discussion

Big Picture



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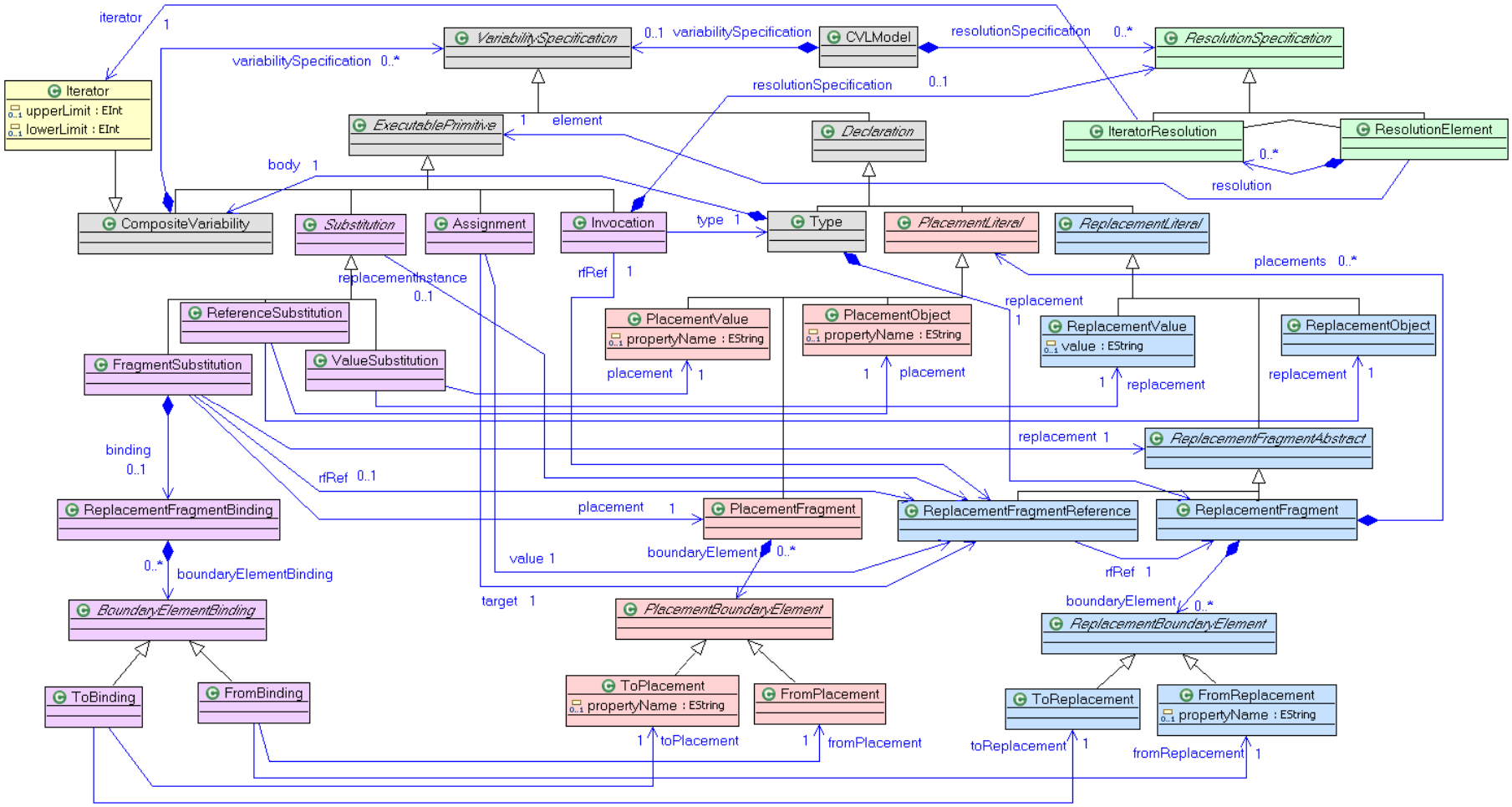
CVL Concepts

- Substitutions
  - Value substitution
  - Reference Substitution
  - Fragment substitution
- Variability
  - Choices
  - Similar to Feature models
  - Constraints
- Choices

CVL Meta-model



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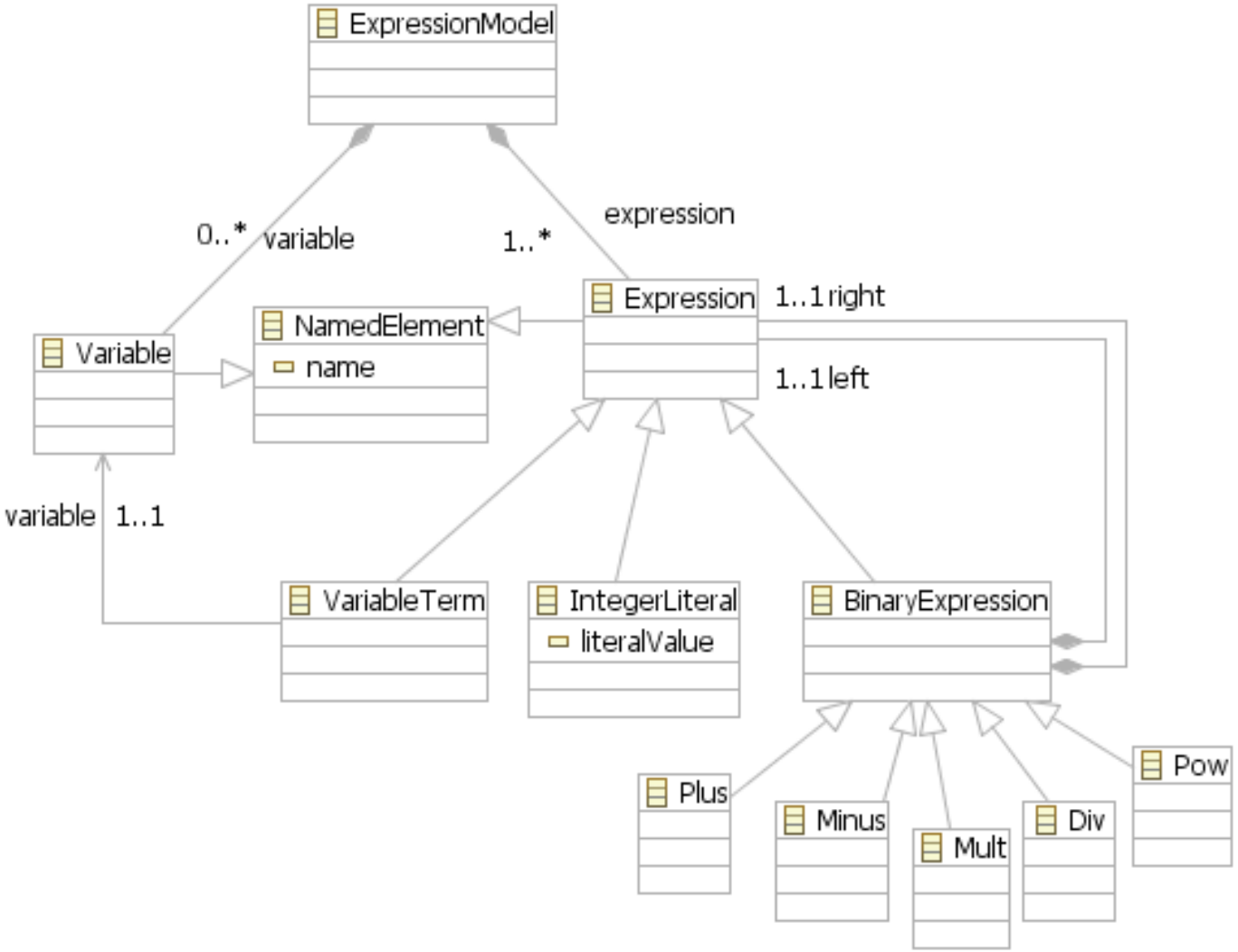
Arithmetic Expressions Meta-Model



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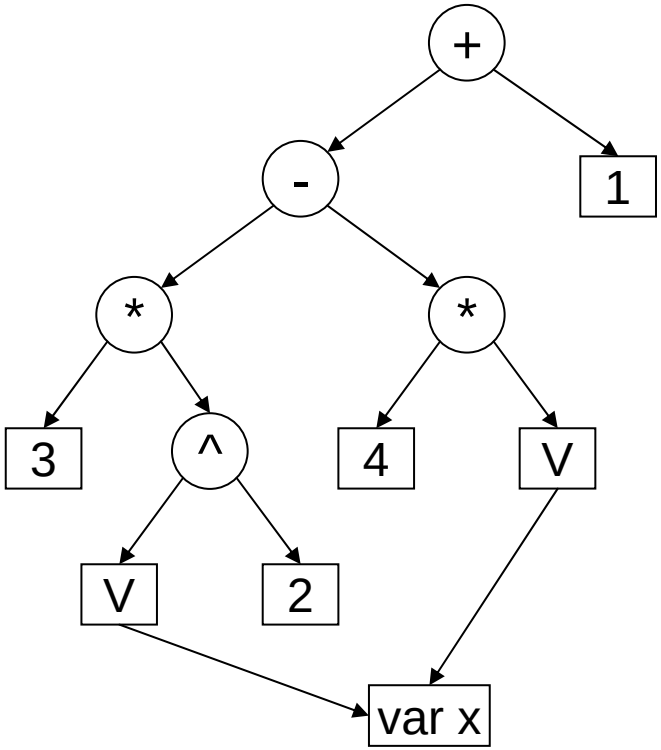
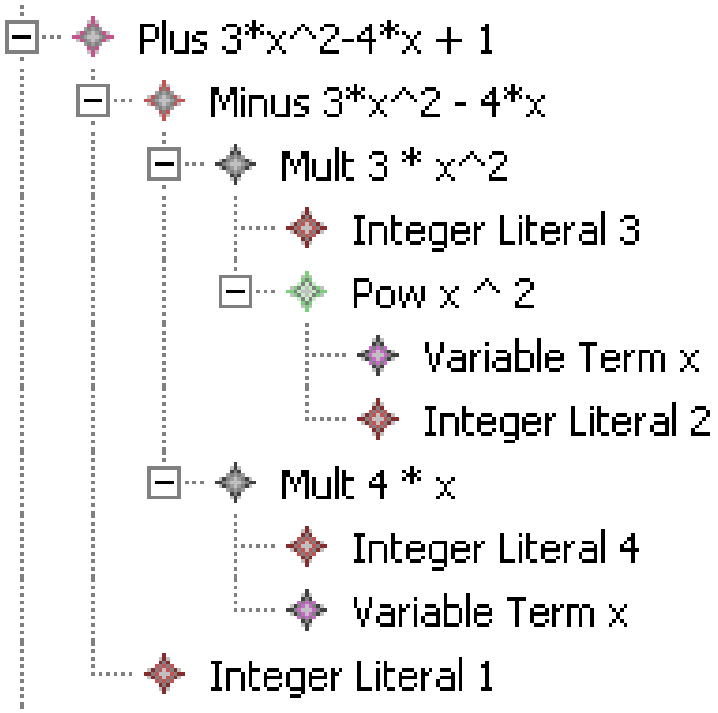
ARI Base Model

$$3x^2 - 4x + 1$$





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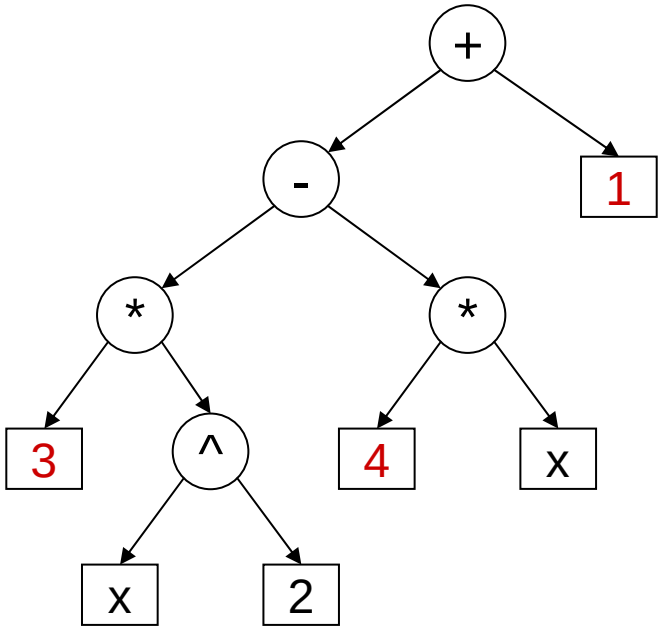
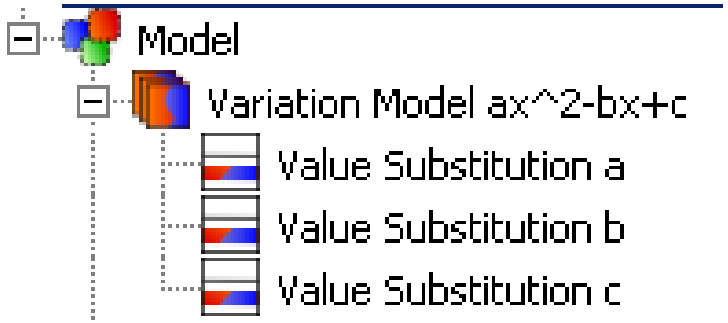
ARI Variation (1)

Variations on the coefficients

$$3x^2 - 4x + 1 \Rightarrow 3x^2 - 4x + 1$$



3 value substitutions



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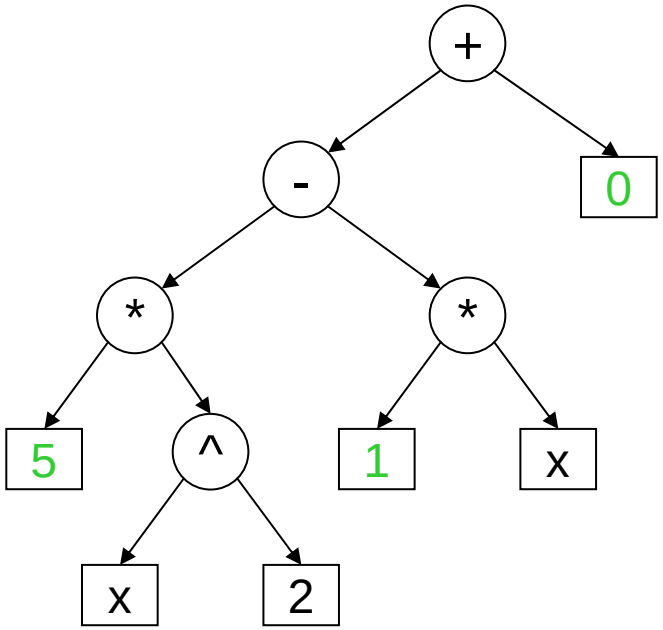
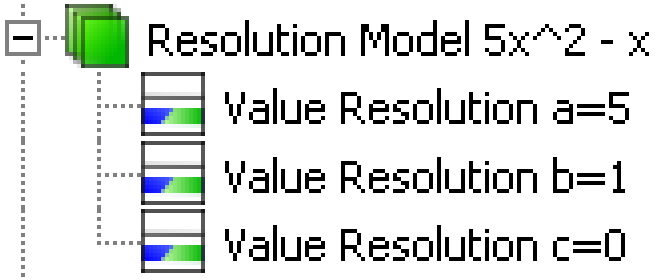
ARI Resolution (1)

Providing the new values

$$3x^2 - 4x + 1 \Rightarrow 5x^2 - 1x + 0$$



3 value resolutions



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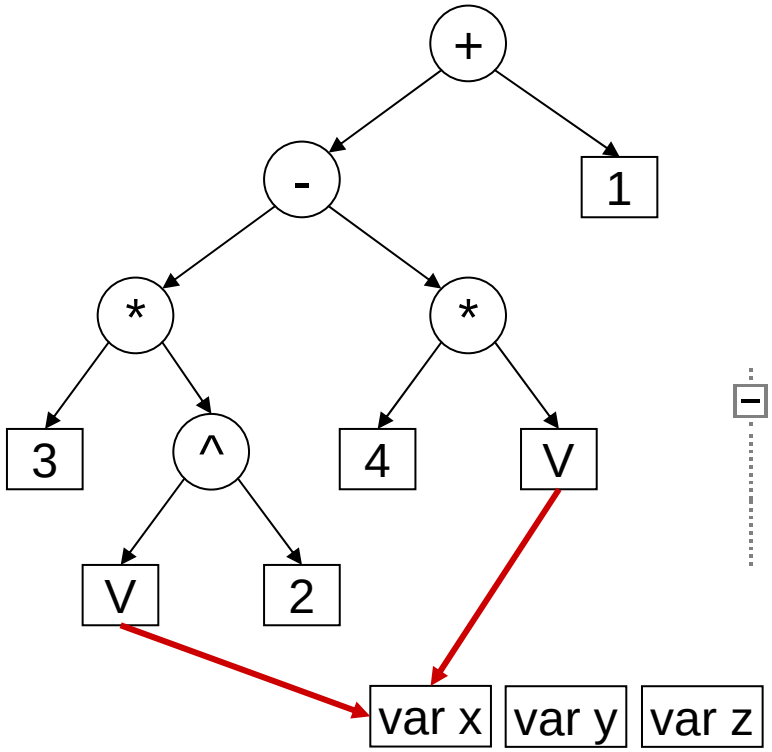
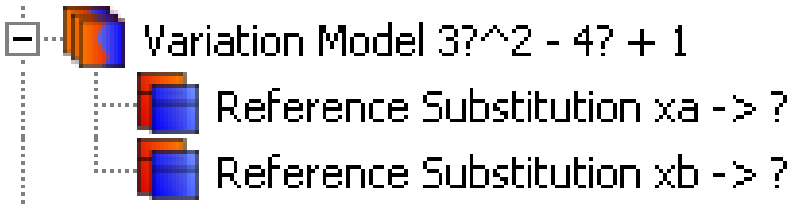
ARI Variation (2)

Variations on the variables

$$3x^2 - 4x + 1 \Rightarrow 3x^2 - 4x + 1$$



2 reference substitutions



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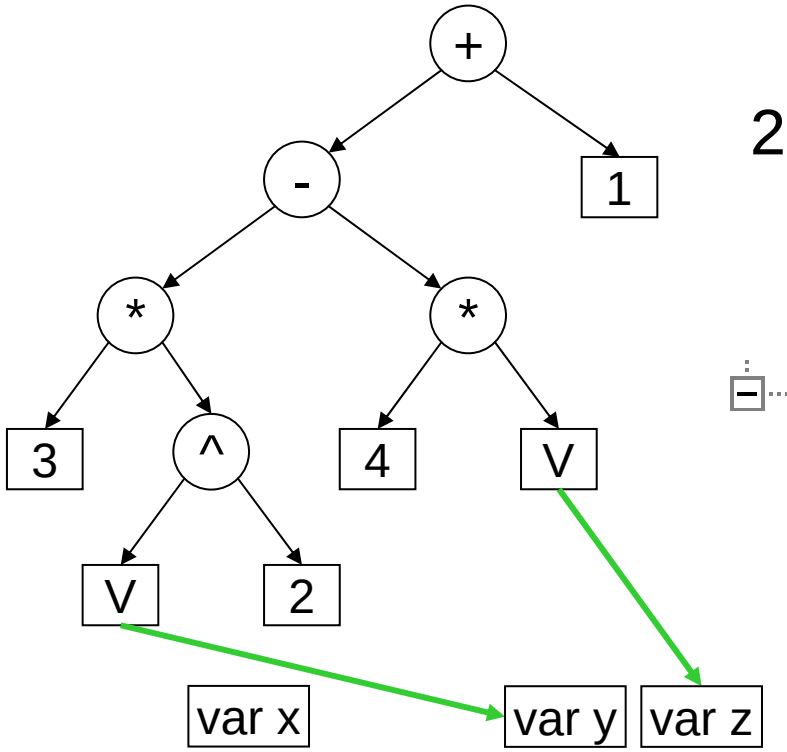
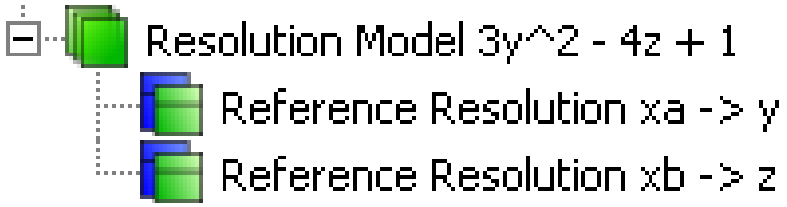
ARI Resolution (2)

Providing replacement variables

$$3x^2 - 4x + 1 \Rightarrow 3y^2 - 4z + 1$$



2 reference resolutions



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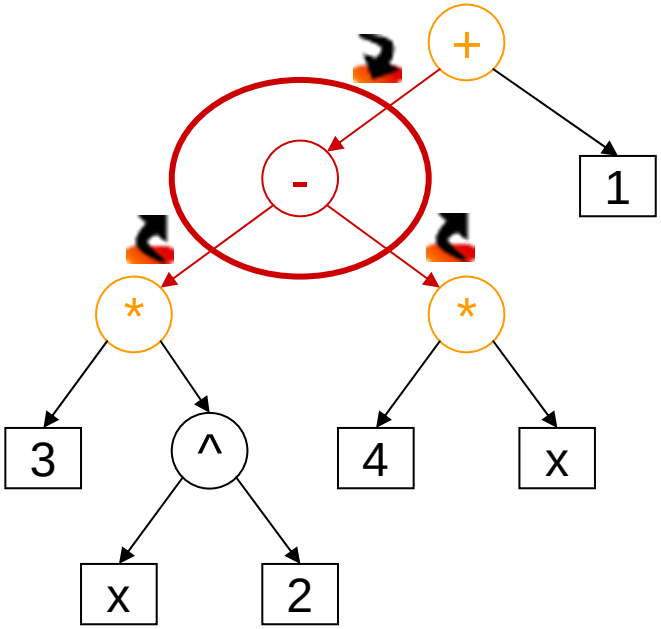
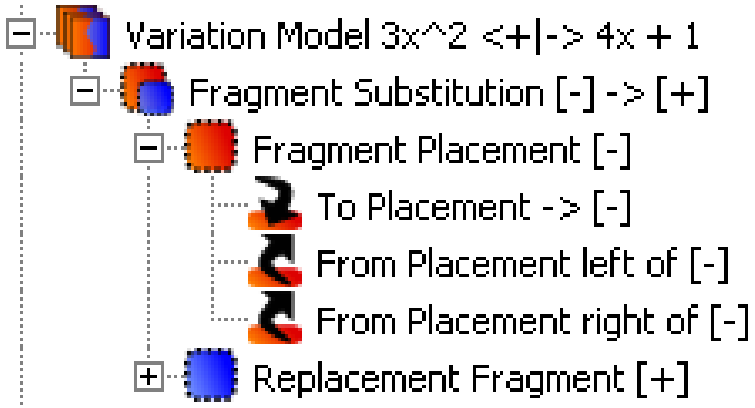
ARI Variation (3) 1/2

Variation on an operator

$$3x^2 - 4x + 1 \Rightarrow 3x^2 - 4x + 1$$



- 1 Fragment substitution
- 1 Placement Fragment
  - 2 From Placement BE
  - 1 To Placement BE



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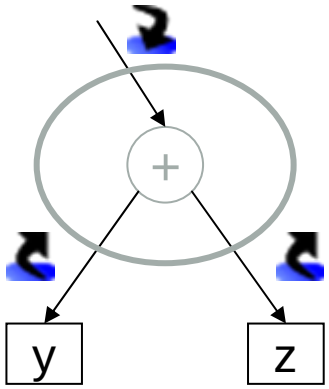
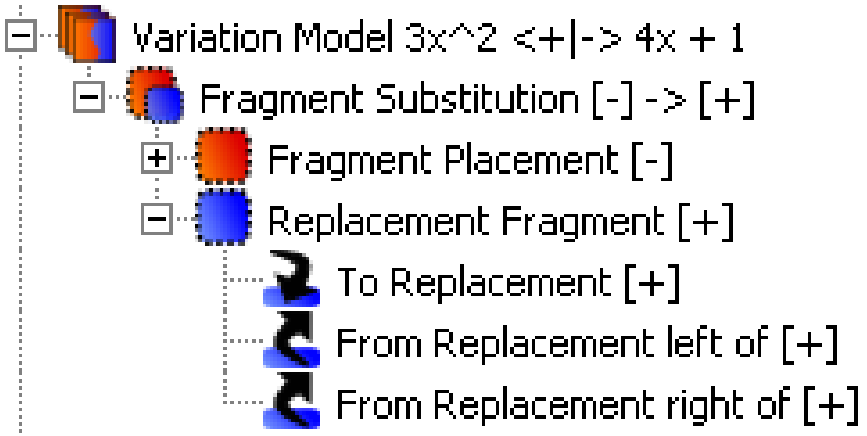
ARI Variation (3) 2/2

Replacement operator specification

x + y



- 1 Replacement Fragment
  - 2 From Placement BE
  - 1 To Placement BE



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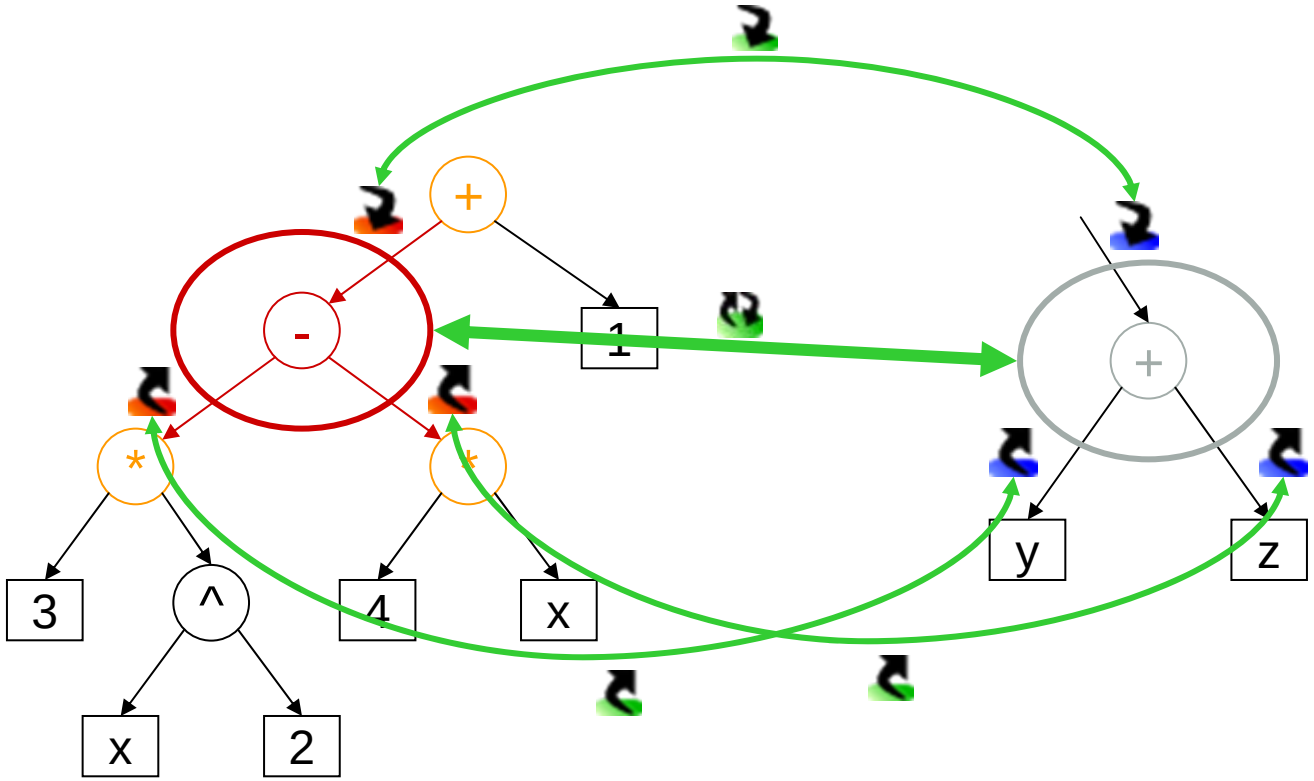
ARI Resolution (3) 1/2

Fragment binding

$3x^2 - 4x + 1$ $x + y$



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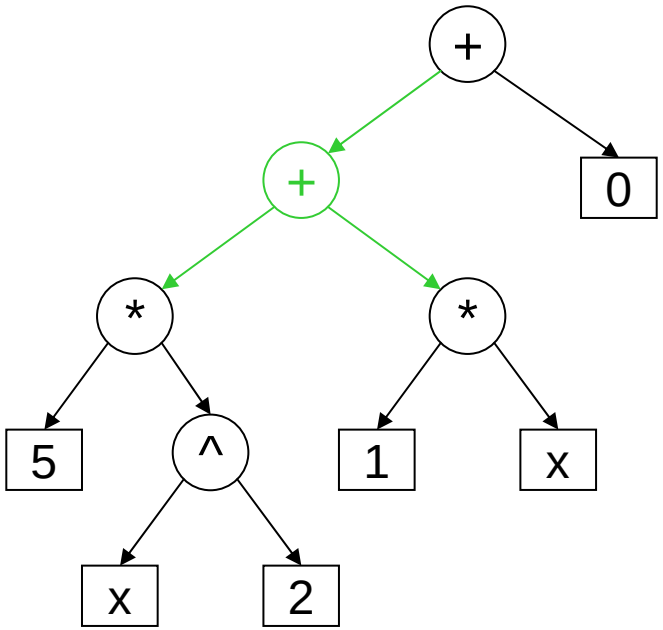
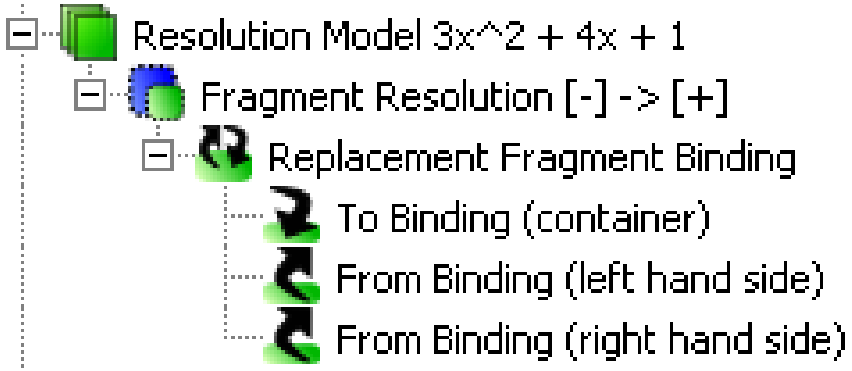
ARI Resolution (3) 2/2

Fragment substitution

$$3x^2 - 4x + 1 \Rightarrow 3x^2 + 4x + 1$$



- 1 Fragment resolution



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  - A simple example
- **Building generic tools**
- Demo
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Variability Tool /Editor

- Specify Variation Models
  - Model Fragments
  - Substitutions
  - Constraints
- Specify Resolution Models
  - Choices
  - Fragment Bindings
- Trigger Transformations

- Generic Tools – DSL independent
  - Transformations
  - Editors

Relations with DSL / DSL Tools

- Reuse exiting DSL tools
  - Keep base-model and variability model separated
  - Only references from the variability model to the base model
  - Generic transformations
- Concrete syntax
  - Generic variability editor
  - Integrate with exiting DSL editors
    - Object editors
    - Text editors
    - Graphical editors
  - Low requirements on the DSL editors
  - Customizable visualization of variability

Integration with DSL Editor

- Solution
  - A required interface for selection and highlighting
  - Many editors already include these functionalities
  - Supported by any editor (tree, text, graphical)
- Interaction with DSL editor
  - Provide object selection
    - Make references to objects
    - Create fragments / boundary elements
  - Provide object highlighting
    - Display referenced objects
    - Display fragments
    - Display substitutions

Eclipse Implementation

- Meta-model defined in EMF
  - EMF based variability editor
  - Integration with any EMF meta-model
- Editor interface for integration

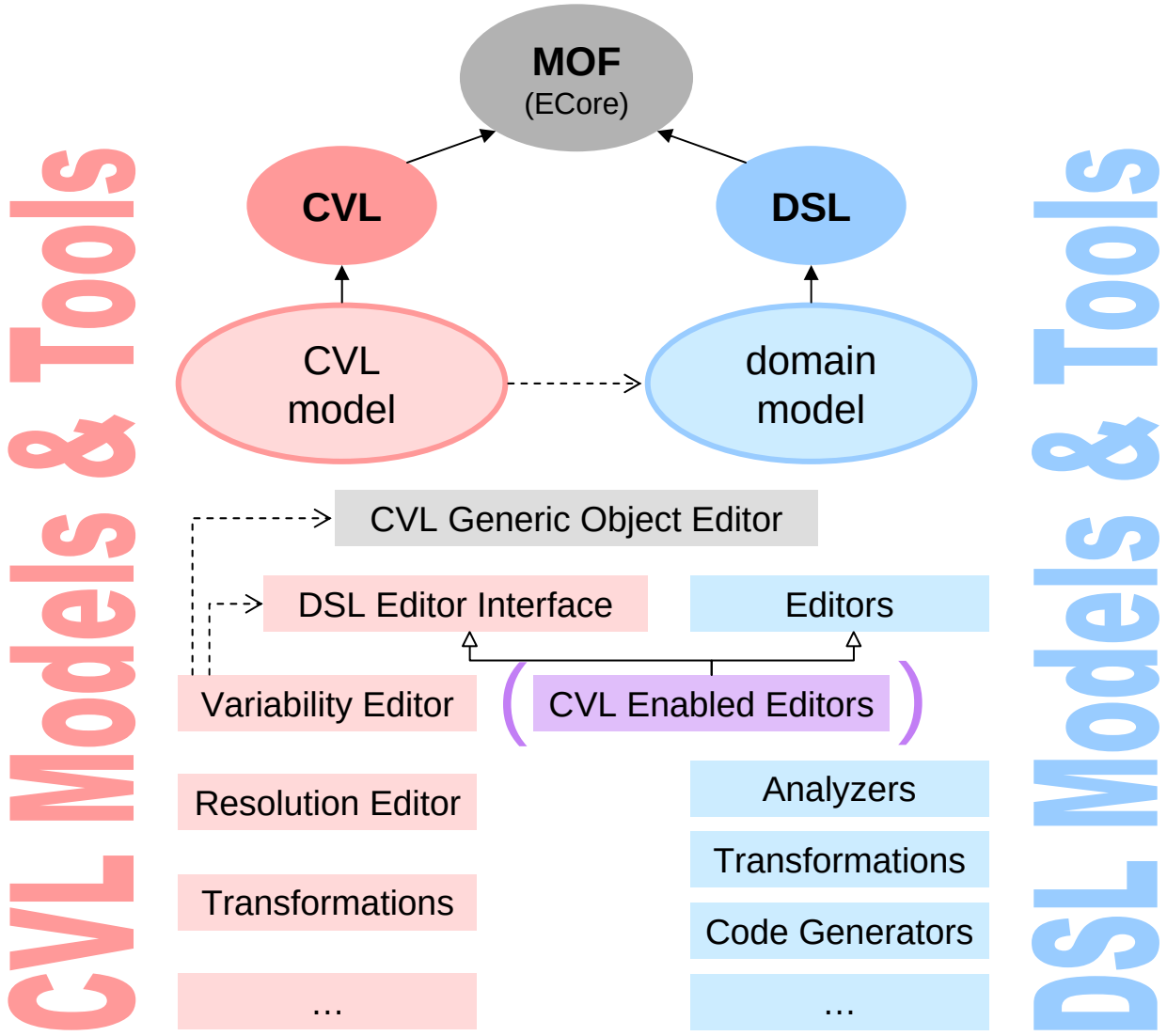
```
/**
 * Highlight in the editor the object identified by xmi_id with the color
 * corresponding to type.
 * The ID of object is provided by the static operation
 * ICVLEnabledEditor.IDProvider.getObjectId(EObject obj). Only this operation
 * should be used to compute the ID of EObjects.
 * @param xmi_id The ID of the object
 * @param type The type of highlighting to use
 */
public void highlightObject(String xmi_id, int type);

/**
 * Remove highlighting for all object in the editor
 */
public void clearHighlighting();

/**
 * Get the editor selection
 * @return The set of domain objects (instances of the DSL meta-model)
 * selected in the editor
 */
public ArrayList<Object> getSelectedObjects();

/**
 * Set the selection of the editor
 * @param objects The IDs of the set of domain object which should be selected
 */
public void selectObjects(ArrayList<String> objects);
```

Tool integration



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Tools integration

- 3 editors:
  - Generic EMF Tree editor
  - Train Control Language Editor (GMF)
  - Papyrus UML Editor (GEF)

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Discussion

- Low level variability meta-model
  - Graph based
  - Fully generic
- Not user-friendly to instantiate by hand
  - Creating fragments / boundary elements
- But, the tedious tasks can be automated with the integration with DSL editors
  - Choosing objects in the base model
  - Creating the fragment
  - Computing boundary elements
- Very low requirements on the DSL tools and editor
  - A simple interface to implement

Thank you for your attention !