Featuring Variability Modeling: Categorizing Expressiveness in Variability Modeling

Christian Kröher
University of Hildesheim, Institute of Computer Science
Marienburger Platz 22, D-31141 Hildesheim, Germany
kroehrer@sse.uni-hildesheim.de
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Problem Statement

- Variability modeling is a core activity of software product line engineering
- Many different approaches to variability modeling have been proposed

**P1:** No detailed justification on why to use a certain modeling concept

**P2:** No guidelines on when to use what kind of modeling concept

**P3:** No overview on dependencies between expressiveness and analyzability
**Contribution**

- Systematic categorization of variability modeling concepts
  - Describing dependencies among concepts
  - Describing the partial order of concepts
  - Covering a range of concepts
  - Providing support for concept selection

➤ **Categorization of existing concepts on a meta-language level**
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Current Work and Open Questions

1. Did we forget other important categories that make a difference?
2. Do more expressive categories exist?
3. How to categorize DSLs?

Expressiveness

Configuration References

Non-Boolean Variability Modeling

Cardinality-Based Variability Modeling

Basic (pure Boolean) Variability Modeling

Analyzability
Introduction  |  Categorization Approach  |  Discussion

**Scope (1/2)**

- We focus on …
  - Characterization of different categories of variability modeling concepts
    - Properties
    - Dependencies
  - Most basic variability modeling concepts
  - Expressiveness of variability modeling concepts
Scope (2/2)

• We exclude concepts, which are designed for …
  – realizing variability
  – mapping elements from configuration to implementation
  – supporting development in the large (modularization, composition, etc.)
• We exclude concepts, that …
  – are syntactic sugar
  – act as aliases for other concepts
  – can be expressed by combining multiple basic concepts
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Categorization Schema – An Overview

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- Expressiveness
- Configuration References
- Non-Boolean Variability Modeling
- Cardinality-Based Variability Modeling
- Basic (pure Boolean) Variability Modeling

<table>
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modeling concepts
Expressiveness – Modeling Concepts

- **Purpose:** definition of the configuration space
- What type of configurable elements are available?
  - Pure Boolean elements
  - Non-Boolean elements, etc.
- What do these elements represent?
  - Single configuration options
  - Multiple selection, etc.
Expressiveness – Constraints

- **Purpose:**
  - Restriction of the configuration space
  - Guarantying the configuration of only valid product configurations
- **What type of operators are available?**
  - Boolean operators
  - Relational operators, etc.
- **What type of constraints can be defined?**
  - Constraints on configurable elements
  - Constraints on, e.g., cardinalities, etc.
Analyzability

- **Purpose**: model and configuration checking
- How complex are problems represented by a model of a specific category?
  - NP-complete
  - Undecidable, etc.
- What type of analysis operations are available?
  - Validity checking
  - Error detection, etc.
- Is tool-support available?
  - SAT-solvers
  - CSP-solvers, etc.
Did we forget other important categories that make a difference?

- For example:
  - Are configuration references really the next level of expressiveness?
  - Is there another category of concepts that is …
    - More expressive than non-Boolean variability modeling
    - Less expressive than configuration references
Do more expressive categories exist / How to categories DSLs?

- For example:
  - Configuration references + $?_1 = ?_2$
    - $?_1$ – What modeling concepts could be added / are still missing?
    - $?_2$ – What kind of category would this be?
  - Are DSLs another category of variability modeling concepts?
    - $?_2$ – Are DSLs more expressive than the categories presented?
    - $?_1$ – What modeling concepts do DSLs provide?
Current Work and Open Questions

1. Did we forget other important categories that make a difference?

2. Do more expressive categories exist?

3. How to categories DSLs?

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