

Visual Modeling of Product Line Variability on basis of Aspect- Oriented Modeling

Reinhard Stoiber, Silvio Meier, Martin Glinz

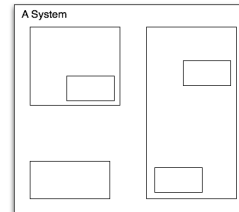
REV'07



University of Zurich
Department of Informatics

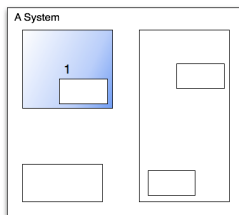
Modeling a Software System (1)

- Concerns



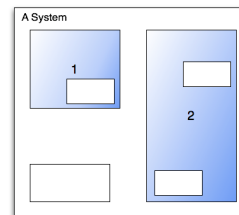
Modeling a Software System (2)

- Concerns
 - 1. Core concern



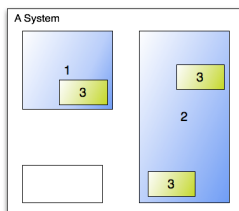
Modeling a Software System (3)

- Concerns
 - 1. Core concern
 - 2. Core concern



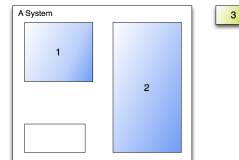
Modeling a Software System (4)

- Concerns
 - 1. Core concern
 - 2. Core concern
 - 3. Cross-cutting concern
 - Multiple distributed occurrences
 - A source of problems.

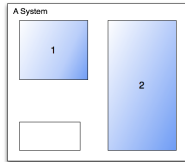


Aspect-Oriented Modeling (1)

- Separation of cross-cutting concerns

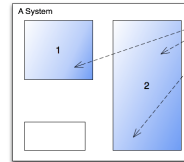


Aspect-Oriented Modeling (2)



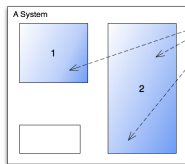
- Separation of cross-cutting concerns
- “3” is now an Aspect

Aspect-Oriented Modeling (3)



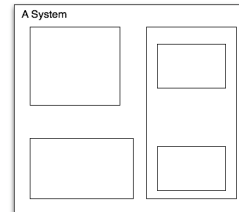
- Separation of cross-cutting concerns
- “3” is now an Aspect
- Indication where to apply
 - Join relationships

Aspect-Oriented Modeling (4)



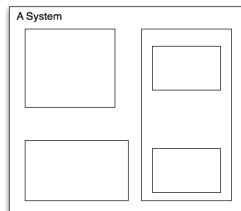
- Separation of cross-cutting concerns
- “3” is now an Aspect
- Indication where to apply
 - Join relationships
- This is an orthogonal concept.

Product Line Domain Modeling (1)



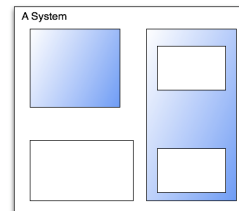
- Customizeable Systems

Product Line Domain Modeling (2)



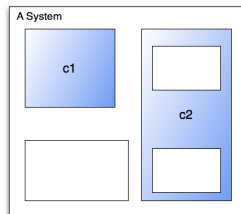
- Customizeable Systems
- Concerns
 -
 -
 -
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 -

Product Line Domain Modeling (3)



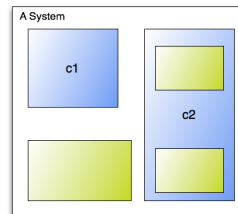
- Customizeable Systems
- Concerns
 - Commonality
 - Commonality
 -
 -
 -

Product Line Domain Modeling (4)



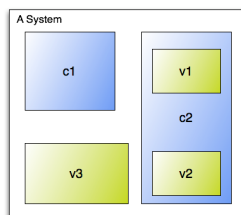
- Customizeable Systems
- Concerns
 - Commonality 1
 - Commonality 2
 -
 -
 -

Product Line Domain Modeling (5)



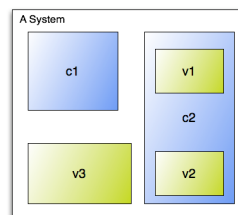
- Customizeable Systems
- Concerns
 - Commonality 1
 - Commonality 2
 - Variability
 - Variability
 - Variability

Product Line Domain Modeling (6)



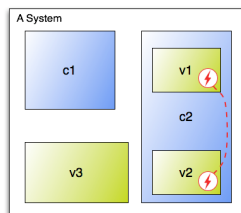
- Customizeable Systems
- Concerns
 - Commonality 1
 - Commonality 2
 - Variability 1
 - Variability 2
 - Variability 3

Product Line Domain Modeling (7)



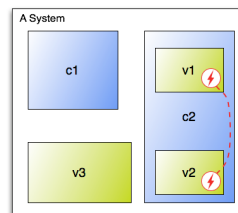
- Customizeable Systems
 - Concerns
 - Commonality 1
 - Commonality 2
 - Variability 1
 - Variability 2
 - Variability 3
- } Alternatives
→ Optionality

Product Line Domain Modeling (8)



- Customizeable Systems
 - Concerns
 - Commonality 1
 - Commonality 2
 - Variability 1
 - Variability 2
 - Variability 3
- } Alternatives
→ Optionality

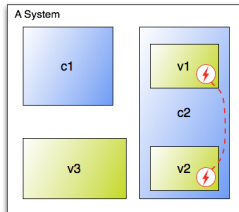
Product Line Domain Modeling (9)



- Customizeable Systems
 - Concerns
 - Commonality 1
 - Commonality 2
 - Variability 1
 - Variability 2
 - Variability 3
- } Alternatives
→ Optionality
- The System is not valid.

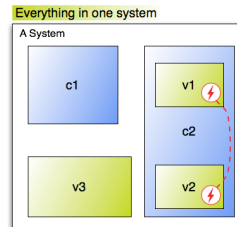
Product Line Domain Modeling (10)

- Solutions?



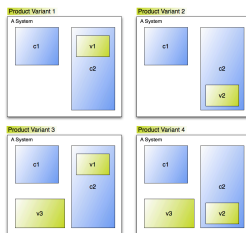
Product Line Domain Modeling (11)

- Solutions?
- 1. A single model
 - Inaccuracy
 - Errors



Product Line Domain Modeling (12)

- Solutions?
- 1. A single model
 - Inaccuracy
 - Errors
- 2. Models of all product variants
 - Valid models
 - Redundancy / Inefficiency
 - Potential Inconsistency



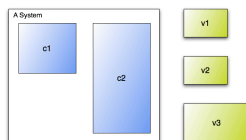
Product Line Domain Modeling (13)

- Solutions?
- 1. A single model
 - Inaccuracy
 - Errors
- 2. Models of all product variants
 - Valid models
 - Redundancy / Inefficiency
 - Potential Inconsistency
- 3. Separation of variability



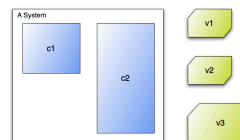
Product Line Domain Modeling (14)

- 3. (continued)
- Orthogonal Concept

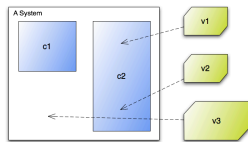


Product Line Domain Modeling (15)

- 3. (continued)
- Orthogonal Concept
- Variabilities as Aspects

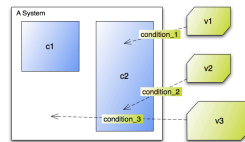


Product Line Domain Modeling (16)



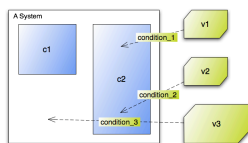
- 3. (continued)
- Orthogonal Concept
- Variabilities as Aspects
- Join Relationships

Product Line Domain Modeling (17)



- 3. (continued)
- Orthogonal Concept
- Variabilities as Aspects
- Join Relationships
- Join Conditions

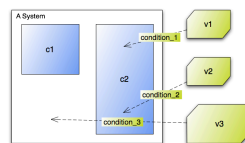
Product Line Domain Modeling (18)



- 3. (continued)
- Orthogonal Concept
- Variabilities as Aspects
- Join Relationships
- Join Conditions
- Decision model

Name	Relevance	Description	Range	Multiplicity	Constraints	Binding Time

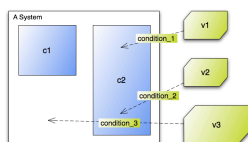
Product Line Domain Modeling (19)



- 3. (continued)
- Orthogonal Concept
- Variabilities as Aspects
- Join Relationships
- Join Conditions
- Decision model

Name	Relevance	Description	Range	Multiplicity	Constraints	Binding Time
condition_1		Is v1 in the product?	true, false	1	alternative to condition_2	installation
condition_2		Is v2 in the product?	true, false	1	alternative to condition_1	installation
condition_3		Additional v3 functionality.	true, false	1		installation

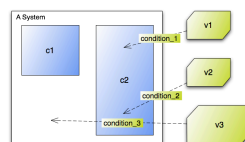
Product Line Domain Modeling (20)



- 3. (continued)
- Orthogonal Concept
- Variabilities as Aspects
- Join Relationships
- Join Conditions
- Decision model

Name	Relevance	Description	Range	Multiplicity	Constraints	Binding Time
condition_1		Is v1 in the product?	true, false	1	alternative to condition_2	installation
condition_2		Is v2 in the product?	true, false	1	alternative to condition_1	installation
condition_3		Additional v3 functionality.	true, false	1		installation

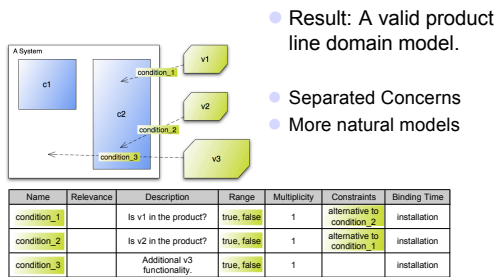
Product Line Domain Modeling by Aspect-Orientation (1)



- Result: A valid product line domain model.

Name	Relevance	Description	Range	Multiplicity	Constraints	Binding Time
condition_1		Is v1 in the product?	true, false	1	alternative to condition_2	installation
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Product Line Domain Modeling by Aspect-Orientation (2)



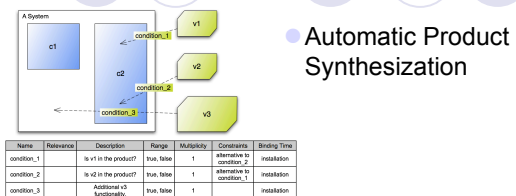
- Result: A valid product line domain model.
- Separated Concerns
- More natural models

- Example.

Achievements (1)

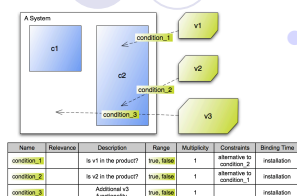
- Automatic Product Synthesis

Achievements (2)



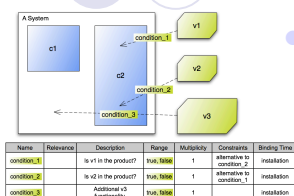
- Automatic Product Synthesis

Achievements (3)



- Automatic Product Synthesis

Achievements (4)

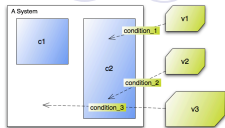


- Automatic Product Synthesis

Decision Making:

condition_1 = true
condition_2 = false
condition_3 = true

Achievements (5)



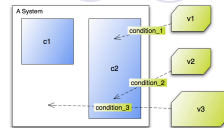
- Automatic Product Synthesis

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Decision Making:

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Achievements (6)



- Automatic Product Synthesis

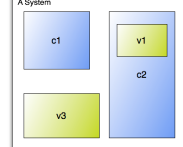
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Decision Making:

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condition_2 = false
condition_3 = true

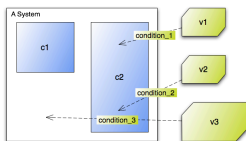


Automatically synthesized Product



Achievements (7)

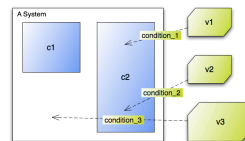
- Accuracy



Name	Relevance	Description	Range	Multiplicity	Constraints	Binding Time
condition_1		Is v1 in the product?	true, false	1	alternative to condition_2	installation
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Achievements (8)

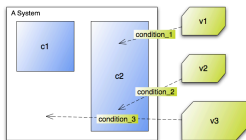
- Accuracy
- Correctness



Name	Relevance	Description	Range	Multiplicity	Constraints	Binding Time
condition_1		Is v1 in the product?	true, false	1	alternative to condition_2	installation
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condition_3		Additional v3 functionality.	true, false	1		installation

Achievements (9)

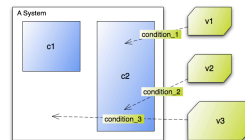
- Accuracy
- Correctness
- Efficiency



Name	Relevance	Description	Range	Multiplicity	Constraints	Binding Time
condition_1		Is v1 in the product?	true, false	1	alternative to condition_2	installation
condition_2		Is v2 in the product?	true, false	1	alternative to condition_1	installation
condition_3		Additional v3 functionality.	true, false	1		installation

Achievements (10)

- Accuracy
- Correctness
- Efficiency
- and Consistency.



Name	Relevance	Description	Range	Multiplicity	Constraints	Binding Time
condition_1		Is v1 in the product?	true, false	1	alternative to condition_2	installation
condition_2		Is v2 in the product?	true, false	1	alternative to condition_1	installation
condition_3		Additional v3 functionality.	true, false	1		installation

Applications

- Requirements Engineers
 - Domains of PLs
 - Negotiation of Requirements
 - Synthesization of Products
 - Aid for RE between
 - Req. Engineers
 - Customers

Discussion and further Research

- ADORA
 - Advanced visualization and rich models
- Current State
 - Aspect-Orientation: Implemented
 - Variability: "Proof of Concept" phase
 - By now weaving based on scenarios
- Future
 - Better decision model integration
 - Extension of variability modeling to other concepts
 - Validation and verification, etc.