33. Macromodel Single Underlying Model (SUM)
with Orthographic Software Modeling (OSM) - A 1-TS-Megamodel with Total Consistency

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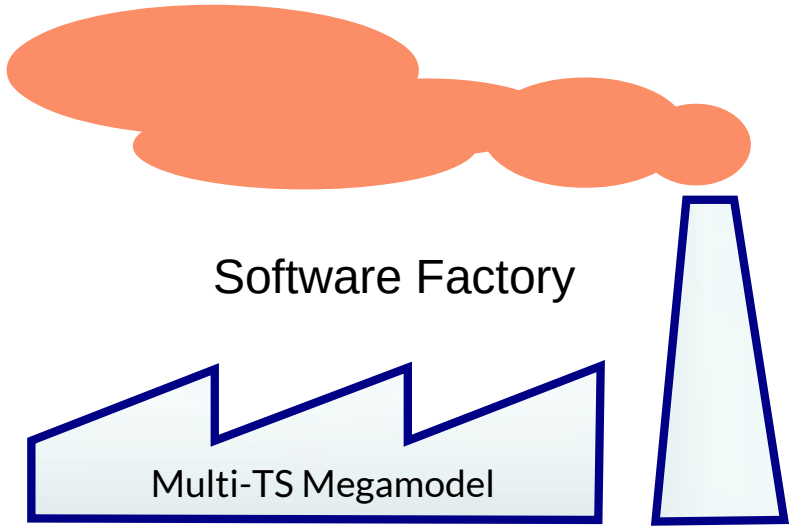
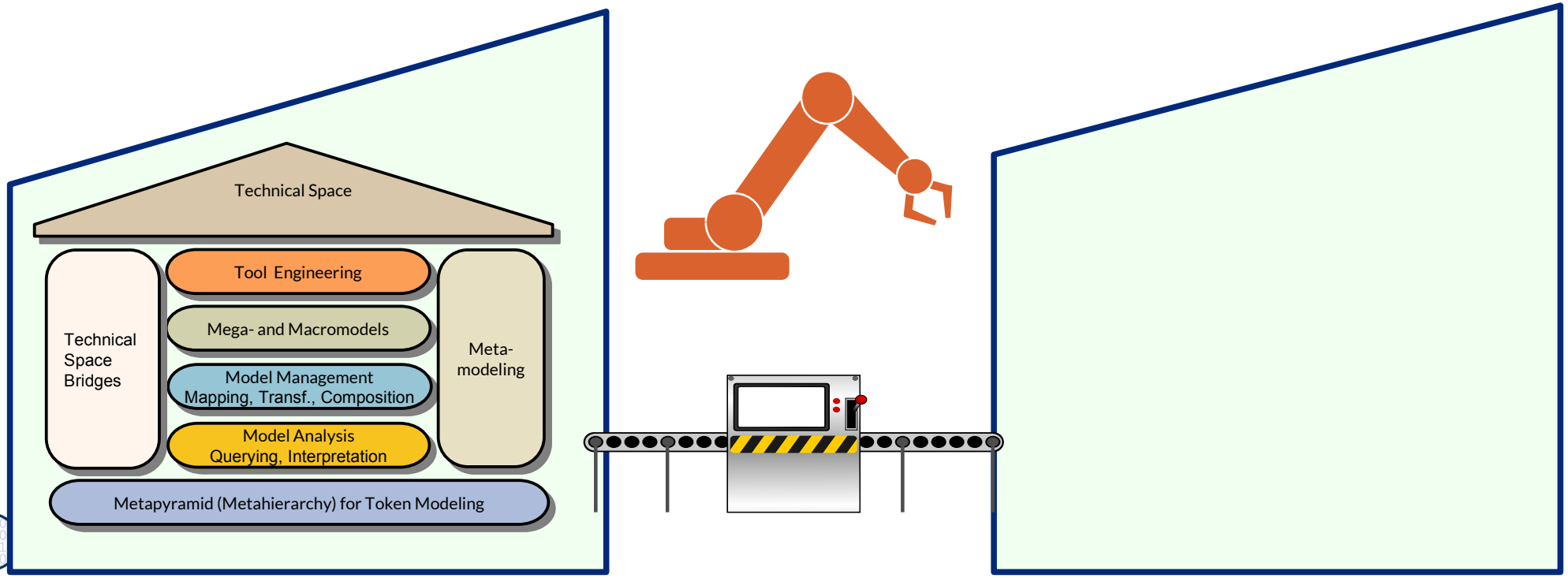
Software Factories with Only 1 Technical Space

In this chapter:
1-TS Megamodel
SUM





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- J. Nathan Foster and Michael B. Greenwald and Jonathan T. Moore and Benjamin C. Pierce and Alan Schmitt. Combinators for Bi-Directional Tree Transformations: A Linguistic Approach to the View Update Problem, ACM Transactions on Programming Languages and Systems, Vol 29(3), pp. 17, 2007
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Overview Table for Link-Tree Macromodels

The Link-Treeware TS is well apt for macromodel construction in a software factory

- A tree node abstracts a subtree (representant)
  - Attributes and attributions are *composable partial mappings* from treenodes
- RAGs are useful for all kinds of structure- and function-modeling in Link-Tree Macromodels, because they abbreviate dependencies in several models with cross-model relations.
  - In a macromodel under an artificial root (rooted macromodel), attributions can work on the SUM to ensure the constraints
- Relational RAGs (RelRAGs) are useful, because they have bidirectional constraints

	(Plain) MDA	General SUM	Skeleton SUM (partial function extension)
RAGs in Repositories	Markings		Repository-SUM: get/put as higher-order attributions of link trees
			• Javadoc-SUM
RAGs in Data-flow architectures	Needs trace models	get/put as model transformations (lenses)	Flow-SUM: Communicating link trees; In-place transformations of SUM
			• Google Docs, Stream-Based MDA

Synchronization of Projective Views on a Single Underlying Model (A Orthographic Macromodel)

Many slides are courtesy to:
Christian Vjekoslav Tunjic,
Prof. Colin Atkinson

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Presented at: VAO 2015

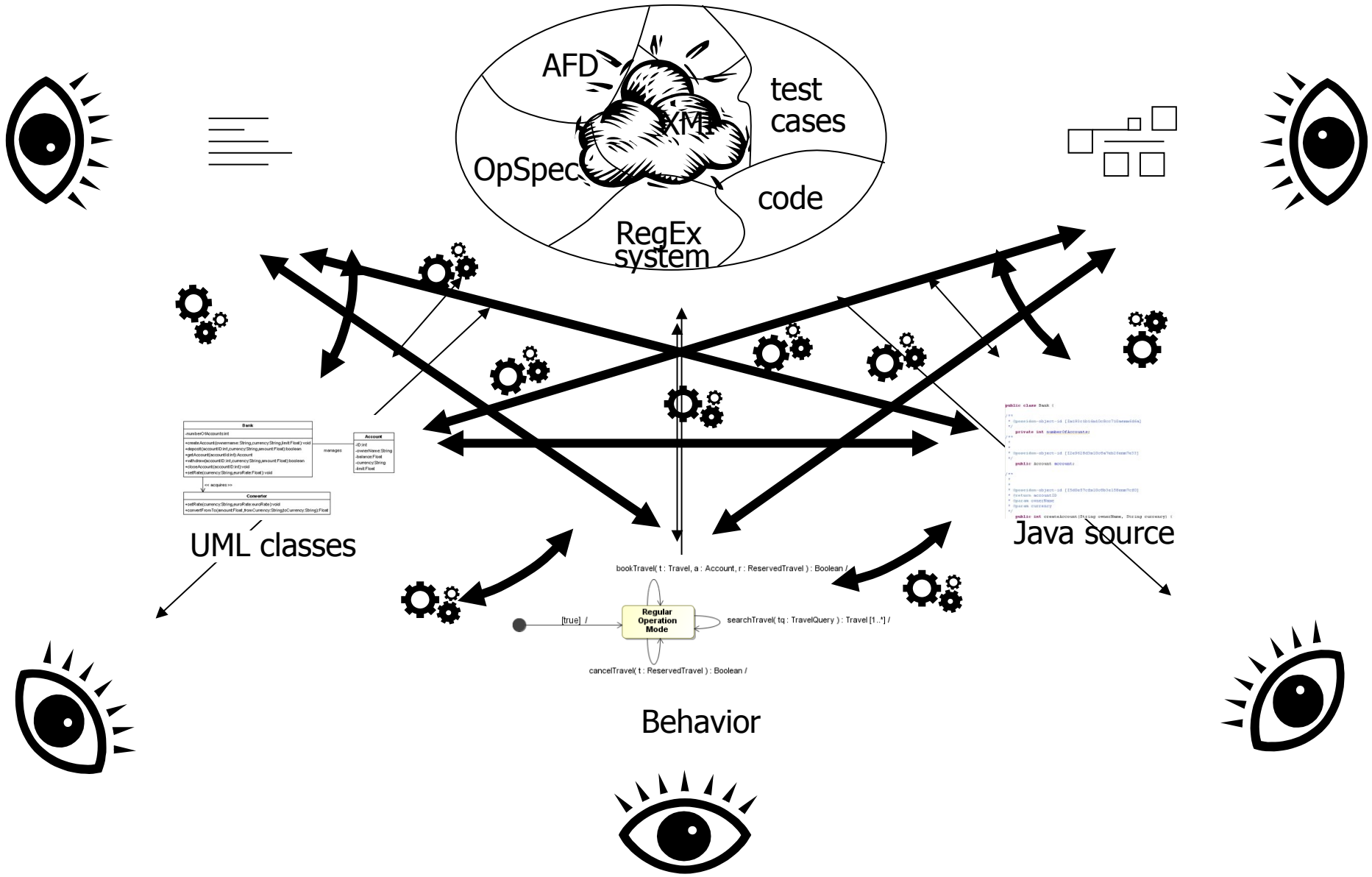
L'Aquila. Italy
21 July, 2015

UNIVERSITÄT MANNHEIM

33.1. The Macromodel “Single-Underlying Model (SUM)”

- is based on a ***repository (repository-based SUM)*** [Atkinson19]

Traditional View-based Software Engineering (VOSE)



On-Demand View Generation in a SUM (Flat Contexts Correspond to Colors or Tags)

The SUM, if editable, provide a single-source view

Single Underlying Model (SUM) (all views merged)

Context 1

View 1

Requirements texts

View 5

Deployment diagrams

Context 5

View 2

UML classes

View 3

Behavior

View 4

Java source

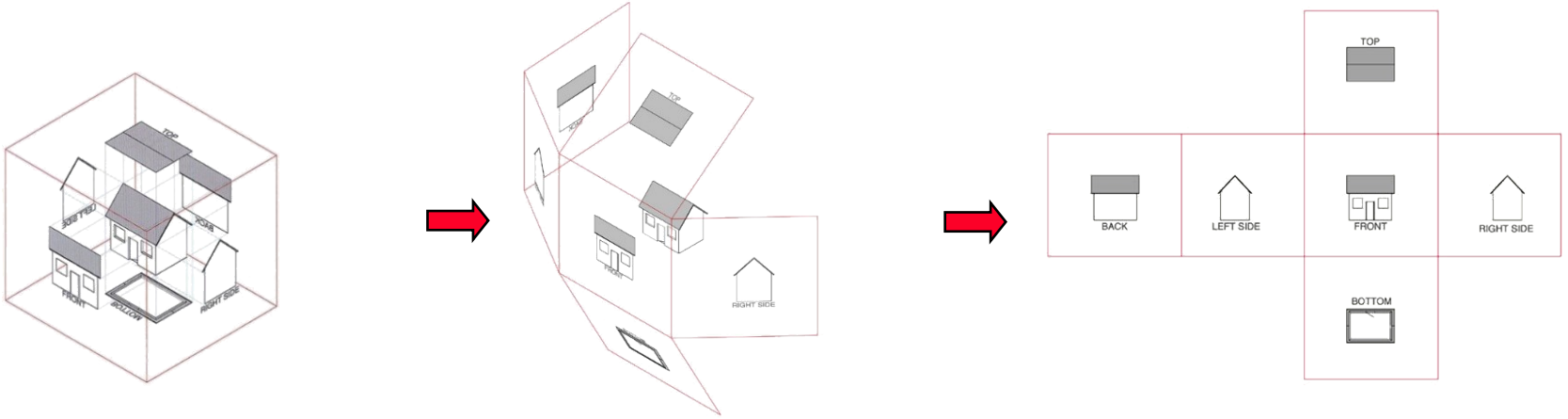
Context 2

Context 3

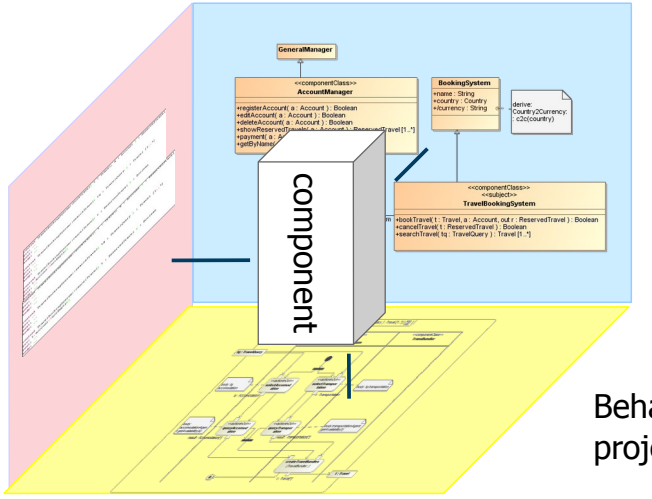
Context 4

Orthographic Software Modeling (OSM) as a SUM

- Many engineering disciplines have a long and successful tradition of technical drawing - orthographic projection



- so why don't we do this in software engineering?

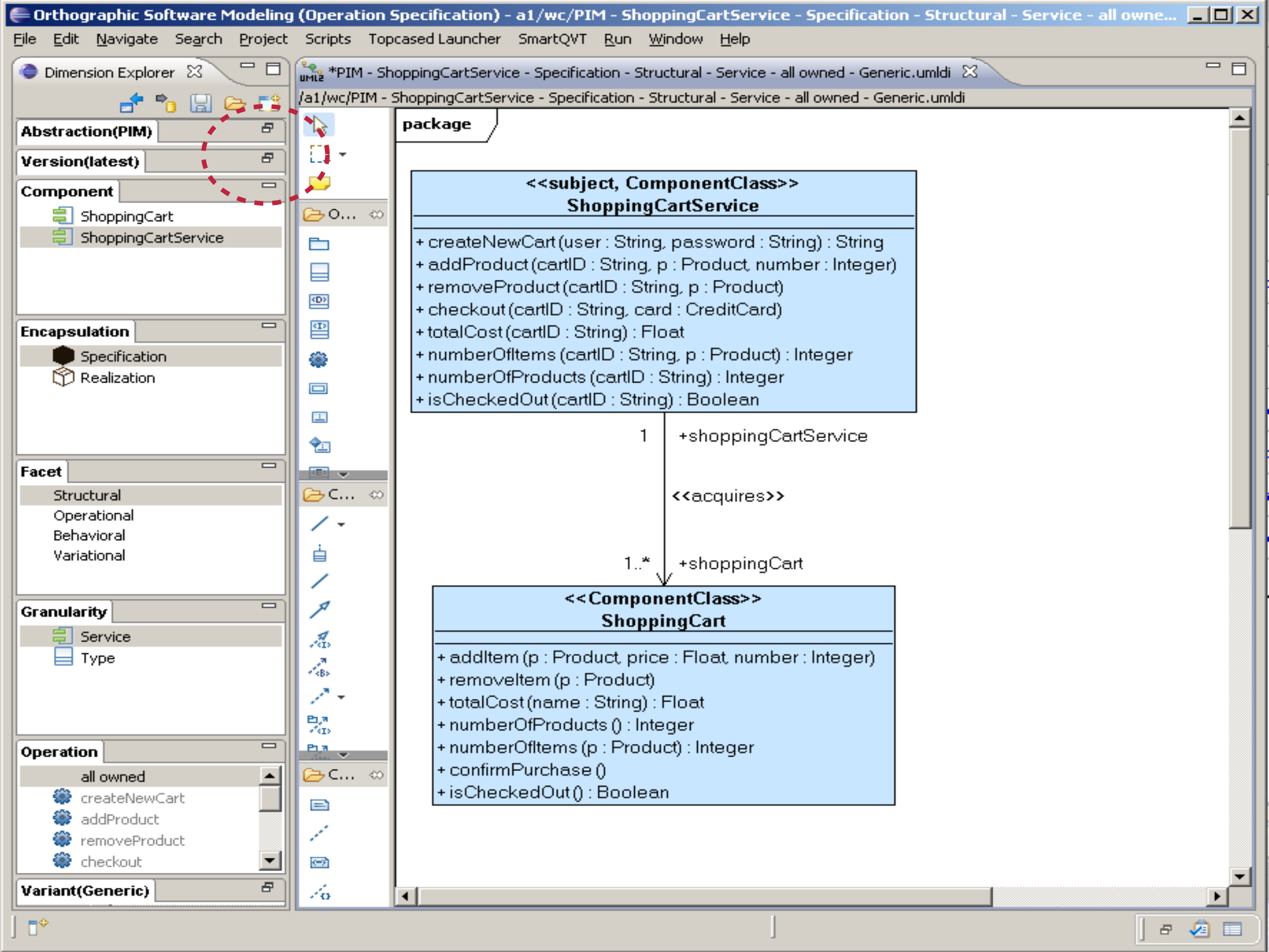


Structural projection

Operational projection

Behavioral projection

- On demand view generation (projective views)
- Dimension-based navigation
- View-based methodology
- Arrangement in a multidimentional SUM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Version(latest)
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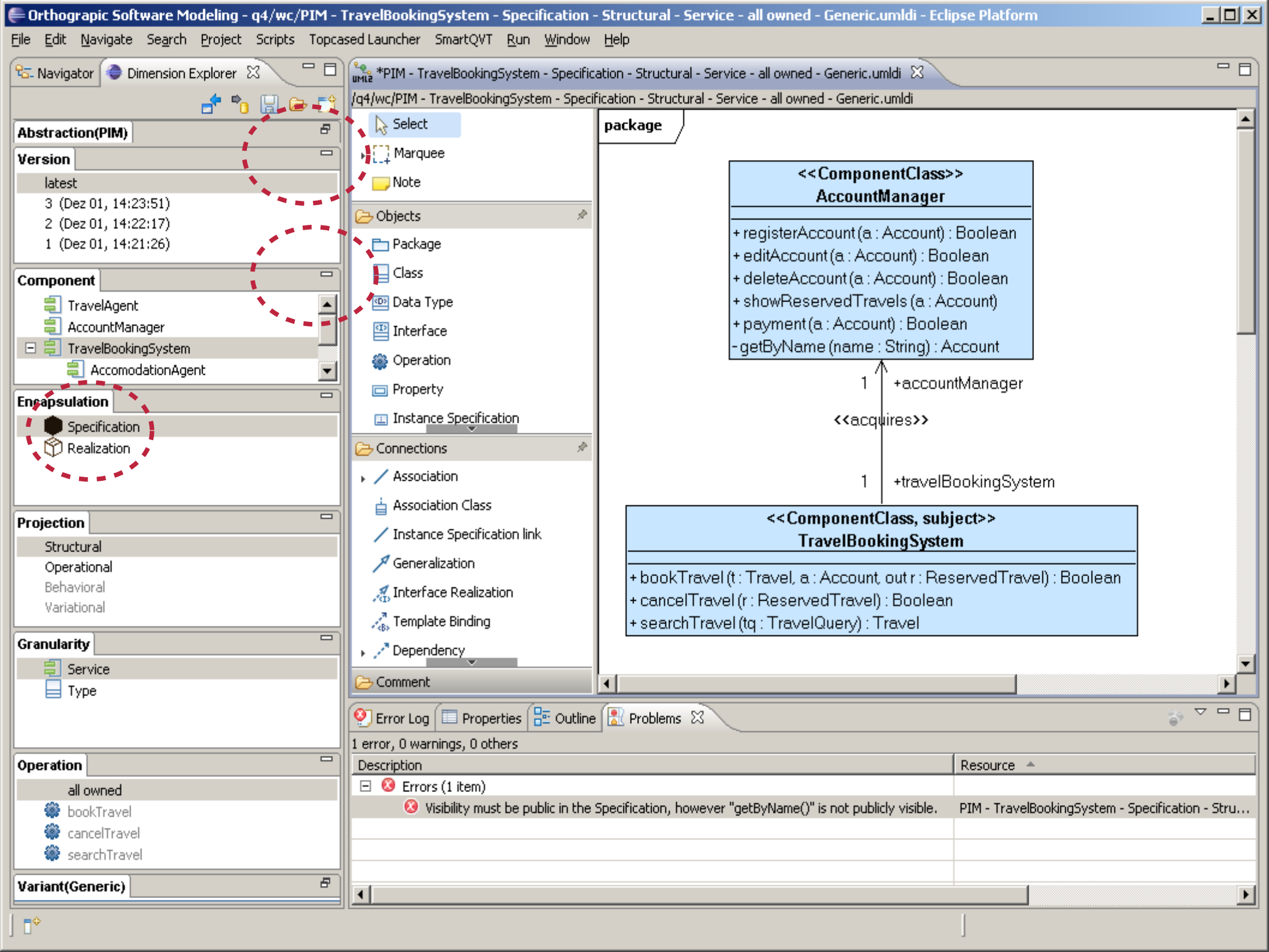
ShoppingCart
ShoppingCartService
Encapsulation
Specification
Realization
Facet
Structural
Operational
Behavioral
Variational
Granularity
Service
Type
Operation
all owned
createNewCart
addProduct
removeProduct
checkout
Variant(Generic)
*PIM - ShoppingCartService - Specification - Structural - Service - all owned - Generic.umldi
/a1/wc/PIM - ShoppingCartService - Specification - Structural - Service - all owned - Generic.umldi
package
<<subject, ComponentClass>>
ShoppingCartService
+ createNewCart (user : String, password : String) : String
+ addProduct (cartID : String, p : Product, number : Integer)
+ removeProduct (cartID : String, p : Product)
+ checkout (cartID : String, card : CreditCard)
+ totalCost (cartID : String) : Float
+ numberOfItems (cartID : String, p : Product) : Integer
+ numberOfProducts (cartID : String) : Integer
+ isCheckedOut (cartID : String) : Boolean
1
+shoppingCartService
<<acquires>>
1..*
+shoppingCart
<<ComponentClass>>
ShoppingCart
+ addItem (p : Product, price : Float, number : Integer)
+ removeItem (p : Product)
+ totalCost (name : String) : Float
+ numberOfProducts () : Integer
+ numberOfItems (p : Product) : Integer
+ confirmPurchase ()
+ isCheckedOut () : Boolean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Abstraction(PIM)
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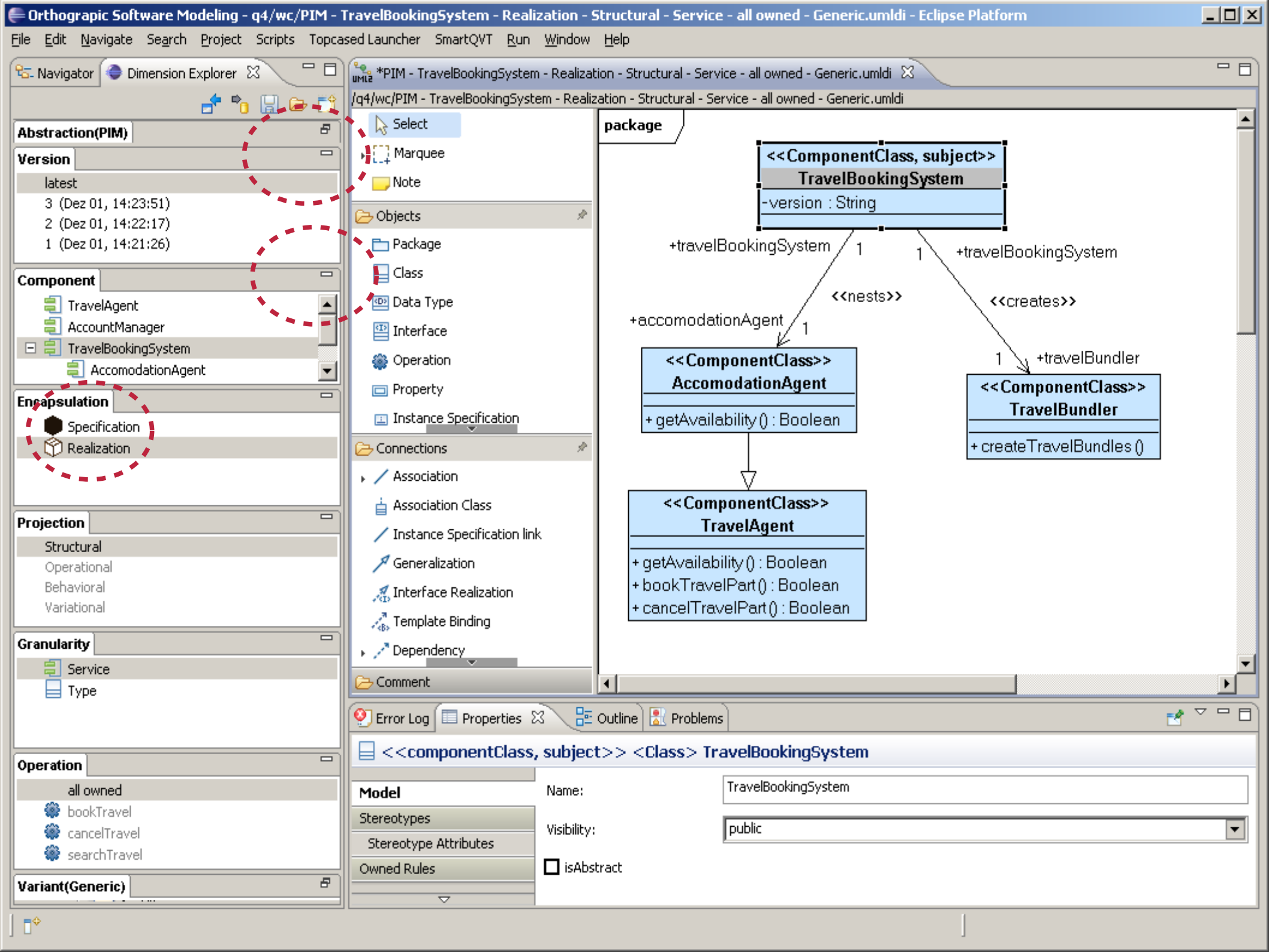
latest
3 (Dez 01, 14:23:51)
2 (Dez 01, 14:22:17)
1 (Dez 01, 14:21:26)
Component
TravelAgent
AccountManager
TravelBookingSystem
AccomodationAgent
Encapsulation
Specification
Realization
Projection
Structural
Operational
Behavioral
Variational
Granularity
Service
Type
Operation
all owned
bookTravel
cancelTravel
searchTravel
Variant(Generic)
*PIM - TravelBookingSystem - Specification - Structural - Service - all owned - Generic.umldi
/q4/wc/PIM - TravelBookingSystem - Specification - Structural - Service - all owned - Generic.umldi
Select
Marquee
Note
Objects
Package
Class
Data Type
Interface
Operation
Property
Instance Specification
Connections
Association
Association Class
Instance Specification link
Generalization
Interface Realization
Template Binding
Dependency
Comment
package
<<ComponentClass>>
AccountManager
+ registerAccount (a : Account) : Boolean
+ editAccount (a : Account) : Boolean
+ deleteAccount (a : Account) : Boolean
+ showReservedTravels (a : Account)
+ payment (a : Account) : Boolean
- getByName (name : String) : Account
1
+accountManager
<<acquires>>
1
+travelBookingSystem
<<ComponentClass, subject>>
TravelBookingSystem
+ bookTravel (t : Travel, a : Account, out r : ReservedTravel) : Boolean
+ cancelTravel (r : ReservedTravel) : Boolean
+ searchTravel (tq : TravelQuery) : Travel
Error Log
Properties
Outline
Problems
1 error, 0 warnings, 0 others
Description
Resource
Errors (1 item)
Visibility must be public in the Specification, however "getByName()" is not publicly visible.
PIM - TravelBookingSystem - Specification - Stru...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Type
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searchTravel
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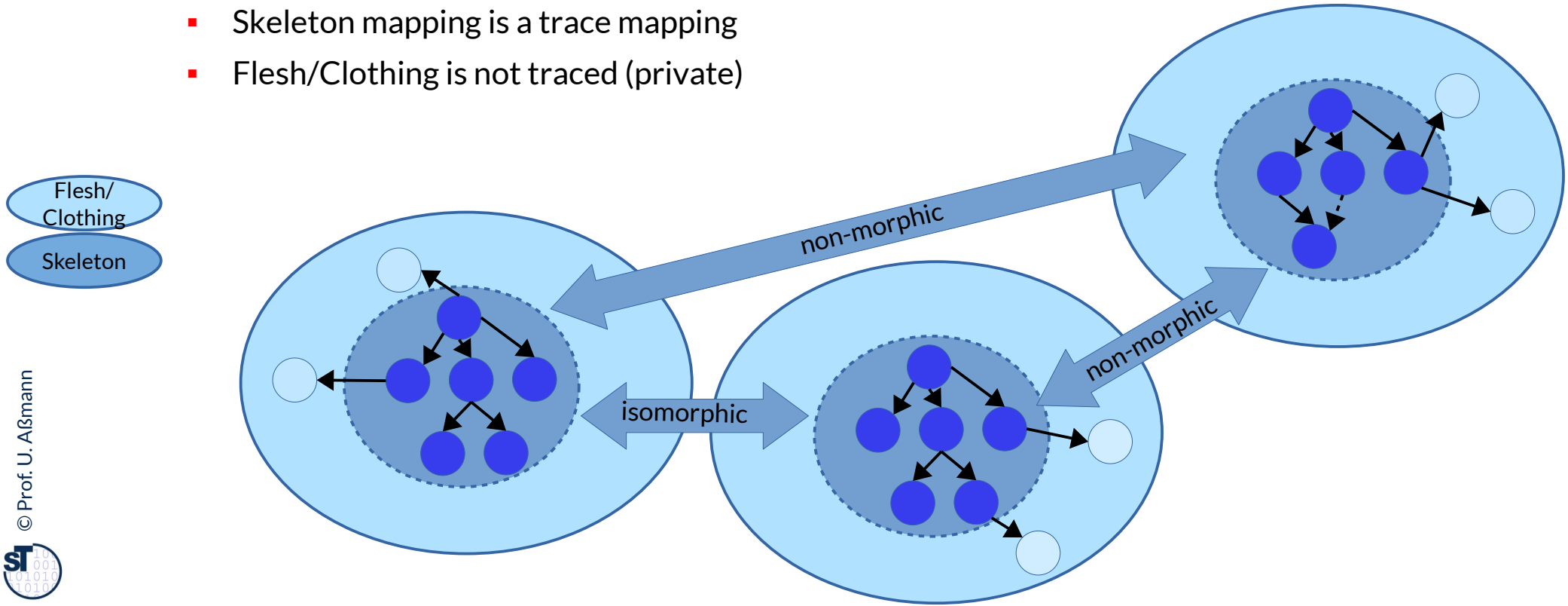
*PIM - TravelBookingSystem - Realization - Structural - Service - all owned - Generic.umldi
/q4/wc/PIM - TravelBookingSystem - Realization - Structural - Service - all owned - Generic.umldi
Select
Marquee
Note
Objects
Package
Class
Data Type
Interface
Operation
Property
Instance Specification
Connections
Association
Association Class
Instance Specification link
Generalization
Interface Realization
Template Binding
Dependency
Comment
package
<<ComponentClass, subject>>
TravelBookingSystem
-version : String
+travelBookingSystem
1
1
+travelBookingSystem
<<nests>>
<<creates>>
+accomodationAgent
1
1
+travelBundler
<<ComponentClass>>
AccomodationAgent
+ getAvailability () : Boolean
<<ComponentClass>>
TravelBundler
+ createTravelBundles ()
<<ComponentClass>>
TravelAgent
+ getAvailability () : Boolean
+ bookTravelPart () : Boolean
+ cancelTravelPart () : Boolean
Error Log
Properties
Outline
Problems
<<componentClass, subject>> <Class> TravelBookingSystem
Model
Stereotypes
Stereotype Attributes
Owned Rules
Name:
TravelBookingSystem
Visibility:
public
isAbstract

33.2. The Skeleton-SUM

[Hettel08]
[Seifert11]

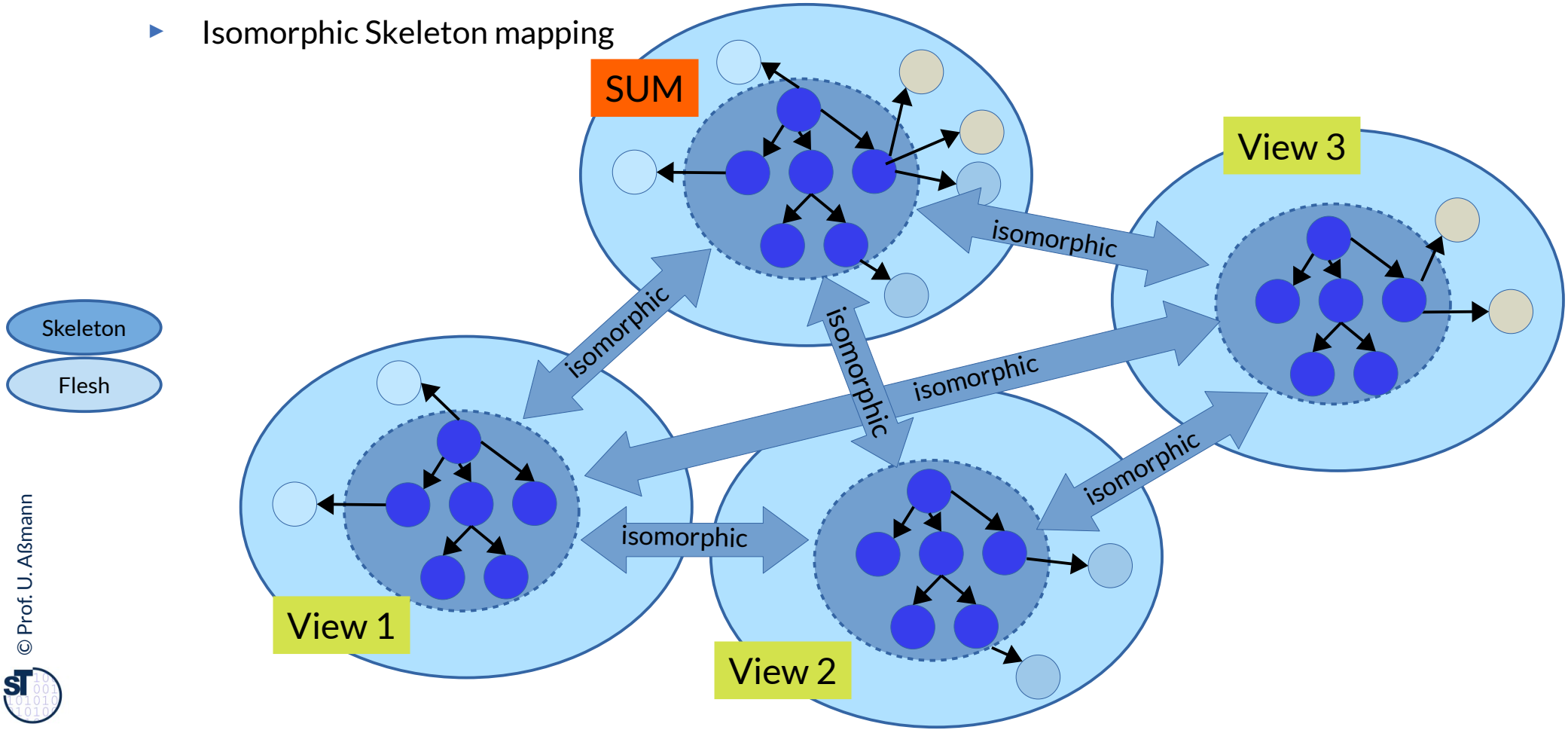
Skeletons and Flesh

- Skeleton splits models into
  - **Skeletons** (redundant) (several contexts)
  - and **flesh (clothing)** (locally different stuff in views, mono-context)
- Global invariants on skeletons vs. local „flesh“ variants
- Flesh must be non-overlapping, extending the skeleton
- Skeletons can have isomorphic, homomorphic, monotonically extended “skeleton” mappings,
  - or may be non-morphic
  - Skeleton mapping is a trace mapping
  - Flesh/Clothing is not traced (private)



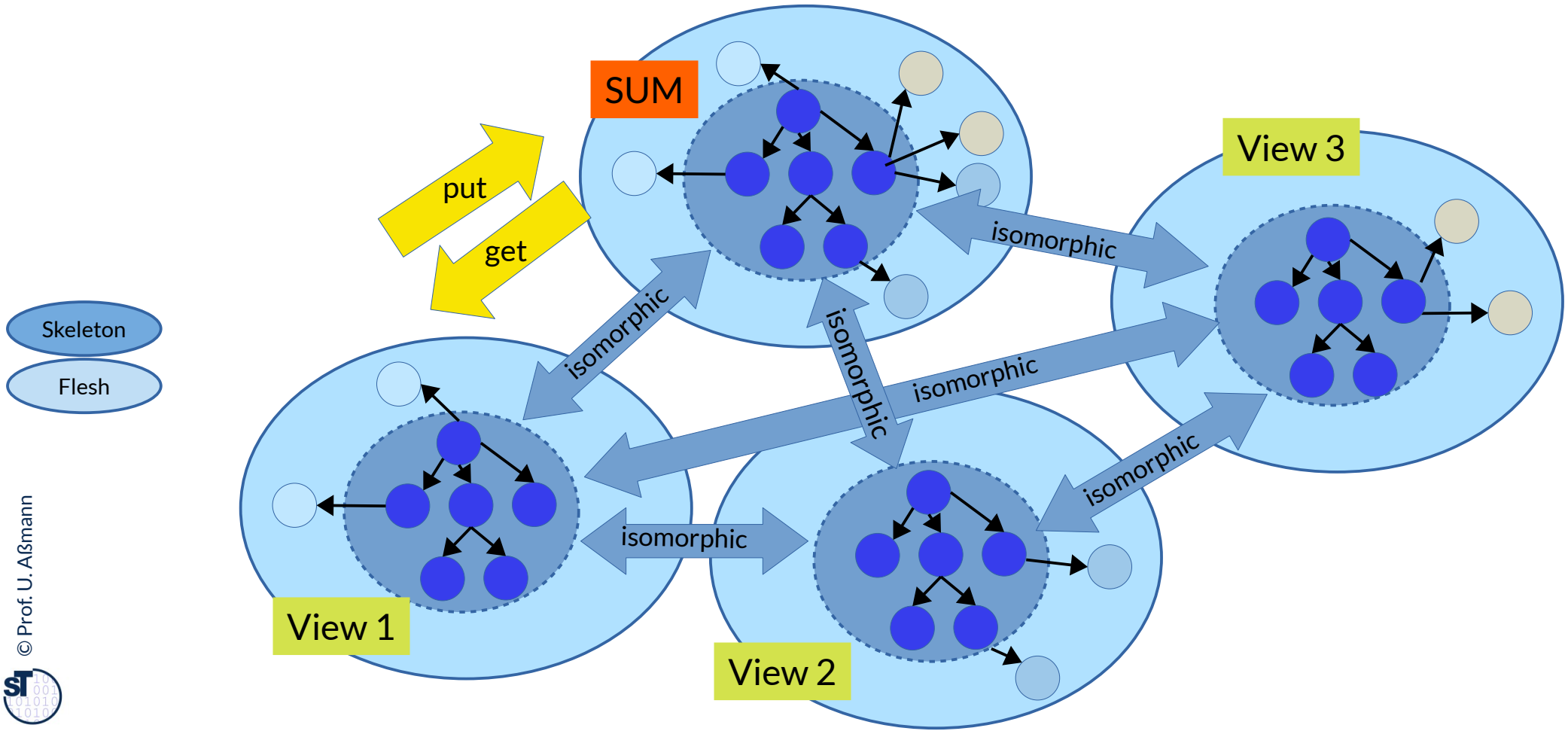
Mono-Skeleton-SUM

- Mono-Skeleton-SUM splits models into
  - **One common Skeleton** (redundant) (several contexts)
  - and **flesh (clothing)** (locally different stuff in views, mono-context) is stored in SUM together with skeleton
- Flesh must be non-overlapping, extending the skeleton
- Isomorphic Skeleton mapping



Get/Put in Mono-Skeleton-SUM

- From a Skeleton-SUM
  - get operation produces a view
  - put operation commits it into SUM

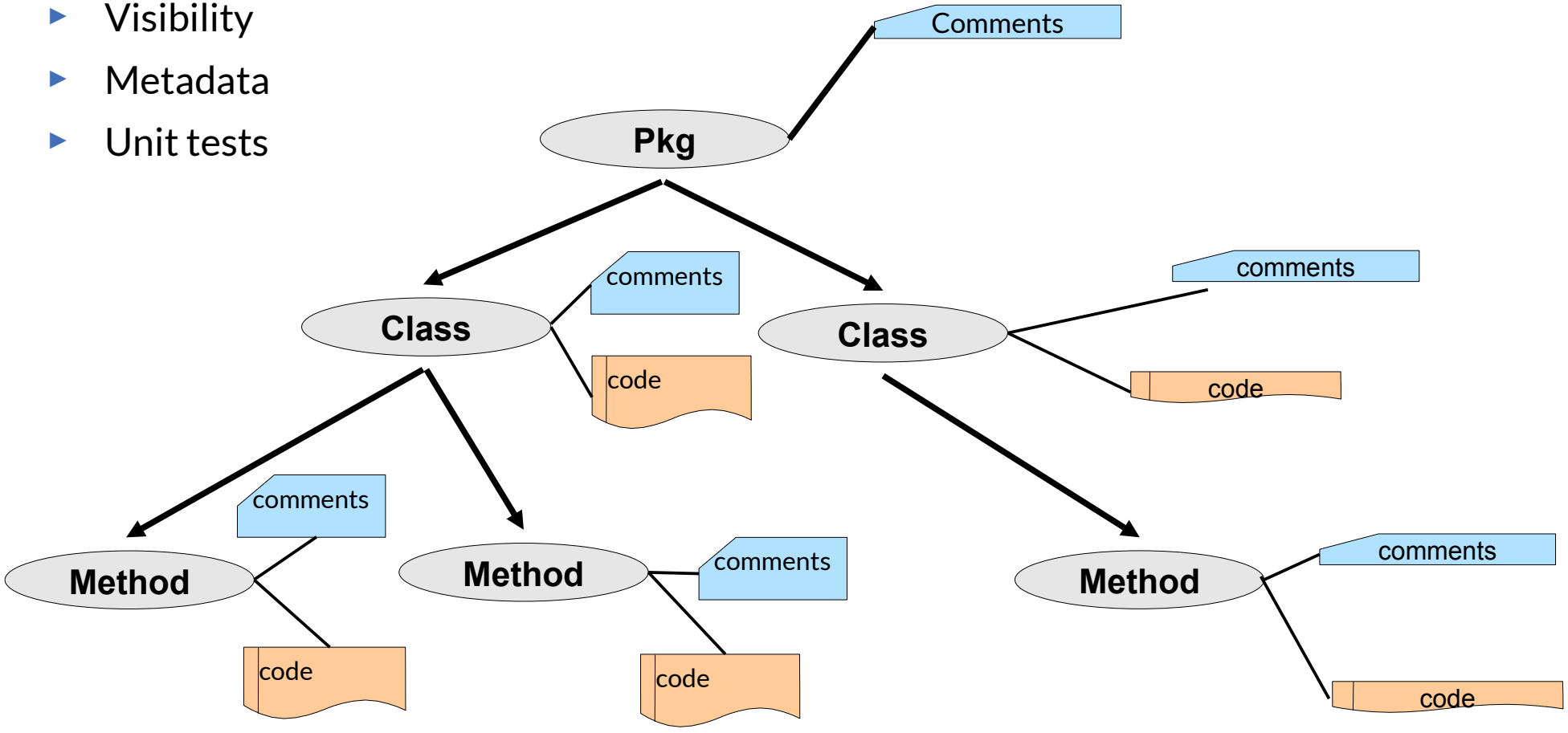


33.2.1 Javadoc-SUM, a Mono-Skeleton-SUM for Documentation

Example Skeleton-SUM: Scope tree of a program (static structuring)

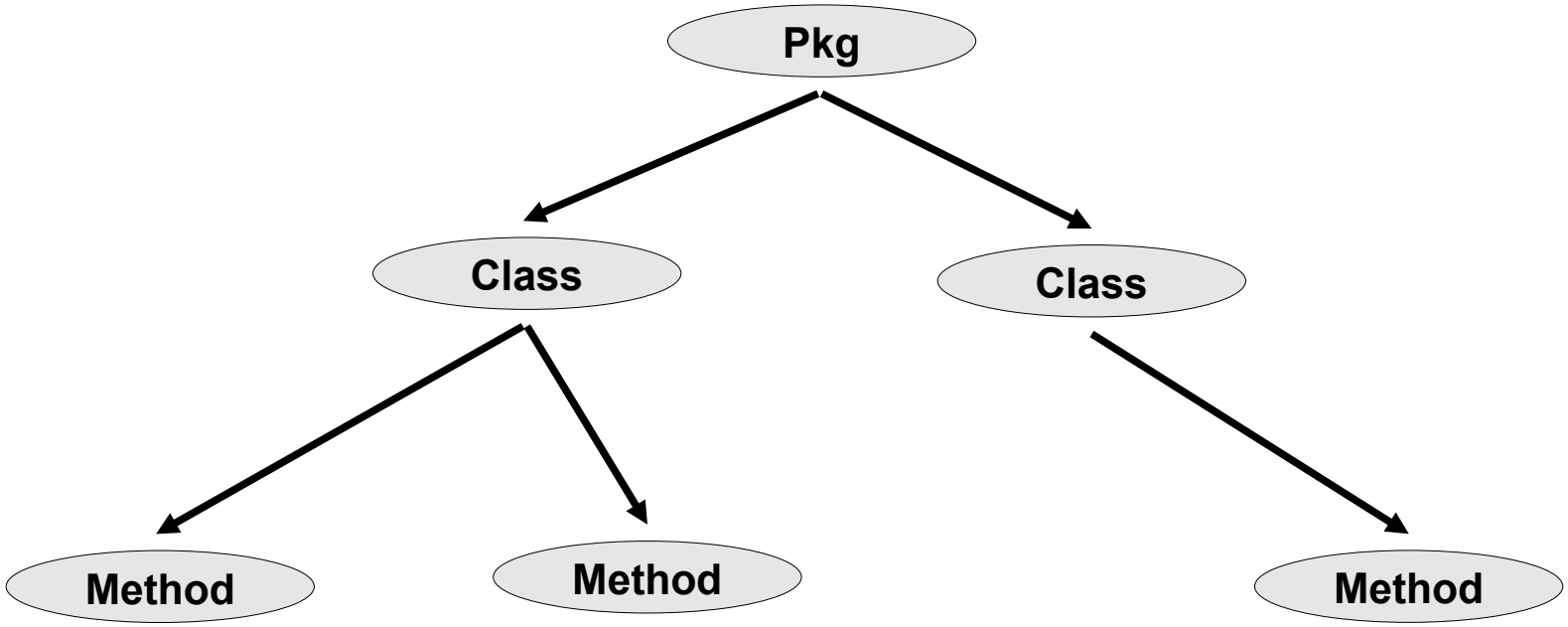
Javadoc comment relies on several attributes of nodes of the syntax tree:

- Comments (package, class, method, parameter)
- Code (*skeleton*)
- Visibility
- Metadata
- Unit tests



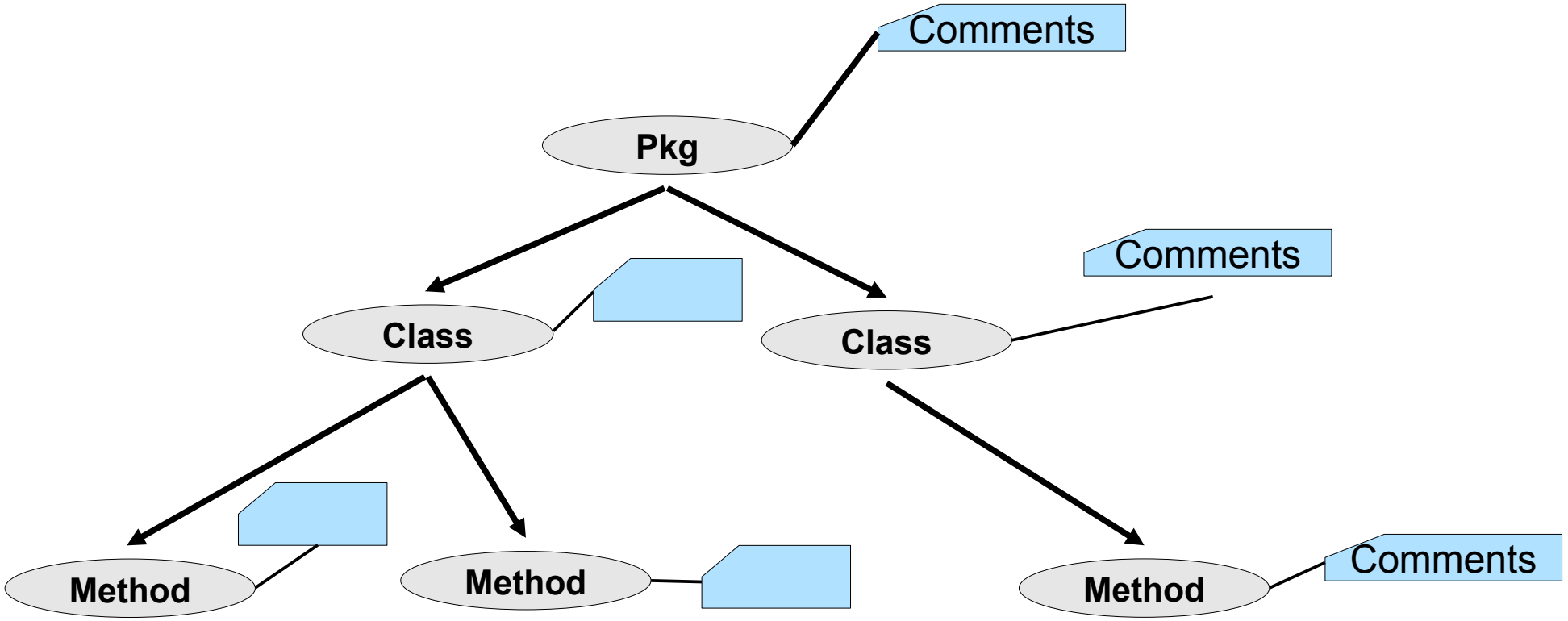
Projecting A Scope Tree for Skeleton

- put/get operations transform SUM to views and back
- Get: partial function projection
- Put: merge of partial function of view and of SUM
- Exa.: result of get operation for Scope Tree “Skeleton”:



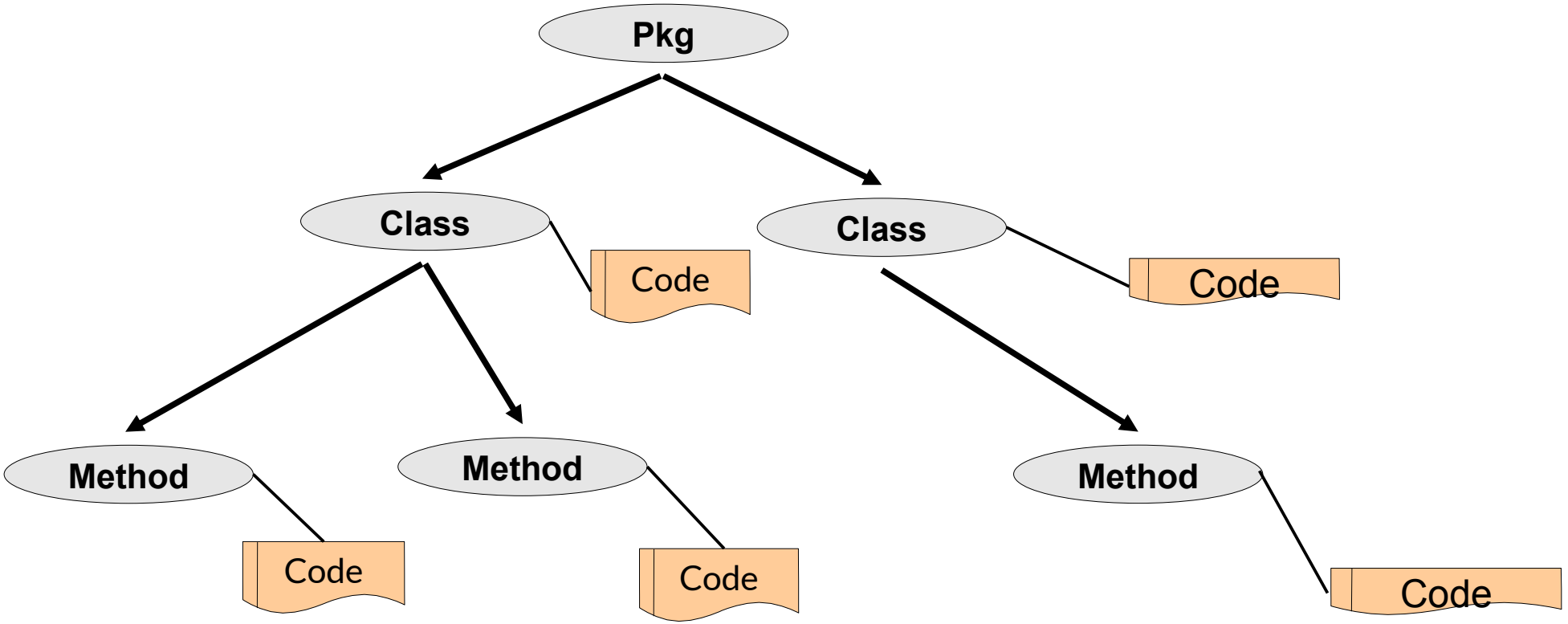
Projecting A Scope Tree for Skeleton

- Result of get operation for For Comment Context “Comment Flesh”:



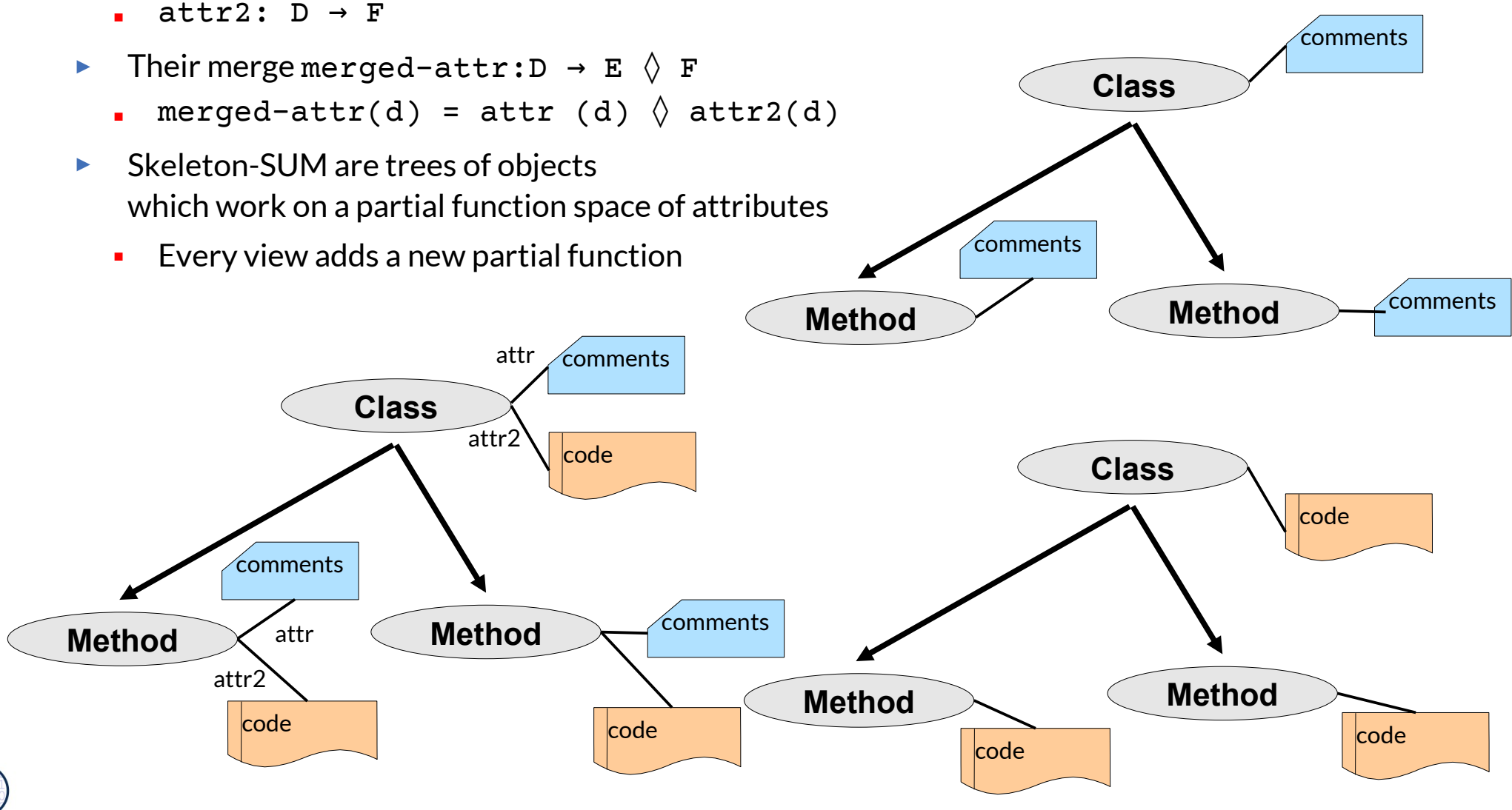
Projecting A Scope Tree for Skeleton

- Result of get operation for Code Context “Code Flesh”:

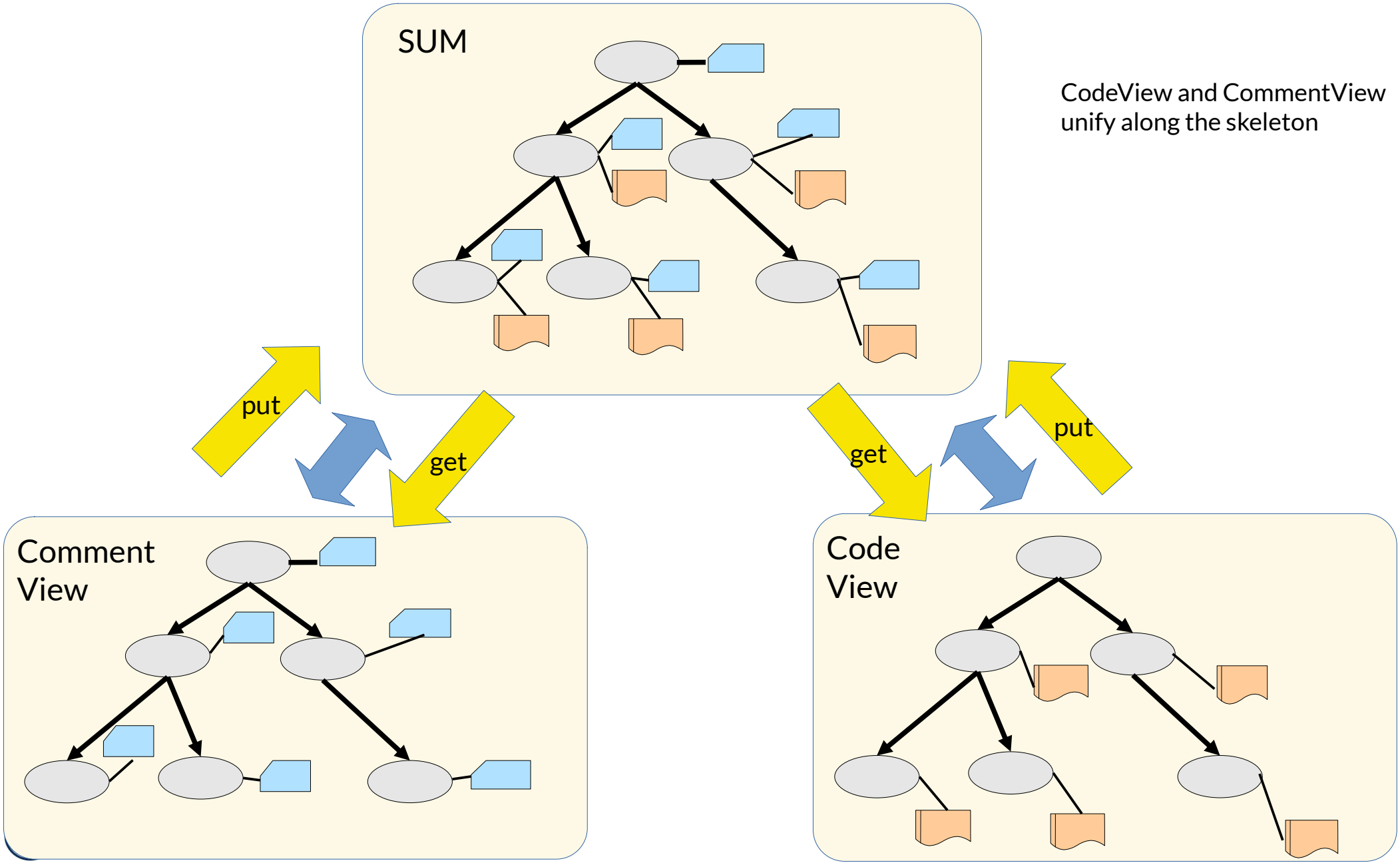


Merge of Partial Functions and Partial Trees in a Mono-Skeleton-SUM

- Given two partial functions on tree-node domain D and two domains E, F:
  - `attr: D → E` and
  - `attr2: D → F`
- Their merge `merged-attr:D → E ◊ F`
  - `merged-attr(d) = attr (d) ◊ attr2(d)`
- Skeleton-SUM are trees of objects
  which work on a partial function space of attributes
  - Every view adds a new partial function



Javadoc-SUM:
A Simple Metamodel-based Mono-Skeleton-SUM



Remarks on Mono-Skeleton-SUM

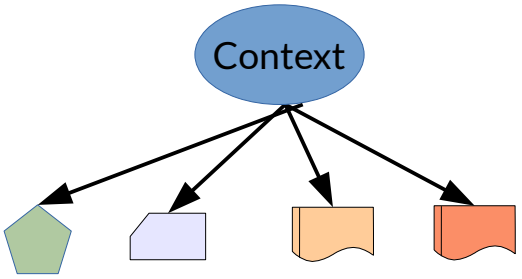
- **Generality:** The Skeleton need not be a link tree; it can be an arbitrary graph data structure
  - But RAGs can model Mono-Skeleton-SUMs very easily: inherit the flesh attributes to all nodes
- Between Skeleton and Flesh there holds a **key dependency**
  - A partial function describes the mapping between skeleton and flesh
  - Different partial functions exist for every view
  - Flesh-skeleton unification employs partial function merge (feature term unification)

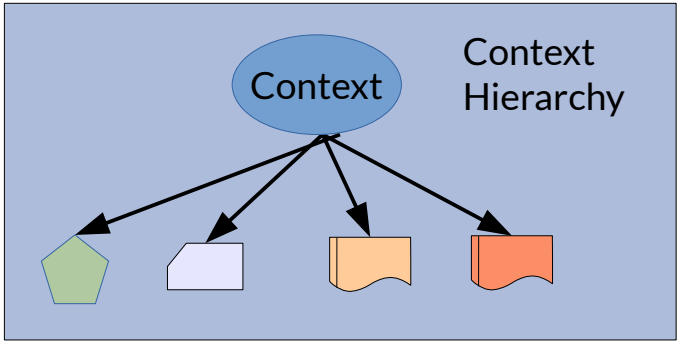
33.3. Context-Based Skeleton-SUM

[Hettel08]
[Seifert11]

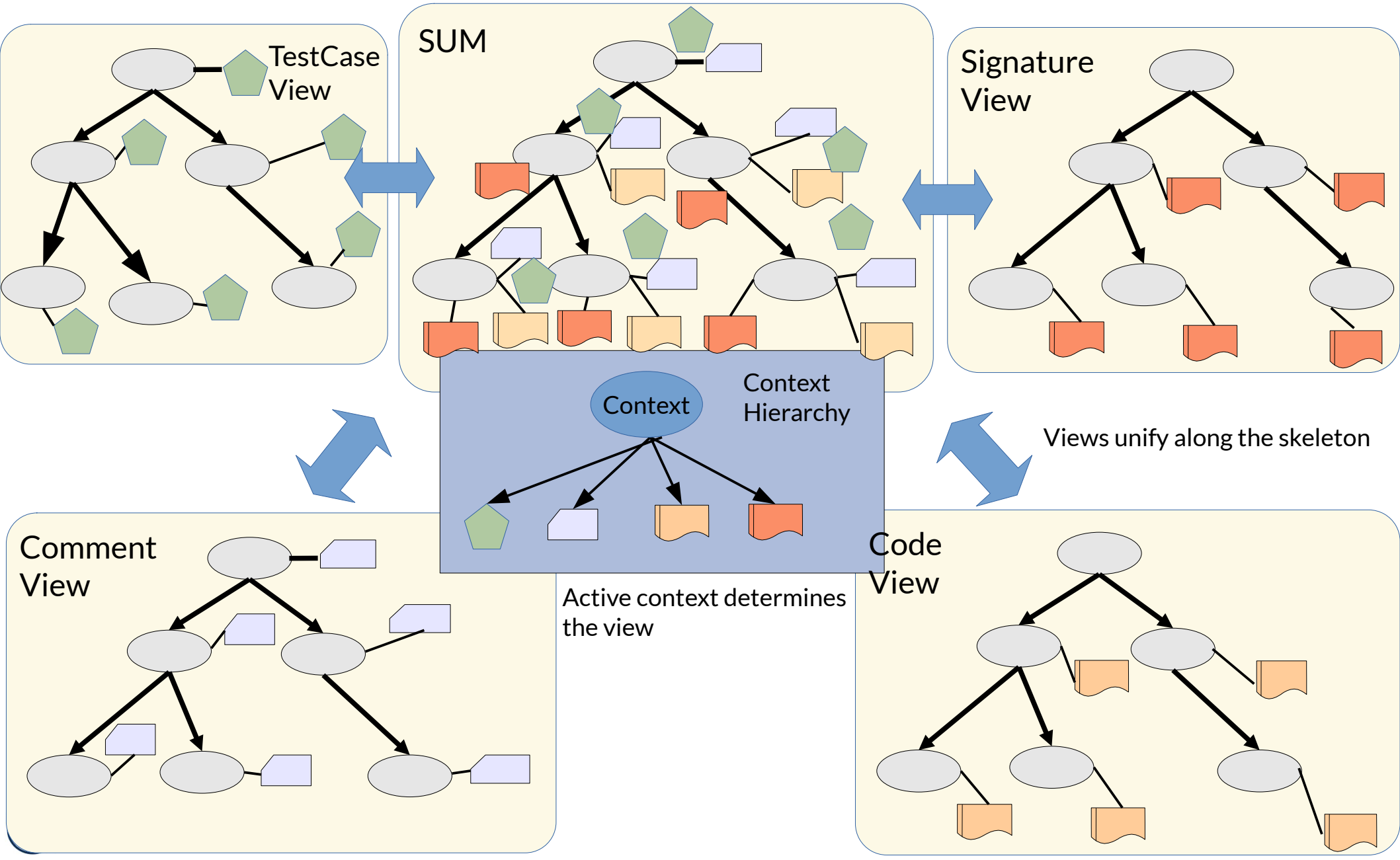
Skeleton-SUM

- Clothing can be associated to context (context-aware clothing)
  - Code context
  - Comment context
- If all clothings have mono-context, the SUM is called ***flat contextual SUM.***





A Metamodel-based Skeleton-SUM with Flat Context Hierarchy



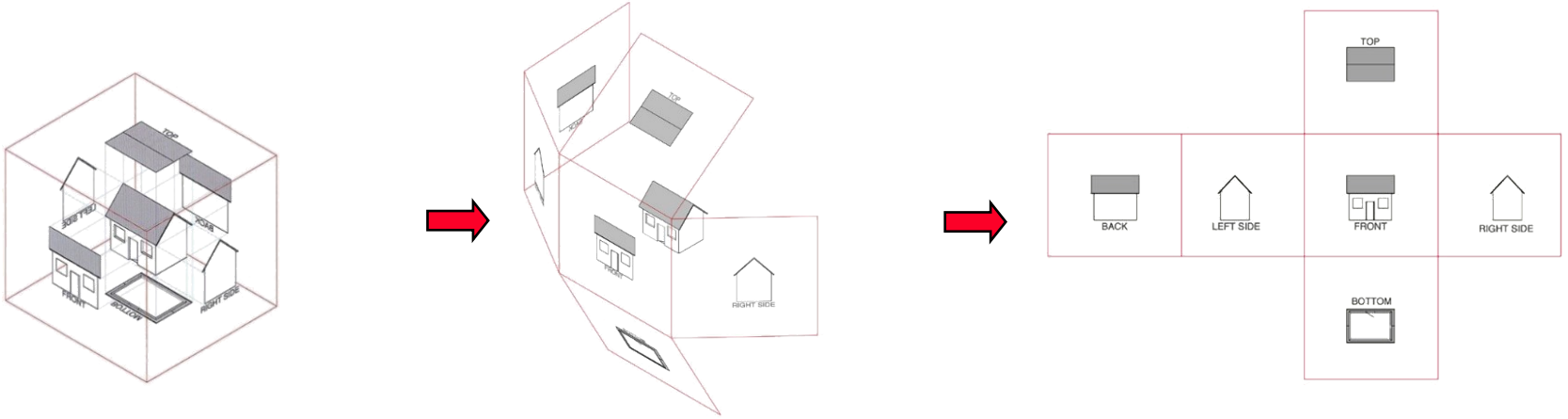
33.3.1. Orthographic Software Modeling (OSM) as a Dimensional, Context-Based Skeleton-SUM

[Hettel08]

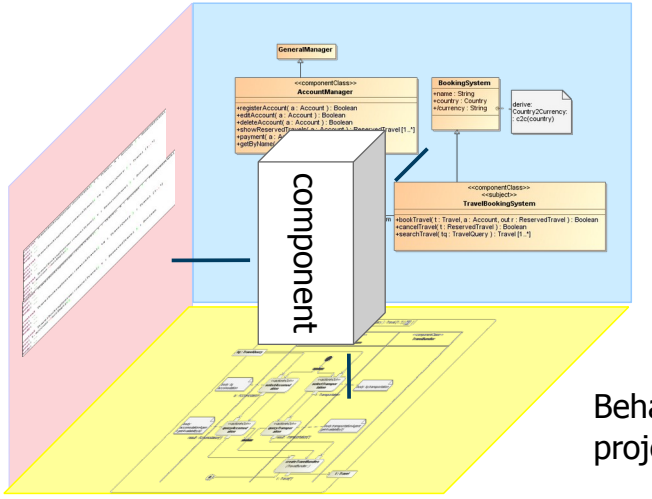
[Seifert11]

Orthographic Software Modeling (OSM) as a Dimensional Skeleton-SUM

- Many engineering disciplines have a long and successful tradition of technical drawing - orthographic projection



- so why don't we do this in software engineering?



Structural projection

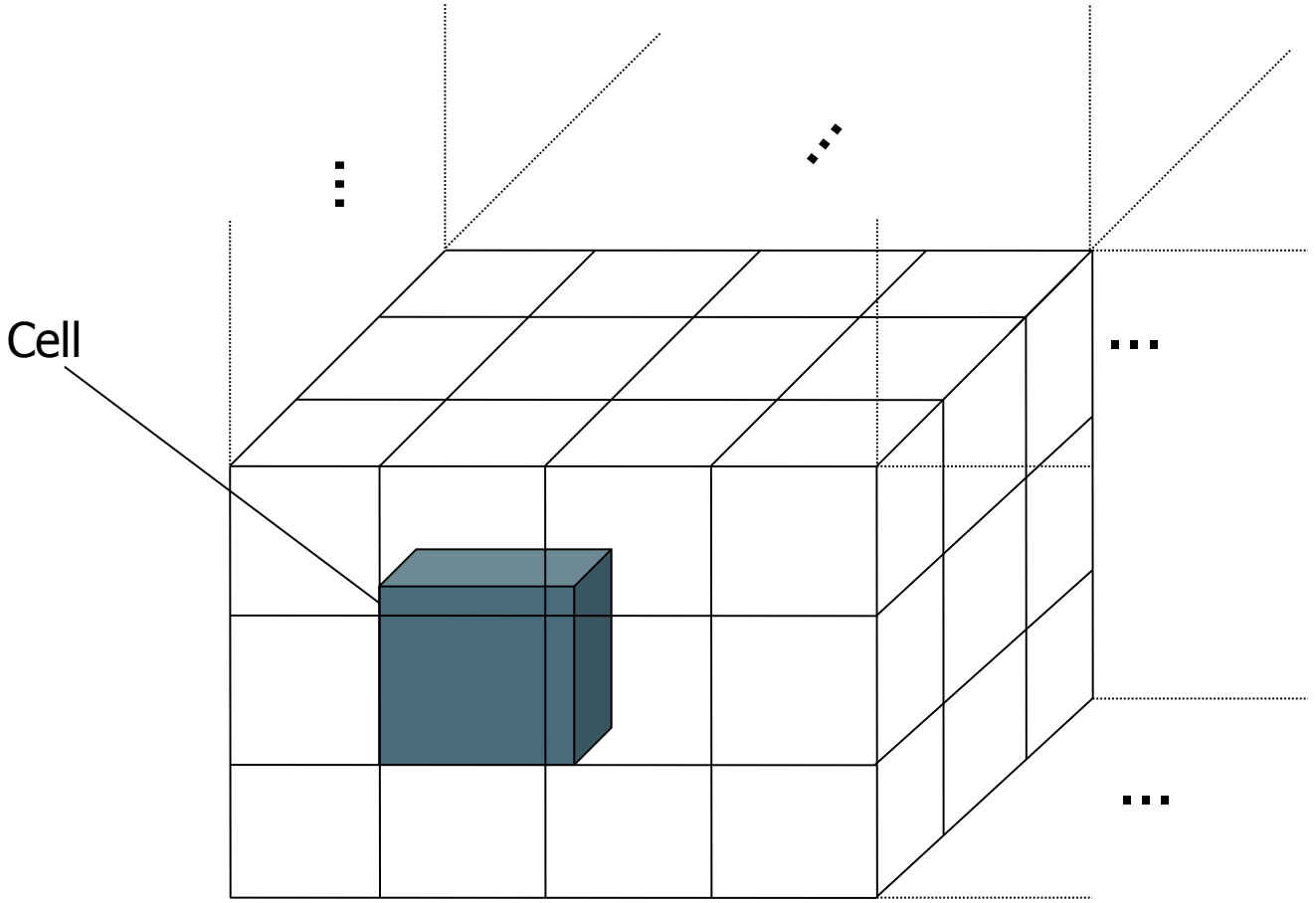
Operational projection

Behavioral projection

- On demand view generation (projective views)
- Dimension-based navigation
- View-based methodology

Dimension Based Navigation

- views organized in a multi-dimensional cube
- one choice always “selected” from each dimension
- each cell represents a viewpoint



OSM is a Flat Contextual Skeleton-SUM

- OSM defines *n-dimensional contexts*, i.e., every model element is related to n contexts.
- OSM can be realized by a Skeleton-SUM providing n mono-contextual clothings
  - i.e., n mono-contextual attributes for every model element (link tree node).
- The n dimensions (contexts) are used for projection
- Instead of attributes, model elements have roles (CROM-Skeleton-SUM)

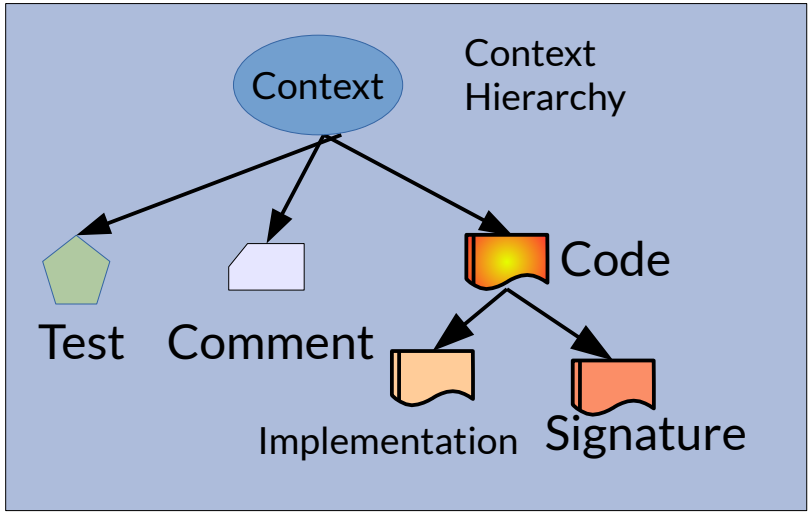
- ROSIMA is a CROM-Skeleton-SUM

33.4. Hierarchic Context-Based Skeleton-SUM

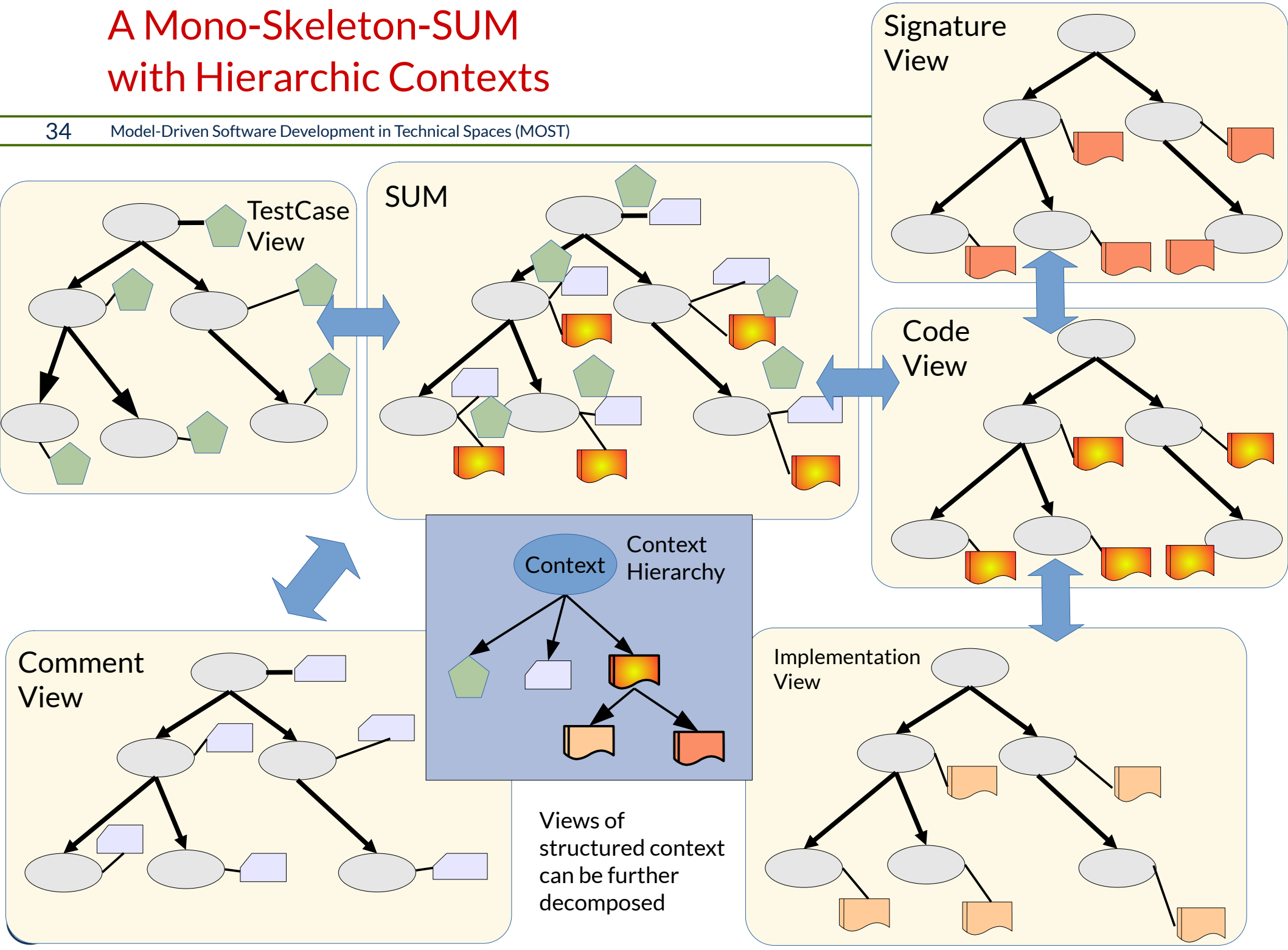
[Hettel08]
[Seifert11]

Hierarchic Skeleton-SUM

- Clothing can be associated to structured context
  - Code context
    - Signatures
    - Implementation
  - Comment context
- If som clothings have an inner (structured) context, the SUM is called **hierarchic contextual SUM.**



A Mono-Skeleton-SUM with Hierarchic Contexts

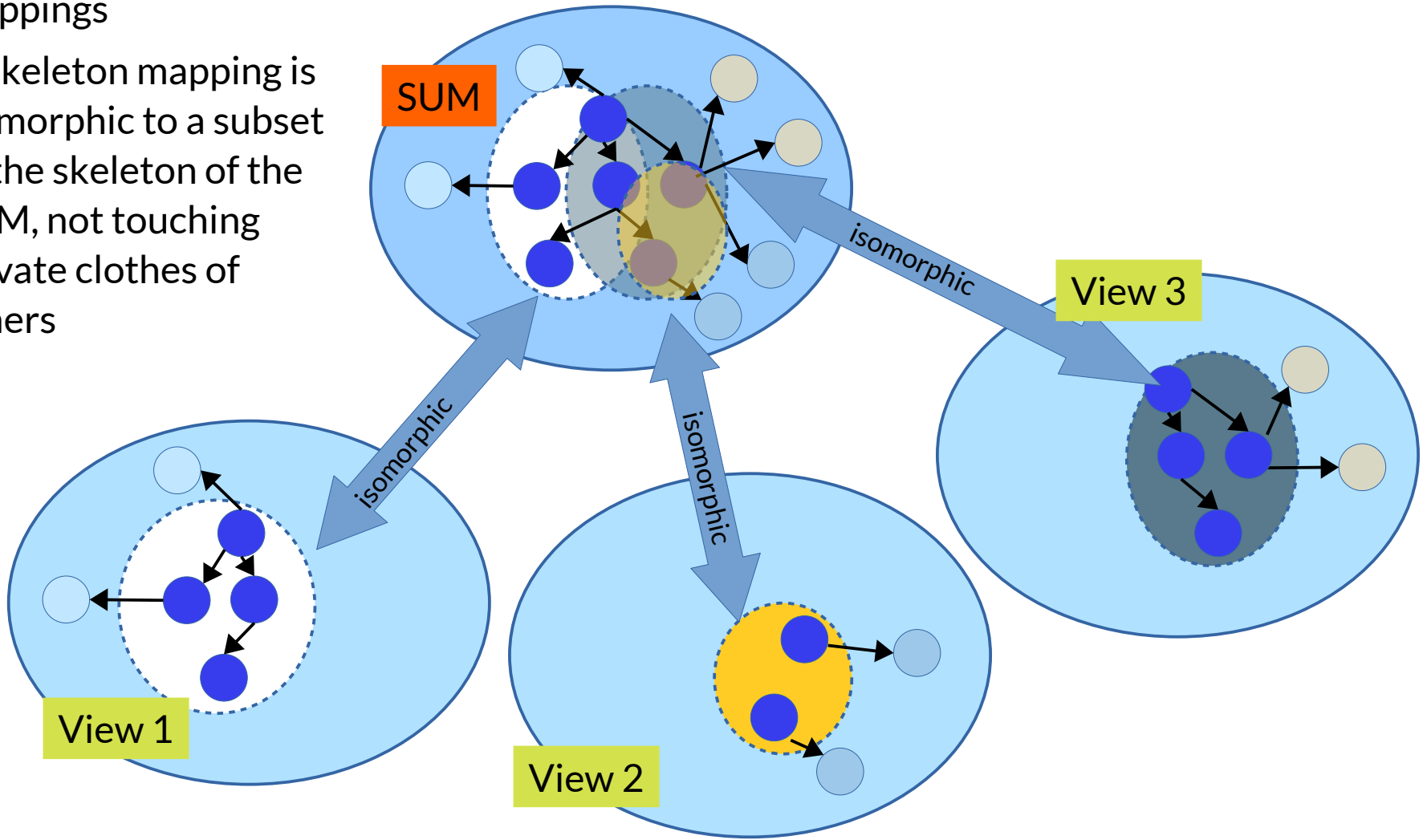


33.5. Multi-Skeleton-SUM

[Seifert11]

Multi-Skeleton-SUM

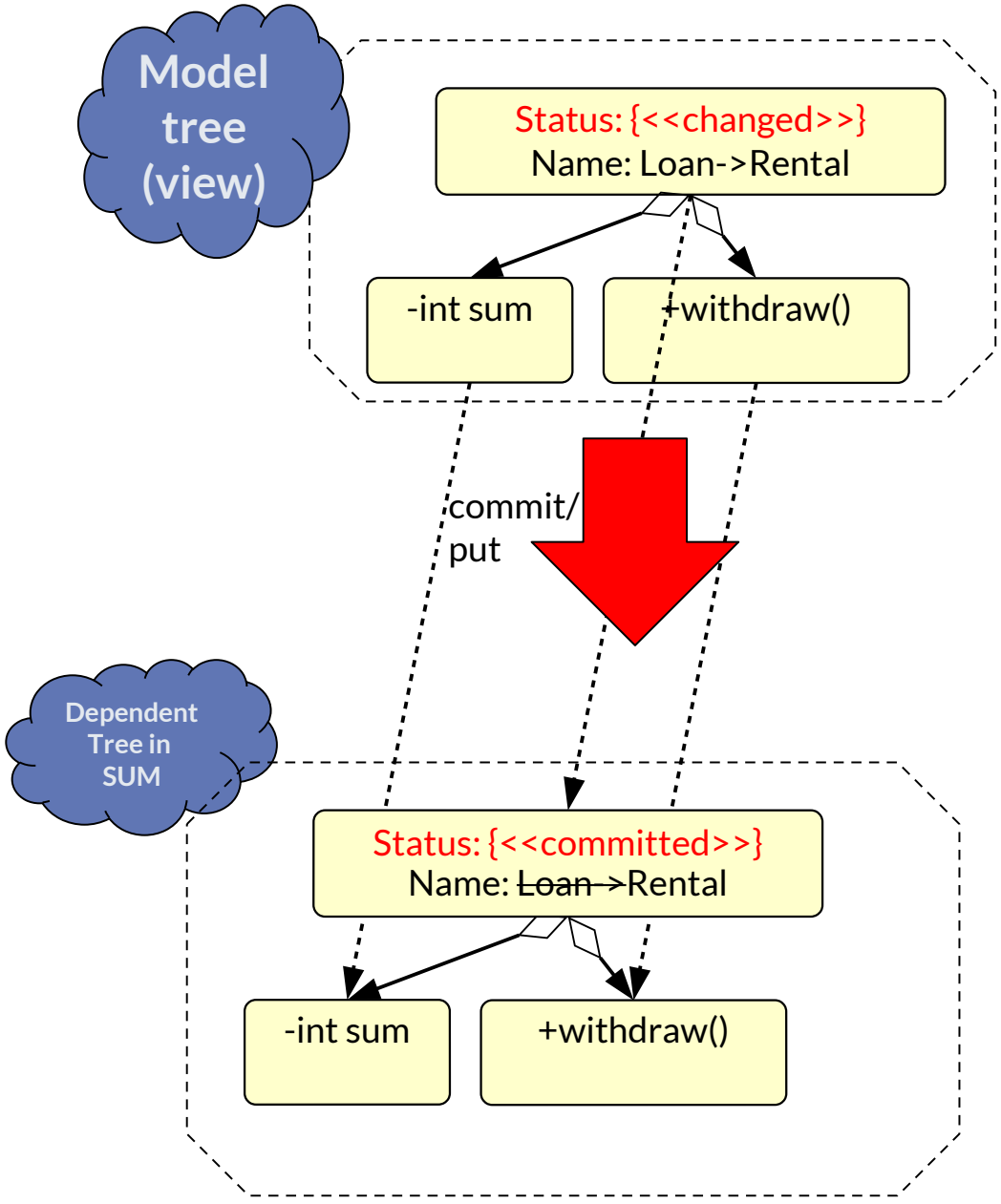
- In SUMs, not all Skeletons need not be a linked by isomorphic mappings
- A Skeleton mapping is isomorphic to a subset of the skeleton of the SUM, not touching private clothes of others
- Every Skeleton must be invariant, and within the SUM, a Skeleton—Skeleton mapping must exist



33.5.2 Put Operations in the MDA-Multi-Skeleton-SUM

Model Synchronization in RAG-MDA by `Put` Operations on Single Underlying Models (SUM)

- A single underlying model (SUM) is a cultimodel with *views*
- MDA can be arranged as MDA-SUM
- A **evolution operation** changes a global name or definition in one model tree a view, which used in several other model trees in the SUM
- To synchronize dependent model elements, we need a `commit/put` operation ("**commit/put to SUM**")
- Its implementation needs to repeat the rewrite in all referencing places
  - Follow the references introduced by global name analysis
  - Standard process in RAG
- Easy traceability by dependency graph between global names



33.6 Delta-Based Lenses for Incremental Modifications for Scalability and Applicability of Skeleton-SUMs

[Diskin]

Delta-Based Lenses for Scalability and Applicability

- Simple minded implementation approach –
  - uni-directional *exhaustive* transformations
    - get: SUM-to-view, put: view-to-SUM
  - create a new (version of the) view whenever there is a change in the SUM
  - create a new (version of the) SUM whenever there is a change in a view
- Would work but too large grained
  - Not scalable (inefficient)
  - No incrementality
  - transformation more complex than necessary

⇒ The necessary get/put operations are called ***bidirectional lenses***

Delta-Based Lenses and Skeleton SUMs

- ***Lenses*** (Pierce et al. 2007) are pairs of bidirectional transformations based on get (exhaustive projection, decomposition, checkout) and put (exhaustive integration, checkin) operations on models
  - axioms for *well-behaved lenses*

    v: View; s:SUM
    get(put(v, s)) = v // *PUTGET invariant rule*
    put(get(s), s) = s // *GETPUT invariant rule*

  - axiom for *very well behaved lenses:* "intermediary puts can be forgotten"

    put(v', put(v, s)) = put(v', s) // *PUTPUT invariant rule*

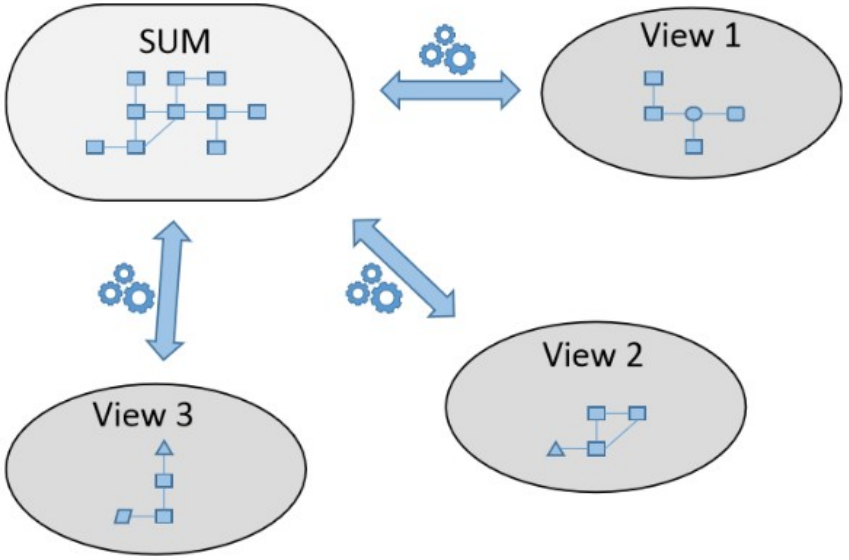
- ***Delta-based Lenses*** optimize the checkin/checkout (Diskin et al. 2011)
  - *Incremental* delta operations dput and dget are driven by the changes to the views
  - axiom for delta-put: "If a delta-commit results in a delta of the SUM, then the next delta-checkout refers only to this delta of the SUM"

    if Δs = dput(Δv, s), then dget(Δs) = Δv // *DeltaPUTPUT rule*

  - much more fine-grained and scalable

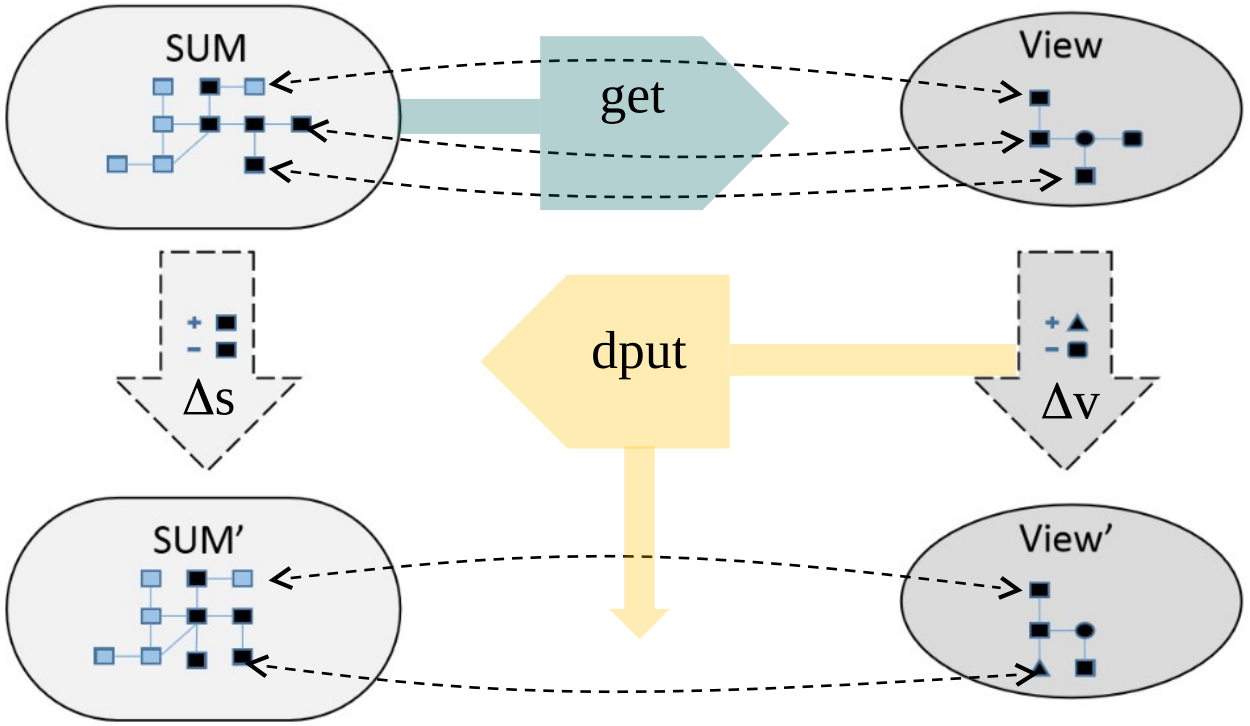
The Background of Orthographic Software Modeling (OSM)

- In OSM, the SUM is much larger than the views
  - the views are relatively small and compact
- Views can be updated concurrently
  - axioms only applicable locally (i.e. to one view at a time)
- Usually have one-to-one correspondences between view elements and SUM elements
  - changes can conveniently be traced to the affected element
- View elements cannot be changed just locally
  - for example, cannot delete an element from just the view, but not the SUM



Hybrid Approach with dput

- use ***get*** to create views from the SUM
- use ***dput*** (delta put) to update the SUM when a view is changed
  - incremental put operation only transmits the delta (increment)

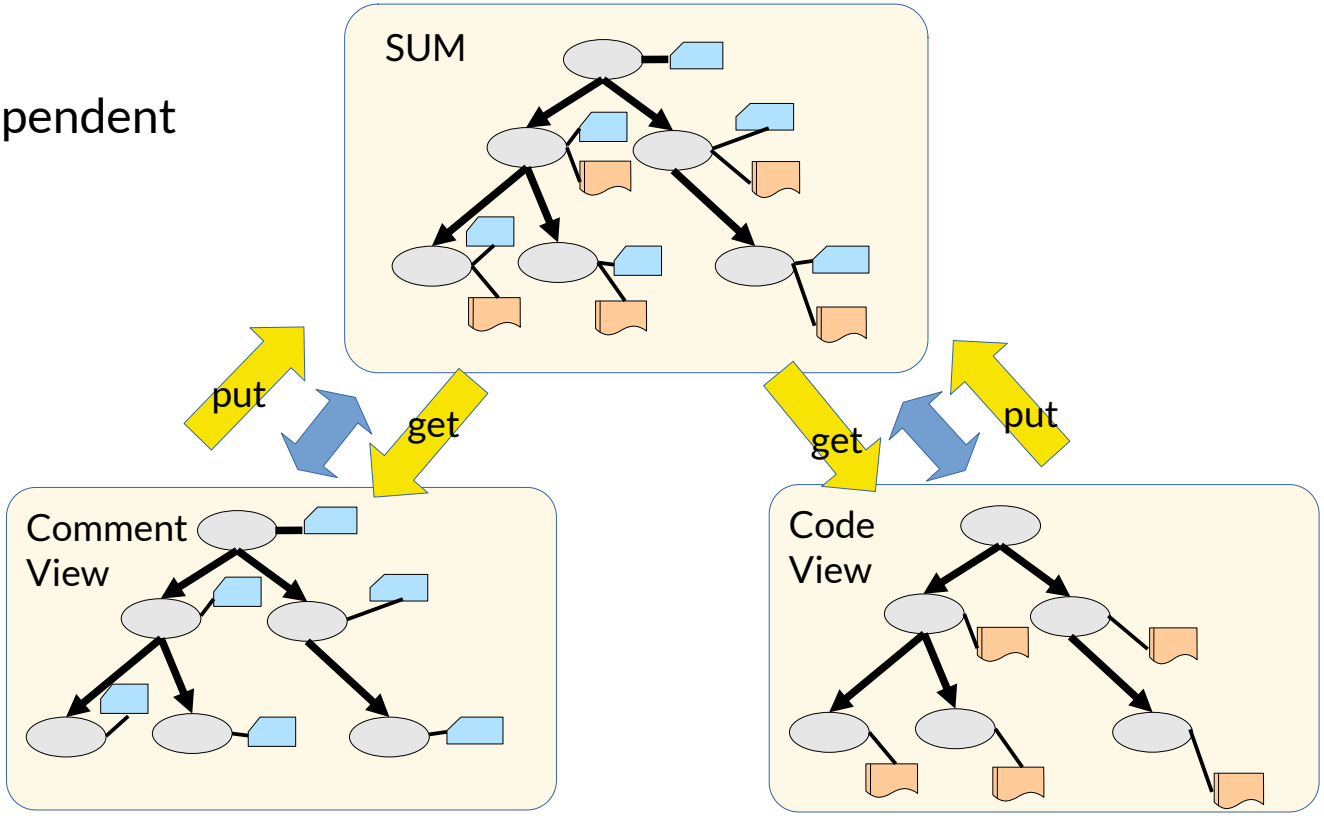


if Δs = dput(Δv, s), then dget(Δs) = Δv // *DeltaPUTPUT rule*

Skeleton-SUM and DeltaPutPut

A Skeleton-SUM fulfills the DeltaPutPut rule.

- Reason:
  - Partial functions are independent
  - Skeleton stays invariant
- Corollary
  - therefore OSM
  - therefore Javadoc-SUM



Pros and Cons of the Hybrid Approach

- **Traces** allow affected SUM elements to be efficiently identified
  - can be generated most mainstream transformation engines
  - Traces also allow the open views impacted by a change to be identified
  - Traces must be updated dynamically a la MVC pattern
- Use of ***get*** to create views reduces the complexity of the transformation with little extra overhead
  - no need to update trace information
- Use of ***dput*** to update the SUM greatly enhances the efficiency of updating SUM
  - the SUM is only ever updated via changes to views
- However, it increases the amount of information that needs to be stored on the server
  - part of the SUM?

33.7 Skeleton-SUM on RoSI CROM

Skeleton-SUM on RoSI CROM

- The SUM principle can be played on all metalanguages, e.g., CROM
- CROM supports Mono-Skeleton-SUM for all
  - Contexts provide *viewpoints*
  - Cores provide *Skeleton*, Roles provide *flesh/clothing*
  - Role-play provides *partial functions from objects to roles* for a SkeletonSUM over cores and roles

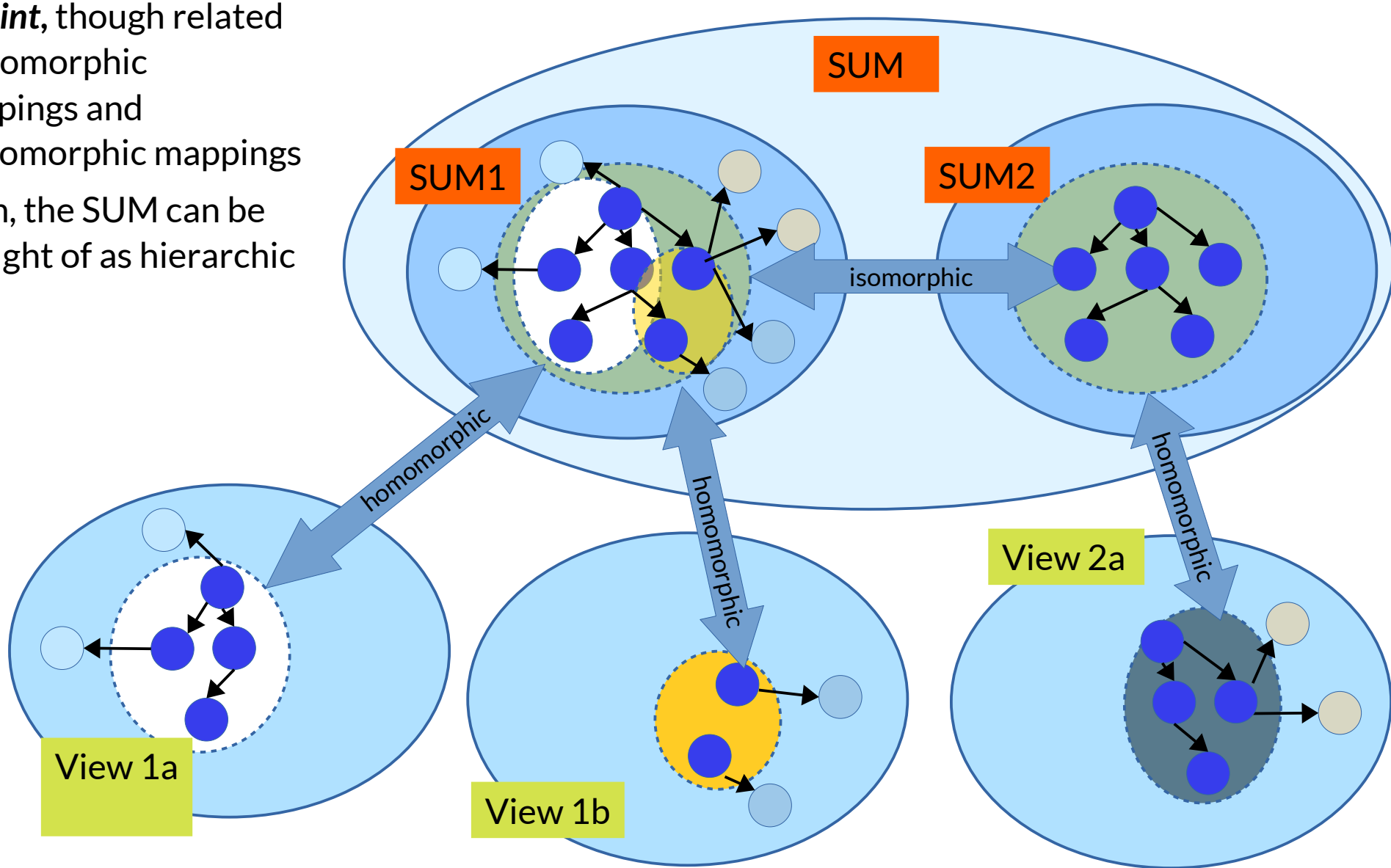
Theorem: A CROM-based Skeleton-SUM fulfils the delta-putput invariant.

33.8. Disjoint-Skeleton-SUM

[Seifert11]

Disjoint-Skeleton-SUM

- Skeletons can be ***disjoint***, though related by isomorphic mappings and homomorphic mappings
- Then, the SUM can be thought of as hierarchic

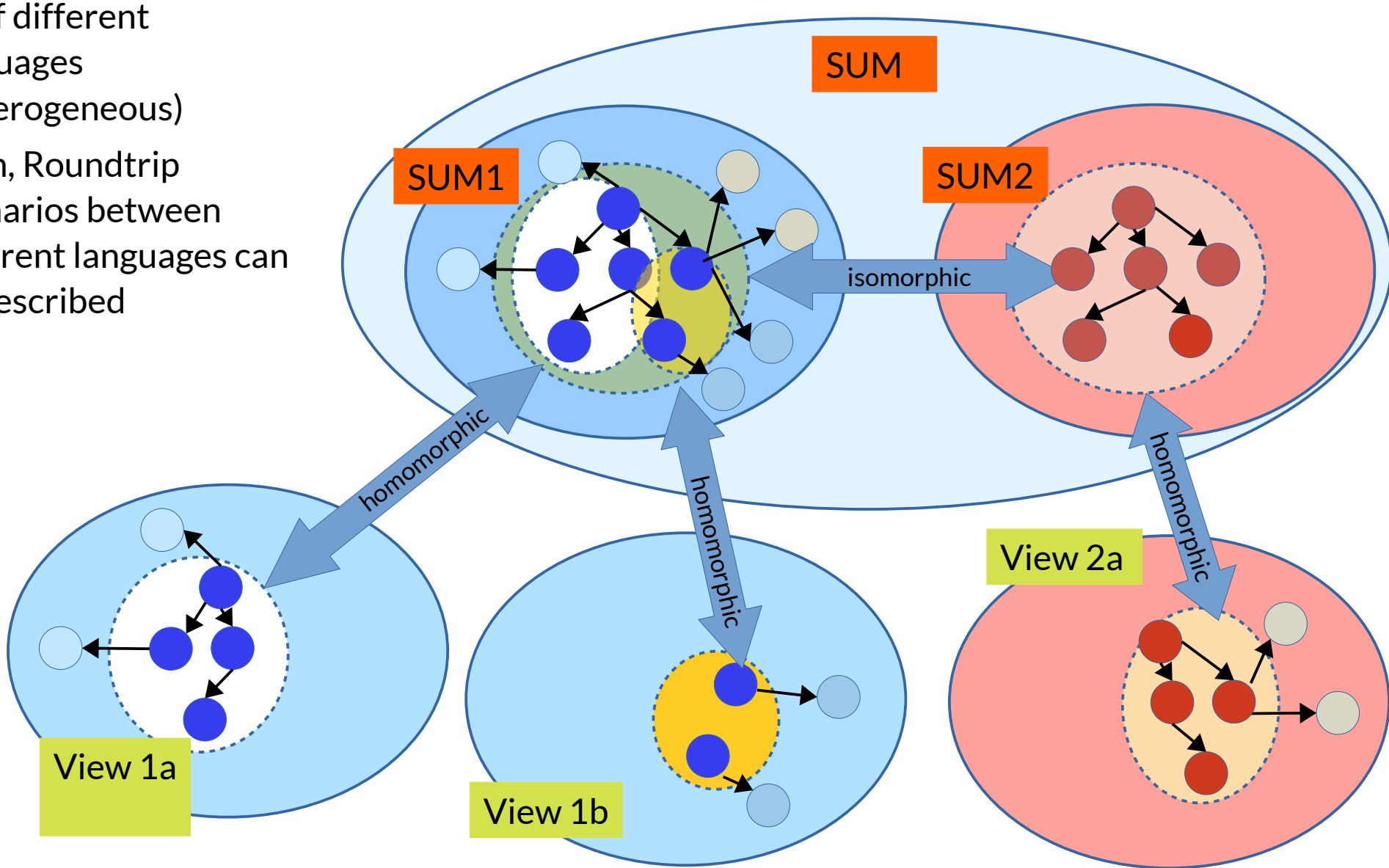


33.8.1 Heterogeneous-Language-Skeleton-SUM

[Seifert11]

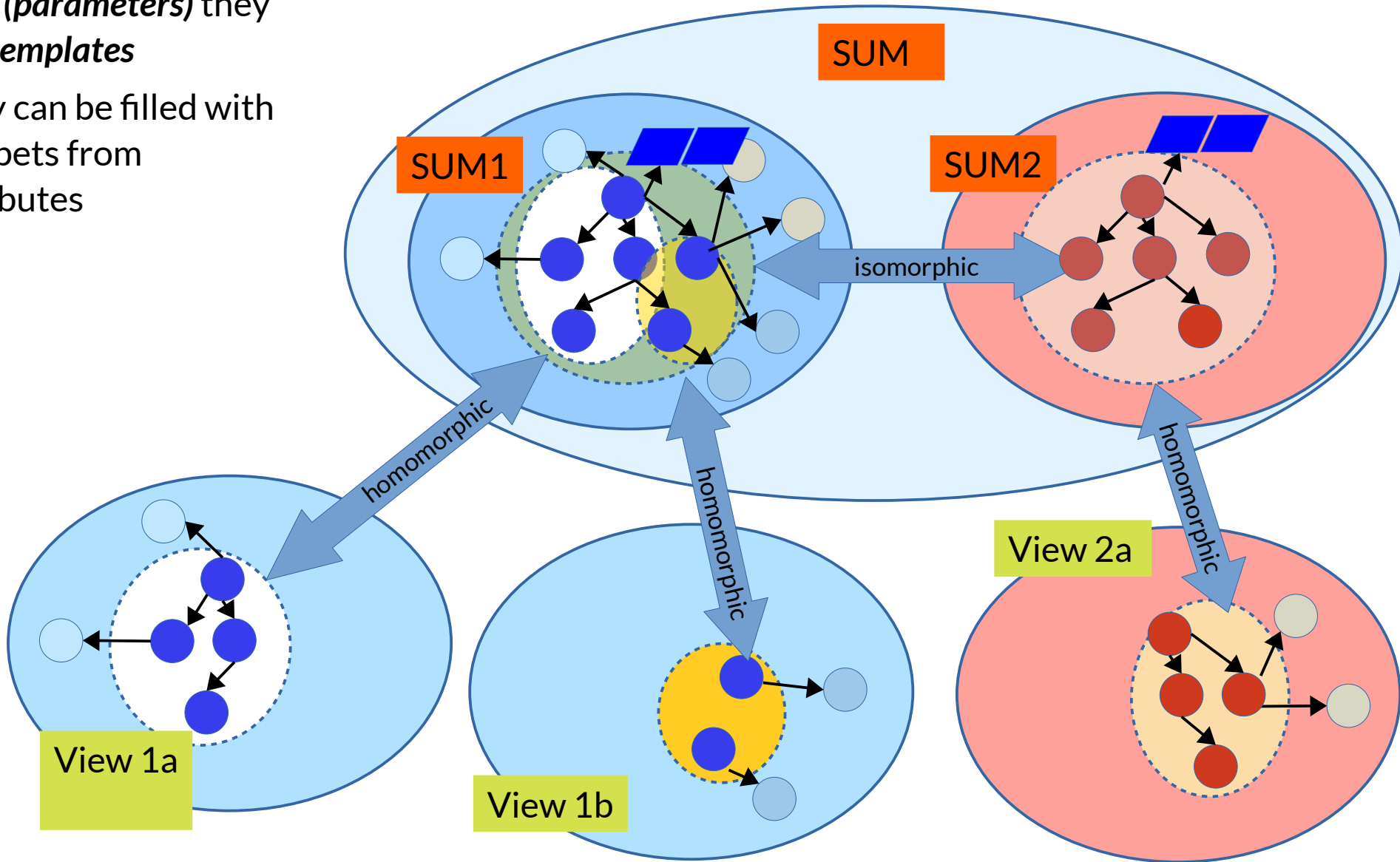
Heterogeneous-Language-Skeleton-SUM

- Disjoing Skeletons can be of different languages (heterogeneous)
- Then, Roundtrip Scenarios between different languages can be described



Heterogeneous-Language-Skeleton-SUM with Templates

- When skeletons have ***slots (parameters)*** they are ***templates***
- They can be filled with snippets from attributes



The End

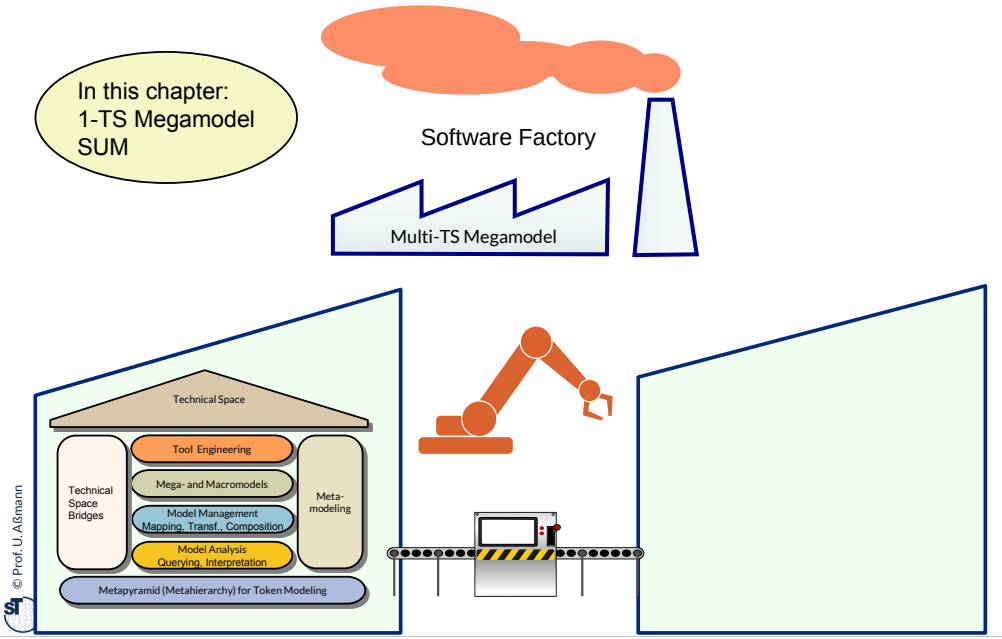
- Explain, how partial functions between objects and attributes enable the projections (get) and the merge functions (put) of a Skeleton-SUM
- Why are contexts important for views?
- What happens if the SUM has several skeletons?
- Which are the contexts of Javadoc-SUM? Why does Javadoc-SUM fulfill the DeltaPutPut rule?
- Which are the contexts of OSM? Why does OSM fulfill the DeltaPutPut rule?
- Why does ROSI-CROM enable Skeleton-SUM?
- Some slides are courtesy to Prof. Colin Atkinson, Mannheim. Used by permission.

33. Macromodel Single Underlying Model (SUM)

with Orthographic Software Modeling (OSM) - A 1-TS-Megamodel with Total Consistency

Prof. Dr. U. Aßmann
Technische Universität Dresden
Institut für Software- und Multimediatechnik
http://st.inf.tu-dresden.de/teaching/most
Version 21-1.1, 22.01.22

Software Factories with Only 1 Technical Space



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  - http://dx.doi.org/10.5381/jot.2011.10.1.a6
- J. Nathan Foster and Michael B. Greenwald and Jonathan T. Moore and Benjamin C. Pierce and Alan Schmitt. Combinators for Bi-Directional Tree Transformations: A Linguistic Approach to the View Update Problem, ACM Transactions on Programming Languages and Systems, Vol 29(3), pp. 17, 2007
  - http://www.cis.upenn.edu/~bcpierce/papers/newlenses-popl.pdf

Overview Table for Link-Tree Macromodels

The Link-Treeware TS is well apt for macromodel construction in a software factory

- A tree node abstracts a subtree (representant)
  - Attributes and attributions are *composable partial mappings* from treenodes
- RAGs are useful for all kinds of structure- and function-modeling in Link-Tree Macromodels, because they abbreviate dependencies in several models with cross-model relations.
  - In a macromodel under an artificial root (rooted macromodel), attributions can work on the SUM to ensure the constraints
- Relational RAGs (RelRAGs) are useful, because they have bidirectional constraints

	(Plain) MDA	General SUM	Skeleton SUM (partial function extension)
RAGs in Repositories	Markings		Repository-SUM: get/put as higher-order attributions of link trees
			• Javadoc-SUM
RAGs in Data-flow architectures	Needs trace models	get/put as model transformations (lenses)	Flow-SUM: Communicating link trees; In-place transformations of SUM
			• Google Docs, Stream-Based MDA

Other Examples form

- Olympic ring decomposition (EAI) marks all modules with “rings” and thereby decomposes them (course ST-1)
- VSUM (Reussner, Burger et al) generates dependent parts by create trace links

Synchronization of Projective Views on a Single Underlying Model (A Orthographic Macromodel)

Many slides are courtesy to:
Christian Vjekoslav Tunjic,
Prof. Colin Atkinson

Used by permission

Presented at: VAO 2015

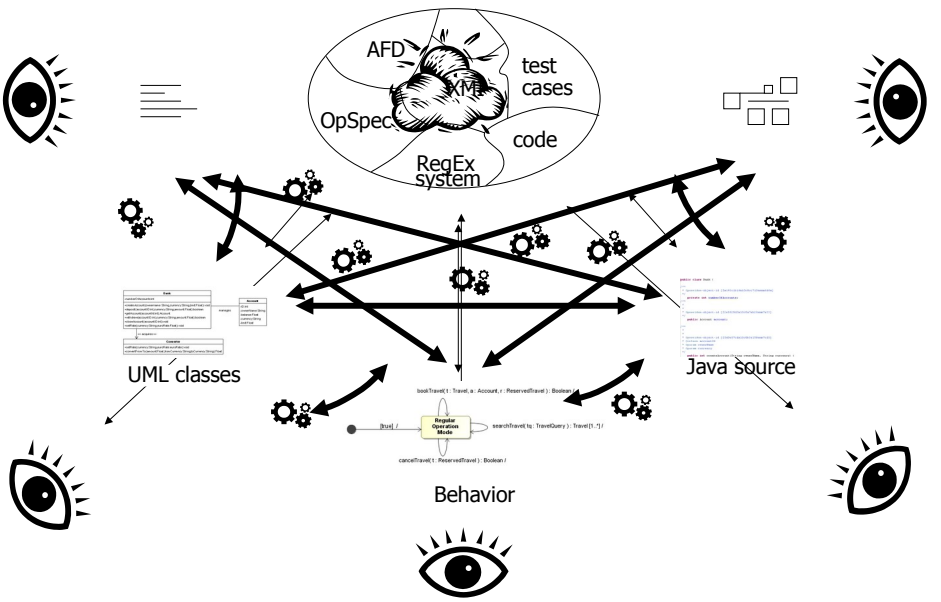
L'Aquila. Italy
21 July, 2015

UNIVERSITÄT MANNHEIM

33.1. The Macromodel “Single-Underlying Model (SUM)”

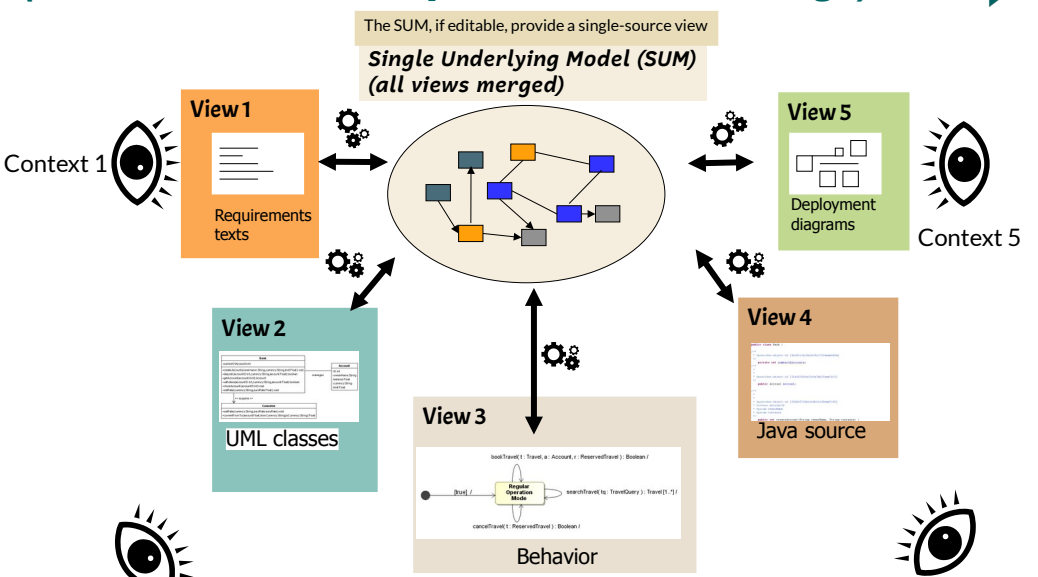
- is based on a ***repository (repository-based SUM)*** [Atkinson19]

Traditional View-based Software Engineering (VOSE)



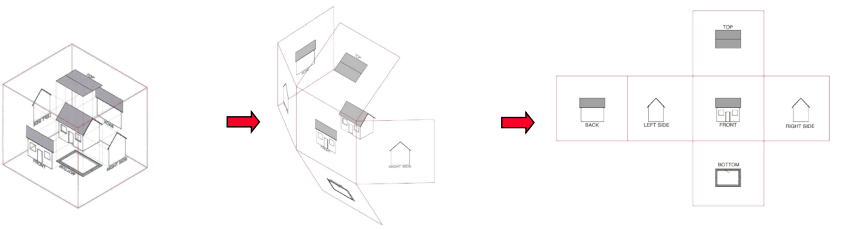
let‘s take a look again at the current status with a picture

On-Demand View Generation in a SUM (Flat Contexts Correspond to Colors or Tags)

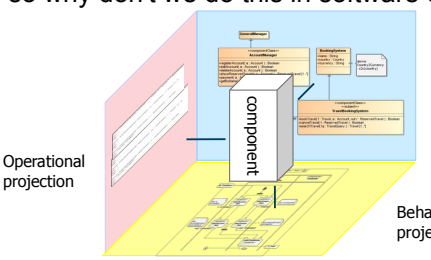


Orthographic Software Modeling (OSM) as a SUM

- Many engineering disciplines have a long and successful tradition of technical drawing - orthographic projection

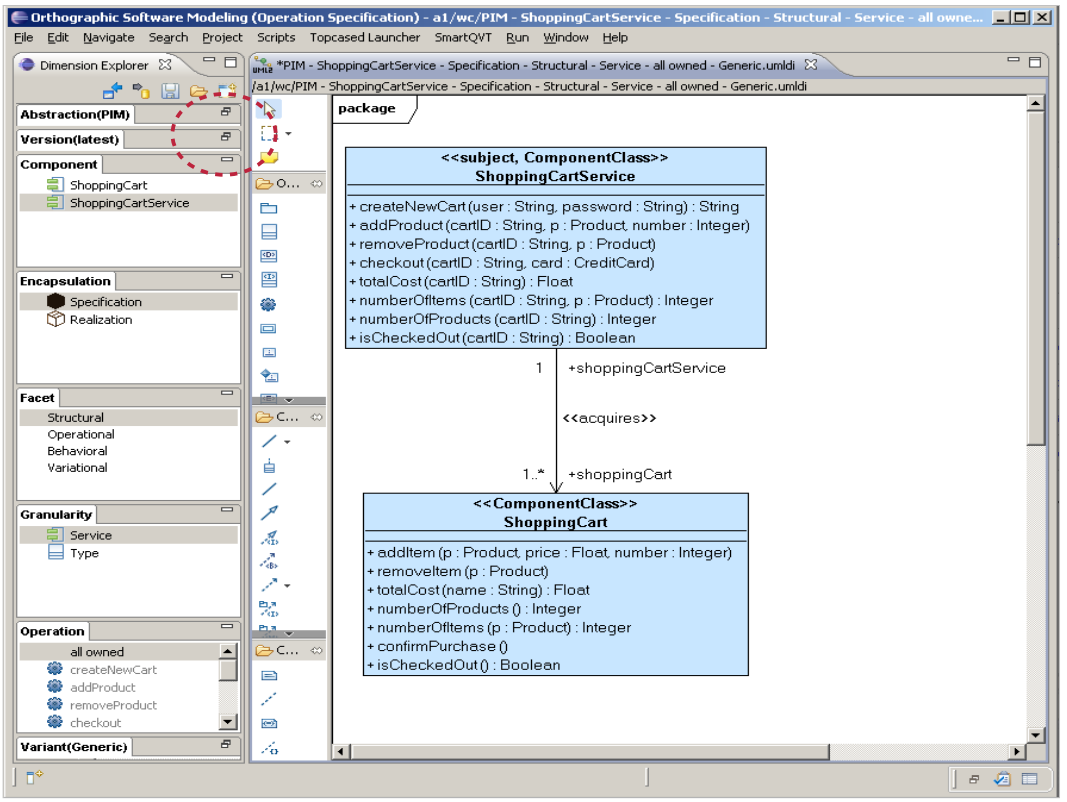


- so why don't we do this in software engineering?



- On demand view generation (projective views)
- Dimension-based navigation
- View-based methodology
- Arrangement in a multidimentional SUM

apply this metaphor to SE


Orthographic Software Modeling (Operation Specification) - a1/wc/PIM - ShoppingCartService - Specification - Structural - Service - all owne...
File Edit Navigate Search Project Scripts Topcased Launcher SmartQVT Run Window Help
Dimension Explorer
*PIM - ShoppingCartService - Specification - Structural - Service - all owned - Generic.umldi
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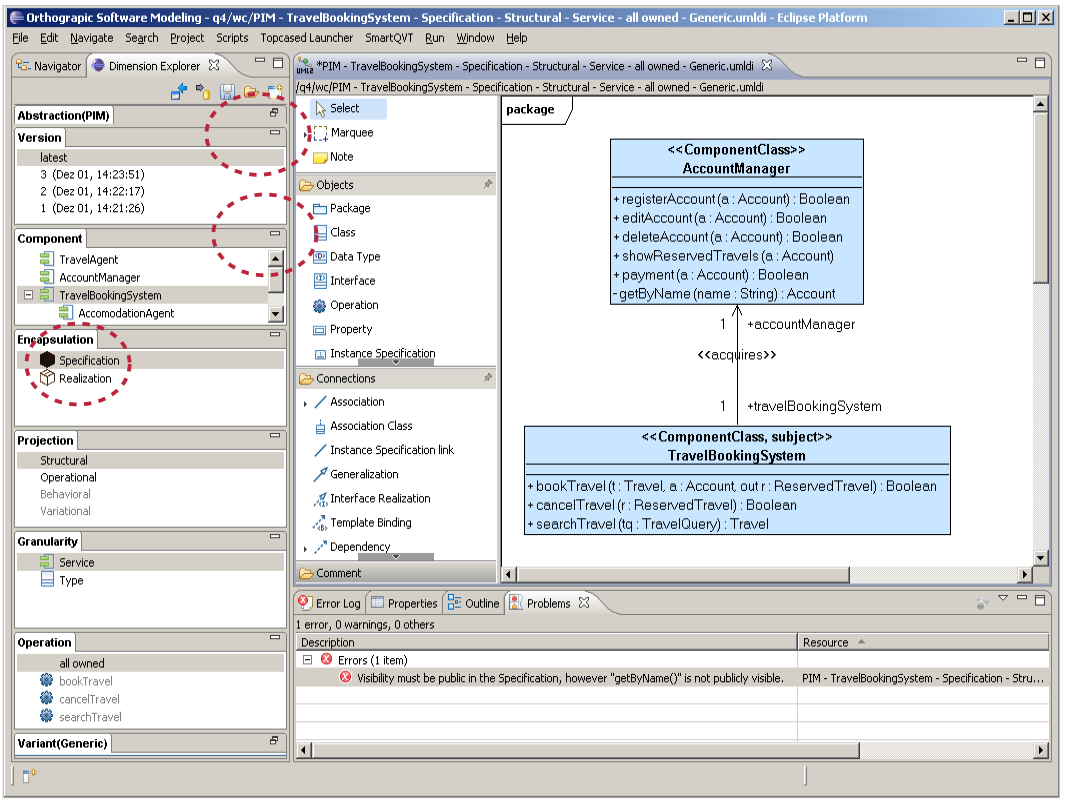
Abstraction(PIM)
Version(latest)
Component
ShoppingCart
ShoppingCartService
Encapsulation
Specification
Realization
Facet
Structural
Operational
Behavioral
Variational
Granularity
Service
Type
Operation
all owned
createNewCart
addProduct
removeProduct
checkout
Variant(Generic)
package
<<subject, ComponentClass>>
ShoppingCartService
+ createNewCart (user : String, password : String) : String
+ addProduct (cartID : String, p : Product, number : Integer)
+ removeProduct (cartID : String, p : Product)
+ checkout (cartID : String, card : CreditCard)
+ totalCost (cartID : String) : Float
+ numberOfItems (cartID : String, p : Product) : Integer
+ numberOfProducts (cartID : String) : Integer
+ isCheckedOut (cartID : String) : Boolean
1
+shoppingCartService
<<acquires>>
1..*
+shoppingCart
<<ComponentClass>>
ShoppingCart
+ addItem (p : Product, price : Float, number : Integer)
+ removeItem (p : Product)
+ totalCost (name : String) : Float
+ numberOfProducts () : Integer
+ numberOfItems (p : Product) : Integer
+ confirmPurchase ()
+ isCheckedOut () : Boolean


Orthograpic Software Modeling - q4/wc/PIM - TravelBookingSystem - Specification - Structural - Service - all owned - Generic.umldi - Eclipse Platform
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Navigator
Dimension Explorer
Abstraction(PIM)
Version
latest
3 (Dez 01, 14:23:51)
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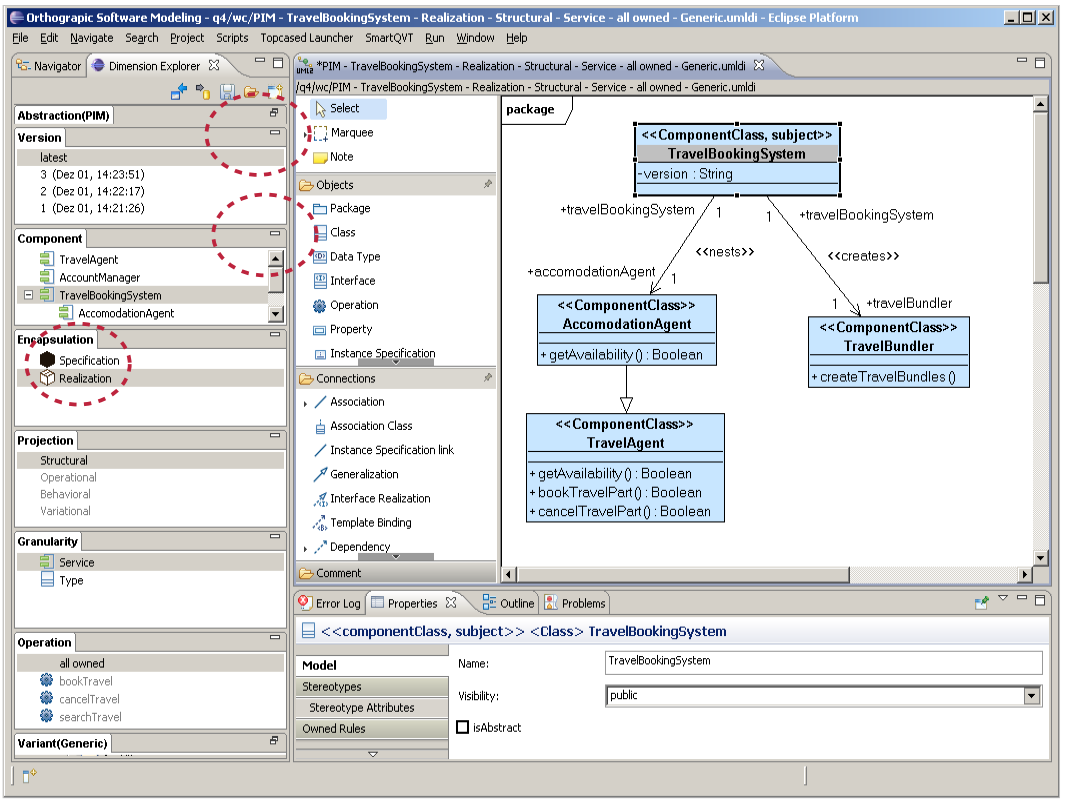
1 (Dez 01, 14:21:26)
Component
TravelAgent
AccountManager
TravelBookingSystem
AccomodationAgent
Encapsulation
Specification
Realization
Projection
Structural
Operational
Behavioral
Variational
Granularity
Service
Type
Operation
all owned
bookTravel
cancelTravel
searchTravel
Variant(Generic)
*PIM - TravelBookingSystem - Specification - Structural - Service - all owned - Generic.umldi
/q4/wc/PIM - TravelBookingSystem - Specification - Structural - Service - all owned - Generic.umldi
Select
Marquee
Note
Objects
Package
Class
Data Type
Interface
Operation
Property
Instance Specification
Connections
Association
Association Class
Instance Specification link
Generalization
Interface Realization
Template Binding
Dependency
Comment
package
<<ComponentClass>>
AccountManager
+ registerAccount (a : Account) : Boolean
+ editAccount (a : Account) : Boolean
+ deleteAccount (a : Account) : Boolean
+ showReservedTravels (a : Account)
+ payment (a : Account) : Boolean
- getByName (name : String) : Account
1
+accountManager
<<acquires>>
1
+travelBookingSystem
<<ComponentClass, subject>>
TravelBookingSystem
+ bookTravel (t : Travel, a : Account, out r : ReservedTravel) : Boolean
+ cancelTravel (r : ReservedTravel) : Boolean
+ searchTravel (tq : TravelQuery) : Travel
Error Log
Properties
Outline
Problems
1 error, 0 warnings, 0 others
Description
Resource
Errors (1 item)
Visibility must be public in the Specification, however "getByName()" is not publicly visible.
PIM - TravelBookingSystem - Specification - Stru...


Orthograpic Software Modeling - q4/wc/PIM - TravelBookingSystem - Realization - Structural - Service - all owned - Generic.umldi - Eclipse Platform
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Variational
Granularity
Service
Type
Operation
all owned
bookTravel
cancelTravel
searchTravel
Variant(Generic)
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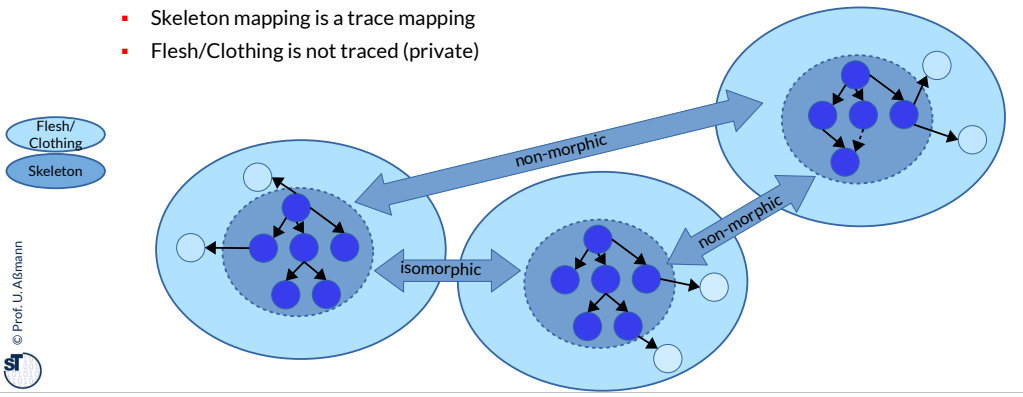
Select
Marquee
Note
Objects
Package
Class
Data Type
Interface
Operation
Property
Instance Specification
Connections
Association
Association Class
Instance Specification link
Generalization
Interface Realization
Template Binding
Dependency
Comment
package
<<ComponentClass, subject>>
TravelBookingSystem
-version : String
+travelBookingSystem
1
1
+travelBookingSystem
<<nests>>
<<creates>>
+accomodationAgent
1
1
+travelBundler
<<ComponentClass>>
AccomodationAgent
+getAvailability() : Boolean
<<ComponentClass>>
TravelBundler
+createTravelBundles()
<<ComponentClass>>
TravelAgent
+getAvailability() : Boolean
+bookTravelPart() : Boolean
+cancelTravelPart() : Boolean
Error Log
Properties
Outline
Problems
<<componentClass, subject>> <Class> TravelBookingSystem
Model
Stereotypes
Stereotype Attributes
Owned Rules
Name:
TravelBookingSystem
Visibility:
public
isAbstract

33.2. The Skeleton-SUM

[Hettel08]
[Seifert11]

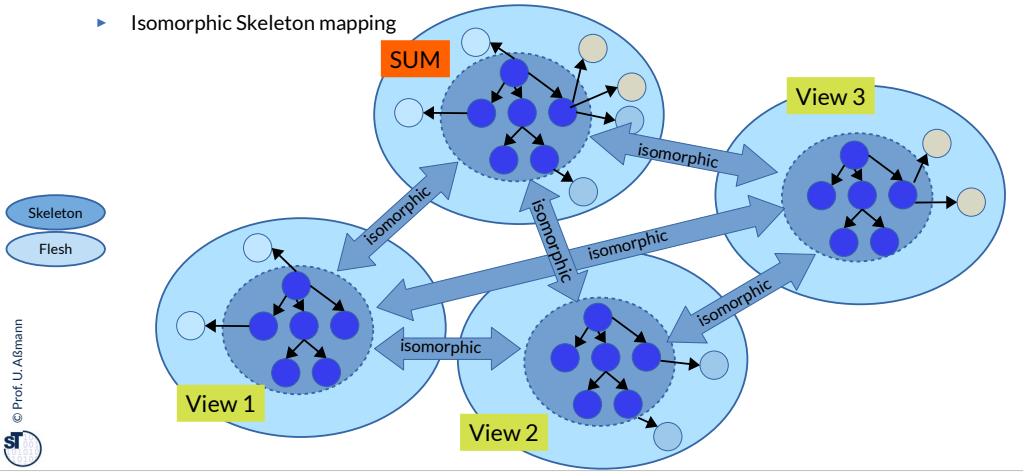
Skeletons and Flesh

- Skeleton splits models into
  - **Skeletons** (redundant) (several contexts)
  - and **flesh (clothing)** (locally different stuff in views, mono-context)
- Global invariants on skeletons vs. local „flesh“ variants
- Flesh must be non-overlapping, extending the skeleton
- Skeletons can have isomorphic, homomorphic, monotonically extended “skeleton” mappings,
  - or may be non-morphic
  - Skeleton mapping is a trace mapping
  - Flesh/Clothing is not traced (private)



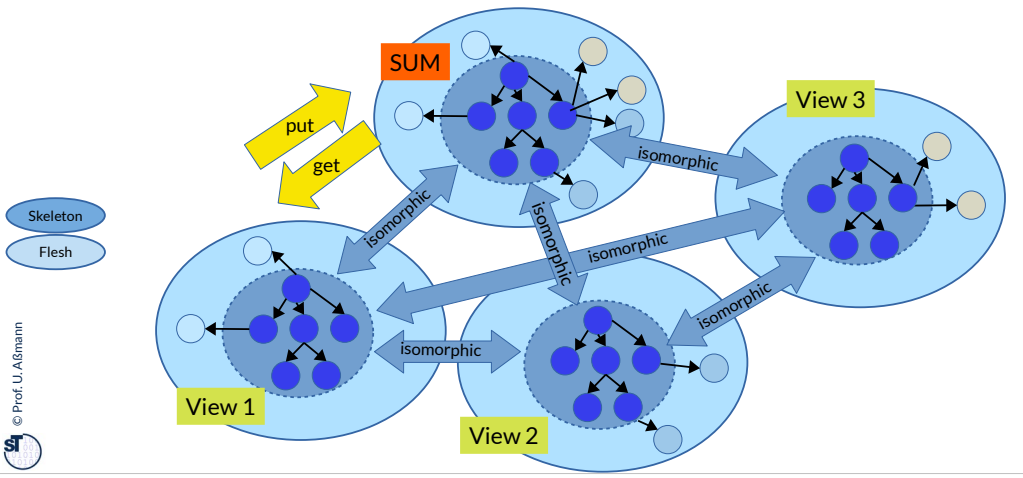
Mono-Skeleton-SUM

- Mono-Skeleton-SUM splits models into
  - **One common Skeleton** (redundant) (several contexts)
  - and **flesh (clothing)** (locally different stuff in views, mono-context) is stored in SUM together with skeleton
- Flesh must be non-overlapping, extending the skeleton
- Isomorphic Skeleton mapping



Get/Put in Mono-Skeleton-SUM

- From a Skeleton-SUM
  - get operation produces a view
  - put operation commits it into SUM

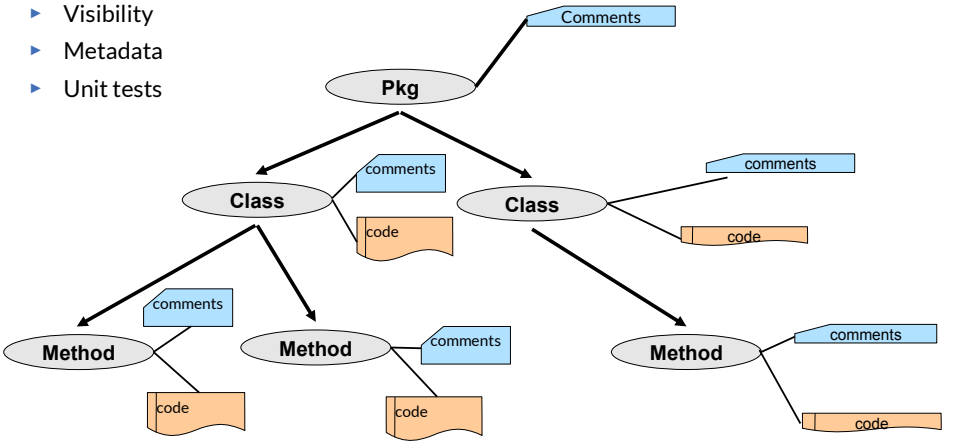


33.2.1 Javadoc-SUM, a Mono-Skeleton-SUM for Documentation

Example Skeleton-SUM:
Scope tree of a program (static structuring)

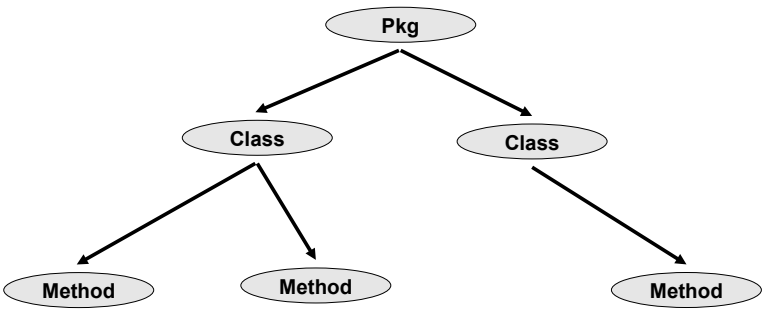
Javadoc comment relies on several attributes of nodes of the syntax tree:

- Comments (package, class, method, parameter)
- Code (*skeleton*)
- Visibility
- Metadata
- Unit tests



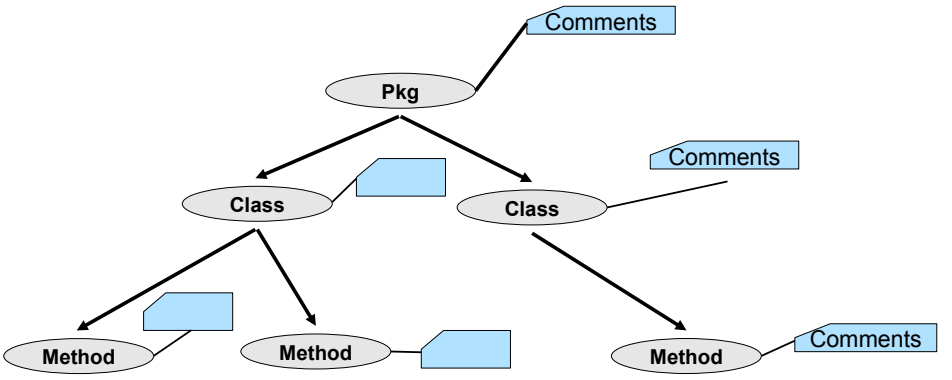
Projecting A Scope Tree for Skeleton

- put/get operations transform SUM to views and back
- Get: partial function projection
- Put: merge of partial function of view and of SUM
- Exa.: result of get operation for Scope Tree “Skeleton”:



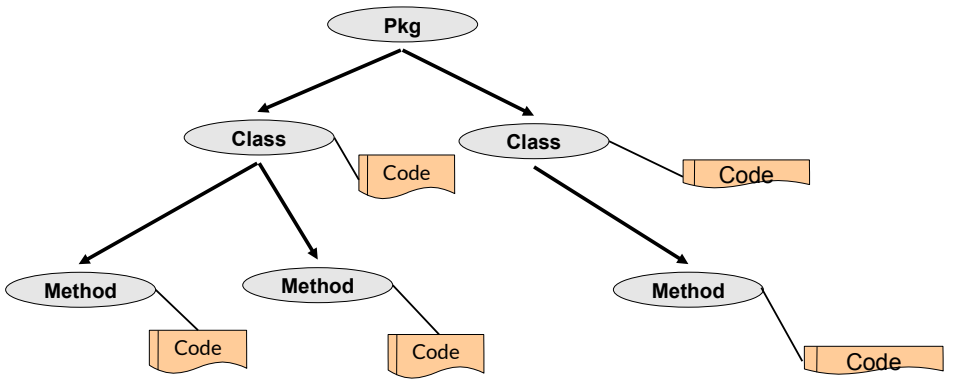
Projecting A Scope Tree for Skeleton

- Result of get operation for For Comment Context “Comment Flesh”:



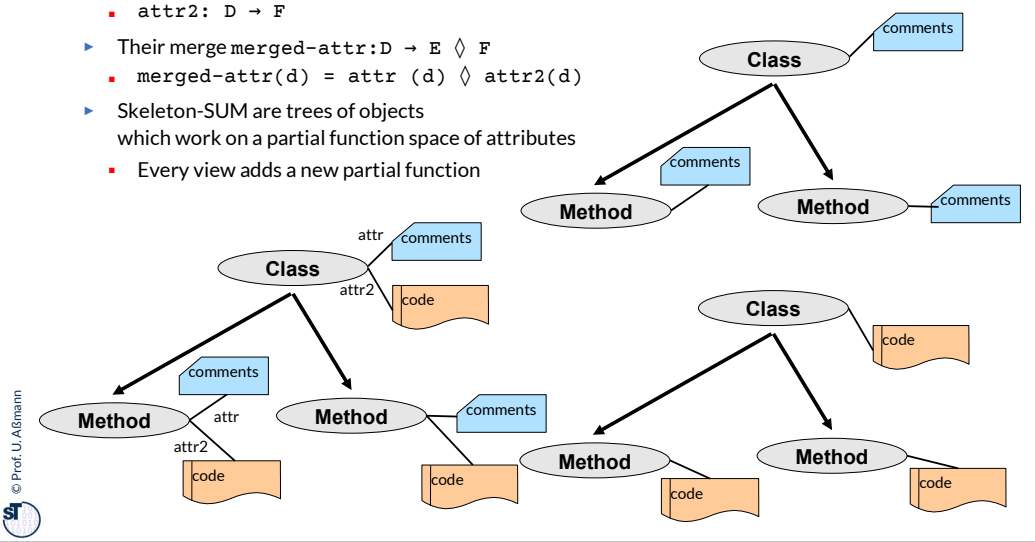
Projecting A Scope Tree for Skeleton

- Result of get operation for Code Context “Code Flesh”:

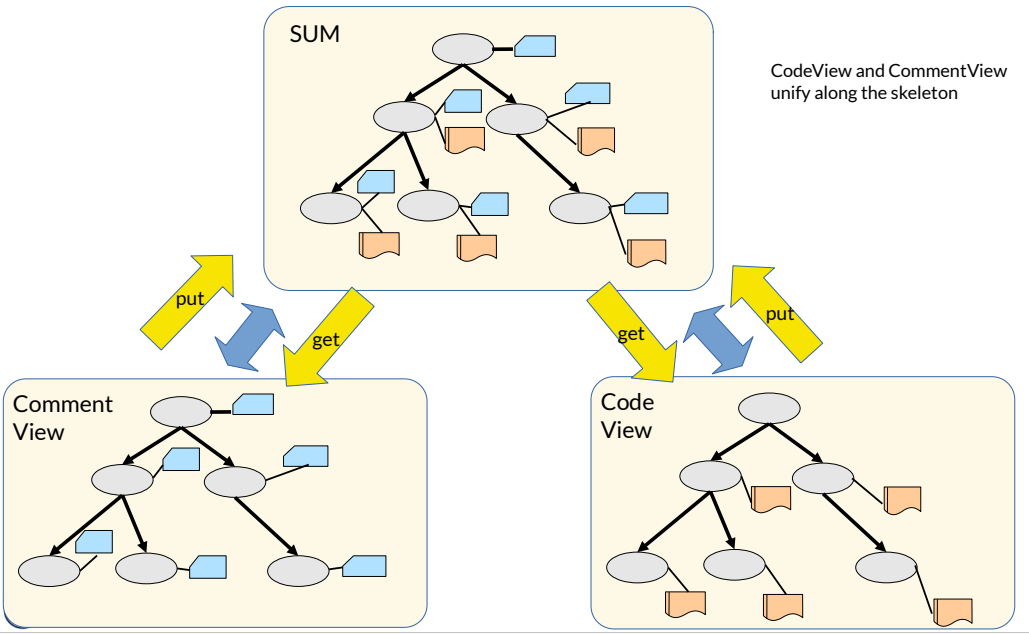


Merge of Partial Functions and Partial Trees in a Mono-Skeleton-SUM

- Given two partial functions on tree-node domain D and two domains E, F:
  - `attr: D → E` and
  - `attr2: D → F`
- Their merge `merged-attr:D → E ◊ F`
  - `merged-attr(d) = attr (d) ◊ attr2(d)`
- Skeleton-SUM are trees of objects
  which work on a partial function space of attributes
  - Every view adds a new partial function



Javadoc-SUM:
A Simple Metamodel-based Mono-Skeleton-SUM



Remarks on Mono-Skeleton-SUM

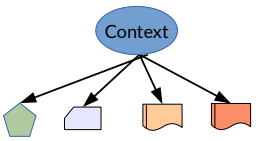
- **Generality:** The Skeleton need not be a link tree; it can be an arbitrary graph data structure
  - But RAGs can model Mono-Skeleton-SUMs very easily: inherit the flesh attributes to all nodes
- Between Skeleton and Flesh there holds a **key dependency**
  - A partial function describes the mapping between skeleton and flesh
  - Different partial functions exist for every view
  - Flesh-skeleton unification employs partial function merge (feature term unification)

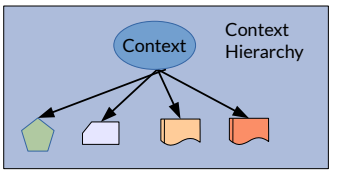
33.3. Context-Based Skeleton-SUM

[Hettel08]
[Seifert11]

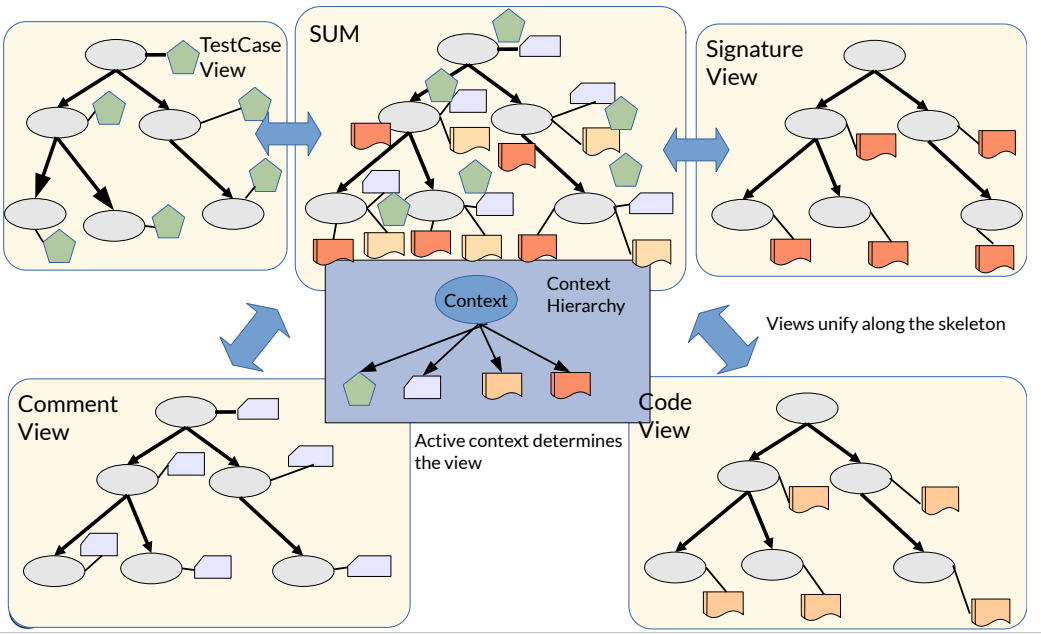
Skeleton-SUM

- Clothing can be associated to context (context-aware clothing)
  - Code context
  - Comment context
- If all clothings have mono-context, the SUM is called ***flat contextual SUM.***





A Metamodel-based Skeleton-SUM with Flat Context Hierarchy



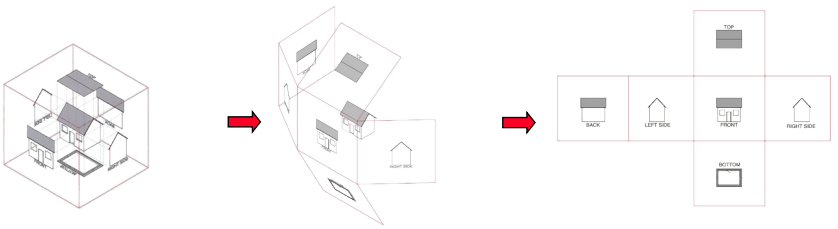
33.3.1. Orthographic Software Modeling (OSM) as a Dimensional, Context-Based Skeleton-SUM

[Hettel08]
[Seifert11]

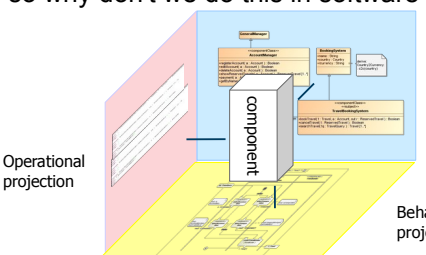
DRESDEN concept
Exzellenz aus Wissenschaft und Kultur

Orthographic Software Modeling (OSM) as a Dimensional Skeleton-SUM

- Many engineering disciplines have a long and successful tradition of technical drawing - orthographic projection



- so why don't we do this in software engineering?

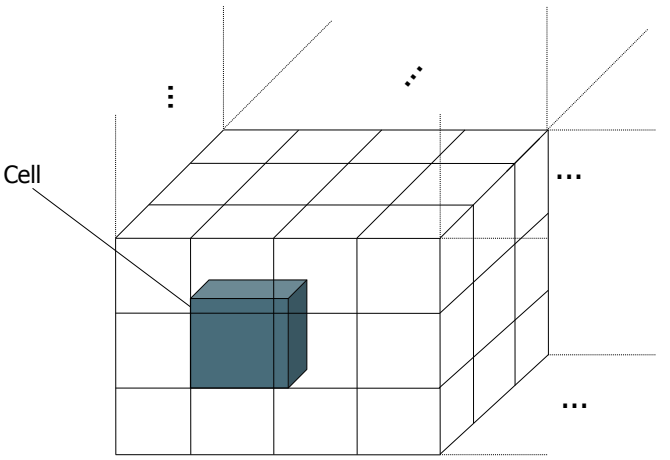


- On demand view generation (projective views)
- Dimension-based navigation
- View-based methodology

apply this metaphor to SE

Dimension Based Navigation

- views organized in a multi-dimensional cube
- one choice always “selected” from each dimension
- each cell represents a viewpoint



OSM is a Flat Contextual Skeleton-SUM

- OSM defines *n-dimensional contexts*, i.e., every model element is related to n contexts.
- OSM can be realized by a Skeleton-SUM providing n mono-contextual clothings
  - i.e., n mono-contextual attributes for every model element (link tree node).
- The n dimensions (contexts) are used for projection
- Instead of attributes, model elements have roles (CROM-Skeleton-SUM)

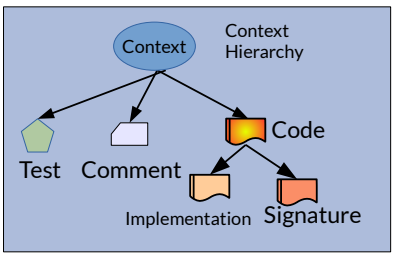
- ROSIMA is a CROM-Skeleton-SUM

33.4. Hierarchic Context-Based Skeleton-SUM

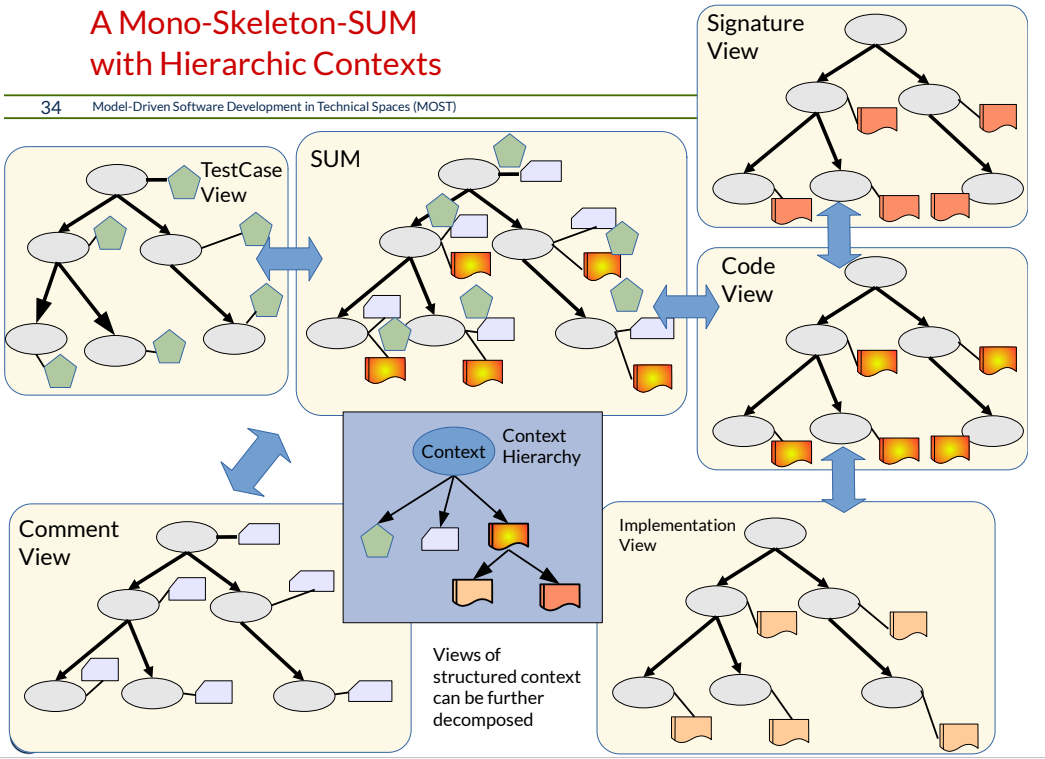
[Hettel08]
[Seifert11]

Hierarchic Skeleton-SUM

- Clothing can be associated to structured context
  - Code context
    - Signatures
    - Implementation
  - Comment context
- If som clothings have an inner (structured) context, the SUM is called **hierarchic contextual SUM.**



A Mono-Skeleton-SUM with Hierarchic Contexts

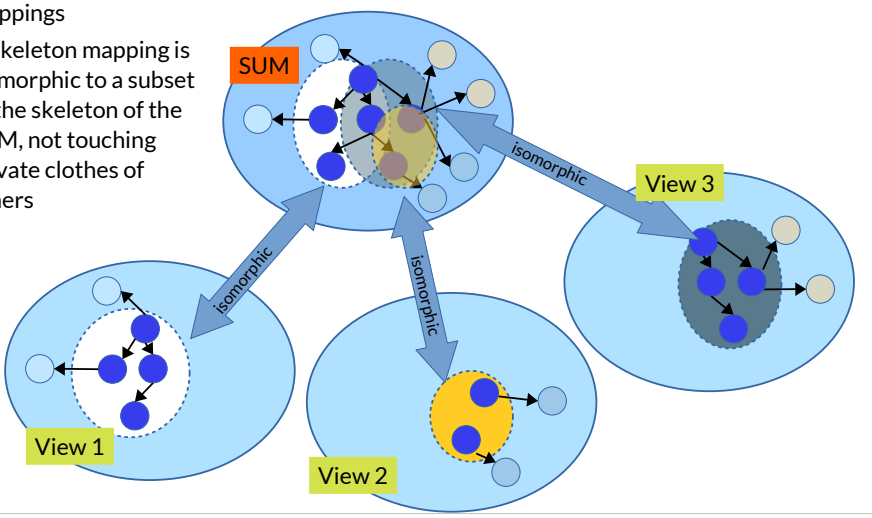


33.5. Multi-Skeleton-SUM

[Seifert11]

Multi-Skeleton-SUM

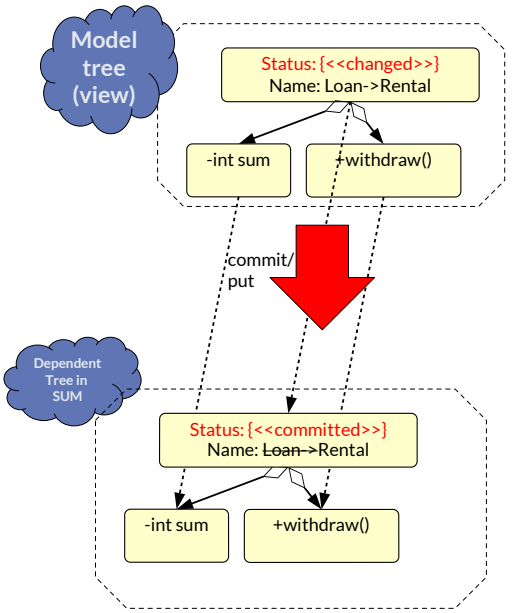
- In SUMs, not all Skeletons need not be a linked by isomorphic mappings
- A Skeleton mapping is isomorphic to a subset of the skeleton of the SUM, not touching private clothes of others
- Every Skeleton must be invariant, and within the SUM, a Skeleton—Skeleton mapping must exist



33.5.2 Put Operations in the MDA-Multi-Skeleton-SUM

Model Synchronization in RAG-MDA by `Put` Operations on Single Underlying Models (SUM)

- A single underlying model (SUM) is a cultimodel with *views*
- MDA can be arranged as MDA-SUM
- A **evolution operation** changes a global name or definition in one model tree a view, which used in several other model trees in the SUM
- To synchronize dependent model elements, we need a `commit/put` operation ("**commit/put to SUM**")
- Its implementation needs to repeat the rewrite in all referencing places
  - Follow the references introduced by global name analysis
  - Standard process in RAG
- Easy traceability by dependency graph between global names



Example: different class implementations of a connector class in a PIM

33.6 Delta-Based Lenses for Incremental Modifications for Scalability and Applicability of Skeleton-SUMs

[Diskin]

Delta-Based Lenses for Scalability and Applicability

- Simple minded implementation approach –
  - uni-directional *exhaustive* transformations
    - get: SUM-to-view, put: view-to-SUM
  - create a new (version of the) view whenever there is a change in the SUM
  - create a new (version of the) SUM whenever there is a change in a view
- Would work but too large grained
  - Not scalable (inefficient)
  - No incrementality
  - transformation more complex than necessary

⇒ The necessary get/put operations are called ***bidirectional lenses***

Delta-Based Lenses and Skeleton SUMs

- ***Lenses*** (Pierce et al. 2007) are pairs of bidirectional transformations based on get (exhaustive projection, decomposition, checkout) and put (exhaustive integration, checkin) operations on models
  - axioms for *well-behaved lenses*

    v: View; s:SUM
    get(put(v, s)) = v // *PUTGET invariant rule*
    put(get(s), s) = s // *GETPUT invariant rule*

  - axiom for *very well behaved lenses:* "intermediary puts can be forgotten"

    put(v', put(v, s)) = put(v', s) // *PUTPUT invariant rule*

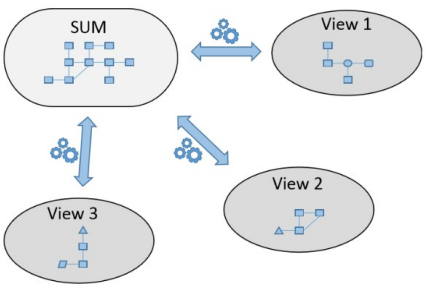
- ***Delta-based Lenses*** optimize the checkin/checkout (Diskin et al. 2011)
  - *Incremental* delta operations dput and dget are driven by the changes to the views
  - axiom for delta-put: "If a delta-commit results in a delta of the SUM, then the next delta-checkout refers only to this delta of the SUM"

    if $\Delta s = dput(\Delta v, s)$, then $dget(\Delta s) = \Delta v$ // *DeltaPUTPUT rule*

  - much more fine-grained and scalable

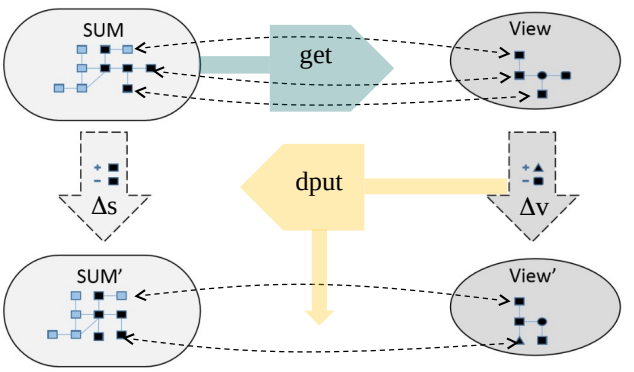
The Background of Orthographic Software Modeling (OSM)

- In OSM, the SUM is much larger than the views
  - the views are relatively small and compact
- Views can be updated concurrently
  - axioms only applicable locally (i.e. to one view at a time)
- Usually have one-to-one correspondences between view elements and SUM elements
  - changes can conveniently be traced to the affected element
- View elements cannot be changed just locally
  - for example, cannot delete an element from just the view, but not the SUM



Hybrid Approach with dput

- use ***get*** to create views from the SUM
- use ***dput*** (delta put) to update the SUM when a view is changed
  - incremental put operation only transmits the delta (increment)

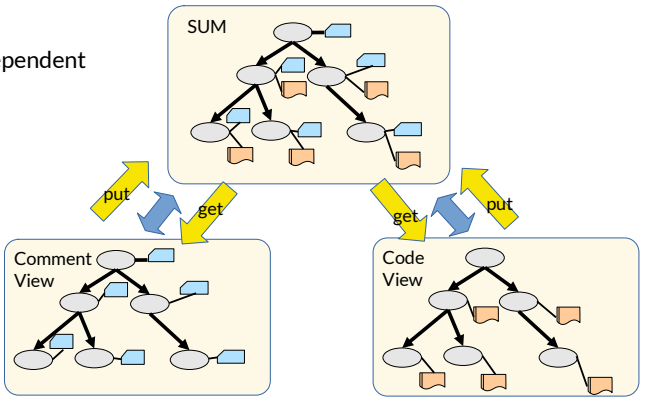


if Δs = dput(Δv, s), then dget(Δs) = Δv // *DeltaPUTPUT rule*

Skeleton-SUM and DeltaPutPut

A Skeleton-SUM fulfills the DeltaPutPut rule.

- Reason:
  - Partial functions are independent
  - Skeleton stays invariant
- Corollary
  - therefore OSM
  - therefore Javadoc-SUM



Pros and Cons of the Hybrid Approach

- **Traces** allow affected SUM elements to be efficiently identified
  - can be generated most mainstream transformation engines
  - Traces also allow the open views impacted by a change to be identified
  - Traces must be updated dynamically a la MVC pattern
- Use of ***get*** to create views reduces the complexity of the transformation with little extra overhead
  - no need to update trace information
- Use of ***dput*** to update the SUM greatly enhances the efficiency of updating SUM
  - the SUM is only ever updated via changes to views
- However, it increases the amount of information that needs to be stored on the server
  - part of the SUM?

33.7 Skeleton-SUM on RoSI CROM

Skeleton-SUM on RoSI CROM

- The SUM principle can be played on all metalanguages, e.g., CROM
- CROM supports Mono-Skeleton-SUM for all
  - Contexts provide *viewpoints*
  - Cores provide *Skeleton*, Roles provide *flesh/clothing*
  - Role-play provides *partial functions from objects to roles* for a SkeletonSUM over cores and roles

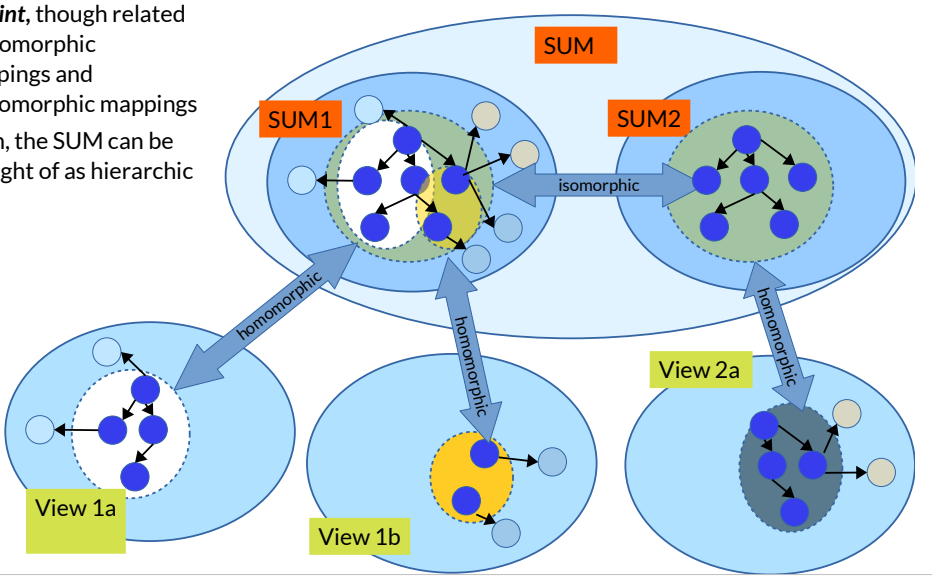
Theorem: A CROM-based Skeleton-SUM fulfils the delta-putput invariant.

33.8. Disjoint-Skeleton-SUM

[Seifert11]

Disjoint-Skeleton-SUM

- Skeletons can be ***disjoint***, though related by isomorphic mappings and homomorphic mappings
- Then, the SUM can be thought of as hierarchic

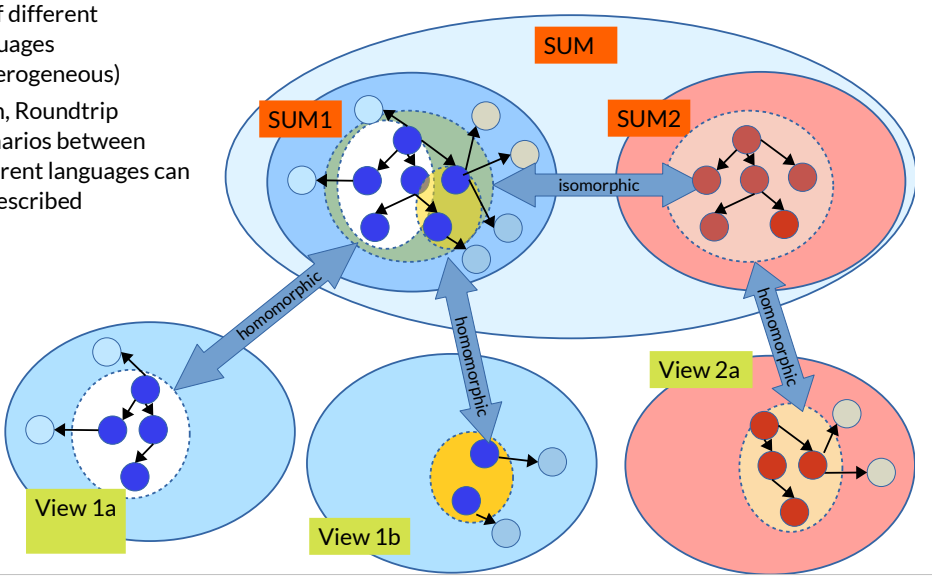


33.8.1 Heterogeneous-Language-Skeleton-SUM

[Seifert11]

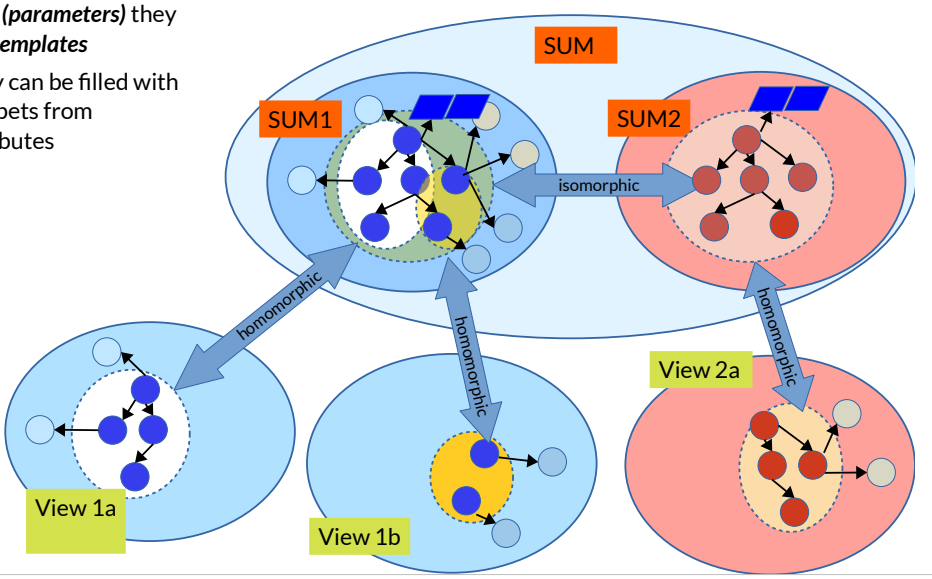
Heterogeneous-Language-Skeleton-SUM

- Disjoing Skeletons can be of different languages (heterogeneous)
- Then, Roundtrip Scenarios between different languages can be described



Heterogeneous-Language-Skeleton-SUM with Templates

- When skeletons have ***slots (parameters)*** they are ***templates***
- They can be filled with snippets from attributes



The End

- Explain, how partial functions between objects and attributes enable the projections (get) and the merge functions (put) of a Skeleton-SUM
- Why are contexts important for views?
- What happens if the SUM has several skeletons?
- Which are the contexts of Javadoc-SUM? Why does Javadoc-SUM fulfill the DeltaPutPut rule?
- Which are the contexts of OSM? Why does OSM fulfill the DeltaPutPut rule?
- Why does ROSI-CROM enable Skeleton-SUM?
- Some slides are courtesy to Prof. Colin Atkinson, Mannheim. Used by permission.