Spatio-temporal Schema Integration with Validation: A Practical Approach.

Anastasiya Sotnykova, Nadine Cullot and Christelle Vangenot
EPFL & Université de Bourgogne

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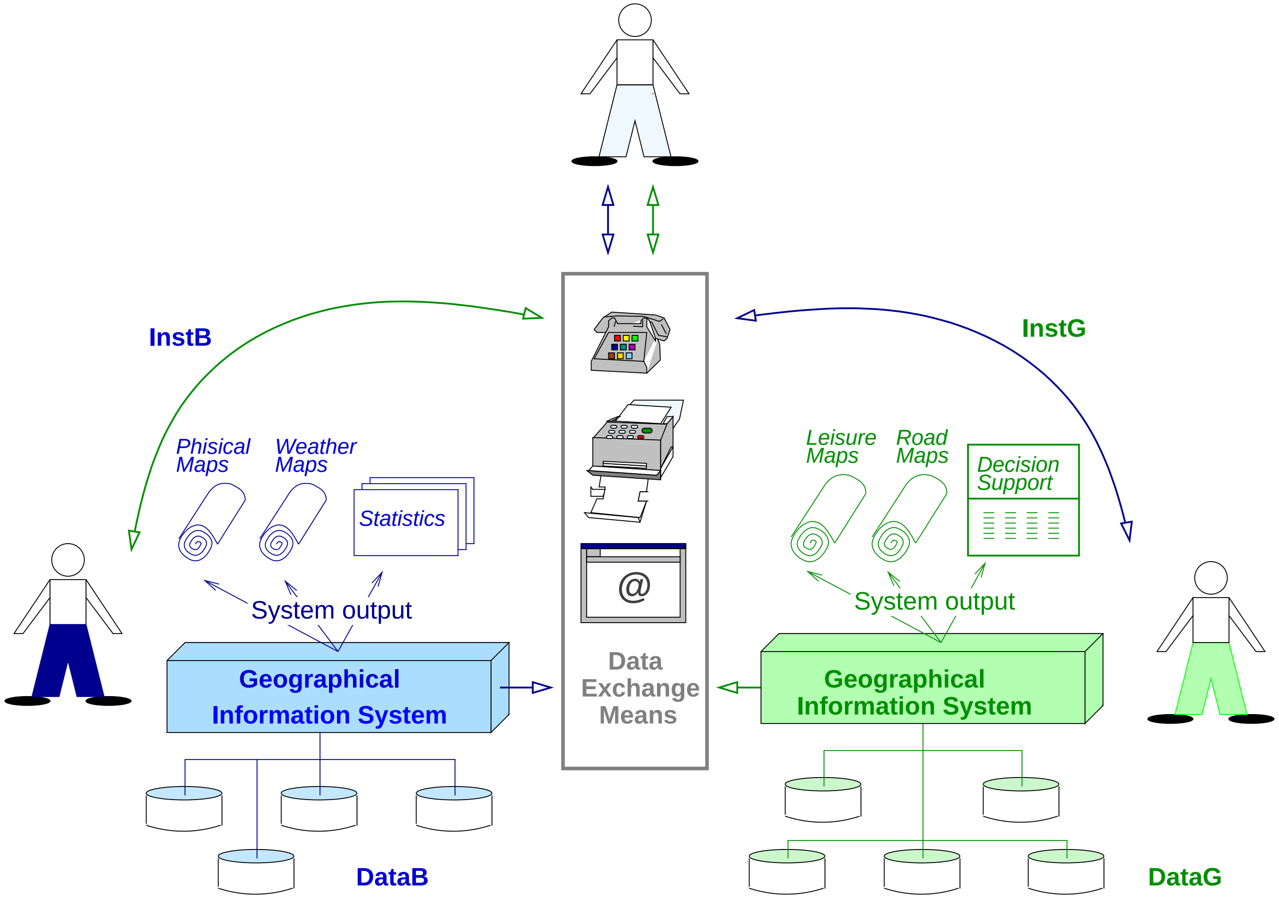
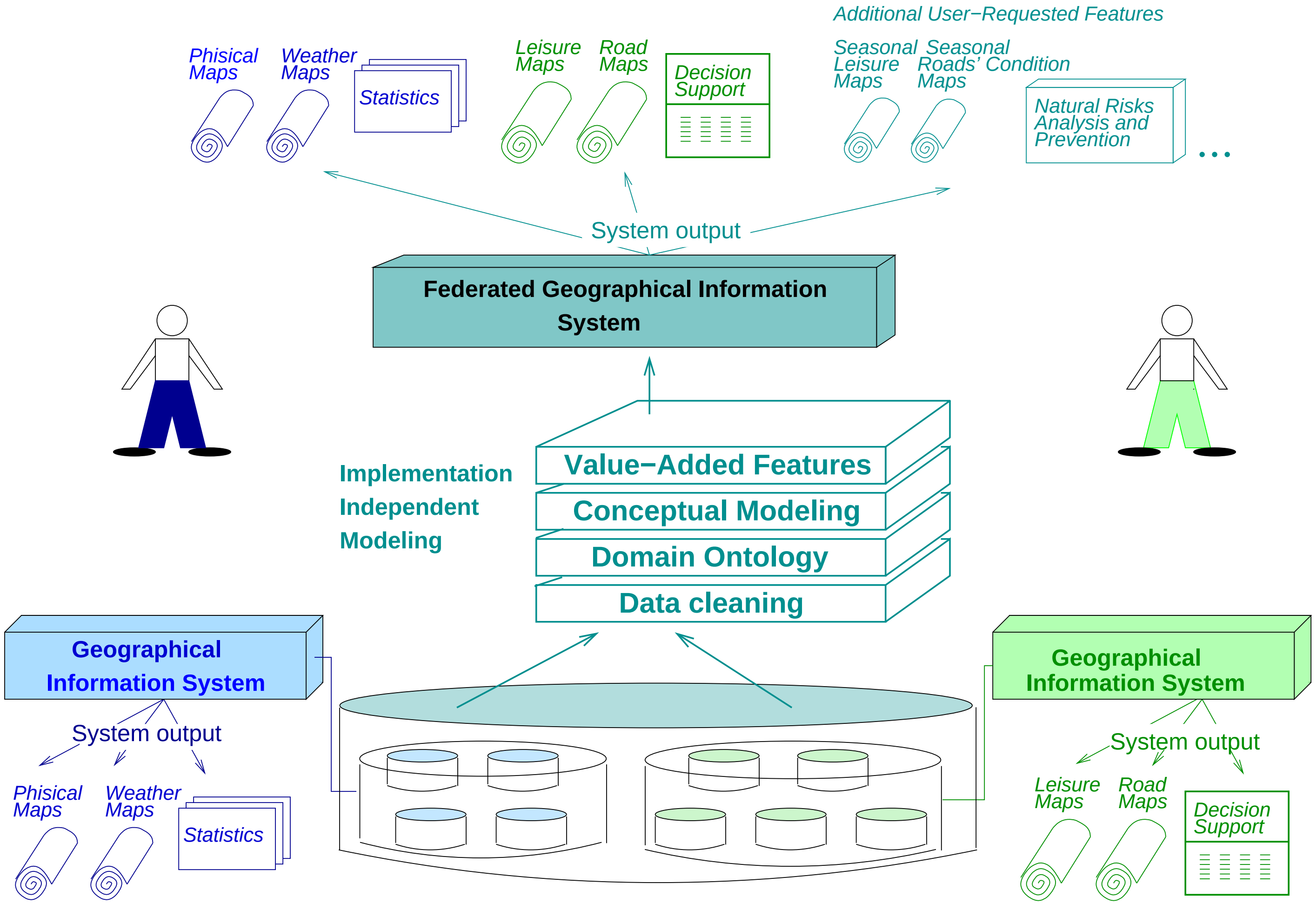
The context . . . before

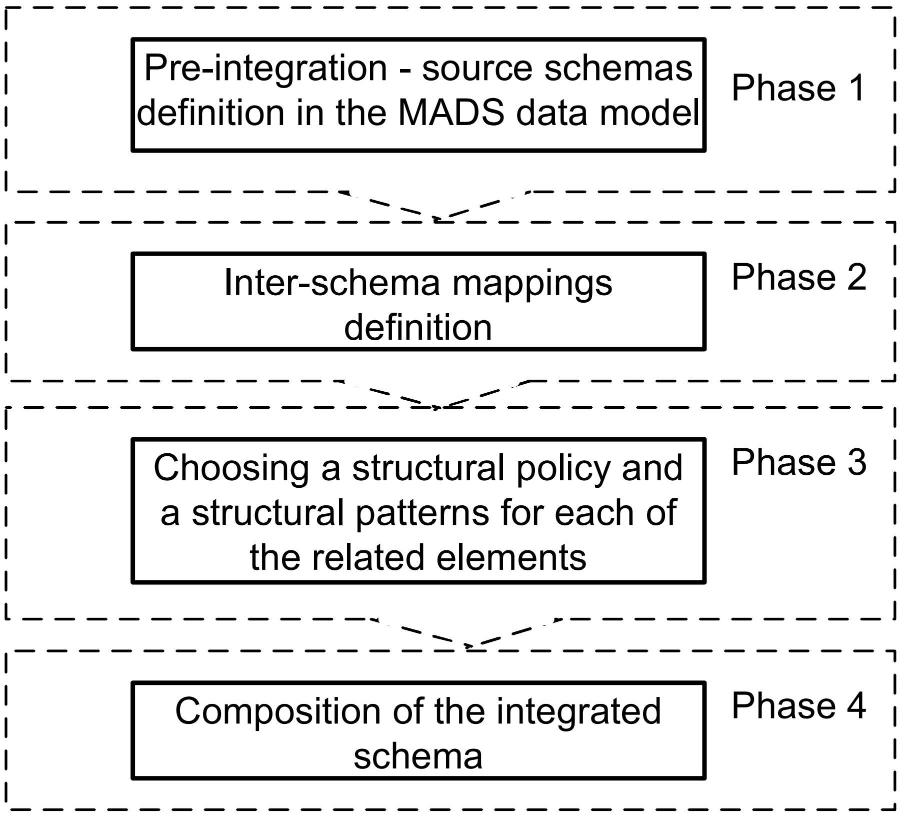


The context . . . after

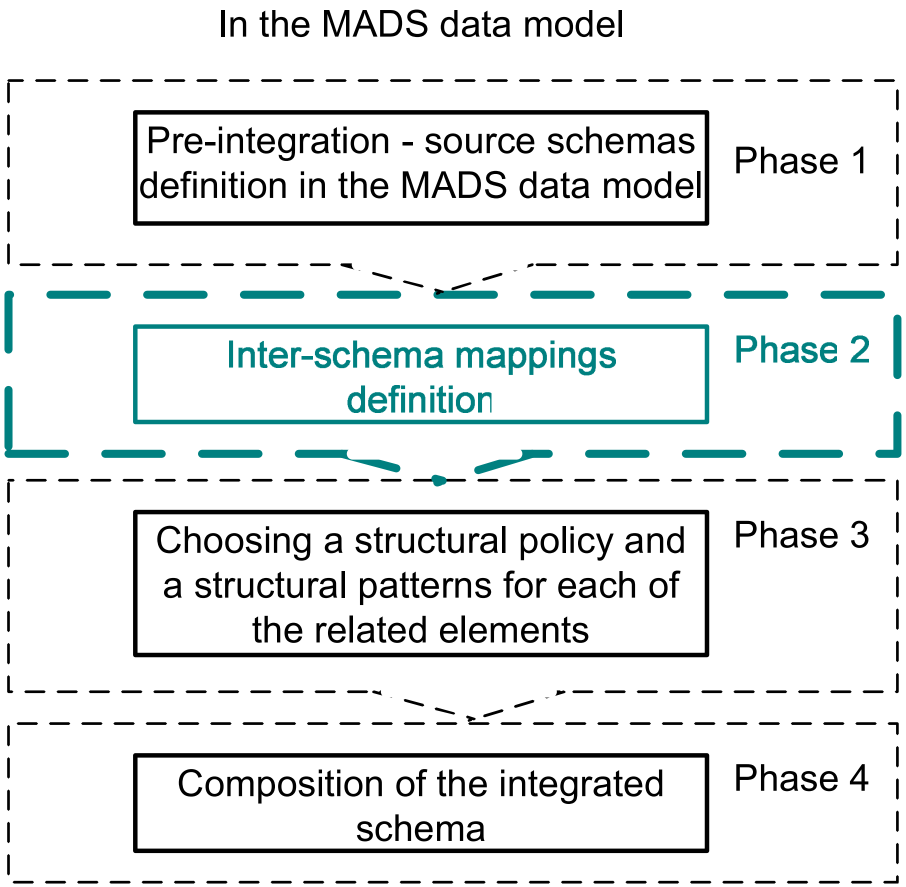


The MADS-based method

In the MADS data model



The MADS-based method



The context . . . semantics

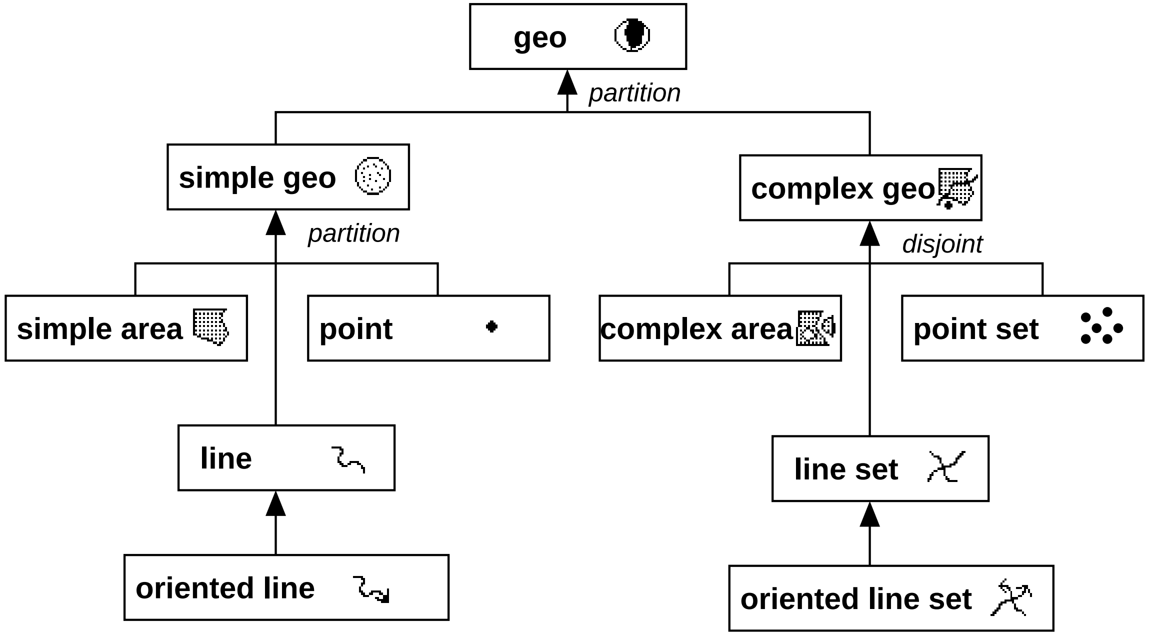
Table 1: How a 'building' object can be represented.

Purpose of representation	User
Architectural style and fitting in the neighborhood environment	Architect department of a city administration
Robustness of the construction of the building and the materials it is built of	Rescue crew of the city
Condition of the building and suitability for living in it	Renovation construction company
Location and dimensions of the building	Cadastral department of the city administration

Common Data Model (CMD) : MADS Data Model

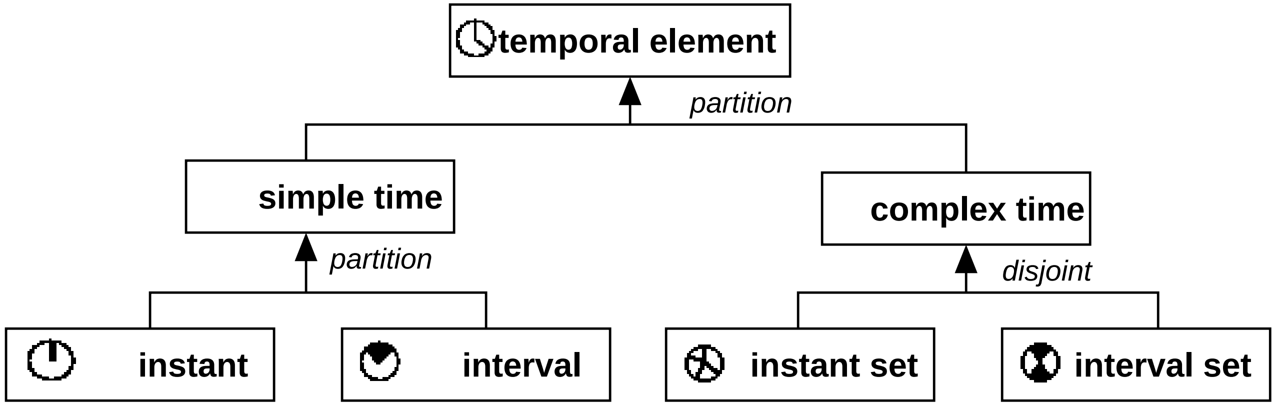
- thematic dimension - ER extended, graphical
- spatial dimension - has a predefined spatial primitives
- temporal dimension - time can be modeled with inbuilt concepts
- topological relationships - relationships between spatial object types
- syncronisation relationships - relationships between temporal object types

MADS spatial



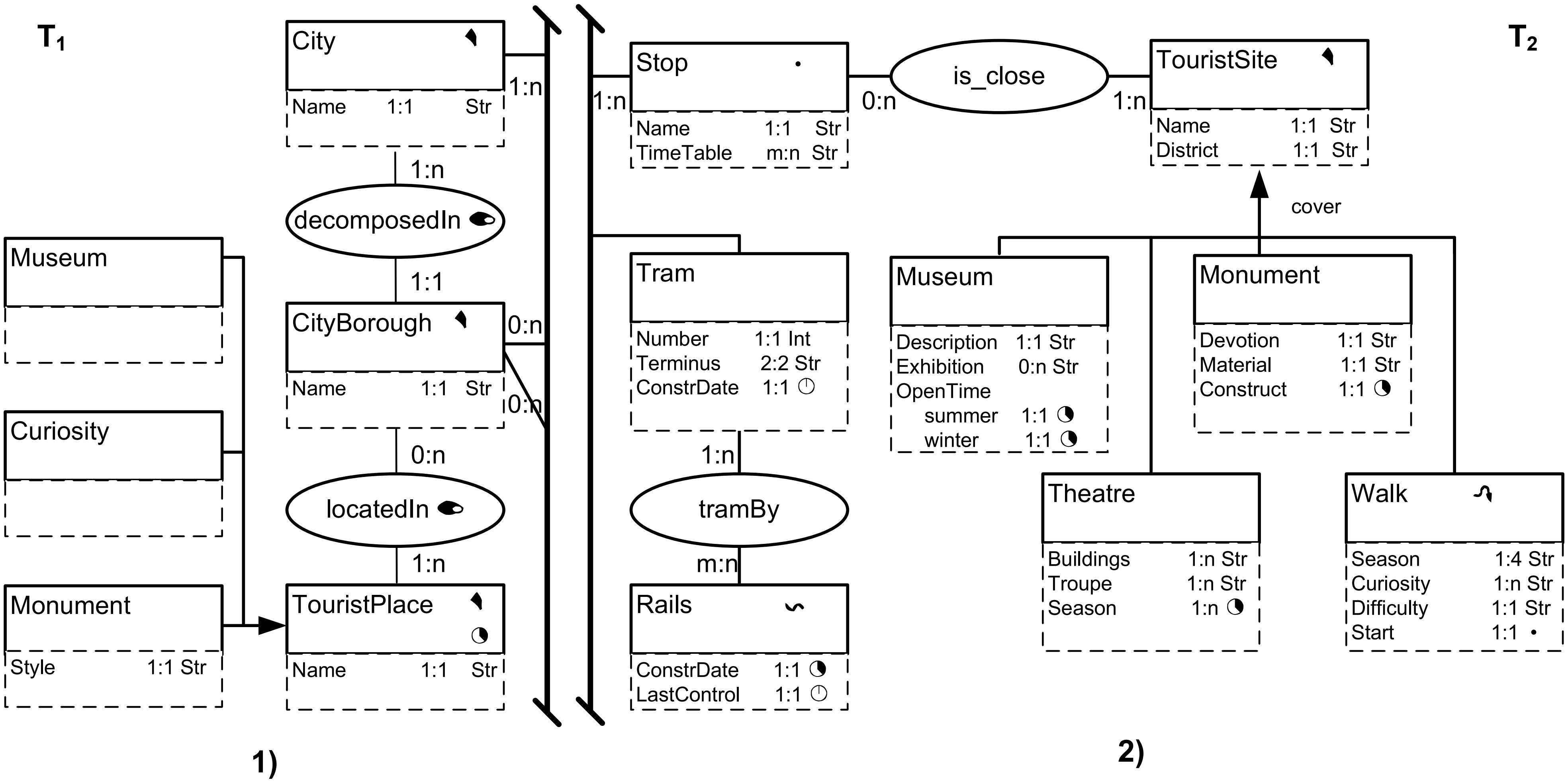
Topological	Icon	Topological	Icon
disjunction	○•	overlapping	◔
adjacency	○•	inclusion	◉
crossing	ς	equality	●

MADS temporal



Synchronization	*Icon*	*Synchronization*	*Icon*
equal		during	
meets		starts	
overlaps		finishes	
before			

Schemas T_1 and T_2



Inter-schema mappings

(1) $\text{TouristPlace}_{T_1} \subseteq \text{TouristSite}_{T_2}$;

(2) $\text{Museum}_{T_2} \subseteq \text{Museum}_{T_1}$;

(3) $\text{Monument}_{T_2} \subseteq \text{Monument}_{T_1}$;

(4) $\text{Museum}_{T_1} \bullet \text{Museum}_{T_2}$;

(5) $\text{Monument}_{T_2} \bullet \text{Monument}_{T_1}$;

(6) $\text{CityBorough}_{T_1}.\text{name} = \text{TouristSite}_{T_2}.\text{district}$;

(7) $\text{TouristPlace}_{T_1} \bullet \text{TouristSite}_{T_2}$

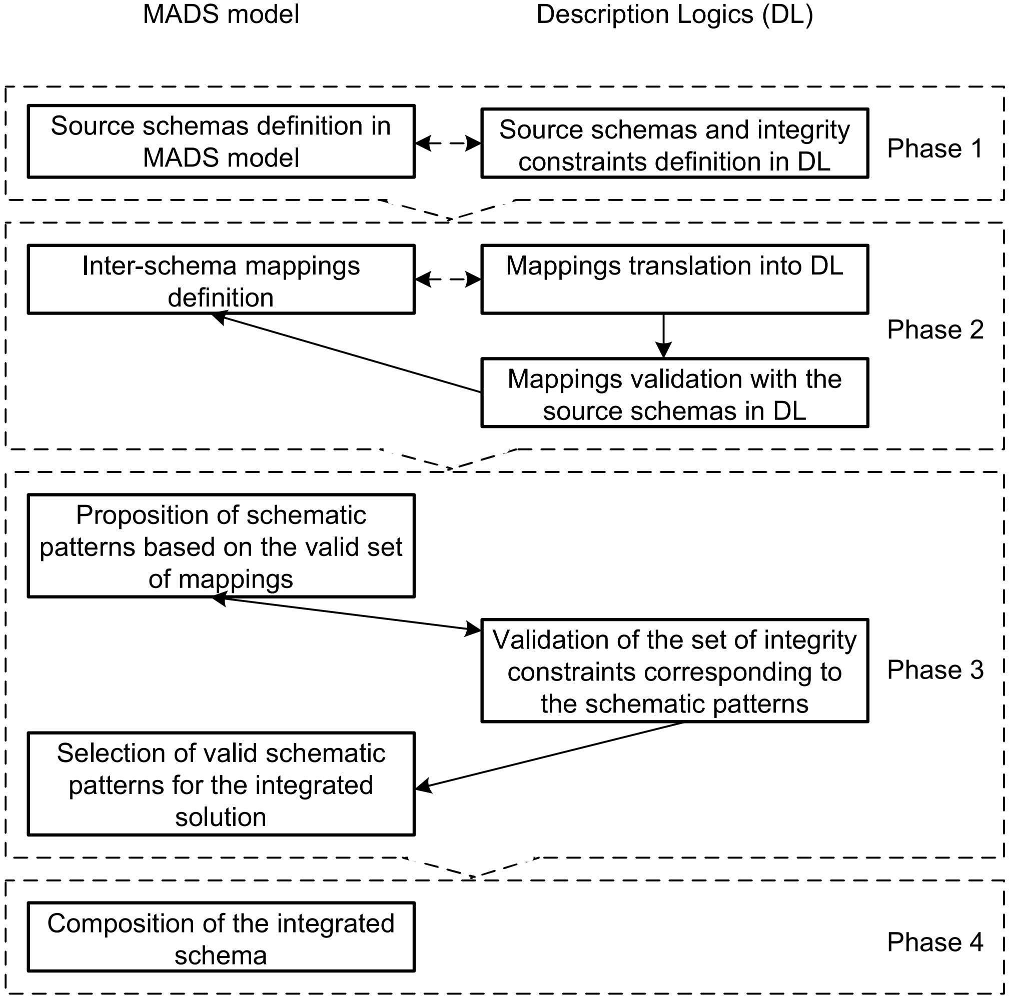
(8) $\text{TouristPlace}_{T_1}.\text{name} = \text{TouristSite}_{T_2}.\text{name}$;

Validation objectives

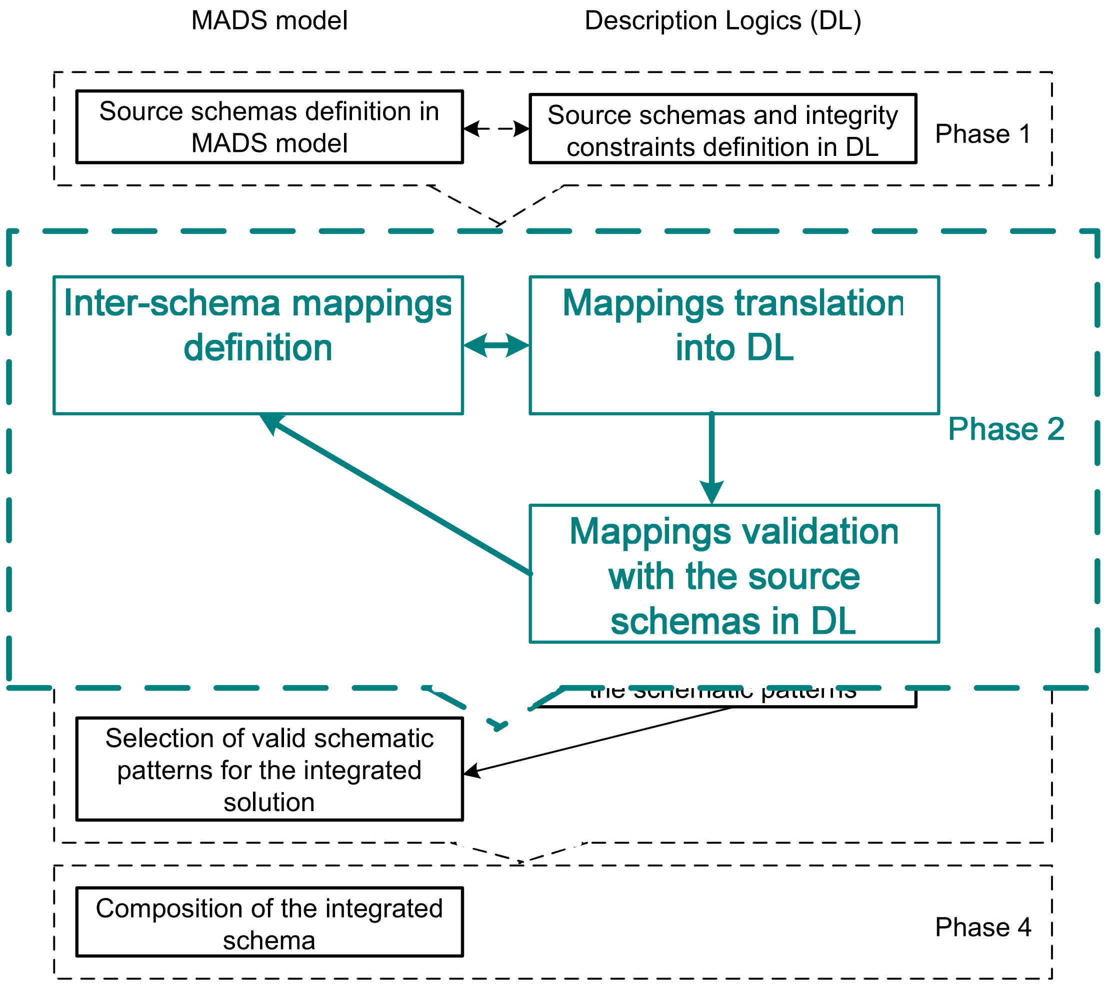
Invalid Correspondences

- $\text{TouristPlace}_{T_1}$ (Time : Interval) ⟛ (no Time) Theatre_{T_2}
- MetroLine_{T_1}(Geometry: Line) ○• (Geometry : Point) Stop_{T_2}
- $\text{TouristPlace}_{T_1}$ (Geometry : Area) • (Geometry : Point) Stop_{T_2}
- Museum_{T_1}(Geometry: Area) ○• (Geometry : Area) Museum_{T_2}
- Museum_{T_1}(Geometry: Area) ⦿ (Geometry : Area) Museum_{T_2}

The MADS + DL method



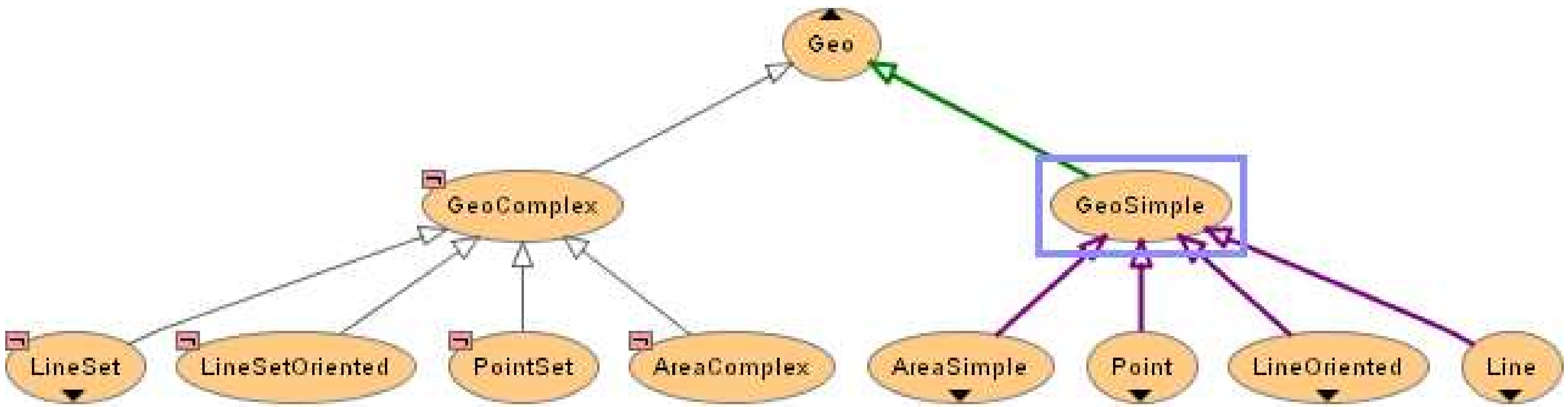
The MADS + DL method



MADS spatial dimension

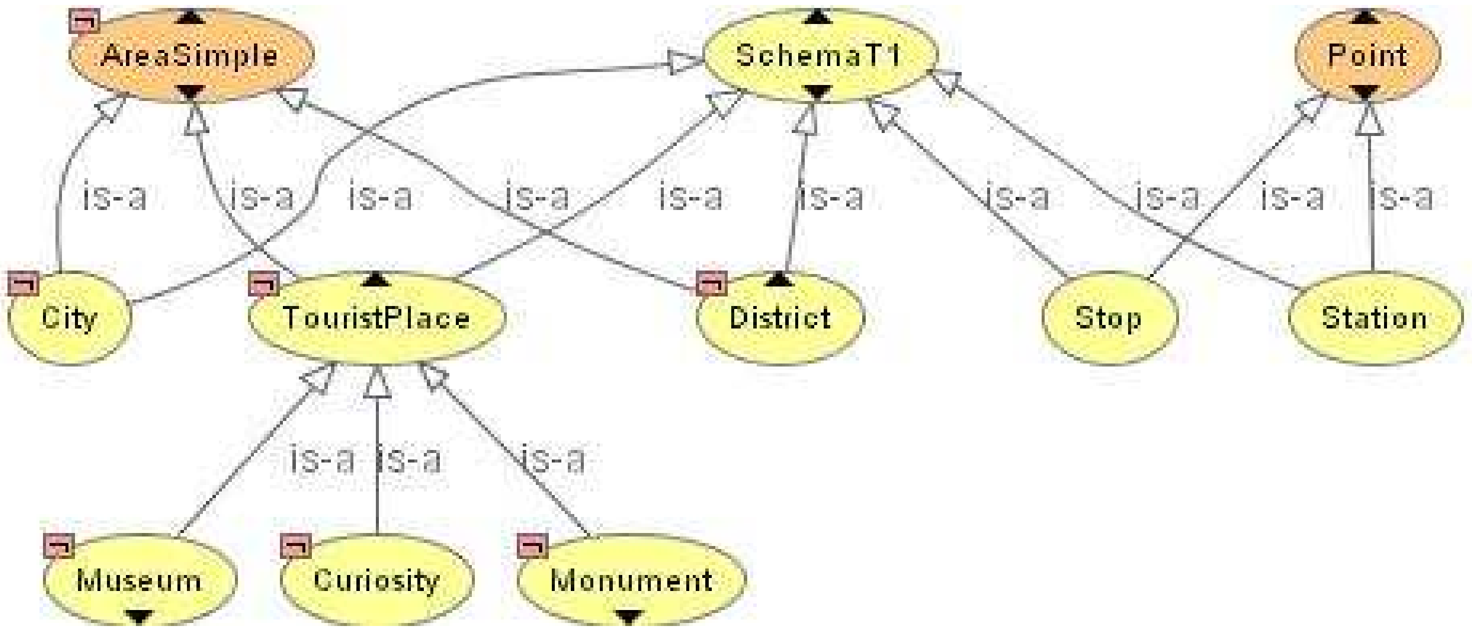
MADS spatial dimension	OWL spatial dimension
Spatial ADT hierarchy	Spatial abstract types hierarchy
Hierarchy in spatial subclasses	not possible in OWL-DL
Mandatory Geometry attribute that defines spatial features	Intrinsic hasGeometry property with predefined values

Spatiality : Types

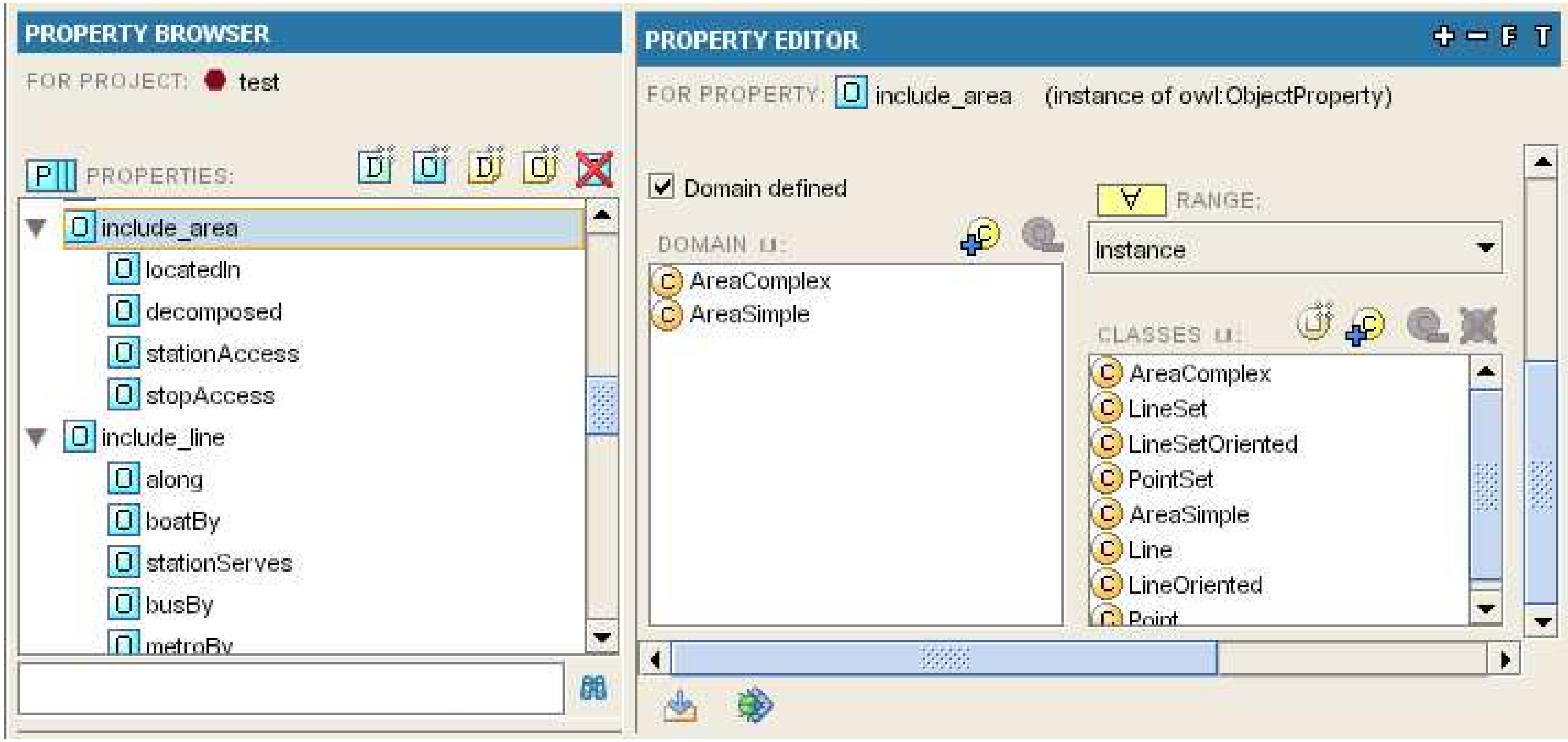


hasGeometry property defined as the necessary & sufficient

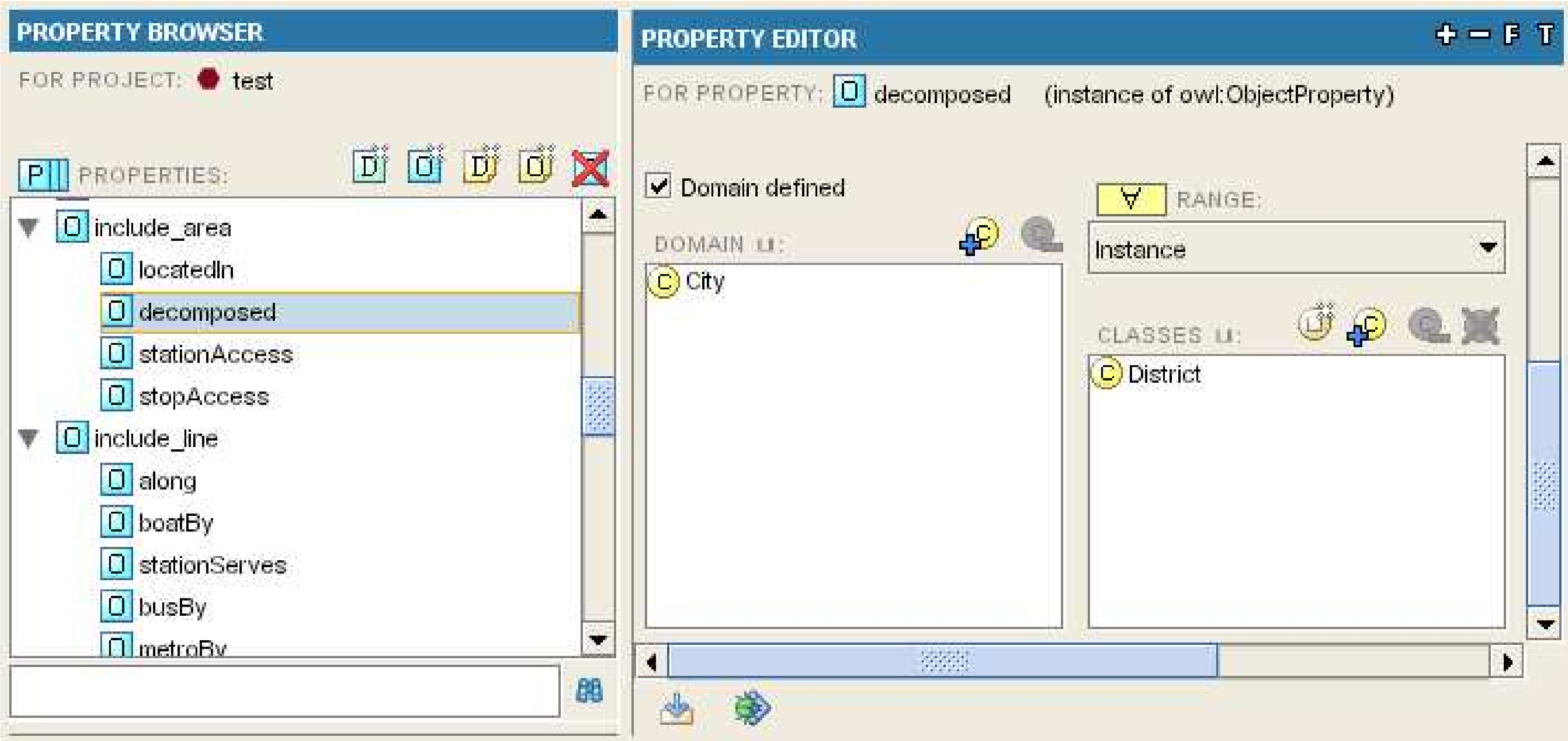
Spatiality : Types



Spatiality : Relationships



Spatiality : Relationships



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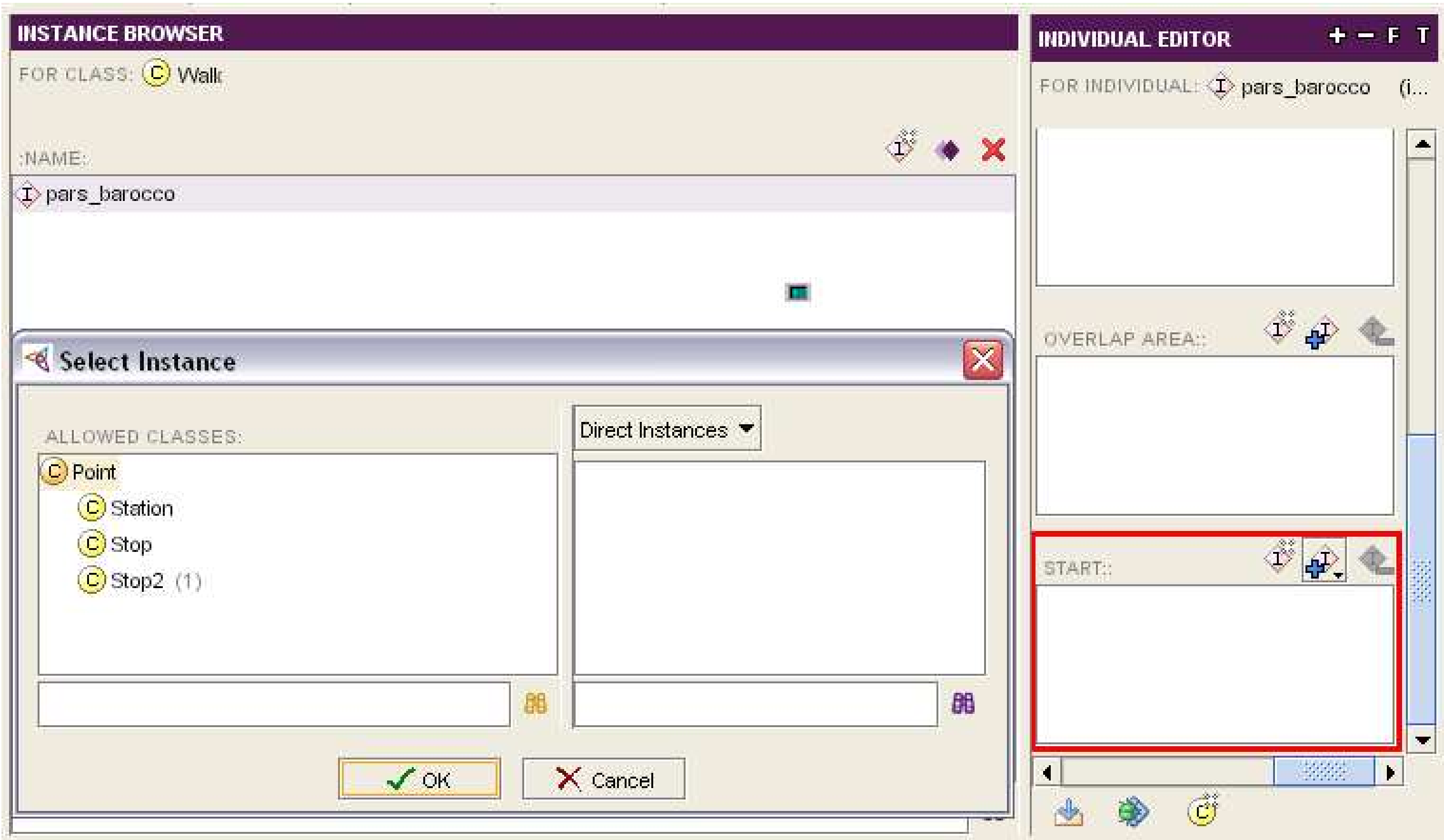
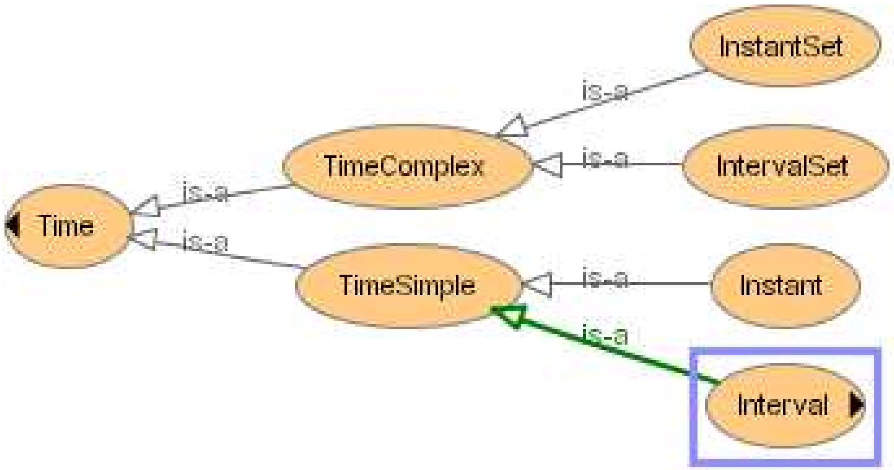
Spatiality : Attributes



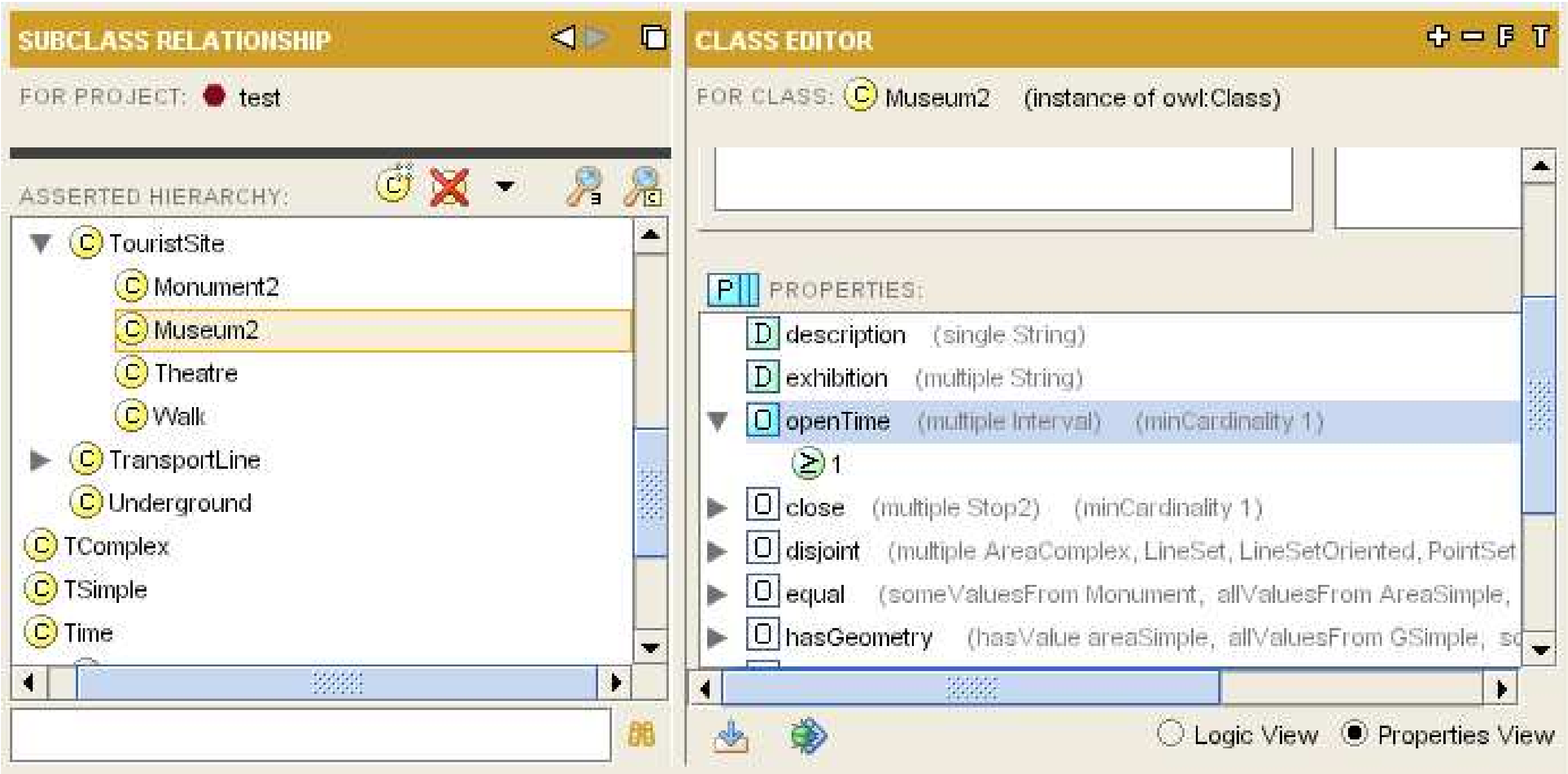
Temporality : Types

MADS temporal dimension	**OWL temporal dimension**
Temporal ADT hierarchy	Temporal abstract types hierarchy
Mandatory LifeCycle attribute that defines spatial features	Intrinsic hasTime property with predefined values

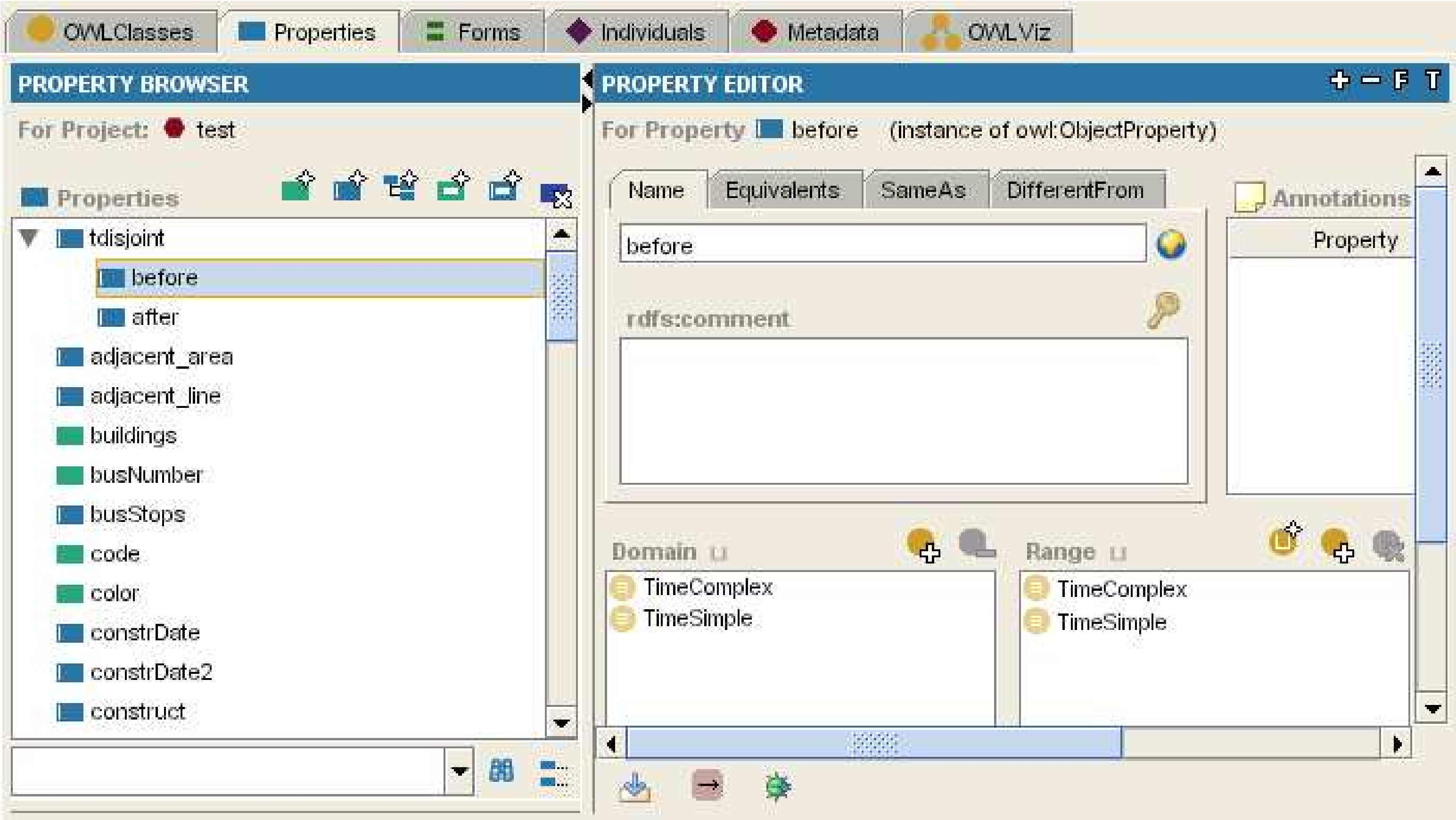
Temporality : Types



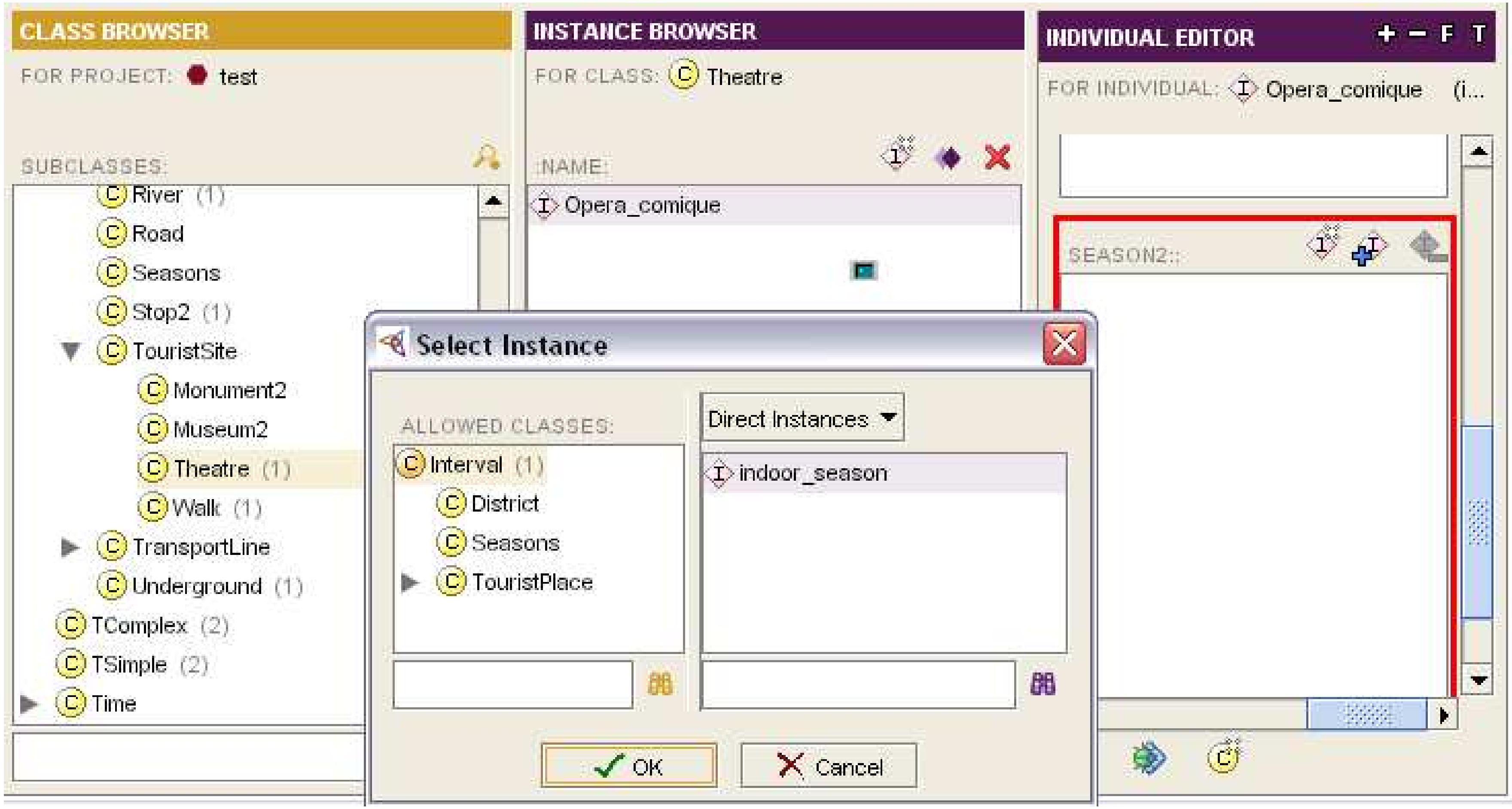
Temporality : Attributes



Temporality : Relation



Temporality : Instance



Validated

- $\text{TouristPlace}_{T_1}$ (Time : Interval) ⊨ (no Time) Theatre_{T_2}
- MetroLine_{T_1}(Geometry: Line) ○• (Geometry : Point) Stop_{T_2}
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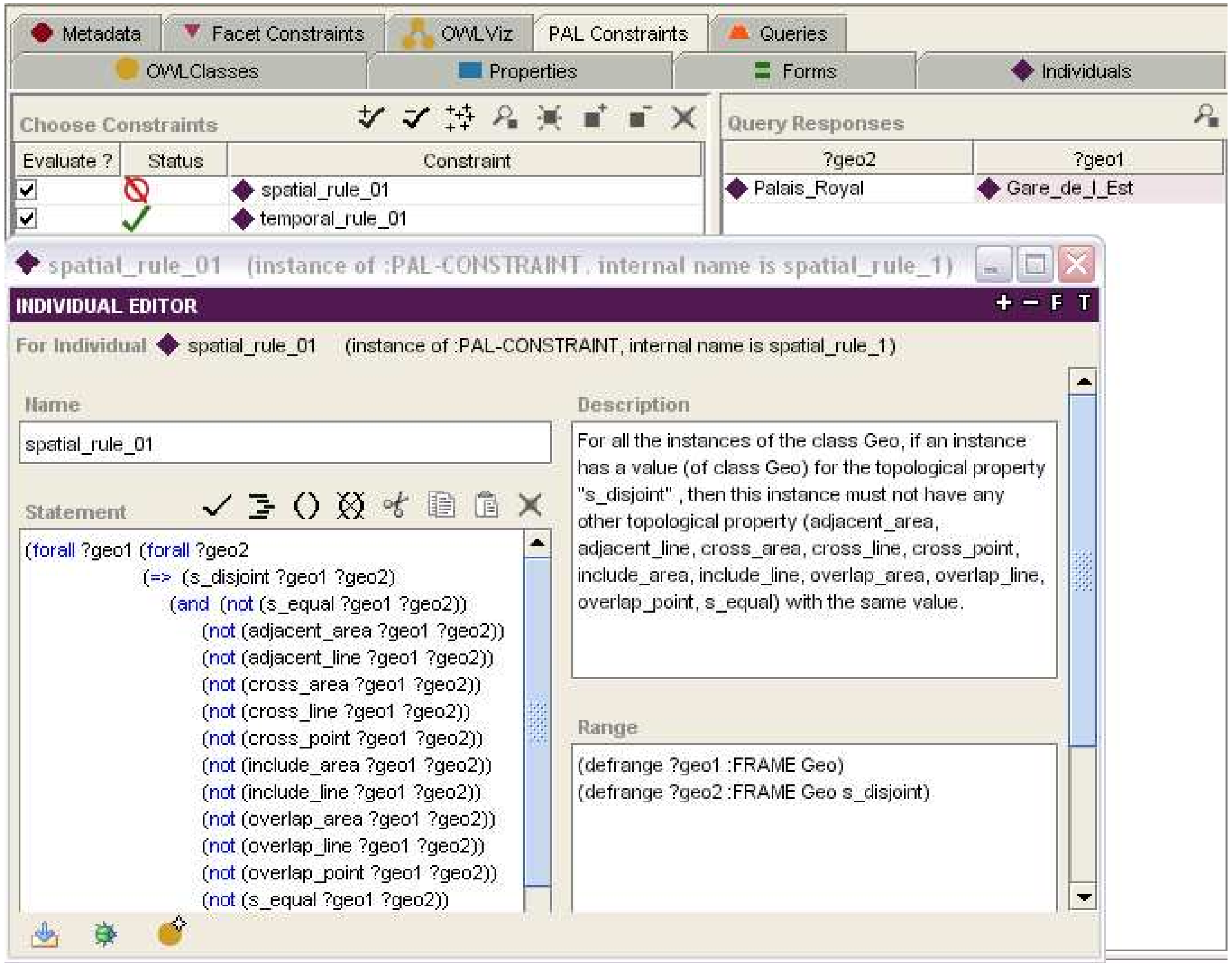
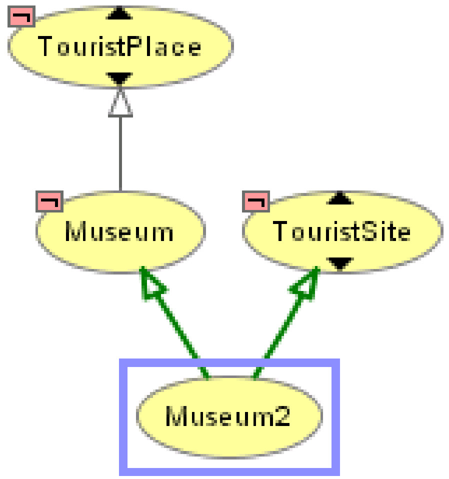
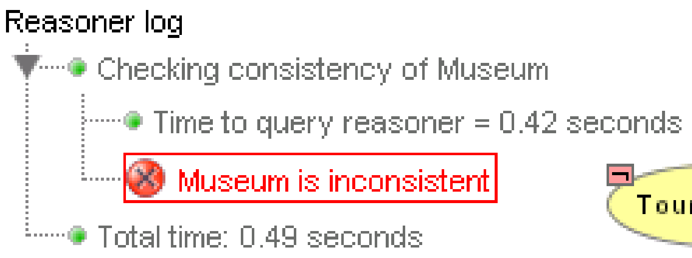
- Museum_{T_1}(Geometry: Area) ⊙ (Geometry : Area) Museum_{T_2}

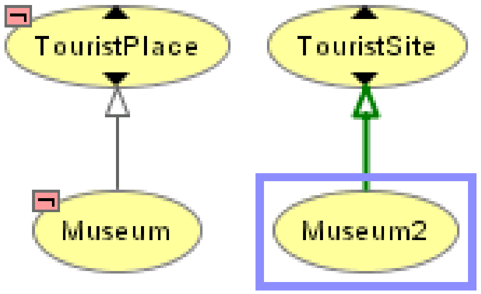
Topological Constraints



Structure Reasoning







Conclusions

- we adhere to a hybrid approach - DB + DL
- we model the semantics of the MADS data model required for mappings validation
- we "emulate" spatio-temporal reasoning for inter-schema mappings
- we shift the emphasis on automation from the a priori discovery to the a posteriori validation of the inter-schema mappings