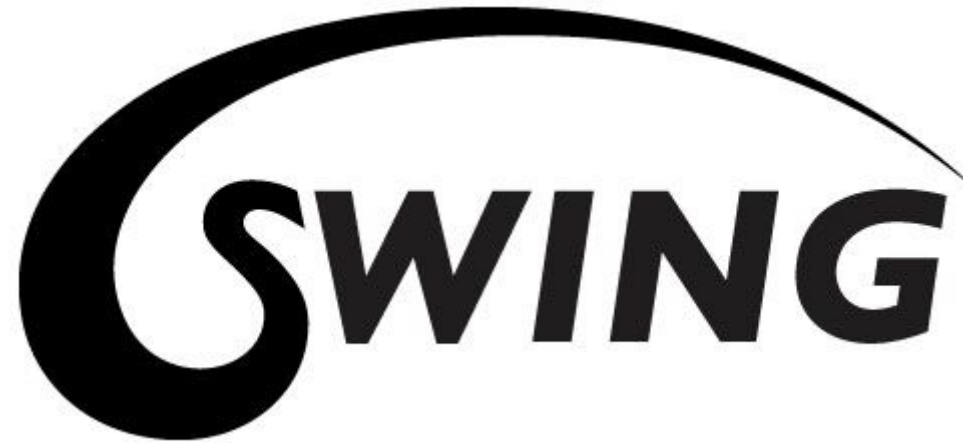




Geospatial ontologies and semantic annotation – experiences from the SWING project

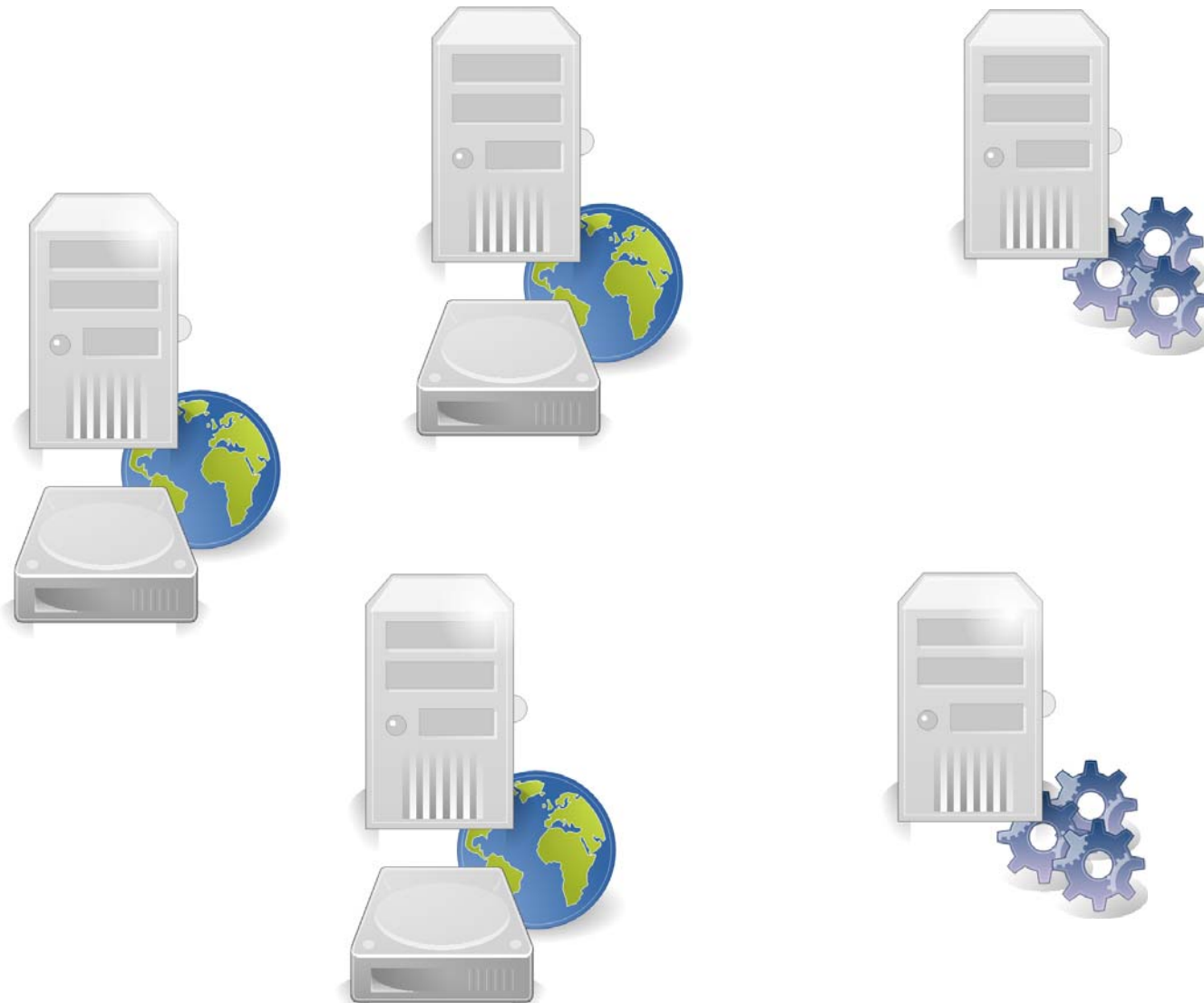
Sven Schade, University of Münster, Germany
(schades@uni-muenster.de)

W3C – TelCon, July 21st, 2009

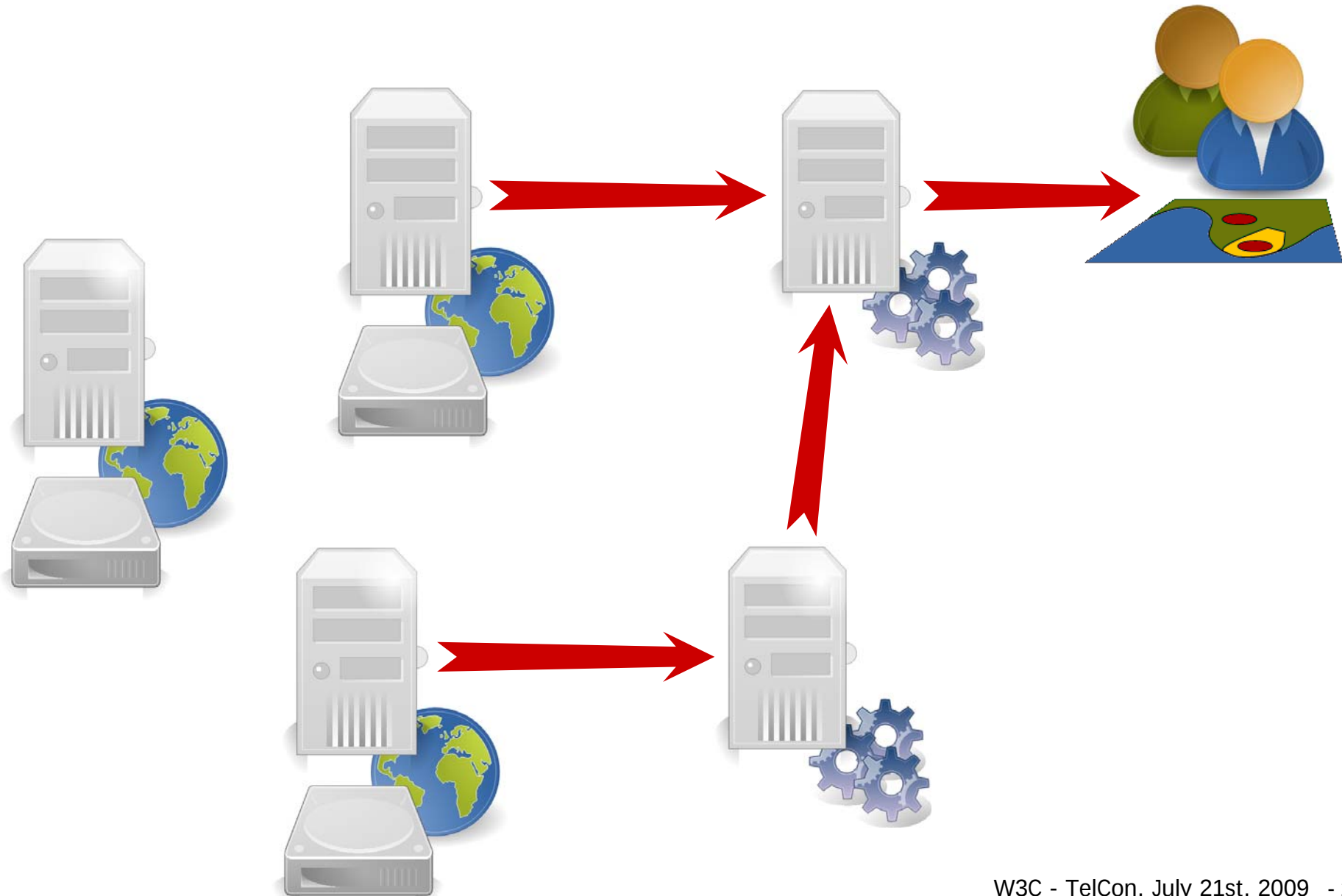
How do we see the Geospatial Web?



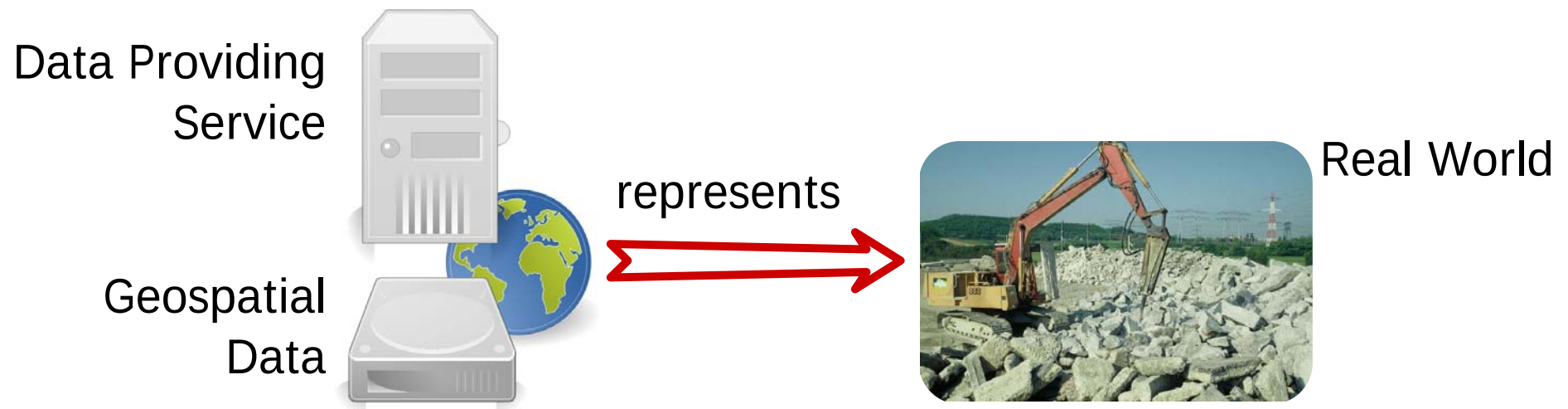
How do we see the Geospatial Web?



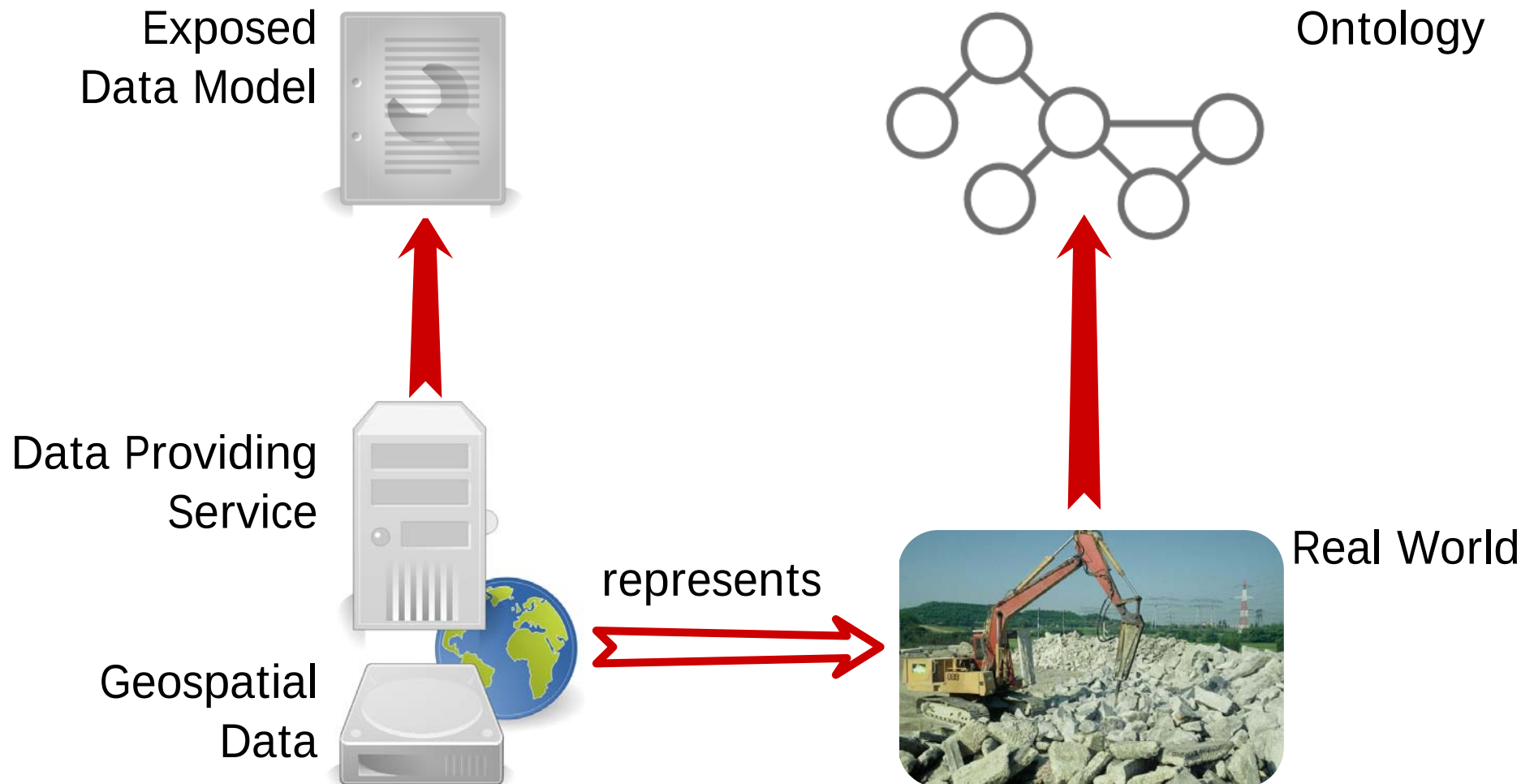
How do we see the Geospatial Web?



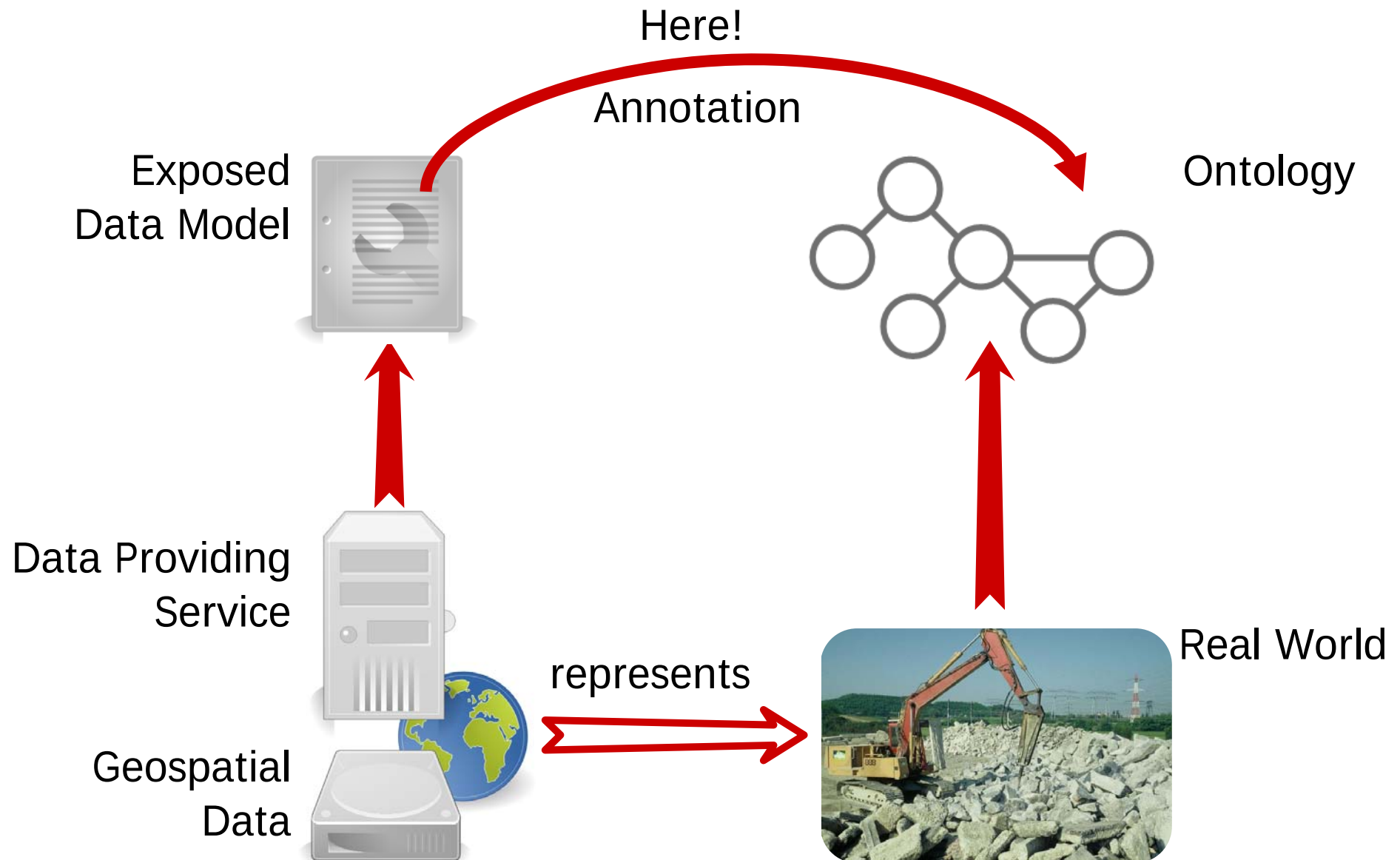
How are Semantics brought in?



How are Semantics brought in?



How are Semantics brought in?



How are Semantics brought in?

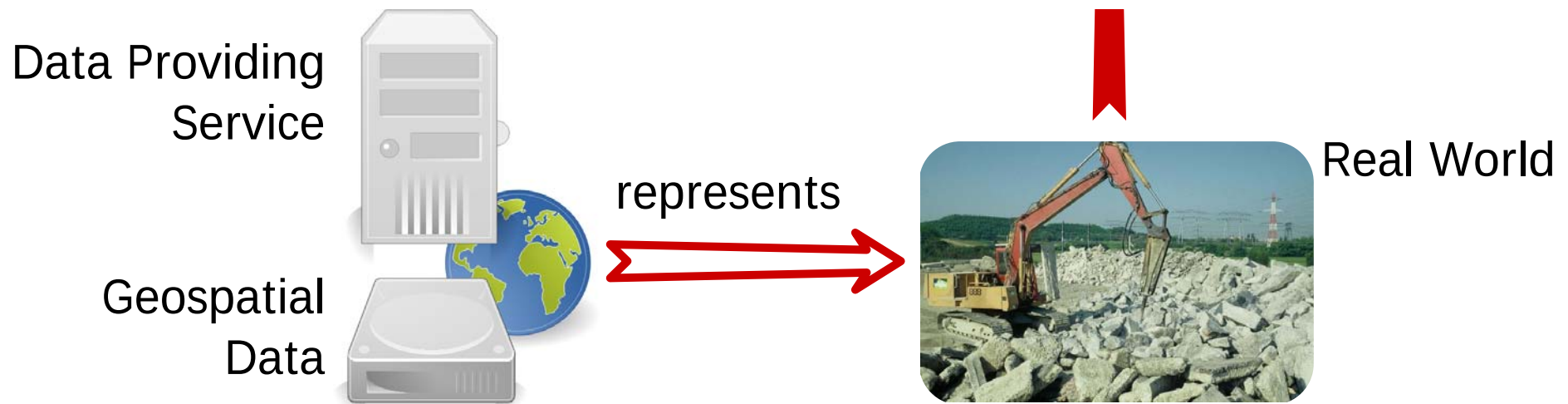
Here!

Annotation

Ontology

Following Guarino:

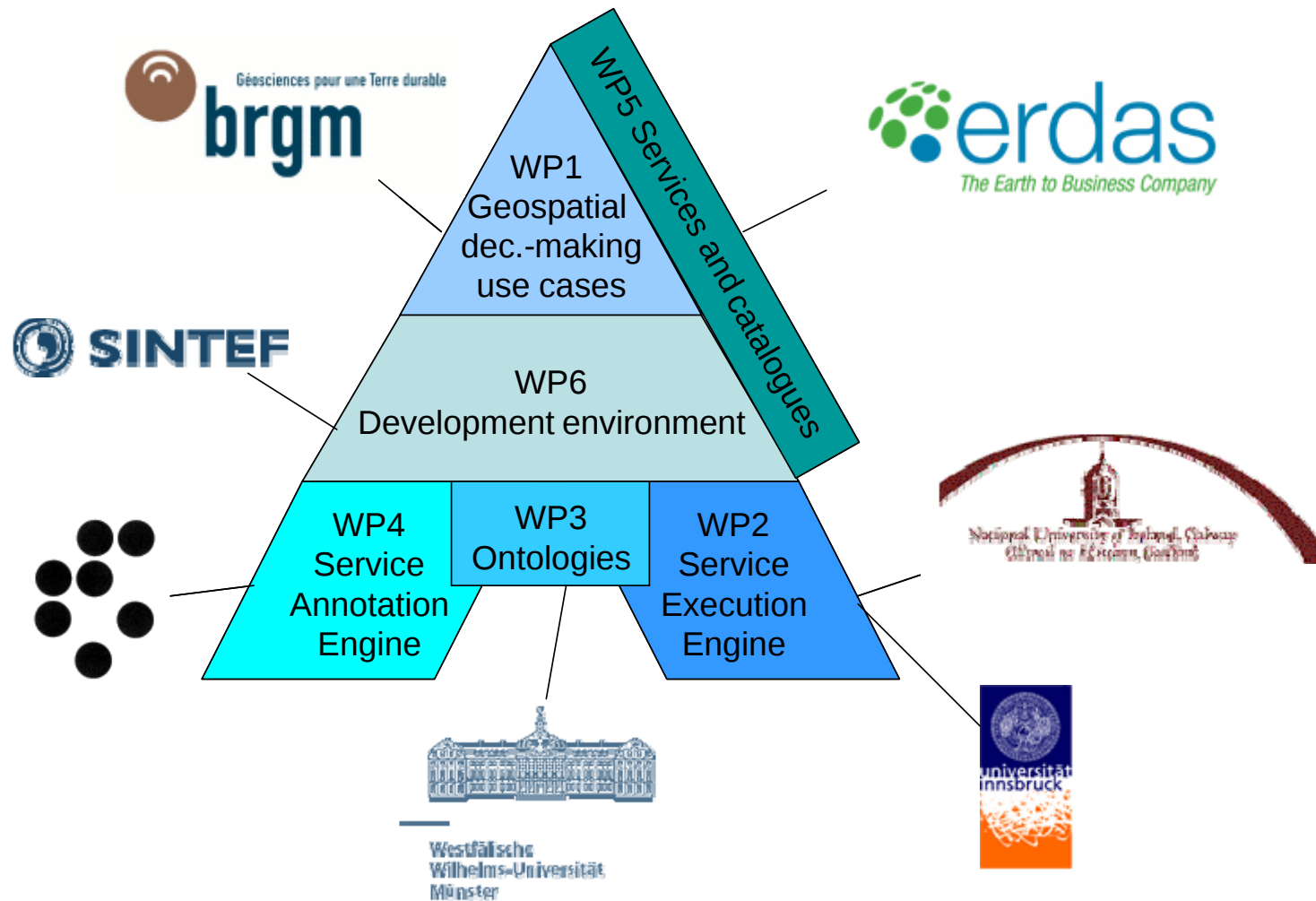
An ontology is a logical theory accounting for the intended meaning of a community's vocabulary.



Problem Definition

- Geospatial decision-support calls for service combination
 - + **Syntactic interoperability** through standards
 - Discovery and integration: **keyword** search and **manual** work
- Semantic Web Service technology is promising! But...
 - Domain ontologies do **not exist** or are **not shared**
 - Requires that services are annotated by **specialists**
 - Has a **high** and **steep** learning curve

SWING Components



Objectives for the use of ontologies

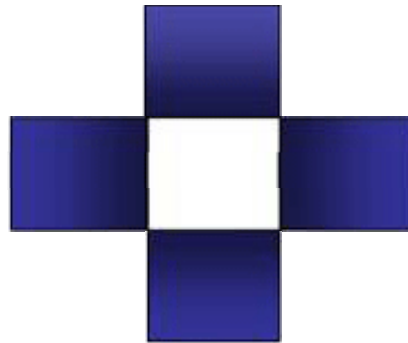
- Development of ontology infrastructure to support:
 - **Semantic annotation** of service capabilities and service contents
 - Support the user in **formulating goals**
 - **Discovery** of geographic information and geoprocessing services
 - **Specify workflows** for service execution

GOALS

Objectives that a client wants to achieve by using Web Services

ONTOLOGIES

Formal specification of **terminology** used by all other components



WEB SERVICES

Semantic description of Web Services:

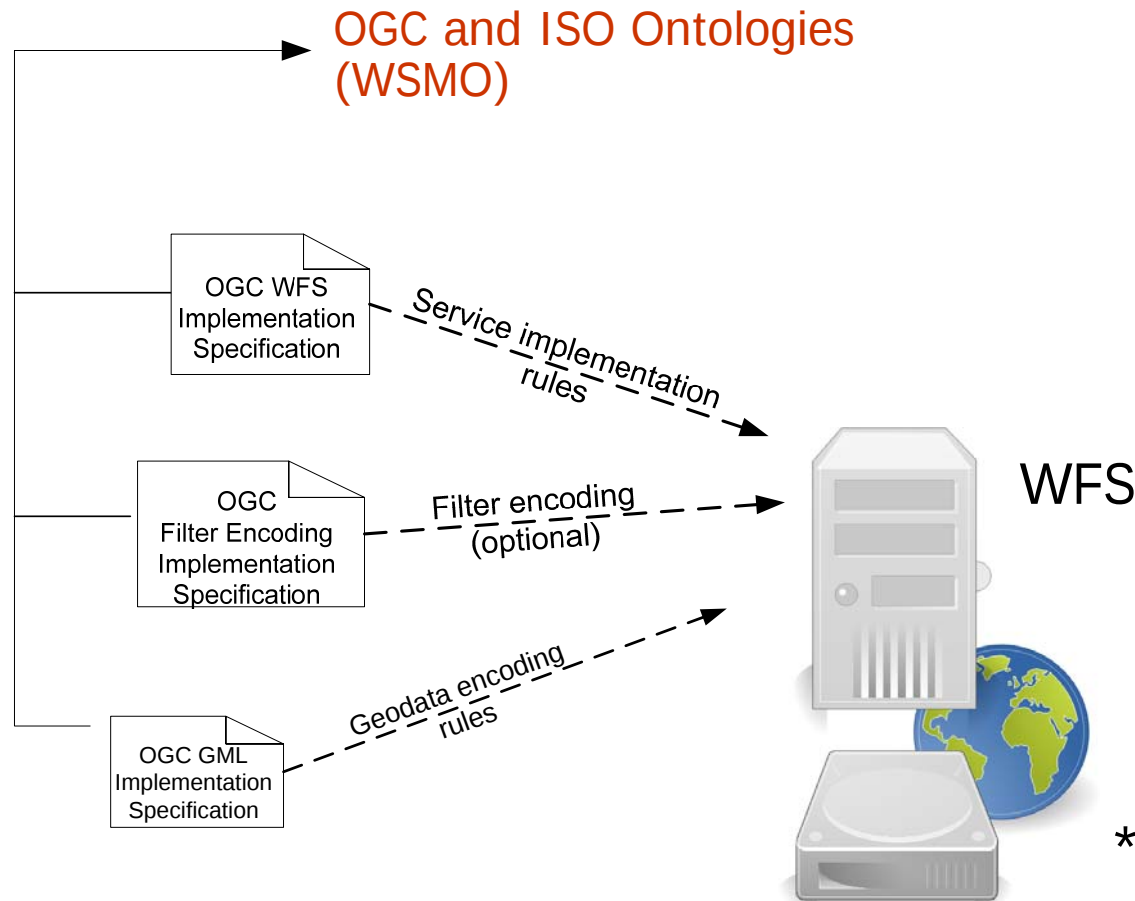
- Capability (functional)
- Interfaces (usage)

MEDIATORS

Connectors between components with mediation facilities for handling heterogeneities

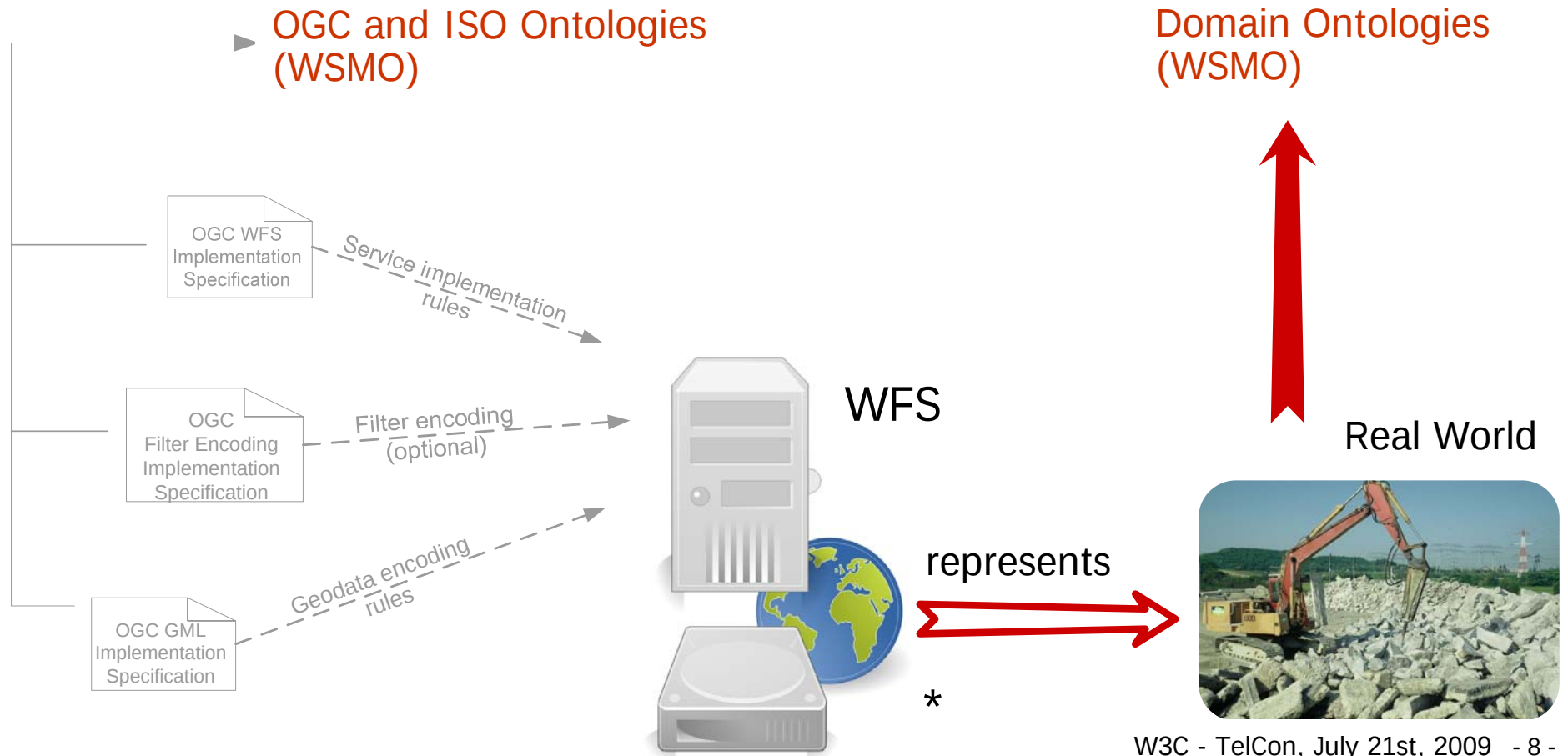
Geographic Information Services...

- ... provide standardized operations for data access



Ontology Formalization in SWING

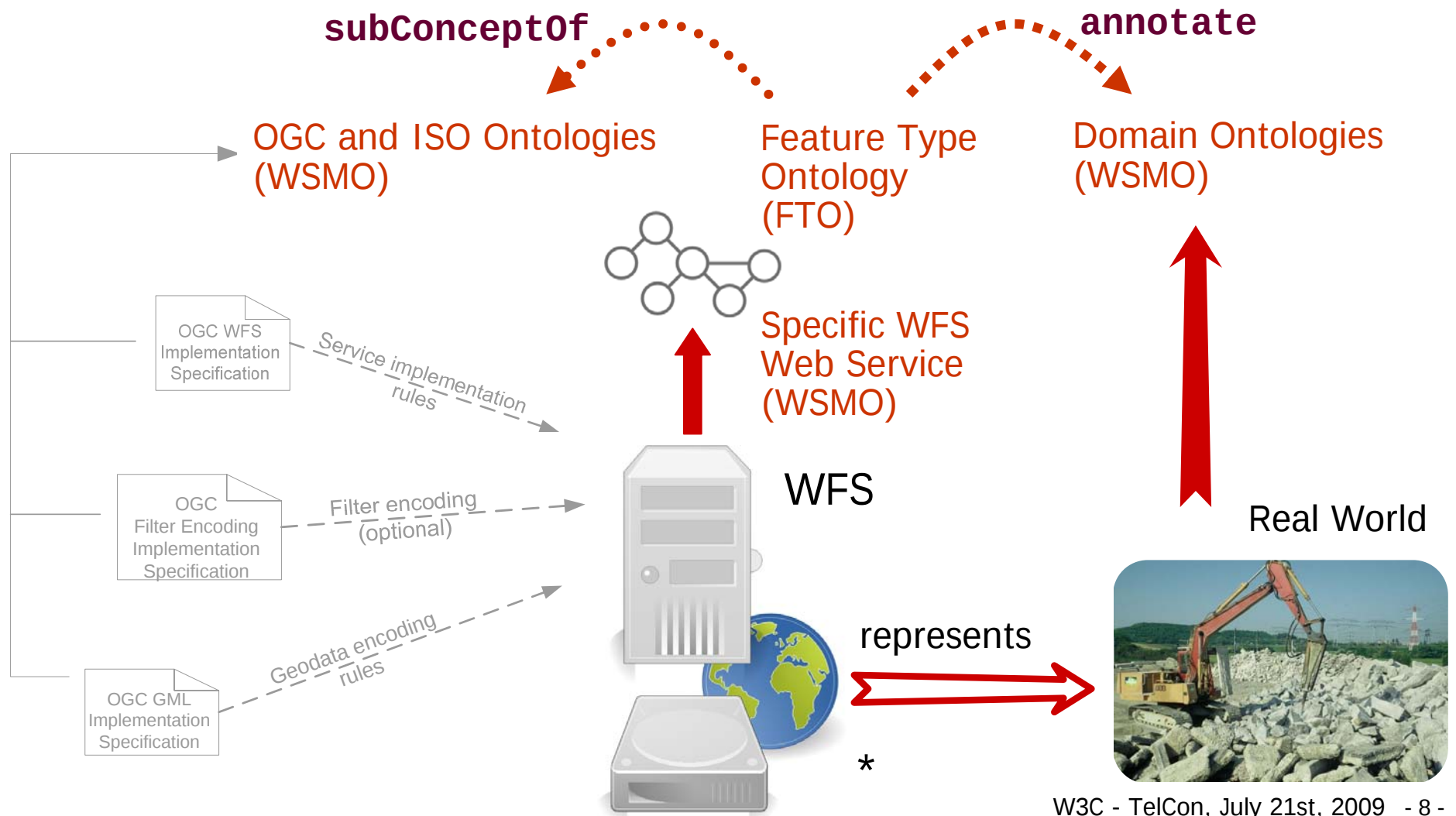
⇒ Semantic annotation needed for data content (domain specific)

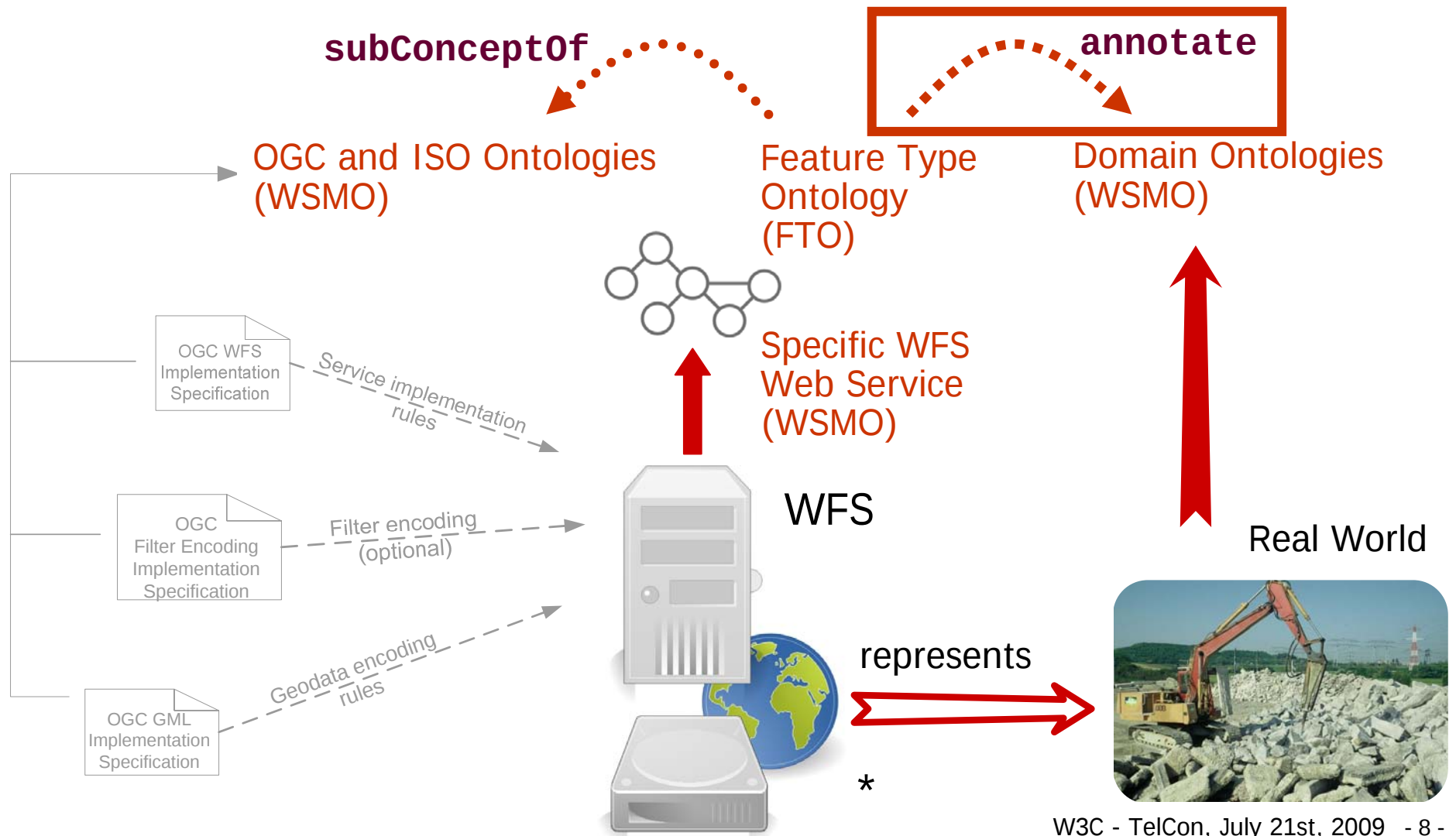




Ontology Formalization in SWING

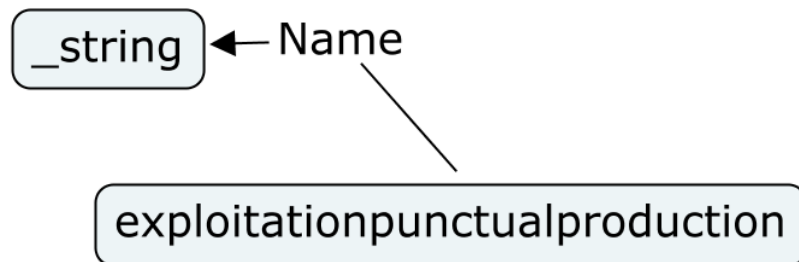
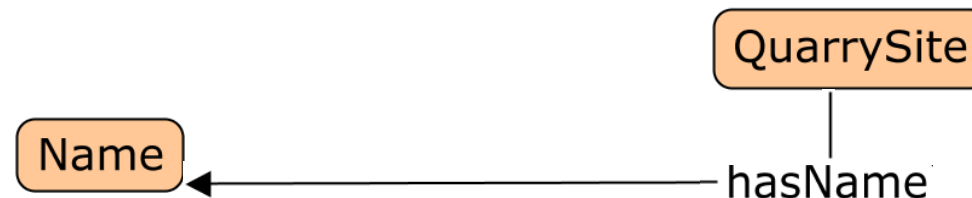
⇒ Semantic annotation needed for data content (domain specific)





Concept-based Annotation: Challenge

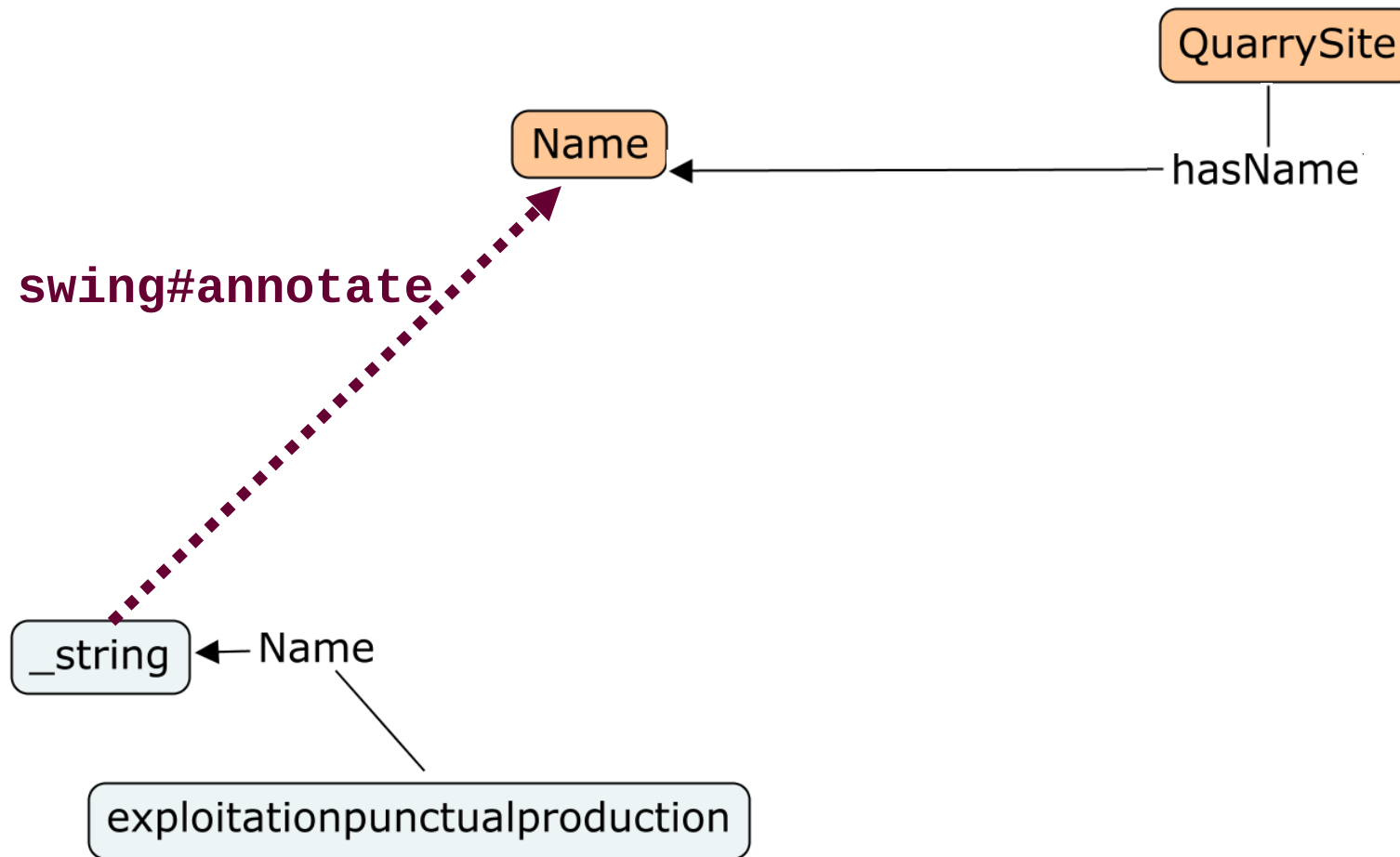
Domain Ontology



FTO

Concept-based Annotation: Challenge

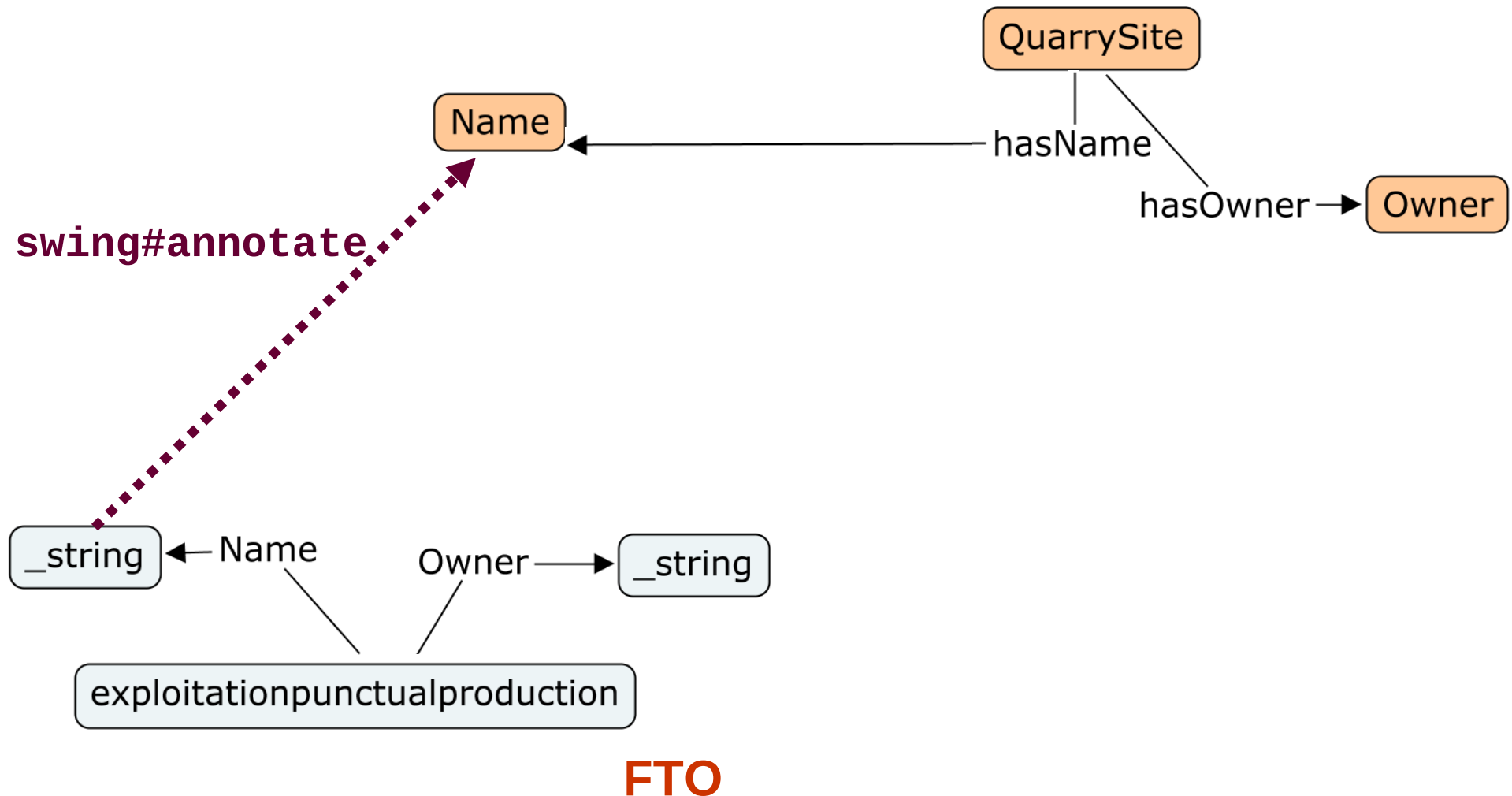
Domain Ontology



FTO

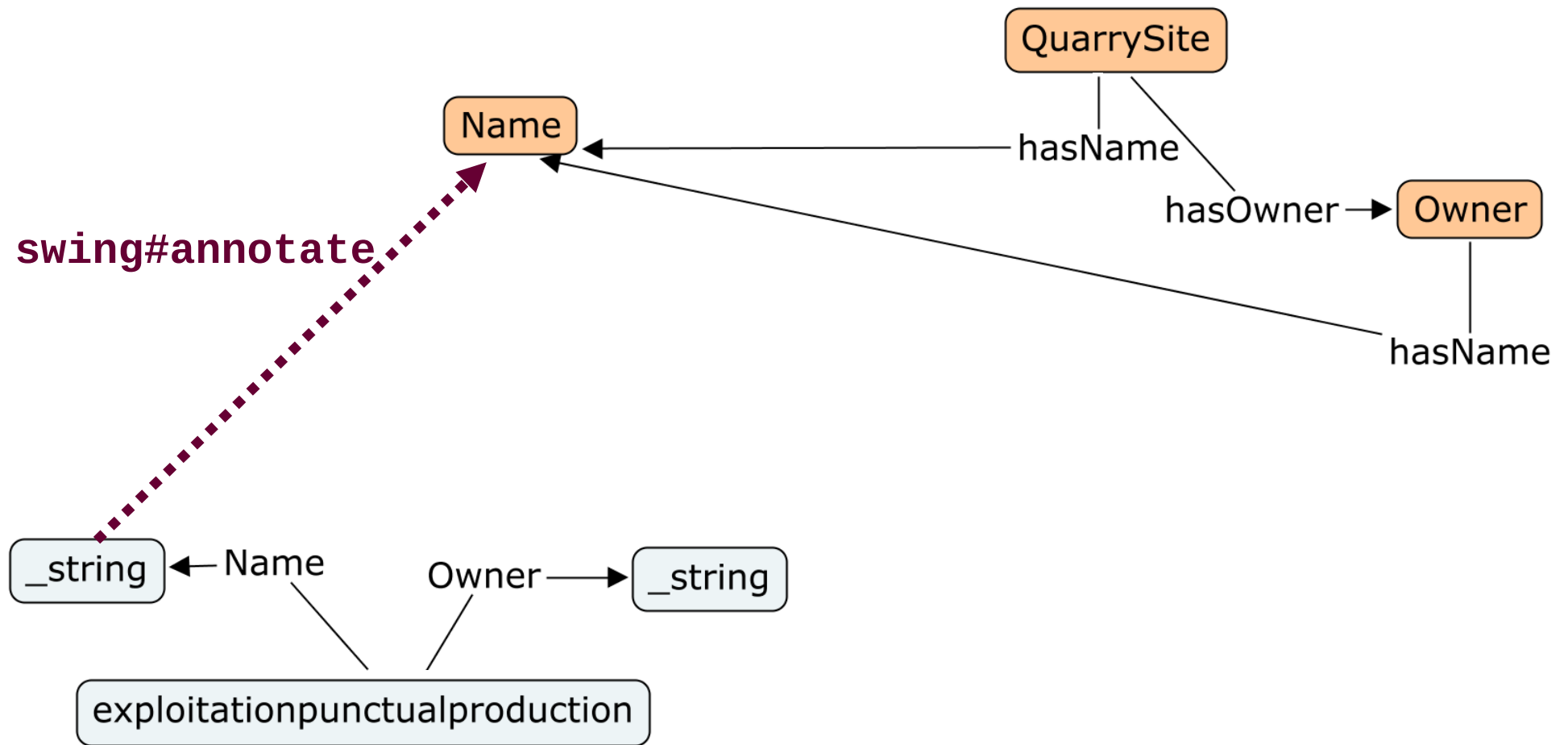
Concept-based Annotation: Challenge

Domain Ontology



Concept-based Annotation: Challenge

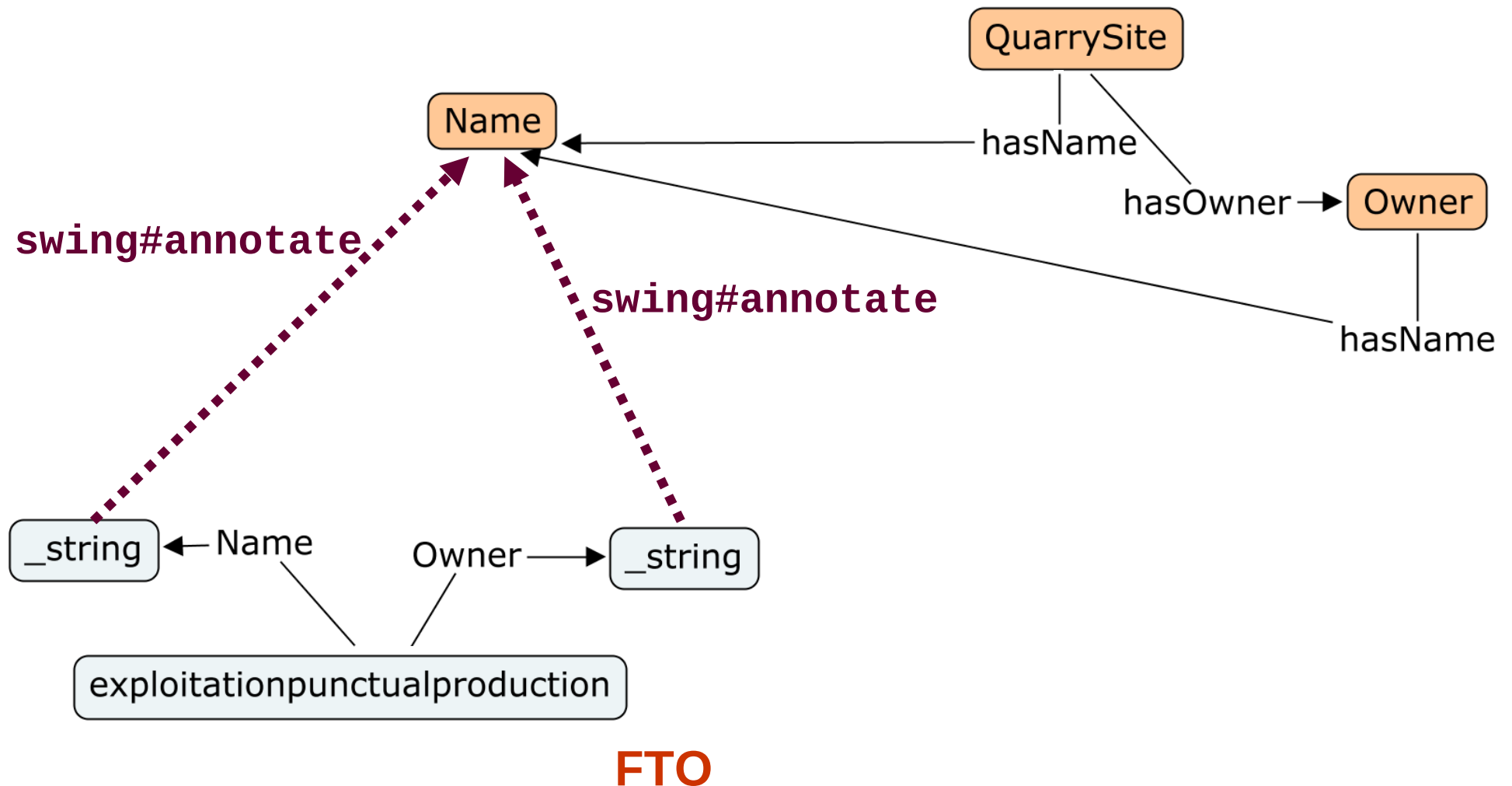
Domain Ontology



FTO

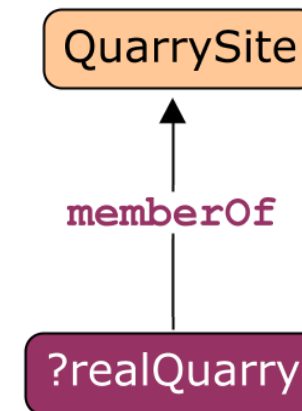
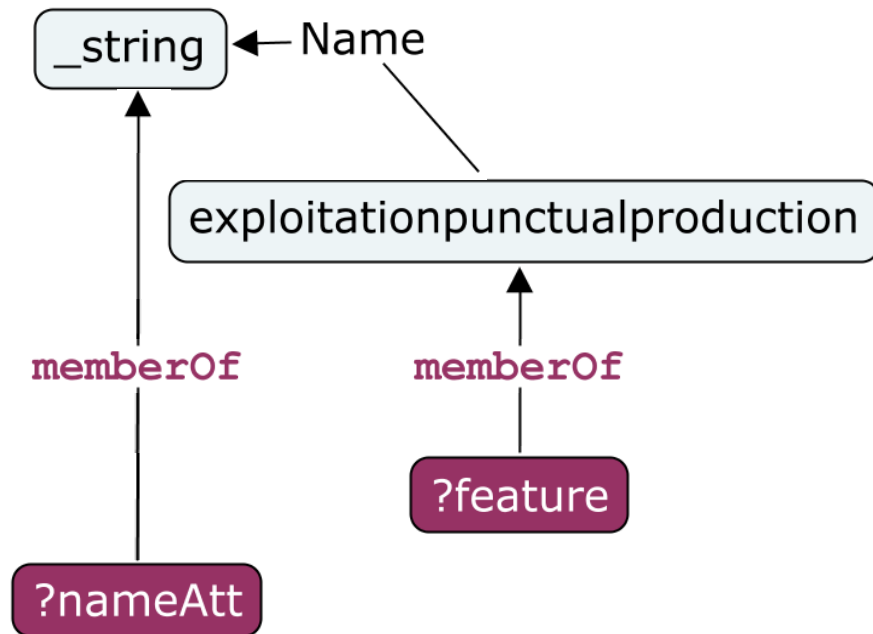
Concept-based Annotation: Challenge

Domain Ontology



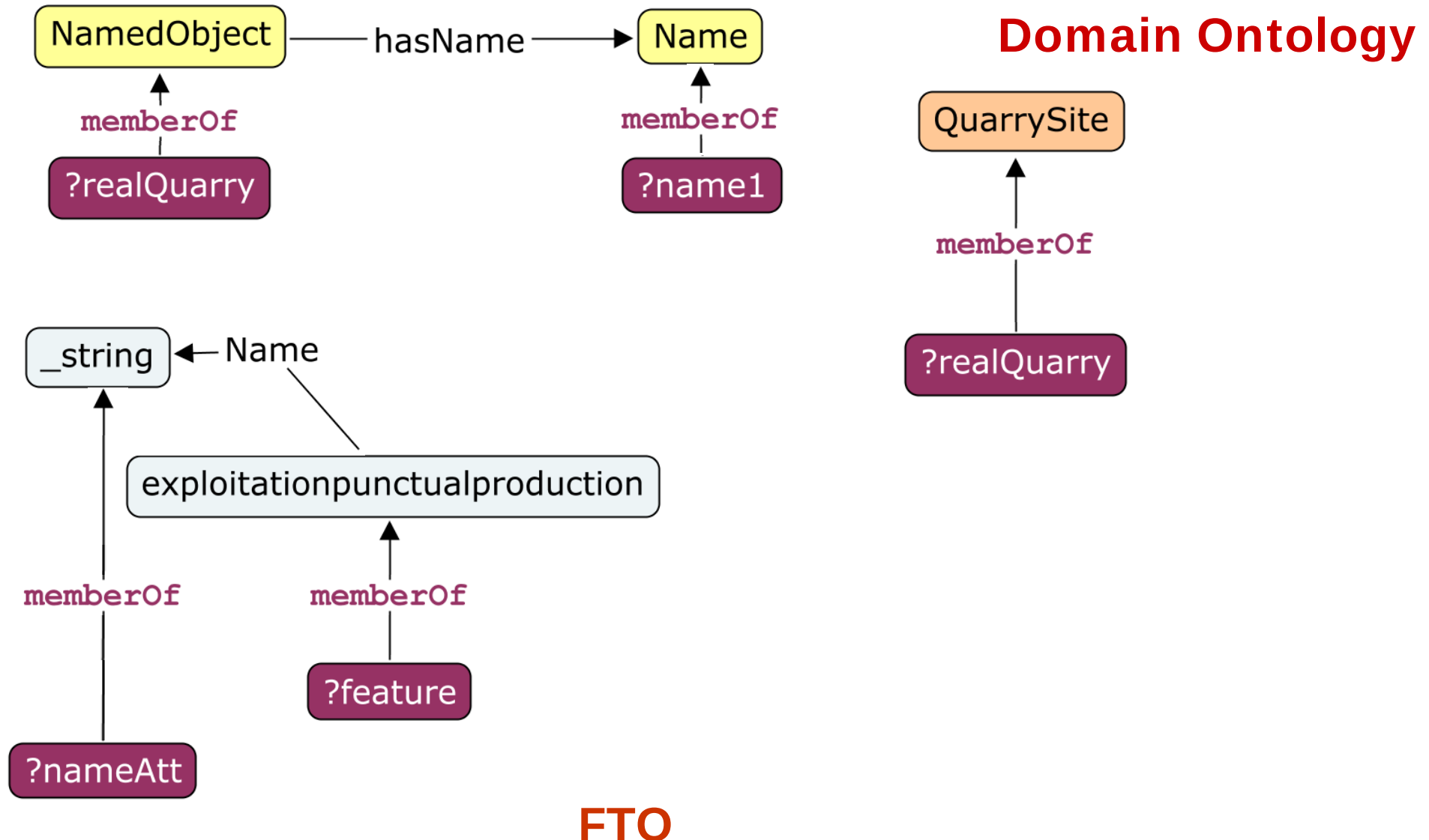
Instance-based Annotation: Introduction

Domain Ontology

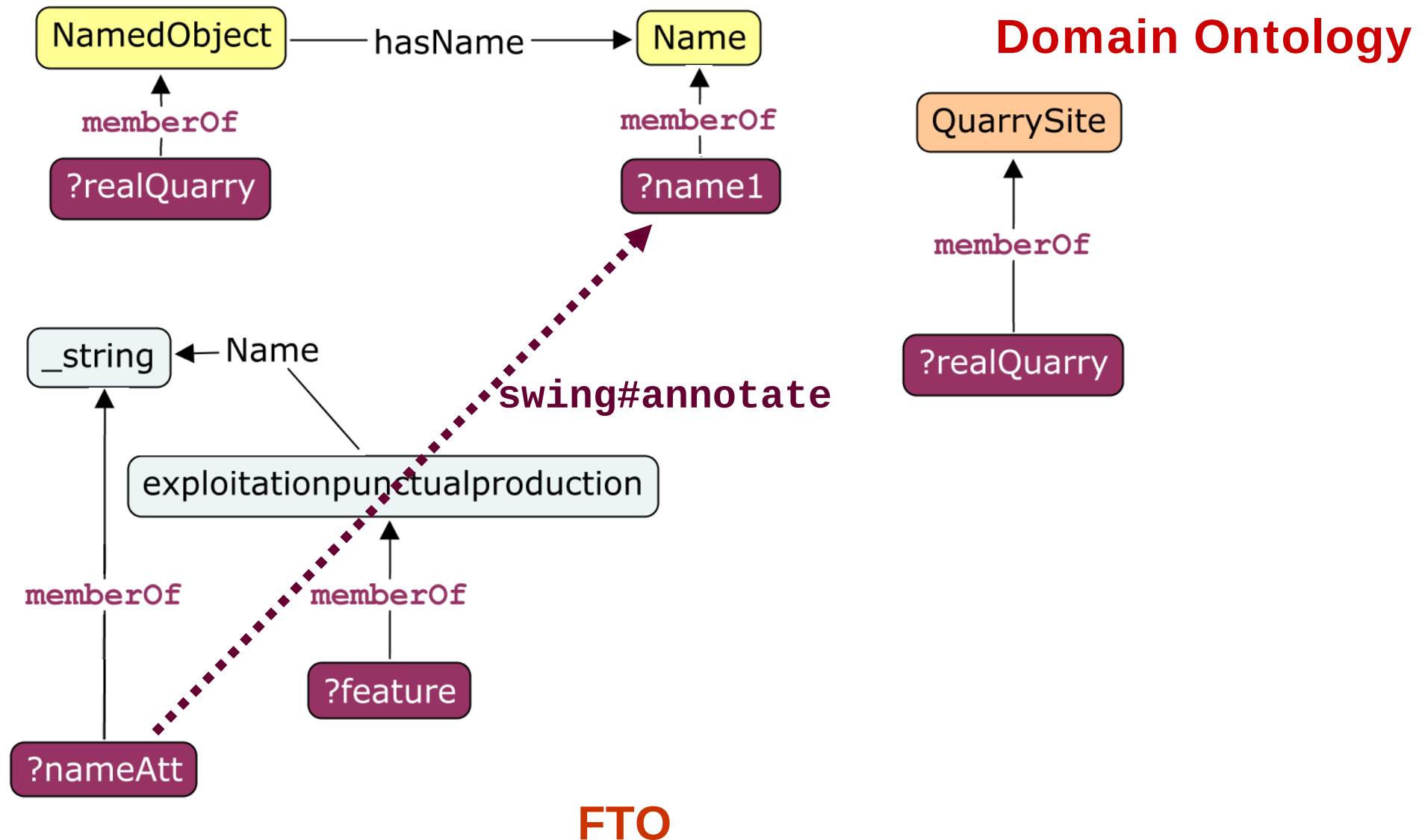


FTO

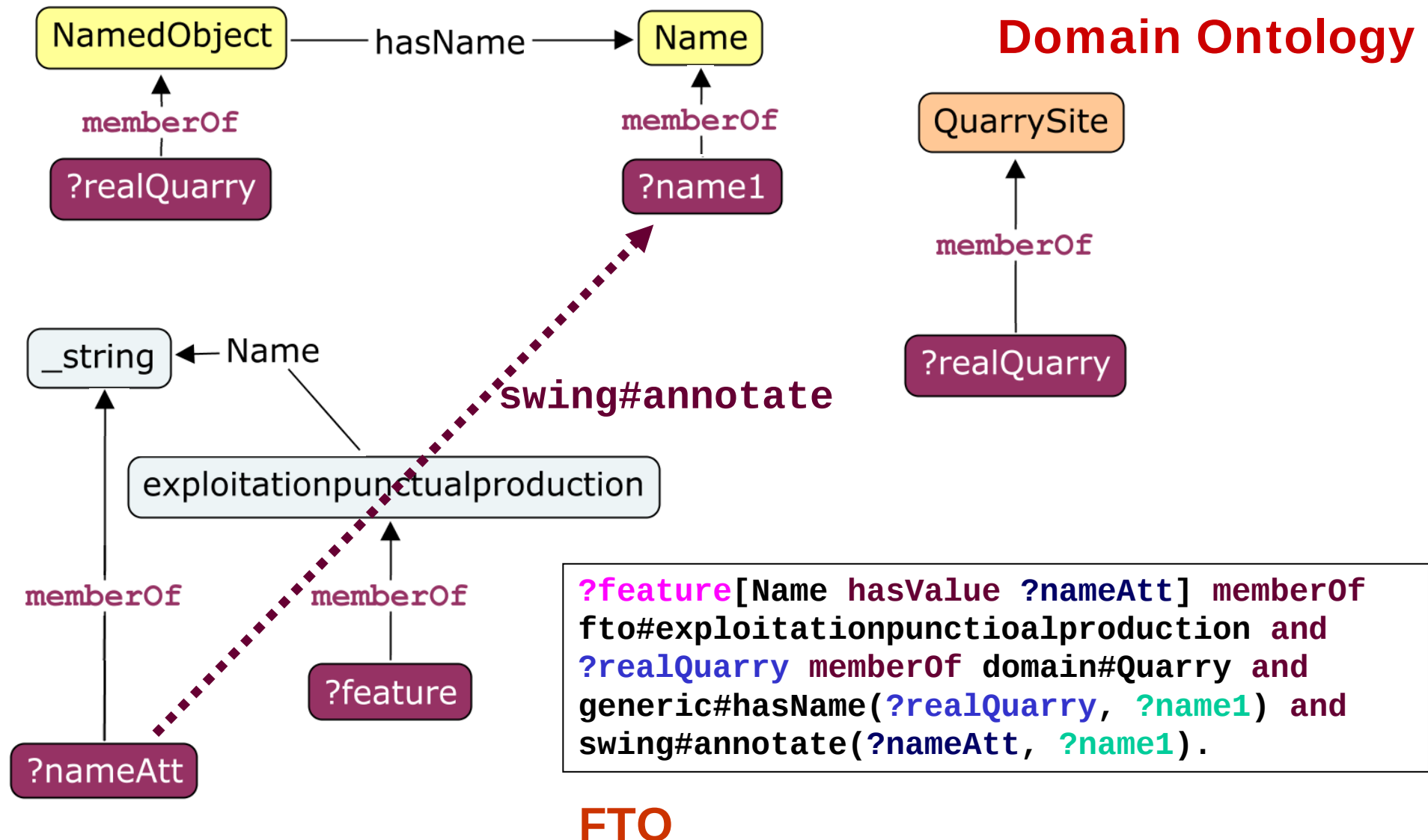
Instance-based Annotation: Introduction



Instance-based Annotation: Introduction

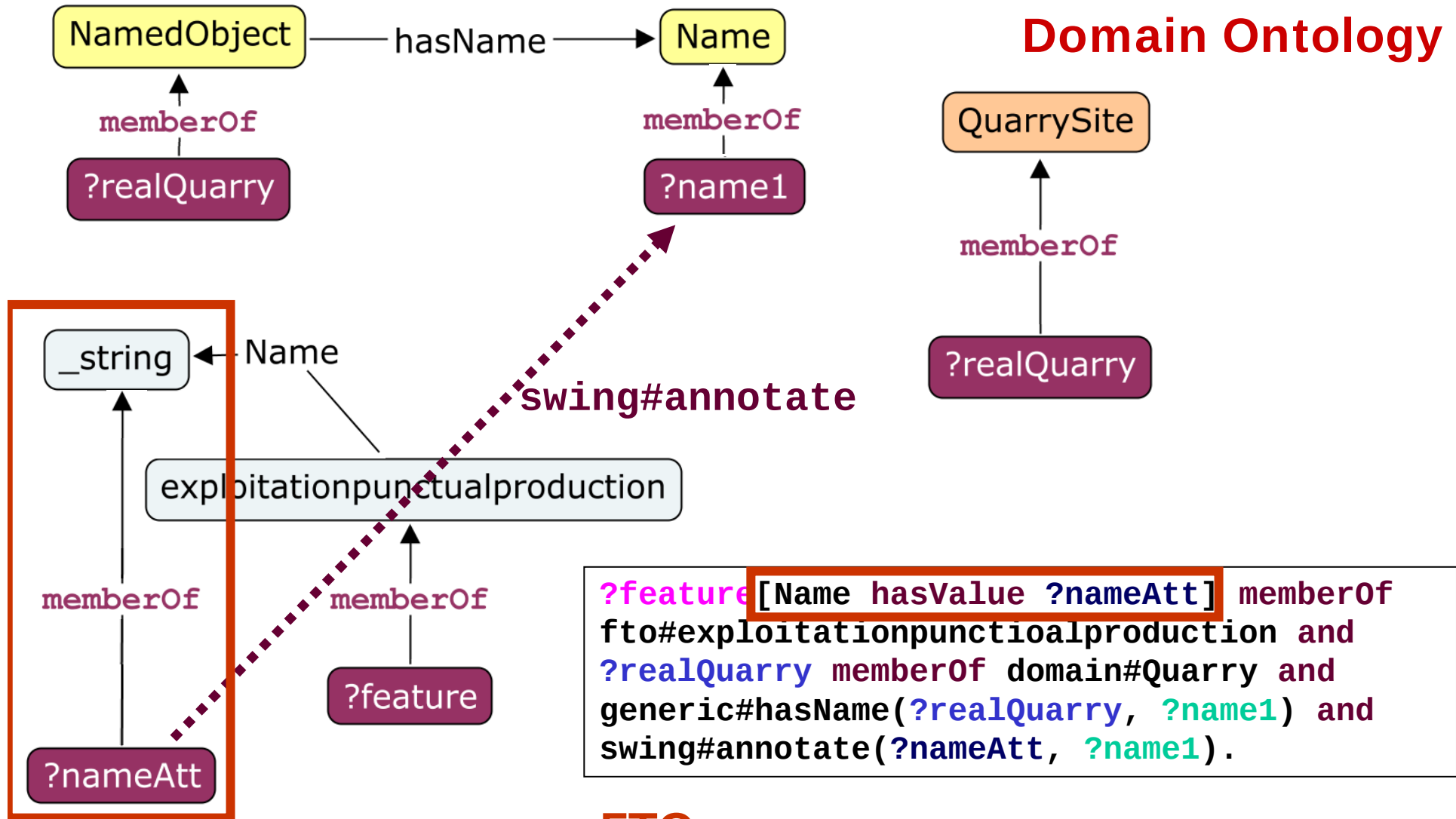


Instance-based Annotation: Introduction



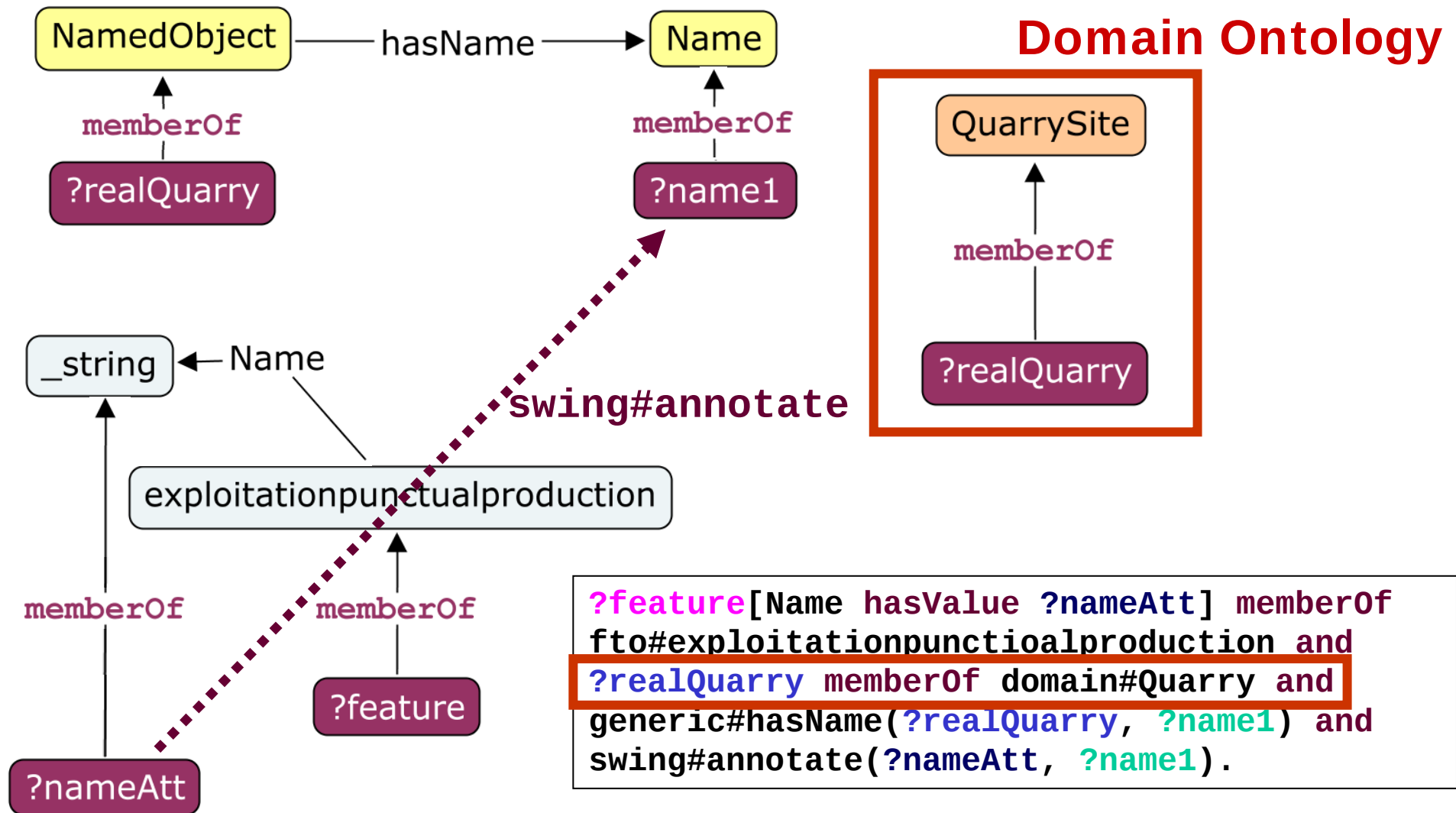
Instance-based Annotation: Introduction

Domain Ontology

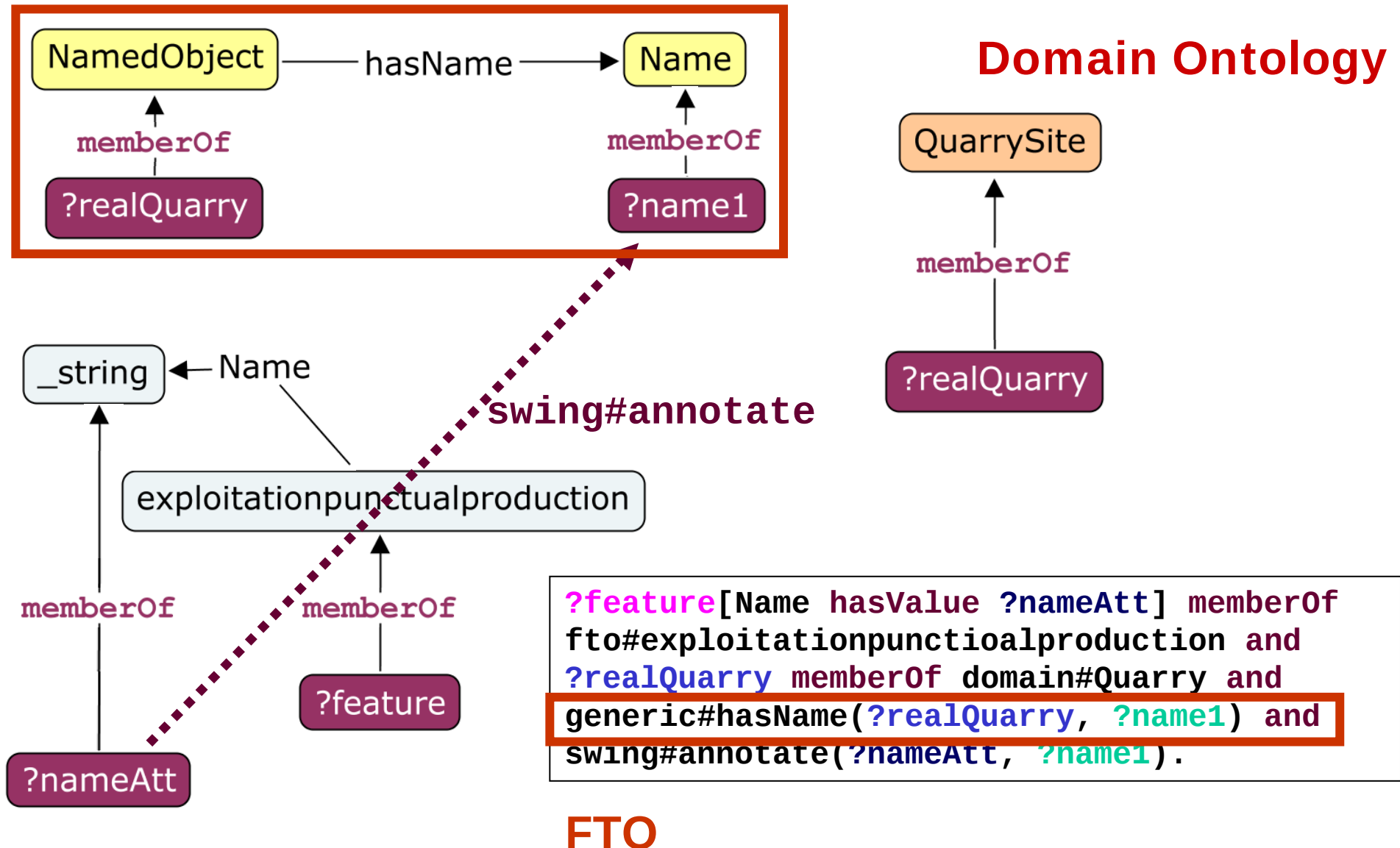


FTO

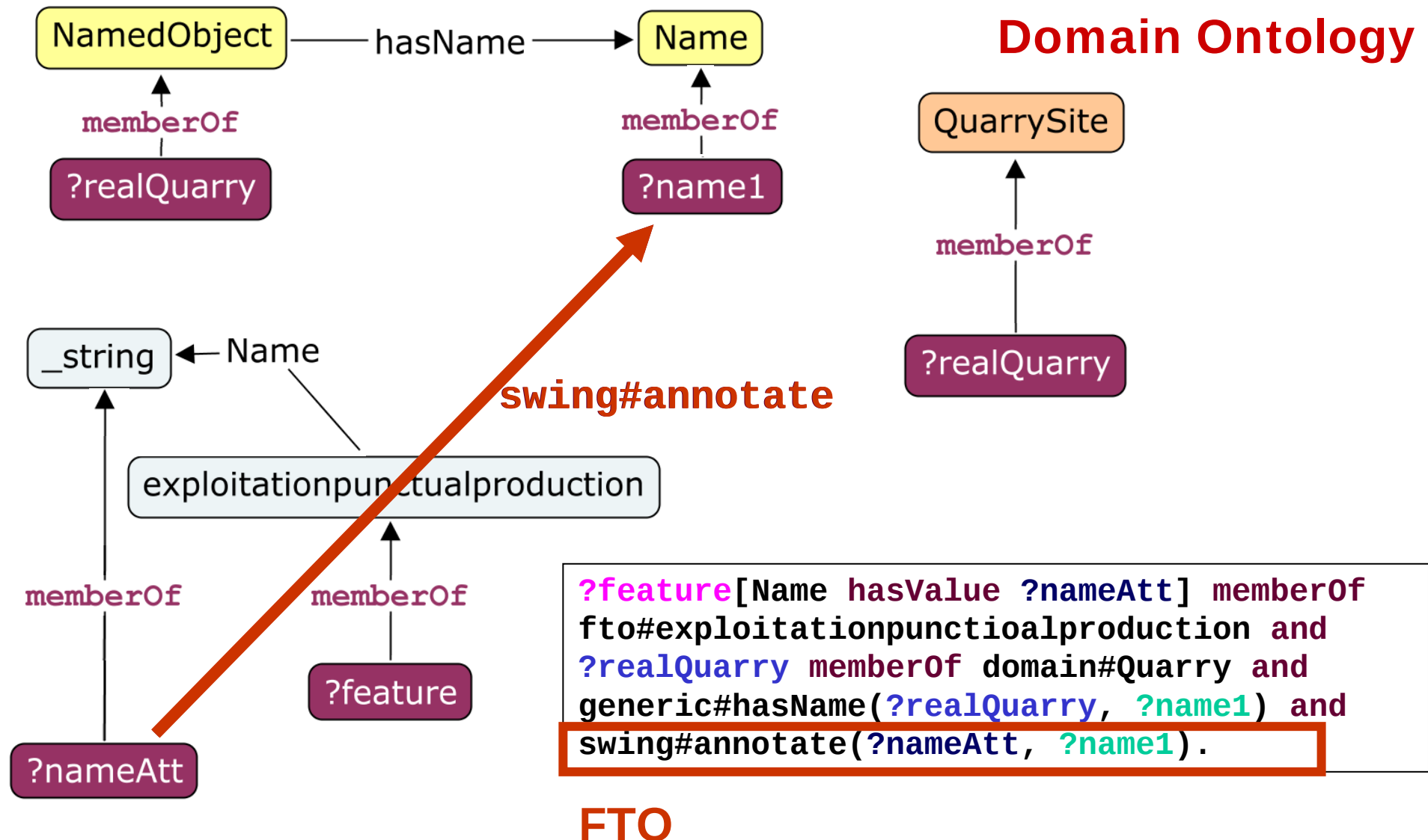
Instance-based Annotation: Introduction



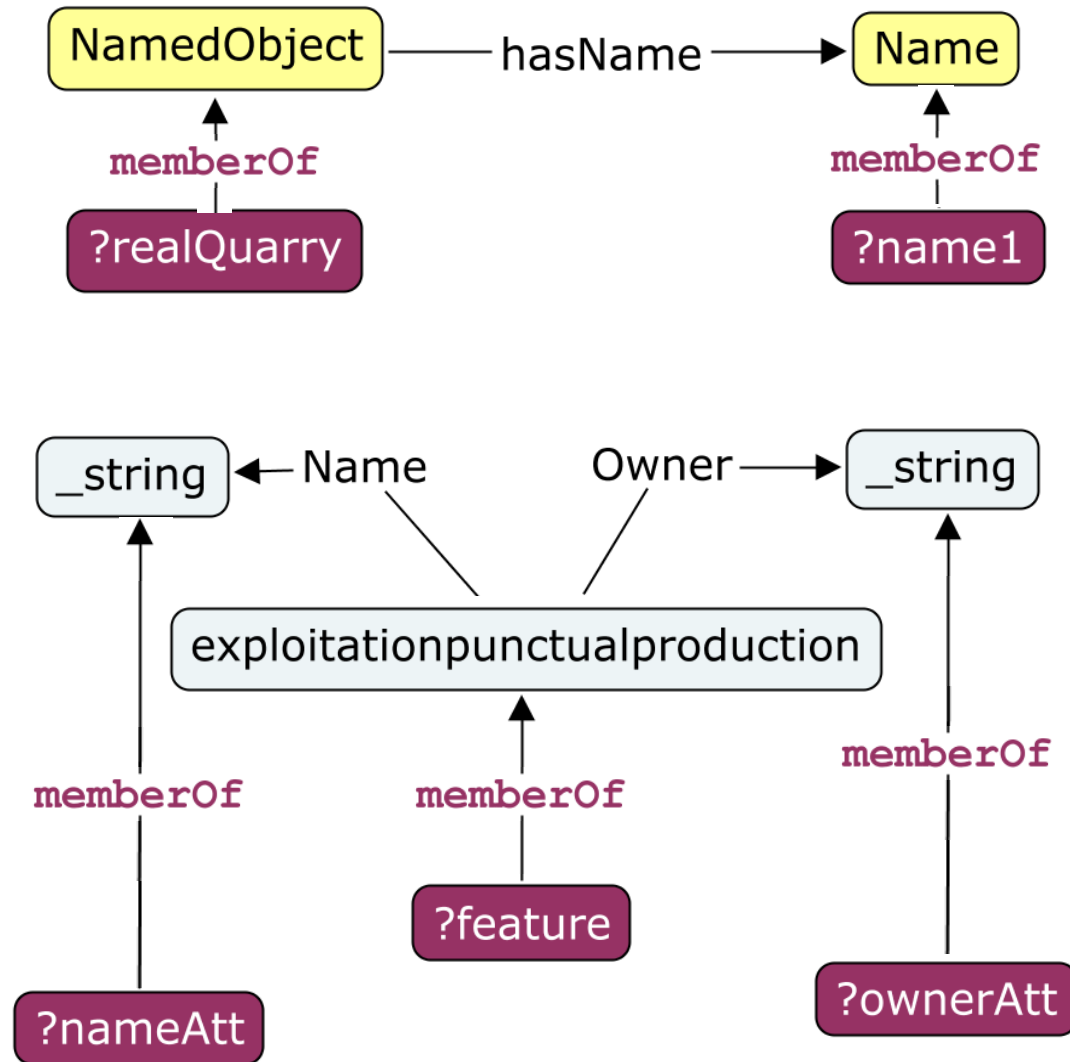
Instance-based Annotation: Introduction



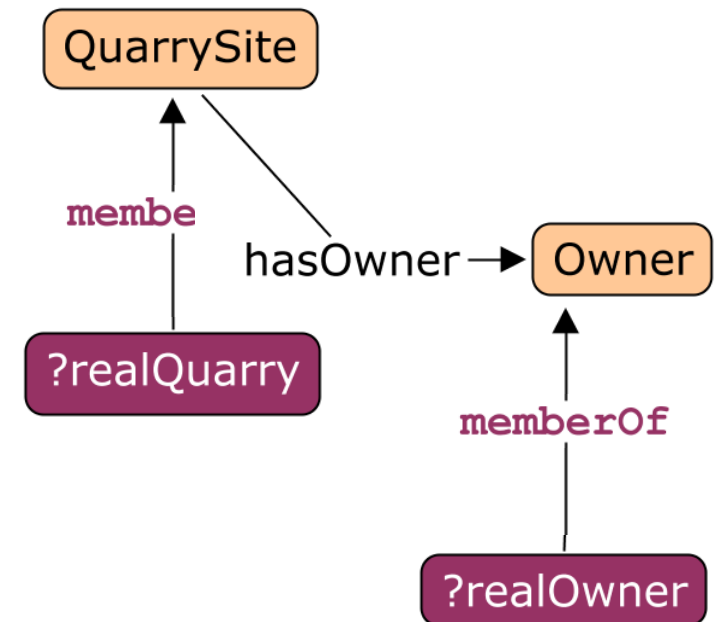
Instance-based Annotation: Introduction



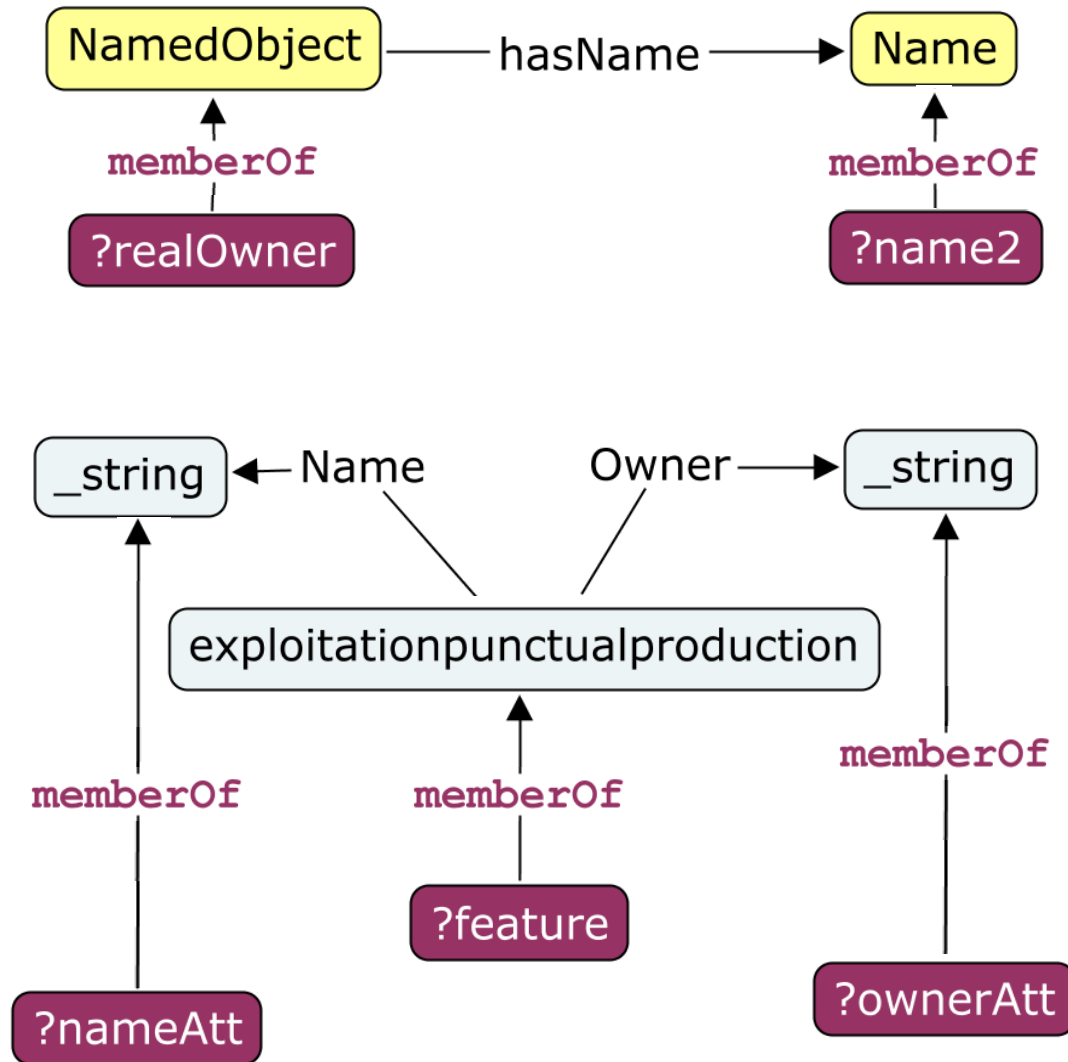
Instance-based Annotation: Introduction



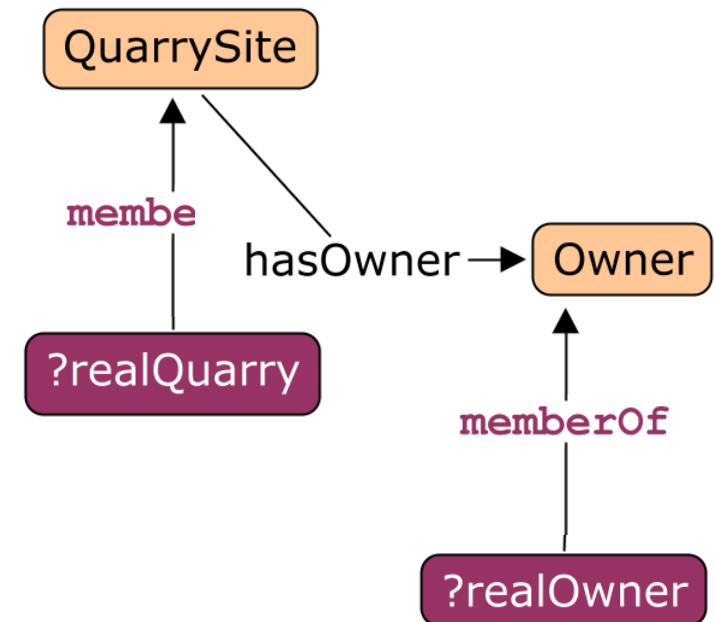
Domain Ontology



Instance-based Annotation: Introduction

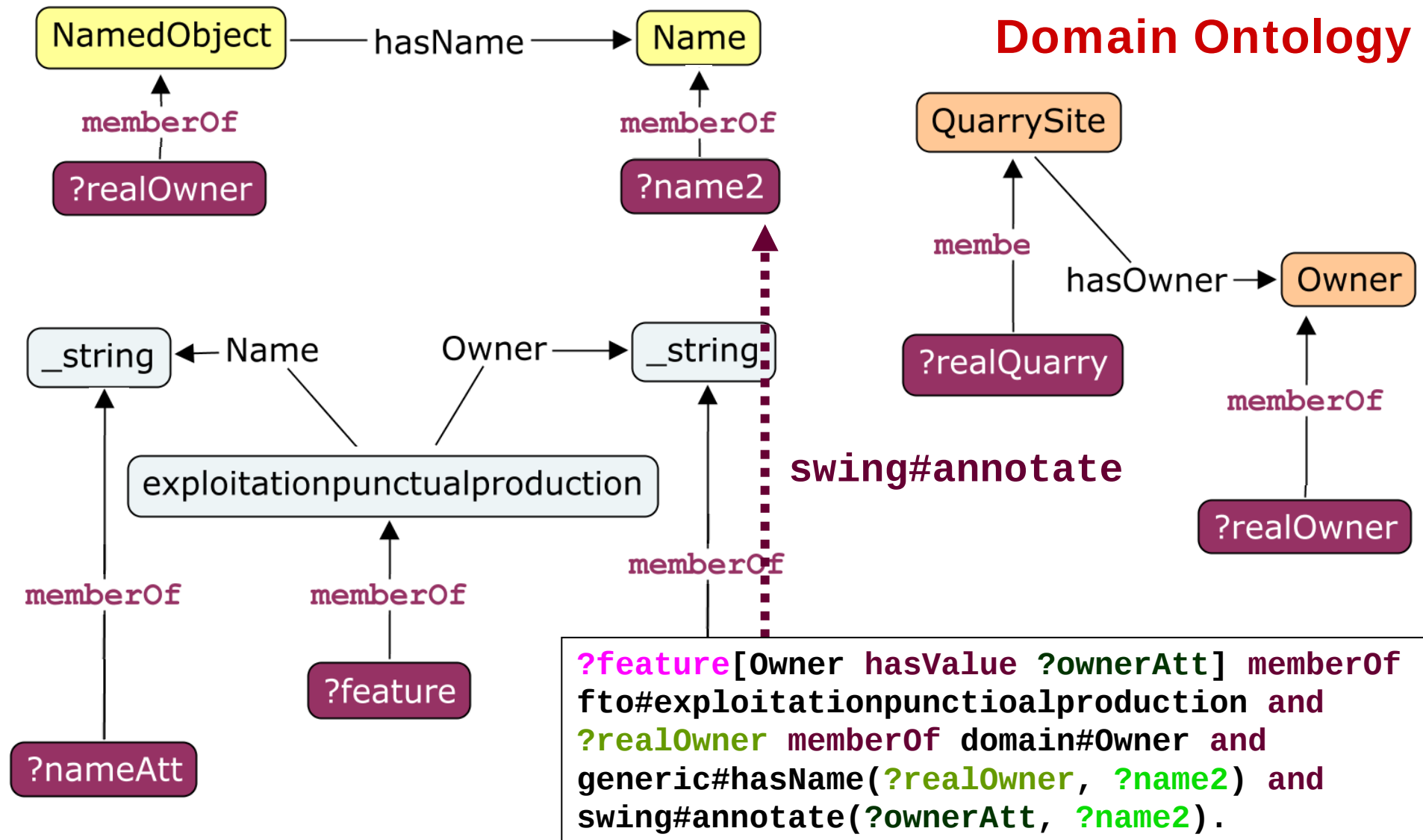


Domain Ontology

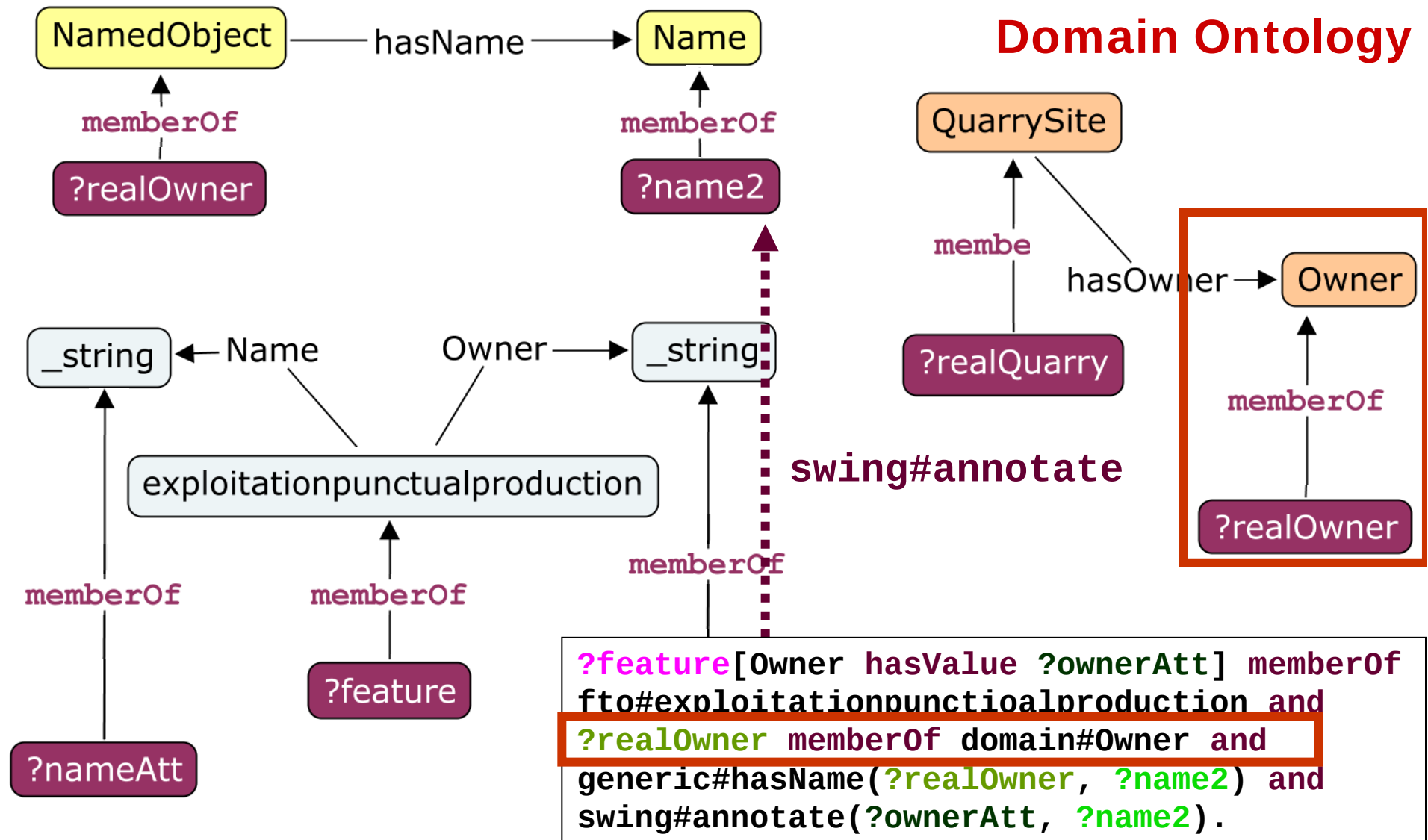




Instance-based Annotation: Introduction

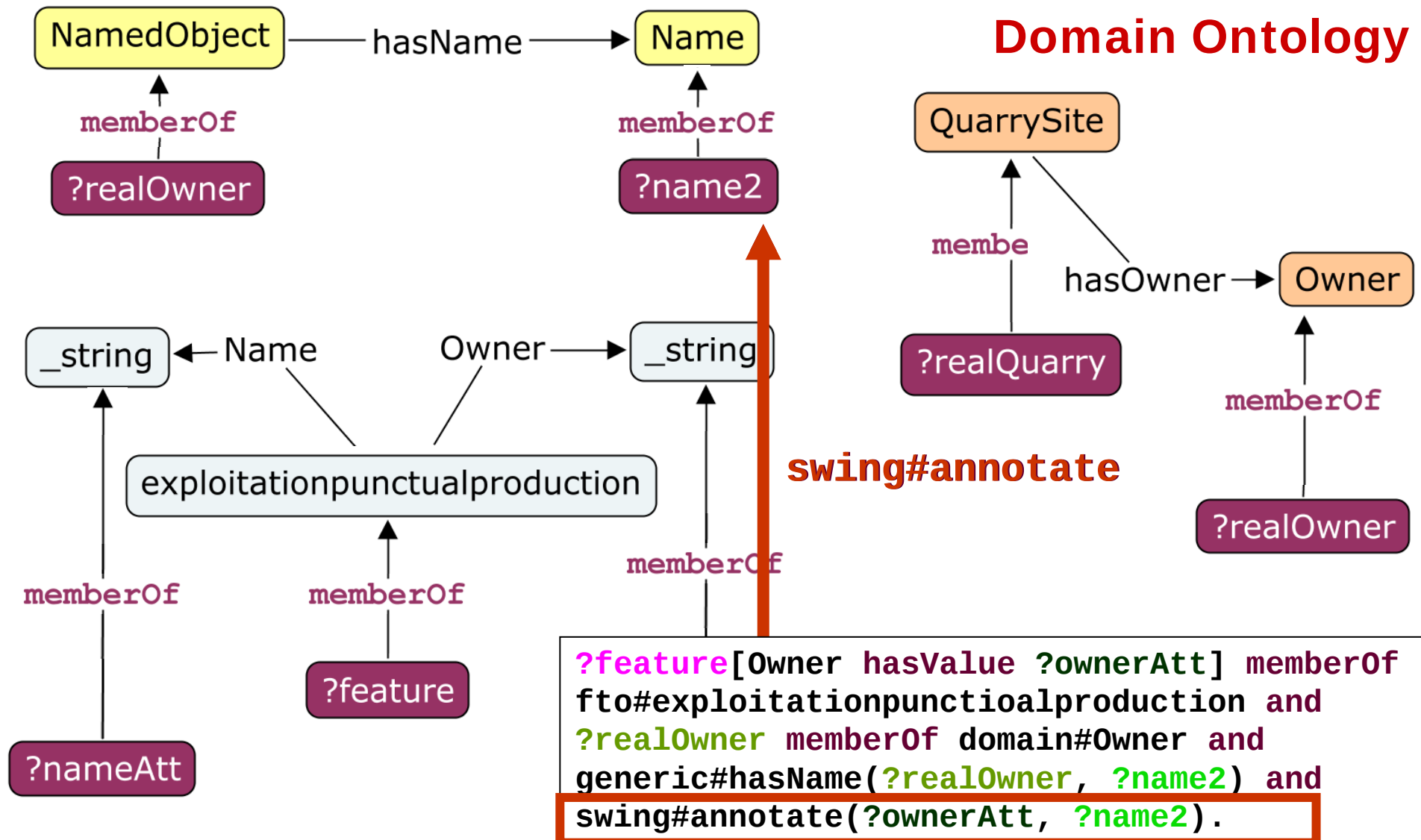


Instance-based Annotation: Introduction





Instance-based Annotation: Introduction



Instance-based Annotation: Benefit

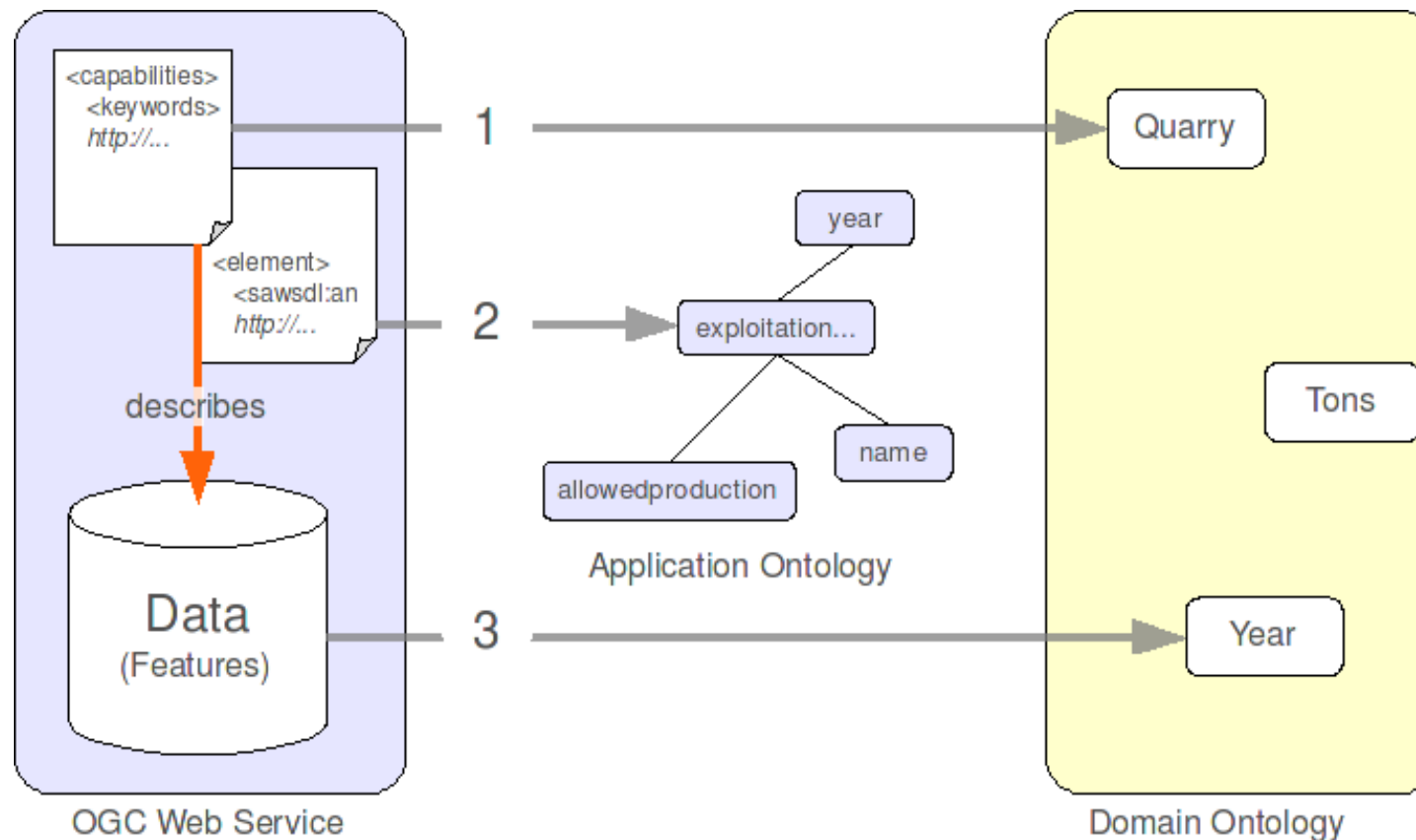


⇒ More **flexible domain ontologies** can be developed

- **Global relations** allow for more flexibility
- Subsumptions can be defined in **axioms**
- Using axioms in **attribute definitions** on domain level
- Using axioms that **restrict attribute values** on domain level
 - E.g. located in “France”

Annotation and GI Standards

- ⇒ Presentations at **ISO/TC211** TC meeting
- ⇒ Presentations at **OGC** TC meetings
- ⇒ An **OGC Discussion Paper**



Thank you!



- SWING IST FP6-26514
- FP6 - STREP
- March 2006 – March 2009
- 7 partners
- <http://www.swing-project.org>



Westfälische
Wilhelms-Universität
Münster

www.uni-muenster.de/



www.sintef.no/



www.igs.si/



www.nuigalway.ie



www.ionicsoft.com/

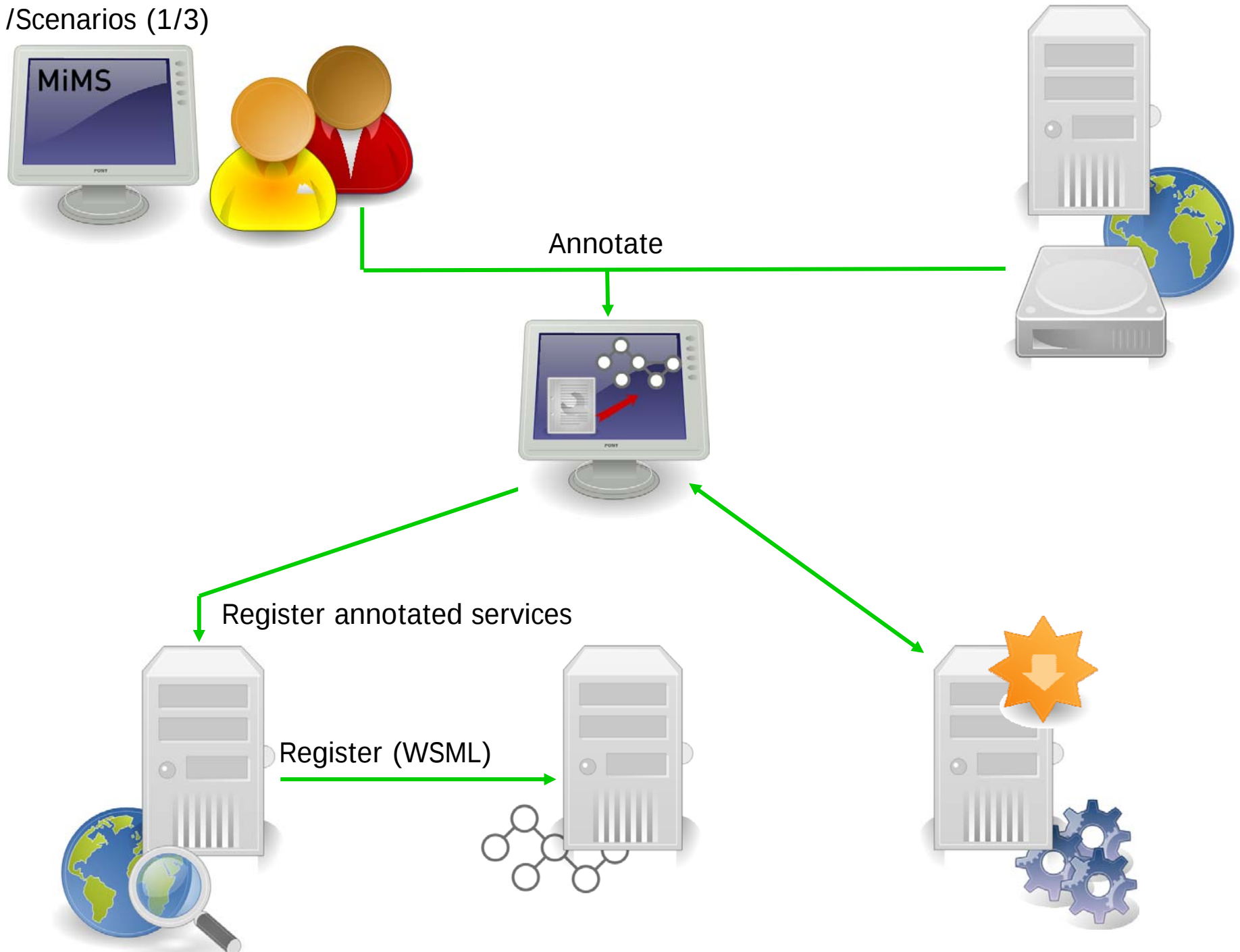


www.brgm.fr

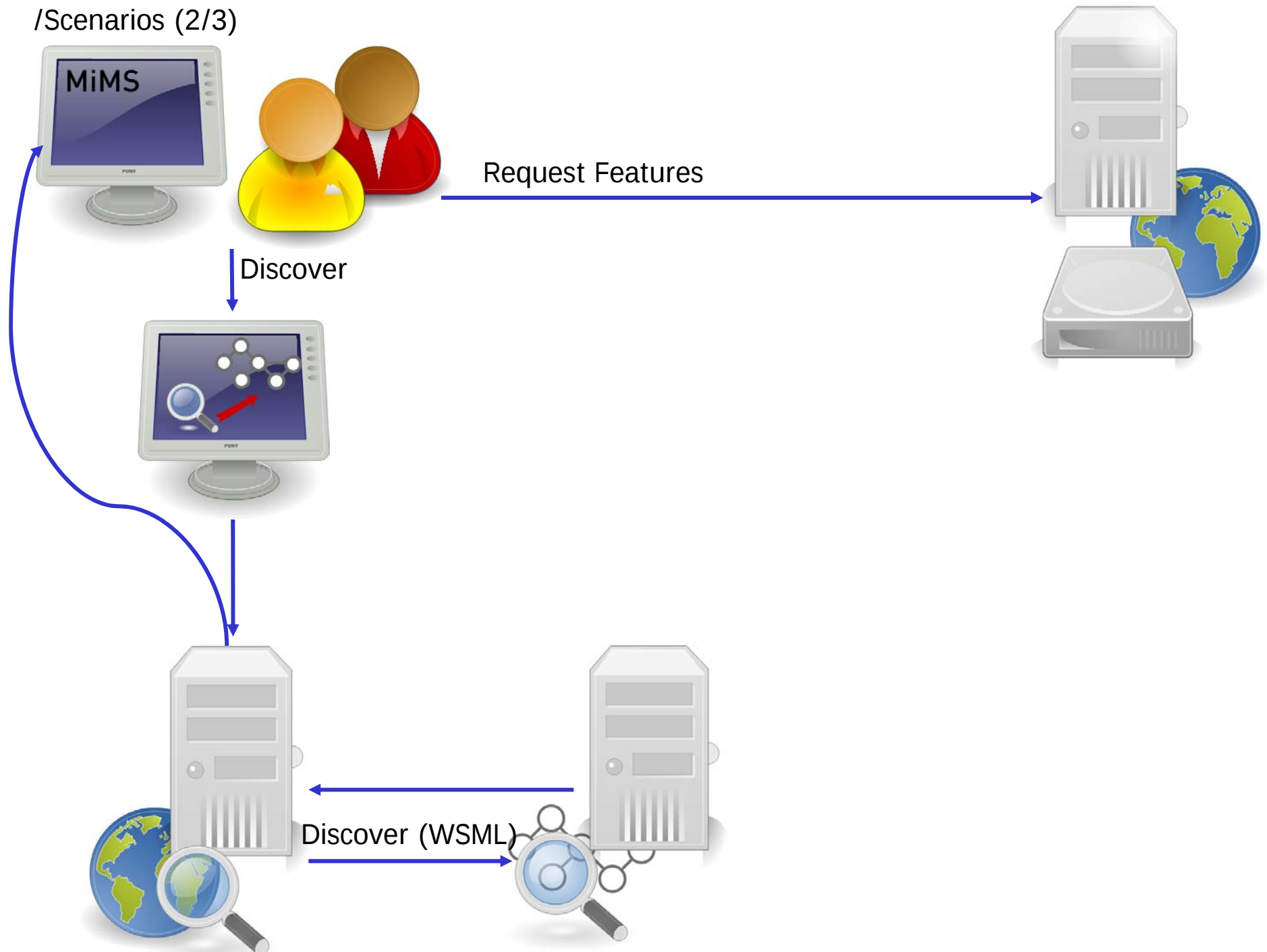


www.uibk.ac.at

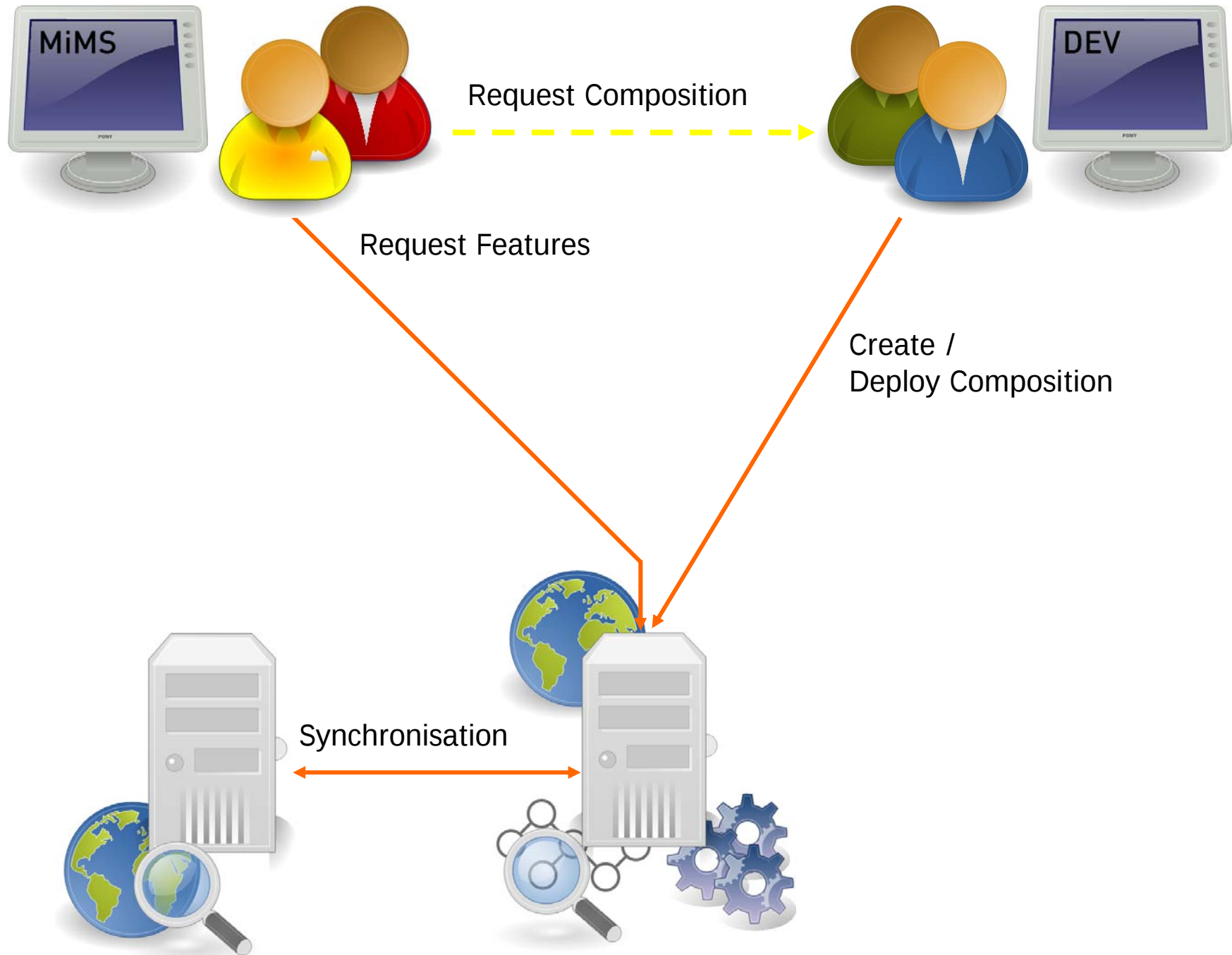
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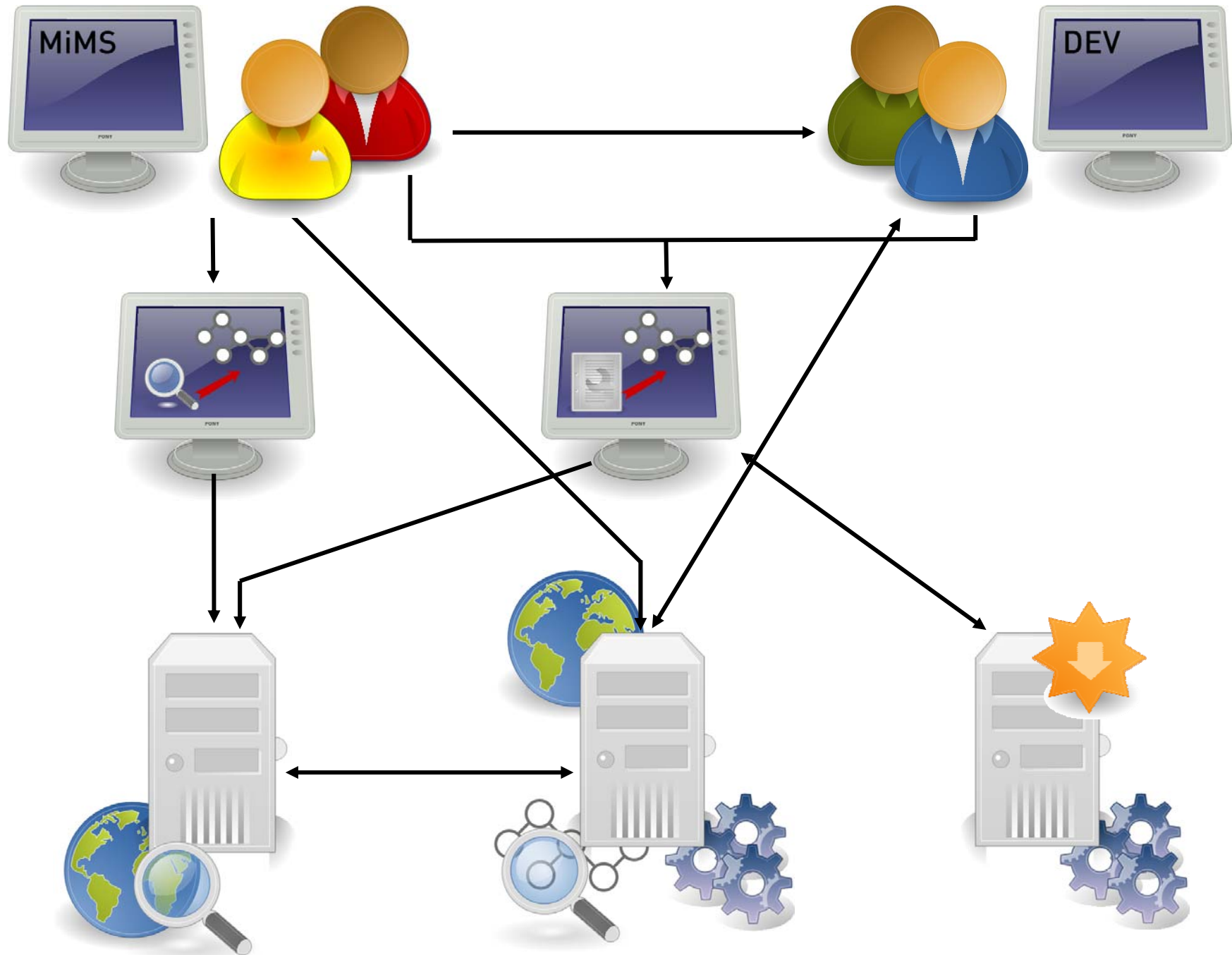
/Scenarios (2/3)

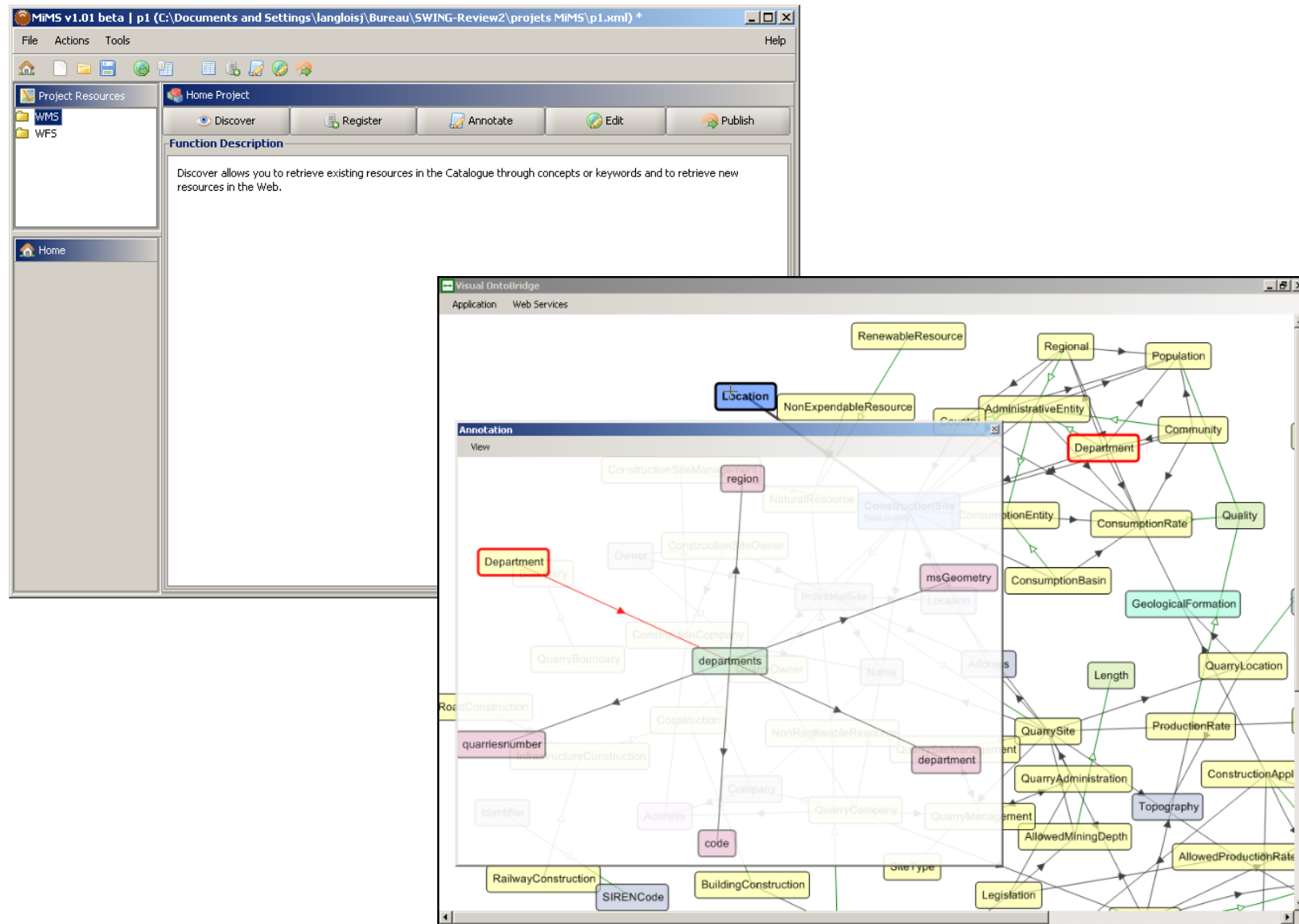


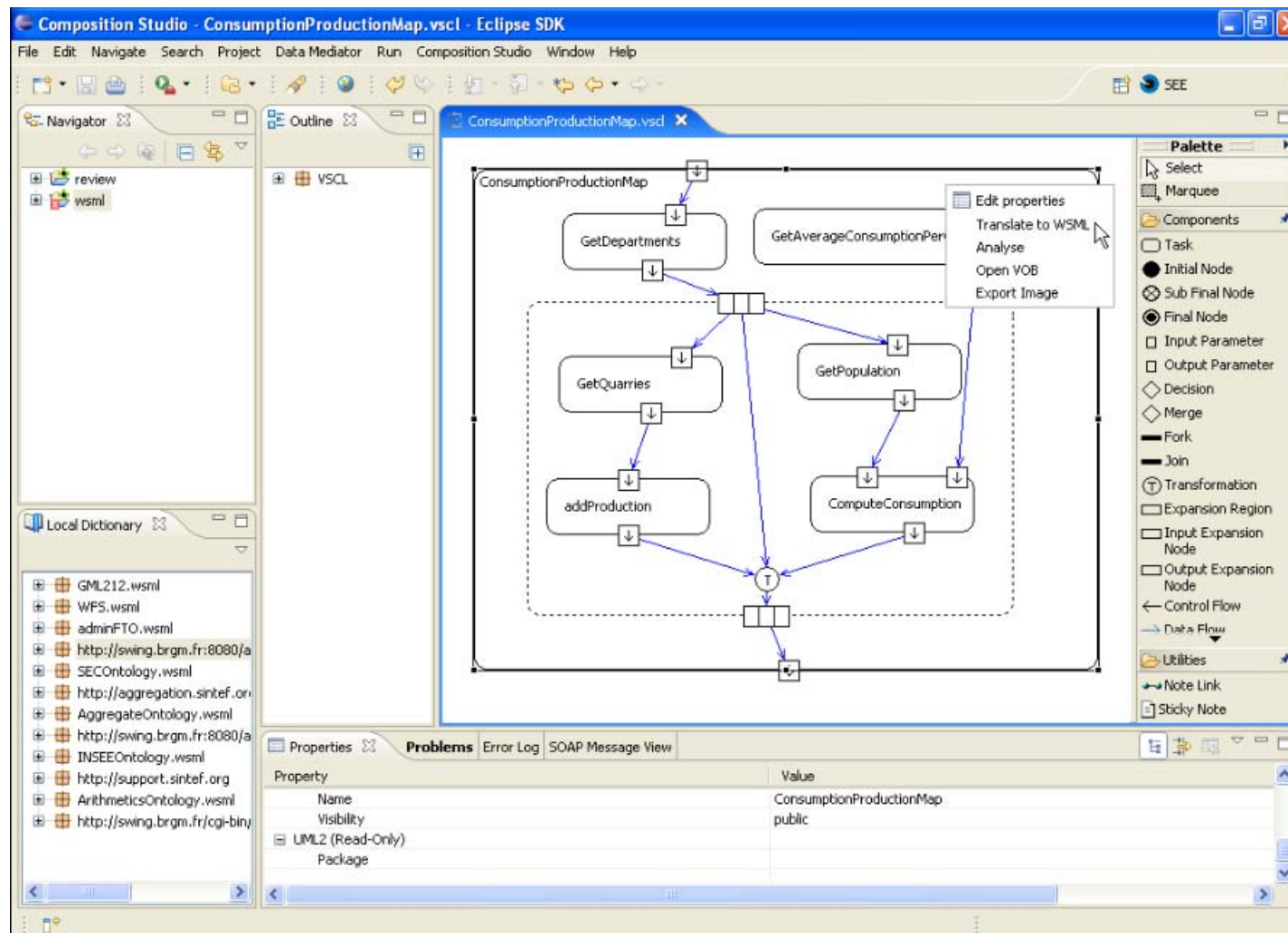
/Scenarios (3/3)



/Scenarios all







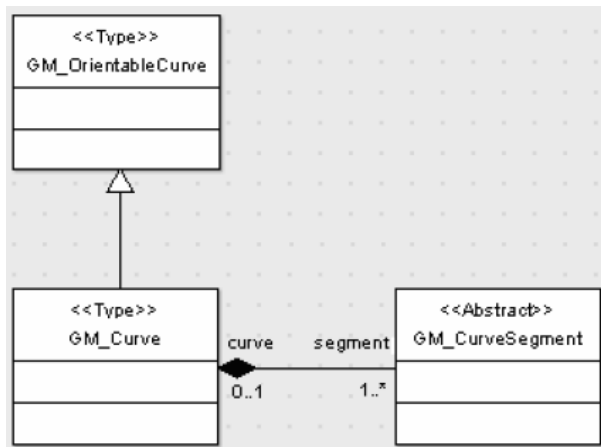
Why do we require ontologies?



How do we build the ontologies?

Knowledge Acquisition Strategy

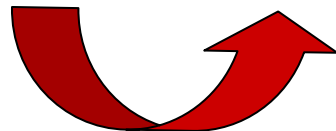
- OGC and ISO standards
 - Knowledge already (semi-) formally available
 - UML via OWL to WSMML to generate ontology skeletons



```
concept GM_OrientableCurve
```

```
concept GM_Curve subConceptOf GM_OrientableCurve
    segment inverseOf (curve) ofType (1 *) GM_CurveSegment
```

```
concept GM_CurveSegment
    curve inverseOf (segment) ofType (0 1) GM_Curve
```



-
- ```

graph TD
 NaturalPhenomena -- has --> PhenomenaDescriptor
 PhenomenaDescriptor -- has --> EconomicValue
 PhenomenaDescriptor -- has --> Quantifiable
 PhenomenaDescriptor -- has --> Volume
 PhenomenaDescriptor -- has --> Shape
 PhenomenaDescriptor -- has --> Size
 PhenomenaDescriptor -- has --> Color
 NaturalPhenomena -- is a --> CrystalThing
 NaturalPhenomena -- kind of --> GeologicalEntity
 GeologicalEntity -- is a --> ThreeDimensionalThing
 GeologicalEntity -- is a --> RockFormation
 RockFormation -- is --> HardRock
 RockFormation -- is --> SoftRock
 HardRock -- formed by --> Magmatic
 HardRock -- formed by --> Metamorphic
 HardRock -- makes --> AggregateResource
 SoftRock -- is --> Solid
 SoftRock -- is --> AggregateResource
 SoftRock -- makes --> Aggregate
 AggregateResource -- source of --> Aggregate
 Aggregate -- produced by --> IndustrialActivity
 IndustrialActivity -- performs --> HumanActivity
 IndustrialActivity -- is a --> Community
 IndustrialActivity -- is a --> Excavation
 Excavation -- is a --> Drilling
 Excavation -- is a --> Blasting
 Excavation -- is a --> Cutting
 Excavation -- is a --> Shoveling
 Aggregate -- produced by --> Gravel
 Aggregate -- produced by --> Sand
 GeologicalEntity -- is a --> Geology
 GeologicalEntity -- is a --> GeologicalProcess
 GeologicalProcess -- is a --> Deposition
 Deposition -- caused by --> Wind
 Deposition -- caused by --> River
 Deposition -- caused by --> Sea
 Deposition -- caused by --> Lake
 Deposition -- is a --> EarthSurface
 Deposition -- is a --> LandscapeObject
 Administration -- registered at --> QuarryLocation
 Administration -- defined by --> QuarryLocation
 QuarryLocation -- defined by --> Geology
 QuarryLocation -- defined by --> GeologicalProcess
 Administration -- defined by --> LandscapeObject
 LandscapeObject -- is a --> EarthSurface

```

W3C - TelCon, July 21st, 2009

# SWING application theme

- Quarries and Aggregates

*Aggregates = crushed hard rock (limestone, volcanic rock, sandstone, recycled concrete, ....), or on- & off-shore sediments (sand & gravel)*

## Use Cases:

1. Create a consumption-production map of aggregates
2. Create a map of constraints
3. Create a map of quarry best locations



## OGC and ISO Ontologies

- Geodata Encoding
  - General Feature Model Ontology
  - Spatial Schema Ontology
  - Temporal Schema Ontology
  - Geography Mark-up Language Ontology
- OGC Services
  - Web Service Common Ontology
  - Web Mapping Service Ontology
  - Web Feature Service Ontology
  - Web Coverage Service Ontology
  - Filter Encoding Ontology
  - Web Processing Service Ontology

## Domain Ontologies

- Ontology on Location
- Ontology on Measurement
- Ontology on Geology
- Ontology on Quarrying
- Ontology on Hydrology
- Ontology on Water Management
- Ontology on Ecology
- Ontology on Environmental Protection
- ...

## OGC and ISO Ontologies

- Geodata Encoding
  - General Feature Model Ontology
  - Spatial Schema Ontology
  - ...
  - (
  - (

<http://swing.brgm.fr/repository/ontologies>

ient

- OGC
  - Web Service Common Ontology
  - Web Mapping Service Ontology
  - Web Feature Service Ontology
  - Web Coverage Service Ontology
  - Filter Encoding Ontology
  - Web Processing Service Ontology

## Domain Ontologies

- Ontology on Location
- Ontology on Measurement
- Ontology on Geology
- ...
- Ontology on Environmental Protection
- ...