UNIVERSITY OF Southampton

The Origin of Ontology Mismatches on the Semantic Web

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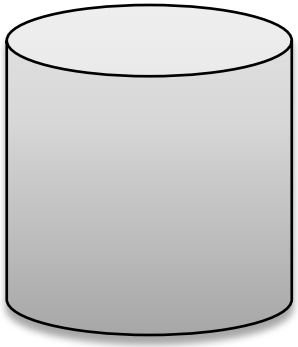
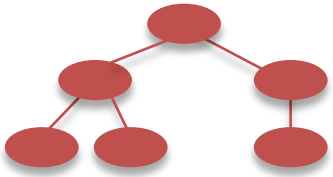
Semantic Integration

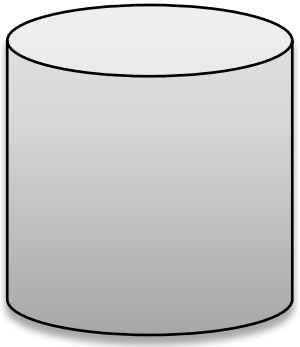
Repository A

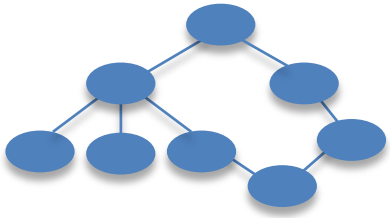




Ontology A

Repository B

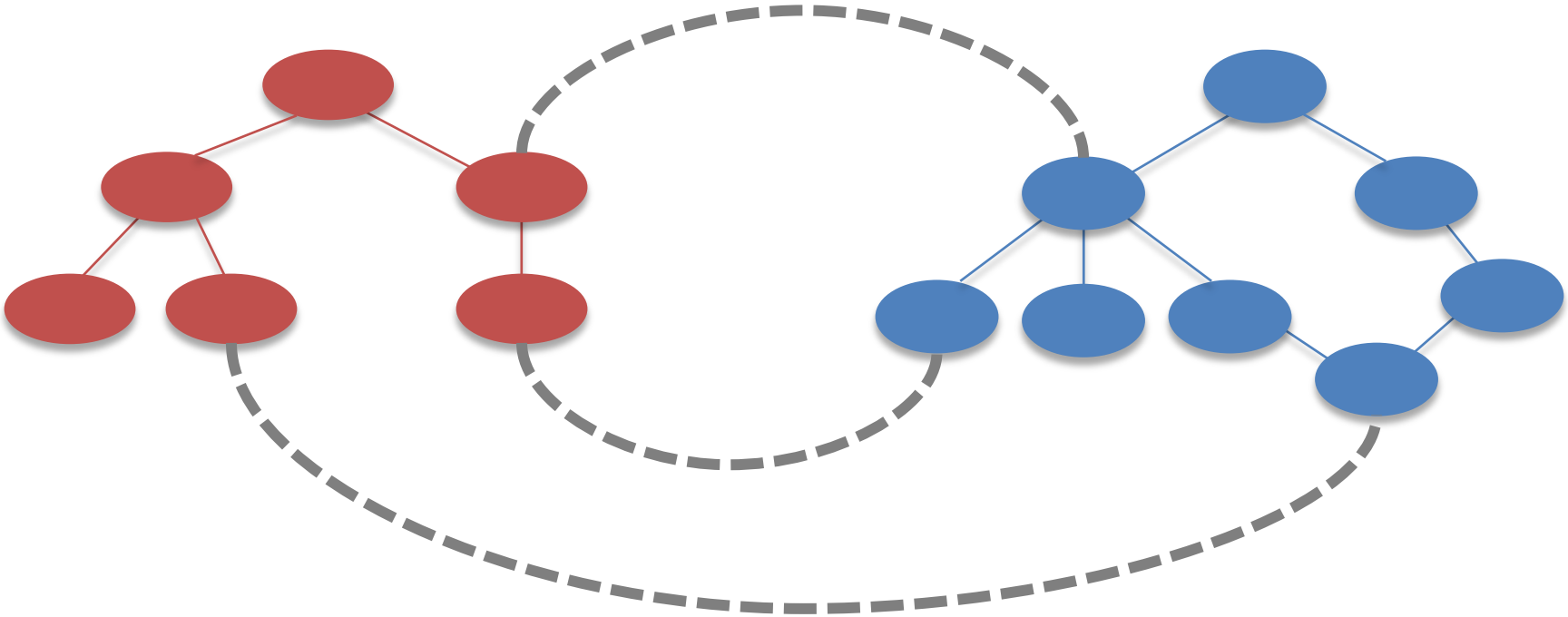




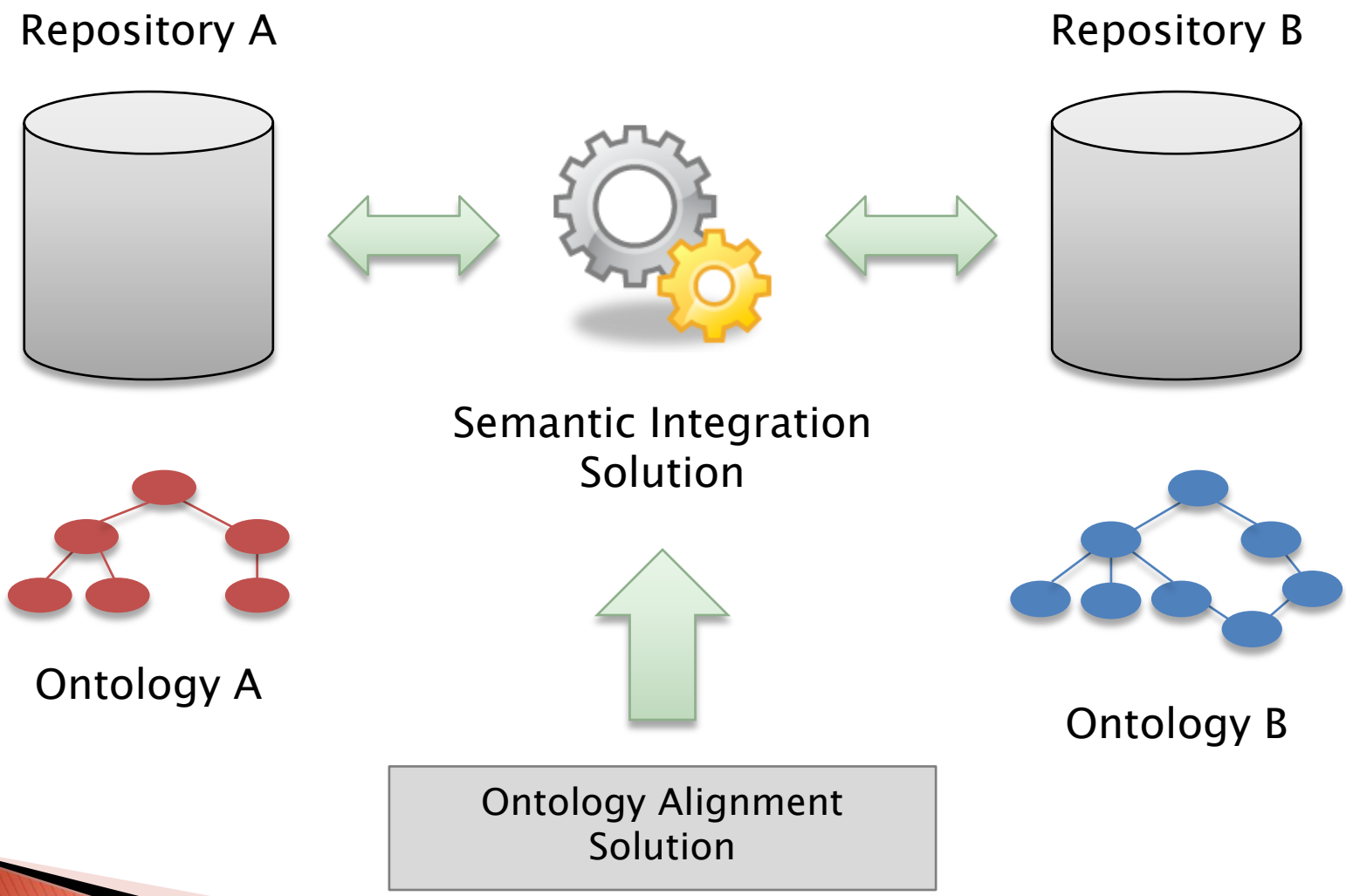
Ontology B

Semantic Integration

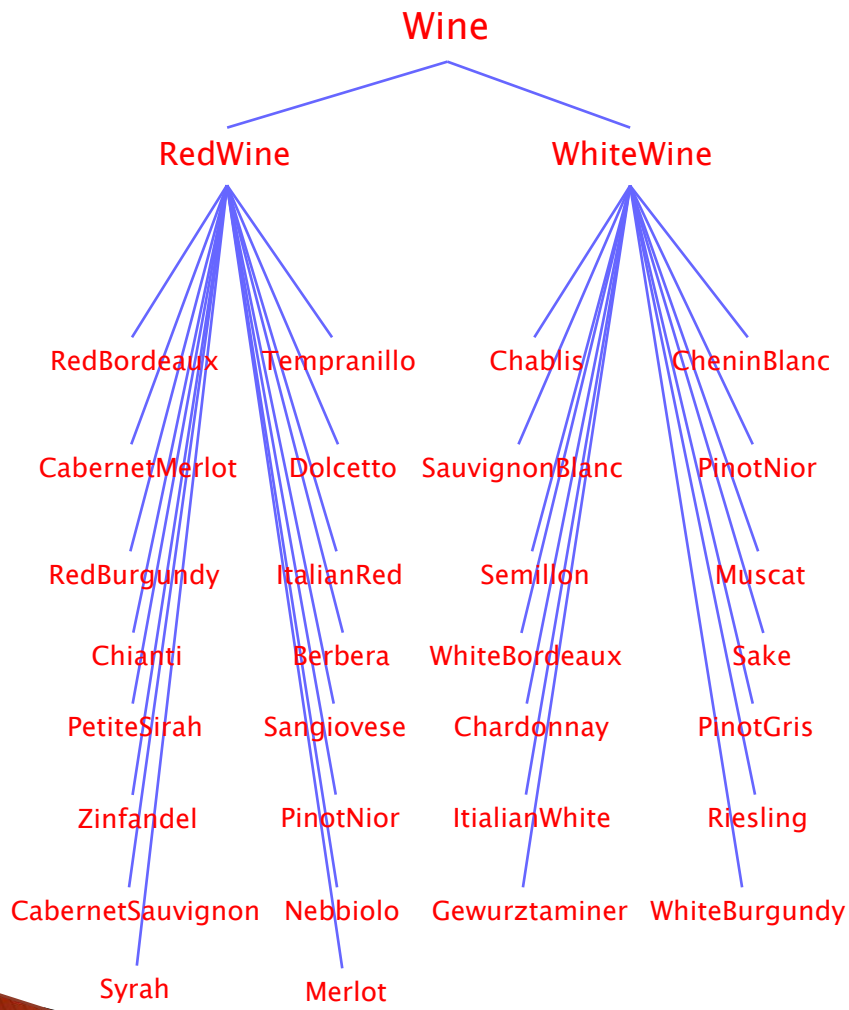
Ontology Alignment Solution

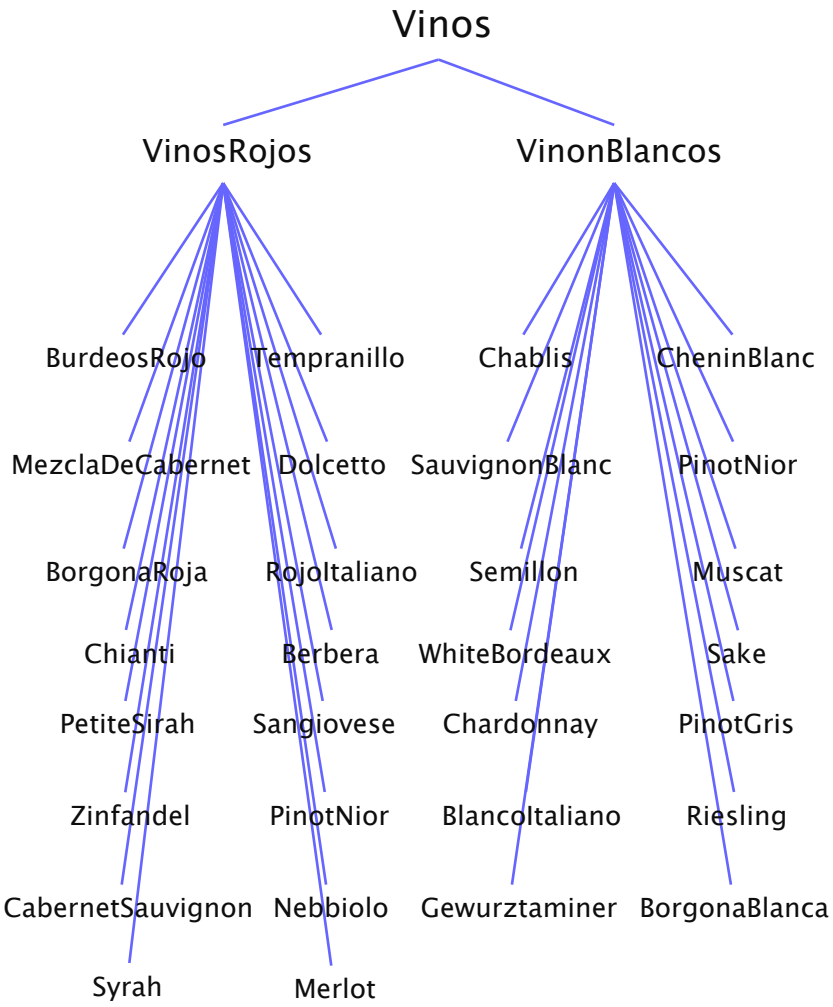


Semantic Integration

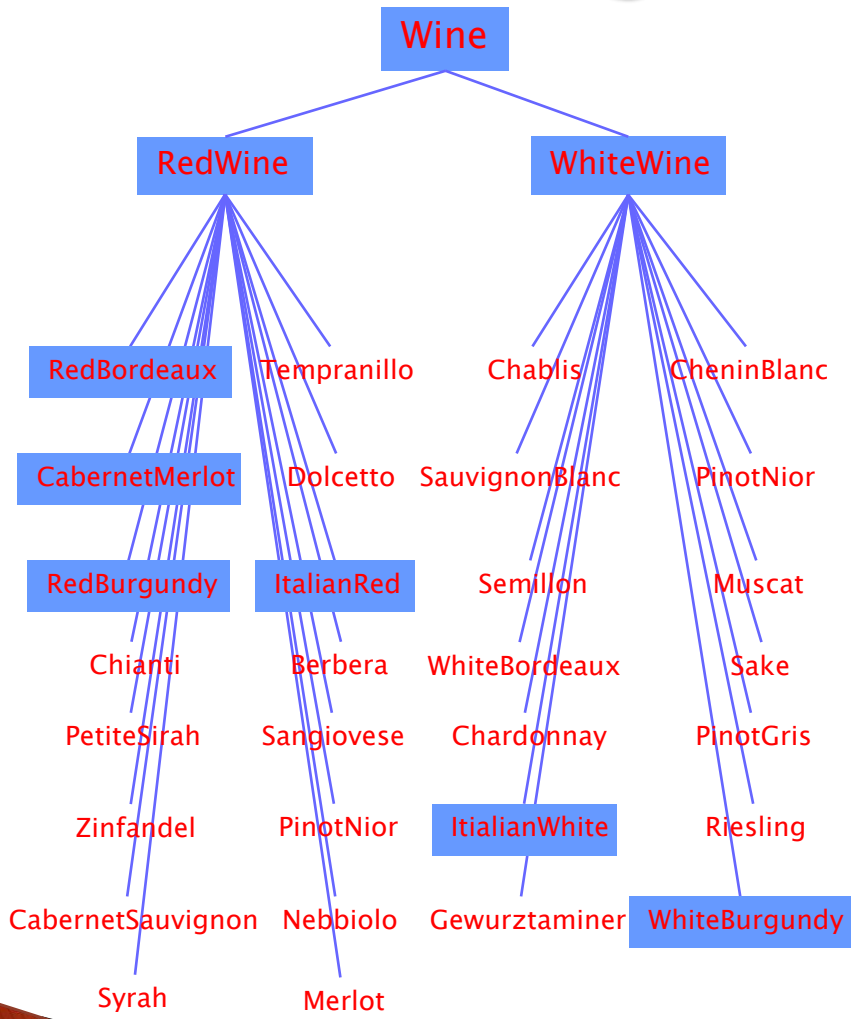


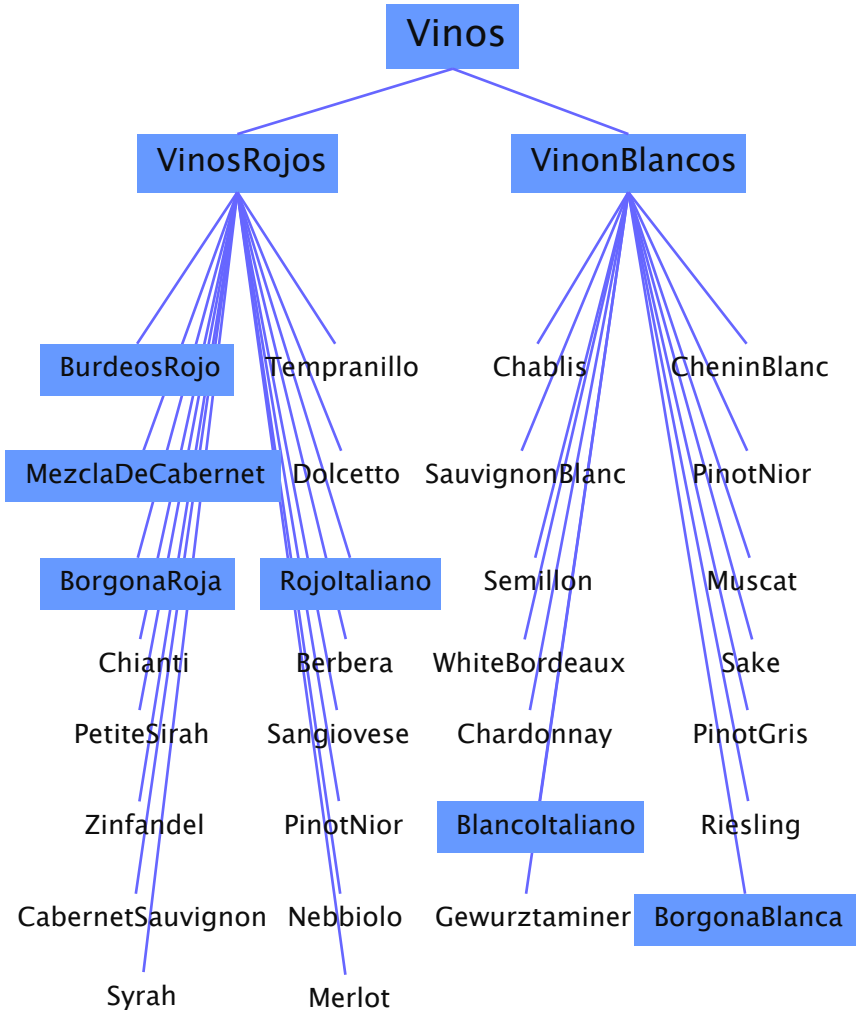
Terminological Mismatches



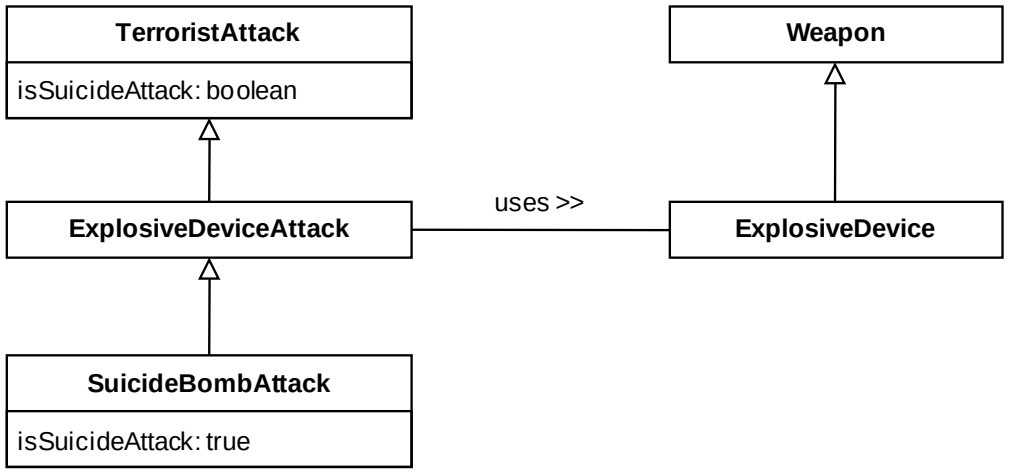


Terminological Mismatches



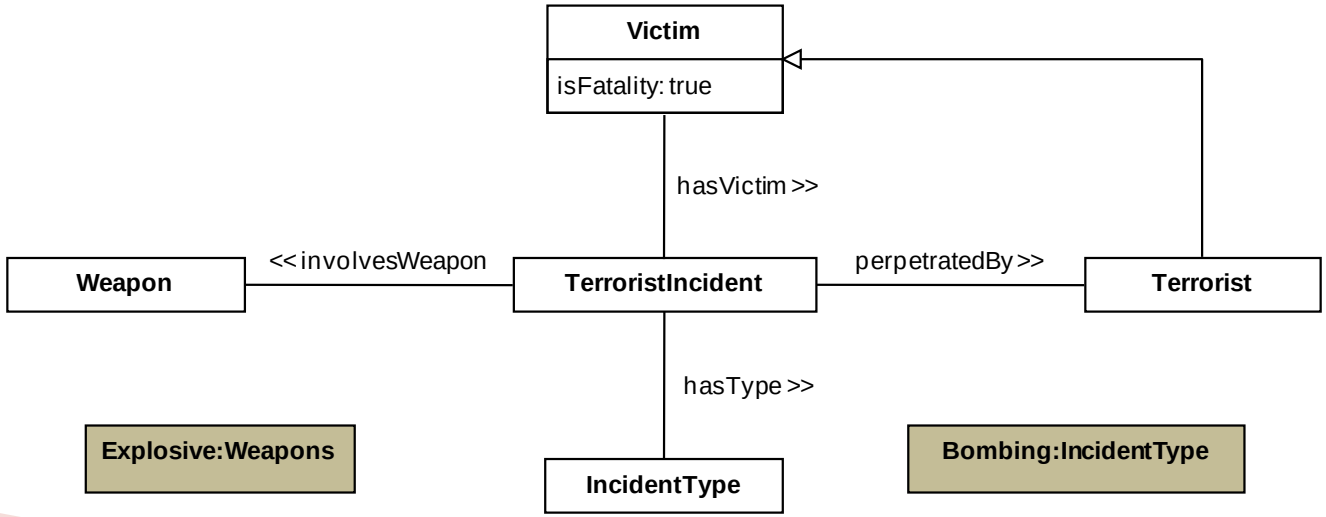


Structural Mismatches



Ontology A (ontA)

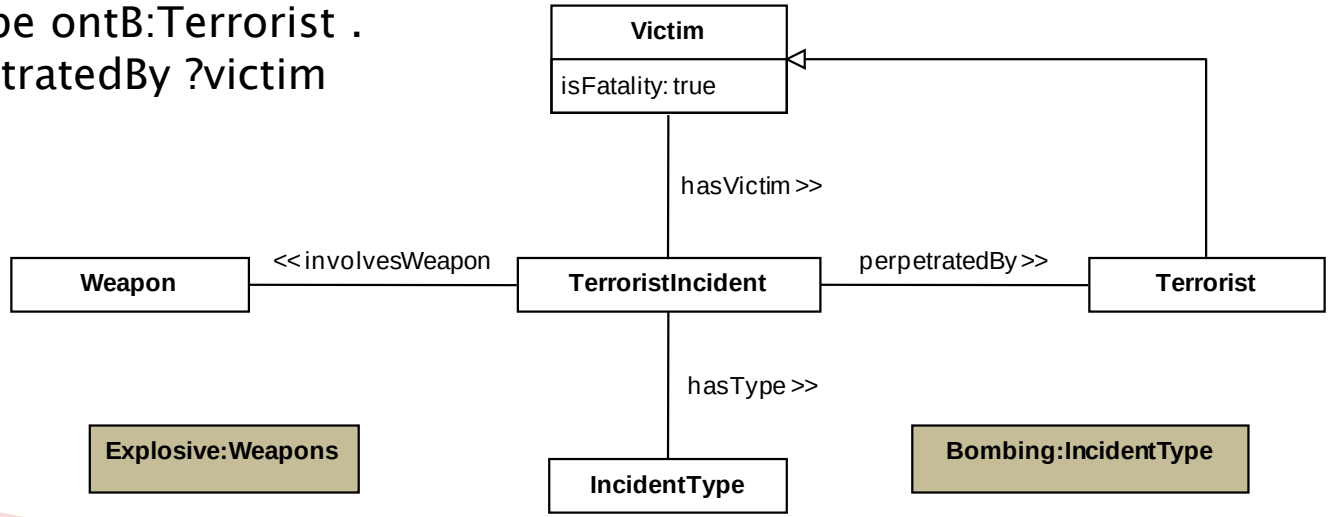
Ontology B (ontB)



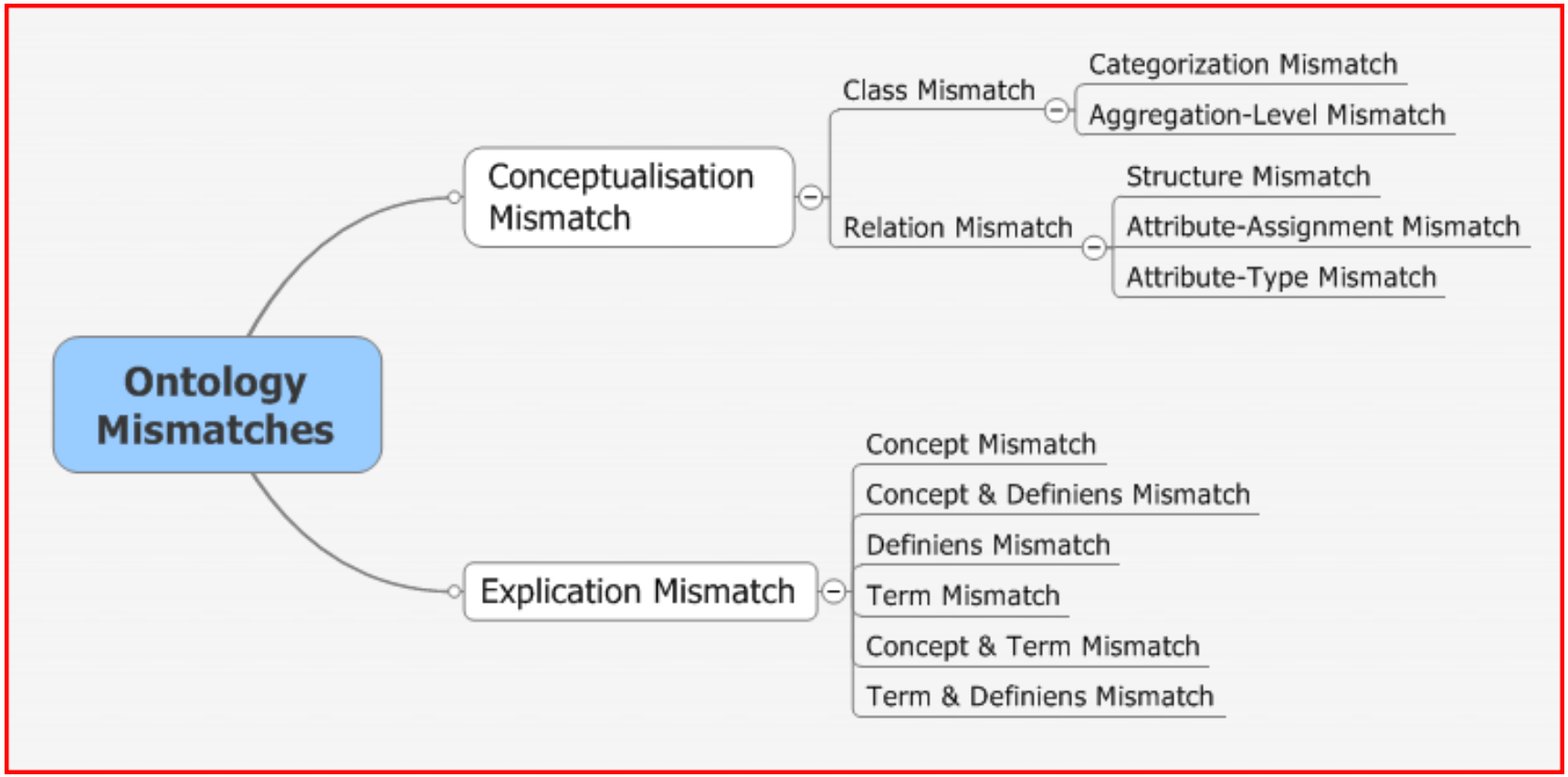
Structural Mismatches

```
CONSTRUCT
{
      ?x rdf:type ontA:SuicideBombAttack
}
WHERE
{
      ?x rdf:type ontB:TerroristIncident .
      ?x ontB:hasType ontB:Bombing .
      ?x ontB:involvesWeapon ontB:Explosive .
      ?x ontB:hasVictim ?victim .
      ?victim ontB:isFatality xsd:true .
      ?victim rdf:type ontB:Terrorist .
      ?x ontB:perpetratedBy ?victim
}
```

Ontology B (ontB)



Ontology Mismatch Types



Visser et al (1997)

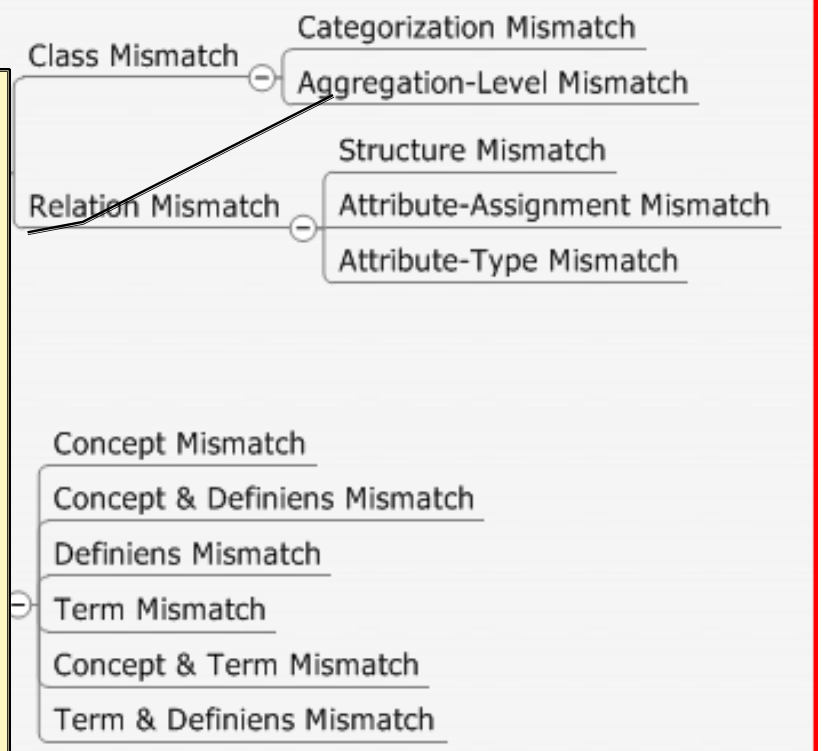
Ontology Mismatch Types

Aggregation-Level Mismatch

An aggregation-level mismatch occurs if both conceptualisations recognise the existence of a class, but define classes at different levels of abstraction.

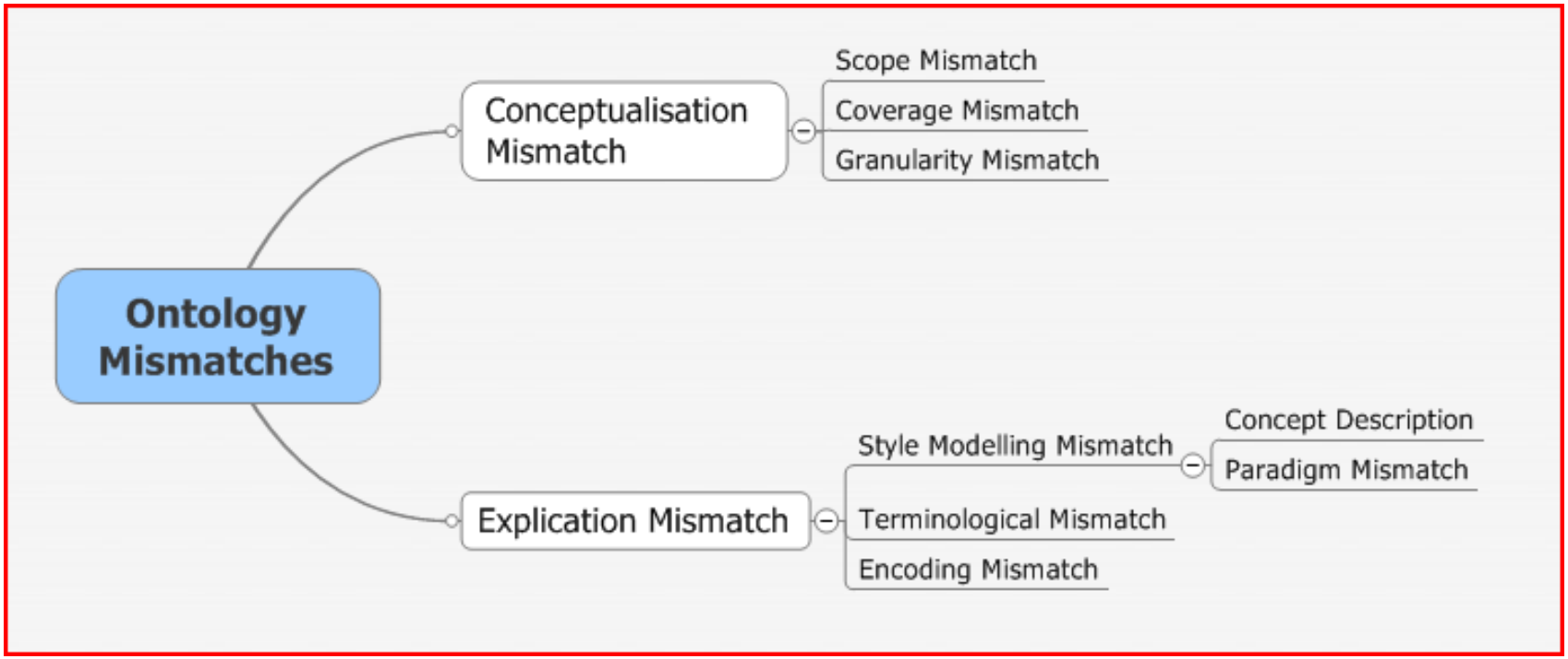
Example:

b:PC → b:Desktop ∪ b:Laptop
c:PC → c:Desktop ∪ c:Tower ∪
c:Portable ∪ c:Server



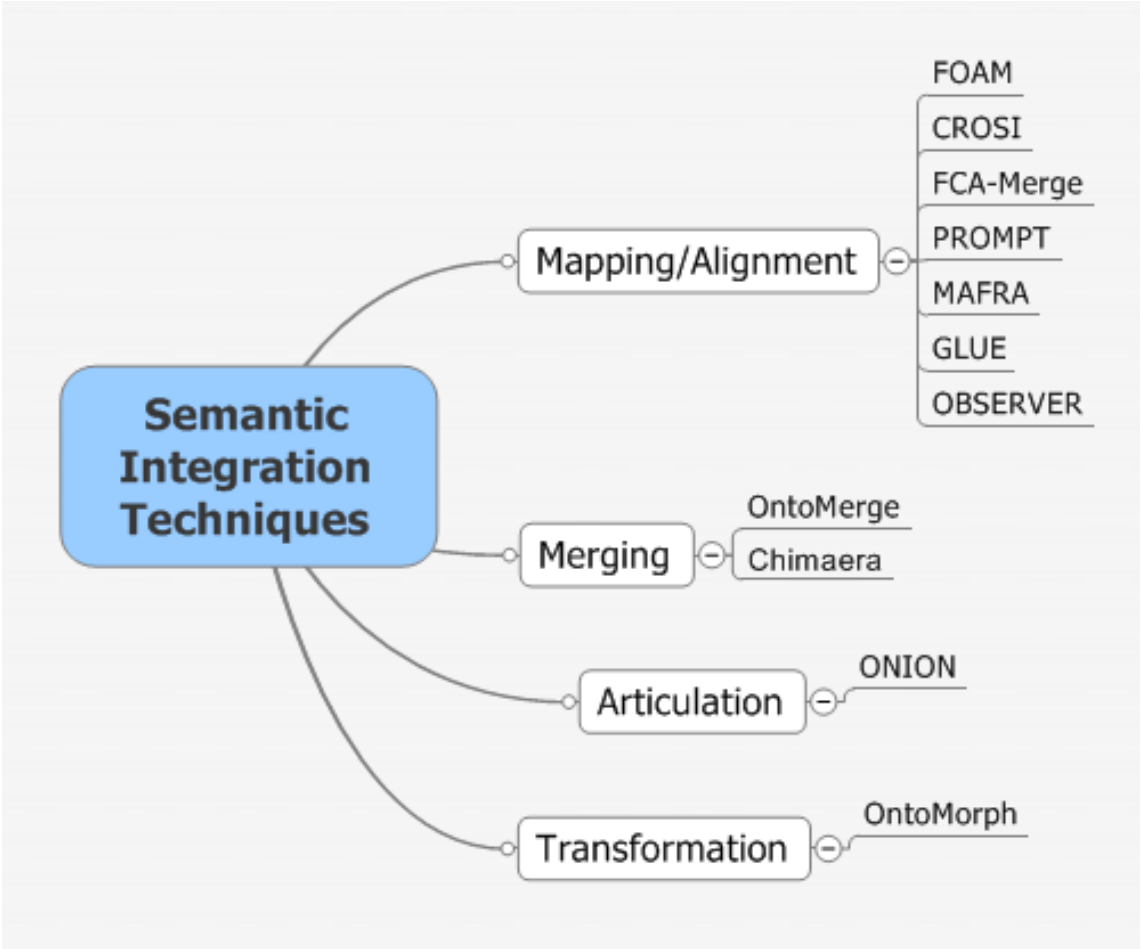
Visser et al (1997)

Ontology Mismatch Types



Klein (2001)

Semantic Integration Techniques



Ontology Mismatches – Origins

- Focus on techniques and technologies for ontology reconciliation
- But why do ontology mismatches occur?
  - Conceptual Processing
  - Dynamic Concepts
  - Knowledge Elicitation Techniques
  - Task Context
  - Ontology Engineering Expertise
  - Domain Expertise
  - Domain Experts
  - Cultural Differences

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Conceptual Processing

- Semantic Web
  - grounded in formal logic
  - classical or defining attribute view of concepts
  - conceptual categorization based on specification of necessary and sufficient conditions
- Humans
  - categorization is NOT based on necessary and sufficient conditions
  - category membership is judged in scalar or probabilistic terms
  - an object is seen as falling under a concept to a greater or lesser extent
  - most concepts cannot be characterized in terms of necessary and sufficient conditions
  - Semantic Web is psychologically implausible – ill-suited to representing human knowledge

Dynamic Concepts

- Semantic Web
  - committed to stable, context-invariant and symbolic representational formalisms
- Humans
  - human conceptual system is dynamic
  - there are no stable, context-invariant representations and what representations there are not symbolic
  - neural processing
  - concepts are never shared because human conceptual system is dynamic – we never have the same concept twice
  - "the same concept is rarely, if ever, constructed for a category" (Barsalou, 1987)
  - therefore not surprising that differences in conceptual models occur

Knowledge Elicitation Techniques

- Knowledge elicitation techniques are differentially effective at eliciting various types of knowledge (Shadbolt)
  - implicit/explicit – repertory grid
  - different knowledge constructs – concepts, attributes, rules
- Use of different techniques can have a significant impact on the kind of knowledge that is elicited and the way it is represented
- Techniques also exert psychological influence
  - object similarity judgements influence by comparison processes

Cultural Differences

- Cultural differences in military planning
- British Army
  - specification of mission objectives and associated rationale
- US Army
  - detailed specification of how to accomplish mission objectives
  - little or no rationale
- Differences reflected in planning ontologies for US and UK armed forces

Rasmussen, L. J., Sieck, W. R., & Smart, P. R. (2008) **US/UK Cultural Differences in Mental Models of Planning**. NATO RTO HFM-142 Symposium on Adaptability in Coalition Teamwork, Copenhagen, Denmark.

Ontology Engineering Expertise

Small pilot study to examine the effect of ontology engineering expertise on approaches to ontology development

Novices	Experts
Use of global property restrictions	Use of local property restrictions
Explicit specification of subsumption relationships	Reliance on reasoner to compute subsumption relationships
Low level of semantic resolution	High level of semantic resolution

Future Research

- Formalization of ontology mismatches
  - validation of existing taxonomies, additional characterizations(?)
- Frequency analysis of ontology mismatch types
  - understand the relative frequency of occurrence of mismatches
- Experimental analyses of causal processes
  - understand the relative importance of different factors in contributing to ontology mismatches

Experimental Analyses

- Independent variables
  - level of ontology engineering expertise, level of domain expertise, use of particular knowledge acquisition technique
- Dependent variables
  - frequency of (different types of) ontology mismatches
- Operationalization of some concepts is problematic, e.g. ontology engineering expertise

Summary

- Increasing maturity of technologies for ontology reconciliation
- However, relatively little research devoted to understanding the origins of ontology mismatches
- Possible causal factors include differences in knowledge capture technique, task context, culture and the nature of the human cognitive system
- Future research aims to examine the relative contribution of causal factors to the emergence of (specific types of) ontology mismatch