Whose "Fault" is This?

Untangling Domain Concepts in Ontology Design Patterns

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Outline

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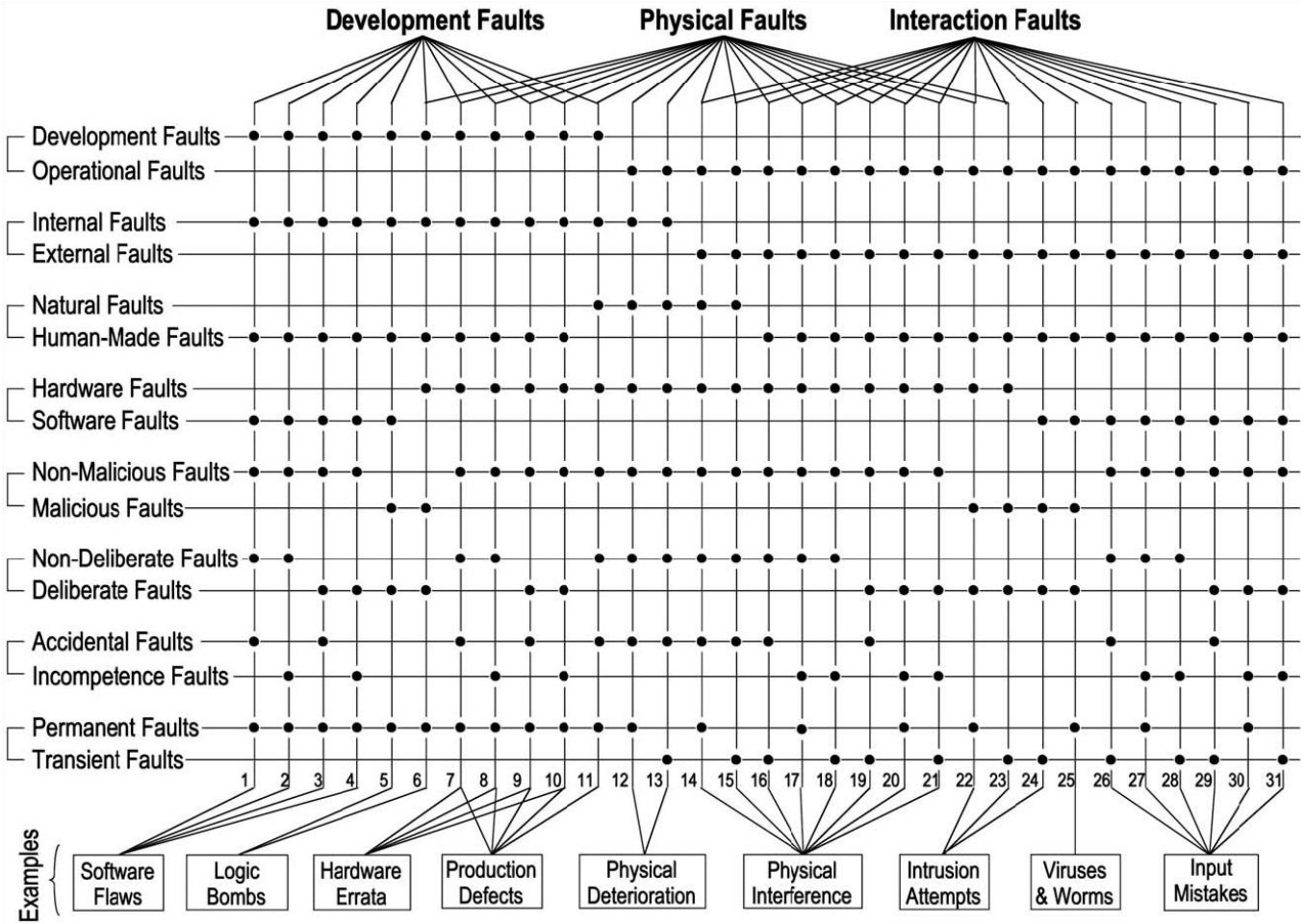
Ontology Design Patterns (ODPs)

- **Ontologies** have emerged as one of the key components for the realization of the Semantic Web.
- **Ontology Engineering** involves a broad range of activities focused on the development of ontologies.
- **Ontology Design Patterns (ODPs)** have evolved from the preceding success of design patterns in software engineering, (and known as *"archetypal solutions to design problems in a certain context"*).

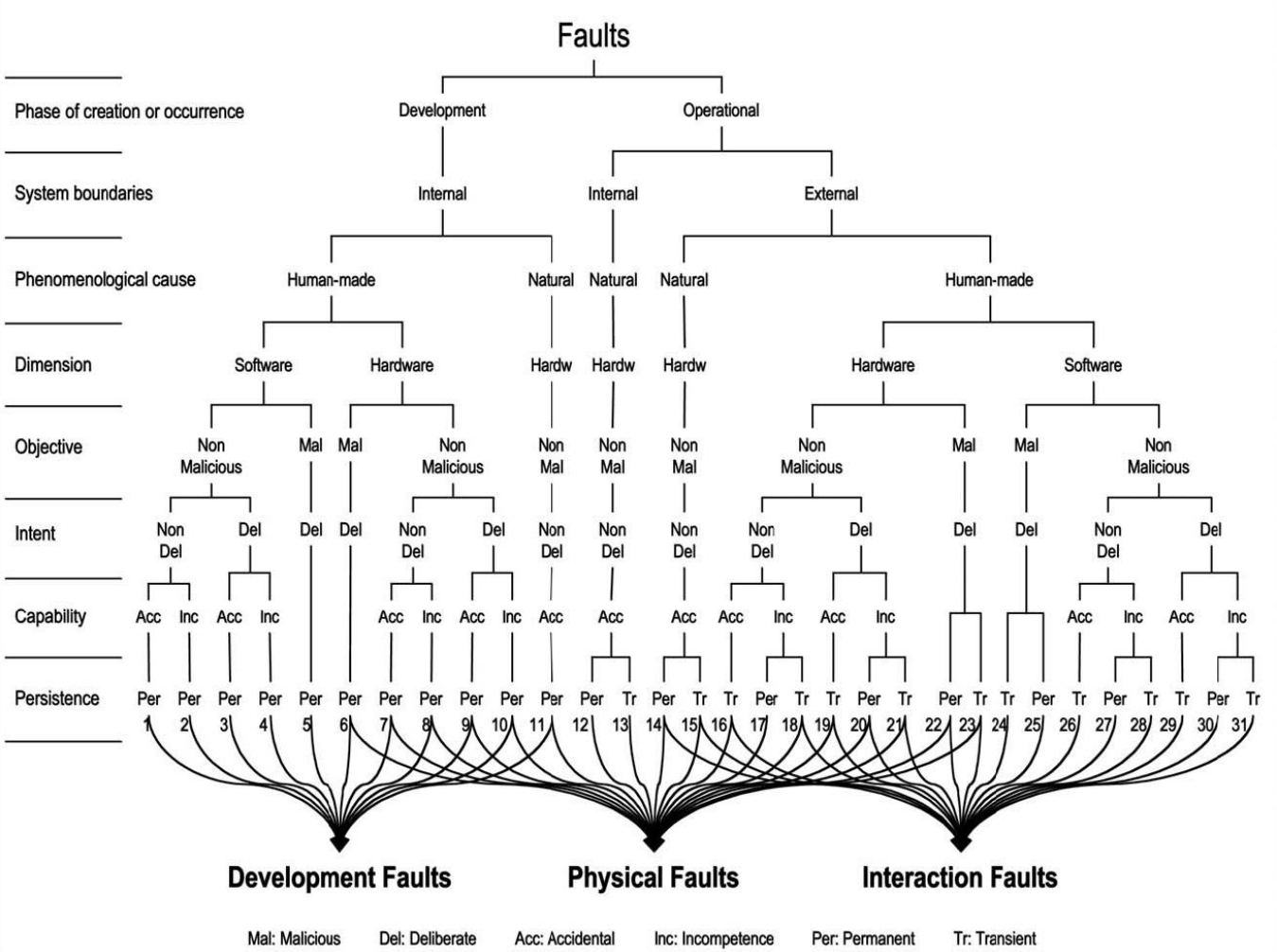
The ReSIST Project

- **The ReSIST Knowledge Base**: an ontologically mediated web portal that enables the end-user to browse and search different type of information in the area of resilient systems. (`http://www.rkbexplorer.com/explorer/`)
- The ReSIST Knowledge Base features an **ontology** in the field of **resilient computing**.
- The representation of the **`Fault` domain concept** in the ontology for ReSIST is challenging due to:
  - The complexity of its **definition**.
  - The **number of roles** that it supports in the ontology.
  - The **relationships** with other domain concepts in the ontology.

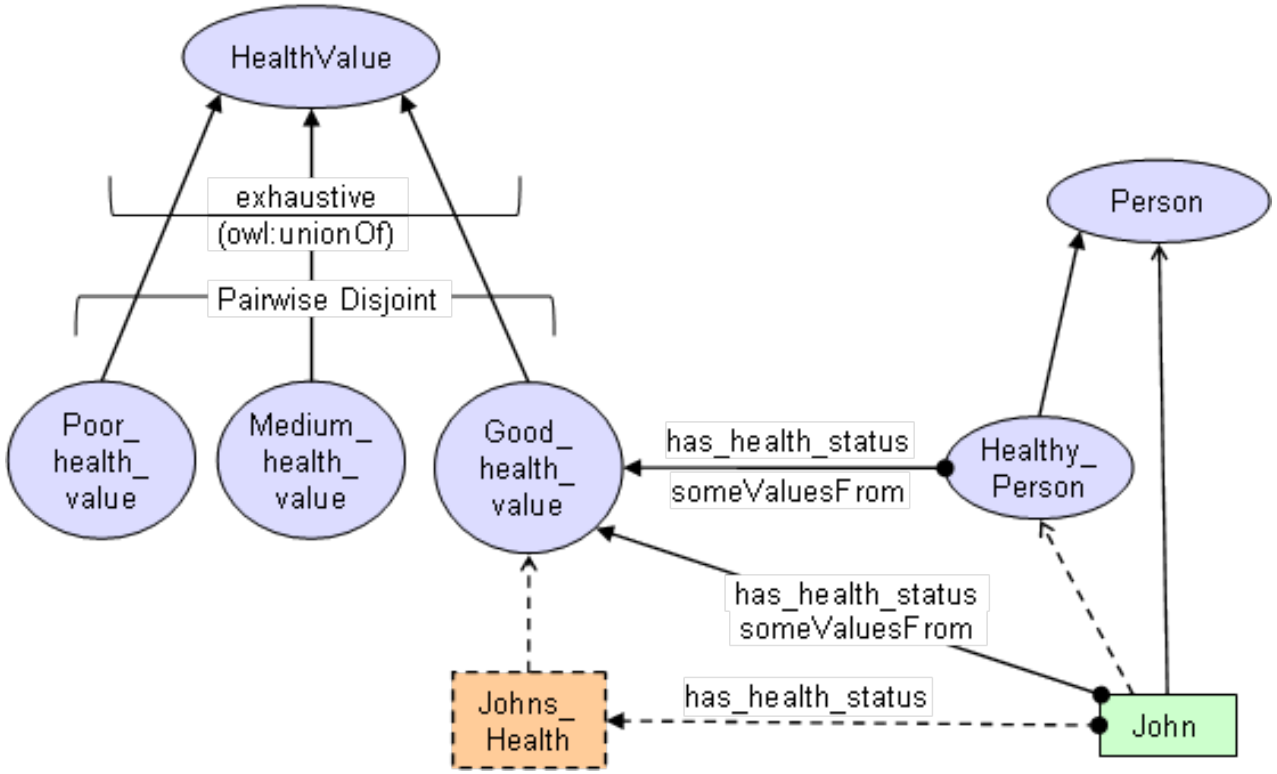
Matrix representation of Fault from (Avizienis 2004)



Tree representation of Fault from (Avizienis 2004)

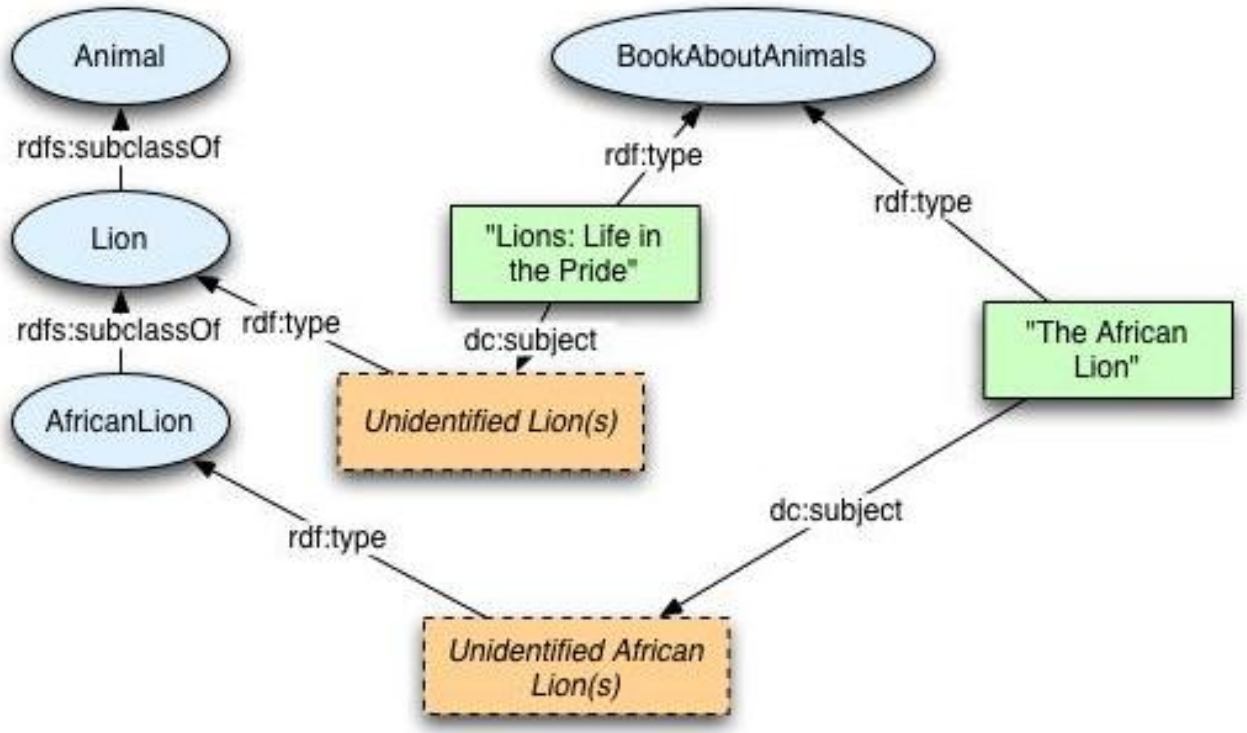


ODP1: Pattern 2-Variant 2 in (Rector 2005)



Representing Specified Values in OWL: “value partitions” and “value sets”

ODP2: Approach 4 in (Noy 2005)



Representing Classes As Property Values on the Semantic Web

Similarities between the 2 ODPs examined

- Both use a **hierarchy of classes** to provide **anonymous individuals** as **property values** for other concepts in the ontology
  - In Pattern 2-Variant 2 from (Rector 2005) the hierarchy is used as a representation of **features, attributes, or modifiers** that describe other concepts in the ontology.
  - In Approach 5 from (Noy 2005) the hierarchy is used as a **subject index** to annotate other domain concepts in the ontology.
- Both keep ontology expressivity within **OWL-DL**

Differences between the 2 ODPs examined

- Regarding the **hierarchy of classes**:
  - In Pattern 2-Variant 2 (Rector 2005) it conforms to the definition of **value partition**.
  - In Approach 4 (Noy 2005) it does **not** and classes could be organized in any hierarchical structure.
- Regarding the **anonymous individuals**:
  - In Pattern 2-Variant 2 (Rector 2005) they are of the **same type** of the other individuals in the class.
  - In Approach 4 (Noy 2005) they are of **different type** of the other individuals in the class. Anonymous individuals are subjects while the others are actual animals.

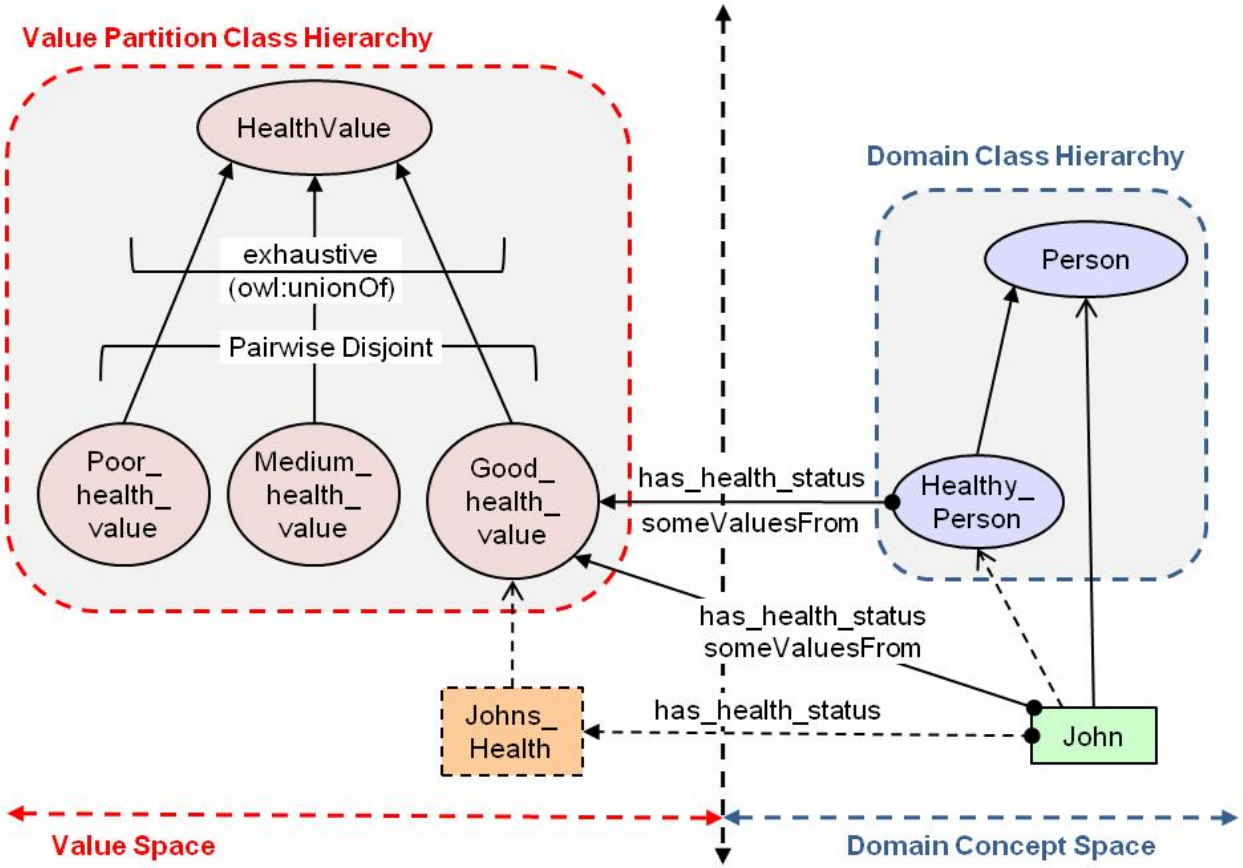
A Terminology for Roles of Domain Concepts I

- **Generic Class Hierarchy (GCH):** refers to a set of classes organized in any hierarchical structure (e.g. a single class or a set of classes organized in a list, a tree or a directed acyclic graph).
- **Domain Class Hierarchy (DCH):** refers to any GCH that contains the classes corresponding to the domain concepts that the ontology is intended to represent.
- **Value Class Hierarchy (VCH):** refers to any GCH that is used to provide anonymous individuals as values to properties for other domain concepts in the ontology.

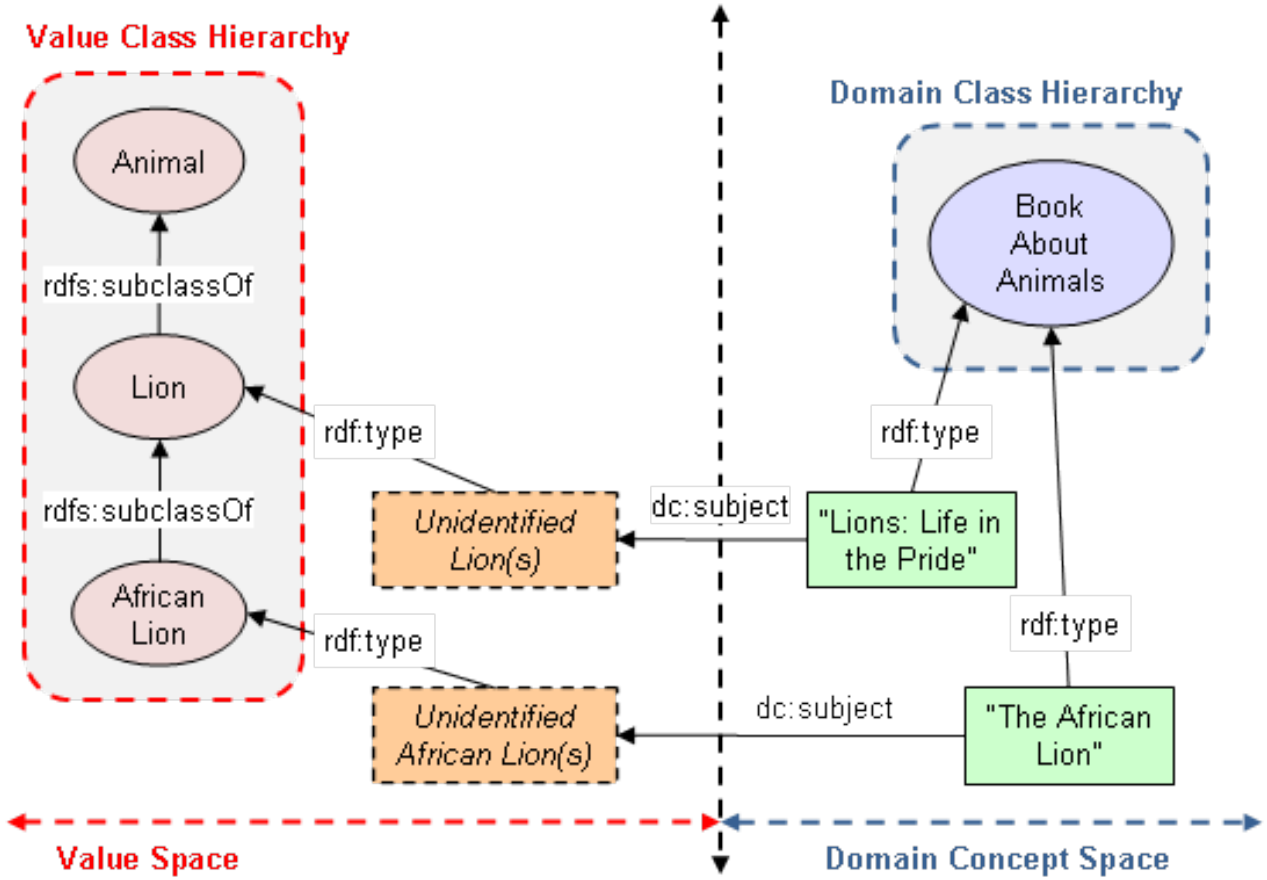
A Terminology for Roles of Domain Concepts II

- **Value Partition Class Hierarchy (VPCH):** refers to a GCH that: **a)** is a Value Class Hierarchy and **b)** conforms to the definition of a value partition
- **Domain Concept Space (DCS):** identifies the subset of the ontology model that contains all the classes that belong to a Domain Class Hierarchy.
- **Value Space (VS):** identifies the subset of the ontology model that contains all the classes that belong to a Value Class Hierarchy or Value Partition Class Hierarchy.

Example 1: Roles of Domain Concepts in (Rector 2005)



Example 2: Roles of Domain Concepts in (Noy 2005)

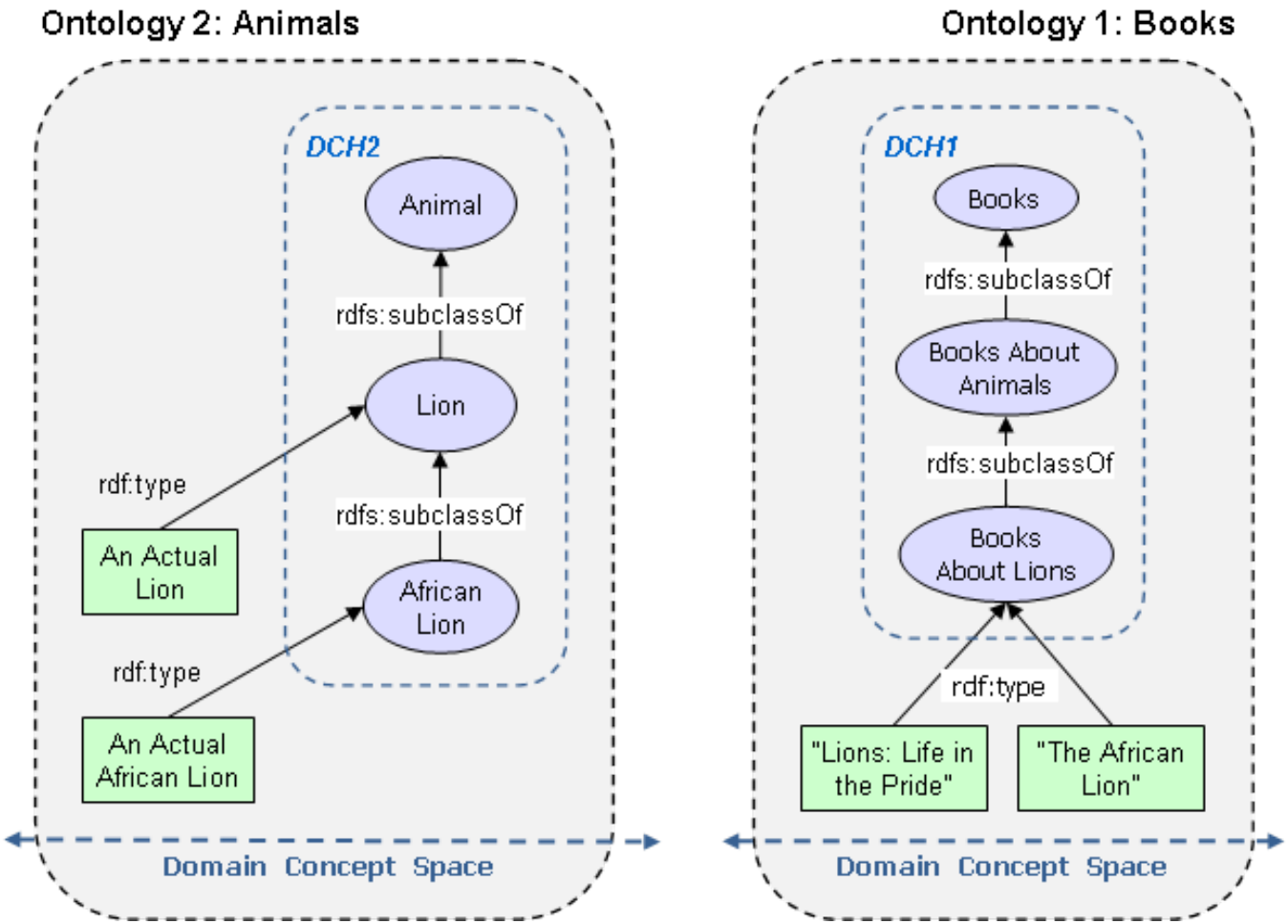


Scenario 1

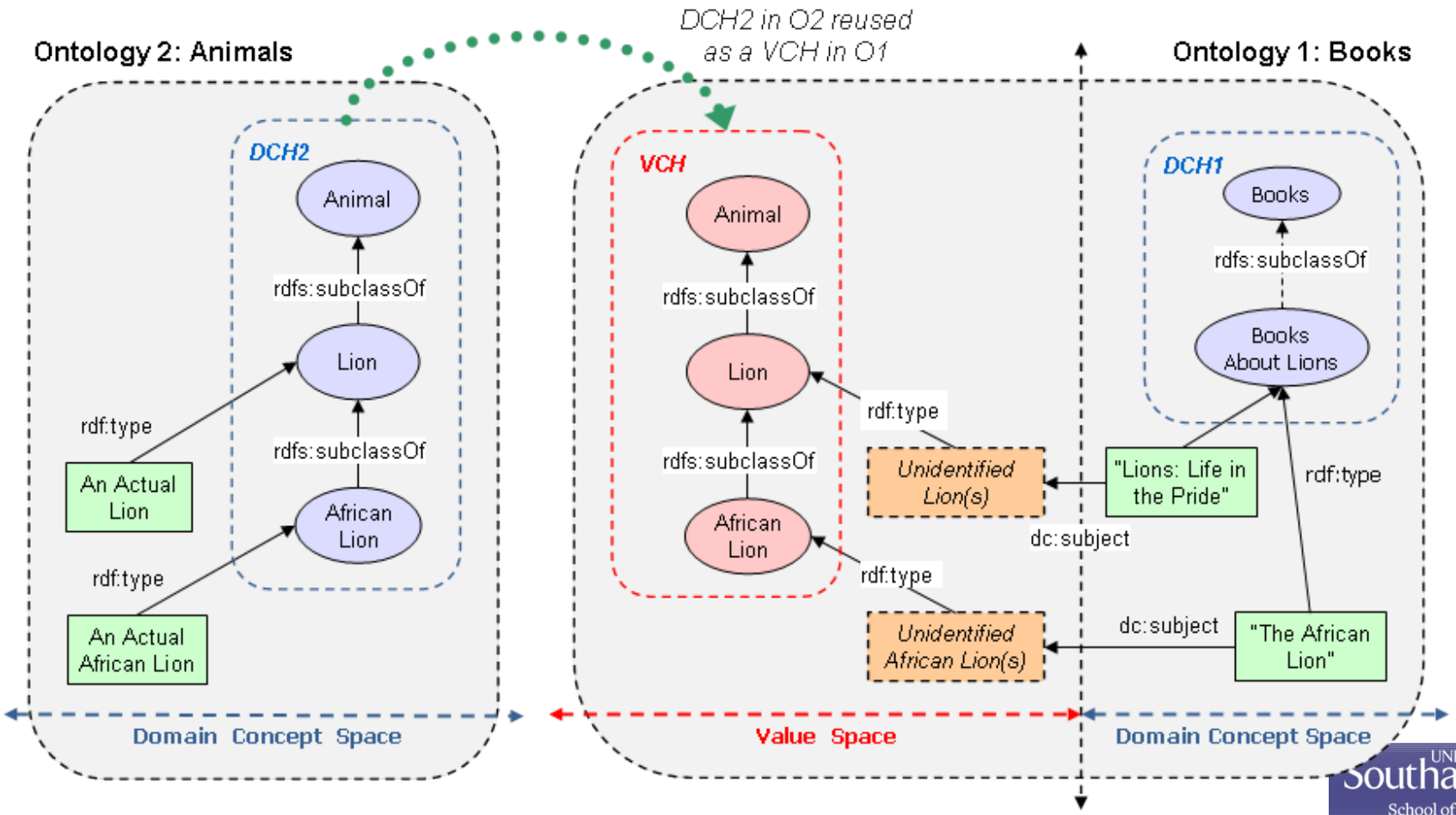
Scenario 1:

- Let us consider two ontologies O_1 and O_2, with two Domain Class Hierarchies DCH_1 and DCH_2 in their Domain Concept Space respectively.
- In the context of (Noy 2005) and (Rector 2005) we can **reuse** DCH_2 from O_2 to support the role of a Value Class Hierarchy in ontology O_1.

Example Scenario 1: Premise



Example Scenario 1: Conclusion

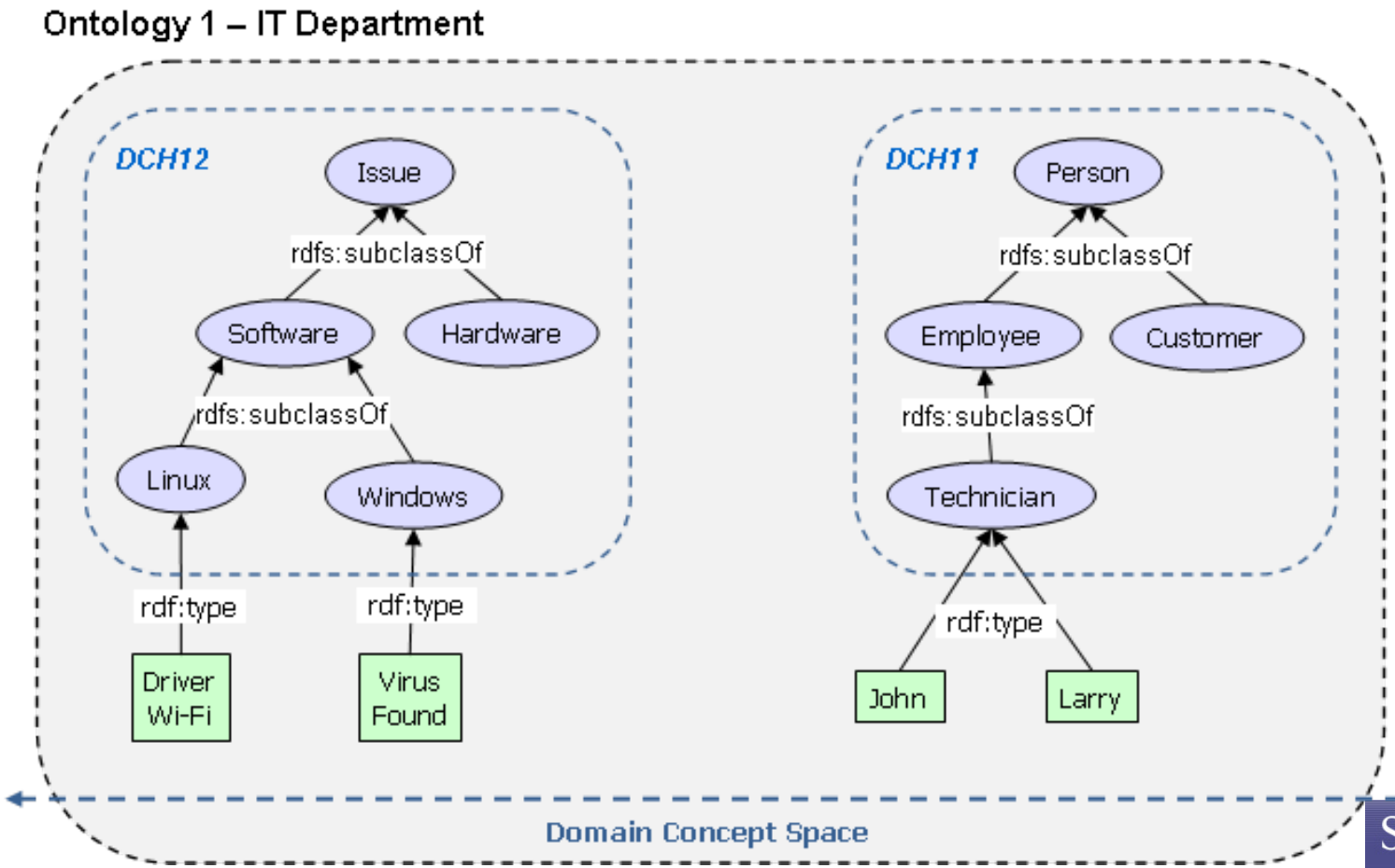


Scenario 2

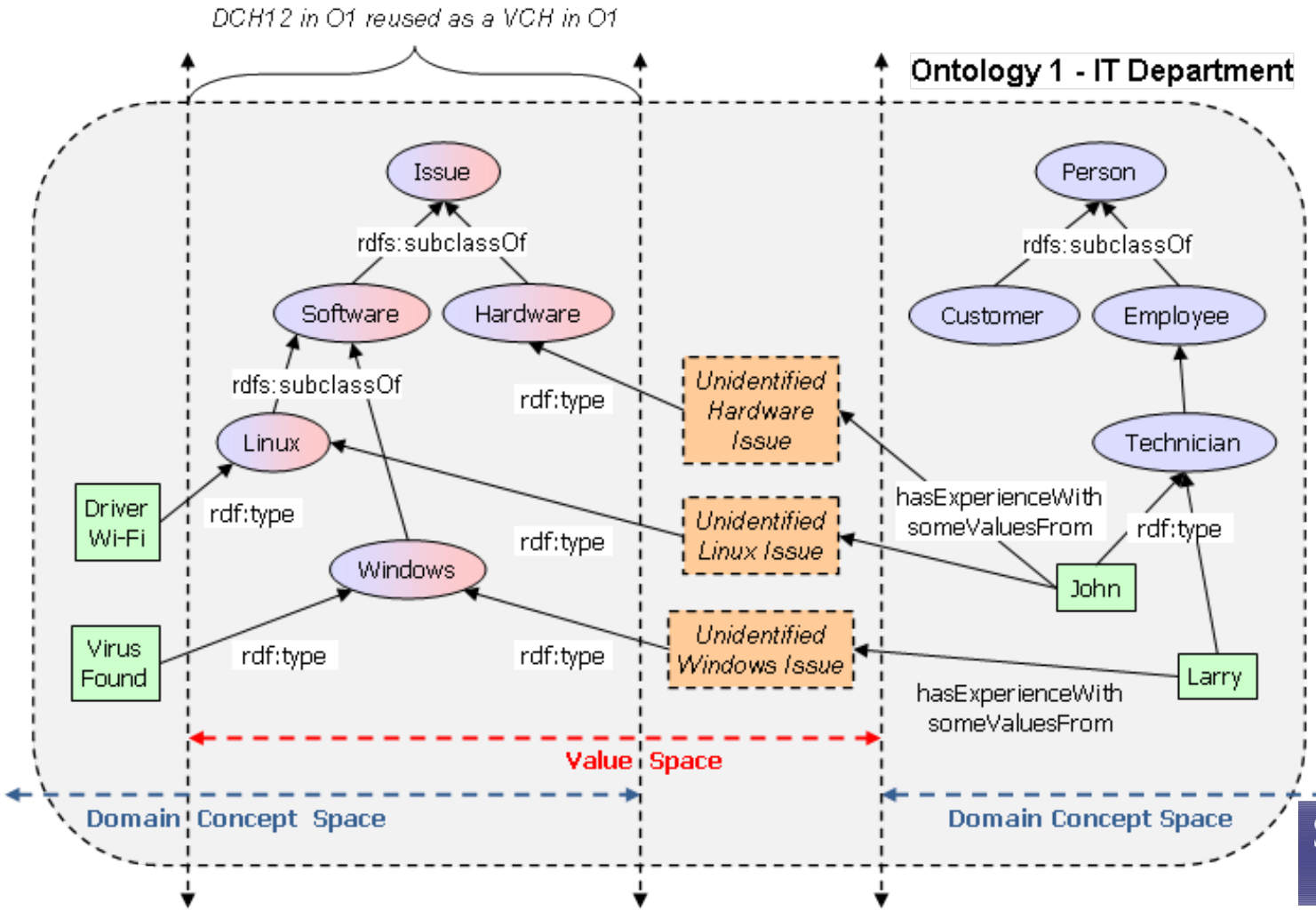
Scenario 2:

- Let us consider a single ontology O_1, with two Domain Class Hierarchies DCH_{11} and DCH_{12} in its Domain Concept Space.
- In the context of (Noy 2005) and (Rector 2005) we can **reuse** DCH_{12} to support the role of a Value Class Hierarchy for DCH_{11} in O_1.

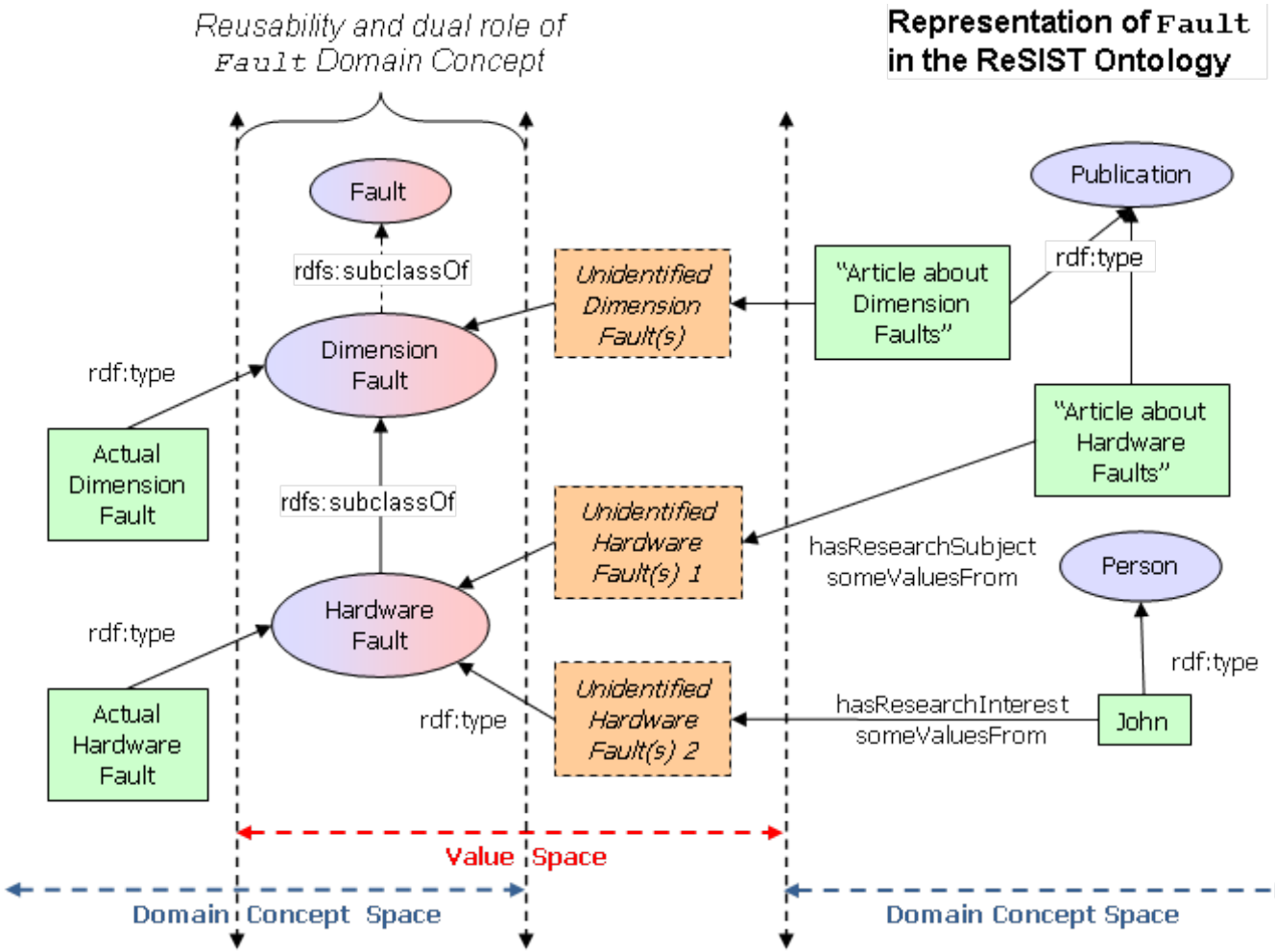
Example Scenario 2: Premise



Example Scenario 2: Conclusion



Representation of Fault in ReSIST fits Scenario 2



Summary

- Performed a comparative analysis of 2 ODPs.
- Characterized the role of domain concepts in the 2 ODPs examined.
- Characterized two reusability scenarios for domain concepts in ODPs.
- Made explicit certain potentially implicit modeling decisions previously taken in ontology building.
- Applied findings to the representation of the `Fault` domain concept in the ontology for ReSIST.

Thanks!!!

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