Untangling Domain Concepts in Ontology Design Patterns

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Abstract. To assist ontology developers modeling complex domain concepts, a comparative analysis of two Ontology Design Patterns (ODPs) has been carried out. As a result, terminology is introduced to characterize certain *role* and *reusability* scenarios of class hierarchies in ODPs. An example that benefits from this study is provided.

1 Introduction

Ontologies have emerged as one of the key components needed for the realization of the Semantic Web and they bring with them a broad range of development activities grouped into what it is called *ontology engineering*. This work focuses on one of such activities known as ontology modeling. Some domain concepts are difficult to model due for example to: a) the complexity of its definition, b) the number of roles that it fulfills in the ontology and c) the number of relationships with other domain concepts in the same ontology. This is the case of the "Fault" domain concept in the ontology for the ReSIST project [1] (an ontology in the field of resilient computing and systems). To assist ontology developers in overcoming the last two of these challenges, we propose a characterization of role and reusability of domain concepts derived from a comparative analysis between two ODPs in the context of OWL [2][3].

2 Characterizing Role and Reusability in ODPs

Approach 4 in [2] uses a hierarchy of classes, potentially organized in any structure (e.g. a list, a tree, or a directed acyclic graph), as a subject or keyword index to annotate other domain concepts in the ontology.

Pattern 2–Variant 2 in [3] uses a hierarchy of classes that conforms to the definition of a *value partition* to represent features or attributes about other domain concepts in the ontology.

Additionally, both examples from [2] and [3]: a) use anonymous individuals from their value partition and subject index class hierarchies respectively as property values for other classes (i.e. domain concepts) in the ontology and b) both design patterns present an expressivity level within OWL-DL.

Based on this comparative analysis, two roles for class hierarchies in the ontology can be characterized: a) *Domain Class Hierarchies* (DCHs) that fulfill the role of a domain concept per se and b) *Value Class Hierarchies* (VCHs) that serve as values to other domain concepts in the ontology (whether they conform to the definition of value partition or not).

Furthermore, the ontology could then be divided into two possible spaces: a) the *Domain Concept Space* (DCS) defined as the subset of the model that contains all DCHs and b) the *Value Space* (VS) defined as the subset containing all VCHs. According to [3] it is a good practice to make these two spaces, DCS and VS, disjoint.

Using this terminology and based on the role that class hierarchies fulfill in the ontology, the following reusability scenarios for these can be characterized:

Scenario 1: Let us consider two ontologies O_1 and O_2, with two Domain Class Hierarchies DCH_1 and DCH_2. It is possible to apply [2] and [3] to reuse DCH_2 from ontology O_2 as a Value Class Hierarchy for DCH_1 in ontology O_1. In that case, DCH_2 becomes part of the Value Space in O_1 and disjoint from DCH_1 in O_1.

Scenario 2: Let us consider a single ontology O_1, with two Domain Class Hierarchies DCH_1 and DCH_2. It is possible to apply [2] and [3] to reuse DCH_2 as a Value Class Hierarchy for DCH_1 in the same ontology O_1. In that case DCH_2 becomes part of the Value Space in O_1 causing both the DCS and the VS in O_1 to overlap.

3 Conclusions and Future Work

The characteristics of *role* and *reusability* presented in Scenario 2 above help untangling these two aspects when modeling the "Fault" concept in the ontology for ReSIST given that "Fault" is represented as a class hierarchy that it is reused to fulfill a dual role: a) the role of a DCH to represent instances of real world faults in systems and b) the role of a VCH for other domain concepts in the ReSIST ontology (e.g. topics of publications or people's research interests).

Current future work includes a characterization of the *conceptual overlap* inherent among the multiple class hierarchies that constitute the definition of "Fault". We expect the outcome of this analysis to set the basis for the development of additional ODPs to address different scenarios of conceptual overlap in domain concepts.

References

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