

Making Axiom Weakening Work in \mathcal{SROIQ}

Roland Bernard Oliver Kutz Nicolas Troquard

Free University of Bozen-Bolzano



Introduction

Background

- Many methods for fixing inconsistent ontologies involve identifying and removing problematic axioms.
- This approach ensures consistency but leads to information loss.
- Axiom weakening is an alternative approach, that has previously been shown to preserve more information in the case of \mathcal{ALC} .

In this paper

- We extend axiom weakening principles to \mathcal{SROIQ} , including weakening of RIAs.
- We discuss a number of scenarios where weakening can impact regularity of \mathcal{SROIQ} RBoxes, and provide a framework where this is avoided.
- We perform experimental evaluation of repairing \mathcal{SROIQ} ontologies with axiom weakening.

Axiom Weakening for Ontology Repair

To achieve axiom weakening, two types of refinement operators are used, a specialization operator and a generalization operator. These are used to define the axiom weakening operator. These need a consistent reference ontology to yield useful results. The process for repairing an inconsistent ontology proceeds as follows:

Repairing ontologies

1. Choose a consistent subset as the reference ontology.
2. Select a problematic axiom.
3. Weaken the selected axiom using the axiom weakening operator.
4. Replace the selected axiom with the weaker axiom.
5. Repeat steps 2-4 until the ontology is consistent.

Extending Axiom Weakening to \mathcal{SROIQ}

Difficulties

- \mathcal{SROIQ} imposes global restrictions on the ontology that can not be checked by looking at axiom separately.
- Non-simple roles may not be used in cardinality constraints, *Self* constraints, or disjoint role axioms.
- RBoxes must be regular.

⇒ Adding valid axioms (e.g., weakenings) to a valid \mathcal{SROIQ} ontology can make the ontology invalid.

Example: Weakening that breaks regularity

Take the ontology

$$\mathcal{O} = \{r \circ s \circ r \sqsubseteq t, \top \sqsubseteq \forall t. \{a\}, \top \sqsubseteq \exists s. \{a\}\} .$$

Since the range of t is restricted to the single individual a , and s contains all connections to a , $t \sqsubseteq_{\mathcal{O}} s$. The axiom $r \circ s \circ r \sqsubseteq t$ could therefore be weakened to $r \circ s \circ r \sqsubseteq s$. Yet, this would result in a non-regular RBox.

Avoiding these problems

- The allowed weakenings must be restricted to ensure the result is a \mathcal{SROIQ} ontology.
- We only use simple roles whenever we have to replace roles using the refinement operators.
- For RIAs we only ever refine the super role if the RIA is simple and the sub role is simple.

⇒ These two rule ensure that all simple roles remain simple even after applying the weakening.

⇒ They further guarantee that the RBox remains regular.

Theorem

Given that the original ontology to be repair and the reference ontology are valid \mathcal{SROIQ} ontologies. For every axiom ϕ of the original ontology, if ϕ' is a weakening of ϕ generated using the weakening operator, then the result of adding ϕ' to the original ontology is also a valid \mathcal{SROIQ} ontology.

Experimental Evaluation

Conclutions and Outlook