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Suitability of Object-Role Modeling Diagrams as an Intermediate Model for Ontology Engineering: Testing Mapping Rules

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Introduction

A promising approach to creating and transferring WHAT-knowledge is combining different forms of knowledge representation using an automatic mapping between different forms. ORM-diagrams are a good candidate for an intermediate model for developing and understanding of OWL2-ontologies.

Goal

Studying the semantic correctness of the ORM-to-OWL mapping rules by testing the ontologies created using the mapping process, verifying preserving the semantic relations of original ORM diagrams.

Method

To evaluate the validity of the mapping rules (MR) we created test ontologies (***TO***) from ORM2 diagrams using these rules. Then using algorithm ***B*** we developed test cases ***TC*** and performed ontology testing using algorithm ***A***. ***TC*** take into account ORM semantics and use one of the test methods to look for semantic and modeling defects in the ontology: (1) Competency Questions (CQ) verification, (2) inference verification, and (3) error provocation. Mapping rule ***mr*** $\in$ ***MR*** is considered correct if all outcomes ***tr*** of all test cases from ***TC*** are positive.

1. Creating and transferring WHAT-knowledge using different forms of knowledge representation

Transferring WHAT-knowledge is possible in textual and graphical forms; the texts may be in natural or formal languages. Each form of knowledge representation has its advantages and disadvantages. *A promising approach is combining different forms of knowledge representation during creation and transferring of WHAT-knowledge using an automatic mapping between different forms.*

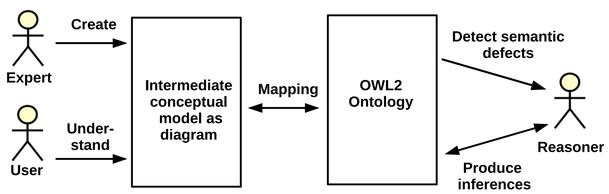

Figure: Creating and transferring knowledge using different forms of knowledge representation

2. Object-Role Modeling (ORM)

WHAT-knowledge consists of concepts and relations between them so it can be naturally presented as a graph. As visualization stimulates human thinking, the most promising intermediate models for ontology development and understanding are ORM2-diagrams.

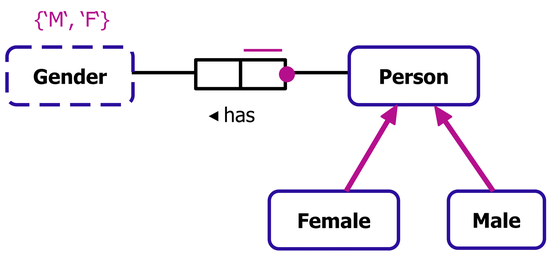

Figure: ORM diagram example

ORM-diagrams are a good candidate for an intermediate model for developing and understanding of OWL2-ontologies. Use cases have shown that ORM can be learned easily, in a short time by domain experts without previous IT background.

3. Mapping ORM2-diagrams

To facilitate using ORM-diagrams as an intermediate model it is necessary to create ORM-to-OWL mapping. ORM2-to-OWL2 language mapping rules were developed by [3, 4, 5]. *The mapping correctness of these rules is not proven.*

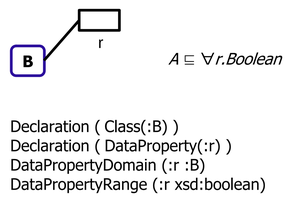

Figure: Rule-2

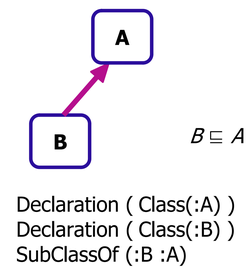

Figure: Rule-3

So researching the semantic correctness of the ORM-to-OWL mapping rules by testing the ontologies created using the mapping process, verifying maintaining the semantic relations of original ORM diagrams is a good area to study.

4. Testing rules for mapping ORM2 language to OWL2 language and creating test case

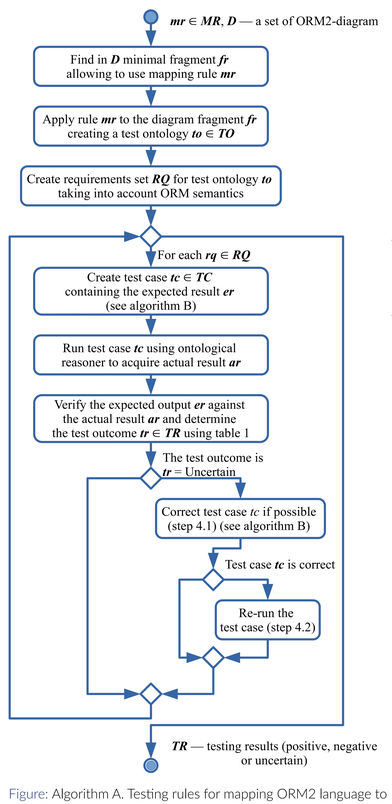

Figure: Algorithm A. Testing rules for mapping ORM2 language to OWL2 language

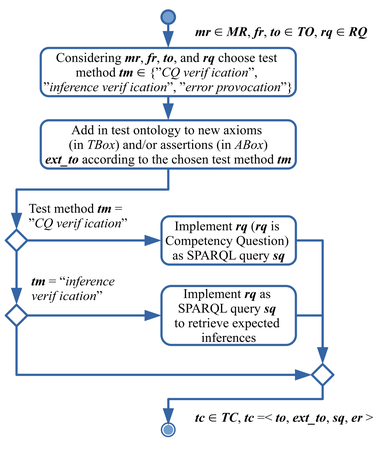

Figure: Algorithm B. Creating test case

5. Determining test outcome

Test method tm		Expected result er	Actual result ar	Test outcome tr
"CQ verification" or "inference verification"	For SELECT query	Non-empty result	Non-empty result equal to expected	Positive
			Non-empty result not equal to expected	Negative
		Empty result	Non-empty result	Negative
			Empty result	Uncertain
	For ASK query	True	True	Positive
		True	False	Negative
		False	True	Negative
		False	False	Uncertain
"Error provocation"		Presence of semantic defect	Presence of semantic defect	Positive
			Absence of semantic defect	Negative
		Absence of semantic defect	Absence of semantic defect	Uncertain
			Presence of semantic defect	Negative

6. Results

The study allowed us to find three discrepancies between ORM semantics and ORM-to-OWL mapping rules:

1. ORM semantics is based on the closed-world assumption while test ontologies use the open-world assumption;
2. Entity Types and Value Types in ORM are disjoint sets while in test ontologies they may intersect;
3. ORM subtypes are proper subtypes, i.e. if B is a subtype of A, in ORM B $\subseteq$A and B $\not=$A. Ontology subtypes are not proper subtypes because B $\subseteq$A or B = A

Conclusions

The study shows that there is a significant difference between the Object-Role Modeling and OWL2-ontologies in basic assumptions and features so that mapping rules give incorrect results. The mapping rules require enhancement to better represent ORM semantics using the OWL2 language.

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