A Comparative Study of Ontology Languages and Tools

Xiaomeng Su[⋆] and Lars Ilebrekke

Norwegian University of Science and Technology (NTNU)
N-7491, Trondheim, Norway
xiaomeng@idi.ntnu.no
ilebrekk@stud.ntnu.no

Abstract. There are many languages and tools for constructing ontologies. In this paper we survey and compare different ontology languages and tools by the aid of an evaluation framework. A semiotic framework is adopted to aid the evaluation.We hope the evluation results can be used in helping user to choose suitable language and tool in the task of onotloy building.

1 Introduction

The word ”ontology” becomes a buzzword nowadays in computer science.In spite of varying interests in research and the use of ontologies, constructing good ontologies is of common interest. The available languages and tools to aid this work are many. In this paper we will survey and compare a selection of languages and tools by the aid of an evaluation framework. The evaluation framework is originated in information system community and we apply it for ontology analysis since as far as we can see, the current meaning of ”ontology” is synonymous with conceptual model.

We will start by presenting the framework for evaluating language and model quality, then we survey the languages and evaluate them in section 3. In section 4 we evaluate the tools using the framework.

2 Quality Evaluation Framework

A semiotic framework is adopted to aid the evaluation. It will be used both for discussing the quality of ontologies (related to tools and underlying methodology), and for evaluating the quality of ontology languages. The framework is described in[2]. This paper gives a short adjusted description of the framework. The framework is based on the following concepts: domain knowledge is represented in an ontology expressed in an ontology language. The ontology is subject to audience interpretation, which includes both human actors and technical actors (tools). The stakeholders that contribute to modeling are called participants.

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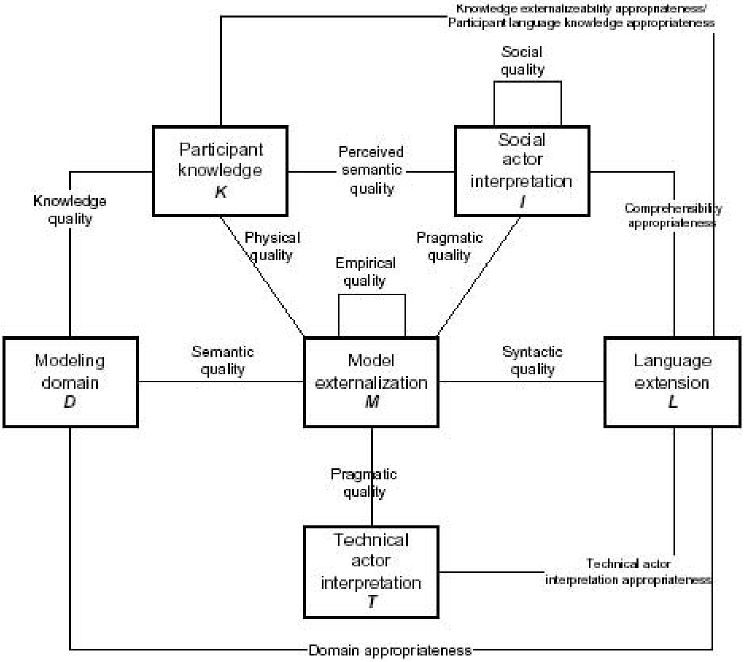
They reflect their participant knowledge of that domain in the ontology. Relationships between these concepts give a framework for understanding quality related to ontology.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Model externalization M
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Language extension L
Pragmatic quality
Technical actor interpretation T
Technical actor interpretation appropriateness
Domain appropriateness

Fig. 1. A framework for discussing quality of conceptual models

3 Survey and Evaluation of Languages

Figure 2 depicts the candidate languages and how they are related to each other. The categorization is adopted from a former evaluation of languages in[1].

The evaluation results are summarized in table 1. The languages are evaluated according to three of the quality aspects mentioned in the evaluation framework. *domain appropriateness, comprehensibility appropriateness* and *technical actor interpretation appropriatness.*

Domain Appropriateness Domain appropriateness is divided into *expressive power*, and *perspectives.*Most of the languages have good expressive power, while Ontolingua and CycL supersede the others.Another important aspect to examine domain appropriateness is to check the coverage of seven modeling perspectives (structural (S), functional (F), behavioral (B), rule (R), object (O), communication (C) and actor-role (AR)).As we can see from the table, most of the ontology

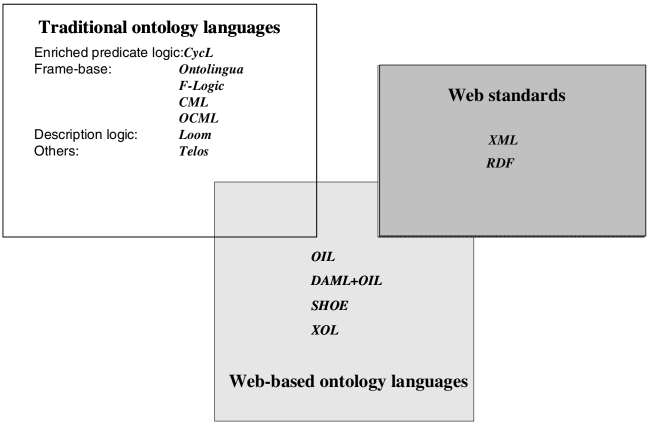


Fig. 2. Classification of language

Table 1. Evaluation of ontology languages

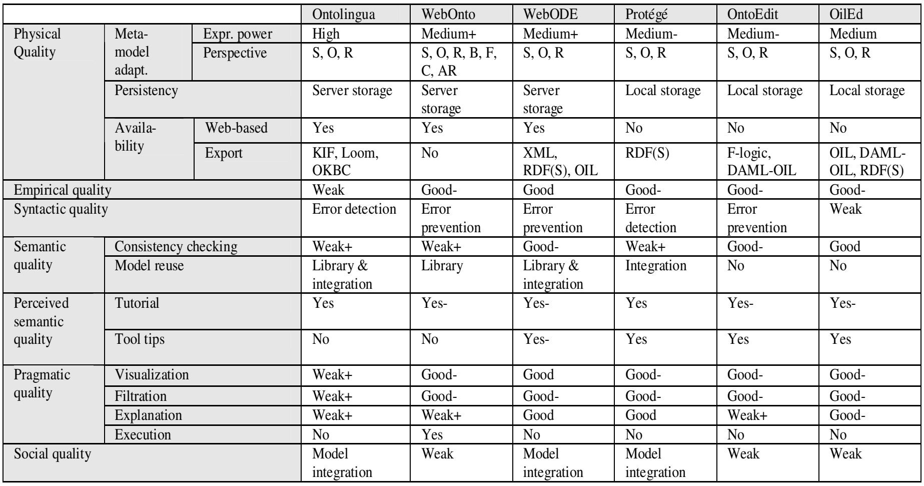
		CycL	Ontolingua	F-Logic	OCML	LOOM	Telos	RDF(S)	OIL	DAML+OIL	XOL	SHOE
Domain appropriateness	Expressive Power	High	High	Medium	Medium+	Medium	High	Medium-	Medium-	Medium+	Medium	Medium
	Perspectives	S,O-,R	S,O+,R	S,O+,R	S-,O,R, F,	S,O+,R,	S,O,R+ F,AR-	S,O,R-	S,O,R-	S,O,R-	S,O,R-	S,O,R
Comprehensibility appropriateness	Number of Constructs	Large	Large	Medium	Medium+	Medium	Medium+	Small	Small	Medium-	Medium	Small
	Abstraction Mechanism	Cla Gen+ Agg Ass	Cla Gen+ Agg Ass	Cla Gen+ Agg Ass	Cla Gen+ Agg- Ass	Cla Gen+ Agg- Ass	Cla Gen+ Agg Ass	Cla Gen- Agg- Ass	Cla Gen Agg- Ass	Cla Gen Agg- Ass	Cla Gen- Agg- Ass	Cla Gen- Agg- Ass
Technical actor interpretation appropriateness	Formal Syntax	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Formal Semantics	Yes	Yes	Yes	Yes	Yes	Yes	Yes-	Yes	Yes-	No	Yes-
	Inference Engine	Weak	No	Good+	Good	Good+	Good	No	Good+	Possible	No	Good
	Constraint Checking	Good	Good	Good	Good	Good	Good	Weak	Weak	Weak	Weak-	Weak

languages are more focused on describing static information, where taxonomy is at the centre, and dynamic information can not be easily described.

Comprehensibility Appropriateness To make the language comprehensible to the social actor, it requires that the number of the phenomena should be reasonable and they should be organized hierarchically. These are the two criteria we use her to measure comprehensibility appropriateness. The abstraction mechanisms are classification (Cla), generalization (Gen), aggregation (Agg) and association (Ass).As we can see from the table, most of the web-based languages have smaller number of constructs and this is one of the reasons why they claim they are simple and easy to use.Besides SHOE and XOL, which don't support slot hierarchy, all the other languages provide abstraction mechanisms for both class and relations. It is not surprising that the abstraction mechanism for class is more at focus for most of the languages. Thus, the abstraction mechanism listed in the table is for class.

Technical Actor Interpretation Appropriateness All the languages have formal syntax and the web-based languages use XML as their syntax base. When it comes to semantics, except XOL, there exist formalizing methods for all the other languages. F-Logic and OIL provide sound and complete inference and automatic classification are supported only by OIL and LOOM (due to their root in description logic). No reasoning support is provided with Ontolingua, largely because of its high express power, which is provided without any means to control it. Some "shallow" reasoning can be conducted in CycL. OCML exceed the others when it comes to executable specifications, operational semantics and automatic prototyping. Telos provides an inference mechanism, but it has not been used in knowledge bases, which use Telos as their underlining knowledge model, and the reason is its inefficiency. RDF(s) and XOL have no inference support and DAML+OIL can use OIL's inference system, because they are quite similar.

Fig. 3. Evaluation of ontology tools



			Ontolingua	WebOnto	WebODE	Protégé	OntoEdit	OilEd
Physical Quality	Meta-model adapt.	Expr. power	High	Medium+	Medium+	Medium-	Medium-	Medium
		Perspective	S, O, R	S, O, R, B, F, C, AR	S, O, R	S, O, R	S, O, R	S, O, R
	Persistency		Server storage	Server storage	Server storage	Local storage	Local storage	Local storage
	Availa-bility	Web-based	Yes	Yes	Yes	No	No	No
		Export	KIF, Loom, OKBC	No	XML, RDF(S), OIL	RDF(S)	F-logic, DAML-OIL	OIL, DAML-OIL, RDF(S)
Empirical quality			Weak	Good-	Good	Good-	Good-	Good-
Syntactic quality			Error detection	Error prevention	Error prevention	Error detection	Error prevention	Weak
Semantic quality	Consistency checking		Weak+	Weak+	Good-	Weak+	Good-	Good
	Model reuse		Library & integration	Library	Library & integration	Integration	No	No
Perceived semantic quality	Tutorial		Yes	Yes-	Yes-	Yes	Yes-	Yes-
	Tool tips		No	No	Yes-	Yes	Yes	Yes
Pragmatic quality	Visualization		Weak+	Good-	Good	Good-	Good-	Good-
	Filtration		Weak+	Good-	Good-	Good-	Good-	Good-
	Explanation		Weak+	Weak+	Good	Good	Weak+	Good-
	Execution		No	Yes	No	No	No	No
Social quality			Model integration	Weak	Model integration	Model integration	Weak	Weak

4 Evaluation of Tools

Tools suitable for ontology development are emphasized, and six tools have been found most relevant: *Ontolingua, WebOnto, WebODE, Protégé-2000, OntoEdit* and *OilEd*.

The evaluation results are given in table 2. Physical quality is discussed according to: *meta-model adaption, persistency* and *availability*. Semantic quality is discussed according to: *consistency checking* and *model reuse*, and perceived pragmatic quality according to: *tutorial* and *tool tips*. Pragmatic quality is discussed according to: *visualization, filtration, explanation* and *execution*. The other three quality types are: *empirical, syntactic* and *social quality*.

References

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