

Benchmarking Criteria to Evaluate Ontology Building Methodologies

Michela Chimienti¹, Michele Dassisti¹, Antonio De Nicola², Michele Missikoff²

¹ Politecnico di Bari,
Viale Japigia,182 – 70126 Bari
michelachimienti@yahoo.it
mdassisti@poliba.it

² Istituto di Analisi dei Sistemi ed Informatica
Consiglio Nazionale delle Ricerche
Viale Manzoni, 30 – 00185 Roma
{denicola, missikoff}@iasi.cnr.it

Abstract. Several ontology building methodologies have been developed endowed with different characteristics, however there is not yet a clear method to select the most appropriate ontology building methodology for a specific application. This paper proposes a few criteria for comparing different ontology building methodologies, starting from a proposal derived from the IEEE Standard 1074-1995 for software development [1].

1. Introduction

This paper mainly addresses the problem of cooperating enterprises trying to solve the interoperability problem by introducing ontology-based reconciliation solutions [2]. Ontology building is a relevant problem since domain experts (e.g., business experts) are often required to build an ontology without having specific competencies in ontological modelling. For this reason, they need to be driven by an effective ontology building methodology. The objective of this work is to support them in the selection process of the most appropriate ontology building methodology by defining a set of criteria that will drive this decision.

According to the IEEE definition, a methodology is “a comprehensive integrated series of techniques or methods creating a general systems theory of how a class of thought-intensive work ought to be performed” [3]. According to Gruber [4], an ontology is “a formal, explicit specification of a shared conceptualization”. As a consequent, an ontology building methodology can be defined as a set of techniques and methods related to the ontology creation that start from capturing ontology users’ requirements and conclude by releasing the final ontology. However, the existing ontology building methodologies have different scopes. Some of them consider ontology building from scratch, whereas others consider it as a process of reusing and re-engineering other ontologies, a process of merging, and an ontology learning process. The focus of this paper is on the ontology building process from scratch.

Among the most important existing ontology building methodologies, we consider: *Cyc Methodology* developed at *MCC* [5]; the one developed at *Edinburgh University* [6]; the one developed at *University of Toronto* [7]; the one developed in the context of the *Esprit KAKTUS* project [8]; *Methontology* developed at *Polytechnic University of Madrid* [1]; the *SENSUS-based methodology* developed at *Information Sciences Institute* [9]; *On-To-Knowledge* developed at *University of Karlsruhe* [10]; the one developed at *Stanford University* [11], and *UPON* developed at *IASI-CNR and University of Rome* [12].

In this paper we present a set of criteria aimed at confronting the quality of existing ontology building methodologies. The concept of “quality” in the ontology building domain refers to the set of features of an ontology building methodology that characterise its use in a specific case.

The rest of the work is organised as follow. Section 2 presents the approach for the evaluation of ontology building methodologies derived from the IEEE Standard 1074-1995 for software development [1] [13], in Section 3 a set of criteria for the benchmarking of ontology building methodologies is presented. Finally, in Section 4, conclusions and future work are discussed.

2. Analysis of the Existing Evaluation Method derived from the IEEE Standard 1074-1995 for Software Development

Despite a growing literature [14], [15] on metrics aimed at assessing the quality of ontologies, the works related to the evaluation of ontology building methodologies are still inadequate.

In [16], an approach to analyse ontology building methodologies inspired by the “IEEE Standard for Developing Software Life Cycle Processes 1074-1995” [13] is proposed. According to the IEEE definition, a software is a set of “computer programs, procedures and, possibly, associated documentation and data pertaining to the operation of a computer system”. According to [16], ontologies are part of software products. For this reason, the author asserts that the quality of an ontology building methodology is connected to the compliance with the IEEE Standard 1074-1995, of course, adapted to the special characteristics of ontologies.

This IEEE Standard, in particular, describes the software development process as the activities to be carried out and the techniques that can be used for developing software. This software development methodology, easily adapted to ontology building, comprises four main processes:

- 1) *Software life cycle model process*. It includes the activities of identifying and selecting a specific software life cycle model, which establishes the order of the different activities involved in the process.
- 2) *Project management process*. It includes the activities related to project initiation, project monitoring and control, and software quality management.
- 3) *Software development-oriented processes*. They are divided into:
 1. pre-development processes, that cover the activity of studying the environment, and the feasibility study;

2. development processes, that include the activities of requirements collection, design, and implementation;
3. post-development processes, that cover the activities of installation, operation, support, maintenance, and retirement.
- 4) *Integral processes*. They cover the phases of verification and validation, software configuration management, documentation development, and training.

In [16], a set of secondary criteria for methodology assessment is also established: degree of adoption of knowledge engineering, level of detail of the methodology, recommendations for knowledge formalization, strategy for ontology building (application dependent, semi-dependent, independent), strategy for identifying concepts (bottom-up, top-down, middle-out), recommended life cycle, recommended techniques, and ontologies developed using the methodology and systems built using these ontologies [16].

3 A Set of Criteria for the Benchmarking of Ontology Building Methodologies

This Section proposes six further criteria that should drive the comparison of ontology building methodologies. These criteria are intended as complementary to the approach presented in [16] [1].

In our approach, the quality of ontology building methodologies should be evaluated according to the following additional guidelines.

- *Specification of measurements*. According to the quality management literature, evaluation criteria of ontology building methodologies must be established defining a measurement method. It is important to fix formal metrics (like quantitative indicators, performance indicators, etc.) for comparison purposes.
- *Ease of use of the evaluation method*. The criteria to evaluate ontology building methodologies must be supported by detailed usage procedures. The evaluation method must specify how quality evaluation should be conducted. The specification of evaluation criteria without defining the process to apply them is a barrier to their effective use in practice.
- *Focus on different perspectives*. There is not only one correct way to model a domain, but there are always several alternatives. The best solution depends on several aspects like, for instance, objectives of ontology users, skills of ontology engineers, and economical resources available for the building process. For this reason, the evaluation has to take into account different perspectives in choosing an ontology building methodology (e.g. training facilities, development time, human resources involved, etc.).
- *Focus on the modellers' knowledge*. The evaluation of ontology building methodologies has to be achieved through interviews with the modellers, domain experts and knowledge engineers, who are involved in the building process. Though this can not be properly seen as an evaluation criterion, it is important to consider: the usability of the methodology, the ability to perform

the intended task by using it, the degree to which the methodology is easy to understand, and, finally, the degree to which each of the method's part is fully specified and developed.

- *Focus on quality improvement.* The evaluation of ontology building methodologies has also to focus on quality of results (defect detection) and has also to consider how to improve them (defect correction).
- *Presence of empirical testing.* The effectiveness of the evaluation method for ontology building methodologies needs to be empirically tested rather than justified by logical or theoretical arguments alone.

4. Conclusions and Future Work

This paper, starting from the analysis of the ontology building methodology evaluation approach, derived from the IEEE Standard for software development, proposes, in the frame of conceptual model quality research, six new guidelines for supporting knowledge modellers in the selection of the most appropriate ontology building methodologies. The extended criteria, presented in Section 3, have already been applied to a first test case and preliminary results are currently under evaluation.

The authors are now extending the research elaborating a new framework, based on the *design science research* [17], to define an evaluation approach in the ontology building domain.

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