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Towards a Improved Methodology for developing domain ontology

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Abstract

Existing methodologies and practical ontology development experiences have explored a broad spectrum of knowledge management challenges. Each has its own characteristics and evaluates only a subset of specific domain. However, there is still no one "correct" way or methodology for developing ontologies. In this paper, we described a methodology for domain driven ontology development, covering the whole lifecycle from the formalization of domain to the evolution of ontologies.

1. Introduction

Ontologies are a core element of the knowledge management architecture, its explicit specification of the terms in the domain and relations among them has been widely used for a computer understandable architecture----enable the people and the computer working together to achieve a more meaningful World-Wide Web.

Sharing common understanding of the structure of information among people or software agents is one of the driving forces for the development of ontologies. Often an ontology is not a goal in itself, it defined a common vocabulary for researchers who need to share information in a domain, allows a common understanding which will contribute a lot to the reuse of certain knowledge.

The recent surge in ontology research range from large taxonomies categorizing Web sites (such as on Yahoo!) to categorizations of individuals and their features in a certain domain (such as Wine ontology). Both ontology web language and disciplines for developing standardized ontologies have evolved drastically in the last few years.

Many methodologies that guide the building process of ontologies have been proposed by several research groups. Each has its own characteristics and evaluates only a subset of the specific domain. Most of them have in common that they start from the identification of the purpose of ontology and the need for domain knowledge acquisition, differ in their following steps to be taken.

As we have mentioned earlier, there is no "correct" methodology for developing ontology, the best solution for the variable alternatives when modeling a domain always depends on the application you use and the outcomes that the end users are expecting to get from the knowledge base. Concerning different methodology-based ontology development, there is a great need for combining ontology development with capabilities for collaboration and tight integration into a framework.

Ontology design is a creative process, not only for the rules: *"there is no single correct ontology for any domain"* [1], but also for no two ontologies by different people would be the same. The potential methodology for guiding the building process and the designer's understanding and view of the domain will lead

the design road.

2. Related Work

Due to the fact that ontology engineering is still a relatively immature field, each research group suggests its own methodology to guide the building process of ontologies, each has its own characteristic and supported by certain applications.

In the following, we will give a brief overview of the mainstream methodologies.

2.1 *On-To-Knowledge (OTK) Methodology* [2]

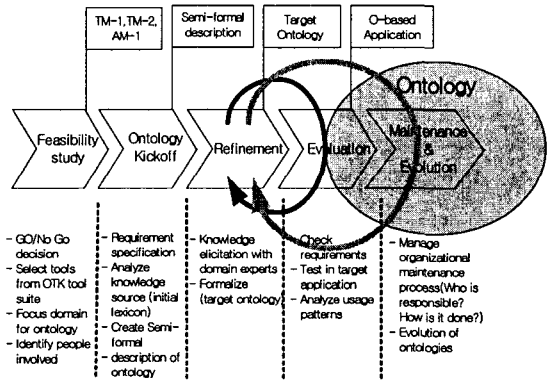

Figure 1 Steps of the on-to-knowledge methodology

It describes a methodology for application driven ontology development, covering the whole project lifecycle from the kick off phase to the maintenance phase. They put ontology development into a wider organizational context by performing a priori feasibility study, which is based on CommonKADS (cf.Schreiber et al., 1999). They modified certain aspect of CommonKADS for a tight integration of the feasibility study into their methodology.

The feasibility study they adopted offers an analysis of the users and use cases. Carry out a scoping and problem analysis study, consisting of two parts:

a. identifying problem/opportunity areas and potential solutions, and putting them into a wider organizational perspective;
b. deciding about economic, technical and project feasibility, in order to select the most promising focus area and target solution.

After these modified CommonKADS steps, the domain scope which goes through the feasibility study is supposed to be falling into 3 aspects of functions dealing with three levels of tasks,

lead to the modified result as indicated in the dark shading in Figure 2.

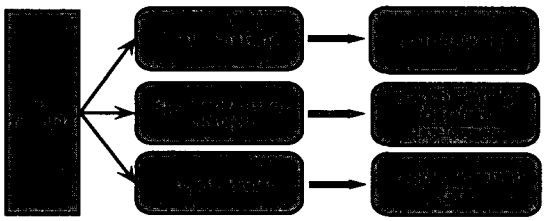

Figure 2 Feasibility Study Results

The results as described above serve as input for the kick off phase, and begin the first stage of ontology development.

2.2 *Skeletal Methodology* [3]

This methodology is based on the experience of building the enterprise ontology (Ushold and King, 1995). The following guidelines for developing ontologies are proposed:

1. Identify purpose. Clarify goal and intended usage of the ontology.
2. Building the ontology, which is broken down into three steps:
   a. Ontology captures. Identify key concepts and relationships.
   b. Coding. Represent the knowledge acquired in 2(a) in the formal language.
   c. Integrate existing ontologies.
3. Evaluation. Make a judgment of the ontologies with respect to a frame of reference, which may be require specifications or competency questions.
4. Documentation. Document ontologies according to the type and purpose.

They catch up with the idea of competency questions and expand their usage not only for evaluation, but also for formulate the lexical entries for concepts and relations, etc. A disadvantage of this methodology is that it does not precisely describe the techniques for performing different activities. For example, it remains unclear how the key concepts and relationships should be acquired; only a very vague guideline, involving the use of brainstorming techniques, is given. A lifecycle

is not recommended. There are no guidelines about the maintenance of evolving ontologies.

3. Towards the New Methodology

Is there a "perfect" way for developing ontologies?

Compare with existing methodologies, each has its own characteristic while remains some problem fields and a wide-open research area uncovered. Some groups argue for the feasibility study before entering the ontology lifecycle, involving giving out the target solution and the promising focus area, on the other hand, lacking the support for the maintenance and evolutionary aspects of ontologies; some argues that under what circumstance the detailed competency questions should be used, is it too specific to guide the early development of ontology? Or Can it serves as a useful technique in the later stage of evaluating ontology coding?

What is the key point to a methodology?

Concerning different methodologies. Focuses on the main steps for ontology development falls into variable alternatives, which depends on the application that you prefer in mind and the extensions you anticipate. Although ontology development is an iterative process, however, we must face the challenge to integrate the whole lifecycle of ontology process from focus the domain to the maintenance stage.

Why we need a collaborative work?

Ontology design is a collaborative work. Typically, ontology engineers and domain experts are joined in a team, working together on description of the domain and the goal of the ontology. These collaborative aspects will also occur during each of the ontology design step.

Since it is necessary to come forwards a shared understanding within a group of people, and the achieved consensus will be reflected during the whole lifecycle of ontology development, the support for these collaborative works within a methodology, consisting of both potential users and use case' s contribution and supported applications, is crucial with respect to construction of complex ontology structures.

3.1 Preliminary Study

The definition of our proposed methodology is analogous to methods of Knowledge Based System. It does not begin from scratch, but it is a refinement cycle, adding the new aspects and perspectives of the systems and integrating the successful ingredients of previous methodologies.

We focus the preliminary study on two aspects:

- Conceptualization. Elicitation task to obtain a first description of the problem and determination of use cases.
- Analysis. The result will be the requirements specification of the intended domain field.

The user and user cases study has been introduced in most of the application driven methodologies, especially in the earliest stages of ontology development. The method of use case modeling determines the requirements of ontology, leave the results to be filled into three aspects of systematical analysis: task analysis, knowledge domain analysis and agent analysis.

The CommonKADS methodology [4] which serves for the development of Knowledge based system offers three models have the same function as described above, here only the extensions to CommonKADS are given.

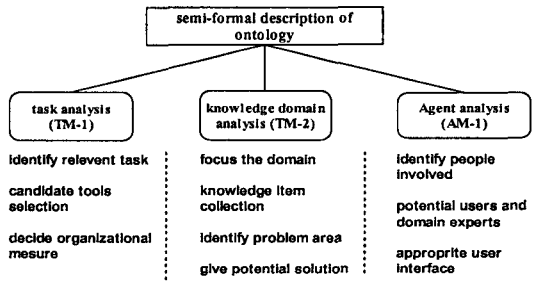

Figure 3 Modified CommonKADS steps

According to CommonKADS, task assignment should be performed in a fixed way, however, we take good use of the result from conceptualization stage to carry out a flexible task analysis, in the meanwhile, remains the restrict forms of the task model; we also enjoyed accepting the agent model as an executor of a task as well as integrating other two CommonKADS models, that are Communication model and Expertise model. Because of the particular role of human agent--users and potential domain experts, knowledge engineers are facilitated to get the exchange of information between different agents, and then have them as input resource for sake of the decision making of

expertise evaluation.

Following the analysis study, a formalized description of domain knowledge will be send into the next step, and begin with ontology development.

3.2 Architecture Design

With the semi-formal description of ontology, knowledge engineers are about to provider a structure, which is suitable for both the developing process and the maintenance afterwards. Here, the general architecture design is subdivided into two levels.

1) Knowledge level: Several design decisions should be taken regarding the management of ontologies:

a) Domain of the ontology. The ontology engineer may use the outcomes of the task analysis to describe the domain of the ontology, specify the particular domain in use.

b) Guidelines for Design. We must make clear how the key concepts and relationships should be acquired, it should not only involving brainstorming techniques, but also containing capture vocabularies from competency questions, reuse of existing ontology to collect a first hand script of class hierarchies.

c) Supported Application. The domain expert may take advantage of outcomes from the candidate tools study, which is part of the TM-1, to get a clear picture about which applications fit the proposed domain and give the proper interface to the potential users.

2) Coordination level: on this level, we will focus on the precious agent analysis (AM-1) in order to clarify the user and user case study.

Lists of potential users and description of each usage scenario should be reported from the real experience: In what situation did they wish such an ontology? How did they proceed without it? Each individual user get a point of view of his scenario, which will finally be reflected on the building process of ontology.

As for human agents, who are likely to be potential domain experts and might be a valuable resource at the stage of refinement phase of ontology development. Human agents might also be users of the system, and therefore might indicate a need for appropriate user interface.

3.3 Coding and Refinements

Depending on the applications that have to be supported, ontology engineers have to consider different representation languages because of their expressive power and supported tools for reasoning.

The refinement phase, which is closely linked with the evaluation phase, will always accept the evaluation result as an input for itself, and performs several iterative steps.

3.4 Maintenance and Evolution

It is most important to clarify who is responsible for the maintenance and how it is performed. Is it a single person or a consortium responsible for the maintenance process?

There has to be strict ways to the update/insert/delete process of ontologies. We plan to extend our effort on these wide-open research areas.

4. Conclusion

A comprehensive methodology has been outlined, and we have suggested some improvement derived from our delicate work on existing methodologies studies.

As we have mentioned, some ontology design toolkits, like OntoEdit, serves as an ontology-engineering environment by combining methodology-based ontology development with capabilities for collaboration and a tight integration into a tool framework. Through our proposed methodology, we hope to find out a right way for our future research, especially on the integration and evolution of ontologies.

5. References

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