Viewpoint Management for Multi-Perspective issues of Ontologies

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ABSTRACT
This paper discusses semantic technologies for multi-perspective issues of ontologies based on ontological viewpoint management. We developed two technologies and implement them in environmental and medical domain. The first one is conceptual map generation tool which allows the users to explore an ontology according to their own perspectives and visualizes them in a user-friendly form, i.e. conceptual map. The other is on-demand reorganization of *is-a* hierarchy from an ontology. They contribute to integrated understanding of ontologies and a solution of multi-perspective issues of ontologies.

Keywords
ontology modeling, viewpoint, multi-perspective issues

1. INTRODUCTION
Ontologies are designed to provide systematized knowledge and machine readable vocabulary of domains for Semantic Web applications. The competences of semantic technologies strongly depend on the ontology which they use. It is important that the ontology captures the essential conceptual structure of the target world as generally as possible and they should be well organized with consistency and reusability. However, we cannot avoid multi-perspective issues when we build an ontology across multiple domains. It is because domain experts often want to understand the target world from their own domain-specific viewpoints. In many cases their interests are different, even if they are experts in the same domain. In some domains, there are many ways of categorization of the same kinds of concepts and different taxonomies are used depending on the purpose and situation. To solve the multi-perspective issues, many efforts are taken. OBO Foundry proposes a guideline for ontology development that we should build only one ontology in each domain[1]. This is an approach to exclude multi-perspective nature of domains from ontologies. Ontology mapping is considered as an approach to accept multiple ontologies based on different perspectives in a domain. It aims to make clear the relationships between the different ontologies.

The authors take another approach to deal with multi-perspective issues of ontologies based on ontological viewpoint management. The main strategy is composed of: (1) the conceptual structure of an ontology is fixed based on ontological theories and (2) on the fly reorganizing some conceptual structures from the ontology as visualizations to cope with various viewpoints. On the basis of this strategy, the authors consider two semantic technologies for viewpoint management of ontologies and implement them. The first technology is conceptual map generation for divergent ontology exploration. The other one is on-demand reorganization of *is-a* hierarchy from an ontology. In this article, we discuss developments of these two technologies.

2. DIVERGENT EXPLORATION OF AN ONTOLGIY
Fig.1. outlines the conceptual map generation tool for the divergent exploration of an ontology [2]. The divergent exploration of an ontology can be performed by choosing arbitrary concepts according to the explorer's intention to obtain what we call "multi-perspective conceptual chains." We define the viewpoint for exploring an ontology and obtaining the multi-perspective conceptual chains as the combination of a focal point and an aspect. The focal point indicates a concept to which the user pays attention as a starting point of the exploration. The aspect is the manner in which the user explores the ontology. Because an ontology consists of concepts and the relationships (properties in OWL) among them, the aspect can be represented by a set of methods for extracting concepts according to its relationships. We classify the relationships and define two methods in each relationship according to the direction to follow it (upward or downward). The multi-perspective conceptual chains are visualized in a user-friendly form, i.e., a conceptual map. It contributes to integrated understanding of the ontology and its target world from multiple perspectives across domains.

On the basis of this observation, we developed an ontology exploration tool which supports the divergent exploration of an ontology. In addition to functions for generating conceptual maps based on viewpoints of the users, the system has the following supplementary functions: (1) searching all conceptual chains which we can obtain from a concept, (2) changing viewpoint of a conceptual map and restructuring the map from another viewpoint, (3) comparing conceptual maps for understanding the difference between viewpoints, and so on. Through these functions, multiple

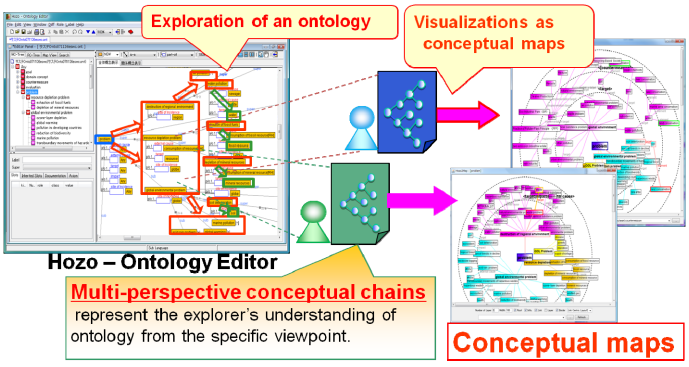

Fig.1. The conceptual map generation tool for divergent exploration of an ontology.

conceptual maps generated from an ontology based on various viewpoints support users' understanding of the knowledge systematically across domains.

The conceptual map generation tool has been used by domain experts of sustainability science (environmental domain) for structuring knowledge. Our tool it is being well received by them [3]. We also tried to use our tool for other existing ontologies in OWL. As the result, it is suggested that usefulness and effectiveness of ontology exploration depend on structures of ontologies. For example, it is useful to understand ontologies which have many kinds of properties. We are considering what types of ontologies are suitable for ontology exploration. The tool is developed as an extended function of Hozo which is an ontology editor based on an ontological theory of role[4]. It also can import/export ontologies in OWL and available at the URL http:www.hozo.jp.

3. ON-DEMAND *IS-A* HIERACHY GENERATION FROM AN ONTOLOGY

To develop a function for the on-demand generation of *is-a* hierarchy, we use definitions (conceptual structures) of focused concepts as viewpoints to traverse an ontology. As an example, Fig.2. outlines how to generate *is-a* hierarchy from a clinical medical ontology which are developed in a project supported by Japanese government[5].

In the medical ontology, diseases are defined by specifying typical disorder roles, such as pathological state, symptom, played by anomaly. Their disorder roles are represented as slots which correspond to relationships between the diseases and classes for constraining slot values. The user chooses a slot which is focused as the aspects to generate *is-a* hierarchies and specifies how to traverse the ontology, that is, along *is-a* hierarchy or part-of hierarchy. The system traverses the ontology according to the aspect and collects information related to the slot. A new *is-a* hierarchy is then generated using this information. For instance, when the user chooses the pathological condition as the aspect, a new *is-a* hierarchy of sub-classes of diseases is generated using *is-a* hierarchy of the anomaly which plays pathological condition role. These sub-classes are used as middle concepts (categories) and diseases defined in the ontology are reorganized under them according to their definitions.

We implemented the technology using API of Hozo. In an informal evaluation, medical experts liked the dynamic classification reorganization, which is a first solution to the multi-perspective issues of medical knowledge.

4. CONCLUSION

We developed two semantic technologies to deal with multi-perspective issues of ontologies based on ontological viewpoint management. Both of them take a same strategy that on the fly reorganizing some conceptual structures from a fixed ontology as visualizations. Their prototypes are received favorable comments from domain experts in environmental and medical domains. We plan to integrate them into a comprehensive technology for viewpoint management of ontologies. We are also developing APIs of these two technologies so that other system can use it. The demonstrations of these systems are available at the URL: http://www.hozo.jp/demo/.

5. ACKONLEGMENT

This work was supported by Grant-in-Aid for Young Scientists (A) 20680009, the Global Environment Research Fund (Hc-082) of the Ministry of the Environment, Japan, and the Development of Medical Knowledge-based Database for Medical Information System of the Ministry of Health, Labour and Welfare, Japan.

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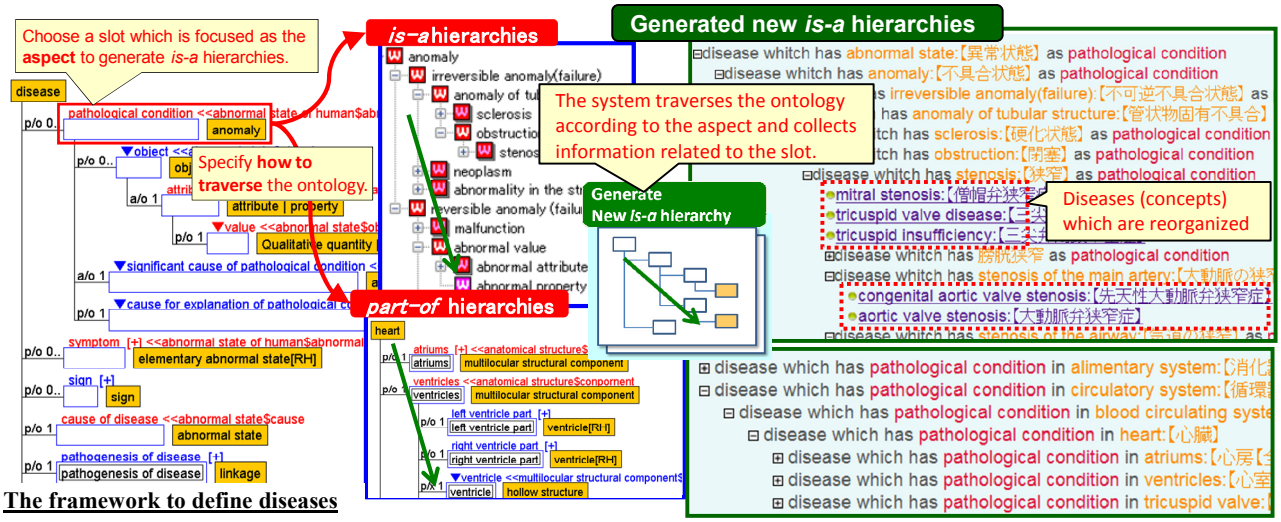

Fig.2. How to dynamically generate *is-a* hierarchy from a medical ontology.