Building Ontologies of Environmental Applications for a Digital Library of Scientific Collections

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Abstract
In this paper, a first attempt is made to build an ontology of environmental applications in the context of search and navigation needs of the Digital Library ARION containing geospatial data sets and environmental applications. The engineering of the ontology is modular where each module is structured according to different facets of scientific information, for example, scientific information may be described according to the data sets, production methods including mathematical modeling etc. These facets correspond to core queries users would like to ask in a scientific DL like ARION. This modular (facet-based) approach scales well with large scientific ontologies, where new information may be appended in accordance to user/provider needs. Our approach is neither exhaustive nor exclusive.

1. ARION: A Digital Library of Scientific Collections
ARION promotes advanced features of Digital Library technology and in addition it promotes features that take into account the content and characteristics of scientific collections. Specifically, it is based on an advanced middleware architecture that seamlessly integrates Digital Library, Intelligent Information Integration, and Workflow technologies. It is comprised of three main cooperating modules: the Metadata Search Engine, the Knowledge Base System, and the Workflow Runtime System. The architecture is shown in Fig. 1 while the functionality of each component is described in [Houstis/Lalis 2001].

A number of tools are developed for the provider in order to publish and install scientific collections into a scientific digital library in a provider friendly manner.

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They allow operationally autonomous and geographically dispersed organizations to selectively “export” their resources. Publishing/installing a new resource with the system requires merely supplying appropriate metadata/ontology, workflow descriptions and wrappers.

2. Ontological Descriptions of Scientific Collections

In ARION, by considering the area of ocean waves, we propose a general framework and methodology and a collection of tools and standards that help to produce an open and effective ontological description of scientific areas. Such descriptions play a central role in any DL system in general and in ARION in particular.

Our effort is based both on existing standards (FGDC 94) and tools (Open GIS) and on derived ontologies. In ARION each specific object is considered as an instance of various ontologies (primary ontologies), like the one presented in Fig. 2, each one of them describing a different view of the examined object. Thus, we decided to build a number of small flexible ontologies instead of a monolithic one that
would try to cover everything. Moreover, a number of secondary ontologies, like those contained in Fig. 3, have been built for the various purposes.

A collection of several other ontologies, some of similar complexity like the one presented in Fig. 2, that accurately reflect the structure knowledge of the area of ocean waves have been defined. For example the associated with “Scientific Models by Phenomena” and the one associated with “Scientific Models by Mathematical Models”. The above two ontologies are in a sense complementary, since they both describe different views of a particular object.

Fig. 2: Scientific Data Ontology: An example of a primary ARION ontology for Ocean Waves.

Fig. 3: Examples of secondary ARION ontologies for Ocean Waves.

In ARION Digital Library system, each specific object is considered as an instance of various primary ontologies, each one of them describing a different view of the examined object. A number of secondary ontologies have been built. Instances of their classes are used as “values” for some properties (attributes) of classes of the primary ontologies. This method is used in cases where the “value” of some attributes is structured and cannot be given just a single number of string etc. Also, in some other cases, the “values” of some attributes of some primary ontolo-
gies are instances of other primary ontologies, relating in this way classes from these two ontologies. The above approach is depicted, for the case of “Mean Sea Level Data”, in Fig. 4.

Fig. 4: An ontology instance derived from ontology facets.

Bibliography

ARION project. [http://www.arion-dl.org](http://www.arion-dl.org)


Open GIS project [http://www.opengis.org](http://www.opengis.org)