GEO-INFORMATION (LAKE DATA) SERVICE BASED ON ONTOLOGY

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ABSTRACT

Recently ontology research has received much attention in geo-information science and the concept of ontology is very important for spatial information concept modeling and data sharing, classification of geographical classes. More importantly, it enriches the semantic theory of spatial information. Geo-information services and geo-information interpretation and extraction are the two main applications of geo-ontology. Ontologies have great application potential for geo-information service.

Keywords: Ontology, Geo-ontology, Geo-information, Lakes

1 INTRODUCTION

1.1 Science Ontology

Ontology is first a philosophical theory; it is regarded as the origin of philosophy. In the past in the western world, ontology emphasized a pure notion, which is a transcendent philosophy. It existed in a world that can not be sensed by humans, and its meaning was embodied through a combination of notion and the definition of logic. It used the words of the real world, but it was endowed by the meaning of ontology theory. The theory of ontology cannot be deduced by common sense, so this is why it does not belong to the real world as well as the reason that it is imported in the field of science to standardize conceptualization.

The meaning of ontology in science is different from its meaning in philosophy. There is no commonly accepted standard definition on science ontology. In the field of information science, ontology has two representative definitions: one was proposed by Gruber (1993) that "ontology is the specific definition of concept;" the other was proposed by Guarino (1992) that, "ontology is the theory about the meaning of the formalization words," Science ontology should include four parts: conceptualization, explicit expression, formalization, and sharing.

1.2 Geo-ontology

Geo-ontology was proposed to introduce ontology into geographic information science. Geo-ontology not only has the meaning of philosophical ontology but also geographical ontology. Philosophical ontology emphasizes a concentration on the object itself; it refers to research geography conceptualization, sorting, relationships, and process. Geography spatial-temporal ontology, uncertainty ontology, and scale ontology are also embodiments of philosophical ontology. The study of philosophical ontology, especially the design of ontology for geography, aims to better understand the world's structure. Information ontology embodies specific aspects of the definition of geographical concepts and the application of the interaction of geo-information and geo-information service.

2 CORE PROBLEMS IN GEO-ONTOLOGY RESEARCH

2.1 Cognition of the geography object

The object of the geo-ontology is the definition of geography. The representation of the object must be based on the cognition. The cognition of a geography entity should be considered in such aspects: (1) identification: the identification or the description of the geographical entity. Generally, one entity is represented by one word, but the same entity also allows other ways to be identified. Also, a geographical entity cannot be altered because of a change of the attributes; (2) cognition of geographical objects: geographical objects are located in geographical space and are related to and inherit the structure of the space; (3) spatial-temporal ontology: the partition of multiple dimension scales and time of a space in GIS is a difficult problem; at the same time, the construction of the ontology cannot avoid these two problems; (4) geographical phenomenon: the correlation of objects leads to a geographical phenomenon. Raper (1995) considered that a geographical phenomenon was composed of differences in spatial-temporal dimensions. The differences are rigorously defined. For example, water overflowing a riverbank can be considered to be a flood disaster, and the disappearance of water flow can be considered to be a drought. The essence of a geographical phenomenon is the effect of internal process and explicit accidental factors; (5) change and incidence: entities of the real world always have some change that should be considered in cognition.

2.2 Geographical classification

The theory of geographical classification must obey subjection and topology. It also has to obey qualitative geometry theory, such as scale and shape. In addition, the dimension of a geographical object must be considered; for example, water can be considered to be three or two-dimensional. The classification can be done according to some theory, but the real world is complex. For example, a pool and a lake can be subjection relations or parallel relations. To solve these problems, much investigation must be done by multi-disciplined groups of people. Geographical classification is a difficult and significant problem in the ontology research.

2.3 Partition boundary of geography objects

Because of the specific spatial characteristics of a geographical object, in the process of classification, the identification of the object boundary is a critical problem, especially for differentiating between bona fide boundaries and fiat boundaries. Bona fide boundaries correspond to a discontinuity in the natural world, such as the boundary of an island. Fiat boundaries are defined to be boundaries such as national boundaries, state boundaries, etc. Smith (1994) researched the problems of fiat objects with respect to fuzzy, uncertainty aspects. How to build the ontology of these objects is a problem that needs deep study.

3 APPLICATION OF GEO-ONTOLOGY IN GIS

3.1 Geo-information service based on ontology

The language heterogeneity problem in geo-information originates from different conceptualization and representation of the same geographical phenomenon. The corresponding language heterogeneity can be divided into two types: one caused by different cognition and the other by different nomination. Cognition heterogeneity has different conceptualization according to the same real geographical world, but nomination heterogeneity uses different names for the same geographical concept. Building mapping relations between corresponding geographical names can solve the problem of nomination heterogeneity. As to cognition heterogeneity, the problem is very difficult. The problem caused by different cognition has been discussed for many years in geographic information science world, but no efficient approach to solve this problem has been proposed. The theory of ontology is a new idea to solve this problem.

Although geo-ontology is a language used to represent geography, formal language is needed to describe it. The representation languages of ontology are of several kinds, and they can be divided into traditional ontology representation languages and ontology markup languages in the web environment. The traditional representation languages are the ontology language developed by different research groups before the XML standard. They included On-tolingua, KIF, Loom, OKBC, OCML, and Flogic. The ontology markup languages have been developed based on the XML standard and include SHOE, RDF, RDFS, OWL+OIL and OWL.

3.2 The interpretation and extraction of geo-information based on ontology

Remote sensing images are important data sources of geo-information. The interpretation and extraction of remote sensing images and the fusion of them and other data sources are the basic problems that need be solved. A remote sensing image has two characteristics. In the perspective of survey, it is the aggregation of fields, but it is the aggregation of defined objects from the perspective of classification. Câmara et al. (2001) proposed to use remote sensing images as an ontology tool in order to obtain changes in a landscape. He believed that remote sensing image ontology should include several parts including: (1) internal quality: the cycle of the data, multi-spectral capacity, and spectral resolution; (2) lack of precision, cycled data acquisition: the response of an image according to differences in object acquisition; (3) concentration on the detection of the change: an image ontology feature must depend on the detection of change, not the content; (4) the application of algorithm knowledge; and (5) dependency on measurement methods: the content of the image is related to the measurement method.

Bahr (1998) considered how image interpretation needed knowledge, and he concluded using knowledge to represent the process of comprehension image as illustrated below (see Figure 1):

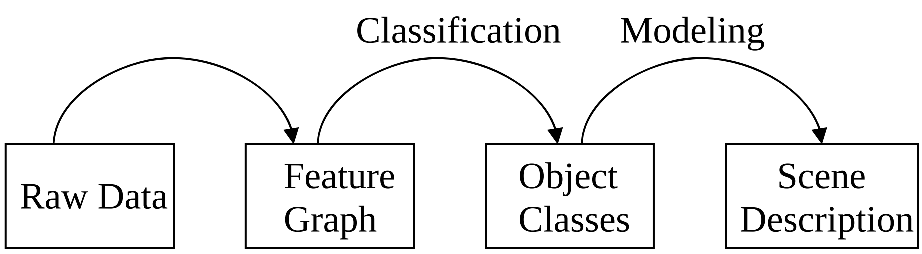

Figure 1. Role in image interpretation extended from (Bahr, 1998)

Fonseca (2001) explained the above image information extraction process by using the ODGIS (ontology-driven geographic information system).

4 CONCLUSION

The information about our earth and geography is expanding rapidly. The information comes not only from new spatial information systems but also from new data collection methods (for example, satellite remote sensing data). How to integrate and provide access to this great volume of data, especially multi-disciplined geographical data, is a great challenge. Ontology perspective is very important for a concept model of spatial information, spatial data sharing, and geographical definition. Past experience indicates that representations of geo-information based on ontology have specific positive attributes. The application of geo-ontology in the development of geographic information science is very promising.

At the same time, we should also realize that ontology research in geographic information science is very complex and difficult. Up to now, it is in its beginning stage of development. The development of a real ontology-based geographic information service system needs considerable time for exploration and research.

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