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Semantic Integration for Multi-Source Geo-Data based on Ontology– A Case of Integration of Chart and Map

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Abstract—To solve the problem of data-sharing between multi-source data for the reason of semantic heterogeneity, paper analysis the problem of semantic heterogeneity and propose a solution for it based on ontology, besides, paper take this solution to reality via VC++ 6.0 and have constructed the model of ontology by Protégé, completed the mapping table and the new coding system, to deal with the semantic gulf between chart and map, solution has been used in national 863-project.

Keywords- ontology; semantic; integration; chart; map; Protégé

1. Introduction

Information is more and more important in this age of information-exploding, especially in the area of Geo-science, data takes a key role there; geo-data is more and more heterogeneous because of the peculiarity of real-time, multi-scale, multi-field in this area. So it is hard to share and has to achieve the same data repeatedly, sharing and interoperate is the hot topic in this area. Maps and charts are wildly used and essential for some key using such as national security, but the heterogeneity between the maps and charts is very typical because they are depending on different standards and using in different areas. The problem here is more typical and more urgent.

Heterogeneity in the information system can be divided into four levels: system, grammar, structure and semantics (A .Sheth, 1998), the semantic integration is the most crucial step for the problem. Along with ontology being imported to the area of information-science, it has been considered as the best way to solve the problem.

2. Semantic Heterogeneity&Ontology

2.1. Semantic heterogeneity

There are nine levels in abstracting real world to computer world, in the define of OGC, because of the different understanding for the real world, the peculiarity of different areas and the different standards, there produces the semantic heterogeneity in the level of real world(1st level) to conceptual world(2nd level),

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interoperation of heterogeneous GIS is the key technology for seamless GIS[1].There is three levels in interoperation of information system by OGC, that is data level, grammar level and semantic level(OGC,1999), and the semantic level is most complex and the most important level, “Semantic integration is the real integration.” Said by Chen Changsong [2].

There are lots of researcher studies on this and some constructive solutions have been proposed. Yaser Bishr, YI Shanzhen proposed the solution via “information standards in different information area, mapping rules and the common understanding for the Geo-information & theory”; The main method in the paper of HUANG Yuxia for solving semantic gulf is establishing standards or by metadata; But compare with the solution implement in the phase of data production, the method base on ontology is more suitable for this problem and have get lots of achievements [3, 4, 5].

2.2. Ontology

The concept of ontology is coming from area of philosophy [6]. Haves used it in the area of artificial intelligence (P.Have.1978). Along with the development of the science, ontology has been used in different areas.

Ontology has its own language to create and mark, the language for creating ontology called “ontology language”, such as CycL, Gellish, KIF, RIF and OWL. OWL is be used in this paper. Ontology Editor is the edit tool for create ontology via ontology language, this paper takes Protégé as the ontology editor, one of the most popular ontology tools.

There are lots achievements in the point of integration between chart and map [7], but the method based on ontology is infrequent. Ontology engineering needs more researches and experiments.

3. Solution

Chart is mainly including elements n the sea, used for navigation, some specific standards such as S-57 of IHO is followed in chart creating. Map describes the elements in the land more detailed. There are lot of difference in map layers, information coding, framing and benchmark. So it is hard to share the data of them, this paper completed the semantic integration by the method discussed above.

3.1. Ontology creating by Protégé

Chart divided its elements into 14 classes such as physical geographic elements, artificial elements, navigation& Obstruction elements. Map includes 8 classes as water, traffic, administrative region [8, 9, 10, 11]. Ontology of chart and map has been created by Protégé based on these standards, peculiarity and needs of semantic integration for them. Ontology of chart as Figure 1 showing, Figure 2 is presentation for ontology of map.

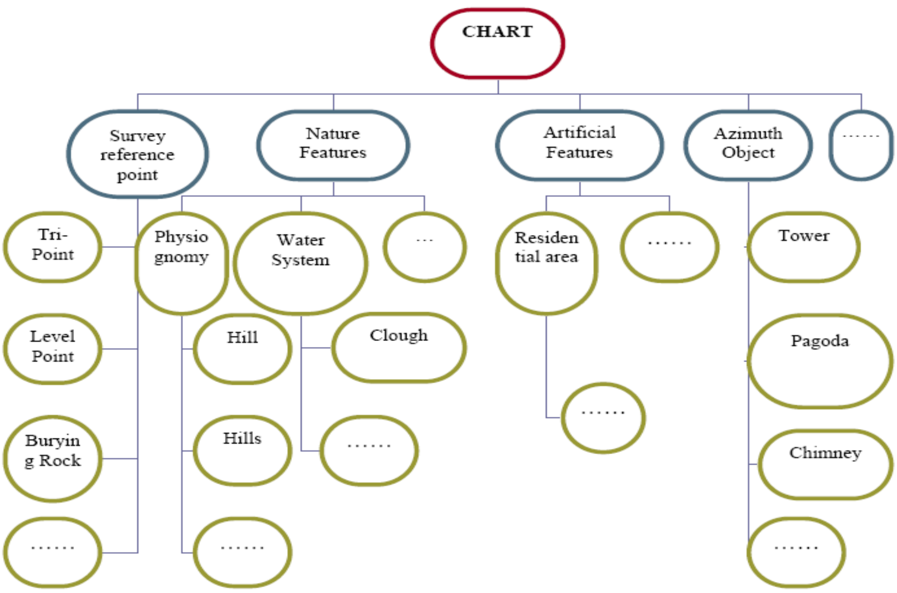

Fig. 1: Schematic diagram for ontology of Chart.

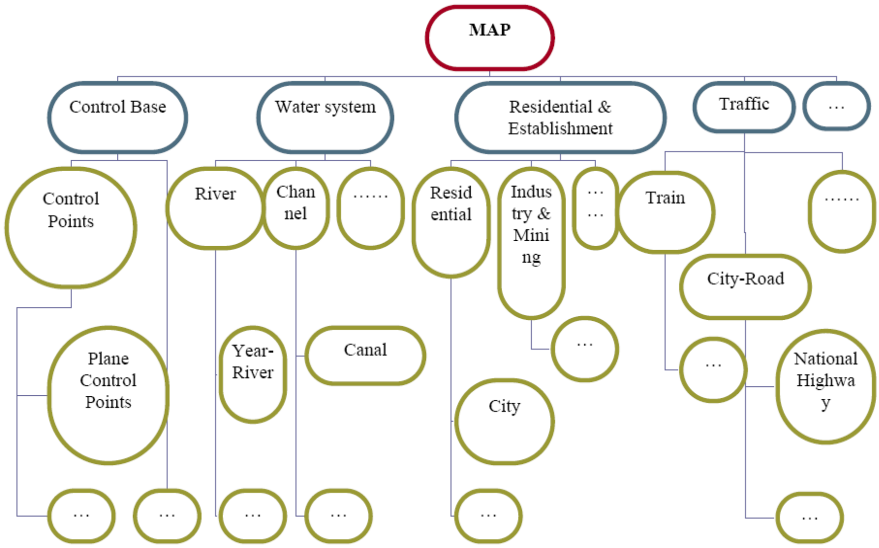

Fig. 2: Schematic diagram for ontology of Map.

3.2.Output Ontology to classes for computer using

3.3.Unify coding system and map layers

A unified classed standard (as Figure 3 showing) is needed. All features include map-features and chart-features are integrating together and reclassify depending on rules& peculiarity of them. The new unify classes include 7 big classes as control bases, ocean features, nature features and so on, 26 middle classes and some small classes. Relationship between features and classes are reconstructed. All features from land or ocean can been arranged efficiently and effectively.

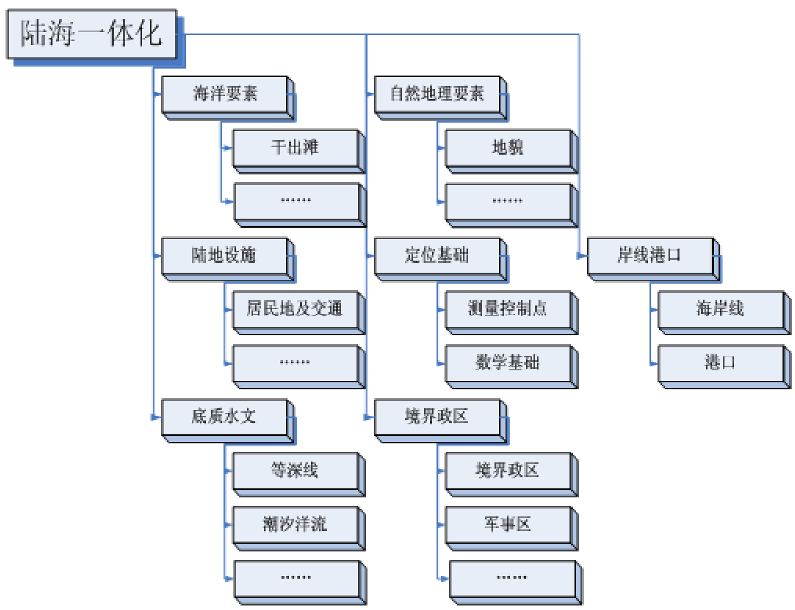

Fig. 3: Schematic diagram for unfied classify standard.

Feature Classify	Date Layers: Layer Name	Date Layers: Description	Geo Type	Main Feature
CONTROL BASESE（C）	CPTP	Surveying Reference Points	POINT	Surveying Reference Points
	CPTL	Coordinate Net	LINE	Coordinate Net
WATER SYSTEM (H)	HYDA	Water System(AREA)	AREA	Lake, Reservoirs
	HYDL	Water System(AREA)	LINE	River

	HYDP	Water System(AREA)	POINT	Well
	…	…	…	…
RESIDENTAL AREA & ESTABLI-SHMENT (R)	RESA	Residential area (AREA)	AREA	Street
	RESL	Residential area (LINE)	LINE	House
	RESP	Residential area (POINT)	POINT	House
	…	…	…	…
…	…	…	…	…

Fig. 4: Schematic diagram for unfied map layers.

A unified coding system and a unified map layers are needed too for a real integration system.

For the conveniences and the speed of the geo-data arrangement, map layers in GIS is divided into 3 types include point line and area. A new unify map layer classify plan is reconstructed (as Figure 4 showing). The storage module tightly relation with the processing speed and the efficiency of a system, No redundancy, integrality & efficiency is the main rule to define the new module.

The new cording system for unify system is including 9 numbers(as Figure 5 showing), number 1 is the cord of big classes, number 2~3 are cord of middle classes, number 4~8 take the meaning of small classes, all these are depending on the new unify classify rules. The last number of cord means type of the data, such as point, line or area; this is for the better data management too.

Paper re-organization all the elements in Chart and Map, re-class them depend on the new coding system, besides, a new map layers system is constructed, all these elements is arranged to new layers defined according to the peculiarity of the integration map of Chart & Map.

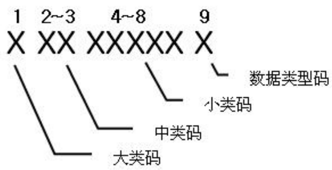

Fig. 5: Schematic diagram for unfied cording rules.

3.4.Construct mapping relationship between two ontologies

To get the purpoes of semantic intergration, the relationship between char-ontology system and map-ontology system must been constructed (As figure 6 showing). Instead of this method, some mapping tables will be worked, but it is hard to reuse and hard to handle with the complex tasks. Expriment have proved that, ontology method is more effective too.

Fig. 6: Table of Semantic Mapping Rule

4. PROGRAMMING AND IMPLEMENT

4.1. Programming for tranlate rules and translate operator

Translate rules is creating for translating among Chart, Map and Integration Map based on ontology which created in step III-(A).

Translate rules include element translate, layer translate and so on, system can get information via these rules; Translate operator is divided into element level and layer level, for processing different level of Geo-data, as Figure 7 showing, all these are implement by VC++ 6.0.

Fig. 7: Interface of translate rules and traslator.

4.2. Programming for main application for demo

Solution has been used in national 863-project, a special application for demo has been programmed in this paper based on all these tools which created above, it can cross the semantic golf between Chart and Map, it can query information across two kinds of maps, and also, it can translate among Chart, Map and Unify Map automatically. The functions of seamless query, display, cartography, modify, store and semantic translate between Chart and Map had been realized via this application. It makes an efficient reuse and integration for Map & Chart data. The main interface of the application is as Figure 8 showing.

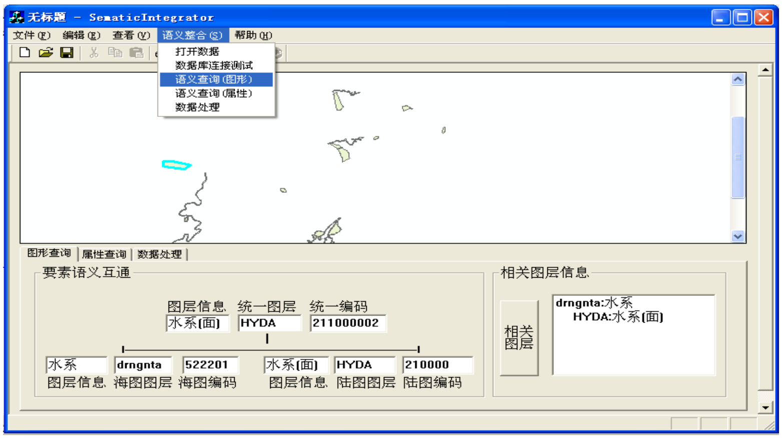

Fig. 8: Main UI of the demo.

5. Conclusion

This paper analysis the problem of semantic heterogeneity and ontology engineering, and combine with the reality of Map & Chart, it solved the problem and constructed a successful model for ontology using in data integration area. But there are some points to been further researched: ①Common solution for the integration of different areas, such as common ontology technology; ②Standardization for the GIS, because it is a efficient way to solve the heterogeneity among the kinds of data.

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