

RESEARCH ON THE FORMALIZATION DESCRIPTION OF USER REQUIREMENT IN GIS DEMAND-BASED SERVICES

CAI Yongxiang^{a,*} Huang ZhongYu^b

^aSchool of Geoscience, Yangtze University, 1 Nanhu Road, Jingzhou, Hubei province, China - caiyx2002cn@126.com

^b Dept. of Electromechanical Engineering, HuBei Three Gorges Vocational and Technological College - 459425965@qq.com

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ABSTRACT:

The formalization description of user needs is one of key issues in GIS on-demand services. A number of user demand documents is collected, the paper analyzes them in semantics and geometric aspects, discusses something reflected in the demands, which is about datasets selection and spatial data visualization in supplying custom products and on-demand services. The existent resources can be described as the fundamental datasets with a certain scale, various generalization operators, and the symbol style library in mapping system. Hereby, the formalization definition of user requirements is given. The requirement extraction module is designed to link user requirements and information resources. Users interact with the interfaces to import their requirements, the various parameter items of requirement formalization description can be obtained, and the extraction result is the basis of producing custom products. The requirement extraction module makes it easy for supplying user custom products and on-demand services.

1. INTRODUCTION

As everyone knows, map producing is a time-consuming work, including information collection, data validity check-up, multi-scales databases creating and data visual representing. At present, National Fundamental Geographic Information Databases have been built according to the given scale series, one of important issues in GIS research areas is how to use these fundamental geographic information resources to serve for demos. On-demand services, supply custom products for users are the demands of society development. Many scholars start work in this area.

An on-demand web mapping tool named UMapIT is proposed (E. Bernier et al. 2005), which is based on a multiple representation database. Bénédicte Bucher et al.(2007) studied the need for web legend services, he thought that some crucial steps of an on-demand map design process are not supported by today's architectures and may greatly benefit from knowledge that has been formalised by cartographers. Alessandro Cecconi etc. put forward an integrated approach that combine multi-scales database with cartographic generalization methods to provide more flexible web mapping. Neun et al. (2005; 2007) and Burghardt et al. (2005) referred to WebGen, a interactive services of tool-based generalization, which is as an open generalization platform properly. Similarly, services supporting the classification, manipulating and processing services have also been proposed for generalization services with different types, Regnauld (2007) proposed to establish a general system by formalizing input data, user needs, geographical knowledge and services based on Geographical-Ontology, on which maps can be derived according to user demands. Wang Zuoning

attempts to get user's demand information by instance databases (Wang Zuoning, 2006).

Although these studies have made some achievements, some problems in GIS services still exist: 1) It is difficult not to exceed time the user expected. From analyzing and understanding user needs, designing service product, to data resource extraction, processing, visual expression, parts of the work is still carried out manually, which needs to spend a lot of time; 2) It is difficult to provide users with on-demand product truly. Most of the content of geographic information services is still dependent on the producers themselves. The key reason is that user demands are various, if there is no formal definition on the user needs, it is difficult to know if these maps really satisfy the users' information needs.

This paper attempts to definite the nature of user needs formally based on analysis series of user requirements, design and implement the requirement extraction module, which is regard as the basis of geographic information service, the final aim is to integrate geographic datasets and visual represent rapidly to provide user with command-based services. The paper has 5 sections:

Section One is introduction; In Section Two, based on analyzing a number of demand documents, it is summarizes several aspects which have an effect on dataset selection and spatial data visualization during supplying custom products and on-demand services; The formalization definition of user requirements is given in Section Three; Section Four is to design and implement the requirement extraction module, which links user requirements and information resources. Users interact with the interfaces to import their requirements, the

* Cai Yong-xiang, School of Geoscience, Yangtze University, Jingzhou, Hubei province, 434102, China.
Email: caiyx2002cn@126.com.

various parameter items of requirement formalization description can be obtained; Last Section is conclusion.

2. ANALYSIS OF USER DEMANDS

The user requirements are various and described by natural language. 48 user requirement documents about geographic information are collected from different channels, two aspects including semantic and geometric aspects are analyzed, because that have an effect on dataset selection and spatial data visualization during supplying custom products and on-demand services. Needs to explain is these map requirement documents are ordinary demands of the public rather than specialized demands of specialized departments.

In semantics, a user requirement includes its specialized requirement, interest and characteristic. Specialized requirement is the specialized purpose of the demanded map, in which fields the map is going to be used, it can determine which data we needed in background map, and their detail level is rough; Interest reflects what points of interest and which aspects the user is concern, and it refers to thematic data; Characteristic reflects precision demands, representation demands, visualization styles and so on.

The specialized purpose of 15 requirement documents in the collected requirement documents is for traffic and navigation application, accounts for 30% more than the total number; 7 requirements documents are for tour sites, account for 15% of the total; 12 requirements documents are for business branches label, account for 25% of total; 7 requirements documents are for locating important cases, account for 15% of total, and 7 requirements documents are for the others, account for 15% of the total, the specialized purpose distributing of requirement documents is shown in figure 1.

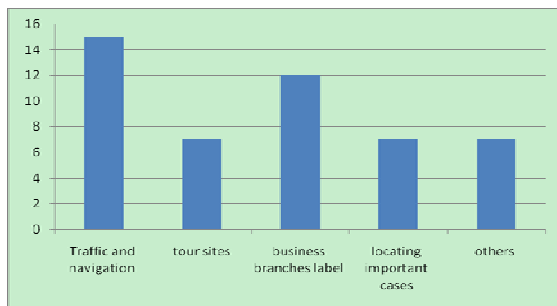


Fig1. The specialize purpose distributing of requirement documents

The specialized purpose of users determines background map features, their interest feature, and it is related to the representation characteristic of maps closely. The following are statistic results of target maps of the collected requirement documents.

It can be seen from the table that background map features are several datasets of fundamental geographic information databases, which are represented in a coarse level in a general way, sometimes, one of them is represented slightly more detailed. Interest features can be one dataset of fundamental geographic information databases, or another thematic data, which must be represented in more details.

In addition, the user's preferences can't be ignored too, it determines the expression style of the demanded product, the feature symbol, color scheme, map configuration and design are related it.

specialized purpose	Background features	Interest features	Representation characteristic
traffic and navigation	watersystem, residential area, district	traffic network	more details: traffic network detail: residential area
tour sites	watersystem, traffic network	viewpoints	more details: viewpoints details: traffic network
business branches label	district, residential area, traffic network	business branches	details: business branches
locating important cases	district, residential area	important cases	details: important cases
the others	water system, district, residential area, traffic network	other thematic features	Details: thematic features

Table 1. The Statistic results of target maps of the collected requirement documents

In geometric aspects, a user requirement includes the area coverage and accuracy of the demanded map. The accuracy of the data is actually the requirements of resolution, can be transformed into a scale according to mapping specification. Different scale topographic maps correspond to different location accuracy in surveying and mapping specification, as shown in table 2.

Scale of topographic map	Flat, foothill (mm)	Upland, alpine land (mm)
1:500~1:2 000	0.6	0.8
1:5 000~1:100 000	0.5	0.75
1:25 000~1:1 000 000 (Compilation mapping)	original map should be consistent with the above precision	

Table 2. Different location accuracy of different scale topographic maps (Surveying and Mapping technology standard and specification)

According to table 2, if the user desired an accuracy of 5m on the ground, then he needs datasets with the scale 1:10000, if he desired an accuracy of 25m on the ground, then he needs datasets with the scale 1:50000.

The two parameters of the demanded map, area coverage and desired scale, determine together which datasets are to be selected from fundamental geographic information databases.

3. THE FORMALIZATION DEFINITION OF USER REQUIREMENTS

In fundamental geographic information databases, the existed datasets can be described as :

Dataset={ID, bound, layerName, level}

ID : unique identifier of the dataset

bound: diagram scope of the dataset

layerName: name of the dataset feature

level: detail level of the dataset, it can be transformed into scale.

According to the above analysis of datasets selection and spatial data visualization based on user requirements in Section 2, the formalization definition of user requirements is given as following:

Definition: A user map requirements can represents as a multi-component tuple: $\langle R, L1, Inte_P, L2, S \rangle$, R means resource datasets the product involved, L1 is the detail level of background features presentation, Inte_P is the interest dataset, it needs detailed presentation, L2 is the detail level of interest dataset, S is styles of the product map.

Obviously, R is a datasets aggregation, including one or muti-datasets, such as water system, traffic network and etc., which come from fundamental geographic information databases and belong to the existed resources, so it can be expressed as:

$$R = \{dataset1(, dataset2, \dots, datasetn)\}$$

Similarly, as the detail levels of background datasets, L1 can be one or muti-levels. For example, the specialized purpose of a map is for tour sites, water system and traffic network are its background features, water system is represented in a coarse level, traffic network is represented in detail comparatively, so, the two datasets have two detail levels. L1 can be expressed as:

$$L1 = \{level1(, level2, \dots)\}$$

As the styles of the product map, S includes style/color configuration of every dataset. Popularly, the background datasets represent with the default configure of symbol and colors, but the interest dataset need reconfigure according to the user's requirement. So, S involves symbol style, symbol size, and color scheme of the interest dataset, as well as other configuration demands.

In a commanded map, the sketch map of resource datasets is shown in figure 2.

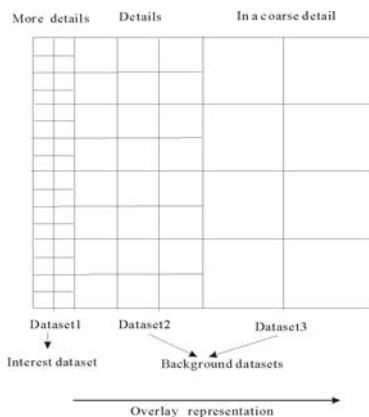


Fig2. Sketch map of resource datasets in a commanded map

4. DESIGN AND IMPLEMENTATION OF THE REQUIREMENT EXTRACTION MODULE

Since the formalization definition of user requirements has been built, now the key issue is to identify the various parameter items of the formalization definition from the natural language of user demands, the formalization description of demand is the basis of on-demand services, and the basis of supplying custom products for users too.

If we design a requirement extraction module to link user requirements and information resources, users interact with the module to import their requirements, the various parameter items of the formalization expression can be obtained. In essence, the requirement extraction module is to establish a bridge between users and their formal expression (to see figure 3), which converts the user's natural language into mapping language, make the users' needs more clearly and accurately and make GIS on-demands services easily.

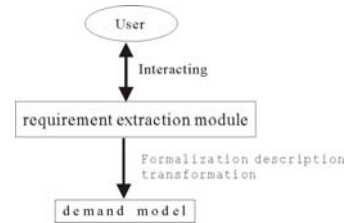


Fig3. The function of the requirement extraction module

We must take into account two aspects in designing the requirement extraction module. Firstly, the module must have a humanized operation interface, through that interaction operations can be done by the way users understand easily. Secondly, the module can capture the formalization configuration of user needs accurately.

According to the formalization definition of user requirements, Various parameter items of the multi-component tuple $\langle R, L1, Inte_P, L2, S \rangle$ must to be identified via user' interaction operations. The specialized requirement, area coverage, detail level and interest of user requirements reflect the requirements of background datasets and interest dataset, the characteristic of user requirements and user' preferences decided the map configuration style, the sketch map of the requirement extraction is to see figure 4.

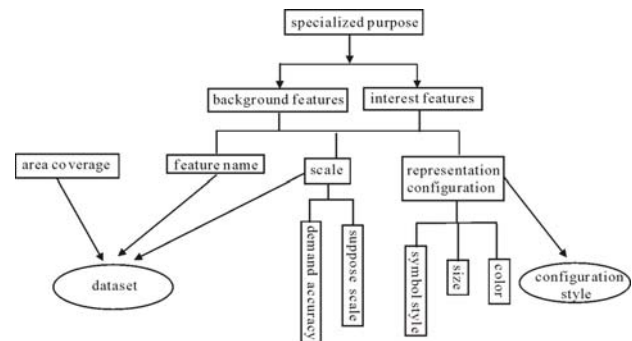


Fig4. Sketch map of the requirement extraction

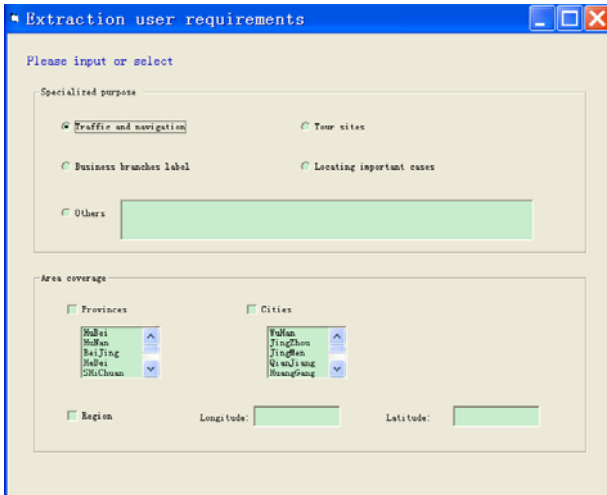
So, we design the interfaces to extract parameter items of formalization demands (to see figure 5).

5. CONCLUSION

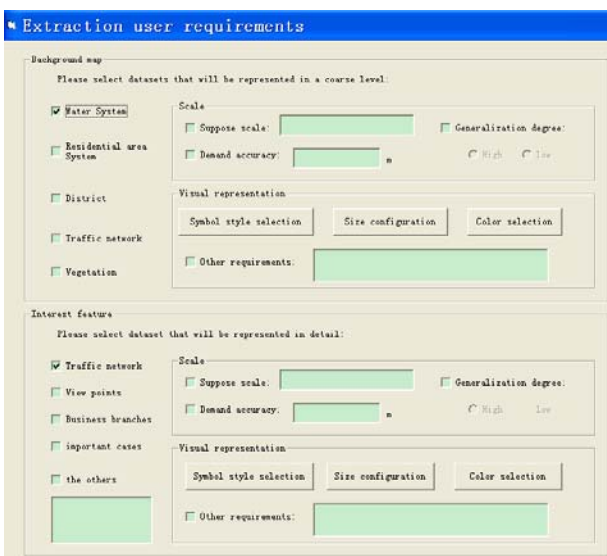
The existent data resource can be described as the fundamental datasets, which has unique identifier 'ID', a certain diagram scope 'bound', a certain detail level 'level'. In a mapping system there is various generalization operators, symbol style library and so on. Based on formalization description of user requirement, the relations between user requirements and

information resource can be set up, it becomes easy to supply on-demand services and custom products for users quickly.

Based on the requirement extraction module, various parameter items of the formalization description of user demand can be obtained. In the multi-component tuple $\langle R, L1, \text{Inte_P}, L2, S \rangle$, all background datasets make of R, the corresponding levels of R constitutes scale L1, interest dataset is Inte_P, and the corresponding level of Inte_P is L2, the representation configuration of all these datasets is S.



(a)



(b)

Fig5. Interfaces of the requirement extraction module

Since the formalization description has been given, according to this description, it becoming easily to derivate on-demand products from known source data. Therefore, the requirement extraction module makes it flexible and fast to supply user custom products and on-demand services.

The further study is to integrate the requirement extraction module with generalization operators to form an intelligent service platform.

REFERENCE

Foerster, T., Burghardt D. et al., 2008, Towards an interoperable web generalisation services framework : current work in progress. In: *Proceedings of the 11th ICA workshop on generalisation and multiple representation*, http://ica.ign.fr/montpellier2008/papers/12_foerster_et_al.pdf.

Hampe, M., Anders, K. H., Sester, M., 2003, MRDB applications for data revision and real-time generalisation, In: *Proceedings of the 21st International Cartographic Conference*, http://www.ikg.uni-hannover.de/fileadmin/ikg/staff/publications/Konferenzbeitrag_e_abstract_review/HampeAndersSester_ICA2003.pdf.

Poppe E., van Elzakker, 2006, User-centred design for application-driven generalization of base maps. Extended abstracts of the 4th International Conference on Geographic Information Science (GIScience 2006), Münster, Germany, 2006, pp. 313 - 317.

Cecconi A., 2003, Integration of Cartographic Generalization and MultiScale Databases for Enhanced Web Mapping . Zurich : Zurich University.

Foerster, T.; Stoter, J. E. & Lemmens, R. L. G., 2008, An interoperable Web Service Architecture to Provide base maps empowered by automated generalization. In: *Proceedings of SDH*.

Neun, M., 2007 : Data Enrichment for Adaptive Map Generalisation using Web Services. PhD Thesis, Department of Geography, University of Zurich.

Regnauld, N., 2007, Evolving from automating existing map production systems to producing maps on demand automatically. In: *10th ICA Workshop on Generalisation and Multiple Representation*, Moscow, Russia.

Barrault, M., N. Regnauld, C. Duchêne, K. Haire, C. Baeijs, Y. Demazeau, P. Hardy, W. Mackaness, A. Ruas & R. Weibel, 2001, Integrating multi-agent, object-oriented, and algorithmic techniques for improved automated map generalization. In: *Proceedings of the 20th International Cartographic Conference (ICC 2001)*, 6-10 August 2001, Beijing, China, pp. 2110-2116.

Fuhrmann, S., P. Ahonen-Rainio, R. M. Edsall, S. I. Fabrikant, E. L. Koua, C. Tobón, C. Ware & S. Wilson (2005), Making useful and useable geovisualization: design and evaluation issues. In: J. Dykes, A. M. MacEachren & M. J. Kraak (eds.), *Exploring geovisualization*, pp. 553-566.

Slocum, T. A., C. Blok, B. Jiang, A. Koussoulakou, D. R. Montello, S. Fuhrmann & N. R. Hedley, 2001, Cognitive and usability issues in geovisualization. *Cartography and Geographic Information Science* 28 (1), pp: 61-75.

Neun M., Weibel R., et al, 2004. Data Enrichment for Adaptive Generalization, ICA Workshop on Generalization and Multiple representation, <http://ica.ign.fr/Leicester/paper/Neun-v2-ICAWorkshop.pdf>.

Urska Demsar, 2007, Investigating visual exploration of geospatial data: An exploratory usability experiment for visual data mining, *Computers, Environment and Urban Systems*, vol 31, 551-571.

Cecconi A , Weibel R., 2001, Map generalization for on-demand mapping . International Journal for Geomatics , GIM, vol. 15 (5) : pp,12-15.

Bertolotto M, Egenhofer M J., 2001, Progressive transmission of vector map data over the world wide web . Geoinformatica , vol. 2001 , 5 (4) , pp: 345-373.