Web Services Based GIS Model Sharing Service

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***Abstract*-Nowadays, Sharing is one of the most frequently hot topics. Compared with adequate data source and data share, it is more important to use the abundant data. Generally, a geographic information system (GIS) consists of two parts which are data and function. Sharing function is a good way to make the data usable. For this purpose, we set up the architecture for GIS model sharing. Furthermore, an archetype system is built to prove the feasibility, and an environment evaluation model is used for a test on Beijing surrounding areas. The archetype system shares the environmental evaluation model via Web Services. It enables end users to combine local data and remote function together to execute environment evaluation and analysis. The archetype system is a proof of the feasibility of the GIS model sharing architecture. The environment evaluation result generated by the archetype system is consistent with the ground truth. It is more convenient to use the archetype system and it also reveals the utility of web services based GIS model sharing service. However, the archetype system needs to be improved in many aspects.**

Key words: GIS; Web Services; Environmental Evaluation Model; Sharing;

I Introduction

With the fast development of information technology, a great progress has been made on acquiring spatial data. As for GIS users, not only professional researchers but also common internet user can get benefit from GIS. As a result, the spatial information sharing technique is more desirable. In fact, much work has been done on sharing data set which is of different sources and different structures. At the same time, productions of application in related fields keep growing. GIS is composed by data and function. While the data sharing is done well, function sharing will be the next important problem to deal with. For similar purpose, ESRI has set up a new GIS architecture for distributed geographic information services named G.net, Google, Microsoft and some other software corps have developed GIS service APIs for website developers. In this paper, we first discuss the mode of integrating professional models and GIS, and the architecture on sharing GIS model based on web service is put forward. And then an archetype was built as a test to prove the feasibility of the new architecture. The models used here are 4 environmental evaluation models which were used in an environment monitoring system in Beijing surrounding areas. The archetype system shares the environmental evaluation model via Web Services; it enables end users to combine local data and remote functions together to do environment evaluation and analysis. The archetype system is a proof of the feasibility of the GIS model sharing architecture.

II GIS and Model

GIS, from his introduction, has shown some great importance in natural resource management field [1], such as the layout of land use, forest resource management, research on wild animal's habitat, water land monitoring and evaluating the lost cost by disaster. Recently, GIS has expanded to do emergency control, marketing, transporting and military affairs. As a tool for data integration and analysis, GIS has the ability to handle huge data, and analyze both property and topology of GIS data. Furthermore, GIS platform also has the professional ability for data expressing, and it can provide intuitionistic view of research result. All of the above reveals that GIS is good for model analysis.

GIS technology is widely used in environmental science. There are many research achievements and application cases. Environment is a huge, complex and open system. It consists of two interknitted parts which are natural environment and human social economical environment [2]. The affecting factors are high related with each other and the relationship between its components is complex. The problem may be simplified with the help of GIS. For modeling could be done in a separated platform with database, data view and analysis tools used which can benefit for model calculation and result analysis. We believe that it will be advantageous to combine GIS and environmental models. In order to achieve the goal, two modes are usually used to integrate environmental models with GIS, which are loose mode and tight mode[3]. The main advantage of loose integrated mode is the support of database and the application of visualization tools. Furthermore, the modeling process will benefit from the application of GIS technology and analysis tools. However, tight integrated mode has the ability to provide more valuable results. In specific fields, the closer the coupling of GIS and professional models, the more important role GIS plays in it. It can be seen that loose mode is more suitable for GIS Model Sharing Service and is used in our archetype system.

Environmental evaluation model is selected to be a test to integrate with GIS, which is the core of the archetype system.

III Why Chose Web Services as GIS Model Sharing Service Platform

Modern technique for geographical information sharing is tended to be more pluralize ways, component GIS can be used to customize for users; Web GIS is used to share geographical information via internet; Mobile GIS can expend GIS on mobile equipments like PDA or cell phone [4]. However, there are limitations in all these technical frameworks. Component GIS is for the professional and not easy to be used by public; Web GIS is hard to inter-operate and cannot take advantage of the resource at client side; Mobile GIS is limited by terminal units. They are all not the best technique for building GIS model sharing platform.

A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards.[5]

Web Services are the latest software craze: the promise of full-fledged application software that need not be installed on your local computer, but it allows systems running in different environments to interoperate via XML and other web standards. They will take place of other distributed computing[6].

As web services are component services, the solutions based on web services gained the flexibility of component system and wide spread of web GIS, plus, web services for mobile utilities are gradually developed[7]. So web services should be the most suitable technique to design model sharing service, should be the new field

for GIS software, ESRI has discussed similar viewpoint in their G.net architecture[8].

IV Web Services and Model Sharing Architecture

Figure 1 shows the web services based GIS model sharing service architecture.

GIS model sharing service platform consists of four main parts: GIS modules supply GIS analysis function, and enveloped by web service to supply interface for remote users; GIS database is the basal data source; Model base stores and manage all analysis model; Model process is the core operation part, it will process the GIS data collection according to model selected.

For web services can be accessed from internet, clients can use the analysis function supplied by the sharing platform. Client could be also web program and desktop program. The desktop programs can analyze local data via uploading data to server.

This architecture concentrates all main functions on server side. As data could be uploaded to server by client program, there is no difference for analysis modules where the data stores. When analysis completes, result will be sent to client.

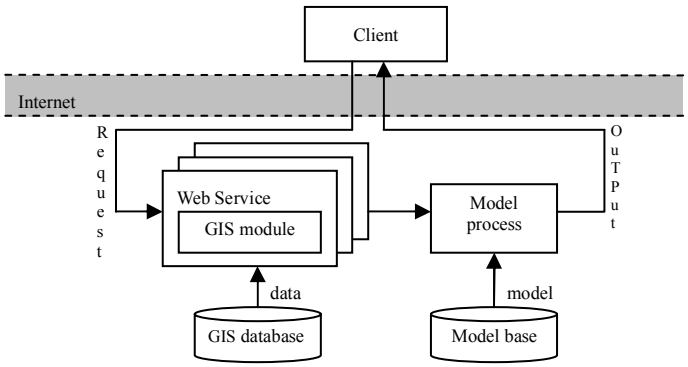

Figure 1 Web Services based GIS Model Sharing Service Architecture

Key problems for developing web services-based evaluation sharing platform:

1) Client program. Client program plays as a carrier for GIS model analysis provided by web services. In order to expand the system functions for users to access functions on server side with local data used easily, we have to design a light client program.
2) Data transportation. Web services transfer data based on XML. It is a suitable way for data transfer to convert GIS data to GML. To reduce the load of data transfer, we need to compress data before sending it to server.
3) Function modules division. It is important to divide function modules. For different types of evaluation models have different requirements on matched data, and the needed functions are different, too. Modules dividing should be flexible, which means dividing the modules into small components that are to be recombined for different use.
4) Matching between GIS function and models: Being universal and being precise is an inconsistency. To be more universal means less precise, and to be more precise means less universal. To fit different user's requirements, we need to balance the two sides, and make a customable platform.

V Archetype System

1. Background Introduction

The environmental models we used in our archetype system are from "Resource and Environment Remote Sensing Monitor data management and application system in Beijing Surrounding Areas". Web Services-based GIS Model Sharing Service Archetype System will provide environmental evaluation function.

Beijing surrounding areas are important areas which China ecological environment department is putting much emphasis on. Because of bad soil quality and sparse canopy, soil degradation becomes more serious. The resource application and ecological environment protection becomes a severe problem. Indeed, the ecological environment problem is not only a problem in Beijing surrounding areas, but also is an obstacle of Tianjin city, Tangshan city in Hebei province and the northeast of China.

"Resource and Environment Remote Sensing Monitor data management and application system in Beijing Surrounding Areas" is to drive the application and service of resource and environment remote sensing monitoring data. The system can provide valuable information to our country and the social public, and is helpful for decision making of related industries. Its regional environmental evaluation module has environmental evaluation models and methods. The module was made by us. The system was set up in 2005.

Our research area consists of 61 counties and cities which cover Hebei province, Shanxi province, inner Mongolia and Shaanxi province. The data we used is from the national land use plan database. Its format is coverage with the scale of 1:500,000.

The sharing models provided by now consist of 3 professional models which are biology abound index model, soil degradation index model, canopy cover model and a comprehensive analysis model. The comprehensive analysis model takes the calculated results of 3 professional models as its input parameters. Combined with other parameters on the regional population information and the social economic information etc, it can to evaluate the regional ecological environment.

2. Developing tools:

We take Microsoft corp's Internet Information Server as web services server, C# as develop language for web services and client program, Oracle 9i as model base to store and mange models, and ESRI product ArcInfo as GIS solution.

3. Archetype system flow chart:

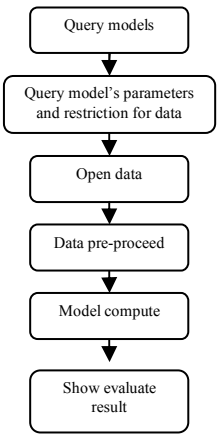

Figure 2 model sharing archetype system flow chart

Figure 2 is model sharing archetype system flow chart. The models in archetype system are stored in server side. When to evaluate, client queries all models via web services first, then client generates the model list according to the query result for users. After a user chooses a model, client fetches the model's parameters and data requirement. Then prompts the user to choose analysis data and do pre-proceed work according to model's requirement. Client uploads the data that after pre-proceed, and submits evaluate request. When server completes the analysis, client gets the evaluated result.

4. Model analysis:

Expanding the models from server only mode to service mode needs to do some change on the origin program. Area environmental evaluation needs at least two data layer: first a land type data layer as the evaluate data source, an area boundary layer as the boundary restriction for evaluate and the layer to display. Image 3 is boundary layer, Image 4 is land type layer, and both two layers are shapefile spatial data.

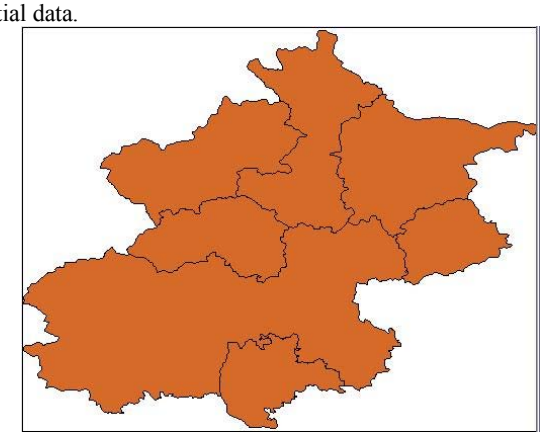

Figure 3 boundary layer

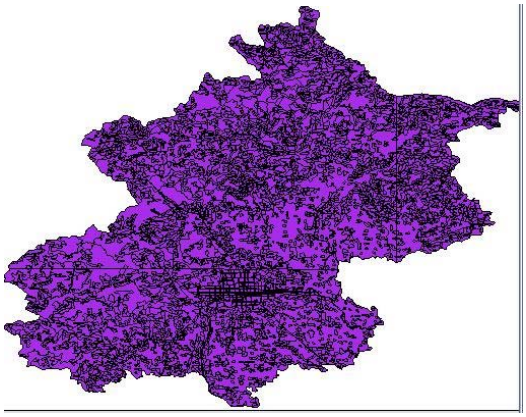

Figure 4 land type layer

Because GIS data on server side is stored in database and well organized, when working on server only mode, user just need to choose which area to evaluate. When calling function via web service, user need to locate the data, if the data property is not exactly the same with original standard, user need to setup a few key fields needed by the model. In "Beijing surrounding area" system, data is organized by counties, it is just suitable for area evaluation, but it is different when facing data on client side. So we take the boundary layer as the restriction for area evaluation. When evaluating, program use the boundary layer to do topology analysis with land type layer, find all polygens inside the boundary as the polygens in that area, and then use model to evaluate these polygens. The polygens in land type layer may cross the polygen in boundary layer, this situation may have effect on the evaluate result. For environmental is area problem, we cannot get precise evaluation of an area cutting all relations with surrounding areas. So, we take the crossing polygens the same as inside ones, if user need, we can change the effect power of the polygens.

Using local data and remote model to do analysis computing has a few ways:

Terminal mode: client only upload the data and show the analyze result. The evaluating, analyzing and computing staff is all on server side, this mode has the lowest client requirement, can sufficiently use the models and other resource on server side, and seldom needs to upgrade client program even server side update, but this mode will take lots of bandwidth and client's function is kind of simple. This mode may suit for small clients like mobile equipments.

Data pre-proceed mode: client fetches the evaluation model and the requirement for data, according to the requirement, client do some compute process first, then send the data and evaluation request to server to complete the evaluation. This mode takes less bandwidth, can flexibly balance between the server and client burden, and has many functions on client side. But this mode needs some GIS function. This mode is the most flexible and can be most widespread used.

Client individual mode: In this mode, client can compute the whole analysis task, and does not need to transfer data to server; the only thing needed to request from server is to fetch the model. This mode takes the least bandwidth, but client program is complex and any updates on model of server side may cause client problem. This mode suits for simplex models and the place hard to access internet.

We take the second mode, data pre-proceed mode. As models in archetype system are similar, and has the same data requirement, it is not hard for us to combine them together, and easy to do design data pre-proceed. Area evaluation need all land types' area sum count, so after we generate the data collection in some area by topology analysis, we sum each land type's area separately, and transfer the sum data to server in XML format via web service, then get the final evaluate value.

5. The Archetype system

Figure 5 is for user to choose needed model. After the model is selected, "nest step" is followed.

Figure 5 Model Choice

Figure 6 shows the process for the user to input the needed parameters. User may use the default ones which are suggested by the system or ascertain it by themselves. Of course, users may withdraw the default parameter whenever they are less suitable for their own parameters.

Figure 7 shows the evaluation result.

6. Evaluating result:

Quantitative environmental evaluation is done with the web services-based GIS model sharing service archetype system for Beijing sounding areas. The environment quality is expressed as environment quality index (EQI) generated by environment evaluation model. Higher EQI means better ecological environment. Our evaluation result shows that the north part of Beijing has better environment than that of the south area. It reveals a gradual change

Figure 6 model parameters

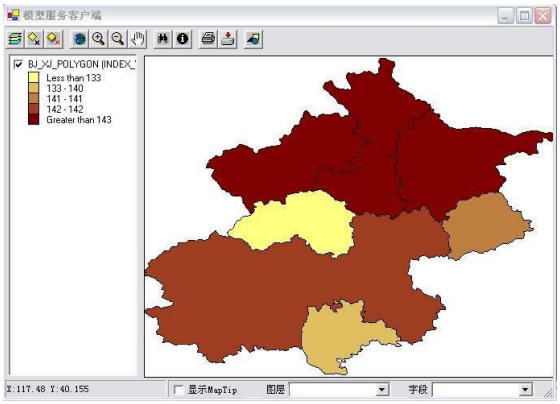

Figure 7 Evaluation Result

which matches the relationship between environment and soil types. But there is an exception in the evaluation result which can be seen in figure 7. We find that some empty data plates result the exception.

VI Conclusion and Discussion

In order to achieve web services-based GIS model sharing service, we take advantage of a loose coupling mode of professional models and GIS at server side. The data pre-processing method at client side is simple, and the shared models are similar which leads to a clear and simple frame. It is only an archetype system. However, a general web services-based GIS model sharing service platform is to be improved in future. The following are some points:

2) GML standard should be used in data transfer.

3) To extend the model management function of Web services, we should provide more models for users to use freely or to let users upload more new professional models for sharing.

An open web services-based GIS model sharing service platform is valuable. We have proofed that web services-based GIS model sharing service frame is feasible. However, we are improving the archetype system for a more usable platform.

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