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Studying on distributed sharing of geographical analysis model

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Abstract

In order to solve the problems of sharing difficulty in geographic analysis model which is classification diversity, the model wrapped method and model service approach based on geographic analysis model metadata are studied in this paper. By the experiments, it has shown that our research can provide a feasible way for sharing geographical analysis model.

1. Introduction

Geographical analysis model is abstraction and expression of geographical phenomenon, geographical mechanism and geographical process. Geographical simulation method is one of the most important methods in geographical research [1]. Although massive geographical analysis models have built by geographers from different domains, those models are distributed all over the world and can't been shared easily. There is no effective way to solve the problem named “geographical model isolated island”, and it has caused many problems, including high using cost, and model resource waste. In order to change present situation, geographical analysis model sharing became another hot problem to be solved urgently besides geographical data sharing in geographical information science.

In this paper, metadata of geographical analysis model is discussed as a starting point. Based on some technologies such as web service, service container building and remote invocation, distributed sharing of geographical analysis model is studied.

2. Metadata criterion for geographical analysis model

As geographical analysis models are used in different fields, there are heterogeneous natures existing in classification, scope of application, model quality, model performance and so on. It is necessarily to study a general metadata criterion used for describing heterogeneous model. It’s the basic approach for geographical analysis model sharing, and will made an immediate effect on the sharing of modeling idea and modeling conception.

In terms of geographical analysis model classification, Changmin Liu summed up mathematical models and formulas published in Acta Geographica Sinica during 1934-1999[2]. A book named *resource environment mathematical model manual* has authored by Tianxiang Yue，almost 3000 kinds of geographical analysis model published at home and abroad are collected and sorted in this book. Those researches have produced active effect for geographical analysis model sharing, but the achievements are expressed in written form and can’t been used by computer directly.

Metadata criterion describing for geographical analysis model are also studied recently. MDL（Model Definition Language） was made in the model integration module of a decision support system by Jin Lin, model name, model library, model description, model interface, model content and so on are included in this Language[3]. Qiao Wang studied model classification, model code, model dictionary and model structure criterion in spatial decision support system [4]. Lihong Su studied the metadata for resource and environment models, he proposed that metadata criterion for geographical analysis model must consist of eight parts, including model classification, scope of application, model parameters, operation condition, model performance, model principle, model realization and management information [5]. In 2001, standardized documentation for geographical analysis model was designed by Tianxiang Yue[6].Shortly after that, Jiantao Bi began to study model classification and model integration; he proposed that metadata must include metadata for data, metadata for model and metadata for function [7]. And also, integration of geographical analysis model and GIS based on metadata was proposed by Zhengguo Niu in 2007[8].However, geographical analysis model is a kind of model used

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for solving geographical problems in special domains, when sharing, it can be regarded as a series of functions and treatment processes. All those researches mentioned above restrict in model itself, but operation structure and runtime interface are usually neglected.

Based on the analysis on the existing geographic analysis model metadata, a specification of geographic analysis model metadata (http://www.vgelab.com) was established by key lab of virtual geographic environments (Ministry of Education) Nanjing Normal University, after referenced the geo-spatial metadata standard of OGC、ISO/TC211、FGDC and national fundamental geographic information metadata standards of China. Sixteen parts were included in this specification, classification information, scope of application, spatial reference, time range, spatial scope, model parameters, modeling principle, solving method, model performance, model coupling, model validation, hardware condition for operation, soft condition for operation, revision marking, distribution marking and distribution information. Furthermore, distribution information is worth mentioning: in order to describe the operation structure and runtime interface, metadata for operating system, programming language and component interface is included in this part. Figure 1 has shown a part of specification metadata of two-D finite difference modeling for groundwater flow, using XML.

```
  <MXYWJC>2-D FEM Model</MXYWJC>
  <MXBB>FEM-10.0</MXBB>
  <MXXLM>1-1-1</MXXLM>
  <MXFBRQ>2003-5-27</MXFBRQ>
</mdBMXX>
<mdXMBSXX>
  <XMMC>String</XMMC>
  <XMLX>国家自然科学基金项目</XMLX>
</mdXMBSXX>
<mdFZDWXX>
  <DWMC>南京师范大学</DWMC>
  <KFZXM>String</KFZXM>
  <KFZZY>自主研发</KFZZY>
  <mdLXFS>
    <GJ>中国</GJ>
    <XZQ>江苏</XZQ>
    <CS>南京</CS>
    <DZ>南京师范大学</DZ>
    <YZBM>String</YZBM>
    <WZ>String</WZ>
    <DZYJDZ>String</DZYJDZ>
    <DHHM>String</DHHM>
    <CZHM>String</CZHM>
  </mdLXFS>
</mdFZDWXX>
<mdMXNRXX>
  <MXKJCD>区域尺度或中小尺度地下水流模拟</MXKJCD>
  <MXSJCD>长序列时间步长</MXSJCD>
  <SJFWLX>分步长时间段模拟（年、月、日）</SJFWLX>
  <MXKFYY>FORTRAN</MXKFYY>
  <ZY>运用有限元方法对饱和含水层地下水流进行二维模拟；边界条件包括一类、二类边界；含越流补给项</ZY>
  <MD>二维饱和含水层地下水流数值模拟</MD>
  <JZ>完成</JZ>
  <ZTFLMC />
  <GJC>二维地下水流、有限元方法</GJC>
  <XZXX>String</XZXX>
  <FWXZ>String</FWXZ>
  <SYXDXZ>String</SYXDXZ>
  <SJZSM>String</SJZSM>
  <MXJDSM>精度主要受含水层概念建模（概化）方法限定</MXJDSM>
  <MXJMYL>（错别字：建模）数学方法（有限元方法）</MXJMYL>
  <KJCZXTLX>平面坐标</KJCZXTLX>
  <MXCSSM>包括空间离散数据、时间离散数据、含水层空间分布参数、含水层属性参数（导水系数、贮水系数）、含水层边界条件参数</MXCSSM>
  <MXQJFF>有限元模拟</MXQJFF>
  <SJL>3.14159E0</SJL>
  <DJ>3.14159E0</DJ>
</mdMXNRXX>
```

Figure 1. Metadata description for geographical analysis model

3. Distributed sharing of geographical analysis model

With the geographical analysis model metadata criterion, geographical analysis model can be described in a unified approach. However, to shield the heterogeneous nature of model when sharing and during runtime, model service container is needed to wrap model when called. After wrapped, geographical analysis model can be shared with web service. Figure 2 has shown the framework of model sharing.

3.1 model service container

Geographic model service container interface and the interaction specification is an integrate standard based on the distributed technology. It defines the interactive methodology between the model accessing middleware and the model service container. Model accessing middleware and the model service container can be implemented separately according to the standard. Model service container can be developed by different distributed platform and won't be restricted.

Model service container plays an important role in the several aspects. First, it encapsulates the calculation resource into the service component in model resource provider client. Second, it maintains the executing environment during runtime. Third, it supervises the environment safety, information interaction and the statement in runtime. Lastly, it manages the native models resource. The models in the model container are assembled with the description using metadata criterion and have been cataloged by the heterogeneous geographic model cataloging tool. Models are pushed into the models service container, checked by the model service container whether they are standardization and available, and registered in the model resource shared portal. A lot of the models can be put in a same container. According to the different sources of the models from native, intranet and internet, models are published and distributed in DCOM,

CORBA and Web service forms, etc. based on the different metadata.

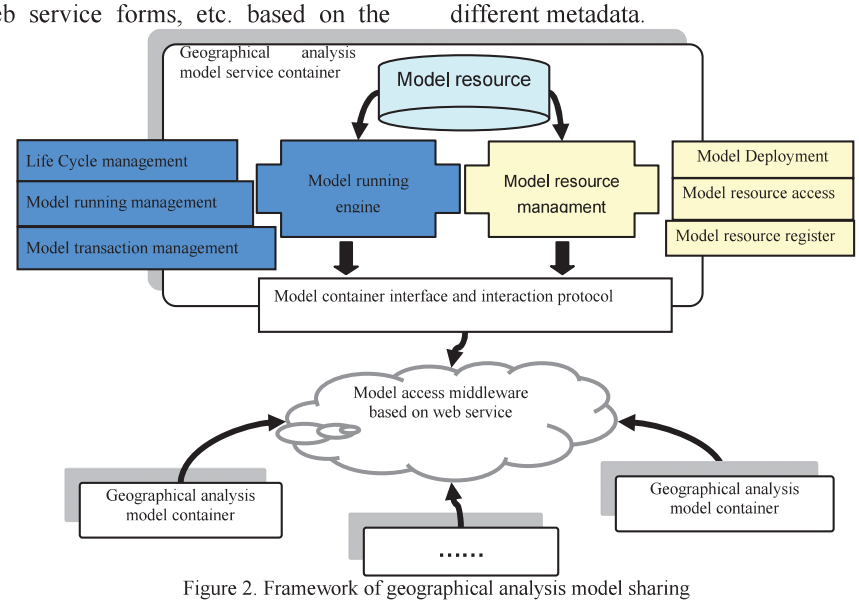

Figure 2. Framework of geographical analysis model sharing

The model running engine is the core component of the model service container. It provides an enclosed environment during runtime. When a model service container gets a connection requirement, it creates a new engine instance according to the metadata information. Native connection interface layer, runtime control layer and basis component layer constitute the model service container. Figure 3 shows the service container of geographical analysis model.

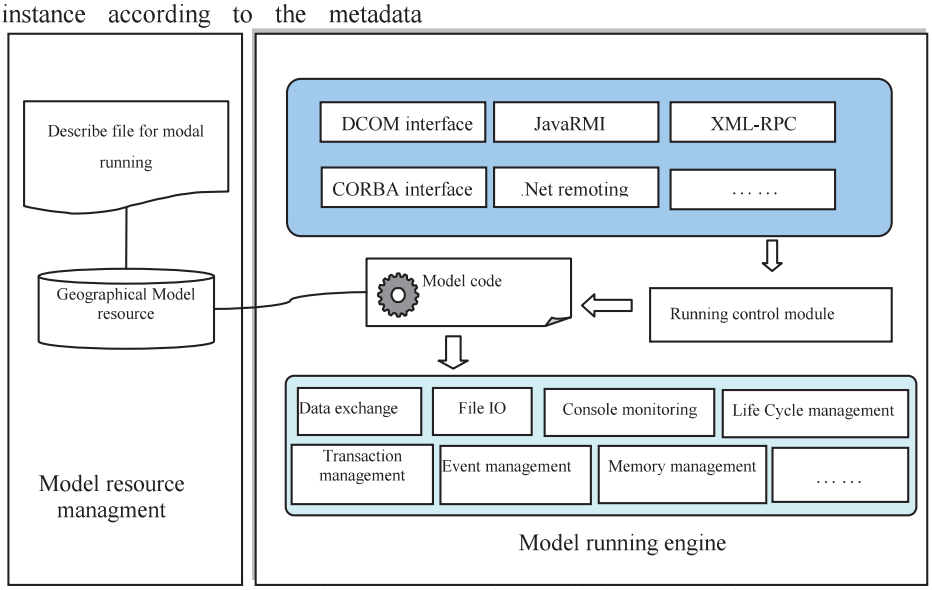

Figure 3. Model service container of geographical analysis model.

3.2 model sharing based on web service

Based on XML and HTTPS, Web service uses SOAP as its communication protocol, WSDL as its service description, and UDDI to find and obtain service metadata. There are three actors in geographical analysis model sharing. First of all is the model service provider, which is used to publish model service, and response to the service calling. The second is model service broker, whose function is register and classify the publish information, provide the search service. The last actor is model service requester, model service requester finds model service using model service broker, and sharing service offered by model service provider. Figure 5 shows the model sharing base on web service.

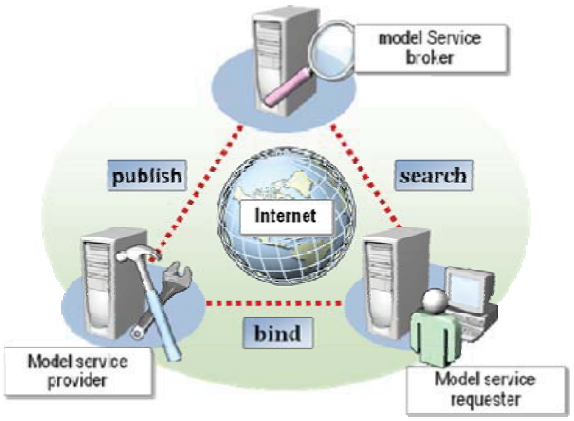

Figure 4. Model sharing based on web service

3.3. Portal website for model sharing

Based on the researches mentioned above, a portal website designed for geographical analysis model sharing is developed by the author. With this website, model publishing, model registering and model requesting can be finally realized. Figure 5 shows the model registering function of this website.

4. Conclusion and prospect

In this paper, we discussed an approach for geographical analysis model sharing. The achievement of this research has been used in Project supported by the State Key Development Program for Basic Research of China (No.2007CB416602),and the Project supported by the State Key Program of National Natural Science of China (No.40730527) at present .

However, the integration of heterogeneous models has not been further mentioned, it is another key issue for distributed sharing of geographical analysis model, and should be stduied further.

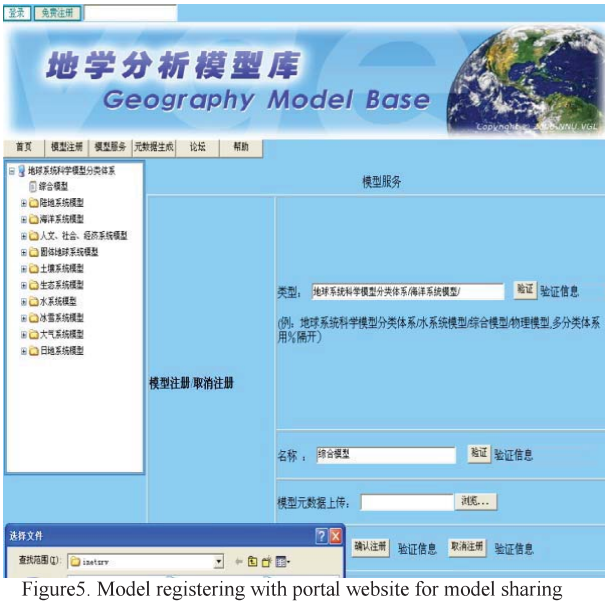

Figure5. Model registering with portal website for model sharing

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