A construction method of water conservancy model library based on Microservice

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Abstract. With the development of network information technology, the water conservancy industry is faced with the new situation of big data and informatization, and the water resources informatization is getting more and more attention. The water conservancy model library is the core part of water conservancy informatization, which provides many functions, including runoff forecast, reservoir operation, accuracy assessment and so on. This paper makes full use of mainstream software science and technology to construct the architecture of water conservancy model library based on microservice, uses Json as the interactive data format of the model, and encapsulates the water resources model as a service. The model library has the advantages of scalability and high availability.

1. Introduction

With the development of network information technology, the water conservancy industry is faced with the new situation of big data\textsuperscript{[1]} and informatization, and the water resources informatization is getting more and more attention\textsuperscript{[2]}. The traditional decentralized water conservancy model management has been unable to meet the new needs of informatization. Water resources informatization has various contents, including information collection, data processing, data mining\textsuperscript{[3]}, water conservancy calculation, decision support and so on.

Among them, the water conservancy model library is the core part of water conservancy informatization. Water conservancy model library is an organic combination of various water conservancy related models, including runoff prediction model\textsuperscript{[4]}, reservoir operation model, forecast evaluation model, flood operation\textsuperscript{[5]} and so on. The water conservancy model library publishes models as resources for external use. And at the same time, models can be invoked to support more complex business functions. All kinds of water conservancy models simulate the collected data, obtain corresponding model results, and help and guide decision-makers in water resources management.

It is necessary to make full use of advanced software scientific achievements to build water conservancy model library. By adopting the model architecture of microservice, the lightweight communication data format and model interaction method, the water conservancy model library can have good scalability and high availability.
2. Model library architecture

There are many kinds of traditional professional water conservancy models, and each model has specific application scenarios, which makes it difficult to organize and manage these models. The construction of model library mainly faces the following problems:

- Provides common internal data access interface
- Provides common external model access interface
- Provides method of communication between models

In order to solve the above problems, we need to make full use of the latest achievements of network information technology. We build high performance water conservancy model library with microservice architecture, implement the encapsulation of water conservancy professional model with Restful (Representational State Transfer) interface[6]. And Json (JavaScript Object Notation) data format[7] is used to realize the communication between water conservancy models. The architecture of water conservancy model library is shown in the figure below:

![Figure 1. The architecture of water conservancy model library.](image)

We encapsulate the water model as a service and provide Restful interfaces, including external call interfaces and data service interfaces. To ensure high availability and stability, each model service is published as a small application cluster with an accessible application interface.

3. Microservice

Microservice architecture is a way to develop a single application as a set of small services, each running in its own process and communicating with lightweight mechanisms (usually HTTP resources). Microservice architecture is a promising implementation of service-oriented architecture with recognized advantages in terms of modularity and continuous delivery[8]. Services are built around internal business functions and can be deployed independently, which is the mainstream technology to develop models with high reusability, high scalability and high maintainability. Therefore, microservice is an ideal architecture for constructing water conservancy model library. The basic microservice architecture is shown in figure 2.
Figure 2. Basic architecture of microservice.

The microservice architecture manages water conservancy model services as interface resources, and each water model service can be accessed through a URL (Uniform Resource Locator) path[9]. As shown in figure 2, the basic microservice architecture consists of multiple modules. Where the gateway forwards the external request to the water model service and returns the model result. The load balancing module distributes the external requests to the water conservancy model service evenly and disperses the pressure of each model service. The registry center is responsible for maintaining and managing running water conservancy models. The system monitoring module is responsible for system flow monitoring, performance monitoring, error handling, etc.

4. Model communication

Traditional Web services, with SOAP protocol[10] as the core, package each model into a linkable component that conforms to a certain interface standard and serve as an analog computing service. As the standards have become more numerous, SOAP has become more bloated and more complex to use. REST technology makes up for the shortcomings of SOAP. Restful Web services are an increasingly popular way to interact with data[11]. Web services based on REST architecture style have the advantages of addressable, standard universality and connectivity. The restful style of interfaces is shown in the figure below.

Figure 3. Schematic of restful style.

Rest-based Web service is a kind of lightweight implementation of Web service. Compared with traditional single software architecture, it has excellent compatibility to various heterogeneous platforms. It includes the following set of specifications:

1. A Uniform Resource Identifier has an ID defined for all resources.
2. Link all resources together.
3. REST emphasizes a uniform interface between components
4. Stateless communication
(5) Rest interface is scalable

Compared with the traditional system integration scheme, the water conservancy model library based on REST architecture is more highly available and reliable. The URI defined by REST style can not only realize the mutual invocation of each module of the system, but also improve the development efficiency of new functional modules.

5. Model interface

The core of establishing the interface of water conservancy model library is to define the interactive data format of the model. Json is a lightweight data interchange format[12]. It stores and represents data in a completely programming language-independent text format. It is easy to read and write, but also easy to machine analysis and generation, and effectively improve the efficiency of network transmission. The basic Json format specification is shown in figure 4.

![Figure 4. Json format specification.](image)

Water conservancy models need to receive input and return results, which require a common data format to define interfaces. Json is used to define input and output parameter formats of various hydraulic models, which can quickly and efficiently encapsulate and interact the models.

6. Data access interface

Data resource is the basis of the model library. All water conservancy models need to input data, and there are many kinds of water conservancy data, including terrain, vegetation, climate, runoff, economy and other data. At the same time, different data formats are also different. In order to provide a common data sharing method, data resources need to be encapsulated as data services. On the one hand, data resources are provided for various water conservancy models, and on the other hand, models and data are decoupled. The unified data interface is shown in figure 5.

![Figure 5. Common data access interface.](image)

Data service is the main factor limiting the performance of model library, so it is necessary to conduct clustering deployment to improve the concurrency performance and the data processing efficiency of data service.

7. Summary

The water conservancy model library is the core part of water conservancy informatization. It is necessary to improve the performance of the model library. In this paper, we adopt microservice architecture, which makes different water conservancy models run and maintain independently. We adopt water model service interfaces of restful style, which provide a simple and unified method of resource access. We provide an independent data service interface to decouple data from models and
improve the development and maintenance efficiency of the model library.

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References
[1] Min C, Mao S, Liu Y. (2014) Big Data: a Survey. J. Mobile Networks & Applications. 19(2): 171-209.
[2] Wang X, Zhou X. (2006) Application and Integration of Information Technology in Water Resources Informatization. In: Asia-pacific Web Conference. Harbin. pp. 1004-1009.
[3] Savic DA, Walters GA. Hydroinformatics, (2013) Data Mining and Maintenance of Uk Water Networks. J. Anti-corrosion Methods and Materials. 46(6): 415-425.
[4] Feng K, Zhou J, Liu Y, et al. (2019) Hydrological Uncertainty Processor (HUP) with Estimation of the Marginal Distribution by a Gaussian Mixture Model. J. Water Resources Management. 1-16.
[5] Liu Y, Qin H, Mo L, et al. (2019) Hierarchical flood operation rules optimization using multi-objective cultured evolutionary algorithm based on decomposition. J. Water resources management. 33(1): 337-354.
[6] Lablans M, Borg A, Ückert F. (2015) A Restful Interface to Pseudonymization Services in Modern Web Applications. J. Bmc Medical Informatics & Decision Making. 15(1): 2.
[7] Wang G. (2011) Improving Data Transmission in Web Applications Via the Translation Between Xml and Json. In: Third International Conference on Communications & Mobile Computing. pp. 182-185.
[8] Shami A. (2019) Exploring Microservices as the Architecture of Choice for Network Function Virtualization Platforms. J. IEEE Network. 33(2): 1-9.
[9] Ducut E, Liu F, Fontelo P. (2008) An Update on Uniform Resource Locator (url) Decay in Medline Abstracts and Measures for Its Mitigation. J. Bmc Medical Informatics and Decision Making. 8(1): 23.
[10] Tsenov M. (2002) Application of Soap Protocol in E-commerce Solution. In: Intelligent Systems, First International IEEE Symposium. Bulgaria. pp. 59-62.
[11] Lanthaler M, Gütl C. (2011) A Semantic Description Language for Restful Data Services to Combat Semaphobia. In: 5th IEEE International Conference on Digital Ecosystems and Technologies. Daejeon, Korea. pp. 47-53.
[12] Rodrigues C, Afonso J, (2011) Tomé P. Mobile Application Webservice Performance Analysis: Restful Services with Json and Xml. In: International Conference on ENTERprise Information Systems. Beijing. pp. 162-169.