The implementation of micro-service technology in the development of geohazard online analysis and evaluation

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Abstract. Improving the capability of geohazard data online analysis and evaluation for geohazard prevention and mitigation is the major developing trend of geohazard information service and relevant research. Making use of the information technologies to solve the technical challenges and difficulties encountered in geohazard big data processing and analysis is important to effectively improve the capacity of geohazard information service. By using the micro-service, one of the advanced information technology, this study proposed an technical solution for the construction of geohazard data online analysis and processing service, which was designed and constructed based on the working mechanism and procedure of the analysis. As an example, the geohazard online susceptibility analysis service was designed and developed. In the proposed technical solution, the online susceptibility analysis service was splitted into multiple operational-independent and also interconnected micro-services for the completion of the analytical process. The developments of each individual micro-service provide support for further revision, upgrade and expansion of the data analysis ultimization or model optimization. The propose of the technical solution further deepens the integration of geohazard research and information technology to improve the level and practical efficiency of geohazard information service leading by the advancement of information technology.

1. Introduction

China is one of the countries most threatened by geohazards in the world. With the rapid development of economy and society, the development of geohazards in China is facing great challenges [1, 2]. The rapid advancements of information technologies such as big data, micro-service, cloud computing have provided technical support to improve the efficiency of geohazard mitigation and prevention. The online analysis and evaluation, by deepening the multi-source data fusion analysis, could improve the accuracy and practicability of the geohazards analysis.

As the demand for information services requested for prevention and mitigation of geohazards has become more refined, online and intelligent, the scattered and redundant data management, simple query statistical analysis, and single information service results, have been unable to meet the needs, especially for the online analysis of geohazards with highly specialized knowledge and interactivity between users and the system. Therefore, the major objective of this paper is to promote the application of information technology in geozards, which only very few researches have been conducted, and enhance the professionalism and interactivity of geohazards information services to improve the intelligence level of information services. This paper proposes an online geohazards analytical technology based on micro-service architecture, and the model principles, development process and an example were introduced.
2. The development and application of online analytical technology in geohazard field

The previous studies indicated that most research institutions of geohazard mitigation and prevention have provided the online services of online data processing, statistical analysis and simulation. For instance, the USGS (US Geological Survey), one of the leading research institute in geosciences in the world, provided multiple forms of online analytical services including source code of numerical simulation for sharing and application programming interfaces (API) for online data analysis for users. In China, most analytical tools in geohazard are provided as offline tools, and comprehensive online analysis and its massive applications are at the initial stage currently. Therefore, it is important to make full use of the online analysis technology, especially for its deep integration with the principles of the geohazard research to improve the online analytical services. The online analytical and evaluation technology has obvious advantages over offline stand-alone tools especially for the efficient upgrade and optimization of the analytical models, functions, and large-scale promotion and application. The analysis performed by stand-alone and offline tools may not be able to be dynamically monitored and evaluated in terms of the performances and then to be adjusted, optimized, and improved in a timely manner. Users can not quickly and deeply integrate the offline analysis into their own research. Therefore, to help to solve the problem, a dynamic and efficient interactive online geohazard analysis and evaluation model and application was built for the demonstration and leading purpose to promote the online analytical technology in geohazard field.

3. The development of micro-service technology

3.1. Advantages of micro-service technology

Micro-service architecture is a new software development technology that is different from previous single-architecture applications. One single-architecture application or system function can be split into a series of micro-functions or services, which are mutually coordinated, connected, and supported. Based on the management and invocation on micro-services, a complex single-architecture application services can be achieved [3]. Each of the micro-services can be developed, called, and maintained independently, and a lightweight communication mechanism can be used to support the mutual connection and cooperation between micro-services, thereby forming a self-contained and systematic functional service capability. The advantages of micro-service technology allows the precise dismantling of an large-scale application, and is more suitable for the development of modern information technology and highly specialized services. Under the architecture of micro-service, developers can focus on the development and implementation of a certain type of micro-service required for highly specialized knowledge, and more generic type of micro-services can be shared among the micro-services. Also, compared with a single service architecture, users do not need to download or install task applications, only need to complete the entire process of data analysis and evaluation from "data preparation-data analysis-results download" through a browser [4].

3.2. Application of micro-service technology in multiple fields

At present, the micro-service architecture has been used in various fields such as weather forecasting, oil field construction, Geographic Information System (GIS) construction, and electrical power system construction. In weather forecasting, to improve the efficiency of rainstorm intensity calculation, researchers built a meteorological big data analysis and service platform by integrating multiple functions including collection, data processing and intensity calculation, and information release. Each function is corresponding to one individual micro-service, and the platform showed great advantages in the layered management of micro-service architecture, flexible technology, and function expansion. The specific micro-service, which is the core of the whole system for quantitative assessment of rainstorm intensity and rapid statistical query, can be quickly updated and optimized based on continuously grown data collection in a timely manner without causing the disturbances to the normal operation of the whole system [5].
3. Development of the online analytical application of geohazards based on micro-services

In the field of geohazard, the integration of geohazards online analysis and evaluation research and development is limited. Professional analysis and evaluation models and tools of geohazard can be processed into micro-services, which can be decomposed into a series of micro-services that can be quickly designed and developed, deployed online, upgraded and optimized. Service functions, through the professional arrangement and integration of a series of micro-services, form a complete online analysis and evaluation tool of geohazards, effectively improve the timeliness, practicality and expandability of geohazards research results. To ensure the coordinated and stable operation of various micro-services, it is necessary to build an efficient and complete micro-service management technology support system to realize the registration and discovery of micro-services, load balancing, message mechanism and status monitoring. This is also the key issue in the construction of analytical application based on micro-services. In this study, a widely used and open source micro-service management framework was selected and further customized based on the data characteristics and modeling mechanisms of geohazards to be used as the micro-service management technology support system [6]. The micro-service management framework adopted in this article is shown in Figure 2, where the core technology components are:

![Figure 1. The architecture of online analytical application of geohazard](image1)

![Figure 2. Architecture of micro-service management](image2)
(1) Getway: Responsible for the configuration management and retrieval of micro-services. Considering the independent operation of various types of geohazards analysis and evaluation micro-services, the API gateway service is customized development.

(2) NGINX-based load balancing: NGINX is used as an HTTP proxy service to handle large concurrent service scenarios, and load balancing of the same type of service is performed.

(3) NATS-based message service system: NATS is an open source messaging system with mature technology and wide application. The core is developed based on EventMachine and based on the message publishing and subscription mechanism.

(4) Prometheus-based monitoring and warning system: Prometheus is a combination of open source monitoring, alarming, and time series databases.

(5) Rapid service development based on Restbed: All micro-services are developed in C++ language in the development work. At the same time, this article uses the RestBed open source library for fast Web service construction and HTTP request response processing. The RestBed framework provides restful functions for programs built in C++11.

5. Development of micro-service based on online analytical application for geohazard
This paper has developed online geohazards main control factor evaluation, geohazards susceptibility evaluation and other geohazards professional analysis and evaluation services, in which the function of each evaluation tool is split, the development and invocation of micro-services as the picture shows. This idea makes full use of the advantages of the micro-service architecture, such as flexible architecture selection, controllable development complexity, high standardization, and independent deployment. It effectively integrates the performance of micro-service architecture with the research and development of geohazards informatization service functions and improves the geology. The degree of specialization of disaster information services. Taking the development of the main controlling factors of geohazards and the susceptibility of online evaluation functions as an example, the technical implementation of the online analysis and evaluation function of geohazards by the micro-service architecture will be described in detail.

The evaluation of the main controlling factors of geohazards is mainly used to analyze and determine the main controlling factors that influence the development of geohazards in a certain area. Based on the function of the main control factor evaluation, the geohazards vulnerability assessment needs to add two additional micro-services: grid overlay calculation and grid zoning, so as to obtain the vulnerability index distribution map and the partition map. Therefore, by repeatedly using the combination of micro-services supporting the evaluation function of the main control factors, and additionally developing grid overlay and grid division micro-services, the online assessment of the susceptibility of geohazards can be quickly completed. Figure 3 shows the functional framework of online analysis and evaluation of geohazards based on the micro-service architecture, and the repeated invocation of related micro-services in different types of geological hazard analysis and evaluation tools. According to this idea, the online analysis and evaluation function development has greatly reduced the repeated development workload and improved the efficiency of information services.
The operation of online analysis and evaluation of geological hazards:

1. Through the process of selection of the evaluation area, import of element data, weight calculation and mapping, the online analysis and evaluation of geohazards can be realized:

2. The user determines the scope of the evaluation area through the three forms of administrative area selection, self-editing and uploading scope;

3. The evaluation system will automatically search for the element data in the back-end database that fully covers the evaluation area and is suitable for accuracy according to the evaluation area, and feed back the search results in the form of a list to the right side of the page;

4. The system will automatically quantify the evaluation element weights, and build an optimal element index system based on the weights and AUC test results;

5. The system automatically superimposes the vector layer results of each element's weight to generate a distribution map of the proneness index, and forms a susceptibility assessment zoning map according to the zoning principle entered by the user.

6. Conclusion

Enhancing the online analysis and evaluation function of geohazards is an important support to realize the refined, real-time and intelligentization of geohazards information services. This paper introduces an online analysis and evaluation based on micro-service architecture in view of the problems of insufficient stability, high upgrade and maintenance costs, low development efficiency, large repetitive workload, and inability to quickly deploy online in the current online analysis and evaluation of geohazards. The types of micro-services can be divided into data micro-services, computing micro-
services, visualization micro-services, and business invocation micro-services. This paper completed the development of the main analysis factors of geohazards and the susceptibility of online analysis and evaluation cases, proposed a micro-service architecture construction plan for the characteristics of geohazards analysis and evaluation, and practiced the proposed micro-service architecture and micro-service management technology Support system. The professionalism and effectiveness of the geohazards information service have been improved, and the micro-service architecture has been effectively integrated with the geohazards.

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