

Design and Implementation of a Health Status Reporting System Based on Spring Boot

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Abstract—The "IamOK" online health status reporting system is developed to meet the needs of colleges and universities to grasp the health status of teachers and students during the Covid-19 epidemic prevention and control period. The development and design framework of the system is elaborated by requirements analysis and overall structure design, followed by the introduction of the development method of using JPA, Redis caching technology, Nginx and other key technologies under the Spring Boot framework.

Keywords- Spring Boot; JPA; Redis; Nginx; vue.

I. INTRODUCTION

Since the outbreak of the Covid-19, General Secretary Xi Jinping has attached great importance to it by personally directing and deploying, and pays much attention to the prevention and control of the epidemic. On January 30th, the Department of Education of Guangdong Province issued a notice requiring colleges and universities to formulate a "four precision" plan to ensure the safety of teachers and students when the new term began. In order to timely, accurately and fully grasp the health status of the school's students, faculties and their family members, and to understand whether they have traveled to key epidemic prevention and control areas or contacted high-risk personnel during the holiday, efficient information collection and statistical methods are required. They can be used to establish a smooth point-to-point communication channel.

During the period, information on epidemic prevention and control need to be effectively collected and transmitted through informatization methods and constitute a virtual space for scientific research, teaching, learning, and office. One university actively responded to the call and began to build a better virtual space through information technology to overcome the impact of physical space isolation and to provide convenience for teachers and students. Measures like upgrade and expansion of the school's virtual private network (VPN), upgrade of the CERNET Authentication and Resource Sharing Infrastructure (CARSI), opening of Office365 server, expansion of access

bandwidth of the online teaching platform, design of remote office solutions based on WeChat Work and WeChat enterprise accounts, organization and pushing of the social open academic resources, promotion on campus virtual cards were taken. The related information were push to all of the teachers and students through the school's personalized instant information platform, official notifications or business notifications, which established special zones on "Information Help Anti-epidemic Series" and "Epidemic Prevention and Control".

Meanwhile, after a comprehensive comparison of the various information reporting systems that existed at the time, the university leadership team and related functional departments made a pre-judgment of various management needs during the future epidemic period. They decided to adopt an independent agile development model and gathered all departments to urgently develop a reporting system named "IamOK" Health Status Online Reporting System with the domain name of IamOK.scut.edu.cn.

II. DESIGN METHOD

The "IamOK" Health Status Online Reporting System requires the characteristics of rapid development, good security, accurate data control, wide statistical scope, good ease of use, support for offline statistics and background data import. In order to meet the development needs, this work is based on Vue, Spring Boot, JPA, Apache Shiro security framework, using Redis caching, Nginx, encryption, identity verification and other technologies to design and implement the system to meet the need of the managers to grasp the health status of teachers and students in time.

A. Functional Design

The "IamOK" system can be divided into two major modules: the teacher-students reporting module and the school management module. The teacher-students reporting module includes functions such as login, registration, update password, fill in, view and modify personal information. A new user needs to register first before logging in and the system can log in automatically later. After that, the system jumps to the user's

personal homepage, where the new users need to fill in their names, contact numbers, health status, contact histories and other required information. The school management module does statistics work while provides reporting safety functions for the users.

To quickly grasp the health status of the school members and make it easy to use, the “IamOK” system has made many convenient designs. First, based on the shared data center that gathers all authoritative source data of the whole school, it is responsible for generating and pushing user lists including basic information of users, and dynamically adjust the list of reporting scopes in accordance with the ever-changing management requirements. Secondly, to reduce the difficulty of the user's reporting, only the address and contact number need to be improved if there is no abnormality in the first reporting, and the daily health status can be reported through the “one-button to report safety”. Finally, the system administrator can quickly locate those who have not reported information, or export global data for various necessary analyses to facilitate the statistical work of the secondary units.

B. Non-functional requirements analysis

1) Ease of use requirements

Vue and component library element-ui were used in the system to build a simple and beautiful front-end interface, with good interactive performance and user experience. In order to improve the ease of use of the system and reduce the burden on users, the system will remember the user status and allow automatic login for a period of time. Besides, it adds humanized prompts in some operations and some user input errors. Quick operation functions such as "one button to report safety" are also provided.

2) Security requirements

A series of measures were adopted to ensure security. The system will set user permissions to ensure the security of data resources. The HTTPS protocol is adopted, and on this basis, the security of the transmission process is guaranteed through transmission encryption and identity authentication. The system is connected to the school's unified identity authentication system to ensure the security of identity authentication and uses the Apache Shiro security framework to achieve multi-dimensional control of user access and management permissions. User behaviors are also recorded by logs, and a database backup mechanism with automatic backup on different machines is adopted to reduce possible losses caused by various emergencies.

3) Performance requirements

The system is implemented with a layered architecture, which can well meet the requirements for system response speed. Meanwhile, the system considers optimized performance in servers load balancing and data caching to provide quick response to user operations, reduce server pressure and ensure data consistency and integrity.

4) Reusability requirements

This work adopts the idea of componentization. The front-end functional modules are encapsulated into reusable components.

5) Rapid development requirements

In the critical period of epidemic prevention and control, to ensure the smooth progress of anti-epidemic work, it is urgent to quickly grasp the health status of school members, and provide comprehensive and accurate data to support various tasks. The “IamOK” system uses the Spring Boot and JPA frameworks which are currently popular and mature for rapid development, and carries out related optimization designs.

III. SYSTEM STRUCTURE

The “IamOK” system adopts the J2EE architecture which is widely used for its good security and scalability. Layered design is adopted to reduce the coupling between various parts and improve the scalability and maintainability of the system. From bottom to top of the system is Data Access Object (DAO) Layer, Service Layer and Controller Layer. The JPA framework is used, including Spring Boot and JPA. Spring Boot completes the logic processing. The DAO layer implements the mapping between java entity classes and the database through JPA technology. The Tomcat plug-in embedded, which is easy to deploy and maintain, is used as a container to provide external Web services in Spring Boot. Redis caching technology is used to realize session sharing and data caching. It can improve system response speed and scalability. The front end adopts the progressive framework “vue” based on building the user interface and the component library element-ui, which can well realize the logic interaction between the browsing page and the background. Nginx is used to implement reverse proxy and load balancing. The system architecture is shown in Fig.1.

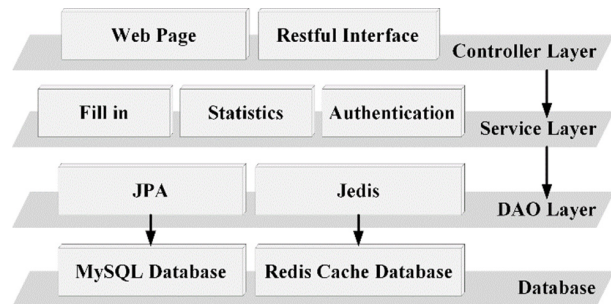


Figure 1. System Structure

IV. KEY TECHNOLOGY

A. Spring Boot

Traditional Spring projects require developers to write XML files and perform complicated configurations. In order to simplify the development process of Spring application development, configuration, debugging, deployment, and meet the needs of rapid development, this system adopts the Spring Boot framework. Spring Boot is a new framework provided by the team of Pivotal. Under the framework, developers can create a stand-alone Spring project through automated configuration [1], thereby improving development efficiency. In addition, the traditional Spring project can only be in the form of war and needs to be published in the Tomcat server. The Tomcat container is embedded in Spring Boot, and makes the project can be published in the form of jar or war, rather than deploying additional war files.

The Spring Boot framework is used in the system to build the background, which provides various functions such as user registration and login, personal information modifies, information report and personnel information statistics.

B. JPA

To realize the addition, deletion, and modification function of the database, reduce the amount of database code and improve development efficiency, this work uses Spring Data JPA to solve these problems. Spring Data JPA is a set of optimized JPA open source libraries developed by Spring [2-3]. The core interface of the JPA library is JPA Repository. By configuring pom.xml, a corresponding repository interface is created for each entity class. The establishment of a data access layer is very simple. You only need to define an interface that inherits JpaRepository. A lot of methods for adding, deleting, modifying, and querying database are defined in the interface. These methods can be called directly by declaring the corresponding method through the instance of the repository without writing SQL statements [2,4].

C. Redis caching

In the health status reporting system, students and faculties need to check in and report safety through the teacher-student reporting terminal every day. These data are submitted from the terminal to the server side, called "upload data". While the school management terminal needs to monitor and count various data, such as the increase or decrease of users or their information. The modification of the management terminal must also be synchronized to the personal terminal device, which is called "download data". Problems such as server congestion and data loss caused by large amounts of data upload may occur during the uploading and downloading of data on the both terminal. To address it, the Spring Boot framework combined with Redis caching is used to implement session sharing and data caching. This technology can reduce the pressure on the server and data loss, while improving the consistency and integrity of the data in the system.

Redis is a key-value storage system. It adapts to storage requirements in different scenarios through a variety of key-value data types. Since Redis is based on memory operations, the read and write speed of it is better than MySQL and other databases. Besides, it supports multiple data types, transaction processing, publish or subscribe and other features. Therefore, Redis is used in this work for data caching.

D. Vue and element-ui

This work adopts the method of separating the front and back ends. The front-end uses the Vue.js framework and component library element-ui to build a web-side teacher-student reporting platform and managers statistics platforms.

Vue.js [5] is a progressive JavaScript framework for building user interfaces. It provides a rich library of components, supports independent development, is simple to use and is easy to integrate with third-party libraries [6]. In the view layer of Vue, the built-in Vue template language realizes the separation of content and style, which is convenient for display and modification. At the same time, single-file components and related libraries are used to develop complex single-page applications [7]. Moreover, Vue.js uses virtual DOM to provide

responsive and componentized components. If the page is regarded as a component, the parent component and the child component establish communication through an interface. Components are oriented through routing, and communication between components is achieved by registering routing and then mounting on the page. Vue focuses on the core library, and other functions such as routing are handed over to related ones.

E. Nginx

The "IamOK" system needs to meet the high concurrency needs of the entire school's teachers and students. To prevent users from being unable to access server data during peak periods and improve access speed, the Nginx is used as a reverse proxy server to maintain optimal performance. It is a high-performance server that can provide both Web services (HTTP) and reverse proxy services [8]. Since the data returned by the server will be stored in the hard disk of the proxy server, the next time the user accesses the same server data, it will be read directly from the hard disk of the proxy server, which acts as a cache and improves the request speed.

F. HTTPS

The "IamOK" system uses the HTTPS protocol to ensure the security of data transmission. HTTPS is an HTTP channel targeting security. It guarantees the security of the transmission process through transmission encryption and identity authentication on the basis of HTTP. HTTPS adds an SSL layer on the basis of HTTP. The security foundation of HTTPS is SSL, so SSL is required for the details of encryption. HTTPS has a default port different from HTTP and an encryption or authentication layer (between HTTP and TCP), which provides authentication and encrypted communication methods. It is widely used in security-sensitive communications on the World Wide Web, such as transaction payments. This work is connected to the school's unified identity authentication system to avoid local storage of user passwords and ensure the security of identity authentication. The Apache Shiro security framework is used to implement multi-dimensional control of user access and management permissions. The "run log and operation log" method records the user's access records, submission records, and editing operations in detail, which is convenient for traceability and accountability. The database backup mechanism of automatic different machine backup can greatly reduce the losses that may be caused by various sudden accidents, such as user error, system failure and hardware failure.

V. FUNCTION TESTING

The "IamOK" system has been put into use after passing the test on the web and mobile. On February 5th, the No.10 document on combating new pneumonia "Notice on Online Reporting of Health Status (Students)" was issued which means the student-oriented "IamOK" system was officially launched. Within 24 hours, 90% of students reported in it. Four days later, the No.14 document "Notice on Carrying out Statistics on the Health Status of Faculty and Staff" showed that the "IamOK" system for faculties and retirees was launched. As of February, 23th, the reporting rate of all types of users exceeded 99%, providing valuable data support for the managers to fully grasp the health status, tourism, family visits and location changes of the users during the period.

The system interface and interaction with users are consistent with the requirements. The teacher-student reporting terminal interface and the school management terminal interface are shown in Fig.2 and Fig.3 respectively.

As of 13:00 on February 19th, the “IamOK” system had covered 42,322 students and 11,493 faculty members. It greatly reduced the intensity of the statistical work of the grassroots staff. Besides, it provides sufficient data preparation for teachers and students to return in batches. Through testing, the system can meet the access needs of 60,000 users under 800 concurrent requests.



Figure 2. User reporting terminal interface

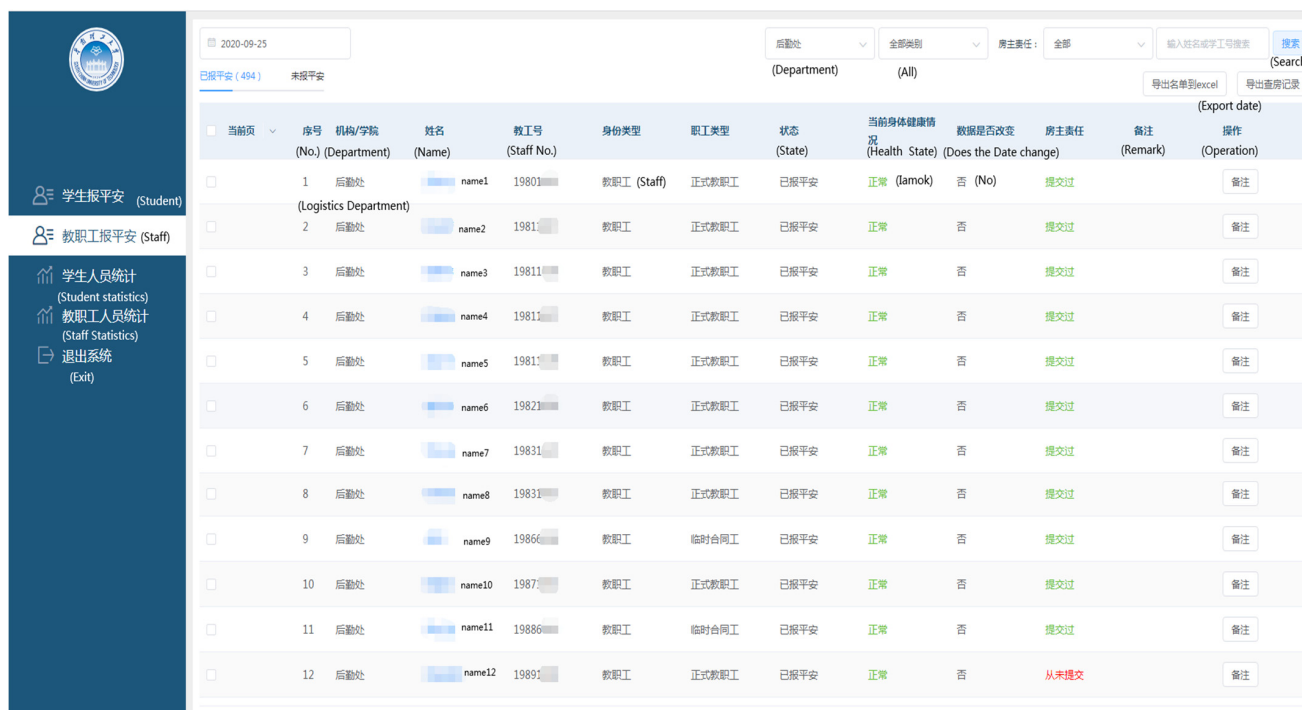


Figure 3. School management terminal interface

VI. CONCLUSION

This work adopts the technical concept of separation of front and back ends. The front end uses Vue.js technical framework and element-ui component library to build teacher-student and management interface. Besides, the Spring Boot and JPA frameworks are used on the server side to simplify development steps and quickly carry out background development. The automatic configuration function provided by it greatly

improves the efficiency of background development. JPA allows developers to easily access the data in the database by exposing the data interface to the front end. Redis caching technology greatly reduces the problem of server congestion, and the data consistency between the terminal and the server can reach more than 98% when the system is running. In addition, the system adopts Apache Shiro security framework, HTTPS protocol, encrypted communication and identity authentication to ensure system security. Log file, backup and other security mechanisms

are also adopted. Through online testing, the system has good security, accurate data control and wide statistical coverage. Moreover, it is good ease of use, and supports offline statistics and background import. Therefore, the “IamOK” system has been promoted in Guangdong universities during the Covid-19 epidemic prevention and control period.

REFERENCES

- [1] Shi Ming, Zeng Dan. School Recruitment Diary System Based on Vue.js and Spring Boot (in Chinese) [J]. Industrial Control Computer, 2020,33(01):95-97.
- [2] Craig Walls. Spring Boot in Action (in Chinese) [M]. Beijing: Posts and Telecom Press Co., 2016: 42-64, 200-207.
- [3] Wang Fuqiang. SpringBoot Unleashed: Microservices Quick Starter (in Chinese) [M]. Beijing: China Machine Press, 2016:120-140.
- [4] Wu Jian, Zheng Chao, Wang Jie. UML foundation and Rose modeling case (in Chinese) [M]. Beijing: Posts and Telecom Press Co., 2015: 57-69.
- [5] Li Ming, Hu J., Lin X.. The Development of Web Application Front-End of Intelligent Clinic Based on Vue.js[M]. Proceedings of 2019 Chinese Intelligent Automation Conference. 2020: 695-702.
- [6] Zhu Erhua. Research on Web Front-end Application Based on Vue.js (in Chinese) [J]. Science and Technology & Innovation, 2017(20): 119-121.
- [7] Chen Xu, Yang Hebiao. Design and implementation of medical insurance data visualization system (in Chinese) [J].Software Guide, 2017,16(06): 59-62.
- [8] Chen Long. Research on Load Balancing Problem Oriented to Service Quality (in Chinese) [D], Beijing: North China Electric Power University, 2017