Asian Games Service Intelligent System Based on Privacy-Preserving Recommendation

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Abstract. As the Hangzhou Asian Games is approaching, the research group has designed and implemented an intelligent system for Asian Games services with privacy-preserving recommendation system, aiming to solve the problem that people cannot obtain personalized Asian Games information. The system adopts Term Frequency Inverse Document Frequency (TF-IDF) and the privacy enhanced matrix factorization to realize the multi-criteria privacy-preserving recommendation. The system can meet the individuals' needs to obtain sports event information with the protection of user privacy. It improves the users' experiences, meanwhile, conduce to the spread of Hangzhou and the Asian Games.

Keywords: Asian Games · intelligent recommendation · privacy protection

1 Introduction

The 2008 Beijing Olympic Games was successfully held, which brought a wave of national sports. The continuous and stable development of China's economy and the increasing improvement of people's living standards have made people's material and spiritual life have a high pursuit [1]. And sports can just meet people's growing spiritual needs, which creates a strong atmosphere for the holding of large-scale comprehensive games. The rich content contained in large-scale comprehensive games is attractive to people. Sports meeting has gradually become the focus of people's close attention [2]. This was perfectly reflected in the Beijing Winter Olympics that just passed. According to statistics,

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the Beijing Winter Olympics has become the Winter Olympics with the highest ratings so far [3]. The enthusiasm of the domestic masses to participate in ice and snow sports is high, and the vision of "driving 300 million people to participate in ice and snow sports" has been successfully realized.

The large-scale comprehensive gamesalso playe a huge role in promoting the development of the economy, transportation, infrastructure construction, tourism and the transformation as well as upgrading of the industrial structure. The Guangzhou Asian Games has promoted the urban development of Guangzhou. The regional GDP brought by the Asian Games city investment is about 100 billion yuan, and the tertiary industry has also been fully developed, accounting for more than 60%. This makes Guangzhou's exhibition economy and modern service industry to flourish [4]. The Olympic venue, the Olympic Park during the Beijing Olympics, has now become a new urban public activity center. With convenient transportation and perfect infrastructure, it has attracted many tourists and promoted the development of tourism [5]. It is precisely the successful holding of these large-scale international multi-sport games, which provides a wealth of experience for Hangzhou to host the Asian Games.

Now, Hangzhou will usher in the 19th Asian Games in 2022, which is a rare opportunity for development in this century. As an ancient city with a long history and culture, it must use the stage of the Asian Games to show its unique charm. After the successful bid to host the Asian Games, the mayor of Hangzhou said that only with the participation and joint efforts of all the people can the concept of the Asian Games be truly practiced and an unforgettable Asian Games be held [6]. Hangzhou takes "China's New Era Hangzhou New Asian Games" as its orientation, "Chinese characteristics, Zhejiang style, Hangzhou charm, and splendidness" as its goal. The Hangzhou Asian Games is a historical choice and an inevitable development.

With the rapid development of modern technology, users can obtain information anytime and anywhere on smart devices such as smartphones and laptops [7]. Under the background of modern society with information explosion, the cost of acquiring information is gradually decreasing, even approaching zero indefinitely, but in the face of massive information, it is difficult to filter out the information we are interested in [8]. Information grows exponentially, but there is very little information that can meet users' needs [9]. When people receive too much repetitive information or information they don't want to read, the efficiency of the users' receiving information will be greatly reduced, and the users' experience will be very bad. Based on the above situation, how to extract and filter out the information that users are interested from the massive information has become an urgent problem to be solved by this research group.

2 System Design

2.1 The Proposition of the Intelligent System of Asian Games Service

With the arrival of the Hangzhou Asian Games, to reduce the ineffective dissemination of information about the Hangzhou Asian Games and serve the public, the research group designed an intelligent Asian Games service system that integrates intelligent recommendation, information, events and dynamics. The system not only uses an intelligent recommendation algorithm to avoid invalid information as much as possible, and greatly reduces the phenomenon of information waste, but also sets up functions such as navigation, dynamic sharing, and quiz, which comprehensively connects events and users, further shortens the distance between the public and the Asian Games and implements the concept of the Asian Games of "all people participating and benefiting the whole people".

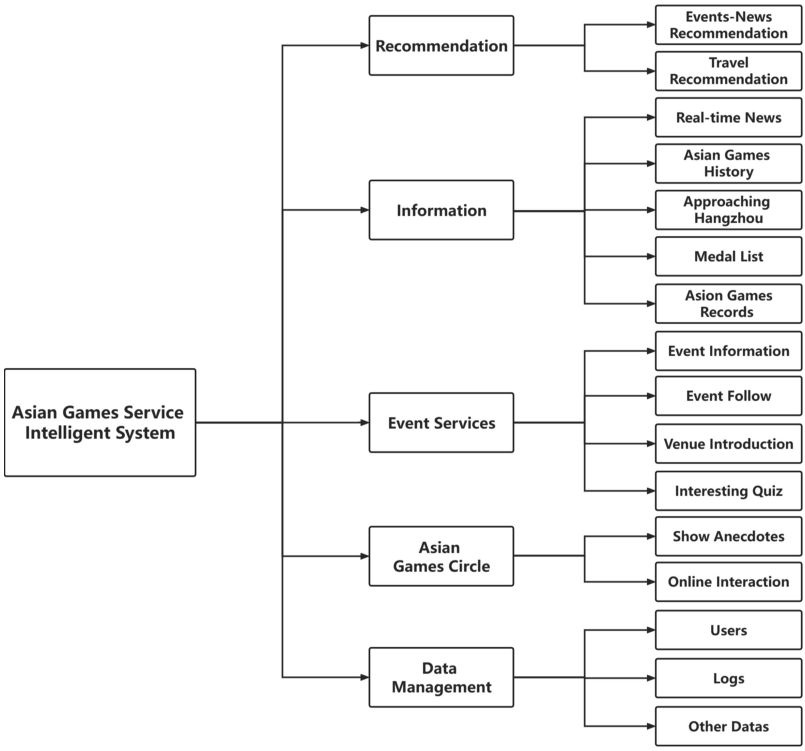

Fig. 1. Architecture

2.2 Architecture

The overall design of the Asian Games service intelligent recommendation system is shown in Fig. 1. The system consists of five modules: recommendation, information, event services, Asian Games circle, and data management.

2.3 Main Functional Modules

Recommendation. This module includes several functions such as events-news recommendation, travel recommendation (as shown in Fig. 2).

– Events-News recommendation: According to the tags of interest selected by the users and the users' browsing records, likes and collections and so on, the system provides privacy-preserving recommendation. Based on users' behaviors and news portraits, it realizes the recommendation of events and news while protecting the users' privacy.

Fig. 2. Events-News And Travel Recommendation

– Travel recommendation: The online map is introduced. Meanwhile, according to the users' geographic location, integrate elements such as time, distance, traffic mode, weather, recommend the optimal travel mode for the users.

Information. An information bulletin module that includes the news information of various Asian Games competitions, the history of the Asian Games, Hangzhou culture, and real-time medal standings.

- Real-time News: Push news of the games, post-game analysis, event introduction, off-court news during the Asian Games.
- Asian Games History: Introduce overview of each Asian Games since the first New Delhi Games.
- Approaching Hangzhou: Take users to "tour" Hangzhou, show Hangzhou's special food, cultural tourist attractions. Enjoy the profound cultural heritage and customs of Hangzhou.
- Medal List: Sort by the number of gold, silver and bronze medals of each country's national team, according to the number of gold medals as the main keyword, silver as the secondary keyword, and bronze as the third keyword.
- Asian Games Records: The Asian Games records of previous events, including the highest scores of the events that have been completed this year, with special notes on the events and results those broke records Fig.2 and Fig. 3.

Fig. 3. Home Page

Event Services. Focus on specific sports competitions and create the ultimate Asian Games feast for users.

- Event Information: Schedule information of all Asian Games competitions, including time, venues, participating teams, etc., and provide online viewing methods and channels.
- Venue Introduction: Details of the competition venue, including brief introduction, history, traffic information, and comprehensive introduction of the competitions or theatrical performances it has hosted.
- Interesting Quiz: Provide a platform to quiz the results of the game, and reward users with points for successful quizzes. When the points reach a certain value, they can get the corresponding title.

Asian Games Circle. Online communication and interaction platform, users can share the anecdotes around the Asian Games and publish their own news on the platform. At the same time, users can also like and comment on the dynamics posted by others, and express their own opinions.

Fig. 4. Asian Games Circle

Data Management. Manage system users and administrators control users' permissions and view users' logs. The system will intelligently detect abnormal risks and lock illegal users. The users can also change the interest items selected when logging in for the first time. At the same time, manage user-followed event information and favorite news, and remind users by means of message push one hour before the game starts to prevent users from missing the game.

3 System Technology

The system adopts the development mode of front-end and back-end separation, applies tools such as Android Studio and IntelliJ IDEA to realize them, and uses TF-IDF model and privacy enhanced matrix factorization to realize intelligent recommendation.

3.1 Client

Development Environment. Based on the Android system, the research group adopts native application, develops this system in the native environment and uses the Kotlin language to develop on Android Studio, which is efficient and fast. The native application runs based on the local operating system, so its compatibility and access capabilities are better. Meanwhile, it has the best users' experience, the best interactive interface, and the overall users' experience are good.

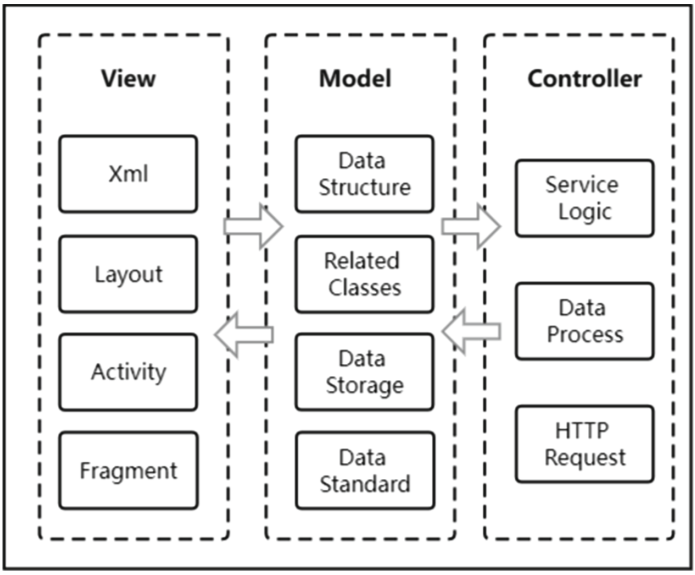

Fig. 5. Android Framework

Front-end. The research group selected the MVC (model-view-controller) framework as the main front-end framework, and used the method of separating the MVC framework function module and data module to organize the code. Among them, the view layer uses XML, Layout, Activity, Fragment and other files to describe the interface, and is responsible for displaying interface data and interacting with users. The model layer establishes relevant classes and data structures for business models, and realizes data storage and specification. The control layer mainly performs business logic, data processing, and network request work, as shown in Fig. 5. Using the MVC framework, the structure is concise, the division of responsibilities is clear, the degree of code differentiation is improved, and the degree of coupling is reduced,which is conducive to software engineering management [10].

3.2 Server

Development Environment. Using Java language as the main development language, IntelliJ IDEA as the main development tool, Tomcat as the web container, Postman as the interface calling tool, MySQL and Redis as the database cluster, and with Navicat Premium database management tool, you can easily and quickly Data transfer between various database systems makes it more convenient to manage different types of data such as tag data and users' information.

Back-end. This system is developed based on the Spring Boot framework and adopts the Spring Cloud microservice design concept. It realizes business decoupling and improve the efficiency of development and deployment. On the one hand, it uses the Hibernate framework to interact with the MySQL database, and implements data caching based on Redis to improve system interface performance. On the other hand, it builds a Swagger server to manage and control all APIs, update code, make API documents automatically update, improve the efficiency of developing and maintaining interfaces, use RESTful style to implement different CRUD operations, unify the interfaces for data operations, and implement standardized management ofAPIs.

3.3 Core Technology

Privacy-preserving Recommendation. In terms of recommendation algorithm, the research group uses Python language to implement functions. The TF-IDF model is built through the jieba Chinese word segmentation framework, and the words in the news are vectorized and given corresponding weights to extract news keywords. The research group built a multi-criteria privacy-preserving recommendation system, as shown in Fig. 6. The system calculates the users' comprehensive rating of the news based on the tags that the users are interested in, the news that the users have viewed, and the keywords corresponding to the news. The privacy-enhanced matrix decomposition algorithm

[11], which satisfies local differential privacy (LDP), is then used to factorize the users rating matrix into users profiles and news profiles while protecting users' privacy, enabling flexible and easily scalable recommendation prediction in multiple scenarios, such as home page news recommendation based on matrix completion, similar news recommendation based on news profiles, etc.

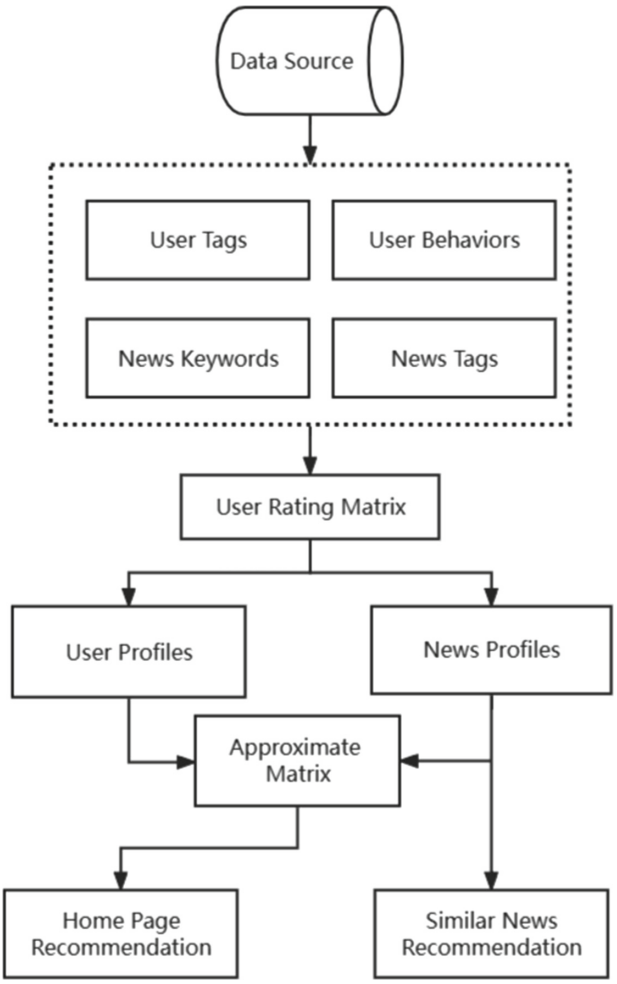

Fig. 6. Privacy Enhanced Matrix Factorization

User Security Verification. After the users log in successfully, the system will generate a Token for it based on the JWT, return this Token to the users, and store it in the database. When users want to access other pages, the Token will be carried, and the Token will be verified in the system. If the Token is not within the validity period or the Token is invalid, this access will fail. If the background verifies that Token is valid, and the corresponding users' identities are parsed through the Token, then the system will go to the database to obtain the corresponding permissions according to the users' identities, so that the API services that meet the identity permissions can be accessed. Users can access the APP within the validity period of the Token, and do not need to log in again. Every time you access the APP, the system will automatically refresh the validity period of the Token, and at the same time return the new Token to the users and store it in the database. When the token expires, the users need to re-enter the account password to log in. As shown in Fig. 7.

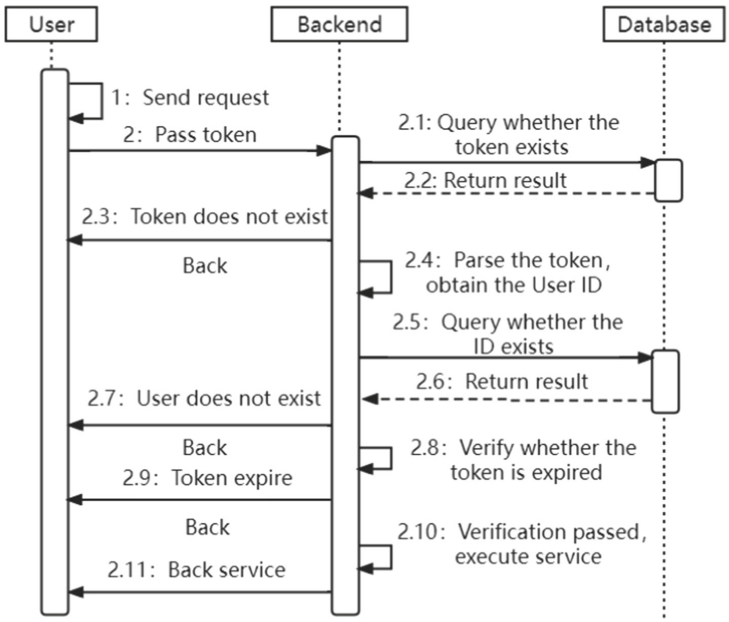

Fig. 7. Privacy Enhanced Matrix Factorization

4 System Features

4.1 Personalized Recommendations

Sports applications are combined with personalized recommendations. Among the 40 major items and 61 subitems of the Hangzhou Asian Games, users can actively select tags with different preferences, so that they can receive recommended content more in line with their personal preferences which help users to get the information they like quickly and efficiently. At the same time, the system will also give weights to each behavior according to the users' browsing records, hobbies, collections and other behaviors. Extracting keywords to label the news can display the keywords corresponding to the news in the recommendation results, which is helpful for users to understand the recommendation results. What's more, keywords have strong stability in capturing the interests of users, which is conducive to accurate recommendation and improves the degree of personalization.

4.2 Diversified Services

Compared with traditional sports applications, the intelligent recommendation system for Asian Games events not only pushes sports event information, but also adds several services about events such as "Approaching Hangzhou", "Asian Games Circle" and "Interesting Quiz" . These services have rendered the Asian Games a casual and cheerful atmosphere. The diversified users' experience are also convenient for faster integration into the Hangzhou Asian Games.

4.3 Privacy Protection

In the process of news recommendation, the system adopts an algorithm that satisfies LDP constraints, which effectively avoids inference attacks from adversaries, increases the difficulty for attackers to identify users' personal information, prevent the leakage of users' private data. What's more, the system has strengthened the protection of users' privacy, so that users can use the system with peace of mind.

5 Conclusion

The Asian Games service intelligence system with privacy-preserving recommendation adopts TF-IDF, privacy enhanced matrix factorization technologies. It's a new design idea for the mobile terminal design of the Hangzhou Asian Games. It effectively solves the problem that users cannot obtain valid information in the face of massive information, and strengthens the protection of users privacy. It is conducive to serve the Asian Games and promote the Asian Games and Hangzhou. However, the system at present still has certain limitations about cross-platform development compatibility and support and maintenance for all versions, and further optimization is required. It is believed that

with the unremitting efforts of the research group, the system will be continuously updated and improved, and finally presented to the public in a perfect manner.

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