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Research Article

Informatization of National Public Service Fitness in Constructing a Smart City Using Big Data

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The public service system of national fitness is the condition and guarantee for the public to participate in various fitness activities. In order to effectively integrate the existing national fitness service resources and to improve the efficiency of the public service supply, this paper aims to study the informatization of building national fitness public services in smart city under the background of big data. Firstly, we build a public service information platform of national fitness in the smart city, consisting of different modules, and then describe each module in detail. Secondly, we consider different types of fitness projects and establish the database structure model of network resources. Thirdly, we obtain the multitree cascade system of the national fitness and the heterogeneous data model of the national fitness benefit index by using high-dimensional statistical analysis method. Combined with the national fitness behavior, data mining, and support vector machine (SVM), the objective function of data mining statistical decision-making is established. Finally, the well-known particle swarm optimization (PSO) method is used to optimize the target parameters so as to realize the national fitness, big data mining, and feature analysis. The simulation results show that the proposed model has superior performance, as it can realize heterogeneous data mining of the national fitness benefit index. In addition, we quantitatively analyze the promoting effect of the national fitness on the physical quality and health level of the public.

1. Introduction

With the gradual development and progress of computer networks and information technology, the important concept of smart city supported by modern information technology and big data has emerged and has been widely used in many fields. Among them, the national fitness service is the main component of the health service system. The cause of national fitness is mainly for the public. It advocates scientific fitness so as to form a healthy lifestyle. It aims to enhance the physical quality of the public, serve the physical health of the public, and promote the development of the public. In fact, the main aim is to enrich the spiritual life of the public, promote the rapid development of the economy as well as society, and enhance the comprehensive strength of the country. Therefore, national fitness is mainly related to the physical and mental health and happy life of the public. It is an important symbol of comprehensive national strength and social civilization and progress. Overall, the national fitness is assumed an important part of building a well-off society. Vigorously advocating the development of national fitness and doing a good job of national fitness are of great and far-reaching strategic significance for improving the physical quality of the public. Subsequently, this may help in accelerating the reform and development of China's sports industry at a new starting point.

Similarly, vigorously developing national fitness and advocating the use of sports fitness activities to improve the physique of the whole people and the distance between national fitness and the public have gradually narrowed. Moreover, sports have gradually become an important part of the social public life, whereas the number of people participating in sports activities has gradually increased. In addition, the physical quality of the whole people has been significantly improved, and the level of physical health has been gradually improved. Besides, big data, Internet of

things, information technology, computer networks, and machine learning-based learning methods can be used to better explore this field of research. In order to effectively integrate the existing national fitness service resources and to improve the efficiency of the public service supply, this paper aims to study the informatization of building national fitness public services in smart city under the background of big data. We believe that this area of research has remained relatively less explored in the existing literature.

In this paper, we firstly build the public service information platform of national fitness in smart city under big data. Then, we introduce the major modules in the platform in detail and build the heterogeneous data model of the national fitness benefit index. Next, we optimize the target parameters by using the particle swarm optimization (PSO) method to realize the big data mining and feature analysis of national fitness. Our evaluation and experimental results demonstrate that the proposed method can effectively integrate the current national fitness service resources and improve the efficiency of public service supply. The major innovations of this paper are as follows:

(i) we build the public service information platform of national fitness in smart city under the big data environment

(ii) introduce the major modules in the platform in detail and build the heterogeneous data model of the national fitness benefit index in order to optimize the target parameters by using the particle swarm optimization (PSO) method and

(iii) we show that the proposed method can effectively integrate the current national fitness service resources and improve the efficiency of public service supply.

The remaining of the paper is organized as follows. In Section 2, state-of-the-art-related work is illustrated. In Section 3, we build a smart city public service information platform for national fitness that is based on the well-known particle swarm algorithm. A mathematical proof of the model is illustrated in Section 4. Implementation and results of the proposed model based on the particle swarm algorithm are discussed in Section 5. Finally, we conclude this study along with future research directions in Section 6.

2. Related Work

In recent years, the informatization construction of national fitness service in the construction of smart city has had a good start and development momentum. Local and regional national fitness guidance websites and platform systems have achieved some results, therefore making national fitness more convenient. Zhang et al. proposed a description algorithm based on the national fitness trajectory [1]. The extracted interest points form the fitness trajectory through the optical flow field. The movement change value is calculated, in detail, through the interest points of the national fitness trajectory. The calculation results are added to the calculation process of the description operator. On the data set of the national fitness service, the calculated value is used to judge the change in fitness information. The codebook is selected according to the change degree of fitness information. In addition, the national fitness data samples are classified, and the experiment is carried out on the deep exercise data set. The simulation results show that the description algorithm based on the national fitness trajectory information has stronger robustness and better performance than other methods, but this method does not improve the efficiency of service resource supply [1].

In order to improve the efficiency of the supply of public services for national fitness, Huang et al. proposed a neural network based on the combination of normalized neural network and neural network with long-term and short-term memory [2]. The normalized idea of the national fitness is introduced, and the fitness data samples, which are input into the network training, are normalized and sent to the long-term and short-term memory (LSTM) neural network. This method is through the national fitness service network model of space-time double flow. The fitness video image is used as the network input, and the fitness behavior recognition results obtained in the space-time dual flow network are weighted and fused. Finally, the recognition results of the national fitness service are obtained. The experimental results show that the spatiotemporal dual-flow neural network method designed in the literature can effectively improve the efficiency of the public services in national fitness behavior; however, the whole process is more complex and less useable [2].

In view of the poor resource integration of the current national fitness service, which leads to the problem of being unable to effectively identify the fitness action, Ma et al. put forward the recognition method of the national fitness behavior [3]. The authors adopted the improved fitness movement dense track and choose the fitness action video as the basic action sequence. Next, they encode its fitness action as the fitness action feature sequence of PA and use affine propagation to turn it into the index sequence. Based on the mining of the sequence patterns, the sequence models of different fitness behaviors are formed. Moreover, the models are efficiently studied, whereas the comparative features, matching features, and sequence set features of fitness service sequences are calculated to form the function of fitness action scoring. In fact, the linear discriminant analysis is introduced to classify and learn the fitness action scoring system so as to complete the fitness exercise recognition and experiment on the corresponding data set. The experimental results show that in the face of various fitness actions, the proposed method can effectively improve the accuracy of the fitness action recognition. Similarly, the model can effectively integrate the national fitness resources, but the supply efficiency of fitness public services is low [3].

Li et al. proposed a model along with the rapid development of various microelectronic technologies, and through the information construction of public fitness services for all, the proposed model is of great significance to the physical quality of the public [4]. In order to investigate that how to improve the integration of service resources and considering the characteristics of fitness mode, the authors

proposed a human fitness mode recognition method based on the CNN and Mogrifier LSTM models. The recognition of human fitness mode mainly extracts the relevant features of the original fitness data through the CNN approach, while Mogrifier LSTM is used to replace the full connection layer, mine the dependence of local relevant features, and identify common fitness actions such as walking and running in fitness. Experimental evaluation shows that compared with some other methods, the recognition accuracy of the proposed method has increased significantly, which also proves the superiority of the CNN algorithm; however, there are also complex processes that reduce the integration of national fitness resources [4].

3. Smart City Public Service Information Platform for National Fitness

The main purpose of the national fitness public service information platform is to activate users in the national fitness service platform in the form of platform points. Users can use different fitness operations on the platform to obtain points and share points with each other. After obtaining points, users can consume them on the fitness service platform. The point consumption can also be used to exchange for other value-added services. Figure 1 shows the relevant contents on the national fitness public service platform [5, 6]. Various modules of the platform are discussed in subsequent subsections.

3.1. Personnel Analysis. The relevant personnel who establish the public service platform for national fitness include (i) athletes, (ii) fitness coaches, and (iii) referees. Figure 2 shows the personnel analysis of the national fitness service platform. On this fitness service platform, the public can search relevant information such as fitness venues, fitness equipment, and activity equipment. Relevant personnel on the service platform use the service to obtain points, which can be consumed after superposition [7, 8].

The main data of the national fitness users include users' basic data such as name, gender, height, and weight.

3.2. Site Analysis. The venues of the national fitness public service platform include common public venues (such as parks, badminton halls, and other fee-paying sports venues), and semiopen venues mainly include school sports venues or sports venues built by enterprises. Figure 3 shows the analysis model of public service venues for the national fitness [9, 10].

The national fitness service information platform collects the venue data including the type and charging standard of the venue as well as the time period of use of the sports venue. Moreover, it displays these data according to the venue category, quantity, and venue type and records the resource data of the sports venue and the venue to the fitness service platform for unified management [11, 12].

3.3. Platform Content Analysis. The operation content of the national fitness service information platform is ecological services and value-added services including (i) the leasing of fitness equipment, (ii) the purchase of fitness equipment, (iii) the introduction of sports items as well as routine sports training, and (iv) various event performance activities. Figure 4 shows the key contents of the informatization construction of the public services for national fitness.

3.4. Planning Platform. The main contents of the information platform construction of the national fitness service in smart city are small programs and official account terminals. After the completion of the fitness service platform, the front end contains multiple modules such as sports columns, events, and personal centers, and the back end includes different modules such as the management of system architecture, the management of authority, and the management of venues [13, 14]. Figure 5 shows the overall planning content of the platform construction.

4. Informatization of the National Fitness Public Service under Big Data

4.1. Mathematical Model Construction of National Fitness Benefit Index Mining. Combined with the above construction of the national fitness public service information platform of the smart city, the mathematical model of national fitness benefit index mining is established in this section. In order to master the improvement degree of physical function of different groups by national fitness exercise, we realize big data mining in order to establish a mathematical model for the index of national fitness benefit. The proposed model ensures to increase endurance, improve coordination, control the ability of different parts of the body, and make the public strong [15, 16]. In the establishment of the mathematical model, different types of fitness items are comprehensively considered, and the vector of positioning state estimation of the data target position is expressed using the following formula:

$$\alpha = (\alpha_1, \alpha_2, \ldots, \alpha_n) \neq 0. \tag{1}$$

According to the goal of the national fitness plan, the heterogeneous data of the diversified national fitness benefit index are provided to different servers. When scheduling the heterogeneous data information resources of the national fitness benefit index, $s_j^{(k)}$ represents the linear input of the system and $y_j^{(k)}$ represents the reversible invariance output, which is expressed through the following equation:

$$\begin{aligned} x^{(k)} &= \left[x_1^{(k)}, x_2^{(k)}, \ldots x_{N_{k-1}}^{(k)}\right]^T, \\ s^{(k)} &= \left[s_1^{(k)}, s_2^{(k)}, \ldots s_{N_k}^{(k)}\right]^T, \\ y^{(k)} &= \left[y_1^{(k)}, y_2^{(k)}, \ldots y_{N_k}^{(k)}\right]^T. \end{aligned} \tag{2}$$

Then, under national fitness, we investigate the time-frequency characteristics of cardiopulmonary function data and use the characteristics as the medium to portray the

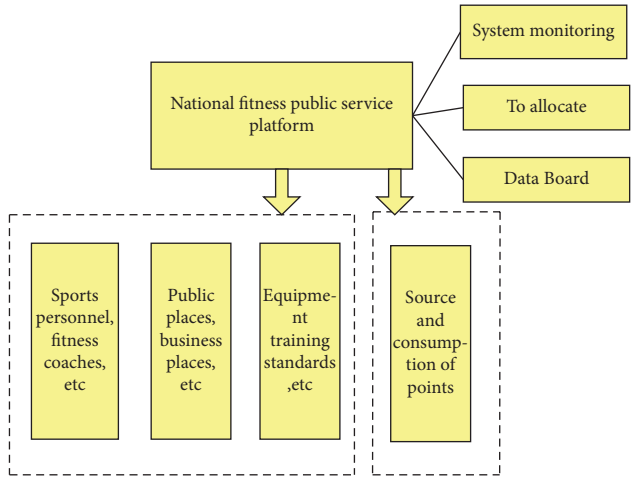

Figure 1: Main contents of the national fitness public service platform.

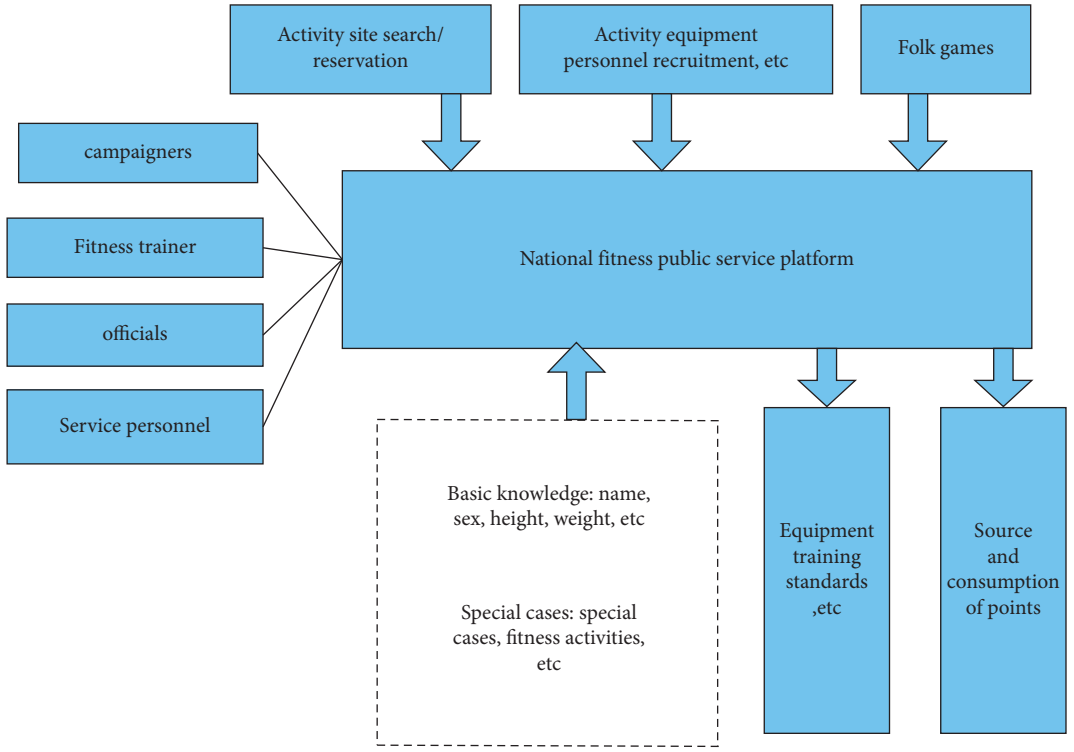

Figure 2: Personnel analysis of national fitness public service platform.

cardiopulmonary function data's original features. Assuming that the data range is N discrete points, $A = \{a_1, \ldots, a_N\}$, the national fitness benefit index's average time is computed as follows:

$$t_m = \frac{1}{G_x} t|x(t)|^2. \tag{3}$$

The mean value of the frequency is expressed as illustrated by the following formula:

$$v_m = \frac{1}{G_x} v|x(v)|^2. \tag{4}$$

From the above formula, the index system of the national fitness benefit based on the linear model or equivalent approximate linear model is obtained.

Based on the data investigation and data sample collection, the detailed promotion relationship between national fitness training and the social public health benefit index is analyzed; meanwhile, the improvement degree of national fitness training on different physical functions is also grasped [17, 18]. Based on multivariate statistical analysis and PCA analysis method, the storage structure fractal of the national fitness benefit index is carried out. The

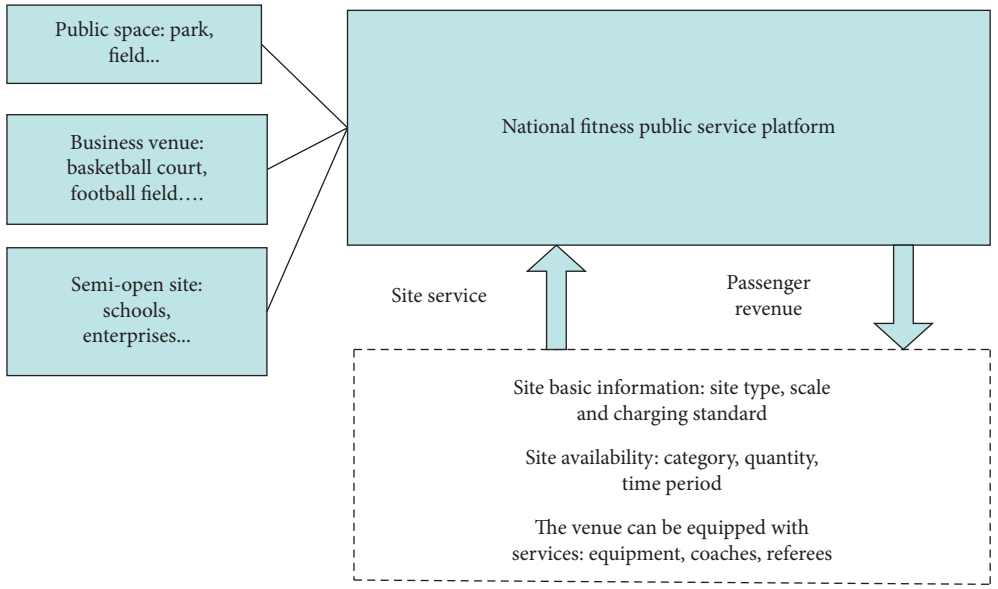

Figure 3: Site analysis of national fitness public service platform.

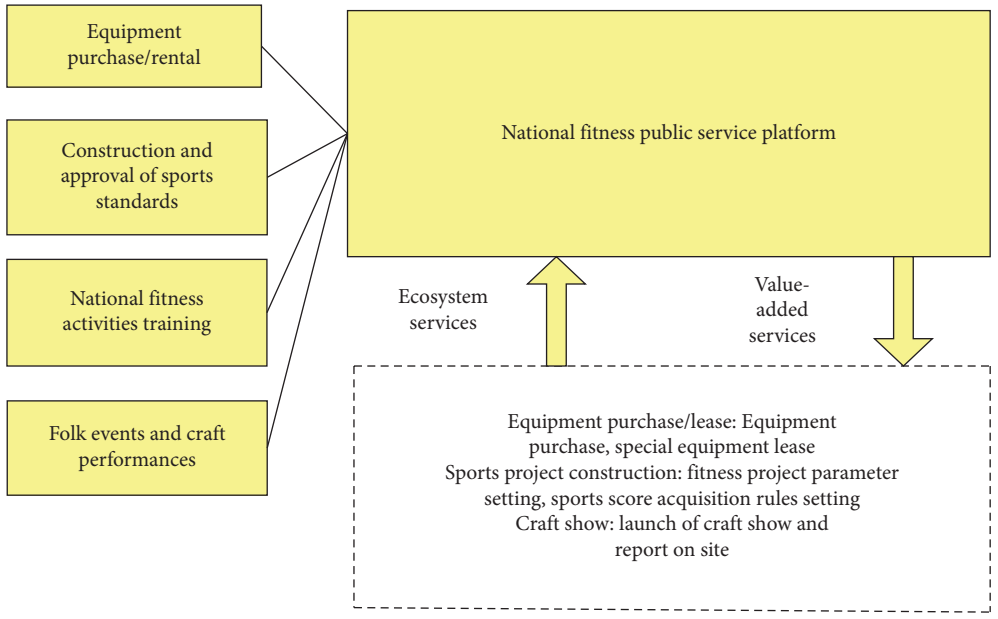

Figure 4: Content analysis of the national fitness public service platform.

matrix C for calculating the covariance of the information storage structure of the fitness benefit index is expressed as

$$C = \frac{1}{N}[X - \overline{X}_l][X - \overline{X}_l]^T. \tag{5}$$

Subsequently, we build a nonlinear dynamic system to fit the impact factors and complete the fitting of the index parameters of the national fitness benefit index. The fitting model can be expressed as

$$\begin{aligned} Z_\beta X &= C\left\{F \in \frac{U}{R} | c(F, X) \le \beta\right\}, \\ Z_\beta X &= U\left\{F \in \frac{U}{R} | c(F, X) \le 1 - \beta\right\}. \end{aligned} \tag{6}$$

This should be noted that the number of principal components must be chosen based on the degree of cumulative variance contribution, and the group of universal impact factors must be included. The relevant principal components m can be utilized as the main components to be selected when the cumulative contribution rate exceeds a particular quantity. It provides a resource database for achieving the heterogeneous data mining model of the national fitness benefit index using the aforesaid fractal design.

4.2. Analysis Model of Fitness Behavior Characteristics Based on Data Mining. Combined with the national fitness benefit index model constructed above, the support vector machine

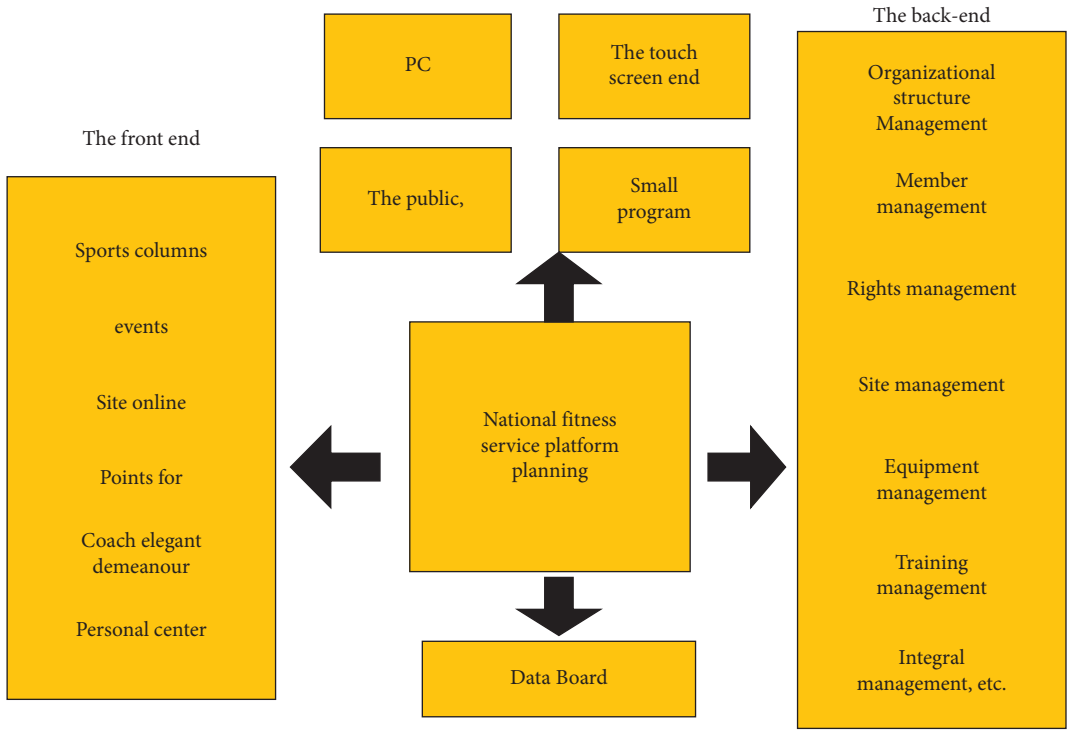

Figure 5: Overall planning of the national fitness platform construction.

(SVM) of the particle swarm optimization (PSO) is used to mine the information of big data of fitness behavior. The process of particle swarm flight is expressed as follows:

$$\begin{cases} v_t = wv_{t-1} + c_1 \text{rand}_1 \cdot (P_{\text{best}} - x_{t-1}) + c_2 \text{rand}_2 \cdot (g_{\text{best}} - x_{t-1}), \\ x_t = x_{t-1} + v_t. \end{cases} \tag{7}$$

In formula (7), v_t represents the running speed of the fitness behavior particles, x_t represents the fitness value of particles, c_1 and c_2 represent the optimal learning operator, and rand_1 and rand_2 represent the random number between $[0, 1]$, respectively. The objective function of constructing the statistical decision-making of the national fitness behavior data mining is expressed as given by the following formula:

$$\begin{cases} x_{i\,d}^{t+1} = \omega x_{i\,d}^{t} + c_1 r_1 \left(P_{a\,d} - x_{i\,d}^{t}\right) + c_2 r_2 \left(P_{g\,d} - x_{i\,d}^{t}\right), \\ P_{a\,d} = \dfrac{1}{m} \sum_{i=1}^{m} P_{i\,d}. \end{cases} \tag{8}$$

In formula (8), $P_{a\,d}$ represents the average value of the individual optimal position of the particle swarm.

The specific individual extreme value P_{best} of the fitness behavior is obtained by using the weighting technique of inertia weight (perhaps the dynamic), and the objective function of the population fitness is premeditated to enhance and improve the parameters values of the objective function of data mining. Therefore, the iterative formula for the particle swarm crossover and mutation is expressed as follows:

$$l_i(k) = (1 - \rho) l_i(k - 1) + \gamma f_i P_i(k). \tag{9}$$

In formula (9), $P_i(k)$ characterizes the movement probability of the i particle at a particular time k, and f_i characterizes the function of X_i which is an error back-propagation. Under the constraints and limitations of the convergence conditions, the optimization procedure of the particle swarm optimization crossover is updated according to the following formula:

$$\begin{cases} v_{i\,d}^{i+1} = \omega v_{i\,d}^{i} + c_1 r_1 \left(P_{i\,d} - x_{i\,d}^{i}\right) + c_2 r_2 \left(P_{g\,d} - x_{i\,d}^{i}\right), \\ x_{i\,d}^{i+1} = x_{i\,d}^{i} + v_{i\,d}^{i+1}. \end{cases} \tag{10}$$

By solving the above optimization problem in the variation process through the data characteristics, we can mine the national fitness behavior data, decompose the fitness behavior characteristics of all particles and fitness functions, and then calculate the state function of the fitness behavior data distribution. Through the stability functional, we can get

$$\min_{Q} \frac{1}{2} \left\| Q|_{\Omega} - P|_{\Omega} \right\|_F^2 + \mu \|Q\|. \tag{11}$$

We adjust the μ value to boost and improve the fitness of public service behavior of national fitness. Moreover, this should be noted that the selection of μ value must meet the following requirements:

$$\left\| Q|_{\Omega} - P|_{\Omega} \right\|_F^2 \approx \mu(\Omega)\sigma^2. \tag{12}$$

Suppose $\mu = (\sqrt{n_1} + \sqrt{n_2})\sqrt{p}$ and n_1 and n_2 are the parameters of the global optimization problem of the fitness

behavior, which characterizes the total quantity of the particle swarm in the data mining training of the national fitness behavior. This should be noted that the optimal value of the fitness behavior data mining is searched in a d-dimensional space. In carrying out the above procedure, the search step of each gradient descent direction could be achieved by using the updated iterative data of the particle swarm optimization, which can be expressed as illustrated in the following formula:

$$\operatorname{dist}(i,j) = \sqrt{\sum_{k=1}^{d}\left(x_{ik}-x_{jk}\right)^2 + \left(f\left(X_i\right)-f\left(X_j\right)\right)^2}. \tag{13}$$

Considering the global optimization of the national fitness $\min\{f(x)\}$, then the fitness rate of the national fitness behavior data mining is expressed as

$$\operatorname{Mdist}F_g = \frac{\sum_{i=1}^{N}\operatorname{dist}\left(i,F_g\right)}{N}. \tag{14}$$

Next, we set the threshold of particle swarm to ξ. Note that when the global optimum (i.e., the optimal value) is not altered in the exact time during the search process, then the moving step S can be used to determine the distinct values (optimal) with the smallest fitness. This should be kept in mind that the position of the i particle at time $k+1$ is expressed with the following formula (18):

$$x_i(k+1) = x_i(k) + s\left(\frac{x_j(k)-x_i(k)}{\left\|x_j(k)-x_i(k)\right\|}\right). \tag{15}$$

During the subsequent process, we input the weight and use the fitness function to assess and determine the particle mean square error (MSE). The calculation expression of the national fitness information data mining error is as follows:

$$\begin{aligned} E &= \sum_{j=1}^{q}\frac{E_j}{(q*k)}, \\ E_j &= \sum_{k}\varepsilon_k^2 = \sum_{k}\left(d_k-c_k\right)^2. \end{aligned} \tag{16}$$

In the above formula (16), q characterizes the total quantity of the input samples of national fitness data, ε_k represents the data mining distribution position vector of the national fitness behavior, and d_k represents the optimal (individual) and the global optimal extremum of the productivity layer, respectively. During the entire process of the iterative search, the weight of each particle can be calculated through adjusting the individual optimization and global optimization.

$$w_k^i = w_{k-1}^i\frac{p\left(z_k/x_k^i\right)p\left(x_k^i/x_{k-1}^i\right)}{q\left(x_k^i/x_{k-1}^i\right)}. \tag{17}$$

The particle swarm optimization (PSO) method is, therefore, adopted in order to enhance and boost the national fitness mining objective function and its associated parameters so as to precisely analyze and mine the big data of national fitness behavior. The characteristic function is expressed as

$$r = \frac{M^{-1}\sum_i j_i k_i - \left[M^{-1}\sum_i 1/2\left(j_i+k_i\right)\right]^2}{M^{-1}\sum_i 1/2\left(j_i^2+k_i^2\right) - \left[M^{-1}\sum_i 1/2\left(j_i+k_i\right)\right]^2}. \tag{18}$$

Finally, we analyze the static features of the data mining for national fitness behavior features and obtain the vector of particle velocity and the optimal (individual) position according to the particle optimization, which are expressed as

$$P = \min\left\{\sum_{i=1}^{\xi}P_i, 1\right\} = [x(n), x(n-1), \ldots, x(n-L+1)]^T. \tag{19}$$

From the above discussion, it is concluded that the process of data mining of the national fitness behavior characteristics is

$$\min\left(w,\xi,\xi^*\right) = X\frac{1}{2}\|w\|^2 + YC\sum_{i=1}^{n}\left(\xi_1+\xi_i^*\right). \tag{20}$$

$$\text{s.t. } H_i(z)\begin{cases} y_i - w^T\Phi(x) - b \le \varepsilon + \xi_i^*, \\ -y_i - w^T\Phi(x) + b \le \varepsilon + \xi_i, \\ \xi_i^*, \xi_i \ge 0. \end{cases} \tag{21}$$

In formulas (20) and (21), X represents the updated balance factor of the particle swarm (algorithm), Y represents the data mining load, and $H_i(z)$ represents the decision function with fuzzy data distribution of national fitness behavior characteristics, respectively [19, 20]. The above process completes the research on the informatization of national fitness public service in the construction of smart city [21].

5. Analysis of the Experimental Results

In order to verify the superior performance of information resource integration of national fitness public services and improve supply efficiency in the construction of smart city under big data, several simulation experiments were carried out. In the simulation experiment, the population of national fitness accounts for more than 30% of the total population, of which 60% of urban residents participate in the fitness activities in different types of sports clubs. The heterogeneous data mining test of the national fitness benefit index includes more than ten sports fitness projects, with a total of 500 fitness college students. Table 1 shows the experimental environment, system configuration, and experimental parameters along with hardware and software tools. Table 2 shows the time of national fitness behavior data mining between the proposed method and the traditional method.

It can be perceived from the detail shown in Table 2 that the data mining time of national fitness behavior data by using the method proposed in this paper is considerably faster than that by using the traditional method. Therefore, it shows that using this method can adaptively adjust the

Table 1: Description of the experimental environment and parameters.

Project	Parameter description and system settings
Node	One management node and 19 computing nodes
The operating system	Windows 7
The simulation environment	MATLAB 2017
The CPU mode	Automatically adjust CPU frequency based on task
The PC configuration	Intel(R)i5-2450M

Table 2: Time of national fitness behavior data mining using different methods.

Different methods for	Mining time/s
Method in this paper	70 s
The traditional method	110 s

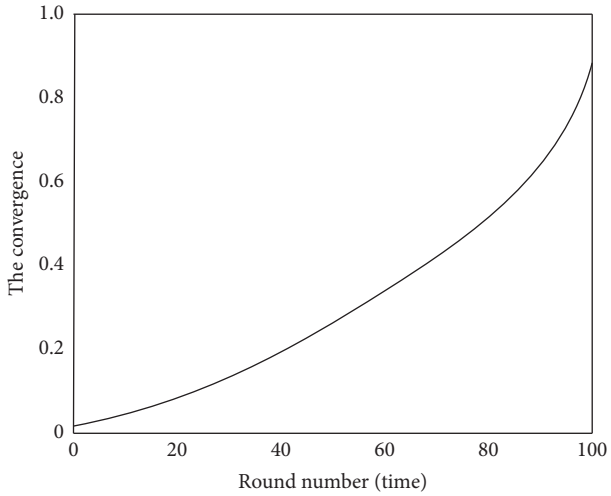

Figure 6: Convergence curve of the data mining algorithm.

Table 3: Overall performance of the data mining under different methods.

Different methods	Accuracy/%	Error rate/%	Reliability/%
Method in this paper	98	0.1	71
The traditional method	80	0.5	97

weight and realize the adaptive convergence of the data mining and big data. The convergence curve of the data mining algorithm is shown in Figure 6. Table 3 shows the overall performance, in terms of accuracy, error rate, and reliability, of the data mining under different methods.

Based on the analysis of Table 3 and Figure 6, using the heterogeneous data mining of the national fitness benefit index, we can get the relationship model of the promotion for the national fitness sports training on the social public health benefit index and master the improvement degree of the national fitness sports on the physical function of different groups. The accuracy and robustness of the data mining are also higher than other competing approaches. Figure 7 shows the comparison of the supply efficiency of public services for national fitness between the method, proposed in this paper, and other state-of-the-art methods proposed in the literature [1, 2].

By analyzing Figure 7, it can be seen that with the increase of data, the supply efficiency of the national fitness service proposed in [1] fluctuates significantly less and has been low. Moreover, the supply efficiency curve of the method proposed in [2] fluctuates more and is higher than that of the method proposed in [1]; however, the overall supply efficiency of the national fitness service is still lower than that of the method proposed in this paper. This shows that the method proposed in this paper can effectively integrate the current national fitness service resources and has good application value.

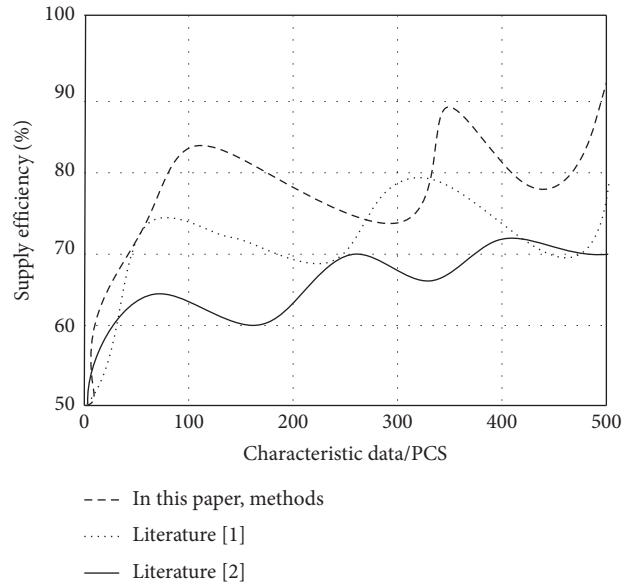

Figure 7: Efficiency of the national fitness service supply using different methods.

6. Conclusions and Future Work

In this paper, we firstly, developed a public service information platform of national fitness in smart city under big data. Then, we introduced the major modules in the platform in detail and proposed the heterogeneous data model of the national fitness benefit index. Next, we optimized the target parameters by using the particle swarm optimization (PSO) method to realize the big data mining and feature analysis of national fitness. Through evaluation and experimental results, we demonstrated that the proposed method can effectively integrate the current national fitness service resources and improve the efficiency of public service supply. Smart city construction under the big data is both an opportunity and a challenge. Through this opportunity, we will vigorously develop the cause of national fitness so that the public can obtain diversified and scientific information on national fitness public services. The national fitness informatization is the main support for constructing a hale and hearty country and an important prerequisite for the public to hanker for a healthier life.

No matter how smart cities will be built and developed, in the future, national fitness is a significant support for constructing a hale and hearty China and an inexorable prerequisite for the people to hanker for an improved and healthier life. The informatization of public service for national fitness must seize the opportunity and should not be limited to independent development but also integrate with different fields. In the future, with the support of the information technology, we will promote the informatization construction of public services for national fitness. In doing so, the government will play its leading role, increase capital investment, innovate development mode, improve service supply efficiency, and effectively improve the public service mechanism for national fitness. We will also investigate machine learning and other state-of-the-art technologies like Internet of things, edge computing methods, and their integration in the proposed method in order to increase accuracy and reliability.

Data Availability

Data are available on request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest in this work.

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