Research Article

A Spatial Spectrum Estimation Method for Optimization and Improvement of Resource Allocation and Management of Public Sport and Health Facilities

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Received 30 March 2022; Revised 4 May 2022; Accepted 10 May 2022; Published 13 June 2022

Academic Editor: Hye-jin Kim

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With the improvement of people’s health awareness, the state increases the construction of public sport facilities, which complicates the allocation and management of resources. The existing spatial spectrum estimation method cannot eliminate the relevant interference data, resulting in duplicate data in the results of resource allocation and management, reducing the accuracy of resource allocation and management. In order to optimize the allocation and management of public sport facilities resources, this study proposes a spatial spectrum estimation method, which is used to deeply tap the potential information in public sport facilities resources and optimize the allocation and management. First, analyze the resources of public sport facilities and put forward the feature vector of allocation and management optimization. Then, use the spatial spectrum estimation method to learn the test samples, get the optimal threshold and weight, and build the resource allocation and management model of public sport facilities. Finally, the accuracy of spatial spectrum estimation method is 98% and the variation range is (0, 10), which is better than the accuracy of the original algorithm is 80% and the variation range is (0, 20). Moreover, change of the spatial spectrum estimation method is smoother, and the correlation between various analyses is better. In unit time, the amount of configuration and management data of spatial spectrum estimation method is higher than that of existing algorithms, which indirectly indicate that the configuration and management time of the spatial spectrum estimation method is short. At the same time, unstructured data account for a large proportion of the data tested this time. Therefore, the accuracy and variation range of the spatial spectrum estimation method is good, which is suitable for the construction of public sport facilities and realizes the optimization of resource allocation and management.

1. Introduction

By the end of 2021, as reported by Zhao et al. [1], China’s provinces and cities will increase public sport facilities, with a facility coverage rate of 23.4%, which can serve 478 million urban and rural residents [2], indicating that the allocation and management of public sport facilities resources is the key issue of public health. When the local government manages the resources of public sport facilities, it will produce a large amount of management information data and consume a lot of human, material, and financial resources. Spectrum estimation, spatial allocation, and management of public sport facilities resources can delete duplicate management information [3] and not only save resource allocation and management costs but also improve the utilization rate of public sport facilities resources and improve the management accuracy of users. Therefore, it has a certain theoretical significance and practical value to optimize the allocation and management of public sport facilities resources of government and health institutions [4]. Domestic literature on resource allocation and management optimization of public sport facilities has increased year by year, and the results are given in Table 1.

In recent years, some scholars have analyzed the allocation and management of public sport facilities resources, combined with the characteristics of public sport facilities resources, mined the data characteristics of customers by Python and the spatial spectrum estimation method, and put
public sport facilities. Comprehensive analysis of data and reduce the error analysis then carries out a detailed analysis, which can realize information method first carries out spatial classification and location of resources but also improve the management level of public sport facilities [12]. Therefore, using the spatial spectrum estimation method can reduce the data dispersion and improve the accuracy of resource allocation and management results of public sport facilities resource management [9] and found that classifying public sport facilities resources can improve the resource allocation and management level of public sport facilities [8]. Some scholars also integrated Fourier series and discrete function into allocation and management and found that this method can improve the resource allocation and management level of public sport facilities [7]. Some scholars combined the k-clustering method with the spatial spectrum estimation method to analyze the allocation and management factors and found that this method can improve the resource allocation and management level of public sport facilities [5]. Scholars also use the clustering method to estimate the spatial distribution and management of public facilities and reduce the dispersion of sport resources [6]. However, when monitoring the resources of public sport facilities, it is found that the calculation accuracy of the spatial spectrum estimation method is negatively correlated with the amount of information and data, which cannot meet the accuracy requirements of public sport facilities resource management and increase the occupation rate of public resources [7]. Some scholars combined the k-clustering method with the spatial spectrum estimation method to analyze the allocation and management factors and found that this method can improve the resource allocation and management level of public sport facilities [8]. Some scholars also integrated Fourier series and discrete function into allocation and management and found that this method can improve the resource allocation and management level of public sport facilities [7].

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### Table 1: Research on resource allocation and management of public sport facilities.

| Time | Number of documents | Growth ratio |
|------|---------------------|--------------|
| 2013 | 595.56              | —            |
| 2014 | 630.00              | 5.78         |
| 2015 | 654.44              | 3.88         |
| 2016 | 676.67              | 3.40         |
| 2017 | 733.33              | 8.37         |
| 2018 | 746.67              | 1.82         |
| 2019 | 913.33              | 22.32        |
| 2020 | 964.44              | 5.60         |
| 2021 | 990.00              | 2.65         |
| 2022 | 1094.44             | 10.55        |

The data come from well-known databases such as HowNet, SCI, and CSCI.

forward the optimization algorithm for the allocation and management of public sport facilities resources [5]. Scholars also use the clustering method to estimate the spatial distribution and management of public facilities and reduce the dispersion of sport resources [6]. However, when monitoring the resources of public sport facilities, it is found that the calculation accuracy of the spatial spectrum estimation method is negatively correlated with the amount of information and data, which cannot meet the accuracy requirements of public sport facilities resource management and increase the occupation rate of public resources [7]. Some scholars combined the k-clustering method with the spatial spectrum estimation method to analyze the allocation and management factors and found that this method can improve the resource allocation and management level of public sport facilities [8]. Some scholars also integrated Fourier series and discrete function into allocation and management and found that this method can improve the resource allocation and management level of public sport facilities [7]. Some scholars combined the k-clustering method with the spatial spectrum estimation method to analyze the allocation and management factors and found that this method can improve the resource allocation and management level of public sport facilities [8]. Some scholars also integrated Fourier series and discrete function into allocation and management and found that this method can improve the resource allocation and management level of public sport facilities [7].

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2. Description of Resource Allocation and Management of Public Sport Facilities

In the process of public sport facility resource management, it is assumed that the configuration and management set \( G = (n, e) \), \( N \) represents the node set of any public sport facility resource, and \( E \) represents the association number set in the public sport facility resource. Any public sport facility resource \( N \) is composed of \( n \) node spaces, which can also be expressed \( N = \{n_1, \ldots, n_n\} \) as belonging to any natural number [16]. \( E \) is composed of \( m \) associations, which can be expressed \( E = \{e_1, \ldots, e_m\} \) and \( n \) \( M \) belongs to any natural number. If the government and health institutions want to allocate and manage the resources of public sport facilities [17], they need to judge the relationship between the resources of public sport facilities and the management unit. The judgment contents are node management and association management. Suppose the management unit \( G_q = (N_q, E_q) \), where \( N_q \) represents the set of nodes configured with the management unit in the server and \( E_q \) represents the set of association numbers in the server management unit [18]. Therefore, the relationship between management unit and public sport facility resources is

\[
Q(N \rightarrow N_q \sum E \rightarrow E_q) = \sum Jaro(N \rightarrow N_q \sum E \rightarrow E_q).
\]

(1)

Among them, the constrained Jaro algorithm is to calculate the similarity of any facility resources, \( \omega \) is the correlation coefficient between public sport facility resources and public health, and \( \sigma \) is the correlation management coefficient [19], which represents the requirements of public health. In order to better allocate and manage the resources of public sport facilities, it is necessary to construct the resource matrix \( H \) of public sport facilities and calculate its eigenvalue, which represents the best value of resource allocation and management [20]. Among them, public sport facilities resource matrix \( H \) is a multiorder matrix of spatial spectrum estimation, as shown in the following formula.
\[ H = \sum_{k=1}^{n} \left( \theta_{11} \cdot \sum P_{11} \cdots \theta_{1n} \cdot \sum P_{1n} \right)^k \]  

(2)

In formula (2), \( \theta_{ij} \) represents the relationship between sport infrastructure and uncertain factors in various regions, and \( p_{ij} \) is the result of the Jaro algorithm to judge the similarity between \( n_i \) public sport facility resources and \( NP \) public sport facility resources \([22]\). The higher the similarity, the lower the level of resource allocation and management, and corresponding optimization is needed. According to formula (2), there are \( n \) fields between two sport facilities, \( P_i \) is the eigenvalue between \( p_{ij} \) and \( p_{ij+1} \), and the similarity space of all fields is \( F \), as shown in the following formula.

\[ F = \begin{bmatrix} (P_1, \ldots, P_n) \\ P_1 = \left[ \begin{array}{cc} p_{ij} & p_{ij+1} \\ p_{ij+1} & p_{ij+1} \end{array} \right] \end{bmatrix}. \]  

(3)

3. Resource Allocation and Management

Algorithm Analysis of Public Sport Facilities

The spatial spectrum estimation method first classifies the data, removes irrelevant data, then gives the data permit, and analyzes the data according to the permission, so as to improve the data processing efficiency. In order to better analyze the allocation and management of public sport facilities resources of government and health institutions, improve the allocation and management effect of public sport facilities resources \([23]\). The solution of this study is as follows: determine the number of correlation paths \( EI \) between the allocation and management node \( NQ \) and public sport facilities resources; according to the number of associated roads \( e \), the space of public sport facilities resources is divided into \( GK \); divide the resource occupancy rate of the node \( N \) of public sport facilities \([24]\). The higher the number of resource occupancy, the higher the weight of the sport facilities on the configuration and management unit \( NQ \) and the higher the configuration of \( NQ \); and sort the analysis results. The specific steps are described as follows.

3.1. Spatial Spectrum Estimation Method

The spatial spectrum estimation methods mainly assume the number of configuration and management unit modes and the quality of public sport facility resources. It is assumed that the input of the \( f \)th node of public sport facility resources is represented by \( II \). It is necessary to calculate the relationship between the associated sport facility nodes and the relationship between configuration and management unit nodes \([25]\). The calculation results are shown in the following formula.

\[ I = \left( \sum_{q=1}^{n} \prod \left( N_q \cdot \alpha \cdot n_i/(q + n) \right) - \alpha_0 \cdot f \left( \left( E_q \cdot \beta \cdot n_i/(q + n) \right) - b_0 \right) \right). \]  

(4)

where \( \alpha \) and \( \beta \) is the adjustment coefficient of node configuration and relevance, \( f \) is the projection function, \( \alpha_0 \) is the maximum number of public sport facility resource nodes, \( b_0 \) is the maximum value of public sport facility resource nodes, \((N_q \cdot \alpha \cdot n_i/(q + n))\) represents the relevance of the in-sport facility, and \((E_q \cdot \beta \cdot n_i/(q + n))\) represents the configuration of the \( f \)th sport facility. Since there is a certain error between the resources and allocation of public sport facilities and the nodes of the management unit, the error adjustment function \( \varphi \) should be constructed to make it closer to the real. The calculation is shown in the following formula.

\[ \varphi(\cdot) = 1/\theta \left[ \cap \left( \left( N_q \cdot \alpha \cdot n_i/(q + n) \right) \right) \right]^2 + \left( f \left( \left( E_q \cdot \beta \cdot n_i/(q + n) \right) \right) \right)^2, \]  

(5)

where \( \cap \left( \left( N_q \cdot \alpha \cdot n_i/(q + n) \right) \right) \), \( f \left( \left( E_q \cdot \beta \cdot n_i/(q + n) \right) \right) \) are the change values of \((N_q \cdot \alpha \cdot n_i/(q + n))\) and \((E_q \cdot \beta \cdot n_i/(q + n))\), which changes with the continuous iteration of sport facilities space until it is less than the preset error value of spatial distribution. If in formula (4), \( \cap \left( \left( N_q \cdot \alpha \cdot n_i/(q + n) \right) \right) > \alpha_0 \) and \( \left( E_q \cdot \beta \cdot n_i/(q + n) \right) > b_0 \), \( \alpha \) is the representative weight, \( 0 \sim 1 \) sport facilities are included in \( g_k \), and then repeat the calculation in steps (4) and (5) until \( i = n \).
represents the sum of relevant data. The greater the value, the
less the correlation of $g_k$. The calculation formula of $\sigma_i$ is
\[
\sigma_i = \max_{\theta} \frac{S(g_k)}{\sum_{n=1}^{N} S(n_i)}.
\] (7)

The importance of public sport facilities resources $S(g_k)$
is the sum of the importance of all sport facilities. $\sum_{n=1}^{N} S(n_i)$
is the ratio of GK in the allocation and management of public
sport facilities resource spectrum estimation, and $\sigma_i$ represents
the best division position of $g_k$ spectrum estimation.
The greater the value, the higher the importance of $g_k$. The
final spectrum estimation $g_k$ of public sport facilities resources
is determined by $\sigma_i$ and $\omega_i$. According to the
resource allocation and management data of sport facilities of
the government and health institutions, set the initial value
of $\sigma_i$ and $\omega_i$ to 1. Through continuous calculation, the best
spectral evaluation score of $g_k$ is determined. Then, output $\sigma_i$
and $\omega_i$ values.

3.3. Poor Management of Public Sport Facilities and
Resources. Bad management will reduce the allocation and
management effect of public sport facilities resources. Bad
data should be identified in time, optimized and improved.
Through the analysis of $E$ and $E_q$ in $g_k$ space, judge the bad
management of public sport facilities resources and redistribute
the corresponding sport facilities. It is assumed that
the bad management of sport facilities is expressed in $R(n_i \sum P)$
and the occurrence rate of bad management is $P(n_i \sum P)$. Then, formulas (8) and (9) can be obtained [26].
\[
R(n_i) = \frac{\langle P(n_i)Q_{n_i} \rangle}{P_i},
\] (8)
\[
P(n_i) = \sin \theta - \prod_{i} \frac{p(n_i|n_{i-m}) p(n_i)}{\sum p(n_i|n_{i-m}) p(n_i)}.
\] (9)

Among them, $n_i$ is any sport facility and $Q_{n_i}$ is the
maximum tolerance of the government and health institutions
for the allocation and management of public sport
facilities resources. According to formulas (8) and (9), the
greater the $R(n_i \sum P)$ value, the worse the poor management
of sport facilities. In formula (9), $P(n_i \sum P)$ and $P(n_i \sum n_{i-m})$
are obtained through the spatial spectrum estimation of
sport facilities. $\prod \sin \theta(p(n_i \sum n_{i-m}) \leftrightarrow p(n_i)/\sum p(n_i \sum n_{i-m}) p(n_i))$ is the probability that sport facilities have no bad management record.

3.4. Implementation Steps of Resource Allocation and
Management Algorithm of Public Sport Facilities. According to
the spatial spectrum estimation method, the following steps
are required:

Step 1: the government and health institutions analyze
the table of sport facilities in allocation and management,
form a collection $N = \{n_1, \ldots, n_m\}$ and

\[ E = \{e_1, \ldots, e_m\}, \] and determine the relationship
between sport facilities in different spaces
\[ n_{m-1} \longrightarrow n_m \longrightarrow n_{m+1}. \]
Step 2: using formulas (5) and (6), obtain $\omega_i$ and $\sigma_i$.
\[ \omega_i < \omega \text{ and } \sigma_i < \sigma \] and meet the allocation and man-
ger conditions of sport facilities; otherwise, the
sport facilities shall be eliminated. At the same time, the
management units of configuration and management
points are divided into multiple independent sets.
Step 3: use formulas (8) and (9) to judge the bad
management records of public sport facilities and re-
sort the space where the sport facilities are
located to get the final configuration and management
results. If the judgment process does not reach the
expected iteration value, repeat steps P2 and 3; other-
wise, proceed to step 4.
Step 4: output the resource allocation and management
results of public sport facilities based on the spatial
spectrum estimation method. The flowchart is shown in
Figure 1.

4. Case Studies on Resource Allocation and
Management of Actual Public Sport Facilities

4.1. Case Introductions. The topological map of public
sport facilities resources is generated by spatial layout software
in the laboratory, and there are 821 sport facilities in total, with
13 spaces. The dispersion of sport facilities in each space is
0.97, which is basically in a completely discrete state.
According to the standardized management measures for
the allocation and management of public sport facilities and
the requirements for the allocation and management of
public sport facilities resources max $\omega$ and max $\sigma$, the space
of sport facilities is divided into 0.77 and 0.73 respectively. In
order to reduce the processing capacity of public sport fa-
cility resource data, the statistical method of random
sampling is adopted $y = \sin \sum 2\pi x_i$, and the number of
simulation iterations is set to 50 to analyze the degree,
accuracy, configuration, and management time of config-
uration and management. The specific simulation model
construction is shown in Figure 2.
4.2. Analysis of Configuration and Management Degree.

The configuration and management degree of the spatial spectrum estimation method and existing algorithms are compared, and the results are shown in Figure 3.

It can be seen from Figure 3 that the configuration and management degree of the spatial spectrum estimation method is concentrated in −20–100%, while the configuration and management degree of the dynamic programming algorithm is concentrated in 0–100%. Moreover, the curve is convex in the middle and descending around, which meets the requirements of normal distribution. Therefore, the configuration and management range of the spatial spectrum estimation method is better than that of the dynamic programming algorithm. Moreover, the configuration and management range of the spatial spectrum estimation method is smaller than that of the existing...
algorithms, which indicate that there are many “redundant” sport facilities in the existing algorithms, and there are a large number of abnormal user values. It also repeatedly explains the phenomenon of “value hopping,” which is consistent with the relevant domestic research [9].

4.3. The Accuracy. Accuracy is the key indicator of resource allocation and management of public sport facilities, as shown in Figure 4.

It can be seen from Figure 4 that the accuracy of the spatial spectrum estimation method is 98%, the variation range is (0, 10), and the accuracy better than the original algorithm is 80%, the variation range is (0, 20). At the same time, the curves show the trend of gradually concentrating, which shows that the solution effect is more obvious. Moreover, the change of the spatial spectrum estimation method is smoother, and the correlation between various analyses is better. Previous studies believe that the accuracy of the dynamic programming algorithm is high, but the influence of amplitude variation of accuracy is ignored. This shows that the main reason for the poor accuracy of the dynamic programming algorithm is not the low accuracy, but the large range of accuracy change, which is

| Different algorithms | Optimal spatial spectrum estimation point | Data output in a single time (MB) | Spatial correlation coefficient (none) | Error variation (%) |
|----------------------|------------------------------------------|----------------------------------|---------------------------------------|--------------------|
| Dynamic time method  | 4                                        | 12                               | 0.62                                  | 16                 |
|                      | 11                                       | 11                               | 0.71                                  | 15                 |
|                      | 12                                       | 12                               | 0.63                                  | 14                 |
| Dynamic throughput method | 4                                    | 12                               | 0.32                                  | 12                 |
|                      | 12                                       | 13                               | 0.38                                  | 13                 |
|                      | 10                                       | 12                               | 0.29                                  | 11                 |
| Spatial spectrum estimation method | 3                        | 14                               | 0.62                                  | 2                  |
|                      | 10                                       | 15                               | 0.60                                  | 9                  |
|                      | 9                                        | 16                               | 0.56                                  | 6                  |
| Dynamic parameter method | 4                                  | 13                               | 0.52                                  | 15                 |
|                      | 9                                        | 12                               | 0.56                                  | 14                 |
|                      | 8                                        | 11                               | 0.58                                  | 13                 |

Figure 5: Configuration and management time of different methods. Positive numbers represent structured data and negative numbers represent unstructured data.
basically consistent with the relevant domestic research conclusions [10].

4.4. Configuring and Managing Data Volume. Configuring and managing the amount of data is an important index of public sport facility resource management, which reflects the data processing ability of the algorithm in unit time. Generally speaking, the resource allocation and management time of public sport facilities is 25 seconds; otherwise, it cannot meet the future development needs of the government and health institutions, nor can it carry out the allocation and management of massive sport facilities. The calculation results are given in Table 2.

It can be seen from Figure 5 that in unit time, the amount of configuration and management data of the spatial spectrum estimation method is higher than that of existing algorithms, which also indirectly indicates that the configuration and management time of the spatial spectrum estimation method is short. At the same time, unstructured data accounts for a large proportion of the data in this test, so most of the data in the figure are unstructured data. Through the comparison of unstructured data, the advantages of the spatial spectrum estimation method are further verified. The main reason is the poor management of sport facilities $P(n)$ and $R(n)$. Through the corresponding probability calculation, the preliminary data standardization processing is carried out to reduce the complexity of public sport facilities and resources.

5. Conclusion

The resource allocation and management of public sport facilities is a process in which the government and health institutions use the comprehensive analysis method to optimize in response to the adjustment of the expansion of power grid and the soaring number of sport facilities [27]. The higher the level of resource allocation and management of public sport facilities, the less the amount of data processed by the servers of governments and health institutions and the lower the difficulty of calculation. The spatial spectrum estimation method of public sport facilities resources has the problem of subjective bias, which will reduce the accuracy of analysis under a large amount of sport facilities information. This not only increases the management cost of the government and health institutions but also wastes a lot of power resources. The spatial spectrum estimation method is a comprehensive analysis method to judge from the two aspects of quantity and quality. It analyzes the unit management in the government and health institutions, judges the resources of public sport facilities in the chain, and estimates, judges, allocates, and manages them. MATLAB simulation results show that the degree of configuration and management of the spatial spectrum estimation method focuses on $69\% - 83\%$, the accuracy is $98\%$, the variation range is $(97, 98)$, and the amount of configuration and management data is $234$ mb, which is significantly better than the existing algorithms. Therefore, the spatial spectrum estimation algorithm for the public sport facilities optimization effect is very obvious, with the distribution of resources in different space, more accurate calculation results. The spatial spectrum estimation method can meet the requirements of the existing government and health institutions for the allocation and management of public sport facilities resources and realize the comprehensive improvement of the management level of public sport facilities resources.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by Xiamen City University.

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