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Research Article

The Prediction of Sports Economic Development Prospect in Different Regions by Improved Artificial Bee Colony Algorithm

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In order to study the development of the sports economy in different regions and analyze the future development prospect of sports economy, this paper uses the k-clustering method to improve the artificial bee colony algorithm and further improve the clustering degree of the bee colony. Among them, the improved artificial bee colony algorithm reduces the incidence of local extreme and improves the accuracy of calculation by setting the weight and threshold of indicators. MATLAB simulation results show that the prediction accuracy of the improved artificial bee colony algorithm for the development prospect of sports economy is 96–99%, and the calculation time is 0–17 seconds. Therefore, the improved artificial bee colony algorithm can best predict the development of the sports economy in different regions, and its accuracy, periodicity, and calculation time are better than those of the original artificial bee colony algorithm.

1. Introduction

With the rapid development of social economy, there is a gap in the sports economy between different regions [1]. To promote the development of sports economy, the national sports department put forward the strategy of sports competitive balance [2]. However, existing sports economic evaluation methods have the problems of poor accuracy and long evaluation time, which cannot achieve the purpose of economic prediction. Scholars at home and abroad have increased the regional prediction of sports economy, and they especially introduced quantitative analysis methods and comprehensive analysis methods to evaluate and predict sports economy. At present [3], the domestic prediction of the development of sports economy is only limited to the theoretical level, or the quantitative analysis method is directly transplanted to the sports economy [4], without improving the original methods, such as Bayesian algorithm, genetic algorithm, and particle swarm optimization algorithm [5]. Therefore, the main research direction is to apply quantitative analysis method and improve it to improve the prediction accuracy of sports economic development. Among them, the artificial bee colony method is widely used in sports economic prediction. However, there are deficiencies in data processing of artificial bee colony, which cannot meet the needs of sports economic development prediction at this stage. The above algorithm mainly has the problem of regional extrema, resulting in large deviation in the calculation. To realize the rational planning of national sports economy, this paper proposes an improved artificial bee colony algorithm and judges the prediction of the sports economy in different regions.

2. Literature Review

Artificial bee colony algorithm is a multidimensional data analysis and calculation method used to solve the selection problem of distinct combination schemes. In the process of collecting honey, bees should traverse distinct honey sources, judge the concentration of honey sources, and finally lead the bee colony to select the optimal honey source. In this process, it involves honey source traversal, source judgment path optimization, and so on [6]. Similar analysis shows that the prediction of sports economic development

in regions is the honey source selection process of bee colonies. Artificial bee colony algorithm can effectively traverse regions. Stone et al. [7] found the reasons for the differences between sports in different regions and put forward solutions according to the prediction results. In addition, in the process of sports economic prediction, the threshold and weight should be calculated to eliminate the data that have no impact on the judgment results. From the above analysis, it can be seen that there are many research studies on the artificial bee colony algorithms in China. At the same time, domestic scholars also believe that the artificial bee colony algorithm has shortcomings and cannot adapt to the analysis of sports economic development in different regions, especially large-scale data analysis. At present, the artificial bee colony algorithm has been improved and applied to the field of sports in China, but it has not been applied to the prediction of the development prospect of sports economy [8]. Therefore, it is an urgent problem to study and improve the role of the artificial bee colony algorithm in the development of sports economy and the prediction effect.

This paper improves the artificial bee colony algorithm, integrates k-cluster analysis, and uses European clustering to reduce the occurrence rate of extrema, to improve the accuracy of calculation. In addition, it can reduce the amount of data preprocessing of the artificial bee colony algorithm to shorten the calculation time. At the same time, k-clustering can adjust the relationship between local extreme value and global value, avoid optimal solution, and improve the accuracy of calculation. When the artificial bee colony algorithm processes data, there will be a problem of regional extrema, resulting in low accuracy of calculation. In order to meet the prediction requirements of the sports economy in different regions, it is necessary to reduce the impact of massive data on the calculation results. By clustering massive data, k-clustering reduces the amount of data processing, reduces the initial amount from data of artificial bee colony, and improves the accuracy of calculation. This paper uses empirical analysis and simulation to verify the effectiveness of the improved artificial bee colony model and tries to provide case and theoretical support for sports economic development planning.

3. Method

3.1. The Description of the Artificial Bee Colony Algorithm. The artificial bee colony algorithm is an optimization method proposed to imitate the behavior of bees. The algorithm searches the honey source target in multiple dimensions, judges distinct combination schemes, and selects the target that is most conducive to the bee colony. Artificial bee colony can reduce the search dimension, improve the search accuracy, and select the target according to the advantage of honey source target. At the same time, the artificial bee colony algorithm can change the search role, and the same bee can play the role of leader and follower. Artificial bee colony algorithm can solve the path selection problem between distinct targets, reduce the complexity between different targets, and is suitable for the calculation of large amount of data. However, the artificial bee colony algorithm has the problem of regional extrema, which affects the accuracy of search results. At present, artificial bee colony algorithms have a wide range of applications and belong to a common comprehensive analysis method. Compared with other analysis methods, artificial bee colony algorithms can reduce the impact of data on the results, improve the calculation efficiency of data, and predict the future development trend according to the existing data. Based on Liang's research [9], this paper attempts to introduce the k-clustering method to improve the artificial bee colony algorithm to solve the problem of inaccurate prediction of sports economic development in different regions [10]. The principle of the artificial bee colony algorithm is shown in Figure 1.

3.2. Determination of the Input Index of the Artificial Bee Colony Algorithm. The index determination of the artificial bee colony algorithm is an important work, which plays a forward-looking role in the prediction of sports economic development trend and affects the accuracy of later calculation results. The indexes in the artificial bee colony algorithm are divided into three kinds: existing indexes, prediction indexes, and transfer indexes, which are not only related to the development potential of sports competition but also related to the influence points of sports economy and the development of sports economy in the future. Different indicators change through transfer factors and show complex indicator relationships. Artificial bee colony algorithm is suitable for large-scale data of calculation and can realize cross regional data analysis. The development of sports economy is not only related to local economic policies, economic development potential, and infrastructure construction but also related to the development environment of domestic sports economy, the market potential of sports economy, and the future development strategy for the region. To realize the prediction of sports economic development in different regions, it is necessary to integrate various indicators and data and establish the dynamic relationship.

Due to the large amount of data collected, it is necessary to preprocess the data in the early stage and eliminate the data that have a little impact on the results, to improve the accuracy of data analysis. In this paper, the k-clustering method is used to cluster the data of 1 ~ 6 regions P I A, I A P, Plav et al. [11]. At the same time, transfer factors are added between different data, integrating the influence of space, time, and policy, to realize the comprehensive analysis of sports economic development. The artificial bee colony algorithm is an analysis method often used in the sports economy, but it requires analysis of large-scale data. The algorithm may have regional extrema problems, which will reduce the accuracy of analytical results. Therefore, after incorporating the k-clustering methods, the occurrence rate of regional extrema can be reduced. Hypothesis 1: the input index of the artificial bee colony algorithm is xi, the transfer factor is yj, the output result is Pij, and i, j belong to set (1,...,n); subsequently, the calculation formula with the result is shown in the following:

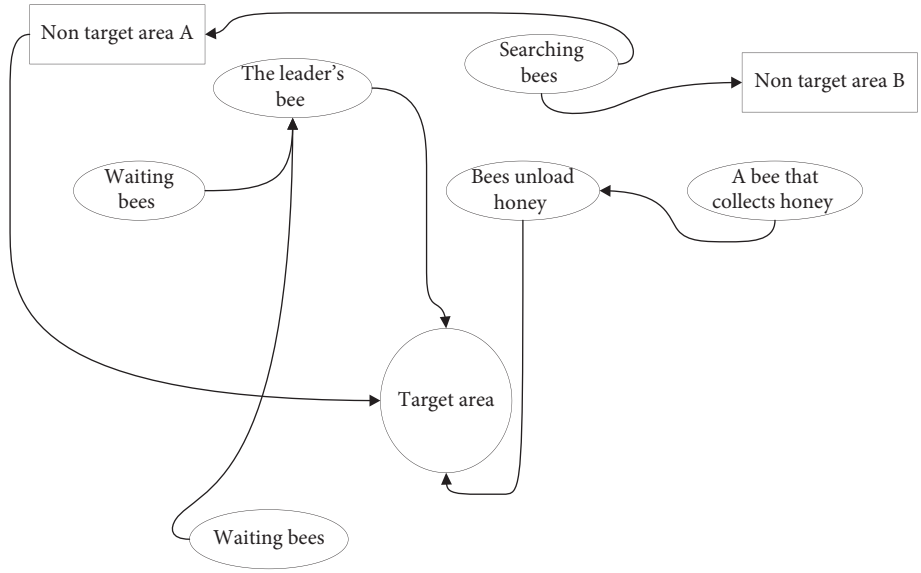

Figure 1: The principle of the artificial bee colony algorithm.

$$P_{ij} = \begin{cases} x_i y_j - \sum_{i,j=1}^{n} \dfrac{\overline{x}_i \overline{y}_i}{\mu, x_i} < x_{i+1}, \\ \\ \overline{y}_j = \dfrac{1}{\mu} \sum_{i=1}^{n} x_i, y_j < y_{j+1}, \end{cases} \tag{1}$$

where μ is the expected optimal result of artificial bee colony, $x_i < x_{i+1}$ is the advanced condition of the input index, $y_j < y_{j+1}$ is the advanced condition of transfer between indexes, $\overline{x}_i$ is the local average of an index, and $\overline{y}_i$ is the local average of any transfer factor.

3.3. The k-Clustering Algorithm. Due to the large number of transfer factors and input indexes of the artificial bee colony algorithm, it is necessary to improve and optimize it and put forward irrelevant data [12]. When artificial bee colony algorithm traverses different regions, it should pass through sports cities as much as possible and analyze the corresponding sports economy [13]. Hypothesis 2: if the Euclidean distance between any index is S; subsequently, the distance between two points is the shortest, and any point between xi and xi + 2 will be eliminated. Therefore, the artificial bee colony algorithm only needs to judge the distance between any two points. If the minimum requirement is met, the mean place shall be excluded; in other respects, it shall be included in the mean place [14]. In addition, the distance between any two points should be directional; in other respects, repeated calculation will occur and increase the amount of calculations.

Hypothesis 3: Si is the Euclidean distance between any two points and St is the direction of the distance between any two points; subsequently, the distance between any two points is divided equally by K and calculated accordingly [15]. The formula is

$$\begin{cases} S_i(x, y) = \dfrac{\sqrt{p(x_i y_j)^2 - q(x_i y_j)^2}}{\max\{q(x_i y_j), p(x_i y_j)\}}, \\ \\ S_t(x, y) = \dfrac{1}{\xi} \sum_{i,j=1}^{n} S_t(x_i y_j), \end{cases} \tag{2}$$

where $p(x_i y_j)$ is the abscissa of xi and yj, $q(x_i y_j)$ is the abscissa of xi and yj, and ξ is the optimal expected time [16]. Hypothesis 4: the threshold is P_E and the index weight is ω_{ij}. In order to ensure the accuracy of calculation, the threshold and weight shall be set. The calculation formula is

$$P_E = \sqrt{\sum_{i,j=1}^{m} \omega_{ij} \left[P_{ij} - min(P_{ij})\right]^2} + \tau, \tag{3}$$

where ω_{ij} is the weight of i input index, j is the transfer factor [17], min (P_{ij}) is the minimum output result, and τ is the adjustment coefficient of local threshold (the coefficient is the GDP of the sports economy in different regions). In k-clustering, the value of the initial cluster is 0 and increases gradually. After Si and St are calculated, they are k equally divided and arranged in the corresponding order [18]. If the results of Si and St are less than P_E, they will be rejected; in other respects, they will be included.

3.4. The Construction of the Improved Artificial Bee Colony Algorithm. Using the objective function, the artificial bee colony algorithm can solve the complex calculation problem of regional economic differences. By traversing the data from different regions, this paper forecasts the development of sports economy [19]. However, with the increase of the number of economic data, the results will fall into regional extrema value, which will affect the accuracy of the calculation results. At the same time, the application of big data,

cloud computing, and other methods also increases the amount of data of zonal sports economy and improves the occurrence rate of local extreme values [20]. Based on the literature at home and abroad, this paper improves the artificial ant colony algorithm, preprocesses the input data and transfer factors through k-clustering, and reduces the dimension of the analysis data with the help of bee routing. In the process of improved artificial bee colony calculation [21], the threshold and weight of input indexes are increased to make the iterative calculation move forward in the specified direction. Since the threshold and weight are positive, the tangent is between 0 and 1 [22]. When there is a negative value in the calculation result of artificial bee colony, the weight will reduce the value and the overall result [23]. If negative values continue to increase and fall below the threshold, they will be eliminated. Therefore, the setting of threshold and weight can put forward negative values and make the calculation results develop in a positive direction. Hypothesis 5: the actual development of the sports economy in different regions is Oij, and the predicted economy is Pij. When the input indicators and transfer factors are the same, the difference is DIJ; subsequently, the calculation formula is

$$d_{ij} = \begin{cases} O_{ij} = f\left[\sum_{i,j=1}^{n}\left(w_{ij}x_i + y_j\right)\right], \\ P_{ij} = f\left[\sum_{i,j=1}^{n}\left(w_{ij}x_i + y_j\right)\right] + \psi, \end{cases} \tag{4}$$

where $f(\cdot)$ is the improved artificial bee colony algorithm and ψ is the adjustment function of the actual value. In the above analysis process, the improved artificial bee colony algorithm is used to judge the target result. If the result meets the threshold [24], the calculation result is output; in other respects, the threshold will be adjusted. In addition, ψ is the interference factor in sports economic judgment, which belongs to the dynamic variable. ψ representative policy, culture, strategy, and other influencing factors [25]; the calculation formula is

$$\psi = \frac{1}{\mu}\sum_{i,t=1}^{n}\left\{\left[g(x) - S_i\right] - \left[z(x) - S_t\right]\right\}, \tag{5}$$

where $g(\cdot)$ is the subjective influencing factor and $z(\cdot)$ is the object influencing factor. Distinct input vectors get distinct output values, so we should adjust the threshold of sports economic prediction index to make it infinitely close to the actual requirements of Kondratenko et al. [26]. Therefore, Fourier series is integrated into the analysis of interference factors, and the specific calculation formula is

$$\lim_{x\longrightarrow\infty}\psi = \frac{1}{\mu}\sum_{i,t=1}^{n}\left\{\left[\triangle g(x)^T - S_i\right] - \left[\triangle z(x)^T - S_t\right]\right\}, \tag{6}$$

where the specialization of $\triangle g(x)^T$ and $\triangle z(x)^T$ is the increment of $g(x)$ and $z(x)$. Formula (6) can realize the standardized treatment of influencing factors, reduce the influence of non important factors that is ψ on the results, and improve the calculation accuracy. Under distinct colony targets, distinct analytical results are obtained by improving artificial bee colony [27]. Further analysis is carried out on the further requirements of the bee colony objective, further calculation steps, and design indicators. Therefore, for sports economic analysis in different regions, appropriate input indicators and thresholds should be selected to improve the accuracy of calculation. Since the eigenvalue of the located and the global thresholds are consistent, the calculation direction of the index shall be constrained, and the calculation direction shall be positive. Before the improved artificial bee colony calculation, all sports economic data are processed for public welfare, the corresponding data values are projected between [0, 1], and the located and global extreme values are set. Hypothesis 6: the located extreme value is Em and the global extreme value is EC; subsequently, the calculation formula of the extreme value is

$$\begin{cases} E_m = \dfrac{\left[\sum_{i,j=1}^{n}\left(x_i - y_j\right)^2\right]}{\lim\limits_{x\longrightarrow\infty} f(x)}w_{ij}, \\ E_{\mathrm{C}} = \dfrac{S_i - S_t}{x_i y_j} \times 100\%. \end{cases} \tag{7}$$

The regional extrema E_m are greater than the threshold but less than 1; the global extrema E_{C} are positive and less than 1. According to the above analysis, the flow of the improved artificial bee colony algorithm can be obtained, which is shown in Figure 2.

4. Results and Discussion

In this paper, the improved artificial ant colony algorithm is used to analyze the sports economy in different regions, and the accuracy and effectiveness of the algorithm are verified in the MATLAB environment. Before analysis, you need to set the weight and threshold of the input indicators. At the same time, 100 iterations of the algorithm are carried out to verify the overall calculation results. Among them, after referring to relevant domestic literature, the number of iterations is determined to be 100. Too many iterations will increase the system burden, and few iterations will reduce the calculation accuracy.

4.1. The Sample Objects. Taking the sports economy of 16 regions as the research object, this paper analyzes the development of the sports economy in different regions. Among them, 2 places are selected in Northeast China, 3 places are selected in North China, one place is selected in Northwest China, one place is selected in Southwest China, five places are selected in Southeast China, and four places are selected in East China. The selected input indicators are economic development potential x1 (unit: none), the proportion of sports economy in GDP x2 (unit: %), the development speed of sports economy x3 (unit: none), and the growth proportion of sports economy x4 (unit: %), the transfer factors y1 (unit: none), indicator function transfers y2 (unit: none), and indicator influence degree transfers y3

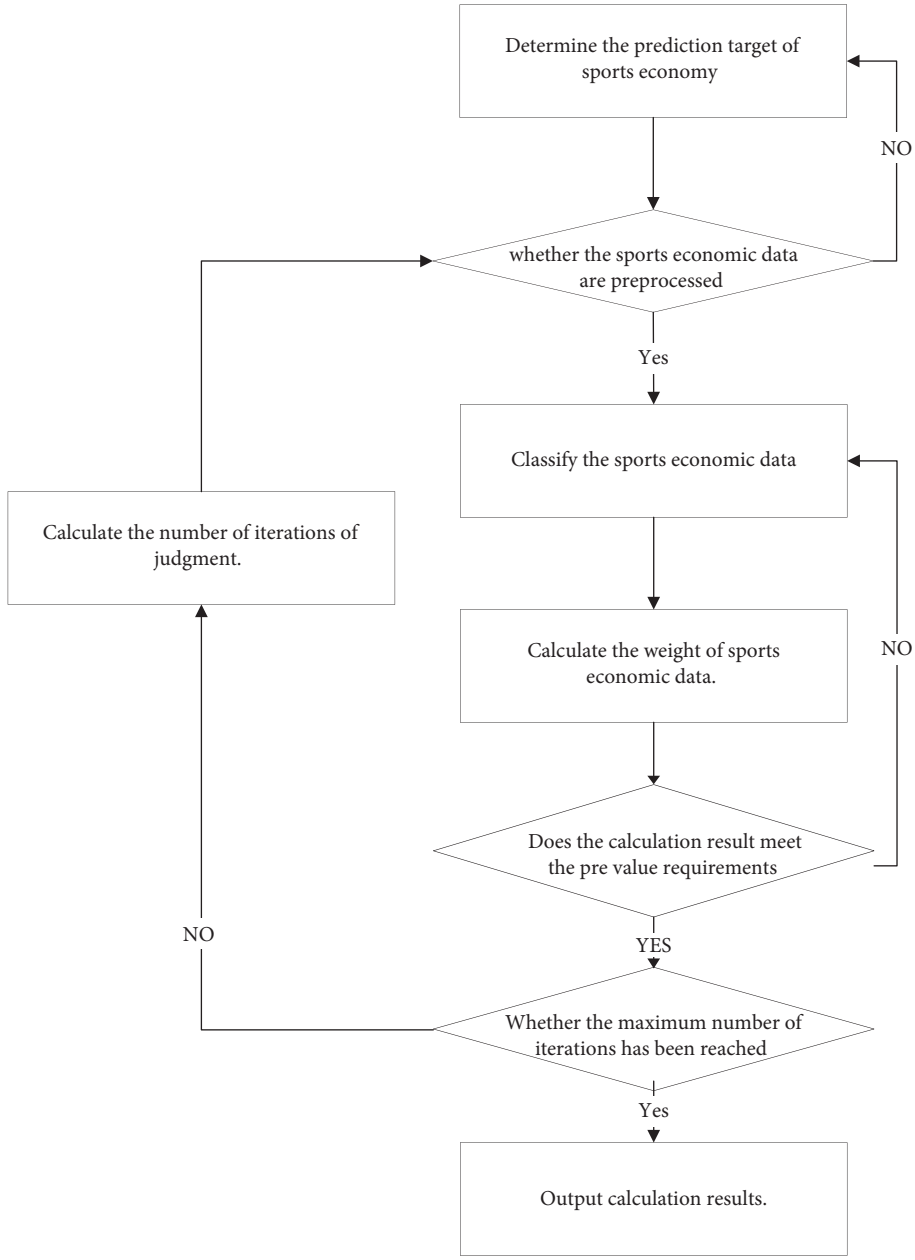

Figure 2: The flowchart of the improved artificial bee colony algorithm.

(unit: %). The k-clustering results of sample objects are shown in Table 1.

It can be seen from Table 1 that the clustering degree of different input indicators and transfer factors is greater than 95% and higher than the global threshold of 0.98, so the sports economical industry data meet the specific requirements and can be analyzed and calculated [28].

4.2. The Accuracy of Prediction of an Economic Development Prospect of the Sports Industry. Compared with the original bee colony algorithm, the calculation accuracy of the improved artificial bee colony algorithm is higher, which can reach more than 95%, which is shown in Figure 3.

It can be seen from Figure 3 that the accuracy of the improved artificial bee colony algorithm is between 96% and 99%. The accuracy of the existing bee colony algorithm in predicting the development prospect of sports economy is only 94%–96%. Therefore, the improved artificial bee colony algorithm has higher accuracy [29]. The reason is that k-clustering is used to make the calculation results iterate in the same direction, which effectively reduces the occurrence rate of local extreme values. The results are shown in Figure 4.

It can be seen from Figure 4 that the iterative data do not change in different directions at the same time. In the projection of sports economic data, the direction of data has always been the same direction. Therefore, the improved artificial bee colony algorithm can ensure the data changes in

Table 1: The sample clustering.

The number of samples	Initial cluster center (%)						$E_C = 0.78$
	x1	x2	x3	x4	y1	y2	
12	97.98	98.91	97.98	95.96	98.93	96.90	0.88
15	97.94	95.96	98.97	98.92	98.91	96.97	0.83
10	95.92	96.91	98.99	97.98	98.94	96.93	0.81
14	96.93	96.93	96.97	95.96	96.92	98.92	0.87
15	98.97	96.92	98.99	96.97	95.93	96.99	0.82

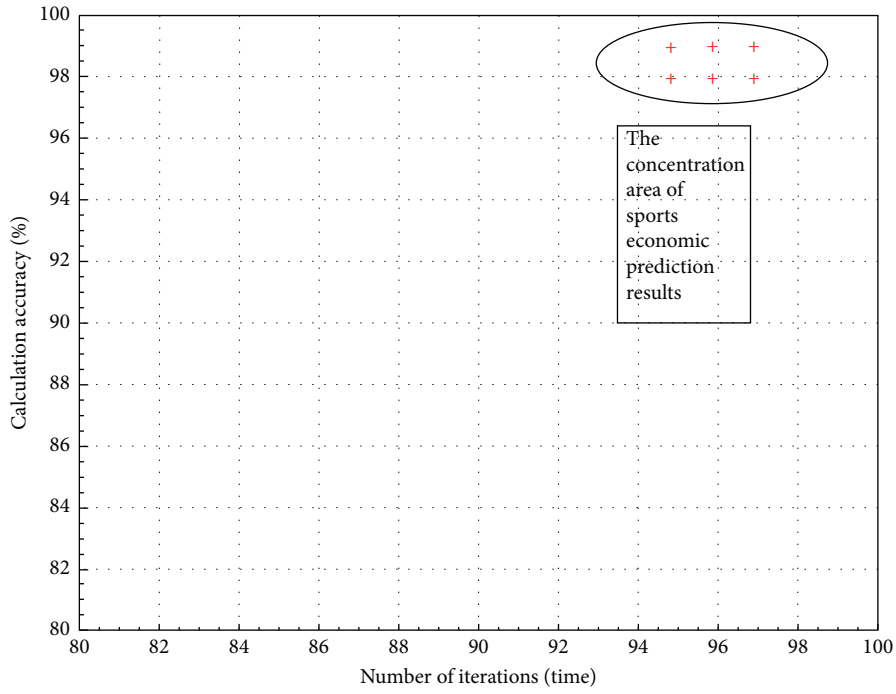

Figure 3: The concentration area of the sports economy calculation results.

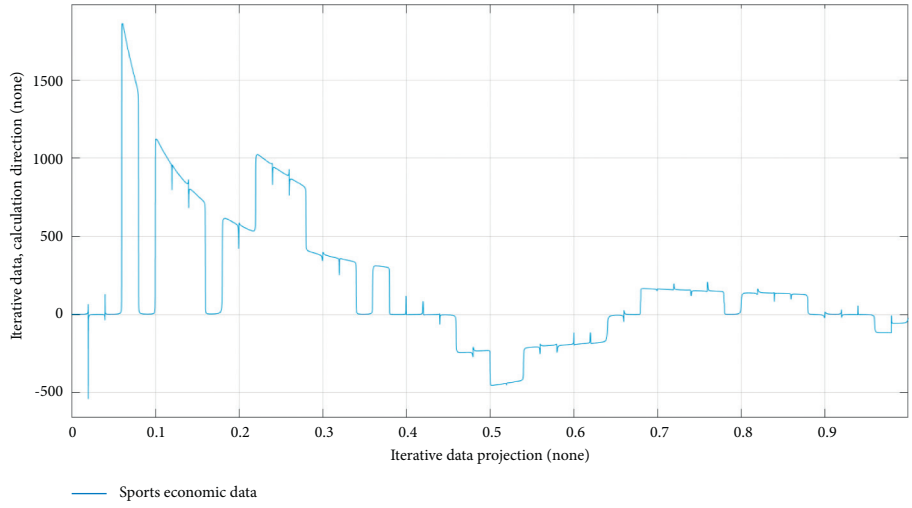

Figure 4: The calculation direction of the improved artificial bee colony algorithm.

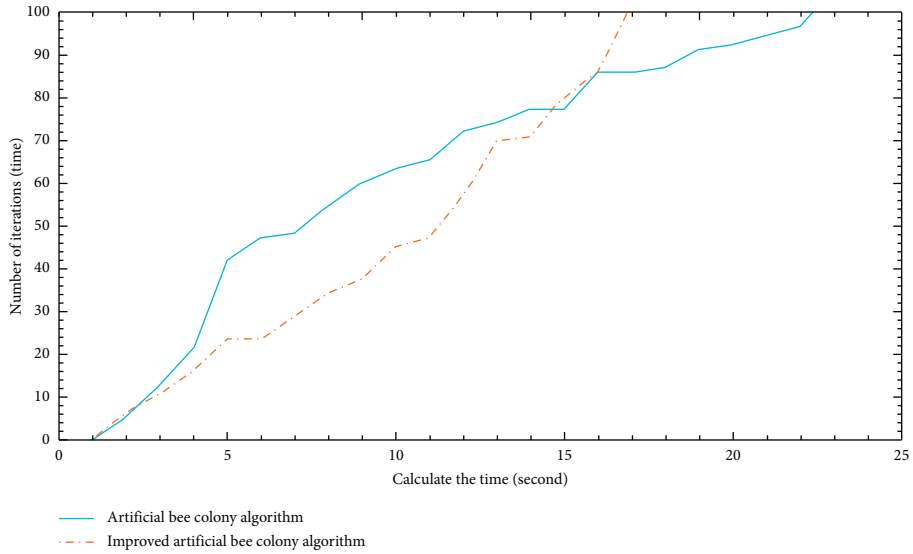

Figure 5: Comparison of calculation time of economic development forecast of sports industry.

the direction. Compared with the original artificial bee colony algorithm, the improved artificial bee colony algorithm has significant advantages in data iteration direction, high accuracy of calculation, and low probability of regional extrema.

4.3. The Forecast Time of Economic Development Prospect of the Sports Industry. In terms of computing time, the improved artificial bee colony algorithm can effectively compare data, propose redundant data, and greatly reduce the amount of data processing [30]. Under the same sports economic data, the calculation time of the clustering algorithm is shorter, and the results are shown in Figure 5.

It can be seen from Figure 5 that the calculation time of the improved artificial bee colony algorithm is 0–17 seconds, and the calculation time of the original bee colony algorithm is 0–21 seconds. There is a significant difference between the two. The main reason for the above problems is that the artificial bee colony algorithm has been improved, and the conclusions are obtained by using the k-clustering method for data preprocessing and the Fourier series for continuous threshold analysis. Therefore, the improved artificial bee colony algorithm has more advantages in computing time.

In the early stage of data processing, the data direction vector is high and shows a downward trend in the later stage. The reason is that the postprocessing volume of data is reduced. The latter data vector is relatively stable without significant change, which further shows that the data processing effect is better.

The change range of the improved artificial bee colony algorithm is small, and it has reached the extreme value after 18 iterations, which shows that the calculation effect of this method is better and the processing effect of economic development data is better. In the future research process, we should pay attention to improving the change amplitude control of artificial bee colony algorithm to make the processing process more stable.

5. Conclusion

The improved artificial bee colony algorithm preprocesses the sports economy data through the k-clustering, compares the differences in region camps, and obtains the clustering of sports economic index data. Subsequently, accuracy and calculation time of sports prediction are compared. MATLAB simulation results show that all sports economic data are relatively concentrated, and the degree of clustering is 96~99%. At the same time, the calculation accuracy of the improved artificial bee colony algorithm is more than 98%, and the calculation time is 0–17 seconds, which are higher than those of the original artificial bee colony algorithm. Therefore, the improved artificial bee colony algorithm has significant advantages in calculation accuracy and time and can predict the development trend of the sports economy in different regions. However, in this paper, the correlation between regions is not deeply analyzed, and the transfer factor is only used as an intermediate value without detailed analysis. In the future research, we will focus on the analysis of regional differences and the role of transfer factors [31].

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

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