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Research Article

Application Analysis of Intelligent Particle Swarm Algorithm in the Development of Modern Tourism Intelligence

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Information technology has been increasingly vital in the rapid expansion of the tourism industry economy. The new information technology has become a significant driving force and factor in the tourism industry's economic development. The application of new information technology to the advancement of modern tourist intelligence has emerged as an essential study area. Smart tourism, aided by informatization, can frequently provide more attractive economic benefits to tourism businesses. Tourism is being positioned as a new economic growth point and core business in an increasing number of cities. Various measures have been taken among the main body of the city to improve the tourism competitiveness of the city, so as to be in an advantageous position in the fierce market competition. Under this background, the research on urban tourism competitiveness has become a research hotspot in the development of modern tourism intelligence. This study used a combined PSO and neural network to assess the competitiveness of urban tourism. First, this paper offers a method that makes use of an improved IPSO. It changes the inertia weight dynamically and nonlinearly based on the particle fitness value. Simultaneously, the particle swarm technique is enhanced by combining the particle iterative cycle to boost position disturbance. Second, in order to build an IPSO-BP network, this work optimizes the initial weights and thresholds of the BP network based on IPSO. This work uses this network to evaluate the competitiveness of urban tourism, which can overcome the defects of traditional BP network. Third, this work conducts systematic experiments on the IPSO-BP method, and the experimental results confirm the superiority of this method in the evaluation of urban tourism competitiveness.

1. Introduction

With the rapid development of modern information technology and its wide application in the world, information technology has played a subversive and revolutionary role in the development, management, and marketing of the tourism industry. The new information technology provides strong support and new impetus for the innovation, construction, and development of the vast number of facilities. The smooth implementation and promotion of new information technology and intelligent systems will definitely have a subversive and revolutionary impact on people's travel patterns and habits. In addition, the launch of intelligent tourism projects will inevitably promote the upgrading and transformation of the traditional tourism industry to the modern tourism industry and the transformation from the traditional service industry to the modern service industry. Smart tourism driven by modern information technology will be a new product developed through the deep integration of information technology and traditional industry development. This is a new direction for the development of my country's tourism industry. Compared with traditional tourism methods, smart tourism places more emphasis on the needs of tourists. This strengthens the provision of more intimate and convenient travel services, which is supported by new generation information technologies such as wireless Internet technology, cloud computing technology, big data technology, Internet of Things, and modern multimedia technology. It focuses on realizing the mutual connection and perception between tourists and various tourism products and service elements in the scenic spot and finally completes the comprehensive promotion and application of smart tourism services after experiencing perception [1–5].

The Ministries of Culture and Tourism places a high value on enhancing the service quality and reception capacity of tourist destinations. Because its construction and development are critical to the transformation and upgrading of the domestic tourist sector, optimizing the structure of tourism products, and leading the national leisure and holiday tourism industry's development. National-level tourism resorts in large cities have recently emerged as new industry indicators, following the national 5A-level scenic sites. The Ministry of Culture and Tourism has also built a dynamic management framework for assessing tourist resorts in order to ensure that tourist resorts are progressing toward high-quality growth. The government has attached great importance to the informatization development of smart tourism, and local governments at all levels have successively issued guidelines to accelerate the green development of the tourism industry. This clearly requires that local governments at all levels should cultivate the tourism industry into a strategic emerging industry and leading industry that supports the transformation of economic structure and sustainable development. The local government should also develop the tourism industry into a modern and new service industry that satisfies the people. The government also emphasized that to develop the tourism industry, it is necessary to break the traditional old development model and thinking and focus on developing smart tourism projects. Smart tourism especially vigorously develops informatization as the main means. Whether it is tourism products or tourism services, the improvement of their quality and the building of brands are inseparable from informatization and intelligence. The main leaders of the national tourism authorities have repeatedly emphasized on many occasions that all localities should accelerate the construction of demonstration projects of tourism informatization and promote the vigorous development of smart tourism [6–10].

A city is a hub for multiple consumptions as well as a distribution point for diverse flows of people, logistics, and capital. Cities are the foundation of modern smart tourism, and their flawless functions can suit the needs of visitors. Urban tourism is the core and primary body of modern tourism, and cities with great urban competitiveness can assist the growth of urban tourism in this region. As a result, when analyzing the competitiveness of urban tourism, a significant topic in smart tourism should strengthen research on the competitiveness of urban tourism. The survival and development of tourism within a country or region are influenced to some extent by the region's urban tourism competitiveness. It can scientifically and objectively evaluate the development status and potential of urban tourism. This avoids unnecessary duplication of construction, resulting in a significant waste of resources. In today's vigorous development of smart tourism, we should pay attention to the role of urban tourism competitiveness in the process of developing urban tourism. The cultivation and promotion of urban tourism competitiveness requires the guidance of theory. Therefore, the study of urban tourism competitiveness has become a research hotspot in tourism academic circles at home and abroad [11–15].

The paper's organization paragraph is as follows: the related work is presented in Section 2. Section 3 analyzes the methods of the proposed work. Section 4 discusses the experiments and results. Finally, in Section 5, the research work is concluded.

2. Related Work

Literature [16] puts forward the essential problem of the modern development of the tourism industry; that is, the development of the tourism industry must focus on bringing more convenient, low cost, and efficient services to tourists. Information technology can help tourism enterprises achieve this goal, which pointed out a clear direction for the organic combination of digital technology and tourism industry at that time. Literature [17] proposed that the development of tourism e-commerce is inseparable from the support of digital technology. Especially for mobile marketing platforms, stable and reliable wireless Internet technology is needed for protection. Literature [18] proposes that the key to the smooth development and implementation of tourism informatization is the direction selection, policy support, professional talent introduction and training, network security protection, and technological innovation. Literature [19] did an extensive and comprehensive study on the promotion and use of intelligent tourism systems, as well as the integration of information technology and the tourism industry from an information technology standpoint. The literature [20] examined in depth the constraints of the traditional tourism industry chain management paradigm against the backdrop of tourism information industrialization promotion. Using the promotion of large travel agencies' smart tourist management model as an example, it exhibits the tremendous impact of tourism informatization and management intelligence on conventional cooperation and labour division in the tourism industry chain. The authors of [21] take the construction of a smart city tourism system as an example and focus on research on urban tourism consultation, service system, online ticketing, and travel reservation services. The authors of [22] study the impact of new information technology on tourism. It proposed that relevant departments should attach importance to the development of smart tourism and take measures to build network infrastructure. The authors of [23] discuss how tourism enterprises can participate in smart tourism projects. It proposed that enterprises should increase investment, increase departments and personnel, and build a free smart tourism service platform. Enterprises should also seamlessly connect with relevant platforms of government departments. With the help and guidance of the government, use smart tourism tools to enhance and improve service quality. The authors of [24] proposed the concept of digital tourism service based on new communication technology. It proposes to use virtual reality technology to satisfy tourists' desire to play. At the same time, it actively promotes the picturesque spot's brand publicity and market marketing. The literature [25] investigated the effect of smart tourism and discovered that smart tourism can boost tourist satisfaction to a certain level. However, there will be certain misunderstandings in the process of building smart tourism in various regions due to differing understandings of the notion of smart tourism. The authors of [26] analyze it from the standpoint of smart cities built by a number of cities. It defines smart tourism by elaborating on the relationship between smart cities and smart tourism. This has become a standard study on the subject of smart tourism.

Literature [27] believes that the strength of urban tourism competitiveness is mainly affected by the need of tourists and the behavior of tourism enterprises. Therefore, a city with strong urban tourism competitiveness must be a destination with tourism attractiveness, and tourism enterprises can develop products that meet the needs of tourists. Literature [28] believes that information network has become an important way to connect tourism suppliers and tourism demanders. In the future, tourists will look for the recreational places they want to visit on the Internet. Tourism competition sites can reflect competitiveness through information structure, information accessibility, information quality, and dissemination speed. According to the literature [29], the competitiveness of tourism destinations should be based on their ability for long-term development rather than their current development. According to the literature [30], the determinants of tourism destination competitiveness include four factors. It also develops a conceptual paradigm for assessing tourist locations' competitiveness. Literature [31] uses urban tourism places with relatively high competitiveness as the research object. It thinks that every link in the destination's chain will have an impact on competitiveness and that competitiveness can only be attained via the application of comprehensive quality management. Literature [32] investigated the disparities in tourism competitiveness due to differences in tourism destination marketing. It believes that the improvement of the competitiveness of tourist destinations requires attention to marketing factors. It should strive to achieve a balance between strategic marketing objectives and sustainable tourism development. The authors of [33], with the help of the tourism environment competitiveness theory, discuss that the environment of the tourism destination is also an important part of the competitiveness of the tourism destination. Therefore, in the process of developing tourism, appropriate environmental management measures and methods should be carried out. This is also an important means to improve the competitiveness of tourist destinations.

3. Method

First, this work proposes an algorithm that utilizes an improved IPSO. It uses the particle fitness value to dynamically and nonlinearly change the inertia weight. At the same time, the particle swarm algorithm is improved by combining the particle iterative cycle to increase the position disturbance. Second, this work optimizes the initial weights and thresholds of the BP network based on IPSO to construct an IPSO-BP network. This work uses this network to evaluate the competitiveness of urban tourism, which can overcome the defects of traditional BP network.

3.1. BP Network. Backpropagation neural network is also known as BP network. Its construction includes hidden layers and input and output layers. The input layer mainly receives the incoming feature data. It is then transmitted to the hidden layer to complete the processing of the hidden layer and passed to the output layer, which completes the final processing. If an error occurs, the weight is altered, and the network is updated by input from the back to the front. The BP network operates on the principle of forward signal propagation and reverse error propagation. The initial feature input is routed through the input layer into the BP network. The outcomes of neuron processing in the hidden layer are finally delivered through the output layer. This is known as forward propagation. At this stage, the connection weight of the network has not changed, and its connection weight is related to the adjacent neurons. Then, if there is only forward propagation, its network accuracy and convergence cannot meet the requirements of target setting. Therefore, the error still needs to be propagated back. If there is an error between the output layer output and the known target, it is passed through the output layer to the next time of the network. The transmission process of the error is the adjustment process of the network to the neuron connection weights and thresholds, and its goal is to make the results more accurate. The structure of BP is demonstrated in Figure 1.

In the input stage, the signal is conducted through neurons. The initial information enters the entire network structure through the input layer and enters the hidden layer through the transfer matrix. After its comprehensive processing, it is passed to the output layer. The output layer completes the final processing of the signal through the activation function and outputs the result.

$$\begin{aligned} \hat{y}_i &= f\left(\sum_{i=1}^{M} w_i x_i + b_i\right), \\ \text{Loss} &= \sum_{i=1}^{M} \left(y_i - \hat{y}_i\right)^2. \end{aligned} \tag{1}$$

The network error is obtained by comparing the output with the measured value during the training phase. If the error is acceptable, the training is complete. When the output does not reach the preset threshold, backpropagation is performed to correct various parameters of the neural network.

$$\begin{aligned} w' &= \frac{w - \partial \text{Loss}}{\partial w}, \\ b' &= \frac{b - \partial \text{Loss}}{\partial b}. \end{aligned} \tag{2}$$

The BP algorithm can approximate any objective function under the premise of nonlinearity. Theoretically, it can achieve any small error precision value and is easy to

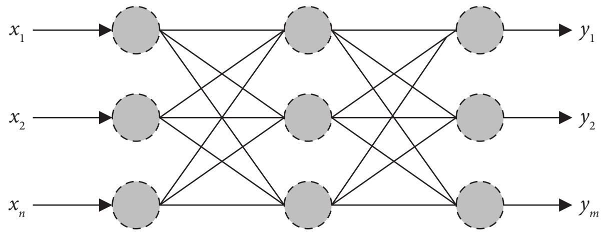

Figure 1: BP structure.

operate, with good generalization ability and strong fault tolerance. Although BP neural network has many advantages, it has some problems. First is random weight threshold for initially training the network. The initial values are all set by the algorithm using random functions. Even if the predefined network training error number is used to validate the output results, it is still possible to slip into a local optimum while the algorithm is running. This causes noticeable discrepancies between the hidden layer's transmission results and the output results, resulting in a considerable disparity between the algorithm's final output results and the predicted outcomes. Second, the algorithm is slow to converge. When the BP network's objective function is somewhat complex, increasing the learning rate of the training network cannot change the fact that the gradient of the error changes very little. As a result, the number of BP network training iterations is too many, and the overall training time becomes longer, and it may take hundreds or thousands of training to achieve the convergence effect. If the learning rate is small, more iterations are required for training, which will cause the training process and convergence time to become longer. If the learning rate is too large, it will cause the training network to diverge, so that the BP network algorithm cannot achieve convergence. Third, the network structure is difficult to build. The number of training network layers and nodes of the BP algorithm directly affects the convergence performance and running time of the algorithm. When the algorithm faces different data, how to build the network structure is particularly important. More and less neurons will produce two different effects. The effect of overfitting can occur if there are too many algorithms. If it is too small, it will directly affect the approximation effect of the algorithm in the training process. In addition, the setting of the network structure is also limited by the hardware device, and the overly complex network structure has very high requirements for the hardware device.

3.2. PSO Algorithm. PSO is an optimization algorithm, which uses Heppner's biological model to analyze, model, and simulate the flock behavior of birds. Its model is similar to most models at the level of group behavior research. It is assumed that all of the birds are in a chaotic flight state from the start, with no objectives and no planned courses. When a bird returns to its habitat, if the set perching threshold is higher than when it continues to accompany the flock, all of the birds will fly to the habitat independently to form another group. Birds use simple laws to decide where they fly and how quickly they fly. When one flies away from the population and returns to its habitat, the others also fly to the habitat. And once the habitat is found, it will not leave, and the entire population will stay here. Birds that first find habitat, and stay, will cause the surrounding population to fly towards their location. This greatly increases the probability that the entire population will find habitat. Such problems are analogous to finding the optimal solution to a particular problem, so Heppner's model was modified so that it could fly into space and find the optimal solution. The basic flow of the PSO algorithm is demonstrated in Figure 2.

The standard PSO algorithm is a global optimization algorithm, which integrates the swarm and optimization principles and optimizes through the fitness value of the particles. The PSO algorithm retains the population-based global search strategy, treating each individual as a particle without weight and volume in an n-dimensional search space. It also flies at a certain speed in the search space. The flight speed is dynamically adjusted by the individual flight experience and the group's flight experience. In each iteration, each particle adjusts its flight speed and position according to the following:

$$\begin{aligned} v_{id}^{t+1} &= wv_{id}^{t} + c_1 r_1 \left(p_{i\text{best}}^{t} - x_{id}\right) + c_2 r_2 \left(p_{g\text{best}}^{t} - x_{id}\right), \\ x_{id}^{t+1} &= x_{id}^{t} + v_{id}^{t+1}. \end{aligned} \tag{3}$$

The conventional PSO method has delayed convergence, particularly as the number of iterations grows. Second, it is quite easy to become trapped in a local optimum. Finally, a larger learning step will skip the target solution and lose the convergence target.

3.3. IPSO-BP Algorithm. Since the initial weight of the original BP network adopts the method of random assignment, it will cause the algorithm to converge slowly and easily fall into the local extreme value. In order to overcome this defect, this paper firstly improves the inertia weight and position update mechanism of PSO. The optimal solution obtained by the improved PSO algorithm is used as the initial weight of the BP network to construct IPSO-BP. Then, IPSO-BP is used as a prediction model for the evaluation of urban tourism competitiveness.

First, this paper suggests an adaptive inertia weight (AIW). The PSO algorithm's performance is directly tied to the parameter parameters. The inertia weight and two acceleration constants are the primary parameters. The inertia weight is critical in balancing the algorithm's global search capability and local development capability. Many researchers have dynamically changed w using the methods of each A to conform to the principles of nonlinear particle motion. Because the majority of these enhancements are proportional to the number of rounds, there will be flaws. First, the particle's inertia weight is only nonlinearly decreased as the number of repetitions increases. At the beginning of the iteration, the particle inertia weight is the largest, and at the end of the iteration, the particle inertia weight is the smallest. Such a simple change only allows the

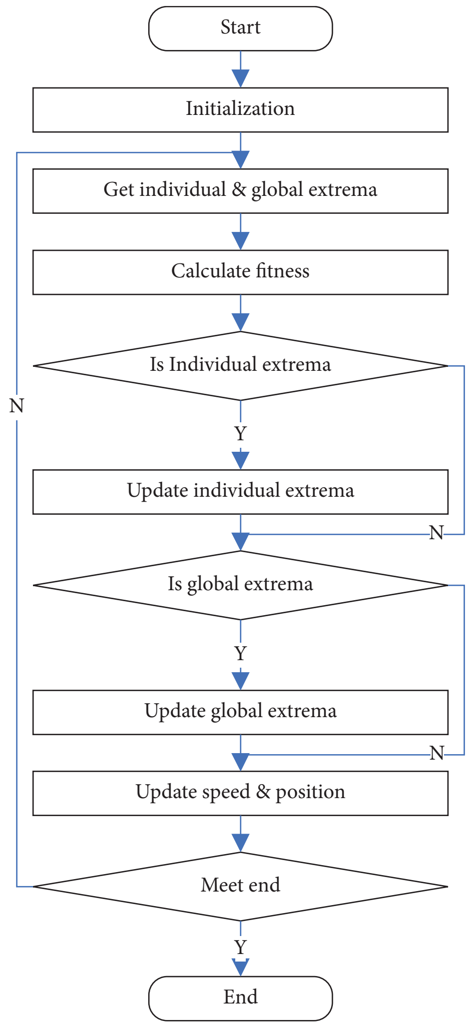

Figure 2: PSO pipeline.

particles to gradually decrease in each iteration and cannot reflect the repeated changes of particles in the iterative process. Second, the inertia weight changes of all particles in an iteration cycle refer to the number of iterations. Then, all particles in the same iteration cycle will only have the same inertia weight. This will reduce the diversity of particles, which is not conducive to particles seeking optimal solutions. In view of the above deficiencies, and combined with the minimization problem, the smaller the particle fitness value, the better the position of the particle. According to the fitness value of particles, this paper proposes an adaptive inertia weight strategy.

$$w = w_{\min} + \frac{(w_{\max} - w_{\min})\left(\ln f_i - \ln f_{gbest}\right)}{\left[6\left(\ln \overline{f} - \ln f_{gbest}\right)\right]}. \quad (4)$$

In this improved method, the inertia weight is a nonlinear dynamic change depending on the gap between the particle's fitness value and the optimal fitness value. This firstly overcomes the shortcoming that the inertia weight can only perform decreasing motion only by relying on the number of iterations. The inertia weight can be changed dynamically based on the difference between its own fitness value and the optimal fitness value. Because particles change based on their own fitness values, each particle has its own fitness value. Because of their own fitness values, particles in the same iteration cycle will have different inertia weights. This has a number of implications, including increasing the diversity of particle populations and seeking the best answer as quickly as possible. Simultaneously, the better method avoids the flaw in which the inertia weight of particles is greatest in the early iteration and lowest in the later iteration. This enables some particles with larger fitness values but not in the optimal range in the later iteration to enhance their global search ability through larger inertia weights, to break through their own limitations, and to find the optimal position again.

Second, this work uses the location perturbation factor (LPF). The standard PSO algorithm is often prone to fall into local optimum, and it is difficult to solve this problem effectively by simply relying on the adaptive dynamic inertia weight. This paper proposes to add a disturbance factor to the position update formula, so that the particle can effectively break through the local optimal defect in the update iteration and quickly find the global optimal range.

$$x_{id}^{t+1} = x_{id}^{t} + \left(\ln\left(\frac{t}{t_{\max}} + 1\right) + 1\right)v_{id}^{t+1}. \quad (5)$$

In the typical position update formula, the velocity is multiplied by a disturbance term. This permits the particles created to have a wider spread and to search the global space more thoroughly. Population updates that are only based on adaptive inertia weights appear monotonous. The fitness value and the number of iterations are combined in this paper to update the particles. This can combine the advantages of the interaction between the two, and the particles can update themselves with each iteration and each change of the fitness value. This enables the particles to comprehensively search for the optimal solution in the space and enhances the population diversity of the particles. This more effectively prevents particles from falling into local optima and improves the performance of particle swarms.

The main idea of the IPSO optimization BP network based on position disturbance of logarithmic function and adaptive inertia weight is to use the optimal solution obtained by IPSO as the initial weight and threshold of the BP network. The IPSO-BP is demonstrated in Figure 3.

4. Experiment

4.1. Data Information. This work collects the corresponding data on the tourism competitiveness of smart tourism cities, and the training set and the test set account for half each. The data information of each data sample is demonstrated in Table 1, and its corresponding label is urban tourism competitiveness.

4.2. IPSO-BP Training. First, this work trains the IPSO-BP network, which is an indispensable step. This work analyzes the network training process of IPSO-BP. The main analysis

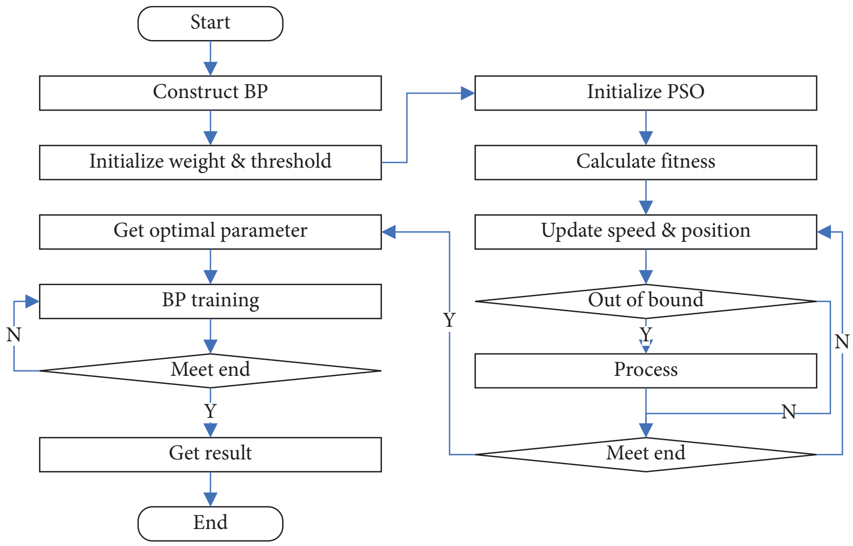

Figure 3: IPSO-BP pipeline.

Table 1: The data information.

Index	Information
x_1	Traffic capacity
x_2	Communication ability
x_3	Degree of openness
x_4	Medical ability
x_5	Economic environment
x_6	Ecosystem
x_7	Social environment
x_8	Demand scale
x_9	Cultural resource

data are the training accuracy and $F1$ score, as demonstrated in Figure 4.

With the increase in training times, the training accuracy and $F1$ score of the IPSO-BP network increased significantly. At this point, IPSO-BP has reached the convergence condition.

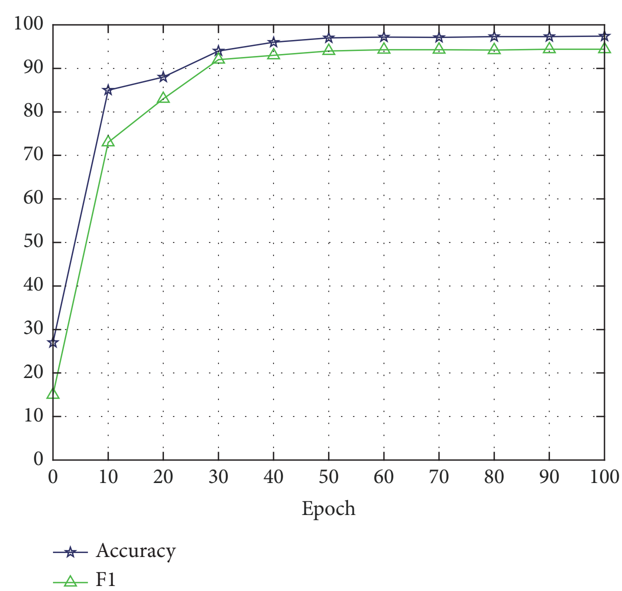

Figure 4: Training performance of IPSO-BP.

4.3. Method Comparison. To verify the superiority of IPSO-BP, this work compares it with other machine-learning algorithms. The experimental results are demonstrated in Figure 5.

In this paper, IPSO-BP outperforms other machine-learning algorithms in terms of evaluation performance. Compared with any other method, IPSO-BP can obtain corresponding performance improvement.

4.4. AIW Evaluation. IPSO-BP uses the AIW strategy. To verify the superiority of this strategy, this work compares the accuracy and $F1$ score without AIW and when AIW is used, as demonstrated in Figure 6.

Compared with the performance without AIW, after using the AIW strategy, IPSO-BP can achieve 1.6% improvement in accuracy rate and 1.70% improvement in $F1$ score.

4.5. LPF Evaluation. IPSO-BP uses the LPF strategy. To verify the superiority of this strategy, this work compares the accuracy and $F1$ score without LPF and when LPF is used, as demonstrated in Figure 7.

Compared with the performance without LPF, after using the LPF strategy, IPSO-BP can achieve 1.4% improvement in accuracy rate and 1.3% improvement in $F1$ score.

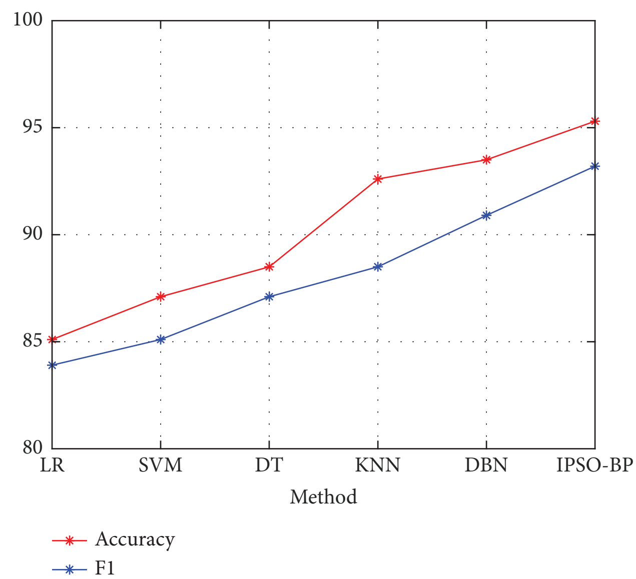

Figure 5: Method comparison.

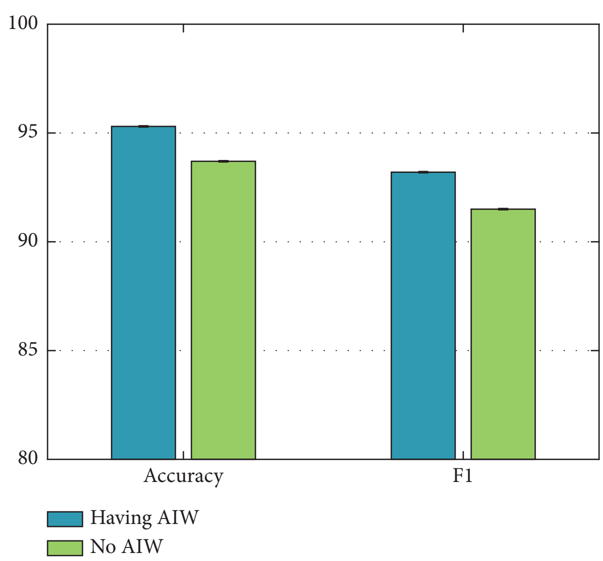

Figure 6: AIW evaluation.

4.6. IPSO Evaluation. This work firstly improves the PSO and then uses the improved IPSO to optimize the BP network. To verify the superiority of this measure, this work compares the performance of BP, PSO-BP, and IPSO-BP networks, respectively, as demonstrated in Table 2.

Clearly, the performance associated with the classic BP network is the weakest. The accuracy and *F*1 score can be enhanced to some level when applying PSO to optimize it. If the PSO is improved and the IPSO is used for the optimization of the BP network, the highest performance can be obtained.

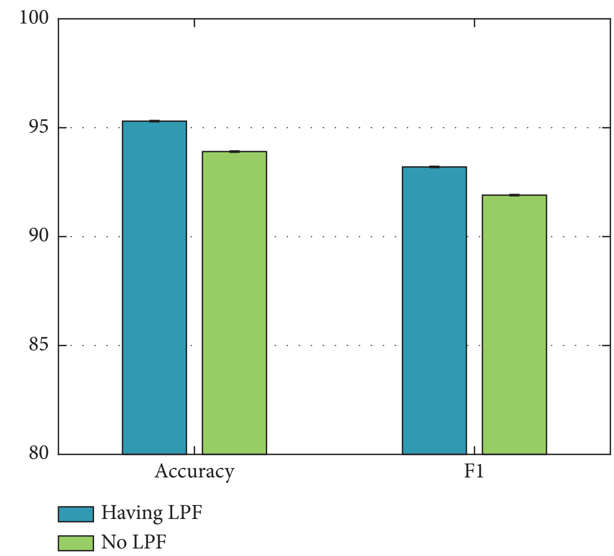

Figure 7: LPF evaluation.

Table 2: IPSO evaluation.

Network	Accuracy	*F*1 score
BP	90.80	89.70
PSO-BP	92.40	91.30
IPSO-BP	95.30	93.20

5. Conclusion

The continuous and in-depth development of information technology in the tourism industry has prompted the birth of the concept of smart tourism. In a smart tourism city, tourists are connected with the network. This enables a deeper understanding of the current tourism economy and related activities, so that tourism plans can be arranged and adjusted in real time and accurately. By perceiving as much travel information as possible, this increases the convenience and experience of travel. Against the backdrop of a thriving economy, the development of urban tourism faces numerous competitions and hurdles. Building a rigorous evaluation system of urban tourist competitiveness to improve urban tourism competitiveness is both theoretical and practical. This work uses a joint PSO and neural network to evaluate urban tourism competitiveness. First, this work proposes an algorithm that utilizes an improved IPSO. It uses the particle fitness value to dynamically and nonlinearly change the inertia weight. Simultaneously, the particle swarm technique is enhanced by combining the particle iterative cycle to boost position disturbance. Second, in order to build an IPSO-BP network, this work optimizes the initial weights and thresholds of the BP network based on IPSO. This paper uses this network to assess the competitiveness of urban tourism, which can compensate for the shortcomings of the standard BP network. Third, this work conducts systematic experiments on the IPSO-BP method, and the experimental results confirm the superiority of this method in the evaluation of urban tourism competitiveness.

Data Availability

The datasets used during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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