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Sports Industrial Structure and Industrial Layout Policy Choice Based on Internet of Things and Federated Learning

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Abstract

It determines which sports industry subindustries are appropriate for the selected model prefecture-level cities and what strategies or layouts the selected model prefecture-level cities employ in developing a sports industry. Under this premise, the research mainly focuses on the sports industry of a model prefecture-level city as the research object to conduct analysis. It organizes information about the industrial environment of the city through literature review and expert interviews and collects data on 63 sports events held in 2019 through field surveys of 100 stadiums and 69 sports training institutions. Traditional federated learning algorithms and frameworks perform badly in analyzing the sports industry structure, industrial layout policy selection, and other data-related scenarios. They also have significant shortcomings in terms of protection for privacy and communication efficiency. This paper mainly focuses on and enhances federated learning in the context of the Non-IID problem. Experimental results reveal that it is possible to increase the initial baseline of the global model by raising the complexity of the local sports industry structure and industrial layout policy selection models. Furthermore, proper local learning rates can improve the algorithm performance on Non-IID data and thus make the adaptive adjustment of the learning rate particularly valuable. In addition, by sharing specific datasets, the degree of Non-IID in the sports industry structure and industrial layout policy selection data can be reduced.

Keywords: internet of things, federal learning, sports industry, industrial structure, industrial layout

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1 Introduction

The sports industry is also part of the "five happiness industries." The interactive development between the sports industry and urbanization has increasingly become important under the influence of national strategies, such as "Fitness for All" and "Healthy China.".

From the point of view of favorable policies on the development of sports, measures like "encouraging large sporting goods manufacturing enterprises to increase investment in research and development" and "reducing or exempting corporate income tax for sporting goods manufacturing enterprises recognized as high-tech" have driven rapid growth of the sporting goods manufacturing industry and developed broad development opportunities for it. Favorable policies have also profoundly influenced the development of the sports competition and performance industry [1].

The sports industry is regarded as one of the most dynamic sunrise industries. It is among the fastest-growing sectors in the post-financial-crisis period and one of the key sectors globally to counter weak economic growth, with its development ranking among the top 10 sectors in national economic development [2, 3]. It is commonly associated with manufacturing and traditional service industries that foster employment and boost national well-being.

In developed economies, the industry's total output usually runs between 1% and 3% of GDP every year. For example, according to estimates in 2015, the total value of the U.S. sports industry was $498.4 billion, consisting of about 2.6% of GDP.

Overall, in line with its structure, industrial distribution, and federal online policy options, this sports industry should open up significant opportunities for growth in absolute terms and as a contributor to GDP. see [4–6].

2 Sports Industrial Structure and Industrial Layout Model Based on Federated Learning

On one hand, we can specify the concrete conditions and their relations. On the other hand, by investigating the influencing factors and interactive connotations, we can explain the connection between the sports industry and urbanization. We can also analyze the interaction mechanism in the coupled system [7]. In this regard, this model is constructed from the perspective of "realistic conditions – connection basis – influencing factors – interactive connotation – connection mode," as shown in Figure 1.

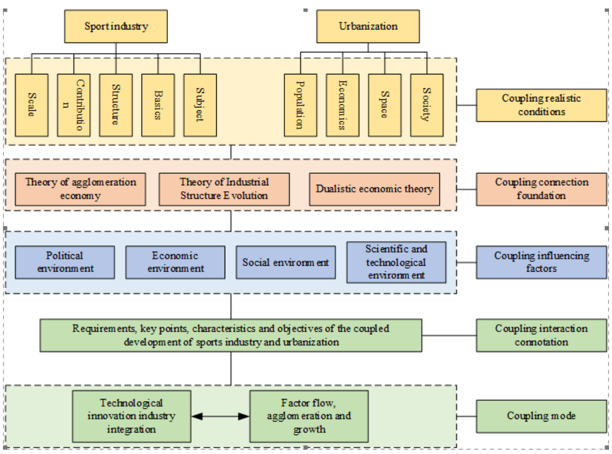

Figure 1. Coupling between sports industrial structure, industrial layout and urbanization

In this model, N data owners are defined $\{C_1, C_2, C_3, ..., C_N\}$, all data holders want to integrate their own data $\{D_1, D_2, D_3, ..., D_N\}$ Privacy protection or even regulatory constraints, so as to complete the macro model design of sports industry structure and industrial layout:

$$\begin{cases} Y_1 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + \ldots + a_{1m}X_m, \\ Y_2 = a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + \ldots + a_{2m}X_m, \\ \cdots, \\ Y_3 = a_{31}X_1 + a_{32}X_2 + a_{33}X_3 + \ldots + a_{3m}X_m. \end{cases} \tag{1}$$

If the $|V_{\text{fed}} - V_{sum}| < \delta$ condition is valid, the following formula can be used to calculate the complexity of sports industry layout:

$$X_i = X_j, \quad Y_i = Y_j, \quad I_i \neq I_j, \quad \forall\ D_i, D_j, \ \ i \neq j. \tag{2}$$

The model features are shown in Figure 2:

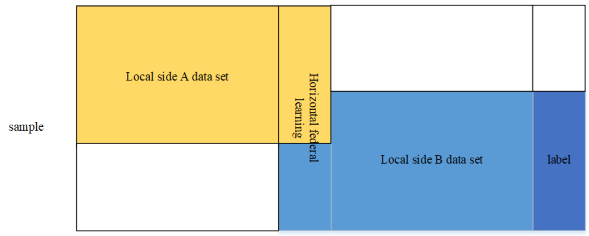

Figure 2. Horizontal characteristics of sports industry layout under federal learning algorithm

After determining the horizontal complexity of the sports industry layout, then the vertical depth has to be assessed as well. Users of institutions in sports cover most of the region's residents, causing extensive overlap among user spaces between institutions. For instance, banks house all data of income by users, while companies handling sports businesses keep records of users' surfing and buying history. Although their feature spaces are quite different, it is possible to merge these features effectively for modeling. Assuming that both parties wish to build a product purchase prediction model, vertical federated learning collects all these different features and applies the privacy protection mechanisms to calculate training loss and gradients. This problem is depicted in Figure 3. From this, it is also called feature-based federated learning, see for example [8, 9].

In summary, the vertical federated learning scenario is as follows:

$$X_i \neq X_j, \quad Y_i \neq Y_j, \quad I_i = I_j, \quad \forall D_i, D_j, \quad i \neq j. \tag{3}$$

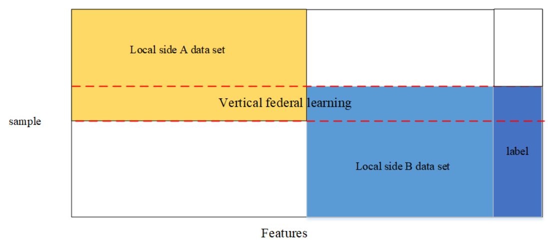

Figure 3. Vertical characteristics of sports industry layout under federal learning algorithm

This section introduces the whole federal learning system, based on these solutions, and applied to the sports program. The system aims to gather many participants in the sports industry to formulate modeling plans and finally standardize the modeling, improve the planning ability of the sports industry, and reduce project costs [10]. As illustrated in Figure 4, the entire system has been broken down into four layers: inconsistent data access, data processing, operator layer, ranking layer among the participants, and cross learning.

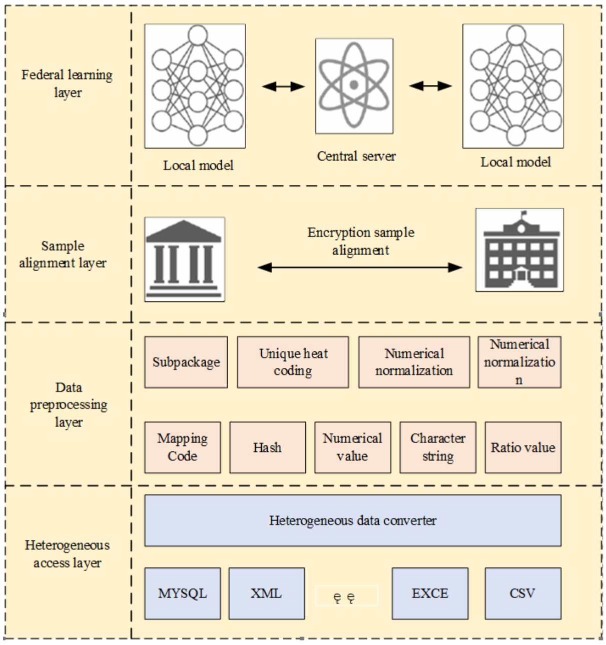

Figure 4. Sports industry layout federal learning framework

The heterogeneous data access layer transforms unstructured and inconsistent data storage formats within participants into a unified, structured big data platform. This platform could provide a consistent Hive interface to external systems for business and technical personnel to uniformly analyze. The data preprocessing layer, built upon the heterogeneous data access layer, encapsulates common data preprocessing methods like box splitting, one-hot encoding, numerical normalization, and missing value imputation. Within this layer, original values, strings, and ratio values are transformed into features suitable for input into the sports industry layout model through operator transformation. This separation of data preprocessing from the sports industry layout model makes the ability to iterate algorithms rapidly for modelers significantly enhanced.

Above this layer is the sample alignment layer, where parties agree to training samples without exchanging original data and ensures the parties are in agreement for modeling; this is done through asymmetric encryption technology. Once all parties determine the samples for modeling, joint modeling is done using the federated learning approach. The aggregation and distribution of gradients are facilitated by a trusted third-party platform, as illustrated in Figure 5.

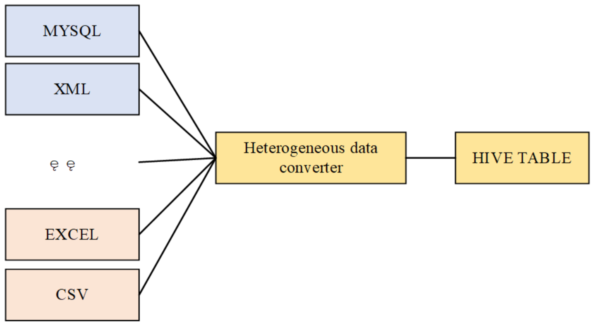

Figure 5. Phantom transformation of model data and sports industry layout

3 Methods

3.1 Evaluation index construction

From the view of systematology, the regional sports industry system is a complete and complex structure at many levels. Assessment of its development potential requires investigation of such complexity from several viewpoints and levels [11, 12]. Such a variety of influences includes social and cultural development, customs, and other systems in the region. All these dependencies should be considered within any scientific evaluation of the sports industry's potential.

It is important to note that the potential of the sports industry is not only determined by internal factors but also by its interaction with other regional systems. The sports diamond model divides the potential of the sports industry into three main areas: supply, demand, and integration. These are shown in Figure 6 to depict the depth and linkages of the sports industry to some extent.

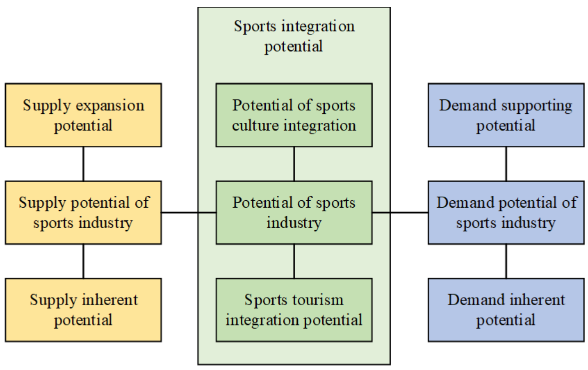

Figure 6. Analysis model of sports industry potential

In combination with the interview with some experts and scholars, the specific situation of Liaoning and the particularity of the sports industry, as shown in Table 1.

This paper screened the indicators by distributing the indicators listed in Table 1 to relevant experts, scholars, and professionals who were actively engaged in the management of sports industries, including model prefecture-level municipal sports bureaus, the Shenyang Municipal Sports Bureau, and the Dalian Municipal Sports Bureau. The Delphi method combined with email communication was implemented in the process. Experts were consulted to gauge how important and sensible the chosen indicator system appeared based on their theory as well as professional experience.

The particular process included the following: Experts were asked to choose 30–40 indicators from a total of 41 indicated indicators that best reflect the potential of the sports industry in the model prefecture-level cities. A questionnaire was distributed to 25 experts to rate all 41 indicators. If less than 30% of the experts chose an indicator, it was excluded.

Based on experts' comments, and calculating the membership degree, the preliminary list of 41 indicators had five indicators deleted and retained 36 indicators. Some of the deletions included:

- This is also because of the low authority and reliability of their statistical data sources. Number of sports organizations (D9), number of sports websites (D12), and urban residents' disposable time (D27).
- Students majoring in physical education, replaced with the number of students in ordinary colleges and universities, as most sports colleges and universities in the model prefecture-level cities concentrate in Shenyang, Dalian, and other large cities, making the indicator unpersuasive for other cities.
- Total urban population (D30) was considered redundant as it significantly duplicated total regional population (D29).

The indicators retained after preliminary screening are listed in Table 2.

3.2 Model operation and fitting analysis

Significant differences exist in various regions in China in terms of social and economic development. These differences have been shown to exist in different fields, such as infrastructure construction, the urbanization process, social governance, and industrial structure. At the same time, these disparities somewhat limit the upgrading of the mass consumption structure and the expansion of service consumption [13–16].

In the proposed system, the process is not sharing individual models. Instead, local models from each user are integrated into a centralized black-box model. This black box model is a meta-structure provided for the users by the cloud server. Users are not allowed to view the inside structure of the model but instead, can input data and receive outputs. In this regard, it adds further security to the data and prevents intermixing of different users' data through the local model. In this approach, the regional industrial structure analysis is done with the most accurate precision. System structure diagram Figure 7.

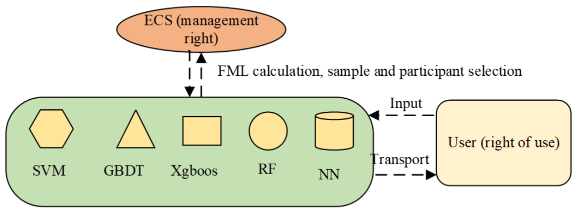

Figure 7. Integrated structure of sports industrial structure and industrial layout model

Although the virtual label R will be ignored in the global maximum model prediction problem and the calculation of FLM, adding (x, R) to the training will reduce $h_{i-}(x, y^-)$, because the trained h_{i-} will be more inclined to mark the sample x as R. The process is shown in Figure 8.

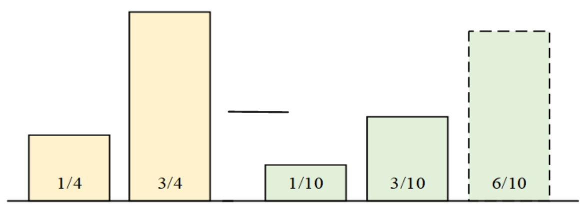

Figure 8. Correction confidence space of sports industrial structure and industrial layout model

4 Case study

4.1 Model accuracy analysis

Industrial layout by using Kronbach coefficient method. It can be seen from the analysis that Cronbach's Alpha=0.945 > 0.9 in the first round of expert consultation in this study shows that

	Level I indicators	Secondary indicators	Index name and number	Company
Evaluation index system of sports industry potential	Supply potential	Supply inherent potential	GDP (100 million yuan) (D1)	RMB100mn
			Sports Industry Planning (100 million yuan) (D2)	RMB100mn
			Number of employees in sports industry (person) (D3)	People
			Number of sports industry policies (D4)	Individual
			The government's position on the sports industry (D5)	Nothing
			Policy support for sports industry (D6)	Nothing
			Number of site facilities (D7)	Individual
			Area of site facilities (D8)	Square meter
			Number of sports organizations (D9)	Individual
			Number of patents submitted (D10)	Individual
			Scientific research investment (D11)	Zhang (volume)
		Supply expansion potential	Number of sports websites (D12)	Individual
			Number of athletes above Grade A (D13)	Individual
			Number of referees above Grade I (D14)	Individual
			Number of international and national sports events (D15)	Individual
			Number of medals won in international and national sports events (D16)	Individual
			Ratio of the number of college students to the total number of college students (D17)	Percentage
	Demand potential	Demand inherent potential	Number of social sports instructors (D18)	Individual
			Population of mass sports (D19)	Individual
			Sales of sports lottery (100 million yuan) (D20)	RMB100mn
			Community health service institutions (D21)	Individual
			Participation rate of residents in sports and fitness activities (D22)	Percentage
			Satisfaction rate of residents' physical fitness activities (D23)	Percentage
			Awareness rate of residents' physical fitness activities (D24)	Percentage
		Demand supporting potential	Per capita disposable income in cities and towns (D25)	Element
			Urban per capita consumption expenditure (D26)	Element
			Disposable time of urban residents (D27)	Hour
			Savings of urban residents (D28)	Element
			Total regional population (D29)	Individual
			Total urban population (D30)	Individual
			Number of students in institutions of higher learning (D31)	Individual
	Integration potential	Tourism integration		Individual
				10000 person times

Table 1. Sports industry layout and development indicator system

Level I indicators	Secondary indicators	Index name and number	Company
Supply potential	Supply inherent potential	Gross regional product (D1)	RMB100mn
		Scale of sports industry (D2)	RMB100mn
		Number of employees in sports industry (D3)	People
		Number of sports industry policies (D4)	Individual
		The government's position on the sports industry (D5)	Nothing
		Policy support for sports industry (D6)	Nothing
	Supply expansion potential	Number of site facilities (D7)	Individual
		Area of site facilities (D8)	Square meter
		Number of patents granted (D9)	Individual
		Scientific research investment (D10)	Zhang (volume)
		Number of athletes above level 2 (D11)	Individual
		Number of referees above second level (D12)	Individual
		Number of international and national sports events held (D13)	Individual
		Number of medals won in international and national sports events (D14)	Individual
Demand potential	Demand inherent potential	Number of social sports instructors (D15)	Individual
		Population of mass sports (D16)	Individual
		Sales of sports lottery (D17)	RMB100mn
		Community Health Service Agency (D18)	Individual
		Participation rate of residents in sports and fitness activities (D19)	Percentage
		Satisfaction rate of residents' physical fitness activities (D20)	Percentage
		Awareness rate of residents' physical fitness activities (D2)	Percentage
	Demand supporting potential	Per capita disposable income in cities and towns (D22)	Element
		Urban per capita consumption expenditure (D23)	Element
		Savings of urban residents (D24)	Element
		Total regional population (D25)	Individual
Integration potential	Tourism integration potential	Annual number of tourists received (D28)	10000 person times
		Total tourism income (D29)	RMB100mn
		Annual days of good air quality (D30)	Day
		Number of cultural venues (D31)	Individual
	Cultural integration potential	Number of people under the Culture, Sports and Entertainment Act (D32)	Individual
		Individual households in culture, sports and entertainment industry (D33)	Individual
		Types of newspapers, periodicals and books (D34)	species
		Number of cable TV households (D35)	10000 households
		Number of mobile phone users (D36)	10000 households

Table 2. Sports industrial structure and industrial distribution indexes after screening

the questionnaire designed in this survey has high reliability, as shown in Table 3 and Table 4.

Cronbach's alpha	Number of items
0.945	44

Table 3. Reliability statistics

The coordination degree of opinions expressed by experts on the sports industrial structure and industrial layout model is tested to determine whether experts'

Indicator layer D	Shenyang	Dalian	Anshan	Fushun	Benxi	Ying Kou	Fuxin	Liaoyang	Tieling	Dandong	Jinzhou	Panjin	Huludao	Chaoyang
GDP (100 million yuan) D1	7281	7731.7	2348	1216.6	1164.62	1513.9	542.2	1029.3	740.8	984.8	1357.6	1267.8	720.3	862.8
Sports industry scale (100 million yuan) D2	186.7	201.3	93.5	10	10.59	10.82	11.28	11.9	7.5	10.7	13.3	10.9	7.5	3.3
3.3Number of employees in sports industry (person) D3	30168	30072	11325	6322	5759	8904	5021	5010	6018	6323	7097	6038	5862	6816
Number of sports industrial policies (nos.) D4	1	4	1	1	1	1	1	1	1	1	1	1	1	1
The government's position on the sports industry D5	Football City Sports Core Area	Blue sports core area of foot, volleyball, tennis and swimming	Military feather	Bing pang, Jian	Blue ball, soldier feather, net	Volleyball, swimming	Basketball City	Bodybuilding		Tennis, health	Blue and volleyball badminton sports business core	Football	Swimming	
	1	4	2	2	4	2	1	1	0	2	3	1	1	0
Number of venues D6	9514	9572	3644	2095	1172	1718	3245	1768	3015	2285	2614	1658	3118	2452
Per capita facility area (m2) D7	1.3	2.48	1.59	1.17	1.39	2.17	1.52	1.27	1.46	1.83	1.77	2.2	1.95	1.23
Number of athletes above level 2 D8	185	174	190	163	179	205	192	214	218	207	183	177	208	234
Number of referees above Grade II D9	146	106	77	57	99	180	166	72	97	146	132	99	136	180
Number of medals in major sports events D10	213	325	99	25	190	148	139	252	69	278	124	37	22	122
Number of community sports instructors (10000 persons D11	2.2	2.1	1.3	0.7	0.5	0.5	0.6	0.5	0.4	0.3	0.6	0.3	0.3	0.2
Number of annual patents granted D12	9035	7182	2289	617	284	997	628	82	528	554	1147	1290	563	197
Scientific research investment (100 million yuan) D13	201	186	114	28	106	16.7	106	8.7	20	23	88	59	44	22
Number of mass fitness activities D14	2400	1011	925	794	293	794	295	42	828	602	458	32	42	248
358S234ales volume of sports lottery (100 million yuan) D15	14.47	17.6	2.2	1.2	0.66	1.2	1.37	1.2	2.2	1.4	1.37	1.7	1.9	1.8
Community health service institutions D16	137	128	24	120	36	100	113	69	121	87	25	74	92	84
Participation rate of residents in sports and fitness activities (percentage) D17	72.3	68.8	53.8	42.7	44.8	50.2	55.8	37.6	57.8	35.5	43.3	30.3	62.5	53.3
Residents' satisfaction with sports and fitness activities (percentage) D18	73.2	81.5	61.5	55.7	49.6	52.7	47.8	46.6	43.8	43.2	49.8	43.8	42.8	42.8
Residents' awareness of sports and fitness activities (percentage) D19	83.8	68.6	53.5	49.6	30.5	47.8	50.3	54.9	44.8	43.6	47.3	42.6	45.6	40.4
Urban per capita disposable income (yuan) D20	36644	35888	29944	26819	27722	30459	22663	26388	20692	24725	27042	32468	24769	21221
Urban per capita consumption expenditure (yuan) D21	25872	25825	23685	18369	19742	20250	19738	18928	13584	16316	19752	23569	15522	11350
Savings of urban residents (100 million yuan) D22	14035.5	13865.4	1956.9	1078.9	762.8	23132	622.9	878.8	809.5	1239.8	1200.5	863.5	975.9	1036
Total regional population (10000 persons) D23	829.2	594.7	347	215.9	151.3	232.7	177.9	179	301.5	239.3	302.7	129.5	280.3	340.8
Number of students in Xiang tong University (10000) D24	44.9	33.2	3.6	4.5	2.4	0	4.6	0.6	2	2.9	8.6	0.8	0.8	0.5
Number of vertical scenic spots (No.) D25	75	52	23	23	21	18	13	13	11	27	27	14	22	36
Annual number of tourists received (10000 person times) D26	9219.3	6829.3	5049	2696.8	2305.8	2112.6	1007.2	1949.6	1704.9	3889	2078.3	2005.2	1829.5	1716
Total tourism income (100 million yuan) D27	1222.3	1009.8	553	223.6	242.8	186.2	69.4	159.4	117.2	512.8	154.2	169	147	129.9
Annual days of good air quality (days) D28	208	272	234	262	275	245	268	249	253	306	245	262	345	304
Number of cultural venues D29	51	45	23	18	16	20	23	38	24	21	16	19	38	44
Number of people in culture, sports and music laws (number) D30	1814	1647	726	285	345	333	552	195	260	452	1013	305	407	472
Number of Individual Households of Culture, Sports and Houle Industry (Nr.) D31	3193	1407	607	795	568	547	1645	355	644	734	1289	395	853	735
Types of Paper, Periodicals and Books D32	66	54	16	8	6	9	10	16	9	7	15	4	5	5
Number of cable TV households (10000 households) D33	279	227	82	20	16	57.1	16	18.7	18	33	59.2	29	42	61
Number of mobile phone users (10000) D34	1349.4	726.3	335.2	201	166	203.2	139.9	186.2	226	196.5	222.7	175.6	200.6	179

Table 4. Data table of sports industry layout and structure analysis indicators

opinions are consistent. Coordination degree among experts refers to how well aligned different experts are in opinions on the same issue. Generally, a high degree of consistency among experts shows that the resultant is very close to the actual situation.

The W coefficient ranges between 0 and 1 and evaluates the consistency of expert opinions. With a higher W value closer to 1, the coordination process among experts receives high levels of assessment, which in turn provide more accurate outcomes for the system of the indicator. The results of the coordination degree analysis are presented in Table 5.

From the Table 5, it is shown that the p-value for two rounds of W coefficient tests is strong at $p = 0.000 < 0.05$. This therefore indicates that the various assessments are highly consistent. Again, the W coefficients for both rounds are 0.235 and 0.246, respectively, which lie between 0–1. This also gives a high evaluation consistency scale.

The coefficient of variation reflects the dispersion of experts' evaluations. For all the indicators, a high coefficient of variation mostly speaks of a level of insufficient coordination. Having analyzed data from the first round of expert consultation, it was determined that the coefficient of variation for all the indicators was less than 0.2, so no indicators were deleted at this stage. In addition, indicators with an average value of less than 4 were treated as being of average importance and marked as having to be further probed during the second round. Details are given in Table 6, where * indicates those with an average value of less than 4.

4.2 Model Validity Analysis

To measure the performance of the algorithm, 20 different random seeds were prepared for multiple experiments, and the range of variation is plotted on the variation curve. In the experimental testing of the algorithm, first, the system calibration process was tested to evaluate the working state of the system under six Non-IID scenarios using the Fashion MNIST dataset. The detailed information of the scenario setting is given in Table 7.

The experimental setup was set with a maximum number of sample corrections in an iterative process set to 100, the number of clients to 10, and heterogeneous models assigned to local users. The models included

Round	Coordination coefficient (Kendall Wa)	Chi square	P value
First round	0.236	118.523	0.000
Second round	0.247	113.169	0.000

Table 5. Consistency test of expert investigation

Index	Mean value	Standard deviation	Coefficient of variation
1. Basic competitiveness	4.68	0.493	0.12
2. Resource competitiveness	4.68	0.493	0.12
3. Environmental competitiveness	4.09	0.794	0.20
4. Core competitiveness	4.76	0.623	0.14
1.1 Economic development level	4.93	0.288	0.07
1.2 Living standard of residents	4.59	0.516	0.12
2.1 Human Resources	4.43	0.902	0.22
2.2 Transportation resources	4.34	0.652	0.16
2.3 Infrastructure resources	4.76	0.453	0.11
3.1 Supporting capacity of relevant industries	4.43	0.516	0.13
3.2 Government input	4.18	0.719	0.18
4.1 Industrial scale	4.52	0.523	0.13
4.2 Industrial structure	4.43	0.516	0.13
4.3 Industrial benefits	4.84	0.392	0.09
4.4 Industrial characteristics	4.84	0.392	0.09
4.5 Industrial cooperation	4.18	0.719	0.18
1.1.1 GDP per capita	4.34	0.652	0.16
1.1.2 GDP growth rate	4.09	0.516	0.14
1.2.1 Proportion of per capita sports consumption in disposable income	4.43	0.516	0.13
2.1.1 Proportion of urban population	4.02	0.604	0.16
2.1.2 Number of college students	3.68	0.652	0.19
2.2.1 Road density	4.02	0.738	0.19
2.2.2 Railway density	3.93	0.670	0.18
2.3.1 Sports ground area per capita	4.59	0.516	0.12
2.3.2 Number of sports venues per capita	4.43	0.668	0.16
3.1.1 Domestic tourism income	4.09	0.794	0.20
3.12 Value added of cultural industry	4.09	0.516	0.14
321 Proportion of cultural, sports and entertainment expenditure in financial expenditure	4.52	0.523	0.13
322 Actual use amount of sports lottery public welfare fund	4.01	0.604	0.16
4.1.1 Total scale of sports industry	4.59	0.516	0.12
4.1.2 Added value of sports industry	4.68	0.493	0.12
4.1.3 Number of legal entities in sports industry	4.34	0.652	0.16
4.2.1 Proportion of added value of sports industry in GDP	4.34	0.652	0.16
4.2.2 Proportion of total scale of sports service industry	4.43	0.516	0.13
4.31 Contribution rate of sports industry to economy	4.43	0.670	0.16
4.3.2 Contribution of sports industry to employment	4.52	0.523	0.13
4.4.1 Number of national sports industry bases	4.18	0.719	0.18
4.4.2 Number of sports tourism featured projects	4.43	0.670	0.16
4.51 Number of sports industry cooperation policy documents	4.43	0.670	0.16
4.5.2 Number of sports events, leisure activities and summit forums jointly held by the urban agglomeration	4.26	0.755	0.19

Table 6. Relative error results of model operation

six 3-layer convolutional CNN networks optimized using SGD (learning rate of 0.01), one SVM, one GBDT, one Boost, and one RF. On the client side, local models were preheated for 10 epochs with the local model, and the locally generated models were preheated for 50 epochs using local data. The initial state of the local model preheating is shown in Table Table 7. The entire experiment was repeated with different random seeds for 10 trials.

Under different scenarios, the precision change curves of the sports industrial structure and industrial layout model system are shown in Figures 9 and 10.

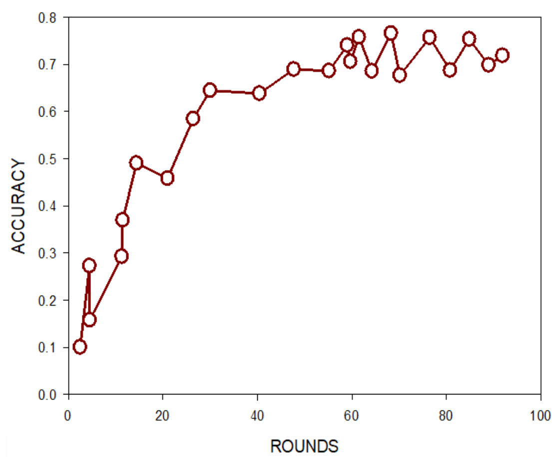

Figure 9. System accuracy change curve (M=1)

5 Conclusion

The key to fostering the effective integration of the sports industry with urban development lies in considering spatial and temporal dynamics, such as the characteristics of the sports industry and urbanization, in order to encourage high-quality

Scene NameNumber of	Customers	Data division	Correction times	Local model	Generator
IID	10	IID Settings	100	CNN, CNN,	W-GAN
Non IID A	10	9 Label equalization	100	CNN, CNN,	W-GAN
Non IID B	10	7 Label equalization	100	CNN, CNN,	W-GAN
Non IID C	10	7 Label equalization	100	SVM, GBDT,	W-GAN
Non IID D	10	5 Label equalization	100	XG Boost, Random	W-GAN
Non IID E	10	2 Label equalization	100	Forest	W-GAN

Table 7. Analysis of experimental scenarios

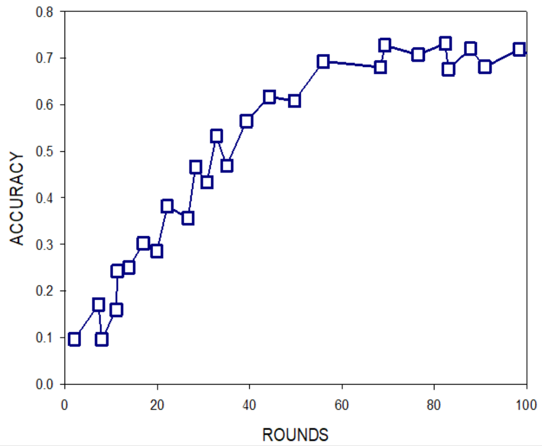

Figure 10. System accuracy variation curve (M=2)

development. Through the spillover effects of technological innovation and industrial integration, the interaction between the sports industry and urbanization can reach a synergistic relationship. Growth factors, thus, may advance urbanization through their flow.

In a comparative experiment on generation model selection, appropriate epochs and choosing the right generation model gave the researchers a balance between computational effort and accuracy. Concerning communication costs, traditional federated learning's aggregation demand results in more communication models, which clearly, significantly increases traffic compared to approaches such as sample sharing and FedEG. FedEG, through its purposeful correction process, increases the accuracy and specificity of sample selection and transmission. Hence, FedEG represents lower traffic consumption than the sample sharing strategy.

Data Availability

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

Conflicts of Interest

The author declares no conflict of interest regarding this work.

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