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Fuzzy clustering analysis-based Chinese sports public services fiscal guarantee development research-take hubei province as an example

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ABSTRACT

After year 2008 Olympic Games, sports public services have sprung up into people's view. Increment of sports facilities, sports fields has brought health and pleasure for people's life. With nation increasing input in sports public services, more people start to focus on sports public services fiscal guarantee problems. The paper takes Wuhan city, Huanggang city, Yichang city, Xiaogan city and Shennongjia of Hubei province such five places as research objects, comprehensive considers sports public services fiscal guarantee problems from sports fields total amount, sports fields areas, sports fields per capita area and sports public service gross investment four aspects. Utilize fuzzy comprehensive clustering analysis method, carry out dynamic clustering on above five places sports public services fiscal guarantee levels, obtained dynamic clustering graph will provide theoretical basis for such kind of problems further researches.

KEYWORDS

Sports public service; Fiscal guarantee; Hubei province; Fuzzy clustering.

INTRODUCTION

Now, China is gradually moving towards world power. Chinese people not only just have material demands, but also have spiritual civilization requirements. China now is a stage of constructing comprehensive well-off society, government investment on all kinds of public services construction has gradually increased. Sports as one part of ordinary people's life, its public services construction have attracted high attentions from government and people of all circles of society.

In 2013, Gao Kui-Ting in the article " Urban and rural sports public services equalization evaluation indicator system construction research", on the basis of referencing lots of relevant literatures, applied KPI method, screened out constructing sports public services equalization evaluation indicators, used analytic hierarchy process method to define all factors weights. To reduce assigned weights subjective influences, the author utilized RSR method to calculate weights. Finally, utilized fuzzy comprehensive evaluation method, researched on Shandong Weifang urban and rural sports public services, research results showed Qingzhou town of Weifang city urban and rural sports public service level was normal.

In 2012, Liu Su in the article "Sports public service equalization implementation path research", from the perspective of fiscal law guarantee, researched on sports publics' services equalization implementation path. The article pointed out that in recent years, sports public services fiscal expenditure was continuous decreasing, sports public services power and property ownership appeared serious asymmetry, system of transferring payment from exchequer was not reasonable. For the phenomenon, author put forward corresponding suggestions that unified power and property ownership, defined system of transferring payment from exchequer, established completed fiscal monitoring system, and set up financial budget system that public could participate in.

In 2011, Tang Ji-Lan in the article "Chinese basic public sports services equalization research", adopted multiple research methods, researched present Chinese basic public sports services non-equalization reasons. Chinese public sports services equalization status overall performance was :Eastern developed regions and middle part undeveloped regions, cities and countryside, schools and societies had significant differences. In view of macroscopic, citizen public services demands deficiency, right and interest expression mechanism deficiency, government public service functions fulfillment process deficiency. In view of micro -scopic, basic public services input was seriously imbalances, basic public sports services construction had mismatching phenomenon, basic public sports service network had partition phenomena.

In 2013, Zhao Yue in the article "Chongqing city urban and rural sports public service equalization research" took Chongqing city urban and rural sports public services as research objects. By investigating Chongqing city urban and rural sports public services status, the author found that government fiscal input on urban and rural sports public services had larger differences. Though supply system had established, total supplies were obviously insufficient. The author pointed out, causes for such phenomenon included reformation of system of tax distribution was not in place, urban and rural economic development was imbalanced, fiscal input deflected from masses sports public interest.

The paper will select Hubei province as research objects, from the perspective of public finance, research on Chinese sports public services fiscal guarantee problems.

MODEL ESTABLISHMENT

Sports public services was the generic terms of certain sports public products, sports fields, apparatus and other relevant services that could provide for people. Its aims are to meet social share demands; they don't have competitiveness and exclusiveness. By far, sports public services fiscal guarantee development level is uneven, the purpose of establishing the model is making classification of different sports public services fiscal guarantee levels, so as to easy to propose targeted improving opinions in later period.

In TABLE 1, data is from the article"Hubei province sports public services equalization fiscal guarantee mechanism research". In TABLE 1, all total number of sports fields, sports fields areas, sports fields per capita area and sports public services total investment reflect Hubei province government investment status on sports public services.

TABLE 1 : Hubei province five places sports public services input status

City	Total number of fields	Field area m^2	Per capita area m^2	Total investment amount (ten thousand Yuan)
Wuhan city	5470	11934682	1.51	323045.3
Huanggang city	4789	6275710	0.87	24683.7
Yichang city	355	5463289	1.37	62023.96
Xiaogan city	1995	3280329	0.65	16185.5
Shennongjia	85	55151	0.7	391

Fuzzy clustering analysis

In daily life, we tend to need classifying multiple indicators according to certain criterions. But in most cases, classification limits are not very obvious, therefore fuzzy clustering analysis application in practice is very widely.
Fuzzy clustering analysis generally has following steps:

(1) Establish matrix

Set classified object is $U = \{u_1, u_2, \cdots, u_n\}$, every object has m pieces of indicators to show its shape:

$$x_i = \{x_{i1}, x_{i2}, \cdots, x_{im}\},\ i = 1,2,\cdots,n \quad (1)$$

Therefore it appears matrix:

$$X = (x_{ij})_{n\times m} \quad (2)$$

In real application, different data correspond to different dimensions, to easier comparing data, it needs to normalize data; in the following it introduces some common normalization methods.

Method that standardized standard deviation:

$$x_{ij}^{'} = \frac{x_{ij} - \overline{x_j}}{s_j},\ i = 1,2,\cdots,n;\ j = 1,2,\cdots,m \quad (3)$$

Among them

$$\overline{x_j} = \frac{1}{n}\sum_{i=1}^{n} x_{ij},\ s_j = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(x_{ij} - \overline{x_j}\right)^2} \quad (4)$$

Range orthonormal method:

$$x_{ij}^{'} = \frac{x_{ij} - \min\{x_{kj}\}}{\max\limits_{1\le k\le n}\{x_{kj}\} - \min\limits_{1\le k\le n}\{k_{kj}\}},\ i = 1,2,\cdots,n;\ j = 1,2,\cdots,m \quad (5)$$

Range standardized method:

$$x_{ij}^{'} = \frac{x_{ij} - \overline{x_j}}{\max\limits_{1\le k\le n}\{x_{kj}\} - \min\limits_{1\le k\le n}\{k_{kj}\}},\ i = 1,2,\cdots,n;\ j = 1,2,\cdots,m \quad (6)$$

Maximum value normalized method:

$$x_{ij}^{'} = \frac{x_{ij}}{\max\limits_{1\le k\le n}\{x_{kj}\}},\ i = 1,2,\cdots,n;\ j = 1,2,\cdots,m \quad (7)$$

(2) Fuzzy similar matrix establishment

Establish x_i and x_j similarity level r_{ij} generally has following methods.

Similarity coefficient method includes included angle cosine method and correlation coefficient method.

(a) Included angle cosine method:

$$r_{ij} = \frac{\sum_{k=1}^{m} x_{ik}x_{jk}}{\sqrt{\sum_{k=1}^{m} x_{ik}^2}\sqrt{\sum_{k=1}^{m} x_{jk}^2}} \quad (8)$$

(b) Correlation coefficient method:

$$r_{ij}=\frac{\sum_{k=1}^{m}\left|x_{ik}-\overline{x_i}\right|\left|x_{jk}-\overline{x_j}\right|}{\sqrt{\sum_{k=1}^{m}x_{ik}^2}\sqrt{\sum_{k=1}^{m}x_{jk}^2}} \tag{9}$$

Distance method:

In general, when using distance method, $r_{ij}=1-c\left(d\left(x_i,x_j\right)\right)^{\alpha}$, c,α are selected suitable parameters that let $0\le r_{ij}\le 1$ to be true. The method used distance $d\left(x_i,x_j\right)$ computational method is as following:

(a) Euclidean distance:

$$d\left(x_i,x_j\right)=\sqrt{\sum_{k=1}^{m}\left(x_{ik}-x_{jk}\right)^2} \tag{10}$$

(b) Hamming distance:

$$d\left(x_i,x_j\right)=\sum_{k=1}^{m}\left|x_{ik}-x_{jk}\right| \tag{11}$$

(c) Chebyshev distance:

$$d\left(x_i,x_j\right)=\max_{1\le k\le m}\left|x_{ik}-x_{jk}\right| \tag{12}$$

Close degree method includes geometric average minimum method, maxi-min method and arithmetic average minimum method, the methods is as following:

(a) Geometric average minimum method:

$$r_{ij}=\frac{\sum_{k=1}^{m}\left(x_{ik}\wedge x_{jk}\right)}{\sum_{k=1}^{m}\sqrt{x_{ik}x_{jk}}} \tag{13}$$

(b) Maxi-min method:

$$r_{ij}=\frac{\sum_{k=1}^{m}\left(x_{ik}\wedge x_{jk}\right)}{\sum_{k=1}^{m}\left(x_{ik}\vee x_{jk}\right)} \tag{14}$$

(c) Arithmetic average minimum method:

$$r_{ij}=\frac{\sum_{k=1}^{m}\left(x_{ik}\wedge x_{jk}\right)}{\frac{1}{2}\sum_{k=1}^{m}\left(x_{ik}+x_{jk}\right)} \tag{15}$$

(3) In the meanwhile of clustering meanwhile, making dynamic clustering graph

Though fuzzy clustering methods are quite a lot, in general it selects transitive closure method, its steps are:

(a) Solve fuzzy similar matrix R transitive closure matrix $t(R)$;

(b) Carry out clustering analysis according to λ value sizes;

(c) Draw dynamic clustering graph.

Mold establishment process

By TABLE 1, it is clear $U=\{x_1,x_2,x_3,x_4.x_5\}$ make classification on these five traditional sports events, select self proportions as standard, and look for Hubei province five places classification path.

At first, according to TABLE 1 data, it constructs characteristic indicator matrix X^*:

$$X^* = \begin{bmatrix} 5470 & 11934682 & 1.51 & 323045.3 \\ 4789 & 6275710 & 0.87 & 24683.7 \\ 355 & 5463289 & 1.37 & 62023.96 \\ 1995 & 3280329 & 0.65 & 16185.5 \\ 85 & 55151 & 0.7 & 391 \end{bmatrix} \quad (16)$$

Adopt maximum normalization method to normalize original data as:

$$X^* = \begin{bmatrix} 4.6\times10^{-4} & 1 & 1.23\times10^{-7} & 2.7\times10^{-2} \\ 7.6\times10^{-4} & 1 & 1.4\times10^{-7} & 3.9\times10^{-3} \\ 6.5\times10^{-5} & 1 & 2.5\times10^{-7} & 1.1\times10^{-2} \\ 6.1\times10^{-4} & 1 & 2.0\times10^{-7} & 4.9\times10^{-3} \\ 1.5\times10^{-3} & 1 & 1.3\times10^{-5} & 7.0\times10^{-3} \end{bmatrix} \quad (17)$$

And then use maxi-min method to construct fuzzy similar matrix, the computational process is as following:

$$r_{12}=\frac{\sum_{k=1}^{4}(x_{1k}\wedge x_{2k})}{\sum_{k=1}^{4}(x_{1k}\vee x_{2k})}=\frac{4.6\times10^{-4}+1+1.23\times10^{-7}+3.9\times10^{-3}}{7.6\times10^{-4}+1+1.4\times10^{-7}+2.7\times10^{-2}}=0.9772 \quad (18)$$

$$r_{23}=\frac{\sum_{k=1}^{4}(x_{2k}\wedge x_{3k})}{\sum_{k=1}^{4}(x_{2k}\vee x_{3k})}=\frac{6.5\times10^{-5}+1+1.4\times10^{-7}+3.9\times10^{-3}}{7.6\times10^{-4}+1+2.5\times10^{-7}+1.1\times10^{-2}}=0.9923 \quad (19)$$

$$r_{24}=\frac{\sum_{k=1}^{4}(x_{2k}\wedge x_{4k})}{\sum_{k=1}^{4}(x_{2k}\vee x_{4k})}=\frac{6.1\times10^{-4}+1+1.4\times10^{-7}+3.9\times10^{-3}}{7.6\times10^{-4}+1+2.0\times10^{-7}+4.9\times10^{-3}}=0.9989 \quad (20)$$

$$r_{34}=\frac{\sum_{k=1}^{4}(x_{3k}\wedge x_{4k})}{\sum_{k=1}^{4}(x_{3k}\vee x_{4k})}=\frac{6.5\times10^{-5}+1+2.0\times10^{-7}+4.9\times10^{-3}}{6.1\times10^{-4}+1+2.5\times10^{-7}+1.1\times10^{-2}}=0.9934 \quad (21)$$

$$r_{13}=\frac{\sum_{k=1}^{4}(x_{1k}\wedge x_{3k})}{\sum_{k=1}^{4}(x_{1k}\vee x_{3k})}=\frac{6.5\times10^{-5}+1+1.23\times10^{-7}+1.1\times10^{-2}}{4.6\times10^{-4}+1+2.5\times10^{-7}+2.7\times10^{-2}}=0.9840 \quad (22)$$

$$r_{14} = \frac{\sum_{k=1}^{4}(x_{1k} \wedge x_{4k})}{\sum_{k=1}^{4}(x_{1k} \vee x_{4k})} = \frac{4.6\times10^{-4} + 1 + 1.23\times10^{-7} + 4.9\times10^{-3}}{6.1\times10^{-4} + 1 + 2.0\times10^{-7} + 2.7\times10^{-2}} = 0.9783 \tag{23}$$

$$r_{15} = \frac{\sum_{k=1}^{4}(x_{1k} \wedge x_{5k})}{\sum_{k=1}^{4}(x_{1k} \vee x_{5k})} = \frac{4.6\times10^{-4} + 1 + 1.23\times10^{-7} + 7.0\times10^{-3}}{1.5\times10^{-3} + 1 + 1.3\times10^{-5} + 2.7\times10^{-2}} = 0.9795 \tag{24}$$

$$r_{25} = \frac{\sum_{k=1}^{4}(x_{2k} \wedge x_{5k})}{\sum_{k=1}^{4}(x_{2k} \vee x_{5k})} = \frac{7.6\times10^{-4} + 1 + 1.4\times10^{-7} + 3.9\times10^{-3}}{1.5\times10^{-3} + 1 + 1.3\times10^{-5} + 7.0\times10^{-3}} = 0.9962 \tag{25}$$

Others r_{ij} computational methods are as above.

$$R = \begin{bmatrix} 1 & 0.9772 & 0.9840 & 0.9783 & 0.9795 \\ 0.9772 & 1 & 0.9923 & 0.9989 & 0.9962 \\ 0.9840 & 0.9923 & 1 & 0.9934 & 0.9956 \\ 0.9783 & 0.9989 & 0.9934 & 1 & 0.9872 \\ 0.9795 & 0.9962 & 0.9956 & 0.9872 & 1 \end{bmatrix} \tag{26}$$

Use squares method to compound transitive closure $t(R) = R^4$ and get:

$$t(R) = \begin{bmatrix} 1 & 0.51 & 0.47 & 0.51 & 0.39 \\ 0.51 & 1 & 0.47 & 0.55 & 0.39 \\ 0.47 & 0.47 & 1 & 0.47 & 0.39 \\ 0.51 & 0.51 & 0.47 & 1 & 0.39 \\ 0.39 & 0.39 & 0.39 & 0.39 & 1 \end{bmatrix} \tag{27}$$

Rank $t(R)$ elements according to size are:

$1 > 0.55 > 0.51 > 0.47 > 0.39$

When $\lambda = 1$, it has:

$$t(R)_1 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \tag{28}$$

X is divided into 5 kinds:: $\{x_1\}, \{x_2\}, \{x_3\}, \{x_4\}, \{x_5\}$。

When $\lambda = 0.55$, it has:

$$t(R)_{0.55} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \tag{29}$$

X is divided into 4 kinds: $\{x_1\},\{x_2,x_4\},\{x_3\},\{x_5\}$。

When $\lambda = 0.51$, it has:

$$t(R)_{0.51} = \begin{bmatrix} 1 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \tag{30}$$

X is divided into 3 kinds: $\{x_1,x_2,x_4\},\{x_3\},\{x_5\}$

When $\lambda = 0.47$, it has

$$t(R)_{0.47} = \begin{bmatrix} 1 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 \\ 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 \end{bmatrix} \tag{31}$$

X is divided into 2 kinds: $\{x_1,x_2,x_4\},\{x_3,x_5\}$。

When $\lambda = 0.39$, it has

$$t(R)_{0.39} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix} \tag{32}$$

X is divided into 1 kind: $\{x_1,x_2,x_4,x_3,x_5\}$。

For above process, use partial dynamical clustering graph to express as Figure1.

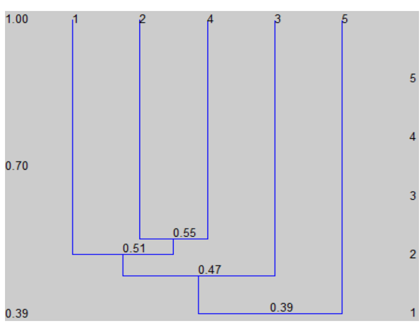

Figure 1 : The figure of part of the dynamic clustering

In Figure 1, “1”represents Wuhan city, “2”represents Huanggang city, “3” represents Yichang city, “4”represents Xiaogan city, and “5” represents Shennongjia. Figure1 provides Hubei province five places’ sports public services fiscal guarantee levels dynamic clustering process.

CONCLUSION

The paper proceeded fuzzy clustering is adopting transitive closure method; its steps are clearly and easier to program with strong operability. In daily life, lots of problems have no clearly limits; therefore, the method application range is wide and well adapted. In general, people will carry out classification handling with research objects according to dynamic clustering analysis chart.

The paper applies fuzzy clustering analysis method into Chinese sports public services fiscal guarantee levels researches, takes Hubei province five regions as examples, shows dynamic clustering process. The method can popularize to whole province and even whole nation, so as to make classification handling with multiple places sports public services fiscal guarantee problems according to actual levels, obtained dynamic clustering graph can be used as important evidence for classifying and releasing reformation measures.

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