FUZZY COMPREHENSIVE EVALUATION OF LAND COVER CLASSIFICATION DATA

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ABSTRACT:

The demarcation of the evaluation grade of surveying and mapping products is too rigid, and the evaluation results are often distorted due to the abnormality of an evaluation index. This paper takes the land cover classification data quality evaluation as an example and analyses the quality model, which includes quality factors and weight coefficients. In this paper, a multilevel fuzzy comprehensive evaluation method is introduced, a reasonable and efficient membership function is designed, and the evaluation results are evaluated by using the relative index of effectiveness and the probability of a single value distribution. The results show the fuzzy comprehensive evaluation method based on the premise of suitability weighting can make the evaluation results retain rich information, and the evaluation results are more reasonable and the improved fuzzy comprehensive evaluation method can be applied to the quality evaluation of other natural resource surveys and monitoring products.

1. GENERAL INSTRUCTIONS

1.1 Land Cover Classification

Land cover and its changes reflect changes in human activities and biological environments. Reliable and high-precision land cover information is of great significance for understanding and monitoring climate change, biogeochemical cycles, and deforestation (See L M, Fritz S., 2006). With the development of remote sensing and satellite technology, a large number of multi-scale and multi-spatial resolution surface coverage products have emerged. Internationally, these classification products are: Anderson land cover classification products (Anderson J R., 1971), USGS surface cover classification products, CORINE surface cover classification products (Bossard M., Ferance J., Otahel J., 2000), IGBP surface cover classification products (Hansen M. C., Reed B., Defries R. S., 2000), UMD surface cover classification products, FAO land cover classification products (Di Gregorio A. 2005), etc. The main land cover classification products in China mainly include the land use classification products of the Ministry of Land and Resources, the land resources classification products of the Chinese Academy of Sciences, and China's first global set of 30 m resolution in 2014. Surface cover products—GlobeLand30, etc. The emergence of these products has different classification purposes, classification methods, and scope of use, which leads to the diversification of surface cover product evaluations. However, multi-scale, multi-data source surface cover products need a relatively uniform evaluation system.

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1.2 The Geographical National Condition Monitoring of China

In 2014, the Chinese government launched a census and monitoring of geographical conditions. For the surface natural and human geography elements within the territory of China, using remote sensing images covering the whole country with a resolution of better than 1 meter, collecting multi-industry special data, and obtaining 10 first-level categories, 58 second-level categories and 135 third-level categories. A total of 260 million map spots in the class type are composed of full coverage, seamless and high-precision massive geographic and national conditions data. Adhering to the principle of "surveying, monitoring, and applying at the same time", more than 100 pilot projects for monitoring geographical conditions have been carried out in different themes and directions. At present, the results of the census and monitoring have been used in the integration of multiple regulations, targeted poverty alleviation, unified registration of real estate, outgoing audit of natural resources assets of leading cadres, remediation of black and odorous water bodies in key cities, special campaigns against illegal land use and illegal construction, and monitoring of changes in typical lake areas. It has played an important role in the census of many fields and geographical names, agriculture, etc. The monitoring content of geographical conditions is divided into 10 first-level categories, 59 second-level categories, and 143 third-level categories. Its quality requirements include mathematical foundation, plane accuracy, classification accuracy, attribute accuracy, current situation, consistency, edge accuracy, and integrity.

The accuracy of the data collection plane, that is, the degree of correspondence between the boundaries and positions of the collected objects and the boundaries and positions of the objects on the image. The overall planar accuracy level depends on two factors, orthophoto accuracy and data acquisition accuracy. On the basis of qualified orthophoto images, the clearly demarcated land cover classification boundaries and geographic and national conditions elements boundaries and the collection accuracy of positioning points on the image should be controlled within 5 pixels. In special cases, such as high-rise buildings occlusion, shadows, etc., the acquisition accuracy should be controlled within 10 pixels in principle.

In the transition zone with no obvious dividing line, the patches in the land cover classification data should at least meet the classification requirements of the previous type. Spots with obvious demarcation lines should be correctly classified in strict accordance with the classification requirements.

The classification data of land cover and the feature data of geographic national conditions must be processed by edge connection, including graphics edge connection and attribute edge connection. Orthographic images should be superimposed when joining the edges. If the distance between the edge lines on both sides of the butt boundary is less than the specified orthophoto margin, the data on one side can be adjusted to connect directly to the edges; the distance is less than 2 times the orthophoto If the margin is poor, the two sides are moved toward each other to join the margin; if the distance is greater than 2 times the margin margin of the orthophoto, the reasons should be checked and analyzed, and the technical person in charge will make a decision based on the actual situation and record it as a major issue. When a new type expanded according to the determined rule is connected with its corresponding upper-level predefined type, it is not necessary to merge the attribute codes of the newly added type. After connecting the edges, ensure that the graphic data is smooth and continuous, avoid hard folds and sharp corners, and ensure that the edges are connected within 0.01 meters of the connecting boundary; the same entity whose graphics are connected should be connected by attributes to ensure the consistency of attribute information.

1.3 The Third National Land Survey of China

In 2017, the Chinese government launched the third national land survey. The third national land survey is based on the results of the second national land survey, comprehensively refines and improves the basic data of national land use, directly grasps the detailed and accurate national land use status and changes in land resources, and further improves land survey and monitoring. and statistical system, realize the information management and sharing of results, and meet the requirements of ecological civilization construction, spatial planning, supply-side structural reform, macro-control, natural resource management system reform and unified registration of rights, and control of land and space use. need.

In accordance with the unified national standards, the third national land survey will use remote sensing, surveying and mapping, geographic information, Internet and other technologies across the country, make overall use of existing data, and use orthophoto maps as the basis to conduct field surveys on the land type, area and rights of the land. It has a comprehensive grasp of the distribution and utilization of land types such as cultivated land, garden land, forest land, grassland, commercial services, industrial and mining storage, housing, public management and public services, transportation, water areas and water conservancy facilities in the country; The quantity, quality, distribution and composition of cultivated land; carry out surveys of inefficient idle land, and comprehensively find out the land use status within the scope of cities and development zones; establish an interconnected and shared collection of images and land types covering the national, provincial, prefecture, and county levels A land survey database that integrates land resources, scope, area, and ownership, and a networked management system that is interconnected and shared at all levels.

The main technical indicators of the third national land survey include mathematical foundation, survey classification, land type map, survey accuracy, survey boundaries, etc.

The survey is carried out with patches as the basic unit (including linear features such as roads, ditches, and rivers). A single land plot, and a single land plot divided by survey boundaries such as administrative districts, towns and villages, or land ownership boundaries are plots. Adjacent parcels of the same land type within towns and villages are merged into one patch. If the road is divided by the ownership boundary, the map will be shown in different spots.

The minimum survey area of the survey map is divided by land type as follows: construction land related land categories and facility agricultural land with a field area of more than 200 square meters need to be surveyed on the map above; agricultural land (excluding facility agricultural land) related land categories If the area exceeds 400 square meters, the above map should be investigated; if the field area of other land types exceeds 600 square meters, the above map should be investigated. In desert areas, the accuracy can be appropriately reduced, but it must not be less than 1,500 square meters.

1.4 Quality Requirements

The surface coverage data are collected in the form of vector data sets. The acquisition accuracy of the demarcated surface coverage classification boundary on the image should be controlled within 5 pixels, and the collection error rate should be controlled within 0.3%. The land coverage classification code should be consistent with the actual features. The cumulative area of the first-level classification code error should not exceed 0.1%, the cumulative area of the second- and third-level classification code error should not exceed 0.4%, and the cumulative number of other attribute errors should not exceed 0.4%. The data should have no gaps, overlaps, or other topological errors, and geometrical abnormalities such as self-intersections and stabs should not exceed 0.4%.

1.5 Method of Evaluation

Whether the quality evaluation method is appropriate determines whether the quality level of the data can be truly and accurately reflected and ultimately affects the degree of use of the data. Hardly cutting the quality change interval into several segments, stipulating the grade of each segment, and using this scale to measure the quality, there is a large defect. How to divide the quality range of products and analyse the degree of each evaluation level so that the description of complex objects is more in-depth and objective. The fuzzy comprehensive evaluation method is proposed to solve this problem.

Under the premise of not changing the current evaluation grades, this paper sets the weights of quality factors according to the application characteristics of land cover classification data, constructs a targeted membership function, carries out the evaluation of the effectiveness of the maximum membership principle, and completes the data fuzzy comprehensive evaluation.

1.6 Quality Factors

Based on the classification of spatial data quality factors in the standard "ISO19113 Geographic Information Quality Principles", the coordinate system, projection parameters, geometric displacement, vector joints, classification codes, surface gaps, surface overlap, geometric anomalies, etc. are proposed for the classification data of surface coverage. Two independent quality check items, and according to hierarchical affiliation, constitute nine quality subelements, including geodetic datum, map projection, plane accuracy, classification correctness, attribute correctness, geometric expression, format consistency, topological consistency, and current status. Factors, as well as six quality factors, such as spatial reference system, acquisition accuracy, classification accuracy, characterization quality, logical consistency, and time accuracy, are shown in Table 1.

Factor	Weight	Subfactor	Weight	Check item	Weight
Spatial reference	0.10	Geodetic datum	0.50	Coordinate system	1.00
		Map projection	0.50	Projection parameters	1.00
Acquisition accuracy	0.25	Plane accuracy	1.00	Geometric displacement	0.70
				Vector Edge	0.30
Classification accuracy	0.45	Classification correctness	0.70	Classification code	1.00
		Attribute correctness	0.30	Other properties	1.00
Characterization quality	0.05	Geometric expression	1.00	Geometric anomaly	1.00
Logical consistency	0.10	Format consistency	0.20	Format	1.00
		Topological consistency	0.80	Gap	0.30
				Overlap	0.70
Time accuracy	0.05	Meanwhile	1.00	Data source	1.00

Table 1. Quality factors and weight set of land cover classification data

2. FUZZY COMPREHENSIVE EVALUATION

2.1 Basic Concepts

The evaluation problems in reality are mostly vague. The meaning of the evaluation level is rather vague, and the division boundary is not obvious. For example, what is "hot", "warm", and "cool"? Similarly, when determining the level of the object, the degree may be different. For example, 75.1 and 89.9 are classified as "good", which exaggerates the degree to which the object belongs to "good." It seems more reasonable to describe the "intermediate state" to a degree.

In 1965, Zadeh proposed fuzzy set theory (Zadeh L A., 1965), which provided a quantitative description and analytical calculation method of fuzzy phenomena and mathematically clarified the fuzzy concept. The comprehensive evaluation method transforms qualitative evaluation into quantitative evaluation according to the membership degree theory of fuzzy mathematics, that is, using fuzzy mathematics to make a general evaluation of things or objects restricted by many factors. It has the characteristics of clear results and strong systematicness, which can better solve vague and difficult-to-quantify problems, and is suitable for solving various non-deterministic problems.

The fuzzy comprehensive evaluation contains six basic elements (Qiu D., 1991): 1) Evaluation factor set U, U represents the set of evaluation factors in the comprehensive evaluation; 2) Evaluation grade set V, which is essentially a division of the object change interval, Such as excellent, good, qualified, unqualified; 3) fuzzy relation matrix R; 4) evaluation factor weight vector A; 5) composition operator, which refers to the calculation method used to combine A and R; 6) evaluation result vector B, right Describe the level of the overall status of each object.

2.2 Factor Set, Weight Vector, Evaluation Set

The set of factors $U=\{U_1, U_2..., U_6\}$ for the classification data of the surface coverage, where U_i is the spatial reference system, acquisition accuracy, classification accuracy, representation quality, logical consistency, and time accuracy. U_i can also have m subfactors (check item) $Ui=\{u_{i1},u_{i2}...,u_{im}\}$; see Table 1.
The weight vector W corresponding to the factor U, $W=(W_1, W_2..., W_6)$, and the m check items of the factor Ui can form the subweight vector $W_i=(w_{i1},w_{i2}...,w_{im})$. The impact of each check item on the evaluation of land cover classification data is different. The size of the weight reflects the relative importance of each factor, and the quality of the value will directly affect the evaluation result. Since these factors have both quantitative and nonquantitative factors and different application objects need to be processed differently, it is very difficult to determine the weight. This paper uses the analytic hierarchy process to determine the weight of each factor, as shown in Table 1. The focus of land cover classification data is the collection accuracy and classification accuracy, so its weight is larger than other quality factors。

The evaluation set follows the current four-level evaluation classification of surveying and mapping products, namely, $V=\{V_1, V_2, V_3, V_4\}=\{excellent, good, qualified, unqualified\}$; see Table 2.

Quality score	Evaluation grade
[90,100]	excellent
[75,90)	good

Quality score	Evaluation grade
[60,75)	qualified
< 60	unqualified

Table 2. Interval division of evaluation grade

2.3 Basic Steps

2.3.1 Membership Function

Based on the fuzzy set idea of this, the membership function shown in Figure 1 is constructed for the classification data of land cover. The sum of membership degrees is 1.

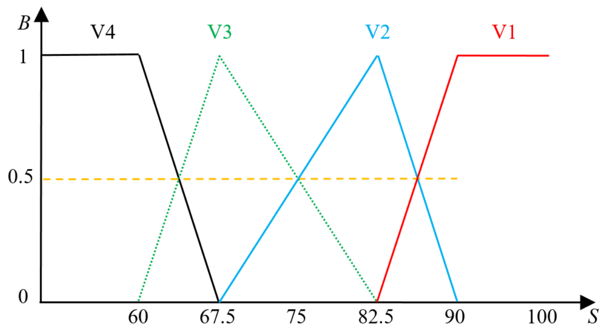

Figure 1. Membership function

The score X of the j-th check item $(1 \le j \le m)$ of the factor Ui is calculated by formulas (1)-(4) to calculate the degree of membership of the jth check item to each evaluation level.

$$V_1 = \begin{cases} 0 & X \le 82.5 \\ (X-82.5)/7.5 & 82.5 < X < 90 \\ 1 & 90 \le X \le 100 \end{cases} \tag{1}$$

$$V_2 = \begin{cases} (X-67.5)/15 & 67.5 < X \le 82.5 \\ (90-X)/7.5 & 82.5 < X < 90 \\ 0 & others \end{cases} \tag{2}$$

$$V_3 = \begin{cases} (X-60)/7.5 & 60 < X \le 67.5 \\ (82.5-X)/15 & 67.5 < X < 82.5 \\ 0 & others \end{cases} \tag{3}$$

$$V_4 = \begin{cases} 1 & X \le 60 \\ (67.5-X)/7.5 & 60 < X < 67.5 \\ 0 & others \end{cases} \tag{4}$$

2.3.2 Fuzzy Relation Matrix

Establish the fuzzy relationship matrix R_i between the m check items and the evaluation grade under the factor U_i.

$$R_i = (r_{jk})_{m\times 4} = \begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ r_{21} & r_{22} & r_{23} & r_{24} \\ & \cdots & & \\ r_{m1} & r_{m2} & r_{m3} & r_{m4} \end{bmatrix} \tag{5}$$

Among them, r_{jk} is the subordination relationship of the j-th check item to the level V_k.

2.3.3 Single-factor and Multilayer Evaluation

The basic model of fuzzy comprehensive evaluation is, which represents the fuzzy relationship W between the evaluation factors and the object, and through the fuzzy relationship matrix R, the fuzzy relationship B between the object and the evaluation level is formed.

The composition operator uses $M(\bullet, \oplus)$ to ensure the full use of the information of the R matrix and the nature of the weight vector of W (Wang Q.G., 2004, He T., 2005). The m check item weight vectors $W_i=(w_{i1},w_{i2}...,w_{im})$ of the factor U_i are calculated with the fuzzy relationship matrix R_i to obtain the evaluation vector $B_i=(b_{i1},b_{i2}..., b_{im})$ of the factor U_i. The fuzzy relationship matrix $R=(B_1, B_2..., B_5)$ of the evaluation object is obtained from the evaluation vector combination of each factor. The i-th row in the R matrix is the evaluation vector of the i-th factor U_i (Wang A.X., 2018). Combining the weight vector W of each factor and the fuzzy relationship matrix R, the evaluation vector of the evaluation object is obtained. If the weight of each evaluation object can be determined (according to the ratio of area to length), the evaluation vector of the sample can be obtained further upward.

2.3.4 Relative Index

The result of the fuzzy comprehensive evaluation is a vector, based on which the evaluation object is judged at its level. The current general method is the principle of maximum subordination, but it has scope of application. Extremely, when the evaluation result B is a set of constants, the principle of maximum membership becomes invalid. Therefore, The validity of the maximum membership principle is related to the proportion of $\max\limits_{1<i<n} b_i$ to $\sum\limits_{i=1}^{n} b_i$, so we define $\beta = \max\limits_{1<i<n} b_i / \sum\limits_{i=1}^{n} b_i$.

When $\max\limits_{1<i<n} b_i=1$ and $\sum\limits_{i=1}^{n} b_i=1$, $\beta=1$, the maximum membership principle is most effective; when $\max\limits_{1<i<n} b_i=c$ and $\sum\limits_{i=1}^{n} b_i=n\cdot c$, $\beta=1/n$, the maximum membership principle fails completely. Which is $1/n \le \beta \le 1$

When the maximum membership principle is completely invalid, β is not necessarily zero, so it is not appropriate to directly use β to judge the validity of the maximum membership principle.

Consider the proportion of $\max\limits_{1<i<n} b_i$ to $\sum\limits_{i=1}^{n} b_i$ and size of $\sec\limits_{1<i<n} b_i$, let $\beta' = \frac{\beta\text{-}1/2}{1\text{-}1/n} = \frac{n\beta-1}{n-1}$ and $\gamma = \sec\limits_{1<i<n} b_i / \sum\limits_{i=1}^{n} b_i$, when $b_i=(1,1,0,\cdots,0)$, $\max\limits_{1<i<n} \gamma=1$; when $b_i=(1,0,0,\cdots,0)$, $\max\limits_{1<i<n} \gamma=0$. Which is $0 \le \gamma \le 1/2$.

Let $\gamma' = \frac{\gamma - 0}{1/2 - 0} = 2\gamma$. In general, the larger the value of β', the more effective the maximum membership principle, and the larger the value of γ'. The less effective the principle of maximum membership is. The definition $\alpha = \frac{\beta'}{\gamma'} = \frac{\frac{n\beta - 1}{n-1}}{2\gamma} = \frac{n\beta - 1}{2\gamma(n-1)}$, it is a relative index to measure the effectiveness of the principle of maximum membership.

When α≥1, the principle of maximum membership is very effective; when 0.5≤α<1, the principle of maximum membership is efficient, and the degree of effectiveness is the value of α; when 0 < α<0.5, the principle of maximum membership is inefficient. In particular, when β≥0.7, it can be directly determined that the principle of maximum membership is very effective (Qiu D., 1989).

2.3.5 Single-Valued Distribution Probability

When the value of α is small, that is, when the bi distribution is more uniform, the implementation of the maximum membership principle will distort the objective level of the evaluation object. At this time, the single-value distribution probability method can not only supplement the deficiency of the maximum membership principle but also overcome the nonequal evaluation level. The deviation from the weighted average under the circumstances.

The basic content of the fuzzy vector single-valued distribution probability is: calculate the highest score and the lowest score corresponding to the evaluation set and calculate the distribution probability P of the evaluation result at each evaluation level according to the distribution ratio of the highest and lowest score interval in each evaluation level interval (Figure 2) This method shows the location of the evaluation object more objectively than using the principle of maximum subordination (Bresenham, J.E., 1965), and the evaluation of panels B and E reflects this situation.

Taking map sheet A in Table 4 as an example, its evaluation vector is $B=(0.65,0.29,0.06,0)$, $S_H=95.7$, $S_L=84.0$, which is located between excellent and good (Figure 2), where the probability of excellent is 0.49, and the probability of good is 0.51, so the object can be rated as excellent with a high probability.

$$S_H = \begin{bmatrix} 0.65 & 0.29 & 0.06 & 0 \end{bmatrix} \begin{bmatrix} 100 \\ 90 \\ 75 \\ 60 \end{bmatrix} = 95.7 \qquad (6)$$

$$S_L = \begin{bmatrix} 0.65 & 0.29 & 0.06 & 0 \end{bmatrix} \begin{bmatrix} 90 \\ 75 \\ 60 \\ 0 \end{bmatrix} = 84.0 \qquad (7)$$

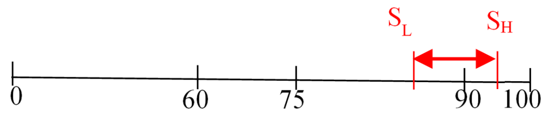

Figure 2. Probability of evaluation grade distribution

3. EXPERIMENT

Take Hangzhou's land cover classification data quality evaluation as an example (Table 3) to carry out fuzzy comprehensive evaluation (Table 4). Hangzhou has a natural environment where rivers, rivers, lakes and mountains blend together (Figure 3). Hills and mountains account for 65.6% of the city's total area, plains account for 26.4%, rivers, rivers, lakes, and reservoirs account for 8%. The world's longest artificial canal, the Beijing-Hangzhou Grand Canal, and the Qiantang River, which is famous for its large tides, pass through it. With an area of 16,596 square kilometers, it embraces six urban districts and seven suburban counties. The city's forest area is 10,900 square kilometres, with a forest coverage rate of 64.77%.

Figure 3. Map of Hangzhou

The results show that the classification accuracy, attribute accuracy, and vector geometric elements of Hangzhou's land cover data are well handled, and the collection accuracy (geometric displacement) is average. Compared with the minimum score principle of GB/T18316, the fuzzy comprehensive evaluation method has more objective and reliable results. The weight setting not only reflects the special requirements for classification accuracy and acquisition accuracy of the project application but also takes into account the need for logical consistency. The relative index of validity α and the single-valued distribution probability P are consistent in most cases for the effectiveness evaluation results of the principle of maximum membership, and contradictions occur in a few cases, that is, when α>1, the results can be directly used to evaluate the degree of membership Judgment, when α<1, the single-valued distribution probability should be used to determine the degree of membership.

No.	Coordinate system	Projection parameters	Geometric displacement	Vector Edge	Classification code	Other properties	Geometric anomaly	Data format	Gap	Overlap	Data source
A	100	100	78	90	88	87	85	100	97	95	100
B	100	100	78	90	80	79	85	100	97	95	100
C	100	100	88	90	88	87	85	100	97	95	100
D	100	100	88	80	88	87	85	100	97	95	100
E	100	100	75	80	88	87	85	100	97	95	100
F	100	100	74	90	80	80	85	100	90	89	100
G	100	100	82	80	80	80	82	100	85	80	100
H	100	100	87	82	82	82	82	100	88	80	100

Table 3. Score of inspection items for land cover classification data in an area

No.	B	α	Result I	S_H	S_L	P excellent	P good	Result II	Result by GB/T 18316
A	(0.65,0.29,0.06,0)	0.91	excellent	95.7	84.0	0.49	0.51	good	good
B	(0.34,0.52,0.14,0)	0.53	good	91.3	78.1	0.10	0.90	good	good
C	(0.78,0.22,0,0)	1.63	excellent	97.8	86.7	0.70	0.30	excellent	good
D	(0.71,0.28,0.01)	1.08	excellent	96.9	85.4	0.60	0.40	excellent	good
E	(0.58,0.32,0.10,0)	0.68	excellent	94.2	82.1	0.35	0.65	good	good
F	(0.33,0.50,0.17)	0.50	good	90.9	77.5	0.07	0.93	good	qualified
G	(0.18,0.72,0.10,0)	1.75	good	90.1	76.0	0.01	0.99	good	good
H	(0.29,0.68,0.03,0)	0.98	good	92.4	78.8	0.17	0.82	good	good

Table 4. Comparison of evaluation results

4. CONCLUSION

The quality factors and weights of land cover classification data proposed in this paper fully consider the technical factors and application characteristics of data production production, and tilt the weights of important indicators to ensure the effectiveness of land cover classification data evaluation. It has been verified by experiments that the method is effective.

The current evaluation method GB/T 18316 for land cover classification data is simple but rough. The processing of the lowest score does not consider the importance of inspection items and quality factors, and the evaluation results cannot fully reflect the overall quality of the ground coverage classification data. It has non-existent The risk of evaluation failure due to abnormal indicators of important factors.

Judging from the evaluation results, the fuzzy comprehensive evaluation result is a vector, not a point value, which is different from any other method. This is determined by the nature of the fuzzy comprehensive evaluation itself, because the object of the fuzzy comprehensive evaluation is something with intermediate transition or both, so its evaluation result should not be categorical, but can only be determined by using The membership of each level is represented. From this, we can obtain an objective description of the vagueness of the attributes of a certain aspect of the thing being evaluated.

From the perspective of evaluation level processing, fuzzy comprehensive evaluation can be processed at multiple levels, which satisfies the evaluation requirements for more complex things. In fuzzy comprehensive evaluation, the evaluation process can be cycled. The comprehensive evaluation results of the former process can be used as input data for the comprehensive evaluation of the latter process. In this way, for a more complex thing, we can carry out multi-level fuzzy comprehensive evaluation. The synthesizable problem of indicators (here expressed as factors) is solved naturally in the process of fuzzy comprehensive evaluation, and does not require special dimensionless processing of indicators.

Fuzzy comprehensive evaluation is generally carried out one by one. For the same evaluated object, as long as the evaluation index weights are the same and the synthesis operators are the same, the result is unique. No matter what the rated object set (space or time) the rated object is in, it will not change. The fuzzy comprehensive evaluation method has strong applicability and makes up for the shortcomings of other methods. The fuzzy comprehensive evaluation can be used for the comprehensive evaluation of subjective indicators and the comprehensive evaluation of objective indicators. There are a large number of them, so the application range of fuzzy comprehensive evaluation is wider, especially in the comprehensive evaluation of subjective indicators, fuzzy comprehensive evaluation can play the unique role of fuzzy method, and the evaluation effect is better than other methods.

Any method has its own limitations, and the fuzzy comprehensive evaluation method is no exception. First, the fuzzy comprehensive evaluation process itself cannot solve the problem of duplication of evaluation information caused by the correlation between evaluation indicators. Therefore, before the fuzzy comprehensive evaluation, the pre-selection of the indicators is particularly important. Only in this way can the indicators with a greater degree of correlation be deleted to ensure the accuracy of the evaluation results.

Secondly, in the fuzzy comprehensive evaluation, the index weights are not generated along with the evaluation process, which belong to the estimated weights, so they can be adjusted. According to the different focus of the evaluator, the weights of the evaluation indicators can be changed. This weighting method has strong adaptability. In addition, several different weight assignments can be used to comprehensively evaluate

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the same object at the same time for comparative research. However, it should be noted that the adjustment of weights often easily destroys the comparability between different evaluation results of the same object. Different evaluated objects use different weights for comprehensive evaluation, which are incomparable with each other.

Also We need pay attention to the importance of the index itself, but the role of human subjectivity is relatively large and can Whether it fully reflects the objective reality needs to be well grasped. In addition, it is worth noting that the amount of index information of each evaluated object is not considered enough, which may affect the discrimination of the evaluation results.

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