Evaluation of Professional Command Ability Based on Cloud Model

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Abstract. On the basis of existing effectiveness evaluation methods, combined with the characteristics of professional command ability of growing officer cadets, an evaluation method based on cloud model is proposed. In view of the fuzziness and uncertainty of the evaluation object, a cloud center of gravity evaluation method based on the cloud model is proposed to obtain the cloud model representation of quantitative indicators. Through the application of weighted deviation degree, the evaluation of students' professional command ability can realize the quantitative and qualitative transformation, and the evaluation results can be more intuitive and suitable for decision-making. Finally, the effectiveness and superiority of the proposed evaluation method are verified by an example.

Keywords: Cloud model · Growing officer cadets · Professional command ability assessment · Cloud gravity center evaluation method

1 Introduction

In the past, most of the professional command ability training systems were described qualitatively, so it is necessary to use probability statistics, grey system, rough set theory and other models to evaluate the uncertainty. Since the professional command ability is composed of 12 dimensions, the cloud center of gravity evaluation method is suitable for evaluation. This method is developed on the basis of cloud model. Because it can realize the uncertain transformation between qualitative concept and quantitative description, it is widely used in data mining, decision analysis, intelligent control and other fields. Compared with other evaluation methods of command ability, it is based on expert experience, retains uncertain information to a large extent, has high accuracy and credibility, and the final language evaluation value is more intuitive [1, 2]. The cloud center of gravity evaluation method integrates the two theories of probability theory and fuzzy theory. It can organically link randomness and fuzziness in the qualitative and quantitative conversion process, thus fully reflecting the uncertainty of the conversion results. Therefore, it has certain advantages in the evaluation of the professional command ability of the growing officer cadets.

V. Balakrishnan et al. (Eds.): ICMEIM 2022, AHSSEH 6, pp. 794–802, 2022.
https://doi.org/10.2991/978-94-6463-044-2_99

2 Cloud Model

2.1 Definition of Cloud

Cloud is a transformation model that uses natural language values to express the uncertainty between a qualitative concept and its quantification, so as to reflect the uncertainty of things or human knowledge concepts in the natural world: fuzziness and randomness, or the cloud model is an uncertainty model used to realize the transformation between qualitative and quantitative. It not only gives an explanation from the random theory and the fuzzy set theory, but also reflects the correlation between fuzziness and randomness, forming a mapping between quantitative and qualitative, making it possible to obtain the range and distribution rules of quantitative data from the qualitative information expressed by language values, and it is also possible to effectively convert from accurate values to appropriate qualitative language values.

Let U be a general set, $U = \{u\}$, which is called the universe. The fuzzy set A in the universe u means that there is a random number $p_A(u)$ with stable tendency for any element u, which is called the membership degree of p to A. If the elements in the universe are simple and orderly, U can be regarded as the basic variable, and the membership degree on U is called (membership) cloud. If the elements in the universe are not simply ordered, and according to a certain rule f, U can be mapped to another ordered universe U', one of U' and only one u' corresponds to u then U' is the basic variable, and the distribution of membership on U' is called (membership) cloud.

2.2 Digital Characteristics of Cloud

The digital characteristics of the cloud are represented by the expected value *Ex*, entropy *En* and hyper entropy *He*, where *Ex* is the center of gravity of the cloud, which marks the center value of the corresponding fuzzy concept and is the point that can best represent the qualitative concept. *En* is a measure of conceptual uncertainty, and its size reflects the range of cloud drops that can be accepted by fuzzy concepts in the universe, that is, the margin of this and that. The excess entropy *He* reflects the aggregation degree of the cloud droplets. The larger the excess entropy, the greater the dispersion degree of the cloud, the greater the randomness of the membership degree, and the greater the thickness of the cloud. When the problem studied is a pure random problem, *En* tends to infinity, and when it is a pure fuzzy problem, $He = 0$ (the expectation curve equation of the membership cloud with normal distribution can be determined by the two numerical characteristics of expectation and entropy).

The cloud gravity center can be expressed as $T = a \times b$. A represents the position of the cloud center of gravity, and b represents the height of the cloud center of gravity. The expected value reflects the information center value of the corresponding fuzzy concept, that is, the position of the cloud center of gravity. When the expected value changes, the information center value it represents changes, and the position of the cloud center of gravity changes accordingly. In general, the height of the cloud center of gravity is a constant value (0.371). Clouds with the same expected value can be distinguished by comparing the different heights of the cloud center of gravity, that is, the height of the cloud center of gravity reflects the importance of the cloud. Therefore, the change of the center of gravity of the cloud can reflect the change of the system state information.

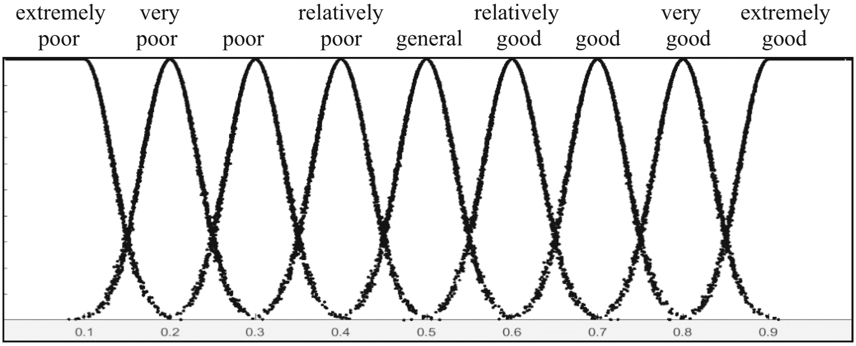

Fig. 1. Normal Cloud Generator for qualitative evaluation.

3 Cloud Generator for Qualitative Evaluation

The cloud generation algorithm can be implemented in software or solidified into hardware, which is called Cloud Generator. The forward Cloud Generator is a mapping from a qualitative concept to its quantitative representation. It generates cloud droplets according to the digital characteristics (Ex, En, He) of the cloud. Each cloud droplet is a concrete implementation of the concept.

Nine levels of comments are used to form a comment set, which is in order from low to high: extremely poor, very poor, poor, relatively poor, general, relatively good, good, very good, extremely good. They are placed on a continuous language value scale and implemented by cloud model to form a cloud generator for qualitative evaluation, as shown in Fig. 1.

4 Cloud Gravity Center Evaluation Method [3–6]

4.1 Step 1: Obtain the Model Representation of the Indicator

In the given system performance index system, it can be expressed by precise numerical values and described by language values. If n groups of samples are extracted to form a decision matrix, then n precise numerical indicators can be represented by a cloud model. Wherein:

$$Ex = \frac{E_{x1} + E_{x2} + \cdots + E_{xn}}{n} \tag{1}$$

$$En = \frac{max\{E_{x1}, E_{x2}, \ldots, E_{xn}\} - min\{E_{x1}, E_{x2}, \ldots, E_{xn}\}}{6} \tag{2}$$

At the same time, each language value type indicator can be represented by a cloud model, so an indicator represented by n language values (cloud model) can be represented by a one-dimensional comprehensive cloud. Wherein:

$$Ex = \frac{E_{x1}E_{n1} + E_{x2}E_{n2} + \cdots + E_{xn}E_{nn}}{E_{n1} + E_{n2} + \cdots + E_{nn}} \tag{3}$$

$$En = E_{n1} + E_{n2} + \cdots + E_{nn} \quad (4)$$

When the index is of accurate numerical type, E_{x1}~E_{xn} are the values of each index quantity; When the indicator is of language value type, E_{x1}~E_{xn} are the expectations of each indicator cloud model, and E_{n1}~E_{nn} are the entropy of each indicator cloud model. In this paper, the language evaluation value of the index is represented by the corresponding three digital features, wherein the i-dimensional index is (Ex_i, En_i, He_i).

4.2 Step 2: Determine the Weight Vector of the Indicator

The determination method of weight calculation is the most important in the comprehensive evaluation. Different methods have different calculation principles. The commonly used weight determination methods include analytic hierarchy process, entropy method, CRITIC method (Criteria Importance Through Intercriteria Correlation) and factor analysis method. In the actual analysis process, the appropriate weight calculation method shall be selected according to the data characteristics and professional knowledge to obtain the corresponding weight vector W^*.

4.3 Step 3: Reflect the System Status of the Indicator

Generally, one indicator is represented by one cloud model. Similarly, n indicators need to be represented by n cloud models. Given a batch of target data with n indicators, the system state of the target can be represented by an n-dimensional comprehensive cloud. Let n-dimensional vector O represent the center of gravity of the integrated cloud, i.e., $O = (O_1, O_2, \ldots, O_n)$, where $O_i = Ex_i \times W_i^* (i = 1, 2, \ldots, n)$.

4.4 Step 4: Measure the Center of Gravity Deviation of the Indicator

Each index value of a system in an ideal state is known. Assume that the barycenter position vector of the n-dimensional comprehensive cloud in the ideal state is $a = (Ex_1^0, Ex_2^0, \ldots, Ex_n^0)$, and the height vector is $b = (b_1, b_2, \ldots, b_n)$, where $b_i = W_i^* \times 0.371$, then the cloud barycenter vector $O^0 = a \times b^T = \left(O_1^0, O_2^0, \ldots, O_n^0\right)$.S imilarly, the barycenter vector $O = (O_1, O_2, \ldots, O_n)$ of the n-dimensional comprehensive cloud of the system under a certain state can be obtained.

In order to compare the change degree of the center of gravity of the cloud model in several cases, the weighted deviation degree θ is introduced to compare the change of cloud gravity center in an ideal state and a certain situation, the smaller the weighted deviation degree, the less significant the difference between the two, and the larger the weighted deviation degree, the more significant the difference between the two. First, normalize the two states to obtain the vector $O^G = (O_1^G, O_2^G, \ldots, O_n^G)$, wherein:

$$O_i^G = \begin{cases} \frac{O_i - O_i^0}{O_i^0} & O_i < O_i^0 \\ \frac{O_i - O_i^0}{O_i} & O_i \geq O_i^0 \end{cases} \quad i = 1, 2, \ldots, n \quad (5)$$

After normalization, the barycenter vectors of the comprehensive clouds representing the system state are all dimensionless values with size, direction and dimension. The ideal state is a special case, that is, the vector is (0, 0, ..., 0). Multiply the normalized vector value of each indicator by its weight value, and then add them to obtain the value of weighted deviation degree θ:

$$\theta = \sum_{i=1}^{n} \left(W_i^* O_i^G \right) \tag{6}$$

4.5 Step 5: Get the Language Comments of the Indicators

Let $y = 1 + \theta$, Substituting the value of y into the normal Cloud Generator used above, if the value activates a certain comment to a greater extent than other comments, the comment is taken as the evaluation result of the target data; If the activation degree of this value for the two comments is similar, a new cloud model can be obtained by conceptual cloud merging or given by the user himself.

5 Algorithm Example [7–9]

5.1 Get Expert Comments

The contents listed in Table 1 are the assessment of the joint assessment and comprehensive exercise performance of the 2021 graduates of aviation service technology and command specialty by six experts participating in the whole process.

5.2 Determine Weight Vector

The analytic hierarchy process is used to obtain the 12 dimensional weight vector after obtaining the analysis data and performing normalization processing:

$$W^* = \left(W_1^*, W_2^*, \ldots, W_{12}^* \right) = (0.088,\ 0.091,\ 0.081,\ 0.085,\ 0.073,\ 0.093,\ 0.099,\ 0.068,\ 0.088,\ 0.062,\ 0.078,\ 0.094)$$

5.3 Computing System Status

Based on the cloud generator of qualitative evaluation, convert different comments into corresponding data to form a decision matrix:

$$A = \begin{pmatrix} 0.7\ 0.5\ 0.6\ 0.50.7\ 0.8\ 0.6\ 0.7\ 0.8\ 0.5\ 0.4\ 0.6 \\ 0.6\ 0.8\ 0.7\ 0.5\ 0.5\ 0.7\ 0.7\ 0.6\ 0.9\ 0.7\ 0.6\ 0.7 \\ 0.7\ 0.7\ 0.7\ 0.4\ 0.7\ 0.6\ 0.5\ 0.7\ 0.7\ 0.8\ 0.7\ 0.7 \\ 0.8\ 0.8\ 0.5\ 0.7\ 0.7\ 0.7\ 0.7\ 0.8\ 0.7\ 0.6\ 0.5\ 0.7 \\ 0.7\ 0.6\ 0.7\ 0.5\ 0.6\ 0.8\ 0.7\ 0.7\ 0.5\ 0.7\ 0.6\ 0.5 \\ 0.8\ 0.6\ 0.8\ 0.6\ 0.5\ 0.7\ 0.7\ 0.7\ 0.6\ 0.7\ 0.5\ 0.7 \end{pmatrix}$$

Each dimension is represented by three numerical features (*Ex, En, He*) where only *Ex* and *En* need to be calculated in Table 2.

Table 1. Status evaluation of each ability index

Indexes	Expert					
	1	2	3	4	5	6
Basic command accomplishment c_1	good	relatively good	good	very good	good	very good
Basic military command theory and skills c_2	general	very good	good	very good	relatively good	relatively good
Professional knowledge and skills c_3	relatively good	good	good	general	good	very good
Engineering literacy c_4	general	general	relatively poor	good	general	relatively good
Insight c_5	good	general	good	good	relatively good	general
Decision making ability c_6	very good	good	relatively good	good	very good	good
Supervision and control ability c_7	relatively good	good	general	good	good	good
Supervision and control ability c_8	good	relatively good	good	very good	good	good
Organization and coordination ability c_9	very good	extremely good	good	good	general	relatively good
Communication ability c_{10}	general	good	very good	relatively good	good	good
Innovation ability c_{11}	relatively poor	relatively good	good	general	relatively good	general
Strain capacity c_{12}	relatively good	good	good	good	general	good

Table 2. Expected value and entropy of cloud model of each ability index

Ability	$c1$	c_2	c_3	c_4	c_5	c_6	c_7	c_8	c_9	c_{10}	c_{11}	c_{12}
Expectation Ex	0.72	0.67	0.67	0.53	0.62	0.72	0.65	0.70	0.70	0.67	0.55	0.55
Entropy En	0.033	0.050	0.050	0.050	0.033	0.033	0.033	0.033	0.067	0.050	0.050	0.033

5.4 Find the Barycenter Vector

The cloud barycenter vector in the ideal state is:

$$O^0 = W^* = (0.088,\ 0.091,\ 0.081,\ 0.085,\ 0.073,\ 0.093,\ 0.099,\ 0.068,\ 0.088,\ 0.062,\ 0.078,\ 0.094)$$

The actual cloud gravity vector calculated from the data in 3 is:

$$O = E_x \times W^* = (0.063,\ 0.061,\ 0.054,\ 0.045,\ 0.045,\ 0.067,\ 0.064,\ 0.048,\ 0.062,\ 0.041,\ 0.043,\ 0.061)$$

Normalize the cloud barycenter vector in the actual state to obtain:

$$O^G = (-0.28,\ -0.33,\ -0.33,\ -0.47,\ -0.38,\ -0.28,\ -0.35,\ -0.30,\ -0.30,\ -0.33,\ -0.45,\ -0.35)$$

5.5 Get Evaluation Results

The weighted deviation is obtained from the above data:

$$\theta = \sum_{i=1}^{12} \left(W_i^* O_i^G \right) = -0.3464$$

$$y = 1 + \theta = 0.6536$$

The value of y is substituted into the normal cloud generator of qualitative evaluation. Its value is between "relatively good" and "good", and the activation degree is not different. Both of them can be used to evaluate the joint assessment and comprehensive exercise of the graduating students. It can generate a new cloud model by changing the comment set and qualitative evaluation cloud generator, or it can be given by the user's own judgment.

Through the whole evaluation activity, it can be analyzed that the overall performance of the students with basic command literacy and decision-making ability is good, which reflects that the professional command ability training system of the growing officer students meets the requirements of the training objectives of the vocational education, while the performance of the students with engineering literacy, innovation ability and coping ability is relatively weak, which needs to be focused on effective improvement.

In calculating the weighted deviation θ, the process quantity is also of great significance in the evaluation. If it is named as the score vector $S_i = W_i^* O_i^G$, then:

$$S = (-0.025, -0.030, -0.027, -0.039, -0.028, -0.026, -0.035, -0.020, -0.026, -0.021, -0.035, -0.033)$$

According to the scores of each ability in the score vector, the scientific decision of priority promotion and cultivation of ability can be made. The higher the absolute value of the score corresponding to the ability, the greater the negative impact of the ability on the overall evaluation of this comprehensive evaluation activity. In the case of limited time and energy, the ability should be given priority to training. For example, the score of Engineering literacy is –0.039, which indicates that in the overall evaluation, the ability lowers the overall evaluation value and affects the evaluation results. Therefore, engineering literacy has become one of the main factors affecting the evaluation results; at the same time, it also shows that the experts are not satisfied with the engineering quality shown by the graduates. In the later period, in the process of cultivating the professional command ability of the officer cadets, it is necessary to further strengthen the actual training time and training teaching items of the cadets, strengthen the engineering quality of the cadets, realize the teaching objectives of the talent training program, and strive to cultivate high-quality professional new-type military talents.

6 Conclusions

By establishing the evaluation model of the professional command ability of the growing officer cadets, determining the evaluation index, and using the cloud model to determine the evaluation value of each index in the evaluation model, the credibility and operability of the model are effectively enhanced. The model is verified by an example. The steps include: obtaining the system evaluation, determining the weight vector, calculating the system state, obtaining the center of gravity vector, and obtaining the evaluation results. The evaluation method based on cloud model can effectively integrate subjective and objective information, and better solve the comprehensive evaluation problem of both qualitative and quantitative indicators in the evaluation of professional command ability of growing officer cadets, with high reliability and objectivity.

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