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Performance evaluation of organizational creativity based on multiobjective evolutionary algorithm

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Abstract. In order to improve the effectiveness of organizational performance evaluation, a performance evaluation method based on multi-objective intelligent water drop algorithm is proposed. First of all, we build a comprehensive performance evaluation index system of organizational creativity, and establish a network structure model of organizational creativity based on deep neural networks. Secondly, we use the multi-objective intelligent waterdrop algorithm to solve this problem. At the same time, Water drop algorithm performance, by drawing on NSGA II congestion degree design method to improve the multi-target intelligent water droplet algorithm population diversity. Finally, the effectiveness of the performance evaluation algorithm of the proposed organizational creativity is verified through simulation experiments.

Key words. Multi-objective evolution, Intelligent drip algorithm, Organizational creativity, Performance evaluation.

1. Introduction

Organizational creativity is the driving force for economic and social development in the 21st century. At present, organizational creativity has become the economic pillar of many developed countries and has become an important part of the overall national strength. Since the accession to the WTO, our country has to hit the unprecedented challenge and impact on the organization creativity. If we want to be invincible in the fierce competition, we must improve the core competitiveness of the organization creativity in our country, and the input-output efficiency is the core competitiveness The concentrated expression. Therefore, to correctly understand the current input-output efficiency of organizational creativity in our country and to find out the factors that affect the input-output efficiency of organizational creativity in our country have an important practical significance for the long-term development

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of organizational creativity in our country [1, 2].

At present, most domestic studies on the efficiency of industry or industry are concentrated in the fields of manufacturing industry, banking industry and service industry. Research on organizational creativity and input-output efficiency of related industries has not drawn much attention. At present, only a small amount of literature is found to study the performance evaluation of organizational creativity in our country. The literature [3] used CCR model to analyze the input-output efficiency of organizational creativity in 31 provinces and autonomous regions of China. The results show that there are 7 provinces in Guangdong, Beijing and other provinces where effective organizational creativity exists in China. Literature [4] The model analyzes the input-output efficiency of organizational creativity in 31 provinces of our country and finds that there is a big gap between the efficiency of input and output of organizational creativity in different regions in our country. Literature [5] applies three-phase DEA model to 31 provinces in China The analysis of the input-output efficiency of organizational creativity shows that after removing the environmental factors and random factors, the efficiency letter of organizational creativity in all provinces in China needs to be improved. However, the above algorithms generally have problems of poor prediction accuracy and low efficiency.

Based on the above analysis, this paper proposes a performance evaluation method of organizational creativity based on multi-target intelligent waterdrop algorithm combined with deep neural network algorithm, which decomposes the input-output efficiency of organizational creativity into comprehensive technical efficiency, pure technical efficiency and scale efficiency, The proposed algorithm achieves the comprehensive performance evaluation of organizational creativity.

2. Organizational creativity comprehensive performance evaluation

2.1. Build a comprehensive performance evaluation index system

Organizational creativity Ability could conduct comprehensive performance evaluation from multiple perspectives, such as organizational creativity development capability comprehensive performance evaluation, organizational creativity relevant enterprise comprehensive performance evaluation, organizational creativity market comprehensive performance evaluation, organizational creativity modern industrial research innovation capability comprehensive performance evaluation And so on, the performance evaluation of different parties selected evaluation index system is also different. Due to the limitation of space, this paper only takes the comprehensive performance evaluation of organizational creativity as an example. The method and process of model construction for performance evaluation of other parties of organizational creativity are similar.

The comprehensive performance evaluation of organizational creativity development capability mainly evaluates the annual level of modernization of organizational creativity in our country to make a more direct, rapid and accurate understanding of the overall development and trend of organizational creativity in our country. There are many factors that reflect the level of the modernized development of organizational creativity. The relevant indexes and data are initially collected by referring to the relevant literature and data, and the gray relational analysis method is used to calculate the degree of association of each index. Finally, the index with greater relevance is selected. According to the evaluation model to be constructed in this paper, the evaluation index system is divided into input index and output index. Input indicators are: the overall industry efficiency, R & D funding, professional staff, the number of organizational creativity patents, the effectiveness of the new organization of creativity, industrial internationalization degree, the rationalization of industrial organization. The output index is: The Index of Modernization of Organizational Creativity, which is a comprehensive index used to measure the level of the modernized development of organizational creativity as the final output of this paper's evaluation model. among them:

(1) Overall Industry Efficiency = Industry Value Added / Number of Employees;

(2) R & D expenditure ratio = industry R & D costs / industrial added value;

(3) Proportion of Professionals = Number of Industry Scientists and Engineers / Number of Employees

(4) Efficiency of new organization creativity = new organization creativity output / total industrial output value;

(5) degree of industrialization of the industry = industry exports / sales revenue;

(6) rationalization of industrial organization = average production scale of enterprises in the industry.

2.2. Comprehensive performance evaluation network model design

Organization Creativity Development Ability Comprehensive Performance Evaluation Model The kernel structure is designed using the above-mentioned comprehensive evaluation model of organizational creativity based on the multi-objective intelligent waterdrop algorithm and deep neural network algorithm. According to the relevant theory, any continuous function can be approximated by a three-layer DNN neural network with a hidden layer. With the increase of the number of hidden layers, the computational complexity of the network is constantly increasing, and the training time of the network is drastically increased . Therefore, the network model uses a three-tier structure, an input layer, an implied layer and an output layer. All layers of the network are fully interconnected, that is, the input layer and the hidden layer are fully interconnected, and the hidden layer and the output layer are fully interconnected. Performance evaluation process is generally received by the input layer of the first standardized data processing index, and then through the internal network layer processing, and finally output from the output layer of the assessment results, namely, the organization of modern index of development of creativity.According to the indicator system of comprehensive performance evaluation of organizational creativity, the input index is 7, then the input layer contains 7 neurons; the output index is 1, then the output layer contains 1 neuron. The number of hidden layer neurons is generally calculated according to the following method:

$h = \sqrt{i+o} + r$, h is the number of neurons in the hidden layer, i is the number of neurons in the input layer. O is For the output neurons, r takes an integer between 1 and 10. Therefore, the number of hidden neurons in this paper is selected as [4, 13], and the number of hidden neurons is initially set to 12. At this point, the initial model for comprehensive performance evaluation of organizational creativity development capability has been designed. The following will use the relevant software tools to establish the initial model, and use the relevant historical data as a sample of the initial model to learn training, the trained model for simulation to build a practical evaluation of organizational creativity and development of comprehensive performance evaluation model, It can be used for future related assessment to make it more scientific, reasonable and effective.

2.3. Deep neural networks

Deep neural networks (DNN) is the basic structure of deep network learning coding, and mainly performs feature extraction and dimension compression. DNNs based on the traditional neural network input and output layer to increase the hidden layer network structure to achieve improvement. Among them, the middle of the hidden layer node requirements than the input layer (encoder) and output layer (decoder) less. Using the network parameter training process, we can construct a common mapping between input and output of learning model. Data dimension compression methods mainly include principal component analysis (PCA), but the literature [13] shows that the depth-coding learning method is better than PCA coding.

In order to effectively train the DNNs network, an unsupervised learning training method is designed to realize unsupervised form-by-layer greedy parameter tuning to solve the local non-ideal extrema of the deep training model. In the same way as above, the Hessian matrix is solved by using the second-order parameter optimization form to simplify the process of deep network learning and training. DNNs structure is shown in Figure 1.

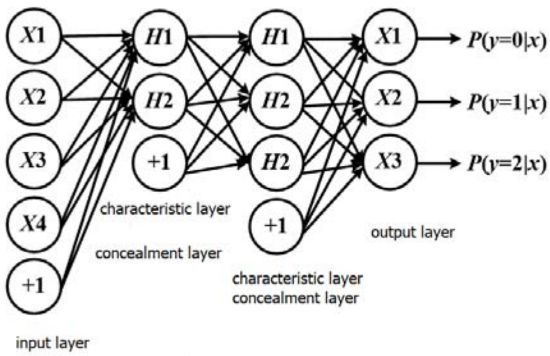


Fig. 1. DNNs structure

Figure 1 shows the structure of DNNs,which is slightly different from that of the traditional neural network. At least one hidden layer structure is added here for learning. This structure can significantly improve the performance of the network structure identification algorithm.

3. Multi-target Intelligent Water Drop Algorithm (MOIWD)

3.1. intelligent drop algorithm

Intelligent water droplets algorithm parameters are: the water droplets moving forward speed $velocity\,(IWD)$ and the number of soil attached to water droplets $soil\,(IWD)$. When the Water droplets move from the position from the position i to position j. The speed increase is $\Delta velocity\,(IWD)$, the value and the amount of soil with drops of water $soil\,(i,j)$ showed the following nonlinear relationship [10]:

$$\Delta velocity\,(IWD) = \frac{a_v}{b_v + c_v\,(soil\,(i,j))^2}\,. \tag{1}$$

In the formula, $a_v b_v$ and c_v is the algorithm default constant parameters. Water droplets follow the principle of conservation of soil volume:

$$\Delta soil\,(IWD) = \Delta soil\,(i,j)\,. \tag{2}$$

The change value of soil content is inversely proportional to the moving time of the drop position change $time\,(i,j)$:

$$\Delta soil\,(IWD) = \frac{a_s}{b_s + c_s\,(time\,(i,j))^2}\,. \tag{3}$$

In the formula, $a_s b_s$ and c_s are as defined above. The formula of $time\,(i,j)$ is:

$$time\,(i,j) \propto \frac{d\,(i,j)}{velocity\,(IWD)}\,. \tag{4}$$

The position moving time of Intelligent water droplet is:

$$time\,(i,j) = \frac{HUD\,(i,j)}{velocity\,(IWD)}\,. \tag{5}$$

$$soil\,(i,j) = \rho_0 \times soil\,(i,j) - \rho_n \times \Delta soil\,(i,j)\,. \tag{6}$$

In the formula, $HUD\,(i,j)$ is the inverse heuristic function. The remaining clay content in the channel is: $soil\,(i,j) = \rho_0 \times soil\,(i,j) - \rho_n \times \Delta soil\,(i,j)(6)$

In the formula, ρ_0 and ρ_n are all weights, and satisfy:

$$\rho_0 + \rho_n = 1\,. \tag{7}$$

The update formula of Water droplets attached to the amount of soil is:

$$soil\left(IWD\right) = soil\left(IWD\right) + \Delta soil\left(i,j\right) \,. \tag{8}$$

River mud is a hindrance to water drop motion, so the water flow automatically chooses to hinder small paths, which is a form of probability embodied in this algorithm:

$$\begin{cases} p\left(i,j\right) = \dfrac{f\left(soil\left(i,j\right)\right)}{\sum_k f\left(soil\left(i,j\right)\right)} \\ f\left(soil\left(i,j\right)\right) = \dfrac{1}{\varepsilon + g\left(soil\left(i,j\right)\right)} \end{cases} \tag{9}$$

In the formula, ε is a normal value, g is used to ensure that the amount of soil change in the path is positive:

$$g\left(soil\left(i,j\right)\right) = \begin{cases} soil\left(i,j\right), \; if \; \min\left(soil\left(i,j\right)\right) > 0 \\ soil\left(i,j\right) - \min\left(soil\left(i,j\right)\right), \; else \end{cases} \tag{10}$$

In the formula, $\min\left(soil\left(i,j\right)\right)$ is the minimum soil content from location i to path j.

3.2. Non-dominated sequence

The non-dominated sequence construction method used is the fast-sort method used in literature [12]:

Step 1: Perform an action on individual droplets p of the IWD algorithm population:

①set $S_p = \phi$, $n_p = 0$. S_p is the individual who holds the individual drip, n_p is the number of individual drip p.

②q is individuals in the droplet population, if $p \succ q$,there is $S_p = S_p \cup \{q\}$ available; otherwise $q \succ p$, then order $n_p = n_p + 1$.

③ If it is satisfie $n_p = 0$, the grade of the assigned water droplet p is $p_{rank} = 1$, and the water droplet p is added to the overall droplet Pareto frontier set, that is $F1 = F1 \cup \{p\}$,

Step 2: Perform the following operations in sequence, if the conditions are met $F_i = \phi$, then terminate the algorithm:

① initialization $Q = \phi$, as a temporary storage space;

For each individual droplet p in F_i, perform the operation: For each individual droplet q, perform: Suppose $n_q = n_q - 1$, if satisfied $n_q = 0$, that is q only dominated by p, set the level of q to $q_{rank} = i + 1$, and order $Q = Q \cup q$;

③ iteration count $i = i + 1$;

④ order $F_i = Q$, and in accordance with the above steps, in order to obtain the $2 \sim n$ drop of non-dominated front $F_2 \sim F_n$.

3.3. Individual congestion of Drops

In the process of evolution of intelligent water droplets population, individuals with high adaptation value and other water droplets with smaller density are reserved. Assuming that f_1. f_2.. f_2 f_r is a r sub-goal of the algorithm, the measurement of the degree of congestion of the water droplet i,$P\left[i\right].m$ is the evaluation value of the water droplet i on the above sub-target m, then the degree of congestion of the water droplet can be calculated by the following formula [11]:

$$P\left[i\right]_{dis} = \sum_{k=1}^{r} \left(P\left[i+1\right].f_k - P\left[i-1\right].f_k\right). \tag{11}$$

If the evolutionary size of the intelligent water droplet algorithm is N,the size of the algorithm, the worst complexity of the algorithm is that the above r sub-goals must be ranked at the same time. In this case, the complexity of the algorithm can be expressed as $O\left(rN\log N\right)$, while the algorithm complexity of the congestion calculation process is $O\left(rN\right)$. The total algorithm complexity of the above multi-target intelligent water droplet algorithm is $O\left(rN\log N\right)$.

3.4. Algorithm steps of Multi-target intelligent waterdrop

Step 1: Set the population size of intelligent waterdrop algorithm is N, terminate the iteration step number gen, upper and lower limits XVmax and XVmin of population droplet value, initialize population pop and carry out fitness evaluation, individual non-dominated sorting of drip and population crowding degree calculation, Let evolution algebra $i = 1$.

Step 2: Based on the binary competition method, $N/2$ single droplet was extracted from the initial population pop to construct the parent droplet parent_pop, and according to section 3.1, the droplet velocity and the soil content update operation were performed to generate the pop1 droplet population of size $N/2$.

Step 3: Mix pop1 with pop into inter_pop. According to sections 3.2 and 3.3, calculate the non-dominated drop order and population crowding degree, and select N water drop to form a new generation pop population pop.

Step 4: Let the number of iteration steps $i = i+1$, then, when $i \leq gen.$ continue to jump to Step 2; when $i > gen$, then, go to Step 5.

Step 5: Outputting the final population of droplet pop, that is, the suboptimal solution of the desired problem Pareto.

4. experimental analysis

4.1. Multi-objective optimization algorithm performance test

The test function used:

$$\text{MOP1:}left\{\begin{cases} f_1(x) = 1 - e^{-4x_1}\sin^6(6\pi x_1) \\ f_2(x) = g(x)\left(1 - (f_1(x)/g(x))^2\right) \\ g(x) = 1 + 9\left(\sum_{i=1}^{6} x_i/4\right)^{0.25} \end{cases} \tag{12}$$

Among them, the range values of x is $0 \leq x_i \leq 1$. $i = 1, ..., 6$.

$$\text{MOP2:}\begin{cases} f_1(x) = x_1 \\ f_2(x) = g \times \left(1 - \sqrt{f_1/g}\right) \\ g = 1 + 9 \times \sum_{i=2}^{n} x_i \bigg/ (n-1) \end{cases} \tag{13}$$

Among them, the range values of x is $0 \leq x_i \leq 1$ $i = 1, ..., 12$.

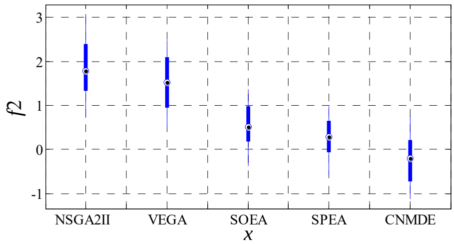
Set algorithm parameters, population size $N = 200$, evolutionary algebra $gen = 500$, crossover and mutation operator of NSGA2II are 20 [12], crossover probability factor and scaling factor of CND-MOIDE algorithm $CR = 0.3F = 0.6$. Simulation comparison algorithm using NSGA II [13], SOEA, SPEA [12] and VEGA algorithm, Pareto optimal solution set obtained by the five algorithms simulation results shown in Figure 2.

Figure 2 shows the Pareto optimal solution box graph obtained by the five algorithms. It can be seen from Figure 4 that the CNMDE algorithm is better than the contrast algorithm in the accuracy and distribution of the solution. The above comparison experiment verifies the validity of the algorithm in the standard test function. The algorithm of wireless sensor network location algorithm will be studied in the following.

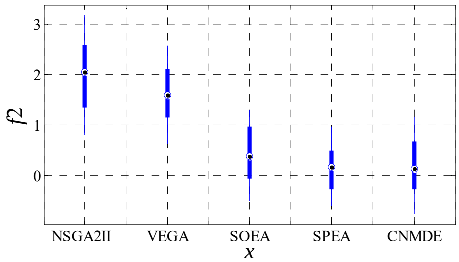
4.2. Data collection and collation

(1) Quantitative data collection. Quantitative indicators of return on net assets, accounts receivable turnover, total asset turnover, quick ratio, cash flow debt ratio, debt ratio, sales growth, capital accumulation rate, new technology investment ratio of nine. This article selects the relevant data of seven state-owned large and medium-sized wholly-owned companies in the manufacturing industry in 2007 as the basis for evaluating the performance of the company's organizational creativity. The required quantitative data from the SASAC in Sichuan Province. These companies are group companies, and have a normal operating history of more than 10 years.

(2) Qualitative data collection. Seven qualitative indicators are the market share,



(a) Distribution of MOP1 Solutions



(b) Distribution of MOP2 Solutions

Fig. 2. Pareto optimal solution box diagram

customer satisfaction, employee satisfaction, safety indicators, the general manager of the basic qualities, general manager management capabilities, comprehensive social contribution capacity. In order to obtain the information of these indicators, this paper collects the related information in the form of questionnaires, including two sets of employee questionnaires and management questionnaires.

First, the design of the questionnaire. The contents of the questionnaire involve the status quo and influencing factors of general manager performance of wholly state-owned companies. In the table are used Richter 5-point scale. The theoretical basis of the questionnaire design: Based on the general manager's contribution to the company, the general manager's contribution to the company, the general manager's contribution to society, the general manager's own basic quality and management ability to build the general manager performance evaluation theory system. The questionnaire design topic mainly through a large number of documents to explore, draw on the relevant content of top journals at home and abroad to determine, and adopted the reliability and validity test. Second, the questionnaire turtle distribution and recycling arrangements. This article selects seven representative general managers of the state-owned manufacturing industry as the research object, the questionnaire for the seven students and SASAC managers to fill in. Each company randomly selected 50 general staff and 25 management staff, including 10 grassroots management staff, middle management staff of 10 people, senior management staff of 5 people. There are also five managers questionnaire filled by the SASAC managers, who will evaluate the performance of the general manager of the seven companies. Through field visits, 20,000 journals were issued and 448 copies were returned with a recovery rate of 80%. Of the 215 questionnaires sent to managers, 182 were retrieved, with an effective rate of 97% and 350 copies of 266 employees, with an effective rate of 93%

4.3. Result analysis

Network model training process shown in Figure 3, only through seven training to learn, the network model has been completed training, the error to standard and much smaller than the required accuracy. As shown in Fig. 4, through the simulation of training data, the actual output value of the network almost matches the expected output value. The simulation results of the training data from 2001 to 2007 are shown in Table 1 (2001-2007) The result of the evaluation result output by the comprehensive performance evaluation model of trained ability of development of creativity is basically equal to the value of the original evaluation index, which shows that the model is normal and good during learning and training.

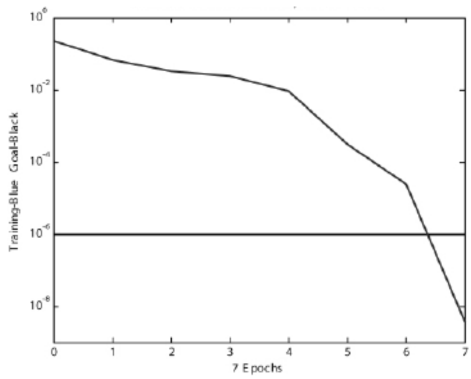


Fig. 3. Network training process

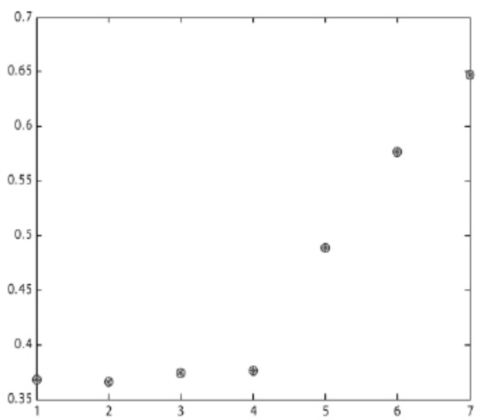


Fig. 4. Simulation results and expectations comparison

The trained network model was tested by using the data from 2008 to 2009 as the test data. The test results are shown in Table 1 (2008 and 2009 data), showing that the network model's evaluation value and expected value Consistent, the assessment accuracy reached 98.7%, indicating that the establishment of an integrated capacity of organizational creativity development performance evaluation model is valid. In order to verify the efficiency of the DNN neural network based on the multi-target intelligent waterdrop algorithm combined with the deep neural network algorithm to establish the evaluation model, DNN neural networks based on other algorithms are used to build the same instance evaluation model for comparison. The comparison results are shown in Table 2 , The most efficient is based on the multi-target intelligent waterdrop algorithm combined with the deep neural network algorithm algorithm, training only seven times, the least efficient is the additional momentum method, the need for 16510 training to establish the model to achieve the same standard accuracy , And the time is equivalent to 2358 times the time based on the multi-target intelligent waterdrop algorithm combined with the deep neural network algorithm, and the time required for the algorithm with relatively high efficiency is also nearly the time based on the multi-target intelligent waterdrop algorithm combined with the deep neural network algorithm algorithm Times, which indicates that the multi-target intelligent waterdrop algorithm used in this paper combined with the depth neural network algorithm is superior.

Table 1. Data simulation results of organizational creativity in the development of modern from 2001-2009

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Original organizational creativity index	0.3675	0.3658	0.3742	0.3763	0.4887	0.5762	06474	0.4343	0.5638
Simulation evaluation results	0.3675	0.3658	0.3742	0.3763	0.4886	0.5761	06473	0.4415	0.5827

Table 2. sets up the network model each algorithm training times comparison

Additional momentum method	adaptive adjustment algorithm	Quasi-Newton method	Tangent Newton's method	conjugate gradient method	Algorithm in this paper
16510	2952	256	218	153	53

5. Conclusion

This paper presents a performance evaluation method of organizational creativity based on multi-objective intelligent waterdrop algorithm. Combined with deep neural network, a network structure model of organizational creativity is established. By means of multi-objective intelligent waterdrop algorithm, experiments proved the validity of the performance evaluation algorithm of the proposed organizational creativity. It can not only distinguish efficiency values under quantitative criteria and quality standards, meet the evaluation requirements of decision makers, but also make the evaluation system more realistic with the inherent characteristics of the model making the weights given to variables more reasonable.

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