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Fuzzy self organizing map ellipse patch evaluation model for technical systems[☆]

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ABSTRACT

This paper proposes an evaluation method of vocational and technical course reform using the minimum-rule self-organizing maps ellipse fuzzy-patch evaluation model. First, it analyses the vocational and technical education course system reform evaluation model. Considering teachers and experts an evaluation model and a determination process of index weight is obtained. Then the situation in which many self-organizing maps nodes may cause complex models and over-fitting is identified. Then we adopt the Pearson correlation coefficient to process determination problems of optimal self-organizing maps grid size and provides suggestions. Then we estimate the ellipse fuzzy patch construction method based on improved Gaussian membership for computing relevant data. Finally, we verify the effectiveness of the method via simulation testing.

1. Introduction

In March 2016, there was an extraordinary event promoting national worker quality. Prime Minister Li Keqiang addressed the National People's Conference and Chinese People's Political Consultative Conference. He formally promoted the concept of “craftsmanship spirit” to cultivate workers equipped with the idea of seeking perfection. Consequently, a learning problem has been exposed, especially in the area of vocational education. Vocational and technical education plays a critical role in this national process and presents new challenges. Comprehensive enhancement of the quality development of workers is thus a new important research topic. The craftsmanship spirit movement is geared to revive the unremitting pursuit of the highest worker quality via vocational education.

Many developed European countries have strongly pursued craftsmanship. For example, we attribute exquisite craftsmanship to German vocations because of their tradition of high-quality vocational and technical application. Their teaching mode is similar to the postgraduate education of our country: it leverages the traditional apprenticeship system. In this system, an apprentice is paired with a master for each professional course in hopes of transmitting the skills of an exquisite craft and mentoring. Similarly, Japan has been at the forefront of the craftsmanship spirit since the 1950s. Their automobiles, electronic devices, and even toilet lids are designed and produced with a quality spirit. Japan and Germany succeed because they persist in their craftsmanship spirit, pursuing superior quality alongside highly-advanced sciences and technologies. They accomplish this through their vocational education programs, which are culturally reinforced into generations of technicians. From the perspective of enterprise management, Germany and Japan has paid considerably more attention to the experience of personal interaction and exchange between superiors and

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subordinates, as well as the technological learning and interaction between workers and peers. Moreover, they attach more importance to shifting the technical positions, which can cultivate workers with stronger technical breadth and broader craftsmanship spirit. Meanwhile, craftsmanship spirit now promulgates research topics related to enterprise management. In this context, the question of how to better cultivate the craftsmanship spirit of technicians is the new enterprise challenge. In addition, Germany and Japan maintain very strict quality control, supervision, and management. They adopt strict supervision methods and a zero-tolerance mode of operations, which clearly instills a deep craftsmanship spirit rooted in quality.

Craftsmanship spirit is the spiritual pillar that supports the traditional manufacturing infrastructure of high-end development, and it is a key educational prerogative of modern vocational institutions, which should be strongly cultivated. Therefore we should face the challenges of better equipping technicians. Our teaching industry should ensure that it transmits technical talents directly and attracts attention to vocational educational development. During the development and improvement processes, the modern vocational educational spirit should persist to strengthen moral education, innovation capability, and value cultivation, as asserted by the important mandates of the 18th National Congress on Comprehensive Education Reform.

The remaining part of the manuscript is described as follows: Section 2 has vocational and technical education model discussed. Section 3 presents SOM fuzzy systems for the process. Experimental results are presented in the Section 4. Section 5 concludes the paper.

2. Vocational and technical education course system reform evaluation model

2.1. Description on the course system reform evaluation model

To model system reform, we let the set of evaluated teachers be $S = \{s_1,s_2,\cdots, s_m\}$, and the teaching quality evaluation index is $P = \{p_1,p_2,\cdots, p_n\}$. The weight vector is $W = \{w_1,w_2,\ldots, w_n\}$, the index for meeting the unitization constraint is $\omega_j \ge 0$, and $j = 1, 2, \cdots,n$, $\sum_{k=1}^{n} w_j^2 = 1$. The set of employed experts is $E = \{e_1,e_2,\ldots, e_s\}$. The weight of an expert, e_k, is λ_k. The value of index p_i, related to teacher s_i, is $a_{ij}^{(k)} = [a_{ij}^{-(k)}, a_{ij}^{+(k)}]$, and constitutes the decision-making matrix, $A^{(k)} = (a_{ij}^{(k)})_{m\times n}$.

The common attribute type contains the benefit and cost types used to eliminate the influence of different physical decision-making dimensions. Thus, standardized processing can be conducted, and the standardized matrix of expert e_k is $B^{(k)} = (b_{ij}^{(k)})_{m\times n}$, wherein, $b_{ij}^{(k)} = [b_{ij}^{-(k)}, b_{ij}^{+(k)}]$.

2.2. Determination of index weight

The evaluation value of interval number $b_{ij}^{(k)} = [b_{ij}^{-(k)}, b_{ij}^{+(k)}]$ is

$$e_{ij}^{(k)} = \frac{b_{ij}^{-(k)} + b_{ij}^{+(k)}}{2(1 + b_{ij}^{+(k)} - b_{ij}^{-(k)})}. \tag{1}$$

Based on the weight vector of the index, $W = \{w_1,w_2,\ldots, w_n\}$, the expert,$e_k$, gives the comprehensive evaluation value, $\sum_{j=1}^{n} w_j e_{ij}^{(k)}$, to the teacher, s_i. Thus, the group comprehensive evaluation value of the teacher is s_i.

$$z_i = \sum_{k=1}^{s} \lambda_k \sum_{j=l}^{n} \omega_j e_{ij}^{(k)},\ i = 1, 2, \cdots,m. \tag{2}$$

The larger the group comprehensive evaluation value of the teacher, the higher the teacher's course system reform. To make reasonable decisions, the selection of index weight causes the group comprehensive evaluation value of all teachers to become large. Therefore, we establish a multi-target optimization model:

$$\max z_j,\ i = 1, 2, \cdots,m, \quad s.\ t. \sum_{j=1}^{n} w_j^2 = 1,\ w_j \ge 0,\ j = 1, 2, \cdots,n \tag{3}$$

Because there exists few preferences among teachers, the above problems can be transformed into equal-weight single-target planning problems.

$$\max \sum_{i=1}^{m} z_i, \quad s.\ t. \sum_{j=1}^{n} w_j^2 = 1,\ w_j \ge 0,\ j = 1, 2, \cdots,n. \tag{4}$$

In Eq. (4), the Lagrange function is

$$L(W, \beta) = \sum_{i=1}^{m} \sum_{k=1}^{s} \lambda_k \sum_{j=l}^{n} w_j e_{ij}^{(k)} + \beta\left(\sum_{j=1}^{j} w_j^2 - 1\right), \tag{5}$$

where in, β is a Lagrange multiplier. Thus, we obtain the partial derivative and set it to 0: