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A novel Dynamic Fuzzy Sets Method Applied to Practical Teaching Assessment on Statistical Software

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Abstract

In this paper, we present a novel dynamic fuzzy sets (DFS) method, which is the generalization of fuzzy sets (FS) and the dynamization of intuitionistic fuzzy sets (IFS). First, by analyzing the degree of hesitancy, we propose a DFS model from IFS. Second, a multiple attribute decision making example applied to practical teaching assessment is given to demonstrate the application of DFS, and the simulation results show that the DFS method is more effective than the IFS method and the FS method. Finally, a multiple-level practical teaching assessment model is proposed according to DFS.

Keywords: fuzzy sets, intuitionistic fuzzy sets, dynamic fuzzy sets, practical teaching assessment

1. Main text

Professor L. A. Zadeh's paper on fuzzy sets (FS, 1965) has influenced many researchers and has been applied to many application fields, such as pattern recognition, fuzzy reasoning, decision making, etc. In 1986, K. T. Atanassov introduced membership function, non-membership function and hesitancy function, and proposed the concept of intuitionistic fuzzy sets (IFS), which generalized the FS theory. In the research field of IFS, Yager discussed its characteristics (2009), and Xu (2007-2010), Wei (2009-2010), et al. applied it to

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decision making. Though many scholars studied IFS and applied it to decision making, most of their methods are suitable for static model and unsuitable for dynamic model. Considering that few references related to the study of dynamic decision-making from IFS was proposed, Xu (2008) presented a dynamic decision making model, which was also studied by Wei, Su, et al. (2009, 2011). However, traditional decision analysis models based on IFS do not involve the detachment of the absent party, which means that the decision-making results may be limited in the scope. Thus, in this paper, we present a novel DFS model by analyzing the hesitancy function.

First, we present the definition and the construction method of DFS. And then, we introduce some ranking functions of IFS and generalize it to DFS. Finally, we apply the DFS model along with its membership function to a multiple level practical teaching assessment problem. The simulation results show that the method introduced in this paper is more comprehensive and flexible than the IFS method and the FS method. Thus, this paper can provide valuable conclusion for the application research of FS to teaching assessment field, and the model of DFS is also useful for the generalization from fuzzy reasoning and intuitionistic fuzzy reasoning to dynamic fuzzy reasoning.

2. Construction of DFS

Definition 1. An IFS A in universe X is given by the following formula (Atanassov 1986):

$$A = \{< x, u_A(x), v_A(x) > | x \in X\}. \tag{1}$$

Where $u_A : X \rightarrow [0, 1]$, $v_A : X \rightarrow [0, 1]$ with the condition $0 \leq u_A(x) + v_A(x) \leq 1 \ \forall x \in X$. The numbers $u_A(x) \in [0,1]$, $v_A(x) \in [0, 1]$ denote a degree of membership and a degree of non-membership of x to A, respectively. For each IFS in X, we call $\pi_A(x) = 1 - u_A(x) - v_A(x)$ a degree of hesitancy of x to A, $0 \leq \pi_A(x) \leq 1$ for each $x \in X$.

Definition 2. A DFS A in universe X is denoted by:

$$A = \{< x, \mu_A^*(x), v_A^*(x) > | x \in X\}.$$

Where $\mu_A(x), v_A(x)$ and $\pi_A(x)$ are from definition 1, and we have $\mu_A^*(x) = \mu_A(x) + \lambda \pi_A(x)$ and $v_A^*(x) = v_A(x) + (1-\lambda)\pi_A(x)$ with the condition $\lambda \subseteq [0,1]$. $\mu_A^*(x)$ and $v_A^*(x)$ are membership function and non-membership function of x to A, respectively.

Theorem 1. Let A be an DFS as mentioned above, then

$$\mu_A^*(x) + v_A^*(x) = 1. \tag{2}$$

According to definition 2, we have theorem 1.

From definition 2, let all sample data be divided into three parts, $\mu_A(x)$ being the firm support party of event A, $v_A(x)$ representing the firm opposition party of event A, and $\pi_A(x)$ showing all the absent party that may become either the support party or the opposition party. In the absent party, if there is $\lambda \pi_A(x)$ sample supporting event A and $(1-\lambda)\pi_A(x)$ sample opposing event A, we have DFS denoted by definition 2.

Obviously, DFS is an extension of FS, and is a dynamization of IFS.