TOPSIS Method for Teaching Effect Evaluation of College English with Interval-Valued Intuitionistic Fuzzy Information

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Teaching effect evaluation of College English is frequently considered as a multiattributed group decision-making (MAGDM) issue. Thus, a novel MAGDM method is needed to tackle it. Depending on the classical TOPSIS method and interval-valued intuitionistic fuzzy sets (IVIFSs), this paper designs a novel intuitive distance-based IVIF-TOPSIS method for teaching effect evaluation of College English. First of all, a related literature review is conducted. Furthermore, some necessary theories related to IVIFSs are briefly reviewed. In addition, the weights of attribute are decided objectively by using the CRITIC method. Afterwards, relying on novel distance measures between IVIFSs, the conventional TOPSIS method is extended to the IVIFSs to calculate closeness degree of each alternative from the interval-valued intuitionistic fuzzy positive ideal solution (IVIF-PIS). Finally, an empirical example about teaching effect evaluation of College English and some comparative analyses have been given. The results show that the designed method is useful for teaching effect evaluation of College English.

1. Introduction

Since the process of making decision is filled with uncertainty and ambiguity [1–7], in order to cope with the accuracy of decision-making [8–14], Zadeh [15] defined the fuzzy sets (FSs). Atanassov [16] defined the concept of intuitionistic fuzzy sets (IFSs). Liu et al. [17] built some intuitionistic fuzzy BM fused operators with Dombi operations. Gupta et al. [18] extended the fuzzy entropy to IFSs. He et al. [19] integrated the power averaging with IFSs. Garg [20] presented a method related to MAGDM on the basis of intuitionistic fuzzy multiplicative preference and defined several geometric operators. Chen et al. [21] developed TOPSIS method and similarity measures under IFSs. Rouyendegh [22] used the ELECTRE method in IFSs to tackle some MCDM issues. Gan and Luo [23] used the hybrid method with DEMATEL and IFSs. Jin et al. [24] defined two GDM methods which can obtain the normalized intuitionistic fuzzy priority weights from IFPRs on the basis of the order consistency and the multiplicative consistency. Xiao et al. [25] defined the intuitionistic fuzzy Taxonomy method. Zhao et al. [26] defined TODIM method for IF-MAGDM based on CPT. Cali and Balaman [27] extended ELECTRE I with VIKOR method in IFSs to reflect the decision-makers’ preferences. Hao et al. [28] presented a theory of decision field for IFSs. Gupta et al. [29] modified the SIR method and combined it with IFSs. Li et al. [30] gave a grey target decision-making with IFNs. Gou et al. [31] defined some exponential operational law for IFNs. Khan and Lohani [32] defined similarity measure about IFNs. Bao et al. [33] defined prospect theory and evidential reasoning method under IFNs. Oztaysi et al. [34] solved the research proposals evaluation for grant funding using IVIFs. Sahu et al. [35] defined the hierarchical clustering of IVIFs. Xiao et al. [36] defined combined weighted averaging operator for GDM under IVIFSs. Zhang et al. [37] defined the programming technique for MAGDM based on Shapley values and incomplete information. Zhang [38] proposed some Frank aggregation operators under IVIFSs. An et al. [39] gave the project delivery system selection with IVIF-MAGDM method. Zeng et al. [40] solved IVIF-MADM based on nonlinear programming methodology and TOPSIS method. Zhao et al. [41] defined the CPT-TODIM method for interval-valued intuitionistic fuzzy MAGDM. Wang and
Mendel [42] solved the aggregation methodology for IVIF-MADM with a prioritization of criteria. TOPSIS was initially developed by Hwang and Yoon [43] to solve MAGDM issues. Compared with other MAGDM, TOPSIS method can consider the distances degree of every alternative from PIS and NIS. This method has been used in various fuzzy settings [44–49]. This paper’s goal is to use TOPSIS method in IVIFSs and build a new decision-making model for actual MADM problems. Thus, the motivation of this study is the following: (1) the weights of attributes are decided objectively by CRITIC method; (2) an empirical example about teaching effect evaluation of College English and some comparative analyses have been given. In order to do so, the reminder of this paper is organized as follows: Some concepts of IVIFSs are reviewed in Section 2. The improved TOPSIS method is defined with IVIFSs and the calculating steps is simply listed in Section 3. An empirical application about teaching effect evaluation of College English is given to show the superiority of this designed approach and some comparative analyses are given to prove the merits of such method in Section 4. At last, we make an overall conclusion of such work in Section 5.

2. Preliminaries

2.1. IVIFSs

Definition 1 (see [50]). The interval-valued IFS (IVIFS) on X is

\[ I = \{ \langle x, \bar{I}_1(x), \bar{I}_2(x) \rangle | x \in X \}, \] (1)

where \( \bar{I}_1(x) \subset [0, 1] \) is named as “membership degree of I” and \( \bar{I}_2(x) \subset [0, 1] \) is called “non-membership degree of I,” and \( \bar{I}_1(x) \) and \( \bar{I}_2(x) \) meet the following condition: \( 0 \leq \sup \bar{I}_1(x) + \sup \bar{I}_2(x) \leq 1, \forall x \in X \). For convenience, we call \( I = (\{\bar{I}_1, \bar{I}_2\}, [v^L, v^R]) \) an IVIFN.

Definition 2 (see [51]). Let \( I_1 = (\{\mu^L_1, \mu^R_1\}, [v^L_1, v^R_1]) \) and \( I_2 = (\{\mu^L_2, \mu^R_2\}, [v^L_2, v^R_2]) \) be two IVIFSs; the operation formula of them can be defined:

\[ \text{IVIFED}(I_1, I_2) = \sqrt[4]{\left[ \left( \mu^L_1 - \mu^L_2 \right)^2 + \left( \mu^R_1 - \mu^R_2 \right)^2 + \left( v^L_1 - v^L_2 \right)^2 + \left( v^R_1 - v^R_2 \right)^2 \right].} \] (4)

2.2. Two Aggregation Operators under IVIFS. Under the IVIFSs, some fused operators will be introduced in this section, including IVIFWA fused operator and IVIFWG fused operator.

\[ \text{IVIFWA}_w(I_1, I_2, \ldots, I_n) = \Phi^n \left( \omega, I_j \right) \]
\[ = \left( \left[ 1 - \prod_{j=1}^{n} \left( 1 - \mu^L_j \right)^{\omega_j} \right], \left[ 1 - \prod_{j=1}^{n} \left( 1 - \mu^R_j \right)^{\omega_j} \right] \right), \]
\[ = \left( \prod_{j=1}^{n} \left( v^L_j \right)^{\omega_j}, \prod_{j=1}^{n} \left( v^R_j \right)^{\omega_j} \right). \] (5)

\[ I_1 \oplus I_2 = \left( \left[ \mu^L_1 + \mu^L_2 - \mu^L_1 \mu^L_2 \mu^R_1 - \mu^R_1 \mu^R_2 \right], \left[ v^L_1 + v^L_2 - v^L_1 \mu^L_2 v^R_1 - v^R_1 \mu^R_2 \right] \right), \]
\[ I_1 \ominus I_2 = \left( \left[ \mu^L_1 \mu^R_2, \mu^R_1 \mu^L_2 \right], \left[ v^L_1 + v^L_2 - v^L_1 \mu^L_2 v^R_1 - v^R_1 \mu^R_2 \right] \right), \]
\[ \lambda I = \left( \left[ 1 - (1 - \mu^L_1)^{\lambda - 1} \right], \left[ (v^L_1)^{\lambda}, (v^R_1)^{\lambda} \right] \right), \lambda > 0, \]
\[ I^T = \left( \left[ (\mu^L_1)^{\lambda}, (\mu^R_1)^{\lambda} \right], \left[ 1 - (1 - \lambda_1)^{\lambda - 1}, 1 - (1 - \lambda_1)^{\lambda - 1} \right] \right), \lambda > 0. \] (2)
where $\omega = (\omega_1, \omega_2, \ldots, \omega_n)^T$ is the weight vector of $I_j$ ($j = 1, 2, \ldots, n$) and $\omega_j > 0, \sum_{j=1}^{n} \omega_j = 1$.

\[
IVIFWG_{\omega}(I_1, I_2, \ldots, I_n) = \frac{n}{\sum_{j=1}^{n} (I_j)^{\omega_j}}
\]

where $\omega = (\omega_1, \omega_2, \ldots, \omega_n)^T$ is the weight vector of $I_j$ ($j = 1, 2, \ldots, n$) and $\omega_j > 0, \sum_{j=1}^{n} \omega_j = 1$.

**3. TOPSIS Method for IVIF-MAGDM with the CRITIC Method**

In this section, we build the IVIF-TOPSIS method for MAGDM. The calculating steps of the designed method can be described subsequently. Let $R = \{R_1, R_2, \ldots, R_n\}$ be the group of attributes, and let $r = \{r_1, r_2, \ldots, r_n\}$ be the weight of attributes $R_j$, where $r_j \in [0, 1], j = 1, 2, \ldots, n, \sum_{j=1}^{n} r_j = 1$.

**Definition 6** (see [51]). Let $I_j = ([\mu_{I_j}^L, \mu_{I_j}^R], [\nu_{I_j}^L, \nu_{I_j}^R])$ ($j = 1, 2, \ldots, n$) be a set of IVIFNs; the IVIFWG operator is

\[
IVIFWG_{\omega}(I_1, I_2, \ldots, I_n) = \left( \frac{1}{\sum_{j=1}^{n} (I_j)^{\omega_j}} \right) \left[ 1 - \prod_{j=1}^{n} \left( 1 - (\nu_{I_j}^L)^{\omega_j} \right) \right], j = 1, 2, \ldots, n.
\]

**Step 3.** Employ CRITIC method to determine the weighting of attributes.

CRiteria Importance Through Intercriteria Correlation (CRITIC) method [55] will be proposed in this part, which is utilized to decide attributes’ weights.

(1) Depending on the normalized overall matrix $Q^N = (q_{ij}^N)_{mn}$ with IVIFNs, the correlation coefficient between attributes can be defined.

\[
IVIFCC_{jr} = \frac{\sum_{l=1}^{m} (S(q_{lj}^N) - S(q_{ij}^N))(S(q_{lj}^N) - S(q_{ir}^N))}{\sqrt{\sum_{l=1}^{m} (S(q_{lj}^N) - S(q_{ij}^N))^2} \sqrt{\sum_{l=1}^{m} (S(q_{lj}^N) - S(q_{ir}^N))^2}}, \ j, r = 1, 2, \ldots, n.
\]
where $S(q^N_i) = (1/m) \sum_{i=1}^{m} S(q^N_{ij})$, and $S(q^N) = (1/m) \sum_{i=1}^{m} S(q^N_{ij})$.

(2) Obtain attributes' standard deviation.

$$IVIFSD_j = \frac{1}{m - 1} \sum_{i=1}^{m} \left( S(q^N_{ij}) - S(q^N) \right)^2,$$  \hspace{1cm} (10)

\[ j = 1, 2, \ldots, n, \]

where $S(q^N_i) = (1/m) \sum_{i=1}^{m} S(q^N_{ij})$.

(3) Obtain the attributes' weights.

$$r_j = \frac{IVIFSD_j \sum_{j=1}^{n} (1 - IVIFCC_{ij})}{\sum_{j=1}^{n} (IVIFSD_j \sum_{j=1}^{n} (1 - IVIFCC_{ij}))},$$  \hspace{1cm} (11)

\[ j = 1, 2, \ldots, n, \]

where $r_j \in [0, 1]$ and $\sum_{j=1}^{n} r_j = 1$.

**Step 4.** Define the interval-valued intuitionistic fuzzy PIS (IVIF-PIS) $A^*_j$ and the interval-valued intuitionistic fuzzy NIS (IVIF-NIS) $A^*_j$ as

$$IVIFPIS_j = \left[ \left( \mu^{L^*}_{ij}, \mu^{R^*}_{ij}, \nu^{L^*}_{ij}, \nu^{R^*}_{ij} \right) \right],$$

$$IVIFNIS_j = \left[ \left( \mu^{L^*}_{ij}, \mu^{R^*}_{ij}, \nu^{L^*}_{ij}, \nu^{R^*}_{ij} \right) \right],$$  \hspace{1cm} (12)

where IVIFPIS = $[\text{[max}_1(\mu_{ij}^L), \text{max}_1(\mu_{ij}^R), \text{max}_1(\nu_{ij}^L), \text{max}_1(\nu_{ij}^R)], [\text{min}_1(\nu_{ij}^L), \text{min}_1(\nu_{ij}^R), \text{min}_1(\mu_{ij}^L), \text{min}_1(\mu_{ij}^R)])$ and IVIFNIS = $[\text{[min}_1(\mu_{ij}^L), \text{min}_1(\mu_{ij}^R), \text{max}_1(\nu_{ij}^L), \text{max}_1(\nu_{ij}^R)]$.

**Step 5.** Compute the positive distances $d^*_i$ between each alternative and IVIF-PIS and the negative distances $d^-_i$ between each alternative and IVIF-NIS as

$$d^*_i = \sum_{j=1}^{n} r_j IVIFED(q^N_{ij}, A^*_j), \hspace{1cm} i = 1, 2, \ldots, m,$$

$$d^-_i = \sum_{j=1}^{n} r_j IVIFED(q^N_{ij}, A^-_j), \hspace{1cm} i = 1, 2, \ldots, m,$$  \hspace{1cm} (13)

where IVIFED $(q^N_{ij}, A^*_j)$ and IVIFED $(q^N_{ij}, A^-_j)$ denote the IVIF Euclidean distances given in Definition 4, and $r_j$ is the weight of attributes.

**Step 6.** Compute each alternative's closeness degree from IVIF-PIS as

$$C_i = \frac{d^*_i}{d^*_i + d^-_i}, \hspace{1cm} i = 1, 2, \ldots, m.$$  \hspace{1cm} (14)

**Step 7.** According to the value, $C_i$ ($i = 1, 2, \ldots, m$). The highest value of $C_i$ ($i = 1, 2, \ldots, m$) is the optimal alternative which is designed.

### 4. The Empirical Example and Comparative Analysis

#### 4.1. Empirical Example

With the increasing development of economy and more frequent communication between countries, English, as an international language, has more important position and plays a greater role. Accordingly, the requirements for English teaching and learning become higher. Although experts and scholars have been trying to reform the English teaching approaches, the result is not satisfactory. In particular, the recent increasing enrollment has challenged the teaching of College English greatly. The increasing number of students and the lack of faculties lead to the larger number of students in English class. So how to improve the quality of large-class English teaching is the great concern of teachers and students, which is also the ultimate purpose of this research. It is evident that the traditional teacher-centered teaching approach cannot meet the demands of the development. At this moment, the popular cooperative learning approach has gained wide attention. Cooperative learning theories and methods have been researched deeply and are adopted widely in many countries all over the world. The core of the cooperative learning is the group work. It emphasizes the student as center and the teacher as designer, instructor, monitor, etc. By means of such instruments as questionnaires, tests, interviews, and classroom observations, the research on the effect of cooperative learning on the large-class College English teaching is conducted. The result of the research shows that the cooperative learning theories and methods are suitable for the large-class English teaching and are helpful to improve the quality of the teaching. The cooperative learning’s heterogeneous group, positive interdependence, individual accountability and group work, and so forth make the classroom atmosphere relaxed and greatly improve students’ positivity of participation and interest in learning. Students make great progress not only in academic performance but also in communication skills, self-confidence, self-esteem, and so forth. Through this research, some disadvantages of cooperative learning in large-class College English teaching are found, such as students’ inadequate preparations for the group work and unequal opportunities and time for participation of group members. On the basis of these findings in the research, some pedagogical implications are put forward to improve the effect of cooperative learning and the quality of large-class College English teaching.

In this chapter, an empirical application about teaching effect evaluation of College English will be provided by making use of IVIF-TOPSIS method. There are five potential College English teaching methods $F_i$ ($i = 1, 2, 3, 4, 5$) preparing to evaluate their investment environment. In order to assess the effect of College English teaching methods fairly, three experts $H = \{H_1, H_2, H_3\}$ (expert’s weight $h = (0.35, 0.32, 0.33)$ are invited. All experts depict their assessment information through four subsequent attributes: ① $R_1$ denotes teaching attitude; ② $R_2$ denotes the teaching methods; ③ $R_3$ denotes student feedback; ④ $R_4$ denotes peer recognition. The decision-making matrices are given in Tables 1–3.

Then, we shall use the defined TOPSIS method for teaching effect evaluation of College English:

**Step 1.** Based on the decision-making information $Q^k_{ij} = (q^k_{ij})_{mn} (i = 1, 2, \ldots, m, j = 1, 2, \ldots, n)$ given in
Table 1: Decision-making information given by $H_1$.

|    | $R_1$                  | $R_2$                  | $R_3$                  | $R_4$                  |
|----|------------------------|------------------------|------------------------|------------------------|
| $F_1$ | (0.16, 0.22), [0.65, 0.78]) | (0.33, 0.42), [0.50, 0.58]) | (0.24, 0.30), [0.65, 0.70]) | (0.47, 0.55), [0.40, 0.45]) |
| $F_2$ | (0.32, 0.40), [0.55, 0.60]) | (0.17, 0.25), [0.70, 0.75]) | (0.71, 0.80), [0.14, 0.20]) | (0.60, 0.70), [0.25, 0.30]) |
| $F_3$ | (0.43, 0.47), [0.50, 0.53]) | (0.32, 0.40), [0.55, 0.60]) | (0.57, 0.62), [0.30, 0.38]) | (0.29, 0.36), [0.58, 0.64]) |
| $F_4$ | (0.32, 0.39), [0.41, 0.61]) | (0.27, 0.36), [0.57, 0.64]) | (0.34, 0.40), [0.50, 0.60]) | (0.32, 0.40), [0.55, 0.60]) |
| $F_5$ | (0.25, 0.30), [0.55, 0.70]) | (0.44, 0.48), [0.50, 0.52]) | (0.62, 0.70), [0.25, 0.30]) | (0.60, 0.65), [0.30, 0.35]) |

Table 2: Decision-making information given by $H_2$.

|    | $R_1$                  | $R_2$                  | $R_3$                  | $R_4$                  |
|----|------------------------|------------------------|------------------------|------------------------|
| $F_1$ | (0.36, 0.41), [0.56, 0.59]) | (0.41, 0.45), [0.50, 0.55]) | (0.74, 0.80), [0.15, 0.20]) | (0.52, 0.62), [0.32, 0.38]) |
| $F_2$ | (0.70, 0.80), [0.15, 0.20]) | (0.36, 0.40), [0.57, 0.60]) | (0.59, 0.65), [0.30, 0.35]) | (0.66, 0.75), [0.20, 0.25]) |
| $F_3$ | (0.55, 0.62), [0.27, 0.38]) | (0.29, 0.35), [0.60, 0.65]) | (0.57, 0.62), [0.32, 0.38]) | (0.60, 0.65), [0.30, 0.35]) |
| $F_4$ | (0.28, 0.46), [0.50, 0.54]) | (0.53, 0.60), [0.35, 0.40]) | (0.68, 0.75), [0.20, 0.25]) | (0.35, 0.40), [0.55, 0.60]) |
| $F_5$ | (0.52, 0.60), [0.35, 0.40]) | (0.46, 0.52), [0.40, 0.48]) | (0.41, 0.52), [0.40, 0.48]) | (0.58, 0.63), [0.30, 0.37]) |

Table 3: Decision-making information given by $H_3$.

|    | $R_1$                  | $R_2$                  | $R_3$                  | $R_4$                  |
|----|------------------------|------------------------|------------------------|------------------------|
| $F_1$ | (0.59, 0.62), [0.26, 0.38]) | (0.63, 0.70), [0.25, 0.30]) | (0.37, 0.45), [0.50, 0.55]) | (0.55, 0.60), [0.32, 0.40]) |
| $F_2$ | (0.65, 0.75), [0.20, 0.25]) | (0.35, 0.40), [0.55, 0.60]) | (0.70, 0.80), [0.10, 0.20]) | (0.52, 0.62), [0.30, 0.38]) |
| $F_3$ | (0.37, 0.40), [0.53, 0.60]) | (0.42, 0.48), [0.50, 0.52]) | (0.19, 0.25), [0.70, 0.75]) | (0.59, 0.65), [0.30, 0.35]) |
| $F_4$ | (0.61, 0.65), [0.30, 0.35]) | (0.38, 0.42), [0.52, 0.58]) | (0.62, 0.70), [0.25, 0.30]) | (0.37, 0.45), [0.55, 0.60]) |
| $F_5$ | (0.35, 0.45), [0.50, 0.55]) | (0.61, 0.65), [0.30, 0.35]) | (0.36, 0.40), [0.55, 0.60]) | (0.55, 0.62), [0.28, 0.38]) |

Tables 1–3 and the expert’s weights $h = (0.35, 0.32, 0.33)$, we can derive the overall matrix $Q = (q_{ij})_{mn}$ $(i = 1, 2, \ldots, m, j = 1, 2, \ldots, n)$ according to equation (10), and the computing results are listed in Table 4.

Step 2. All the attributes are beneficial attributes; thus, this step is omitted.

Step 3. Decide the attribute weights $r_j$ $(j = 1, 2, \ldots, n)$ by CRITIC method as listed in Table 5.

Step 4. Calculate the IVIF-PIS $A^+_j$ and the IVIF-NIS $A^-_j$ according to equations (20) and (21).

$$A^+_j = \begin{cases} 
(0.6862, 0.1569), (0.4924, 0.2844), \\
(0.4413, 0.1625), (0.5054, 0.2042), \\
(0.3169, 0.2763), (0.1986, 0.5885), \\
(0.2051, 0.3945), (0.3078, 0.4041), 
\end{cases}$$

$$A^-_j = \begin{cases} 
(0.6862, 0.1569), (0.4924, 0.2844), \\
(0.4413, 0.1625), (0.5054, 0.2042), \\
(0.3169, 0.2763), (0.1986, 0.5885), \\
(0.2051, 0.3945), (0.3078, 0.4041), 
\end{cases}$$

Step 5. Compute the distances $d^+_i$ and $d^-_i$; the results are as follows:

$$d^+_i = 0.1823, d^-_i = 0.1978, d^+_i = 0.1043, d^-_i = 0.2123, d^+_i = 0.2213;$$
$$d^+_i = 0.1246, d^-_i = 0.1623, d^+_i = 0.2509, d^-_i = 0.1366, d^+_i = 0.1735.$$

Step 6. Compute each alternative’s closeness degree $C_i$ from IVIF-PIS by equation (14); the results are as follows:

$$C_1 = 0.3709,$$
$$C_2 = 0.4982,$$
$$C_3 = 0.6976,$$
$$C_4 = 0.3869,$$
$$C_5 = 0.3916.$$
Closeness is calculated as follows: 

\[ DRC_j = \frac{1}{n} \sum_{i=1}^{n} \left( \frac{S_j - S_i}{\max S - \min S} \right) \]

where \( DRC_j \) is the distance from the ideal solution to alternative \( j \), \( n \) is the number of alternatives, \( S_j \) is the score of alternative \( j \), and \( S_i \) is the score of alternative \( i \), \( \max S \) is the maximum score, and \( \min S \) is the minimum score.

The closest ideal score values are the following: \( DRC_1 = 0.2778 \), \( DRC_2 = 0.2192 \), \( DRC_3 = 0.2612 \), \( DRC_4 = 0.2418 \), \( DRC_5 = 0.5894 \).

When we can obtain the calculating result. The total assessment score (AS) of each alternative is calculated as follows: 

\[ AS_j = \sum_{i=1}^{n} w_i S_{ij} \]

where \( w_i \) is the weight of alternative \( i \), and \( S_{ij} \) is the score of alternative \( j \) with respect to criterion \( i \). Then we can get the total assessment score for each alternative. For example, the calculated AS of alternative \( F_1 \) is calculated as follows: 

\[ AS_1 = 0.4478 \times 0.2908 + 0.3848 \times 0.4723 + 0.3536 \times 0.6149 + 0.4550 \times 0.3636 + 0.4872 \times 0.5702 + 0.4127 \times 0.4153 = 0.5265 \]

Similarly, we can calculate the total assessment score for alternatives \( F_2, F_3, F_4, F_5 \).

The developed method to some extent. Thus, the highlights of this study are the following: (1) the weights of attributes are derived objectively by CRITIC method; (2) an empirical example about teaching effect evaluation of College English and some comparative analyses have been given to show the effectiveness of the designed IVIF-TOPSIS method in MAGDM issues. In our future works, the designed model

### Table 4: The overall matrix with IVIFNs.

|     | \( R_1 \)               | \( R_2 \)               | \( R_3 \)               | \( R_4 \)               |
|-----|-------------------------|-------------------------|-------------------------|-------------------------|
| \( F_1 \) | \([0.5265, 0.5879], \[0.2908, 0.4079]\) | \([0.4478, 0.5187], \[0.3848, 0.4723]\) | \([0.5356, 0.6149], \[0.4550, 0.3636]\) | \([0.4872, 0.5702], \[0.4127, 0.4153]\) |
| \( F_2 \) | \([0.5623, 0.6406], \[0.3011, 0.3594]\) | \([0.3034, 0.3589], \[0.5872, 0.6411]\) | \([0.6589, 0.7498], \[0.1660, 0.2502]\) | \([0.5875, 0.6829], \[0.2511, 0.3171]\) |
| \( F_3 \) | \([0.4125, 0.4685], \[0.4625, 0.5315]\) | \([0.3638, 0.4299], \[0.5243, 0.5701]\) | \([0.5273, 0.5805], \[0.3471, 0.4195]\) | \([0.5144, 0.5866], \[0.3420, 0.4134]\) |
| \( F_4 \) | \([0.4759, 0.5699], \[0.3497, 0.4301]\) | \([0.4333, 0.5053], \[0.4275, 0.4947]\) | \([0.5314, 0.6012], \[0.3298, 0.3988]\) | \([0.3010, 0.3678], \[0.5677, 0.6322]\) |
| \( F_5 \) | \([0.3160, 0.4106], \[0.5152, 0.5894]\) | \([0.4702, 0.5165], \[0.4317, 0.4835]\) | \([0.5080, 0.5864], \[0.3567, 0.4136]\) | \([0.4932, 0.5582], \[0.3658, 0.4418]\) |

### Table 5: The attributes weights \( r_j \).

| \( R_1 \)               | \( R_2 \)               | \( R_3 \)               | \( R_4 \)               |
|-------------------------|-------------------------|-------------------------|-------------------------|
| \( r_{F_1} \)           | 0.2778                  | 0.2192                  | 0.2612                  | 0.2418                  |

### Table 6: Evaluation results of these methods.

| Methods                  | Ranking order | The best alternative | The worst alternative |
|--------------------------|---------------|----------------------|-----------------------|
| IVIFWA operator [54]     | \( F_1 > F_2 > F_3 > F_4 > F_5 \) | \( F_3 \)           | \( F_1 \)           |
| IVIFWG operator [54]     | \( F_1 > F_2 > F_3 > F_4 > F_5 \) | \( F_3 \)           | \( F_5 \)           |
| IVIF-VIKOR method [56]   | \( F_1 > F_2 > F_3 > F_4 > F_5 \) | \( F_3 \)           | \( F_5 \)           |
| IVIF-CODAS method [57]   | \( F_1 > F_2 > F_3 > F_4 > F_5 \) | \( F_3 \)           | \( F_5 \)           |
| The developed method     | \( F_1 > F_2 > F_3 > F_4 > F_5 \) | \( F_3 \)           | \( F_5 \)           |

**5. Conclusion**

With the development of multimedia technology and the wide use of the Internet and computer, College English teaching is becoming more and more multimodal. The rapid development of information technology promotes the change in the ways of communication and the education idea. However, the traditional teaching mode is not adapted to the requirements of the times. This paper offers an effective solution for this issue, since it designs a novel intuitive distance based IVIF-TOPSIS method to build the teaching effect evaluation of College English. Then a numerical example has been given to confirm that this novel method is reasonable. What is more, to verify the validity and feasibility of the developed method, some comparative analysis is also given. However, the main drawback of this paper is that the numbers of DMs and attributes are small, and interdependency of attributes is not taken into consideration, which may limit the application scope of the developed method to some extent. Thus, the highlights of this study are the following: (1) the weights of attributes are derived objectively by CRITIC method; (2) an empirical example about teaching effect evaluation of College English and some comparative analyses have been given to show the effectiveness of the designed IVIF-TOPSIS method in MAGDM issues. In our future works, the designed model
and algorithm will be needful and meaningful to apply to solve other real MADM or MAGDM problems [58–62], and the designed methods can also be extended to other uncertain settings [63–68].

Data Availability

The data used to support the findings of this study are included in the article.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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