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RETRACTED: Comprehensive evaluation analysis of mental health status of poverty-stricken college students at present age with interval-valued intuitionistic fuzzy information

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1. Introduction

Education is an important basis for building a harmonious socialist society. But at this stage, because regional income disparity and family income gap still exist, some students from low-income families cannot afford the university tuition fees. In order to promote education fair and promote the coordinated development of education, the State Council of the People's Republic of China promulgated Views on the Establishment and Improvement of the Financial Assistance Policy System for Poor Students in Undergraduate Universities, Higher Vocational Schools and Secondary Vocational Schools in May 2007. This marked that the financial assistance policy system for poor students had been fully established, including state scholarships, state scholarships for encouraging students, state grants, free education for normal

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school students, national student loans, work-study project, fee remission and school grants for students with special difficulties. In the policy system, colleges and universities, which play the role of the actor of the financial assistance activities, have to face a variety of theoretical issues and practical issues, such as how to promote the overall development of poor students by means of managing the financial assistance resources and implementing the financial assistance activities. With the reform of the system of higher education, the number of students increased year by year, with the number of poor college students is in a rising state. The high tuition has brought some family burden. To the problem of poor college students go to school also caused the social attention. Economic difficulties not only bring to their lives, but also affects the change of their hearts. The poor college students are no longer specifically to those poor families of students, and includes three types: economic poverty, capability poverty and mental poverty students. To change their present this state to overcome their own problems and transformation thought erroneous zone, get rid of the psychological barriers, positive face yourself, to better integrate into society.

Mental disorders, including attention deficit disorder (ADHD), disruptive behavior disorder (DBD), mood disorders, tic disorder (TD), and anxiety spectrum disorder [1], strongly affect learning and quality of life in children and adolescents and are closely related to adult mental health [2, 3]. Children's self-cognition is limited, and parental assessment is subjective [4]; therefore, there are few applicable epidemiological methods available [5–9], and few epidemiological studies have examined mental disorders in children and adolescents, the results of which are inconsistent [10, 11]. Comprehensive evaluation analysis of mental health status of poverty-stricken college students at present age under interval-valued intuitionistic fuzzy environment is classical multiple attribute decision making problem [12–34]. In this paper, we investigate multiple attribute decision making problems for evaluating the mental health status of poverty-stricken college students at present age under interval-valued intuitionistic fuzzy environment. By using interval-valued intuitionistic fuzzy Maclaurin symmetric mean (IVIFMSM) operator, a novel algorithm to evaluate the mental health status of poverty-stricken college students at present age with interval-valued intuitionistic fuzzy information is developed. In the end, an example is given to verify the developed approach and to demonstrate its practicality and effectiveness.

2. Preliminaries

Atanassov and Gargov [35, 36] further introduced the interval-valued intuitionistic fuzzy set (IVIFS) and The intuitionistic fuzzy set and interval-valued intuitionistic fuzzy set has been concentrated on with its appearance [37–55].

Definition 1 [35, 36]. Suppose that X be a universe of discourse, An IVIFS $\tilde{A}$ over X refers to an object which is defined as follows [1, 2].

$$\tilde{A} = \{\langle x, \tilde{\mu}_A(x), \tilde{\nu}_A(x)\rangle \,|\, x \in X\} \quad (1)$$

where $\tilde{\mu}_A(x) \subset [0, 1]$ and $\tilde{\nu}_A(x) \subset [0, 1]$ denote interval numbers, and $0 \le \sup(\tilde{\mu}_A(x)) + \sup(\tilde{\nu}_A(x)) \le 1, \ \forall x \in X$. To be simple, we assume that $\tilde{\mu}_A(x) = [a, b]$, $\tilde{\nu}_A(x) = [c, d]$, so $\tilde{A} = ([a, b], [c, d])$.

Definition 2 [12]. Assume that $\tilde{a} = ([a, b], [c, d])$ be an interval-valued intuitionistic fuzzy number, then a function S defined follows:

$$S(\tilde{a}) = \frac{a - c + b - d}{2}, S(\tilde{a}) \in [-1, 1] \quad (2)$$

Definition 3 [12]. Assume that $\tilde{a} = ([a, b], [c, d])$ be an interval-valued intuitionistic fuzzy number, a function H is defined as follows:

$$H(\tilde{a}) = \frac{a + b + c + d}{2}, H(\tilde{a}) \in [0, 1] \quad (3)$$

Afterwards, Xu et al., [12] provide an order relation between 2 interval-valued intuitionistic fuzzy values by the following equation:

Definition 4 [12]. Assume that $\tilde{a}_1 = ([a_1, b_1], [c_1, d_1])$ and $\tilde{a}_2 = ([a_2, b_2], [c_2, d_2])$ denote 2 interval-valued intuitionistic fuzzy values, $s(\tilde{a}_1) = \frac{a_1 - c_1 + b_1 - d_1}{2}$ and $s(\tilde{a}_2) = \frac{a_2 - c_2 + b_2 - d_2}{2}$ refer to the scores of $\tilde{a}$ and $\tilde{b}$, and let$H(\tilde{a}_1) = \frac{a_1 + c_1 + b_1 + d_1}{2}$ and $H(\tilde{a}_2) = \frac{a_2 + c_2 + b_2 + d_2}{2}$ be the accuracy degrees of $\tilde{a}$ and $\tilde{b}$. Next, if $S(\tilde{a})$ is lower than $S(\tilde{b})$, the condition $\tilde{a} < \tilde{b}$ is satisfied. On the other hand, if $S(\tilde{a})$ is equal to $S(\tilde{b})$, then $H(\tilde{a}) = H(\tilde{b})$ and $\tilde{a} = \tilde{b}$ are satisfied.

(2) if $H(\tilde{a}) < H(\tilde{b})$, the condition $\tilde{a} < \tilde{b}$ is satisfied.

3. Interval-valued intuitionistic fuzzy Maclaurin symmetric mean

Sun and Xia [56] extended MSM to interval-valued intuitionistic fuzzy environment.

Definition 5 [56]. Assume that $\tilde{a}_j = ([a_j, b_j], [c_j, d_j])\ (j = 1, 2, \cdots, n)$ be a set of interval-valued intuitionistic fuzzy values, and let IVIFMSM: $Q^n \rightarrow Q$, if

$$\mathrm{IVIFMSM}^{(\mathrm{k})}(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n) = \left(\frac{\underset{\substack{1 \le i_1 \le \cdots \\ \le i_k \le n}}{\oplus} \left(\overset{k}{\underset{j=1}{\otimes}} \tilde{a}_{ij} \right)}{C_n^k} \right)^{1/k}$$

$$= \left(\left[\left(1 - \left(\prod_{\substack{1 \le i_1 \le \cdots \\ \le i_k \le n}} \left(1 - \prod_{j=1}^{k} a_j \right) \right)^{C_n^k} \right)^{1/k}, \left(1 - \left(\prod_{\substack{1 \le i_1 \le \cdots \\ \le i_k \le n}} \left(1 - \prod_{j=1}^{k} b_j \right) \right)^{C_n^k} \right)^{1/k} \right], \left[1 - \left(1 - \left(\prod_{\substack{1 \le i_1 \le \cdots \\ \le i_k \le n}} \left(1 - \prod_{j=1}^{k} (1 - c_j) \right) \right)^{C_n^k} \right)^{1/k}, 1 - \left(1 - \left(\prod_{\substack{1 \le i_1 \le \cdots \\ \le i_k \le n}} \left(1 - \prod_{j=1}^{k} (1 - d_j) \right) \right)^{C_n^k} \right)^{1/k} \right] \right) \quad (4)$$

then $\mathrm{IVIFMSM}^{(\mathrm{k})}$ is named as the interval-valued intuitionistic fuzzy Maclaurin symmetric mean (IVIFMSM), where $(i_1, i_2, \cdots, i_k)$ traversal all the k-tuple integration of $(1, 2, \cdots, n)$, C_n^k is the binomial coefficient.

The IVIFMSM operator has the following properties.

Theorem 1. (Idempotency) *If* $\tilde{a}_j(\tilde{a}_j = ([a_j, b_j], [c_j, d_j])) = \tilde{a}(\tilde{a} = ([a, b], [c, d]))$ *for all* j, *then*

$$\mathrm{IVIFMSM}^{(\mathrm{k})}(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n) = \tilde{a}$$

Theorem 2. (Commutativity) *Let* $\tilde{a}_j = ([a_j, b_j], [c_j, d_j])\ (j = 1, 2, \cdots, n)$ *be a collection of interval-valued intuitionistic fuzzy values, if*

$$\mathrm{IVIFMSM}^{(\mathrm{k})}(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n) = \mathrm{IVIFMSM}^{(\mathrm{k})}(\tilde{a}'_1, \tilde{a}'_2, \cdots, \tilde{a}'_n)$$

where $(\tilde{a}'_1, \tilde{a}'_2, \cdots, \tilde{a}'_n)$ *is any permutation of* $(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n)$.

Theorem 3. (Monotonicity) *Let* $\tilde{a}_j = ([a_j, b_j], [c_j, d_j])\ (j = 1, 2, \cdots, n)$ *be a set of interval-valued intuitionistic fuzzy values,*

$$\mathrm{IVIFMSM}^{(\mathrm{k})}(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n) \le \mathrm{IVIFMSM}^{(\mathrm{k})}(\tilde{a}'_1, \tilde{a}'_2, \cdots, \tilde{a}'_n)$$

if

$$a_j \le a'_j, b_j \le b'_j, c_j \ge c'_j, d_j \ge d'_j.$$

Next, we will consider several cases of the IVIFMSM operator by selecting various values of k.

- If $k = 1$, then using the definition of IVIFMSM operator, we have

$$\mathrm{IVIFMSM}^{(1)}(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n) = \left(\frac{\underset{1 \le i \le n}{\oplus} \left(\overset{1}{\underset{j=1}{\otimes}} \tilde{a}_{ij} \right)}{C_n^1} \right)^{1/1}$$

$$= \left(\left[\left(1 - \left(\prod_{1 \le i \le n} \left(1 - \prod_{j=1}^{1} a_j \right) \right)^{C_n^1} \right)^{1/1}, \left(1 - \left(\prod_{1 \le i \le n} \left(1 - \prod_{j=1}^{1} b_j \right) \right)^{C_n^1} \right)^{1/1} \right], \left[1 - \left(1 - \left(\prod_{1 \le i \le n} \left(1 - \prod_{j=1}^{1} (1 - c_j) \right) \right)^{C_n^1} \right)^{1/1}, 1 - \left(1 - \left(\prod_{1 \le i \le n} \left(1 - \prod_{j=1}^{1} (1 - d_j) \right) \right)^{C_n^1} \right)^{1/1} \right] \right)$$

$$= \left(\left[1 - \prod_{j=1}^{n} (1 - a_j)^{1/n}, 1 - \prod_{j=1}^{n} (1 - b_j)^{1/n} \right], \right.$$

$$\left[\left(\prod_{j=1}^{n} c_j\right)^{1/n}, \left(\prod_{j=1}^{n} d_j\right)^{1/n}\right]\Bigg)$$

- If $k=2$, then based on the definition of IVIFMSM operator, we have

$$\mathrm{IVIFMSM}^{(2)}(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n)$$

$$= \left(\frac{\underset{1\le i_1<i_2\le n}{\oplus}\left(\overset{2}{\underset{j=1}{\otimes}} \tilde{a}_{ij}\right)}{C_n^2}\right)^{1/2}$$

$$= \left(\left[\left(1-\left(\prod_{1\le i_1<i_2\le n}\left(1-\prod_{j=1}^{2} a_j\right)\right)^{C_n^2}\right)^{1/2},\right.\right.$$

$$\left.\left(1-\left(\prod_{1\le i_1<i_2\le n}\left(1-\prod_{j=1}^{2} b_j\right)\right)^{C_n^2}\right)^{1/2}\right],$$

$$\left[1-\left(1-\left(\prod_{1\le i_1<i_2\le n}\left(1-\prod_{j=1}^{2}\left(1-c_j\right)\right)\right)^{C_n^2}\right)^{1/2},\right.$$

$$\left.\left.1-\left(1-\left(\prod_{1\le i_1<i_2\le n}\left(1-\prod_{j=1}^{2}\left(1-d_j\right)\right)\right)^{C_n^2}\right)^{1/2}\right]\right)$$

$$= \left(\begin{array}{l} \left[\left(1-\prod_{\substack{i_1=i_2=1\\ i_1\ne i_2}}^{n}\left(1-a_{i_1}a_{i_2}\right)^{1/n(n-1)}\right)^{1/2},\right. \\ \left.\left(1-\prod_{\substack{i_1=i_2=1\\ i_1\ne i_2}}^{n}\left(1-b_{i_1}b_{i_2}\right)^{1/n(n-1)}\right)^{1/2}\right], \\ \left[1-\left(1-\prod_{\substack{i_1=i_2=1\\ i_1\ne i_2}}^{n}\left(1-\left(1-c_{i_1}\right)\left(1-c_{i_2}\right)\right)^{1/n(n-1)}\right)^{1/2},\right. \\ \left.1-\left(1-\prod_{\substack{i_1=i_2=1\\ i_1\ne i_2}}^{n}\left(1-(1-d_{i_1})(1-d_{i_2})\right)^{1/n(n-1)}\right)^{1/2}\right] \end{array}\right)$$

4. Multiple attribute decision making algorithm using the IVIFMSM operator

In this section, we will study on the multiple attribute decision making problems using the IVIFMSM operator. Suppose that $\tilde{R}=(\tilde{r}_{ij})_{m\times n}=([a_{ij},b_{ij}],[c_{ij},d_{ij}])_{m\times n}$ is the interval-valued intuitionistic fuzzy decision matrix, where $[a_{ij},b_{ij}]$ denotes the degree that the suppliers alternative A_i satisfies the attribute G_j, where $[a_{ij},b_{ij}]\subset[0,1]$, $[c_{ij},d_{ij}]\subset[0,1]$, $b_{ij}+d_{ij}\le 1$, $i=1,2,\cdots,m$, $j=1,2,\cdots,n$.

Next, we exploit the IVIFMSM operator to solve multiple attribute decision making problems. The method involves the following steps:

Step 1. Utilize the matrix $\tilde{R}$, and the IVIFMSM operator

$$\tilde{r}_i=([a_i,b_i],[c_i,d_i])=\mathrm{IVIFMSM}^{(k)}(\tilde{r}_{i1},\tilde{r}_{i2},\cdots,\tilde{r}_{in}),\ i=1,2,\cdots,m$$

to derive the overall preference values $\tilde{r}_i(i=1,2,\cdots,m)$ of the alternative A_i.

Step 2. Calculate the $S(\tilde{r}_i)$, $H(\tilde{r}_i)(i=1,2,\cdots,m)$ of the collective overall values $\tilde{r}_i$ $(i=1,2,\cdots,m)$ to rank all the alternatives $A_i(i=1,2,\cdots,m)$ and then to choose the optimal one(s).

Step 3. Rank all the alternatives $A_i(i=1,2,\cdots,m)$ and choose the optimal one according to $S(\tilde{r}_i)$ and $H(\tilde{r}_i)$ $(i=1,2,\cdots,m)$.

Step 4. End.

5. Numerical example

Under the background of higher education popularization in our country, the non-compulsory nature of higher education has been emphasized outstandingly, and due to the university cost-sharing system, fees and charges rise year by year. Coupled with the imbalance of China's socio-economic development, a number of contemporary social vulnerable groups-impoverished undergraduates have appeared in the college and university. With the enrollment of colleges and universities continuing to expand and the rapid growth of the students, the number of impoverished undergraduates increases sharply. The phenomenon of impoverished undergraduates' becomes increasingly prominent, therefore, a series of impoverished undergraduates' problems urgent to be resolved are more conspicuous. How to solve the impoverished undergraduates' financial difficulties and other issues initiated by financial difficulties effectually, ensuring that impoverished undergraduates don't drop out of school, and making their physiology, psychology to develop in a healthy way has become a common concerned problem. In this regard, the government, schools, families, communities and other organizations including various NGO should cooperate actively in the hope of forming a strong, effective social support system to ensure that the college students able to successfully complete their education, and guiding their values positively. Since the 70's of last century "social support" has been introduced into psychiatry, social support and its functions have been studied from sociology, psychiatry, economics and social psychology etc. Using questionnaire and case interview materials, the dissertation analyzes impoverished undergraduates' social support and its influences on their values. Therefore, we provide a numerical example an example to evaluate the mental health status of poverty-stricken college students at present age with interval-valued intuitionistic fuzzy information to describe the proposed algorithm. There are five possible poverty-stricken college students $A_i (i = 1, 2, 3, 4, 5)$ for four attributes $G_j (j = 1, 2, 3, 4)$. The four attributes include the ability to make immediate response (G_1), interpersonal relationship (G_2), ability to organize and coordinate (G_3) and the problem of anxiety (G_4), respectively. The five possible poverty-stricken college students $A_i (i = 1, 2, \cdots, 5)$ are to be estimated with the interval-valued intuitionistic fuzzy numbers based on the decision makers under the above four attributes. Next, the decision matrices are given as $\tilde{R} = (\tilde{r}_{ij})_{5\times4} = ([a_{ij}, b_{ij}], [c_{ij}, d_{ij}])_{5\times4}$

$$\tilde{R} = \begin{bmatrix} ([0.4, 0.5], [0.3, 0.4]) & ([0.4, 0.6], [0.2, 0.4]) & ([0.3, 0.4], [0.4, 0.5]) & ([0.5, 0.6], [0.1, 0.3]) \\ ([0.5, 0.6], [0.2, 0.3]) & ([0.6, 0.7], [0.2, 0.3]) & ([0.5, 0.6], [0.3, 0.4]) & ([0.4, 0.7], [0.1, 0.2]) \\ ([0.3, 0.5], [0.3, 0.4]) & ([0.1, 0.3], [0.5, 0.6]) & ([0.2, 0.5], [0.4, 0.5]) & ([0.2, 0.3], [0.4, 0.6]) \\ ([0.2, 0.5], [0.3, 0.4]) & ([0.4, 0.7], [0.1, 0.2]) & ([0.4, 0.5], [0.3, 0.5]) & ([0.5, 0.8], [0.1, 0.2]) \\ ([0.3, 0.4], [0.1, 0.3]) & ([0.7, 0.8], [0.1, 0.2]) & ([0.5, 0.6], [0.2, 0.4]) & ([0.6, 0.7], [0.1, 0.2]) \end{bmatrix}$$

In the following, we use the IVIFMSM operator to multiple attribute decision making to evaluate the poverty-stricken college students with interval-valued intuitionistic fuzzy information. The proposed approach contains the following steps:

Step 1. Exploit the decision information given in matrix $\tilde{R}$, and the IVIFMSM operator, we get the overall preference values $\tilde{r}_i$ of the poverty-stricken college students $A_i\ (i = 1, 2, \cdots, 5)$.

$$\tilde{r}_1 = ([0.323, 0.521], [0.276, 0.423])$$
$$\tilde{r}_2 = ([0.449, 0.684], [0.178, 0.291])$$
$$\tilde{r}_3 = ([0.213, 0.452], [0.326, 0.475])$$
$$\tilde{r}_4 = ([0.315, 0.598], [0.195, 0.336])$$
$$\tilde{r}_5 = ([0.397, 0.553], [0.219, 0.385])$$

Step 2. Compute the scores $S(\tilde{r}_i)\ (i = 1, 2, \cdots, 5)$ of the collective overall preference values $\tilde{r}_i\ (i = 1, 2, \cdots, 5)$

$$S(\tilde{r}_1) = 0.095,\ S(\tilde{r}_2) = 0.343,\ S(\tilde{r}_3) = -0.076$$
$$S(\tilde{r}_4) = 0.215,\ S(\tilde{r}_5) = 0.186$$

Step 3. Rank all the poverty-stricken college students $A_i (i = 1, 2, 3, 4, 5)$ according to the scores $S(\tilde{r}_i)\ (i = 1, 2, \cdots, 5)$ of the overall preference values $\tilde{r}_i\ (i = 1, 2, \cdots, 5)$: $A_2 \succ A_4 \succ A_5 \succ A_1 \succ A_3$, and then the most desirable poverty-stricken college student is A_2.

5. Conclusion

At present, the reality to strengthen and improve ideological and political education for college students and the current severe employment situation faced by college students, especially poor college students, has brought about opportunities and challenges together with new requirements for the ideological and political education in the employment guidance. At present, from the angle of poor college students, the research concerning ideological and political education in employment guidance has not been given due attention. Although many scholars have done different researches in terms of poor college students' psychology concerning career choice and employment situation, there still exists some insufficiency in terms of theoretical basis, research system and practicality. In this paper, we investigate multiple attribute decision making problems for evaluating the mental health status of poverty-stricken college students at present age under interval-valued intuitionistic fuzzy environment. By using interval-valued intuitionistic fuzzy Maclaurin symmetric mean (IVIFMSM) operator, a novel algorithm to evaluate the mental health status of poverty-stricken college students at present age with interval-valued intuitionistic fuzzy information is developed. In the end, an example is given to verify the developed approach and to demonstrate its practicality and effectiveness. In the future studies, we shall extend the proposed approaches and models to other domains and environment [57–67].

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